12th International Penguin Conference 2026

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Advancing global research, conservation and action

The 12th International Penguin Conference (IPC12) is a prestigious event that unites expert scientists, conservationists, environmentalists, students and communities from around the world. Together, we will share groundbreaking research, innovative conservation strategies, and actionable solutions to address the challenges penguins face in a rapidly changing world.

This conference fosters collaboration across disciplines, ignites meaningful dialogue, and inspires a global movement to protect penguins and the marine ecosystems they call home. Supporting this conference helps translate scientific knowledge into actionable policies and prioritises critical conservation actions.

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KEYNOTE SPEAKERS

Dr Beth Fulton

Dr Beth Fulton is a Chief Research Scientist at CSIRO Environment, helping lead the Integrated Ocean Stewardship Research Domain. For over 30 years, she has developed pioneering whole-of-system models like Atlantis to balance marine ecosystems, fisheries, aquaculture, and climate impacts. Her tools inform decisions for Australian and international agencies, from regional planning to UN bodies. An Adjunct Professor at the University of Tasmania's Centre for Marine Socioecology, she advances the blue economy. A Fellow of both the Australian Academy of Science and the Academy of Technological Sciences & Engineering, her work drives ocean sustainability.

Dr Akiko Kato

Dr Akiko Kato is a research engineer at the Centre d'Etudes Biologiques de Chizé (CNRS-La Rochelle University, France). Since the start of her career, she has used bio-logging techniques to study the ecology, behaviour, and physiology of seabirds, focusing on how they adapt to changing environments. She leads long-term bio-logging programs of Adélie and little penguins using advanced bio-logging tools and stays at the forefront of new data-logging technologies and analytical methods to deepen understanding of seabird responses to environmental change.

Prof Hugh Possingham

Professor Hugh Possingham FAA FNAS FRS is a distinguished conservation biologist and mathematician, renowned for his pioneering work in ecology, threatened species and conservation planning. He has held key academic and leadership roles, including Queensland Chief Scientist and Chief Scientist at The Nature Conservancy (USA). Hugh co-developed the influential Marxan software used globally for systematic conservation planning and has published over 760 peer-reviewed scientific papers. He is a Fellow of the Australian Academy of Science, the Royal Society, and a foreign associate of the US National Academy of Sciences, reflecting his significant contributions to environmental research and policy.

Dr Alistair Hobday

Dr Alistair Hobday works in CSIRO's Sustainable Marine Futures Program and is based in Hobart, Australia. His research projects have included documenting the impacts of climate change on marine biodiversity (including seabirds) and fishery resources, and developing, prioritising and testing adaptation options to underpin sustainable use and conservation into the future. He has worked in multi-disciplinary teams and seeks to support management and policy uptake of research via co-production with stakeholders. Alistair co-founded the International Marine Heatwaves Group and the Oceania Ecological Forecasting Initiative. In 2018, he received the Australian Society for Fish Biology's Lifetime Achievement Award, and in 2023, he was elected as a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE).

Dr Stephanie Jenouvrier

Dr Stephanie Jenouvrier is Senior Scientist at Woods Hole Oceanographic Institution whose research focuses on how climate change affects seabird populations, including but not limited to extreme oceanographic events. She uses demographic and computer modelling to study how extreme oceanographic events affect population dynamics and conservation outcomes. Stephanie's work contributes to understanding species' responses to global change and informs strategies for biodiversity conservation in a warming world.

Dr Thomas Mattern

Dr Thomas Mattern has spent two decades convincing penguins to wear increasingly sophisticated electronics – and building those electronics himself when necessary. A movement ecologist with a tech habit, he created the animal-borne PenguCam, uses drones to rethink seabird surveys, and is developing app-based community monitoring systems so humans can keep up, too. His research spans bio-logging, population dynamics, and the ways people interfere with wildlife. Although rooted in New Zealand's penguins, he also works with Humboldt and Magellanic penguins in South America. Thomas co-leads the long-term Tawaki Project and chairs the Tawaki Trust, championing Aotearoa's tawaki/crested penguins. As the Oceania representative of the Global Penguin Society, he also works across all of New Zealand's penguin species – including helping communities keep tabs on the breeding antics and foraging adventures of kororā/little penguins.

Adélie penguins as monitor of the marine environment

Dr Akiko Kato

Centre d'Etudes Biologiques de Chizé (CNRS-La Rochelle University, France)

Antarctica is uninhabited and remains the last continent not governed by any single country. Its natural environment is largely untouched and far removed from most human activities. Yet, Antarctica is not immune to global climate change. The Antarctic Peninsula is one of the fastest-warming regions on Earth and the extent of sea ice around Antarctica, is showing an overall declining trend despite considerable regional variability. In the Antarctic marine ecosystem, krill is a keystone species because of its large biomass and its role as food source for many predators. The Adélie penguin, a sentinel species widely distributed around Antarctica, feeds mainly on krill. Since 2010, we monitor their breeding, foraging behaviour and physiology on Petrel Island, East Antarctica. The aim of our project is to evaluate the long-term impact of changes in sea ice onto the foraging efficiency and breeding success of Adélie penguins. The population experienced two years of catastrophic breeding failure, in 2013/14 and 2016/17, during which none of the ca. 18,000 breeding pairs successfully raised a chick to fledging. These failures occurred after the calving of the Mertz Glacier in 2010, which altered the sea-icescape within the penguins' foraging grounds. Additionally, an increase of extreme weather events, such as increased precipitations, had severe consequences for chick survival. In this presentation, I will introduce additional results from our long-term study, highlighting how environmental changes are affecting Adélie penguins and the underlying mechanism through which these changes impact the penguins.

From linear foraging to seabed mining, from marathon to super-charged penguins - 25 years of penguin research in Aotearoa New Zealand

Dr Thomas Mattern

University of Otago, New Zealand

Aotearoa New Zealand hosts about one third of the world's penguin species, many of which are endemic. These range from the smallest - kororā/Little penguin - to one of the largest species - hoiho/Yellow-eyed penguin - with four species of crested penguin sprinkled in for good measure. Although these species span across three different genera, they have one unifying characteristic: they belong to the least known and least studied penguins world-wide. A core issue for penguins in New Zealand is that the majority of them live and breed in remote locations that are difficult and expensive to get to. However, another problem is certainly that with a population of 4-5 million people, there isn't a large enough pool of individuals crazy enough to want to work with penguins under local conditions. First student projects started in the late 1980s when one particularly foolhardy individual got a lecturer position at the University of Otago, although it wasn't until the turn of the millennium that more and more students started to take a closer look at New Zealand penguins. The advancements of microtechnology - or more specifically bio-logging devices - certainly contributed to this. It was now feasible for a student project to study species that not only spend most of their lives out at sea, but in fact below the surface. Over the past 25 years, much has changed; today we know considerably more about most of these once poorly-known species. The Yellow-eyed penguin today can even be considered one of the best studied penguin species world-wide. Yet, it still slowly but surely slides towards extinction. And for some of the other species like the Eastern Rockhopper or Erect-crested penguins - the picture isn't much rosier. This raises the question - why is that? Do we still not know enough about them? Or have we been studying the wrong aspects of their biology? So let's look back at the past 25 years of penguin research across all species in New Zealand, what we've learned, how it contributed to their protection, and how the comparatively late start means we are only now reaching the point where we know enough to act effectively - at a time when the conditions for doing so are becoming increasingly difficult.

From Prediction to Preparation: Forecasts for Proactive Penguin Conservation

Dr Alistair Hobday

CSIRO Hobart, Australia

Ocean extremes, particularly marine heatwaves (MHWs), can have profound impacts on marine ecosystems and the species that depend on them, including penguins and other seabirds. The risk posed by these events depends not only on their intensity and duration, but also on their proximity to breeding colonies, their overlap with key foraging habitats, and their timing relative to critical life-history stages such as pre-breeding and chick-rearing. As a result, MHWs provide both an immediate stress test for wildlife, managers, and coastal communities, and a window into the conditions that may become increasingly common under future climate change. Advances in seasonal forecasting now make it possible to predict MHW risk several months in advance in many regions of the world. These forecasts are already supporting the development of regional response plans and other adaptation measures that can help reduce ecological and socio-economic impacts. For penguin researchers and managers, early warning also creates opportunities to implement targeted monitoring, deploy additional field efforts, and design studies that capture ecological responses before, during, and after extreme events. With El Niño declared in July 2026 and global ocean temperatures tracking toward another exceptionally warm year, the likelihood of widespread marine heatwave conditions is high. Are we—and the penguins we study and manage—prepared for the ocean extremes ahead?

Not the Dove of Peace but the Penguin of Insight

Prof Beth Fulton

CSIRO Australia

Little penguins (Eudyptula minor) are among the best-studied seabirds in the Southern Hemisphere. Over the past year modelling studies have looked at the future of Australia's marine ecosystems, little penguins included. Delving into those models lets us ask does climate change help or hurt? In model world the answer is it depends – effects are mechanistically diverse, partially offsetting, strongly lagged, and above all site-specific. However, one thing is clear, conservation outcomes have been dominated by controllable local threats (predators, habitat, disturbance), while the slow beat of climate-driven stress is a slower-building, scenario-dependent tail risk. Whether that risk is felt in the near or far term depends on where you are and how fast shocks are encountered. Phillip Island is one of the most promising places for Little Penguins but even there questions remain. How do we support them through extreme events (like a bird flu outbreak)? How will the opposing effects of autumnal sea surface temperature (SST) and a strengthening gradient in Bass Strait SST and shape first year survival in coming decades? Models suggest that there are windows of hope. Little penguins have natural plasticity (e.g. diet switching after prey collapse) and with sufficient coastal productivity there is the potential for increasing double-brooding into the future. There will be surprises (such as the uptick in raven predation as foxes were removed) but there are some tangible places to start – nest-box design and watercraft-restrictions and a management logic build on "manage what you can control to buffer what you can't". As compounding pressures rise shocks create a more uncertain future as there is less time and capacity to rebuild. Models have a role in understanding when flexibility might fail and when increasingly interventionist responses may be required. In this way little penguins are a "model animal" for exploring what the future of coastal management and conservation might hold – species plasticity, cumulative effects, integrated planning, ecoengineering, regenerative practices translocation, passive guide versus active intervention might hold.

What 25 Years of Research Tell Us About the Future of Emperor Penguins in a Changing Climate

Dr Stephanie Jenouvrier

Woods Hole Oceanographic Institution, USA

For more than two decades, emperor penguins have served as a sentinel species for one of the most pressing questions in conservation biology: how will wildlife respond to a rapidly changing climate? Their life cycle is closely tied to Antarctic sea ice, making them particularly sensitive to environmental change. Understanding their future, however, has required bringing together expertise from field ecology, satellite remote sensing, climate science, mathematics, genomics, and conservation biology.

This presentation retraces a 25-year scientific journey that has continually been driven by new questions. Long-term demographic studies first revealed how changes in sea ice influence survival, reproduction, and population growth at a single colony. This naturally led to a broader question: if one colony faces a high risk of extinction, is the same true across Antarctica? Advances in satellite remote sensing then made it possible to monitor nearly every emperor penguin colony on the continent, allowing us to scale from local studies to continent-wide forecasts. We developed metapopulation models to investigate whether dispersal could rescue populations by enabling penguins to track suitable habitat as environmental conditions change. More recently, genomic data have provided new insights into connectivity among colonies, leading to improved forecasts of future population dynamics.

As our forecasts became more ambitious, so too did the challenge of uncertainty. We progressively incorporated uncertainty arising from climate projections, demographic processes, and model structure itself, culminating in a new eco-ensemble forecasting framework that integrates multiple climate models, demographic models, satellite observations, and genetic information. While individual projections differ, they all point to the same conclusion: under continued high greenhouse-gas emissions, emperor penguins are projected to undergo severe declines across Antarctica, whereas strong climate mitigation substantially improves their prospects for persistence.

These forecasts have contributed directly to conservation decisions, including the listing of the emperor penguin as Threatened under the U.S. Endangered Species Act and, more recently, as Endangered on the IUCN Red List. Finally, I will discuss the next frontier in ecological forecasting: can evolutionary adaptation alter these projections? Although motivated by research on emperor penguins, the interdisciplinary forecasting framework developed over the past 25 years provides a foundation for understanding the future of penguins—and, more broadly, how biodiversity may respond to rapid environmental change.

Why count penguins?

Prof Hugh Possingham

University of Queensland, Australia

Monitoring is essential for nature conservation, but many programmes are criticized for lacking purpose. We argue that monitoring delivers impact only when grounded in a clear theory of how activities lead to change. We clarify and categorize 15 distinct reasons to monitor within a theory-of-change framework, outlining how these can guide decisions about where to invest effort. These reasons fall into five groups: basic and applied research aimed at causal evaluation; monitoring integrated with on-ground actions; monitoring to inform policy; monitoring that strengthens enabling conditions for conservation; and curiosity-driven monitoring. Efforts to quantify the benefits of monitoring often focus on narrow, intervention-specific purposes, typically within adaptive management or evidence-based conservation approaches. However, much ecological monitoring serves functions beyond these frameworks. A broader perspective reveals additional, often overlooked, reasons to monitor, especially those that build the enabling conditions required for effective policy and practice. The benefits of these reasons for monitoring have rarely been articulated or quantified. Before designing a monitoring programme for penguin conservation, organizations should articulate a theory of change that makes their reasons for monitoring explicit. We provide a checklist of 15 reasons to support transparent logic, intentional design and clear links between monitoring information and improved policy or management outcomes.

Antarctic ParasiteNet: A global network on host-parasite interactions across Antarctica

Dr Meagan Dewar[1]

[1]Federation University Australia, Berwick, Australia

The Antarctic ParasiteNet Network aims to integrate and analyse existing sample sets and generate standardized data on parasite communities on a temporal and spatial scale across different Antarctic regions, establishing baselines, detecting trends, and guiding conservation efforts.

Key Objectives:

1) Assess the impact of climate change on parasite diversity and host-parasite dynamics;

2) Standardize protocols and integrate parasitological data into conservation frameworks;

3) Build capacity by training early-career researchers in fieldwork, analysis, and data sharing.

This network will create a robust, interoperable database of parasite-host records that supports early-warning systems and resilience assessments for ecosystems. By linking ecology, parasitology, climate science, and conservation, the project will provide a scalable model for biodiversity monitoring in vulnerable regions.

We invite members of the Penguin Community to join the network and this new global initiative. This workshop will provide potential members with an overview of the project and to begin discussions on moving forward with this project.

Improving Methods for Population Estimates and Identifying Research Priorities for Rockhopper Penguins

Dr Jeff White[1], Dr. Julie McInnes[2], Dr. Andrea Raya-Rey[3]

[1]Cornell University, United States

[2]Australian Antarctic Division, Australia

[3]CONICET, Argentina

In this workshop, we aim to bring together experts to discuss the need for accurate population estimates globally, regionally, and locally and identify research priorities for rockhopper penguins. Globally rockhopper penguins have been experiencing declines in recent decades, yet in many cases quantifying these population changes is difficult because of a lack of accurate population counts and inadequate surveying methods for these unique species. Unlike the many penguins which breed in large, open colonies, most rockhoppers breed in more cryptic locations. For example, in the South Pacific rockhopper colonies are often concealed by dense tussock, boulder fields, or caves making censuses difficult and often inaccurate. While sub-colonies have been well monitored (in some cases), the sharp decline seen across rockhoppers worldwide warrants a more comprehensive surveying methodology to quantify these losses and inform research priorities. By bringing together rockhopper experts working at diverse sites, we hope to facilitate discussions of what is currently working (or not) and brainstorm alternative methods. From our discussions we hope to identify research priorities for rockhopper penguins, particularly those related to population dynamics. Topics discussed and ideas will be compiled and made available to workshop participants following IPC 12.

International Penguin Early Career Scientists (IPECS) 6th Early Career Workshop

Alex Thornton[1,2], Ms Paula Wasiak[1,3], Ms Ruth Peacey[1,4], Mr Jeff White[1,5]

[1]International Penguin Early Career Scientists, International

[2]Fairybanks, Fairbanks, United States

[3]Australian National University, Canberra, Australia

[4]Independent Wildlife Conservationist, Producer, & Director, Portishead, United Kingdom

[5]Cornell University, Ithaca, United States

Early career researchers (ECRs) are central to the future of penguin science, yet their long-term engagement and retention depend on access to supportive, collaborative professional spaces. This workshop is organized by ECRs for ECRs, and focuses on evidence-informed approaches to strengthening ECR participation by fostering community, skill-building, and meaningful connections across career stages.

Drawing on more than a decade of experience developing international ECR networks in penguin science, the program emphasizes structured, participant-informed engagement that strengthens collaboration, conference participation, and career persistence:

- The workshop will open promptly at 9:00 AM with a behind-the-scenes experience at Phillip Island, introducing participants to local penguin research while providing opportunities for networking, icebreakers, and sharing their own research interests.
- Participants will then rotate through two interactive small-group workshops before and after lunch (available for purchase at the cafeteria): a professional development session exploring science communication, professional identity, conference engagement, and strategies for communicating research across diverse audiences; and a hands-on media training workshop where participants will practice on-camera interviews, receive individualized feedback, and develop skills for engaging with journalists and the public.
- A Penguin Science Panel will bring together researchers from academia, government, NGOs, and conservation organizations to discuss diverse career pathways, followed by an interactive discussion on navigating career transitions and building professional networks.
- The day will conclude with a collaborative recap, networking activities, and facilitated introductions designed to foster lasting connections throughout the conference and beyond.

Given the three-year interval between International Penguin Conferences, this workshop maximizes a rare opportunity for ECRs to build enduring international networks. Organized by an international team of ECRs, the program reflects participant needs while strengthening connections across the global penguin research community.

Please email earlycareerpenguins@gmail.com if you have any accessibility needs that we can work to accommodate or if you foresee any other potential barriers to equitable inclusion. To facilitate participation, organizers are coordinating private transportation as well as carshare options to the workshop venue at low cost; please contact us for details. This workshop will be offered in English, but we can work to translate materials in advance if we have proper notice.

Signals Before the Storm: detecting Early-Warning Signals of Regime Shifts in Penguin Populations

Ms Alice Eparvier[1], Dr André Chiaradia[2,3], **Dr Vincent A Viblanc**[1], Dr Claire Saraux[1]

[1]Centre National De La Recherche Scientifique, IPHC, UdS, Strasbourg, France

[2]Phillip Island Nature Parks, Cowes, Australia

[3]School of Biological Sciences, Monash University, Melbourne, Australia

Predicting penguin populations' future requires understanding their resilience to disturbance in marine and terrestrial habitats. While many environmental changes are gradual, ecosystems can also undergo abrupt, persistent reorganizations known as regime shifts. Identifying tipping points beyond which such critical transitions occur is therefore essential.

Detecting these thresholds is complex. Theory aimed at identifying early-warning signals (EWS) indicating when a system approaches a critical tipping point is well established, but empirical applications remain limited. The expansion of long-term ecological monitoring programs, many now spanning several decades, creates new opportunities to evaluate EWS in real populations.

Around 2008, the mega-colony of little penguins on Phillip Island, monitored over twenty-six years, experienced an abrupt transition suggestive of a critical transition. Breeding phenology advanced by ~6 weeks, double-brooding emerged in ~25% of birds, divorce rates reduced, and adult mass gain during foraging increased, leading to increased interannual variability in breeding success.

This dramatic shift, the starting point for Alice Eparvier's PhD project, raises the question of whether this pattern is specific of the Penguin Parade colony or a more regional/ global change affecting other populations. Can critical transitions across penguin populations be detected and anticipated through EWS?

In this workshop, we seek collaborators (1) monitoring other little penguin colonies to investigate the generality of this possible regime shift on a global level; (2) to expand the quantification of changes in penguin life-history traits to other penguin species: abrupt regime shifts vs. gradual trends; (3) to build a global network advancing analytical tools on EWS.

The Science Communication of Penguins: a new approach

Professor Lloyd Davis[1], **Dr Wiebke Finkler**[1]

[1]University of Otago, Dunedin, New Zealand

Two-thirds of penguin species are endangered in some way. We can document this with our research all we like but it will have little effect unless we can communicate the results of our science to the public and politicians in a way that moves them to action. In this workshop, we demonstrate a new approach to science communication that marries storytelling and design with marketing. We will show you how to "sell" your science and how that can evoke behaviour change. The workshop covers story structures that work, visual literacy, understanding your audience, and how to develop a campaign with the intention of producing behaviour change. While these are general techniques that can be applied to nearly all science communication, we make it particularly relevant to this conference by applying these techniques using instances of penguin conservation as exemplars.

Trouble-shooting terrestrial predation at mainland African Penguin colonies: towards evidence-based mitigation

Dr Lisa Nupen[1], Mr Albert Snyman[1]

[1]SANCCOB, Cape Town, South Africa

Terrestrial predation is an emerging and urgent threat to African Penguins, especially at mainland colonies in South Africa, which now support ~20% of the global population. While island colonies give refuge from land-based predators, sites like Stony Point and Simon's Town near Cape Town experience increasing predation by inter alia caracal, mongoose, and Kelp Gulls. Between 2017 and 2025, >650 suspected predation cases were recorded at SANCCOB, with caracal predation disproportionately affecting adults, mongoose predation impacting chicks, and gulls taking eggs. Intensifying predation pressure, including confirmed surplus killing events by caracal, poses a significant risk to already declining populations of this Critically Endangered species.

Evidence from other systems, such as puma predation on Magellanic Penguins in Argentina, demonstrates how predictable, seasonal prey aggregations can alter predator behaviour and drive repeated exploitation. Similar dynamics may be occurring at mainland African Penguin colonies, yet predator behaviour, movement ecology, and the effectiveness of mitigation interventions remain poorly understood.

We propose an interactive workshop to develop and refine an evidence-based framework for terrestrial predator management. The workshop will focus on peer-learning, experimental design and methodological approaches to test mitigation strategies, including predator-proof fencing (planned for 2026–2028), deployment of camera trap arrays, and the use of collars to track caracal movements and identify high-risk periods and locations. Collaring provides a non-lethal, adaptive management tool to predict and prevent predation events, assess post-capture behavioural responses, and inform trap placement and fence design.

Additional approaches, including aversive deterrents (e.g., scent cues, guardian animals, hazing), will be discussed.

What Works for Banded Penguins? Translating Science into Effective Conservation for African and Humboldt Penguins

Dr Patty McGill[1], Dr. Susana Cárdenas-Alayza, Dr. Alistair McInnes, Dr. Lauren Waller

[1]National Aviary, United States

Banded penguins are among the most threatened seabirds globally, with both African (Spheniscus demersus) and Humboldt penguins (S. humboldti) undergoing rapid population declines. African penguins have declined by ~80% over the last three decades, largely driven by prey depletion linked to climate variability and industrial fishing. Similarly, Humboldt penguins along the coasts of Peru and Chile face sustained declines due to fisheries interactions, habitat disturbance, climate variability (including El Niño), and emerging threats such as disease.

Despite decades of research and conservation action, population trajectories remain negative, raising a critical question: which conservation strategies are truly effective, scalable, and resilient under changing ocean conditions?

This workshop will bring together researchers, practitioners, and policymakers to synthesize lessons learned across the range of banded penguins, focusing on African and Humboldt penguins. We will highlight evidence from long-term monitoring programs, experimental management interventions, and cross-sector collaborations in Peru, Chile, and southern Africa. Key themes include: (1) fisheries management and spatial protection (e.g., no-take zones, bycatch mitigation); (2) colony-based interventions e.g. predator control, artificial nests, disturbance reduction; (3) adaptive monitoring frameworks linking oceanographic variability to demographic responses; and (4) roles of governance, stakeholder engagement, and international partnerships in sustaining conservation outcomes.

Participants will engage in interactive discussions to identify best practices, knowledge gaps, and priority actions. The workshop will (1) produce a concise policy brief summarizing evidence-based recommendations for decision-makers, and (2) establish an international working group on banded penguin conservation to facilitate ongoing collaboration, data sharing, and coordinated action across regions.

Oral

A Multi-Use Noninvasive Fecal Sampling Approach for Hormone, Microbiome, and Genetic Sex Monitoring in African Penguins (Spheniscus demersus)

Dr. Susan Smith[1], Danielle Lavoie[1], Dr. Tracy Romano[1]

[1]Mystic Aquarium, Mystic, United States

The African penguin (Spheniscus demersus) is a critically endangered species experiencing continued population decline due to environmental and anthropogenic stressors. To support expanded conservation monitoring, this study evaluated noninvasive fecal sampling in African penguins under professional human care at Mystic Aquarium (CT, USA). Over a one-year period encompassing both breeding and molting cycles, fecal samples were analyzed to assess relationships among reproductive hormones (testosterone, estradiol, progesterone), thyroid hormones (triiodothyronine [T3] and thyroxine [T4]), and corticosterone metabolites. In addition to hormone profiling, this study demonstrated that the same fecal sample can be used for microbiome sequencing and genetic sex determination. Following full validation of hormone assays, results revealed expected seasonal trends, with reproductive hormones elevated during breeding season and thyroid hormones peaking during molt. Corticosterone metabolite levels increased in response to veterinary examinations but returned to baseline within 48 hours, supporting their utility as indicators of short-term stress. Microbiome sequencing identified a core microbial community consistent with other S. demersus populations, suggesting strong host phylogenetic influence. Reduced microbial diversity and signs of dysbiosis were observed in individuals experiencing illness or molting complications. Additionally, fecal DNA enabled successful amplification of the CHD1 gene, allowing accurate in-lab sex determination of adult and chick S. demersus. Collectively, these findings validate a streamlined, noninvasive approach to simultaneously assess physiology, health, and sex in African penguins. This methodology is being extended to wild populations to investigate diet, health, and estimate sex ratios, with the goal of enhancing comprehensive conservation monitoring for this critically endangered species.

A novel, localised cellulitis syndrome in African Penguins (Spheniscus demersus) during catastrophic moult

Mr Albert Snyman[1], **Dr David Roberts**[1], Dr Lisa Nupen[1]

[1]SANCCOB, Cape Town, South Africa

Since 2022, a novel and severe condition termed cellulitis syndrome has emerged in wild African Penguins (Spheniscus demersus) on Robben Island, South Africa. The syndrome is highly seasonal (austral summer), strongly localised to a single beach, and predominantly affects adult penguins (72%) approaching, undergoing, or recently completing their annual catastrophic moult.

Moult represents a critical physiological bottleneck, characterised by fasting, hormonal shifts, and reduced immunocompetence. Increasing environmental pressures may exacerbate vulnerability to local stressors during this period. The spatial clustering of cases suggests a site-specific environmental driver threatening a rapidly declining colony (684 breeding pairs).

Clinically, affected penguins present with severe subcutaneous oedema of the legs and tail, vesicular and pustular dermatitis, and marked emaciation often masked by fluid accumulation. Secondary complications frequently include pododermatitis, respiratory disease, and septicaemia.

During the 2024–2025 summer, 67 cases were recorded (61 from Robben Island), with a mortality rate of 39% (n = 26) despite intensive treatment. Recurrence in late 2025 confirmed persistence of the syndrome, with some individuals deteriorating and dying within 24 hours of admission.

Diagnostic investigations, including bacteriology, histopathology, endocrinology, and environmental sampling, indicate a multifactorial process. Multi-drug resistant bacteria (e.g., Enterobacter spp.) were likely opportunistic. Findings suggest systemic metabolic and immune dysfunction, with hyperplastic goitre in some cases indicating possible exposure to endocrine-disrupting compounds.

This syndrome highlights how catastrophic moult may increase susceptibility to localised environmental threats, underscoring the need to identify and mitigate site-specific drivers in endangered seabird populations.

A penguin epigenetic clock and its application to demography

Dr Robin Cristofari[1], Dr Céline Le Bohec, Dr Klemens Pütz, Mrs Mikaela Hukkanen, Ms Sofia Westerlund, Dr Simon Jarman, Ms Maite Arriagada, Ms Aurora Fernandez Duran, Dr Juliana Vianna

[1]University Of Helsinki, Finland

A persistent difficulty when studying penguin population dynamics and dispersal is their longevity: gathering complete vital rate information essentially takes decades of hard work, which makes the study of small/isolated/newly threatened colonies extremely challenging.

Here, we present an inexpensive and simple PCR-based epigenetic assay derived from our work on the evolution of ageing in birds. This assay currently allows us to infer the age of an individual penguin within <10% of its longevity (2.5 years for a King penguin), thus enabling the construction of an unbiased age pyramid in a cross-sectional way in any given population.

Coupled with a short-term CMR experiment, such data allows the inference of local population dynamics, and can detect the role of positive migration flux in sustaining local demography. We demonstrate through an application to a small, newly formed population of King penguins on the leading edge of their colonisation range, in Tierra del Fuego.

We also underline the possible application of this new methods to central issues such as estimating the impact of fisheries bycatch on population vital rates.

A Prototype Automated Population Counter for Magellanic Penguins Using Thermal Drone Imagery and Machine Learning

Dr Brett Buzzanga[1]

[1]Conservation Technology Accelerator, Los Altos Hills, United States

Wildlife population monitoring remains heavily dependent on manual survey methods that are labor-intensive and difficult to scale, limiting census frequency, spatial coverage, and the quality of long-term datasets. Magellanic Penguins (Spheniscus magellanicus), a keystone species in Patagonia with an estimated 1.1–1.6 million pairs, exemplify this challenge: surveys typically require researchers to walk colonies and conduct direct nest counts, while larger colonies are estimated using aerial imagery and extrapolation. Both approaches involve trade-offs in accuracy and substantial logistical effort.

To address this, we developed a prototype penguin counting service through a collaboration with the Global Penguin Society (GPS). The system uses enterprise-grade drone platforms equipped with LiDAR and thermal sensors flying optimized paths over active colonies. Field campaigns in 2024 and 2025, conducted with GPS, provided ground-truthed data for training and validating a custom machine learning detection algorithm. Tested across three colonies, the model achieves approximately 15% uncertainty, demonstrating proof-of-concept feasibility.

Our approach complements traditional methods by improving count accuracy while reducing human, logistical, and financial demands. We present the system architecture, field methodology, and validation results, and outline a pathway toward operational deployment. Planned 2026 fieldwork will expand training data across colonies to reduce uncertainty and support reliable repeat monitoring. This work highlights how integrating remote sensing and artificial intelligence can enable scalable, repeatable population surveys for conservation.

A Winter's Tail: Feather amino acid isotopes identify contrasting seasonal trophic niches in two Antarctic penguins with differing migration strategies

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Penguins act as sentinels of the ecosystem effects of climate change and fisheries in the Southern Ocean. However, most diet studies have focused on the summer breeding season, and little is known about these species' diets during the winter. Bulk tissue stable isotopes analysis has been used to infer penguin diets during the non-breeding season but often cannot distinguish shifts in a penguin's diet (i.e. what it eats) from geographic or temporal variation in baseline isotopic values (i.e. where and when it is eating). We resolve this uncertainty using the isotopic analysis of amino acids to compare the breeding (chick rearing) and non-breeding (winter) trophic niches of Adélie (Pygoscelis adeliae) and Chinstrap (P. antarctica) penguins from the South Shetland Islands, Antarctica while explicitly accounting for varying isotopic values at the base of the food web. We found that both species had trophic positions (3.3-3.4) reflective of krill consumption during the chick rearing period. However, trophic position was higher in Chinstrap penguins (4.0), relative to Adélie penguins (3.1) during the winter. Trophic positions also differed between Chinstrap penguins wintering in the Scotia Sea (3.6) vs. the Pacific sector of the Southern Ocean (4.0). These results suggest that estimates of penguin diets and krill consumption from the breeding season may not be necessarily reflective of the trophic niches of these species year-round and underscores the need to quantify winter ecology when using Antarctic marine predators as sentinels of environmental change.

African Penguin mutual display song playback encourages breeding behaviour: implications for conservation

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African penguins (Spheniscus demersus) are highly vocal, burrow-nesting seabirds, though detailed studies on the structure and function of certain vocalisations remain limited. The Mutual Display Song (MDS), which is produced jointly by both partners of a bonded pair, has received little attention in past research. While early descriptive studies focussed on the birds recognised the MDS's connection to pair interactions and its socially contagious nature, its functions have never been tested experimentally. During the 2025 and 2026 breeding seasons, at the Stony Point Penguin Colony in South Africa, we exposed African Penguin pairs at the nest to playback of stranger MDS, stranger Ecstatic Display Songs (EDS, common during the breeding season to attract mates and defend territory), and white noise. We further monitored their responses based on the type of stimulus and the duration of the stimulus presented. We found that couples exposed to playback of MDS of other pairs showed a strong trend towards exhibiting nest-related behaviours (such as nest scraping and collecting nest material), courtship behaviour, and copulation, while such reactions were nearly absent in response to EDS and white noise treatments. Therefore, beyond its putative intra-couple function, the MDS might also be a specific acoustic stimulus serving to synchronize nest behaviour, courtship, and copulation among neighbouring couples. This opens up new possibilities for future conservation efforts, which might include MDS playback on a colony level to encourage nest building and copulation in not only the Critically Endangered African Penguin, but other nesting penguin species as well.

AI comes of age to integrate timelapse monitoring with population counts

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Rapidly shifting environmental conditions across the Antarctic Peninsula are driving rapid changes in pygoscelid penguin populations, yet our ability to understand the mechanisms underpinning these trends remains constrained by the logistical challenges of large-scale demographic monitoring. Networks of time-lapse cameras deployed across dozens of colonies have already demonstrated the capacity to capture breeding phenology shift in response to localised warming. We present a framework in which AI-assisted automated counting of time-lapse imagery moves reproductive success monitoring from labour-intensive, site-limited ground surveys to a scalable, near-continuous data stream. Crucially, we show that these phenological shifts carry within- and between-season carryover effects, suggesting that first-order climate impacts may cascade through successive breeding seasons. Finally, we apply a spatial leverage analysis to identify where targeted deployment of additional monitoring stations would most reduce uncertainty in regional demographic estimates. Breeding propensity in particular appears to be driven by local environmental factors, and its spatial autocorrelation structure across the South Shetland Islands and western Antarctic Peninsula suggests that strategically placed stations could yield disproportionate inferential gains. We invite collaboration to prioritise these data gaps and build towards a peninsula-wide demographic monitoring network fit for the pace of current environmental change.

An integrated database for Tasmanian Little Penguins

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Little Penguins Eudyptula minor breed on many coastal areas around the Tasmania and on offshore islands. Other than limited preliminary surveys in the 1970s to the mid-1990s, there have been very few censuses since, primarily at a few easily accessible sites. The anthropogenic threats to Little Penguin survival are increasing rapidly in their intensity, duration, frequency and diversity. Primary threats are the loss of nesting habitat from expansion of human occupation, increasing mortality from dog and cat predation, and drowning in recreational gill-nets. Emerging threats arising from climate change are changes in penguin prey species and increasing rates of coastal erosion. Management of anthropogenic threats is critical to Little Penguin survival in Tasmania. Fundamental to all management efforts is contemporary knowledge on the status, distribution and trends in breeding populations. We are presently consolidating all survey and monitoring data, and reports of fatalities from anthropogenic sources into a single data structure, including data sets from targeted research. This integrated approach will facilitate holistic assessments of population trends, threats and efficacy of management efforts throughout Tasmania.

Antarctic Site Inventory: 32 years of counting penguins in Antarctica

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The Oceanites Antarctic Site Inventory (ASI) presents three decades of continuous penguin population monitoring across the Antarctic Peninsula, one of the most rapidly warming regions on Earth. Since 1994, the ASI has systematically surveyed breeding populations of Adélie (Pygoscelis adeliae), chinstrap (P. antarctica), and gentoo (P. papua) penguins at over 200 sites spanning from the South Shetland Islands to the southern reaches of the Peninsula, compiling the most geographically comprehensive long-term dataset of its kind.

Over 32 years, our data reveal striking and divergent population trajectories among sympatric Pygoscelis species that reflect the uneven fingerprints of climate change and ecosystem disruption. Adélie and chinstrap penguin colonies in the northern and western Peninsula have experienced significant declines—in some sites exceeding 50%—coinciding with reduced sea-ice extent, altered krill availability, and increased precipitation events. In contrast, gentoo penguins have demonstrated remarkable range expansions southward, with breeding populations established at sites where the species was previously absent, consistent with a generalist foraging strategy and tolerance of ice-reduced conditions.

Long-term trends point to structural ecological change rather than natural cyclical fluctuation. Site-level analyses further highlight the heterogeneity of local responses, cautioning against peninsula-wide generalizations.

These findings underscore the value of sustained, broad-scale field monitoring in detecting ecological change. We discuss implications for penguin conservation status, Antarctic protected area management, and the use of penguins as sentinel indicators of Southern Ocean ecosystem health.

Beyond individual personality traits: Behavioural syndrome in little penguins

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Animal personality (consistent differences in behaviours among individuals of the same species) and behavioural syndromes (the correlation of personality traits within individuals) are increasingly recognised as key drivers of ecological and evolutionary processes. However, their prevalence and potential fitness consequences in long-lived marine species remain poorly understood. This is particularly important for seabirds as they must navigate highly variable and unpredictable environments, in which personality could shape foraging strategies, risk tolerance, and/or reproductive investment. Here, we quantified three personality traits (boldness, exploration, and aggressiveness) in Australian little penguins (Eudyptula novaehollandiae) to test for the presence of a behavioural syndrome. We measured boldness at the nest towards a simulated predator intrusion and exploration towards a novel object (neophilia) in both adults and chicks. In adults, we also measured aggressiveness towards a simulated conspecific using playback experiments. We found a moderate correlation between personality traits in both adults and chicks. The presence of a behavioural syndrome at the chick stage suggests that these personality traits may be under similar developmental or genetic constraints, indicating that behavioural strategies may develop prior to environmental or selective pressures.

Bridging the Gap: Leveraging Ex Situ Expertise for In Situ Penguin Conservation

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Bridging the Gap: Leveraging Ex Situ Expertise for In Situ Penguin Conservation

The conservation of penguin species requires a multidisciplinary approach to address complex environmental stressors. The One Plan Approach advocates for combining management strategies and conservation actions across in-situ and ex-situ populations to enhance conservation efforts. This presentation explores the advantages of partnering with institutions accredited by the Association of Zoos and Aquariums to enhance conservation impact. These institutions provide a range of expertise including specialized veterinarians, geneticists, population biologists and animal care specialists. Recognizing zoos and aquariums as key players and stakeholders, can develop alignment in conservation actions funneling funds and resources to specific conservation actions to increase support. AZA institutions also reach broad audiences, enabling behavior change messaging to be communicated at scale. Drawing on examples of successful collaboration between ex situ and in situ programs, this presentation highlights practical frameworks for integrating field research and zoological expertise to support the long-term viability of penguin populations.

Catastrophic decline in a super colony of little penguins

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Little penguins, Eudyptula minor, are a locally abundant seabird breeding in complex habitats on islands around southern Australia, yet their population trends are largely unknown because population estimates for about 60% of colonies are data deficient. Such assessments are vital at a time when marine environments in south-eastern Australia have been identified as a global warming hotspot, driving changes which are expected to affect penguin colonies.

We developed density surface models combining distance sampling surveys with spatial covariates from remote sensing datasets to estimate the detectability and density of active burrows in large colonies. We validated the generalisability of the model to provide rapid population assessments requiring minimal fieldwork and applied it at one of the largest little penguin colonies in the world, Gabo Island in far eastern Victoria, in 2012, 2021 and 2023.

Results indicate the colony has suffered a catastrophic decline from 26,200 (95% CI: 22,400 – 30,800) active burrows in 2012 to 1770 (1170 – 2700) and 1,600 (1,100 – 2,400) active burrows in 2021 and 2023 respectively; less than 6% of the colony remaining. We explore the environmental conditions that may have driven the colony decline including rising sea-surface temperatures, habitat degradation and predation. We also describe the utility and potential biases of the DSM approach to allow rapid assessments of penguin colony size at other colonies in the region which are data deficient and whose population trends are unknown.

Climate Lags Matter: SST Anomalies Drive Stage-Specific Shifts in Humboldt Penguin Breeding

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Effective conservation and fisheries management depend on understanding how climate variability affects key species. In the highly productive yet climate-sensitive Humboldt Current System, fluctuations in sea surface temperature (SST), particularly during El Niño events, can alter food availability and disrupt breeding in top predators such as the Humboldt penguin (Spheniscus humboldti). However, the drivers behind the observed decline in nest numbers at Punta San Juan over the past decade remain unclear. We analyzed a 25-year dataset of Humboldt penguin breeding activity in Peru, including active nests, roosting adults, and nests with chicks. Using generalized additive models, we quantified phenological metrics—breeding onset, peak, end, and duration—and evaluated their relationship with SST anomalies (SSTA) at multiple time lags (0, 3, 6, and 9 months). We tested both linear and non-linear responses and used AIC-based model selection to identify the most relevant temporal relationships. Results showed no consistent long-term trend in breeding timing, but strong interannual variability. Breeding onset and duration for active nests and roosting adults were significantly associated with SSTA 3–6 months prior, underscoring the importance of pre-breeding environmental conditions. In contrast, nests with chicks exhibited a more limited response, with only peak timing linked to SSTA at a 3-month lag. Importantly, the peak number of nests with chicks declined over time and was negatively associated with warmer SSTAs 3–6 months prior, suggesting reduced reproductive output under warmer conditions. Understanding these mechanisms is critical for predicting population dynamics and informing conservation strategies in a rapidly changing marine environment.

Comparison of Fine-scale Breeding and Molt Data to Reveal Population Change in Humboldt Penguins in Peru

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Annual molt censuses of Humboldt penguins have taken place on important sites in coastal Peru since 2000. Over the years, counts show a positive trend between 2000-2015 and a negative trend since. Arising from the workshop on censusing Spheniscus penguins at the last IPC, there is currently discussion on best, preferred technique(s) to reflect population abundance. Punta San Juan (PSJ) has traditionally been the most significant breeding colony in Peru. Importantly, it is the only site in the annual molt census that also has over one-quarter century of data collection on Humboldt penguins, including molt and breeding counts. This paper compares results of censusing Humboldt penguins at one key site, PSJ, using breeding season counts vs molt counts from 2000-2025. The presentation will also discuss factors affecting each set of results and key patterns that can be seen. For example, in all years, the counts are within range of each other, yet in some years the breeding count is higher whereas in other years molt count is higher. Both methods yielded low counts in 2000, shortly after the severe 1997-98 ENSO. It is alarming to see that counts from PSJ in 2025 using both methods are even lower than 2000; the reasons are not fully known. However, because molt counts include significant sites all along coastal Peru, the overall molt census shows a distinct shift northward for Humboldt penguins. Thus, continued molt census reveals a broad scale pattern that is not detected at the fine scale of individual sites.

Constructing gentoo penguin food webs for ecosystem monitoring: seasonal shifts in diet and network structure at Macquarie Island

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Understanding how marine predator diets vary across space and time is central to detecting ecosystem change, yet translating high-resolution dietary data into effective monitoring tools remains challenging. Here, we quantify inter- and intra-annual diet variability of gentoo penguins at Macquarie Island using DNA metabarcoding and ecological network analysis to detect spatial and temporal change for ecosystem monitoring.

Diet was characterised across six years, three breeding sites, and within seasons, enabling assessment of spatial and temporal variation across ecological scales. This represents the first study to compare the diet of gentoo penguins across North, South, and West breeding sites on Macquarie Island over multiple seasons. Across all locations, Zanclorhynchus spinifer was the dominant fish species, contributing the highest proportional share of any prey. However, its contribution varied temporally, with reduced proportions in the North during 2022/23 (<1% overall diet proportion), where Gymnoscopelus piabilis and Electrona subaspera became dominant, alongside increased cephalopods and amphipods.

A total of 51 predator–prey networks were constructed across all combinations of site, season, month, and sex, and network metrics sensitive to ecological change were calculated. Food web structure varied spatially. In contrast, traditional diet indices showed limited spatial variation but captured temporal changes across seasons and months, demonstrating complementary ecological insights.

Our findings highlight the importance of spatial and temporal sampling design when assessing localised change. Using gentoo penguins as a case study, we provide recommendations for applying DNA metabarcoding and ecological network approaches to support the use of penguins as ecosystem monitoring tools.

Cumulative effects of extreme events on little penguin (Eudyptula minor) foraging performance in a global warming hotspot

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Understanding animals' responses to climate extremes is essential for effective conservation, as climate change drives more frequent and intense extreme climatic events (ECEs), such as heavy rainfall, strong winds, and marine heatwaves (MHWs). In climate-change hotspots like southeastern Australia, ocean warming exceeds the global average. However, important gaps remain in understanding how single and cumulative ECEs affect resident species. We assess how MHWs and extreme winds influence little penguin performance over short timescales by altering prey availability and accessibility. We use a 32-year time series (1993-2025) of sea surface temperature and wind speed to detect MHWs and extreme wind events in the penguin foraging zone in the Bass Strait, Australia. MHWs have increased in frequency and intensity in the area, while no clear trend emerged for extreme wind events. We then linked these events to long-term records of daily little penguin performance for the Phillip Island mega colony, analysing attendance patterns and foraging efficiency, and quantifying the temporal lags and persistence of effects. Ongoing analyses are assessing potential cumulative effects when these events occur in close succession. The MHW effects emerged around 10 days after peak intensity, with a surprising increase in attendance, reflecting delayed changes in prey availability and accessibility. In contrast, extreme winds caused an immediate decline following peak wind days, consistent with short-term deterioration of foraging conditions. These contrasting responses indicate that marine heatwaves and extreme winds affect penguin behaviour through different temporal pathways, with potential long-term consequences for population resilience under increasing frequency of climate extremes.

Declining Humboldt penguins in Chile: trends, possible causes and future perspectives

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Half of the world's 18 penguin species are currently threatened, and 12 of them exhibit decreasing populations. In the southeastern Pacific, the Humboldt Penguin occurs exclusively from northern Peru to southern Chile, where it is regionally classified as Endangered due to declining populations. To characterise the long-term population trends in the Chilean population of Humboldt penguins, we analysed the data available for the period 1980-2025. We considered only data reporting the maximum number of breeding pairs for a specific colony and specific year, obtained through direct counts. To derive population trends, we used a Bayesian count model with weakly informative priors. We obtained data for seven colonies along the Chilean coast, ranging from 26° to 33°S. Together, these colonies accounted for ca. 8,000 pairs during the 1980s but only ca. 2,000 pairs during the 2020s, suggesting a 75% decline in 40 years (ca. three generations). During the study period, four colonies (Pan de Azúcar, Chañaral, Huevos and Pájaro Niño) declined at average rates of -5.1 to -8.1% per year, with the largest absolute losses occurring during the 1980s and 1990s. The remaining colonies (Choros, Pájaros and Cachagua) showed no clear tendencies. We discuss the roles of some relevant threats, including interactions with fisheries (mortality and resource competition), alien species and, most recently, disease outbreaks. We also discussed how the use of different methodologies has contributed to the overestimation of the population of this species. Financial support was provided by Sphenisco e.V. (Germany) and Universidad Andrés Bello (Chile).

Determinants and consequences of pair bond disruption in little penguins

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For better or worse? Determinants and consequences of divorce in little penguins

Mate fidelity and divorce are common features of seabird breeding systems, yet whether mate switching is adaptive or arises from environmental stochasticity that disrupts pair bonds remains largely unresolved. In seabirds, poor breeding performance after partner change—the so-called "first-year bond syndrome"—may mask potential benefits of divorce unless long-term outcomes are considered. Using a 23-year longitudinal study of individually marked little penguins (Eudyptula minor), we examined the environmental and individual drivers of divorce and its short- and long-term fitness consequences. Divorce rates varied strongly among years, ranging from 2 to 38%, and were higher following poor breeding seasons and during more synchronous breeding years, indicating a key role for environmental conditions but also tentative mate availability in pair-bond disruption. At the pair level, divorce probability declined sharply with increasing pair-bond experience, particularly among pairs with a history of breeding failure, while individual age, foraging performance, and phenological mismatch played a minor role. Divorce was weakly repeatable among individuals. Contrary to expectations of short-term costs in seabirds, fledging success increased immediately after divorce, reaching levels similar to faithful birds and exceeding those of widowers, without delaying breeding phenology. However, divorce propensity had no effect on longevity or lifetime reproductive success. Together, these results suggest that seabird divorce is environmentally driven, moderated by pair familiarity, and yields short-term but not lifetime fitness benefits.

Diet–microbiome shifts and disease resilience in endangered hoiho (yellow-eyed penguins)

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Hoiho (yellow-eyed penguins; Megadyptes antipodes) are classified as Nationally Endangered (NZTCS), with the Northern Aotearoa population declining by 83% over the past 15 years and projected to become functionally extinct within decades. This decline coincides with increasing disease incidence, mass mortality events, starvation, fisheries interactions (set netting and bottom trawling), and climate change. In contrast, tge two Southern sub-Antarctic populations on Enderby and Campbell Islands - long considered a species stronghold - remain chronically understudied.

The major hypothesis of this research is that fisheries-driven shifts in prey availability are altering diet and, in turn, gut microbiome composition, with consequences for host health and disease resilience. In the 1980s, studies indicated mainland hoiho diets were dominated by small pelagic fish (e.g., sprat and juvenile red cod), whereas recent observations suggest a shift toward larger benthic species such as blue cod.

We analysed over 500 faecal samples from all three populations (sampled between 2017–2024) using shotgun metagenomics to characterise diet and gut microbiomes. Microbiome composition was significantly structured (PERMANOVA, $R^2 = 0.133$, $p = 0.001$), with variation associated with population, life stage, age class, and year.

These patterns align with observed dietary shifts and support a link between dietary change and microbiome restructuring, with potential implications for disease susceptibility and conservation management.

Divergent responses of rockhopper penguins to extreme oceanographic variability

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Marine heatwaves and cold spells are intensifying under climate change, yet their cascading effects on top predators remain poorly understood. We examined how these events influence the breeding biology and non-breeding ecology of rockhopper penguins (Eudyptes chrysocome), emphasizing the need to align environmental variability with species phenology and demographic responses before drawing conclusions.

We analyzed winter dispersal tracks from two subpopulations—Falkland (Malvinas) Islands (1998, 1999, 2000, 2016) and Staten Island (2002, 2003, 2016)—and compared movement patterns and oceanographic conditions. Trip duration and distance were consistent within colonies across years, but oceanographic environments varied markedly. During baseline years, penguins encountered relatively stable sea surface temperature (SST) conditions and showed consistent directional movement. In contrast, 2016 was characterized by the strongest negative SST anomalies recorded during winter dispersal, linked to a prolonged regional cold spell.

At both colonies, SST anomalies in 2016 were significantly lower than in all other years. Falkland birds also experienced positive SST anomalies prior to winter, creating a thermal contrast that may have increased energetic demands. In 2016, penguins from both colonies showed more dispersed, less directional movements, suggesting disruption of typical behavior. Models indicated that colony identity in 2016 was primarily explained by SST rather than movement metrics, highlighting colony-specific sensitivity to oceanographic forcing.

Do ecological niche models predict abundance? Insights from spatial structure, oceanography, and genetics in Antarctic penguins

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Understanding the extent to which ecological niche models (ENMs) capture biologically meaningful properties of species distributions remains a key challenge for predicting responses to climate change. Although ENMs are widely used to estimate environmental suitability and forecast species distributions, their ability to predict population attributes such as abundance remains uncertain. Here, we assess how climate-driven changes in environmental suitability may influence the distribution and spatial patterns of abundance in four Antarctic penguins: Adélie (Pygoscelis adeliae), Chinstrap (P. antarcticus), Gentoo (P. papua), and Emperor (Aptenodytes forsteri), by evaluating the relationship between environmental suitability, colony abundance, and genetic diversity.

Using data from MAPPPD, we test the niche centroid–abundance hypothesis by quantifying the relationship between environmental suitability and colony abundance across two time periods (1970–2000 and ≥2000). We then evaluate whether processes operating at different spatial scales improve model performance, including oceanographic features associated with prey availability (coastal polynyas and submarine canyons) and spatial structure among colonies. Finally, we examine the association between environmental suitability and genetic diversity (π) across published genetic datasets, as a potential indicator of longer-term demographic processes.

Preliminary results indicate that environmental suitability alone shows limited explanatory power for abundance, whereas models incorporating spatial structure and colony density perform better. In Emperor penguins, oceanographic variability appears to play a stronger role. These findings highlight limitations of ENMs for predicting abundance and emphasize the importance of integrating spatial and environmental processes to improve predictions under climate change.

Do Humboldt penguins forage differently across colonies? A multi-site tracking study

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Understanding spatial variation in foraging behavior is essential to evaluate how seabird populations respond to environmental variability and human activities. We investigated the at-sea movements of chick-rearing Humboldt penguins (Spheniscus humboldti) across three colonies in southern-central Peru using GPS dataloggers: Melchorita (MEL), Chincha Norte Is. (CHN) and Punta San Juan (PSJ). This study represents the first multi-colony assessment of foraging ranges and core use areas for this species within the Humboldt Current System. Colony-specific differences in movement patterns were evident, including variation in maximum foraging range (MEL= 24 km, CHN = 28 km, PSJ = 30 km) and spatial concentration of core use areas (MEL= 18 km2, CHN = 52 km2, PSJ =136 km2). Across colonies, penguins exhibited predominantly coastal foraging strategies, with most activity occurring relatively close to breeding sites. Core areas were spatially structured and frequently overlapped with zones used by artisanal and commercial fisheries. These patterns suggest that potential interactions with fisheries are likely to be localized and colony-specific. By providing the first comparative framework of Humboldt penguin foraging ecology across multiple colonies in Peru, this study offers new insights into the spatial ecology of the species and its exposure to human activities. The spatially explicit nature of these data provides a valuable basis for identifying priority areas of use and understanding how penguins interact with heterogeneous marine environments. These findings highlight the importance of incorporating colony-specific dynamics into conservation planning and fisheries management within the Humboldt Current ecosystem.

Drone–AI approaches for monitoring remote penguin colonies at Heard Island and McDonald Islands

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Monitoring penguin populations on remote sub-Antarctic islands remains a challenge. The Heard Island and McDonald Islands (HIMI) are among the least accessible regions in the Southern Ocean, resulting in substantial gaps in population data for breeding penguins. We applied a combined drone and artificial intelligence (AI) approach to survey penguin colonies during two research voyages in the austral summer of 2025/26. Drone operations were conducted from both vessel and shore, enabling coverage of much of the ice-free coastal areas where penguins breed. In total, surveys comprised more than 120 flights, exceeding 54 hours of flight time and covering over 1,600 km. Imagery was processed using AI-based detection and classification tools to identify and enumerate penguins, providing rapid and standardised population estimates for some species. This approach led to the identification of previously undocumented colonies and delivered a rare insight into penguin populations on McDonald Island. Our findings demonstrate that drone–AI workflows can overcome key logistical barriers to monitoring penguins in remote environments while minimising disturbance. These tools offer a practical pathway for improving population assessments and supporting conservation decision-making in rapidly changing sub-Antarctic ecosystems.

Effects of sibling rank and sex on CORT and growth in two-chick broods of little penguins

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Conditions experienced during early development can have substantial and long-lasting effects on individual phenotype. In particular, sibling competition within the nest can represent a significant source of stress influencing individual chick access to food and subsequent growth trajectory. Here, we investigated how brood composition influences growth and stress levels in little penguin (Eudyptula minor) broods. In particular, we tested whether sex and hatching order played a role in establishing social hierarchies within two-chick broods. We assessed chick stress by measuring feather corticosterone (CORT) levels at the end of growth (n = 42 broods; 2024 season), and quantified growth asymmetry according to brood composition and environmental conditions (n = 131 broods; 2003, 2004, 2005, and 2024 seasons).

Our results reveal a strong effect of brood composition on both chick growth and stress. Male-only broods exhibited higher CORT levels (+14%) and competition than female-only broods (15% vs 1% of asymmetry respectively). Males from mixed broods had higher CORT levels when hatching second (1.24 vs 1.42 pg/mg in first and second position respectively), but showed a clear growth advantage when hatching first (+140g of maximum mass compared to its younger sister). These findings suggest that male chicks are more competitive than females, likely due to sexual size dimorphism (males 14% heavier than female chicks), but that their higher energetic demands also make them more vulnerable to stress, particularly under unfavourable environmental conditions.

This highlights brood composition as a critical factor mediating adaptive trade-offs that can shape offspring fitness under changing environmental conditions.

Emergence of a prey depletion halo through penguin–krill behavioural dynamics

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Predators can influence prey through both consumption and non-consumptive effects arising from their behaviour. In colonial central-place foraging systems, repeated predator activity near breeding sites can generate zones of reduced prey availability, termed prey-depletion halos (Ashmole's halo). However, it remains unclear whether these spatial gradients in prey availability arise primarily from consumptive reductions in prey abundance or from non-consumptive redistribution that reduces prey accessibility to predators. We addressed this question using fine-scale behavioural data of breeding Adélie penguins (Pygoscelis adeliae) feeding on krill in East Antarctica. Combining GPS tracking, three-dimensional dive paths, and feeding events, we quantified accessibility and quality of prey patches across the foraging area. Penguins foraged most intensively near the colony, where dive depths and under-ice feeding distances were greater, indicating reduced accessibility, with no concomitant changes in patch quality. Within bouts, penguins progressively exploited deeper or more distant prey patches while maintaining similar feeding rates within patches, consistent with krill redistribution as escape responses. Redistribution of prey within foraging bouts can accumulate near the colony, generating colony-scale gradients in accessibility. These findings suggest that prey depletion halos arise through prey redistribution without substantial reductions in abundance, supporting a role of non-consumptive behavioural processes.

Evidence of olfaction and olfactory communication in Humboldt penguins

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Animals use a variety of signals to communicate, including visual, auditory, and chemical signals. However, many penguin species have reduced olfactory bulbs and fewer olfactory receptors, suggesting limited use of olfactory signalling, and the importance of olfaction is highly debated in penguins. Humboldt penguins (Spheniscus humboldti), colonial seabirds of conservation concern, are commonly kept under human care in breeding programs. Interestingly, Humboldt penguins can use preen oil—a waxy secretion primarily used for feather maintenance and waterproofing—as a scent signal to discriminate between kin and non-kin. We hypothesized that Humboldt penguins rely more on olfactory cues than previously thought and use preen oil as a scent signal to identify mates. Penguins at the Calgary Zoo were exposed to scent cues from their mates versus non-kin, non-mate colony members, and their behaviors were observed. Initial results indicate that penguins identify non-mate scents and show adverse responses to non-kin, non-mate stimuli. Penguin preen oil samples have also undergone GC-MS analysis to determine individual scent profiles as well as search for sex, age, and temporal variation. These findings enhance our understanding of scent signalling in penguins and offer conservation managers novel strategies for penguin management and remediation.

Fishery-Induced Changes in Prey Schooling Reduce Foraging Efficiency and Energy Balance in African Penguins

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Competition between commercial fisheries and seabirds for shared prey is well recognised, yet isolating fisheries effects from environmental variability remains challenging. We synthesise findings from a rare long-term experimental purse-seine fishery closure around African penguin (Spheniscus demersus) colonies in South Africa to assess how local fishing influences prey behaviour, penguin foraging efficiency, and energetic balance. Over 12 years, fishing was alternately prohibited and permitted within 20 km of breeding islands, enabling direct comparisons of penguin and prey responses. Acoustic surveys revealed that fishing altered prey field structure, producing more numerous but smaller fish schools, likely reducing prey detectability for penguins. During fishing periods, penguins showed reduced foraging efficiency, with a lower proportion of dives resulting in prey capture attempts. Foraging efficiency declined consistently under local fishing pressure, driven by interactions among fishery status, prey availability, and fishing intensity. Reduced sardine availability and higher sardine fishing intensity had particularly strong negative effects, reflected in fewer prey capture attempts. To link these behavioural effects to demographic consequences, we developed a bioenergetics model. When modelling current conditions, around half of breeding penguins operate in energy deficit, constraining chick-rearing success. Simulated reductions in fishing pressure, especially those increasing sardine availability, improved energetic outcomes, although many penguins rearing two chicks still experienced deficits. Together, these findings demonstrate that fisheries can indirectly affect seabirds by modifying prey behaviour and accessibility, not merely prey abundance. Incorporating prey behavioural responses into ecosystem-based fisheries management will therefore lead to better conservation outcomes for threatened seabirds.

Foraging among the fleet: biological and environmental drivers of habitat selection and foraging performance of Magellanic penguins in fished seascapes

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As human-induced environmental change rapidly alters ecosystems, animal movement decisions are shaped by an increasingly complex interplay of anthropogenic, biological, and environmental factors. Despite growing recognition of these interacting influences, how biological state and environmental contexts jointly shape animal movement in human-disturbed landscapes remains underexplored, particularly in marine systems. Here, we use GPS tracking data collected across five breeding seasons, including accelerometry and time-depth recorder data from three seasons, from adult Magellanic penguins to measure the effect of human fishing activity on foraging habitat use and performance. Specifically, we consider how sex and oceanic productivity modulate (1) selection of fished versus unfished foraging sites and (2) the effect of fisheries co-occurrence on foraging efficiency. Results indicate that penguins generally avoid foraging sites with fishing activity, though the strength of avoidance varies considerably among individuals. Females tend to avoid fished areas less strongly than males, with some individuals actively selecting to forage in fished habitats. There is also some evidence that avoidance weakens when oceanic productivity is low, though this effect is less strongly supported. We will quantify whether foraging near fishing activity is associated with changes in time spent diving and prey encounter rates, providing a direct measure of how fisheries overlap affects foraging performance. This work clarifies how human disturbance interacts with biological and environmental contexts to shape foraging decisions, with implications for understanding behavioral responses to anthropogenic disturbance and their consequences for energy acquisition and individual fitness.

Foraging of southern rockhopper (Eudyptes chrysocome) and royal penguins (Eudyptes schlegeli) on Macquarie Island

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Macquarie Island hosts significant populations of the globally declining southern rockhopper (Eudyptes chrysocome) and endemic royal penguin (Eudyptes schlegeli). Yet we still know little about their foraging ecology at this site. This is a critical knowledge gap because population persistence in crested penguins is often linked to foraging success, making understanding of at-sea behaviour fundamental to assessing population risks. This study explores at-sea space-use by these two species during brood and early creche on Macquarie Island. We investigate horizontal and vertical movement using GPS and TDR data collected from a total of 107 individuals from multiple colonies in 24/25 and 25/26 austral summers. We compare trip-level metrics of foraging effort and diving, and assess overlap in core foraging areas. Both penguin species underwent trips that were either long (>200 km) or short (<200km) depending on breeding stage and sex. Between species, there were strong similarities in trip duration, length, and diving behaviour, for both long and short trips, resulting in a substantial overlap of core foraging areas. Rockhopper penguins were more consistent in horizontal space-use across two consecutive years of tracking, with royal penguins displaying greater variation, particularly from some sites. The results suggest royal penguins show higher interannual plasticity space use than rockhopper penguins, which may suggest a greater capacity to respond flexibly to different environmental states. These results further our understanding of the foraging ecology of these species within the Macquarie Island Marine Park, and in turn, elucidate mechanisms supporting the persistence of these populations in the region.

Future winter habitat suitability of an ice-obligate Adélie penguin under different climate scenarios

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Rapid, climate-driven changes in sea-ice extent and dynamics are reshaping Southern Ocean ecosystems, driving species redistributions and habitat shifts. However, the consequences of these changes on the wintering ecology of penguin species remain poorly understood, limiting our ability to assess ecological responses. For the ice-obligate Adélie penguin (Pygoscelis adeliae), winter represents a critical period for survival during which individuals must maintain access to suitable foraging habitats within highly dynamic environment. We integrated five years of individual tracking data of Adélie penguins breeding in Terre Adélie, East Antarctica, with species distribution models to quantify their winter habitat preferences. We then projected potential changes in habitat suitability under three climate change scenarios for years 2050 and 2100. Winter habitat suitability was primarily structured by distance to the sea ice edge and westward oceanic circulation, highlighting the role of physical drivers in shaping prey availability and movement corridors. Across all scenarios, projections indicated a slight increase in habitat suitability area by 2050, followed by a pronounced decrease and spatial redistribution by 2100. Habitat loss was less severe under the low emission scenario. While the mid- and high-emission scenarios indicated a similar extent of suitable area, their spatial distribution diverged, from concentrated area into fragmented patches. A persistent wintering core area west of the breeding colony was retained across scenarios. These findings reveal the sensitivity of Adélie penguin winter habitat to future change in sea ice conditions and emphasize the need to consider the full annual cycle when assessing climate vulnerability in Antarctic penguins.

Gentoo penguin occupation and colonization in relation to glacial retreat and sea ice decline near Palmer Station, west Antarctic Peninsula

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As glaciers retreat in Antarctica, ice-free areas create new opportunities for seabird colonization and range expansion. Highly mobile species, such as penguins, can rapidly take advantage of these opportunities by establishing new colonies but it remains unclear how quickly they can respond and what habitats they prefer. The gentoo penguin Pygoscelis papua is one species that is considered to be a climate change winner as their populations have increased and they have expanded their range southward amidst rapid climate change along the western coast of the Antarctic Peninsula. Here, we provide a case study at Point 8, Anvers Island, involving satellite-based documentation of glacial retreat, drone-based habitat mapping, and the monitoring of gentoo penguin occupation as they colonize newly exposed land. Gentoo penguins were first observed at Point 8 in the winter of 2019, which coincided with rapid glacial retreat between 2018 and 2020. They nested first in 2020 but did not successfully rear chicks until 2023, following low sea ice years. We hypothesize that gentoos arrived here as juveniles, began nesting at 2–4 y of age, upon reaching maturity, but did not successfully breed until the age of 5–6 y. The increase in the number of molting adults suggests continuous immigration has been occurring. The time between glacial loss and colonization may suggest the colonization process can happen more quickly than previously thought. Continued sea ice decline and glacial retreat may support further range expansion and colonization by gentoo penguins in the study region.

Habitat use by high-latitude penguins: A comparison of biologging and at-sea surveys

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Two species of pagophilic penguins nest along the coast of Antarctica: Emperor Penguin Aptenodytes forsteri and Adélie Penguin Pygoscelis adeliae. For both, location of their colonies is dependent on the open water provided by latent heat polynyas; and both forage largely in waters overlying the continental shelf and slope. A negative relationship exists between them in regard to colony size, i.e. inter-specific competition for food: where both occur, large colonies of one precludes a large colony of the other. This relationship is affected by intra-specific competition: foraging area increases with colony size. Thus, only small colonies can exist within the foraging area of large colonies. To further understand the interaction within and between these species, in East Antarctica and the Ross Sea sectors, we modeled foraging habitat using data from both at-sea surveys and biologging. The latter typically involves just breeding individuals from select colonies, whereas the former quantifies the occurrence patterns of the entire population in a region. Therefore, the two approaches should be complementary. Instructive in the inter-specific comparison is the very narrow, almost non-existent shelf of East Antarctica vs the broad shelf of the Ross Sea. The latter supports ~35% of the global population of Adélie Penguin and ~25% of the Emperor Penguin. Common to both regions are the shelf break front and various marginal ice zones. Differences and similarities in exploitation of these and other features reveals much about these two species.

Health and infectious disease surveillance of rockhopper (Eudyptes chrysocome) and gentoo (Pygoscelis papua) penguins in the Falkland Islands (Islas Malvinas) from 2018 to 2024.

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The Falkland Islands are a marine biodiversity hotspot that supports globally important breeding colonies of rockhopper and gentoo penguins. Long-term monitoring since 1989 indicates fluctuating but broadly stable trends; however, infectious diseases remain an ongoing pressure that is likely exacerbated by climate change. Mortality events related to toxic algae poisoning, avian poxvirus and more recently, highly pathogenic avian influenza have underscored the need for continued health monitoring.

During three field seasons, 109 rockhopper and 124 gentoo penguins were evaluated through veterinary examination and collection of blood and choanal and cloacal swabs to assess overall health and test for infectious disease. Serological testing for antibodies and molecular testing (PCR) of swabs was used to screen for pathogens.

Seroprevalence was identified for avian paramyxoviruses (10.0%) and avian reovirus (21.3%). No or very low serologic response was present for avian influenza (0%), infectious bronchitis virus (0.8%) avian encephalomyelitis virus (1.3%) and West Nile virus (0%). Although 38% of penguins tested positive for chlamydia via complement fixation in one season, PCR results over all years were negative. PCR testing performed in the last two seasons detected adenovirus (39.1%), herpesvirus (33.1%), gammacoronavirus (16.7%) and mycoplasma (100%). Sanger sequencing of select viruses allowed comparison to viruses seen in seabirds globally.

Normal ranges were developed for hematology, biochemistry and protein electrophoresis values. These ranges and examination findings were used to identify normal versus abnormal individuals and correlated with the results of bacterial and viral testing to evaluate the health impacts of pathogen positivity.

How food availability shapes penguin foraging success

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Global changes are responsible for widespread declines in marine biomass, disrupting food webs and affecting top predators through bottom-up processes. Seabirds are particularly vulnerable, with reproductive success declining once prey biomass falls below critical thresholds. Yet, prey biomass alone may not fully explain foraging limitations. However, the relative importance of prey abundance versus prey availability remains largely untested due to the lack of independent, fine-scale prey data in pelagic systems.

Using an unmanned surface vehicle equipped with an echosounder, we collected independent, high-resolution spatio-temporal acoustic data on the prey field of little penguins over two breeding seasons (2023–2024), and matched these data with fine-scale monitoring of penguin foraging behaviour and body condition.

We tested the hypothesis that prey availability - integrating abundance, 3D accessibility, and aggregation - better predicts foraging success than prey abundance alone, quantifying the relative contributions of abundance, distance from the colony, vertical accessibility, and aggregation.

Our results show that prey abundance was not retained in any of the best-supported models. Instead, models incorporating prey within the penguins' preferred depth range outperformed those based on the full water column, and prey distance and aggregation consistently explained variation in foraging success and its variability, suggesting that only the most efficient individuals could exploit distant prey.

These findings demonstrate that predator performance is driven by prey availability rather than biomass alone, representing a conceptual advance in predator–prey ecology and highlighting the need to incorporate fine-scale prey landscapes into conservation strategies.

HPAI assessments in penguin populations at Heard Island and McDonald Islands

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High pathogenicity avian influenza (HPAI) strain H5N1 clade 2.3.4.4b has been circulating the globe since 2021, causing high mortality in seabirds and pinnipeds. In 2022/23 the virus reached the sub-Antarctic islands off South America and the Antarctic Peninsula and from September 2024 onwards, the virus has been detected at Marion, Crozet and Kerguelen Islands. Heard Island and McDonald Islands (HIMI) are located 450km from Kerguelen and are home to over one million breeding seabirds, including four penguin species (king, macaroni, gentoo and rockhopper). Two visits to HIMI were conducted in summer 2025/26 and included assessment for HPAI. Drone surveys and ground surveys were carried out at Heard Island across both voyages and McDonald Island on the second voyage to assess for signs of animal mortalities above baseline levels, and where possible, to assess for signs consistent with HPAI. Samples were collected from a small number of penguins across both voyages. Unusual levels of mortality were detected in king penguins and HPAI was confirmed in samples collected from gentoo penguins. We show spatial and temporal variability in king penguin mortalities across the islands. Genetic sequence data enable us to estimate the likely virus incursion pathway and timing. We discuss the challenges of these surveys and high importance of understanding the spread and impact to wildlife populations in the region

Hydrodynamic optimization of penguin bio-logging devices

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Bio-logging has improved our understanding of foraging strategies of penguins and other marine predators, yet still hold substantial potential for growth. A remaining challenge in bio-logging is understanding and mitigating the effects of hydrodynamics of attached devices (hereafter referred to simply as “devices”). Current bio-logging studies have identified device drag and water resistance as potential stressors for swimming penguins. While some studies have explored device shape and drag reduction, not all aspects of device shape have been investigated in great detail and the devices widely used today are much varied in shape. This study uses computational fluid dynamics (CFD), a proven engineering analysis tool, to quantify drag on devices commonly deployed on penguins. Design exploration techniques then guide an optimal device shape positioned on a penguin body, ensuring low drag while accommodating the necessary electronics. Our results demonstrate that, while reducing the cross-sectional area decreases absolute drag, a non-streamlined device negates this effect by significantly increasing drag. We compare the drag coefficients associated with different device designs and examine the specific design features that contribute most to drag generation. A key finding of this study is that streamlining the tail-end of the device, an aspect often neglected, can also significantly reduce drag. Additionally, we illustrate the hydrodynamic mechanisms responsible for increased drag through CFD-generated visualizations of fluid flow around a penguin model equipped with a device in various positions. Minimizing drag ensures reduced physiological impact on swimming penguins, minimizing behavioral data bias and thereby improving the accuracy of scientific conclusions.

Investigating Carry-Over Effects in Pygoscelid Penguins Using Long-Term Time-Lapse Camera Monitoring

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Pygoscelid penguins breed synchronously within their species to counter predation and align with peak krill availability during the austral spring, as well as with accessible, snow-free breeding sites. Shifts in breeding phenology have been documented over recent decades in response to climate change. Here, we use 16 years of time-lapse camera data deployed across 45 colonies spanning the Antarctic continent and subantarctic islands, with penguins identified using Pengbot, a deep multi-task convolutional neural network. Combined with environmental variables (temperature, Southern Annular Mode, and sea ice cover) and landscape characteristics, we apply linear mixed models and multistate models to investigate arrival and departure phenology and within-season synchronicity in Gentoo (Pygoscelis papua), Adélie (P. adeliae), and Chinstrap penguins (P. antarcticus), as well as mixed-species colonies. We show that shifts in breeding phenology not only affect the current breeding season but carry over into the following year, with earlier departures associated with earlier arrivals the next season. These phenological shifts appear to narrow the temporal niche overlap between species, with Gentoo penguins emerging as the most adaptable generalists, while Chinstrap and Adélie timings converge; a concerning trend given their population trajectories and the potential for increased nest usurpation. Colony landscape characteristics also appear to drive intrinsic differences in phenological timing. These findings highlight the importance of carry-over effects in understanding and predicting pygoscelid penguin responses to ongoing climate change, with implications for long-term conservation.

Linking El Niño-driven Ocean Warming and Anchovy Availability on Humboldt Penguins Breeding Phenology in Punta San Juan, Peru.

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Humboldt penguins (HUPE, Spheniscus humboldti), are sentinels of the Humboldt Current ecosystem. Punta San Juan (15°22'S, 75°12'W) is a historical source colony for HUPE on the Peruvian coast, where top marine predators such as HUPE rely on Peruvian anchovy (Engraulis ringens) availability. In PSJ, HUPE breeds in two peaks from April to December. In 2023, Humboldt penguins skipped the first nesting season (April-August) for the first time in over 40 years of long term monitoring. Also, Peruvian anchovy industrial fishing closed due to reduced biomass. Researchers postulate that food availability is a driving force behind phenology. However, the link between anchovy availability and HUPE breeding remains to be characterized. We estimated peak count of nests with chicks, onset and duration of the first nesting season between 2021 and 2024. Linear models revealed a direct positive link between nest number and the duration of nesting (R^2=0.96). Negative relationships were found between SSTA 3 months prior to peak counts of nests with chicks (R^2=0.95) and anchovy biomass estimations (R^2=0.67). A positive linear relationship between duration of the nesting season and the number of anchovy fishing days over our study period (R^2=0.84) and also between breeding onset (R^2=0.68) suggests that both efforts fluctuate together and could indicate competition or depletion of resources. However, the positive relationship between anchovy landings and nests with chicks (R^2=0.50), suggests other sources or spatio-temporal scales at play that need to be further investigated.

Linking ocean foraging to life on land: carry-over effects on Southern Rockhopper Penguins phenology across a decade

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Linking ocean conditions to life-history timing remains a central challenge in marine ecology. In seabirds, variation in foraging conditions at sea can generate carry-over effects that shape the timing, duration, and performance of subsequent life-history stages. We examined how interannual variation in trophic ecology relates to phenology and reproductive performance in Southern Rockhopper Penguins (Eudyptes chrysocome) over a 10-year period at Isla de los Estados, Argentina. Using a network of time-lapse cameras and AI-assisted image analysis (Pengbot), we quantified breeding and pre-moult phenology, while stable isotope analyses ($\delta^{13}C$ and $\delta^{15}N$) estimated trophic niche width as a proxy for foraging variability. To account for uncertainty in trophic estimates, we implemented a Monte Carlo resampling framework, repeatedly fitting linear models linking isotopic niche width to phenological traits. This approach allowed us to evaluate the strength and consistency of carry-over effects across life-history stages. We found that broader trophic niches were associated with longer pre-moult trips, indicating increased time spent at sea during this phase. In contrast, during the breeding season, broader trophic niches during chick-rearing were associated with longer breeding periods, suggesting delayed completion of reproduction. No clear relationship emerged between trophic conditions during chick-rearing and breeding success. Together, these results indicate that variation in foraging ecology can influence the duration of marine foraging phases and the timing of subsequent terrestrial stages, but does not necessarily translate into differences in reproductive output. This highlights complex, stage-dependent carry-over effects, where variability in trophic conditions propagates through the annual cycle without directly affecting fitness.

Living with the enemy: Humboldt penguins appear to defy fisheries and coastal development in central Chile

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Humboldt penguins were recently uplisted to Endangered in Chile. We investigated their population status and foraging behaviour across contrasting environments. While populations have declined dramatically in the Humboldt Archipelago, the species appears to thrive on Isla Cachagua, located off the densely populated Valparaíso region of central Chile. Despite adverse environmental conditions (including the 2023/24 El Niño event, which suppressed breeding across much of the species' range) Humboldt penguins continued to breed successfully on Isla Cachagua. To explore the drivers of this apparent resilience, we deployed GPS dive loggers and PenguCams over three consecutive breeding seasons. Our data reveal predominantly coastal foraging behaviour, with most dive effort occurring within 5 km of the shoreline and core activity concentrated within 20 km south of the island. Notably, more than half of the tracked individuals foraged near Quintero, a highly industrialized area, occasionally even entering the bay and foraging amidst bustling port activity. Industrial activity and heavy marine traffic may effectively exclude artisanal fishing from nearshore areas, reducing fisheries-related mortality and prey depletion, factors that appear to outweigh the immediate negative effects of pollution and disturbance at this site. However, the apparent resilience of penguins at Cachagua should not be mistaken for tolerance of industrial development - such environments impose their own suite of stressors on an already endangered species and cannot substitute for genuine habitat protection. We discuss the conservation challenges and opportunities associated with coastal development and highlight the need for improved marine protection in the face of accelerating environmental change.

Long-term stability of tawaki pre-molt foraging revealed through stable isotope analysis

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The annual cycle of crested penguins is characterized by alternating periods of fasting and recovery. Perhaps the most significant recovery (and preparatory) phase is the pre-molt foraging period which bridges the breeding season and the annual molt. This period is crucial not only for building fat stores to fuel the molt, but also for replenishing reserves lost during the breeding season. The Fiordland penguin/tawaki (Eudyptes pachyrhynchus) embarks on one of the longest pre-molt journeys yet recorded for crested penguins. Yet this trip takes tawaki far from highly productive coastal waters near their breeding colonies in favor of distant foraging grounds along the Subtropical and Subantarctic Fronts. This study assessed tawaki pre-molt foraging by analyzing the bulk stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) derived from feathers. We analyzed feathers collected from contemporary tawaki and museum specimens (n = 287) to assess the stability of pre-molt foraging areas and prey resources since the 1870s. Overall, tawaki exhibited a flexible generalist niche through the pre-molt, similar to the breeding season. Although we found variability among years, we did not find evidence of significant shifts in isotopic niche or foraging area over the last 150 years. This consistency contrasts with some other crested penguins in New Zealand (i.e. Eastern rockhoppers Eudyptes filholi) that have shifted towards lower trophic level prey and have experienced significant population declines. We conclude that dietary flexibility and stable resource availability help explain the long pre-molt trips and are key factors in the success of tawaki populations.

Magellanic Penguin foraging efficiency during chick provisioning declines with increased commercial fishing hours

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Understanding competition between fisheries and seabirds is critical for developing ecosystem-based management strategies that balance harvest and conservation goals. Best practices for assessing seabird-fisheries competition include estimating the effect of increased fishing on foraging success, yet these data are difficult to obtain at meaningful spatial and temporal scales. We assess the effect of commercial fishing hours on the foraging success (kg·foraging trip-1) and efficiency (kg·day-1) of provisioning Magellanic Penguins (Spheniscus magellanicus) across the 2015/16 – 2018/19 breeding seasons (n = 927 foraging trips from 154 individuals). We found that (1) as the average number of fishing hours increased within the penguins' foraging area, adult foraging efficiency decreased, and (2) both adult sex and the timing of fishing effort relative to chick age influenced this effect. When males were feeding small chicks (≤ 30 days of age), an increase in the average number of fishing hours three days prior to the end of the foraging trip reduced their efficiency. When adults were raising large chicks (> 30 days of age), foraging metrics had no relationship to fishing hours, likely because adults can leave larger chicks unattended and are thus less spatially and temporally constrained in their foraging efforts. Our results also indicate fishing may not be affecting the amount of food breeding adults acquire on a foraging trip, but the rate at which they acquire it. These results suggest that restricting fishing during the early stage of chick development will have the greatest positive impact on adults provisioning their chicks.

Paradise Lost? Dramatic population changes in the world's largest penguin colony

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The South Sandwich Islands, home to 38% of the global chinstrap penguin population, have remained largely isolated from fishing and tourism impacts due to their remote location. While their penguin populations were thought to be stable, creating a refuge for chinstrap penguins amid broader regional declines, accurate survey data has been scarce. In December 2023, we conducted a comprehensive survey of Zavodovski Island, previously considered the world's largest penguin colony with an estimated 690,000 pairs of chinstrap and macaroni penguins. Using drone surveys, satellite tracking, and fecal DNA metabarcoding, we documented a shift in the penguin community: chinstrap numbers declined by 62.9% to 201,000 pairs, while macaroni penguins increased by 25% to 218,000 pairs. The overall colony size declined by 39%, surrendering its status as the world's largest penguin colony. Satellite tracking of the two species revealed significant habitat partitioning, with chinstrap penguins targeting cooler waters to the northwest of the island, and macaroni penguins targeting warmer waters to the northeast. Fecal DNA metabarcoding revealed subtle dietary differences during the incubation period, with both species feeding predominantly on Antarctic krill, but with macaroni penguins also feeding on fish at low frequency. The reversal in species dominance suggests a climate-driven shift, making Zavodovski Island increasingly favorable for the sub-Antarctic macaroni penguin over the maritime Antarctic chinstrap penguin.

Penguins, prey and policy: evaluating new fisheries closures for the Critically Endangered African Penguin

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The African Penguin was recently classified as Critically Endangered and could become extinct by 2035 if current rates of decline persist. A key driver of this species' decline is the availability of their specialized prey, sardine and anchovy, which are also the targets of the largest fishery by volume in South Africa, the purse-seine fishery. Resource competition between the purse-seine fishery and African Penguins has been investigated since the inception of experimental no-take zones around four colonies in 2008 which concluded in 2020. The results of this experiment have been the subject of prolonged debate between fisheries stakeholders and seabird scientists regarding the need to implement representative no-take zones around six of the largest African Penguin colonies. Several forums and task teams were established to consider the scientific evidence alongside socio-economic implications. Following a prolonged stalemate, the South African government appointed an independent international panel of six experts to review the evidence. Closures implemented after this process were widely regarded as insufficient for penguin conservation, and subsequent court action in 2025 by seabird NGOs, informed by the panel's findings, led to improved closures. These took the form of revised purse-seine fishing no-take zones around six African Penguin colonies, which together supported approximately 76% of the global population at the time. This presentation will review the history of penguin-related fishing closures in South Africa and evaluate the significance of the new closures for African Penguin conservation.

Population genomics of yellow-eyed penguins uncovers subspecies divergence and candidate genes linked to respiratory distress syndrome

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Over the last five years, respiratory distress syndrome (RDS) has been the leading cause of yellow-eyed penguin chick mortality, with significant impacts on the population. Investigations have found a novel virus, called yellow-eyed penguin gyrovirus (YPGV), in chicks that died from RDS, suggesting a pathogenic link to the disease. This virus is related to, but highly genetically distinct from, chicken anaemia virus. Furthermore, RDS has been found only in the Northern population (mainland of New Zealand) but not in the Southern population (subantarctic Auckland Islands and Campbell Island). We wondered whether there were genomic associations with disease risk.

We sequenced ~250 penguin genomes to identify genetic associations with RDS. Approximately half of these genomes were from Northern population and the other half from the Southern population. Within the Northern population, equal numbers of diseased and healthy individuals were sampled.

The analyses revealed candidate immune genes linked to RDS in the Northern population. Remarkably, whole genomic data analyses also revealed three distinct populations with no gene flow. We suspect that these represent three subspecies. Phylogenetic divergence dating estimates the split of Southern and Northern populations 4000-6000 years ago and the Enderby and Campbell populations 2000-4000 years ago. Furthermore, genetic differences were also identified in the Southern population in genes associated with cold adaptation, making genetic rescue a challenge for the Northern population. These findings show the power of genomics to identify disease-risk associated genes along with distinct populations on the brink of extinction in order to guide urgent conservation management.

Precipitation as a novel threat for penguins. Increased catastrophic snowfall events break historic breeding success trends; breeding failures now frequent in all three pygoscelids throughout the Antarctic Peninsula

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In this study we investigated breeding success as a driver of the known diverging population trends between the three Pygoscelid species: Adelies, Chinstraps (both declining) and Gentoos (Increasing). Using 14 years of time-lapse imagery from 30 colonies distributed throughout the Antarctic Peninsula we observed several changes in breeding success (BS). First, in all three species BS follows a bimodal distribution with some colony-years showing the traditionally high BS (1 to 1.5 chicks per nest) for these species while other colony-years show frequent catastrophic breeding failures. Second, this is a very colony-specific dynamic, with neighbouring colonies frequently doing very differently in the same year. Third, Breeding failure is directly correlated with the amount of days of snow presence in the colony during the first half of the season. Our images show snow this mostly affects young chicks and eggs but imagery has also revealed dead adults as a consequence of heavy snowfall. Fourth, these snow-induced breeding-failure events were rare until 2018 but these have since become increasingly common throughout the Peninsula. On one hand, this shows pygoscelid population changes prior to 2017-18 were not due to a lack of breeding success but to some other cause. On the other hand, it shows precipitation (here in the form of snow) is a new threat that risks deepening Adélie and Chinstrap population declines and hampering Gentoo's recent increases.

Predicting prey fields in little penguin foraging habitats using autonomous acoustic monitoring

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Little penguins (Eudyptula minor) foraging area and efficiency exhibit pronounced temporal variability, within and among seasons. While several environmental factors are known to drive foraging patterns, their influence may operate indirectly through modifications of prey availability. For instance, little penguins preferentially forage in highly productive areas (high chlorophyll) and adjust diving behavior according to thermocline depth, conditions believed to also influence pelagic fish distribution.

In 2023, we began a monitoring program of their foraging grounds using an uncrewed surface vehicle equipped with an echosounder, aiming to test the extent to which environmental variability drives prey spatio-temporal distribution and availability to little penguins.

After two seasons and 245 days at sea, we modelled pelagic fish habitat as a function of seasons, abiotic environment (current, surface temperature, salinity, sea level anomalies, thermocline), primary productivity (chlorophyll a) and anthropogenic pressure (vessel activity).

We applied a multi-model framework to identify key environmental drivers and improve predictive performance. Our results showed strong effects of current, sea level anomalies, salinity, and temperature, with an explained deviance of 33 % for top-performing model.

Given that prey accessibility to penguins also encompasses the depth at which fish are encountered, we will present a three-dimensional characterisation of prey fields by predicting fish schools' depth according to abiotic conditions, particularly water column stratification. Building on this, we could use hindcast projections to reconstruct historical fish distributions, providing a unique opportunity to examine how past prey availability has influenced penguin foraging over the last two decades.

Projected redistribution of Southern Ocean penguins under climate change

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Climate change is redistributing species. Area-based protection measures must anticipate range shifts to limit the cumulative impacts of climate change and other anthropogenic threats. Here we model the future suitability of both penguin breeding habitat and foraging habitat in the Southern Ocean using circumpolar colony locations and foraging telemetry data, and project end-of-century shifts using global climate models. Models projected a polewards redistribution of most species, and a major range contraction for emperor penguins, estimated to lose up to 70.4% of their core habitat. A low-emissions future correlated with reduced magnitudes of range shifts and contractions for all species. Results highlight that implementing proposed marine protected areas in Antarctica and complementing them with process oriented protections would shield key climate refugia and improve the climate-resilience of penguins. As sentinel species, range projections of penguins warn of potential redistributions of terrestrial and marine ecosystems in Antarctica and the Southern Ocean.

Quantifying social bonds and coordinated foraging in African Penguins, Spheniscus demersus

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African penguins, Spheniscus demersus, are undergoing rapid population decline across their range, and there is growing concern that shifts in social organisation may influence access to schooling fish that rely on collective disturbance for capture. Social structure within colonies is an important element of this ecological setting, since individuals that depart or return in coordinated groups may benefit from increased foraging efficiency at sea. This study analysed UID PIT tag detections collected over a ten-year period to test whether repeated co-timed movements reflect deliberate partnerships rather than incidental overlap at colony entrances. More than 350 000 detections were standardised and examined using temporal grouping, permutation tests, and generalised linear mixed models. We found pair frequencies that exceeded null expectations, with p-values below 0.001, and 28 pairs completed repeated same-day round trips. These results indicate that synchrony among familiar individuals is a consistent feature of colony behaviour and may contribute to foraging cohesion in a species that depends on cooperative tactics to corral schooling prey. This study was able to conclude that African penguins form intentional foraging pairs since probabiliyt that the observed synchrony arises through random overlap is less thatn one in 10 000..

Re-establishment of an African Penguin colony: refining strategies for bolstering recruitment potential

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The African Penguin Spheniscus demersus has recently been uplisted to Critically Endangered, largely due to a lack of available prey, sardine and anchovy. A novel conservation action being undertaken is to establish mainland breeding colonies in areas of high fish abundance, where penguins have not been able to establish new colonies naturally due to predation by terrestrial predators. A small penguin colony established naturally in 2003 in the De Hoop Nature Reserve, growing to at least 18 pairs, but was abandoned by 2008 due to high predation levels. Work began in 2018 to re-establish this colony. A predator-proof fence was constructed, and decoys and call playback are being used to attract penguins. Over 300 hand-reared juvenile African Penguins have been released at the site since 2021. All released birds have been fitted with Passive Integrated Transponder (PIT) tags for individual identification and PIT readers have been installed at this colony and other existing colonies. In addition, 19 released penguins have been fitted with satellite tags to monitor at-sea movements directly after release. We investigate the relative levels of fidelity of fledgling African penguins released at De Hoop using transponder recapture rates to assess the influence of factors such as natal colony and rescue age. We also assess the at-sea movements of tagged fledglings and compare these to those of fledglings tagged in previous studies from established colonies. Results of this assessment will help inform and refine strategies for ongoing fledgling releases at the newly re-established colony.

Rising parasite pressure in Antarctic penguins: increasing tick infestation across Pygoscelis colonies

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Climate change is rapidly transforming Antarctic ecosystems, with rising temperatures and extended ice-free periods reshaping species interactions within penguin colonies. One emerging concern is the expansion of the seabird tick Ixodes uriae, an ectoparasite increasingly affecting Pygoscelis penguins.

We investigated spatiotemporal patterns of tick infestation in Adélie, chinstrap, and gentoo penguins across the Antarctic Peninsula during the 2022/23 and 2023/24 austral summers. Field surveys were conducted in multiple colonies within the South Shetland Islands and adjacent regions. Ticks were collected from beneath stones within rookeries of Pygoscelis penguins. Tick abundance per stone was recorded, and specimens were collected using forceps and preserved for identification. Adult penguins and chicks were also examined to assess on-host infestation. Ticks were identified to developmental stage using morphological criteria, and prevalence was compared with prior surveys alongside colony characteristics.

All developmental stages were recorded, with larvae and nymphs primarily associated with chicks, while adult females parasitised both chicks and adults. Tick prevalence peaked during the guard phase, with the highest levels in gentoo (58%) and chinstrap (50%) penguins, and lower levels in Adélie colonies (28%). Tick abundance ranged from single individuals to over 2,000 per stone.

Comparisons with previous studies indicate increasing prevalence and geographic expansion, suggesting that environmental change is facilitating the spread of I. uriae. This rising parasite pressure may have important implications for penguin health, breeding success, and population resilience.

Saving starving seabirds: The development of a sex-specific body condition index (BCI) for African Penguins to understand if spatial and temporal patterns of emaciation are linked to food availability

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The African Penguin (Spheniscus demersus) population has declined by ~78% over the past three decades, with functional extinction projected by 2035 under current trends. A key driver of this decline is reduced availability of small pelagic prey, exacerbated by competition with the commercial purse-seine fishery. Spatial fishing closures were implemented around key colonies in 2025, and robust, data-driven tools are required to evaluate their effectiveness.

This study develops and validates a sex-specific Body Condition Index (BCI) for adult African Penguins to define emaciation and describe its spatial and temporal drivers. Building on established BCI approaches for chicks, we use morphometric, mass, and condition data from SANCCOB necropsies over the past decade to define sex-specific thresholds for emaciation. The BCI is then applied to historical datasets from PIT-tagged penguins, with molecular sex determination conducted using CHD gene protocols.

We apply the validated BCI to long-term datasets from key colonies characterised by contrasting fishing pressure and closure efficacy, to quantify trends in adult body condition. These data will be integrated with outputs from Automated Penguin Monitoring Systems (APMS), which provide near real-time information on individual body mass and foraging effort, and with concurrent hydroacoustic fish surveys assessing prey availability.

By linking penguin body condition to fine-scale variation in prey density and fishing pressure, this work provides a novel, sensitive indicator of ecosystem change and fisheries management effectiveness. The adult BCI represents a critical tool for conservation monitoring, rehabilitation assessment, and adaptive management of this Critically Endangered species.

Schrödinger's Penguin? Divergent population trajectories and the challenge of assessing the threat status of the Erect-crested penguin

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The Erect-crested penguin (Eudyptes sclateri) is currently listed as "Endangered" by the IUCN, based on old and inconsistent data. Between 2022 and 2024, we surveyed the entire global range of the species across its only two breeding sites: the Bounty and Antipodes Islands. Drone surveys and ground counts yielded approximately 27,800 breeding pairs on the small Bounty Islands and 29,800 on the much larger Antipodes Islands.

The data reveal two starkly different population trajectories. While the Bounty Islands population has remained stable for at least 25 years, the Antipodes population - historically the species' stronghold - has declined by over 40% since the mid-1990s. Here, Brown Skua predation on chicks generates a self-reinforcing Allee effect: as colonies shrink and fragment - potentially a result of inadequate recruitment - collective defence weakens and decline accelerates. Skua predation probably amplifies an existing trajectory: oceanographic differences between the two sites may drive divergent survival and recruitment outside the breeding season.

This creates a "Schrödinger's cat" scenario where the species is simultaneously stable and sliding toward extinction. Under IUCN criteria, the stability of the Bounty population could downgrade the global threat level to "Vulnerable". This presents a conservation conundrum: combined global data improves the species' status while masking a severe population crisis on the Antipodes Islands. The Bounty Islands are emerging as the species' last stable stronghold. A global downlisting to 'Vulnerable', however technically defensible, risks weakening the already-limited fisheries protections around the Bounty Islands precisely when safeguarding that population has become most critical.

Seabirds to Seascapes: Integrating multi-disciplinary research to inform management of Little Penguins in New South Wales

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Reliable population estimates are fundamental to the conservation and management of Little Penguins (Eudyptula minor); however, in New South Wales (NSW), historical data are sparse and ecological parameters are largely inferred from colonies outside the region. In NSW, Little Penguin colonies are primarily restricted to offshore islands, where they are less exposed to terrestrial predators and human disturbance. Despite this, multiple colonies were shown to be in decline, and the magnitude and drivers of these changes are still unknown.

The Seabirds to Seascapes (S2S) program is a multi-agency research partnership that integrates population surveys, biologging, genomics, diet and health assessments, and citizen science to improve understanding and management of marine-dependent species. Between 2023 and 2025, S2S undertook statewide surveys of Little Penguin breeding colonies across 12 sites, using standardised methods during peak nesting periods. Counts of landing adults were combined with nest content sampling to generate the first contemporary population estimate for NSW. This initial estimate of approximately 2,439 ± 225 breeding pairs confirms evidence of declines at several historically significant colonies.

Complementary tracking data are being used to identify key foraging areas and explore environmental drivers of foraging success, while genomic analyses reveal patterns of connectivity and highlight unique genetic variation in northern NSW colonies. Together, these data improve understanding of population structure, dispersal, and vulnerability to emerging threats.

By integrating research streams at a statewide scale, S2S provides a unique framework for assessing population status, identifying priority management areas, and establishing an updated dataset to inform future monitoring.

Sedimentary ancient DNA reveals long-term ecological dynamics of Adélie penguins in the Ross Sea, Antarctica

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We report 156 sediment metagenomes from active and abandoned Adélie penguin colonies along the Ross Sea coast, Antarctica, spanning the past 6,000 years. These data reveal distinct spatiotemporal patterns in Adélie penguin diet, including spatial variation in the consumption of cnidarians. Elevated mitochondrial nucleotide diversity in upper stratigraphic layers from several active colonies is consistent with recent population growth. Sedimentary ancient DNA also reveals prior occupation of the Cape Hallett colony site by southern elephant seals, demonstrating the utility of terrestrial sedimentary ancient DNA for detecting faunal turnover events in Antarctica driven by past climate or sea-ice conditions. We additionally detected multiple bacterial and viral taxa known to be pathogenic in seabirds, including penguins. While the proximity of colonies around Ross Island to areas of human activity could suggest anthropogenic introduction of some pathogens, their presence in older deposits indicates a longer regional history. Low levels of cytosine deamination indicate exceptional DNA preservation, highlighting strong potential for recovering substantially older records from local Pleistocene terrestrial sediments. Overall, our study demonstrates that soil and sediment environmental DNA from penguin excreta provides a powerful framework for reconstructing long-term dietary change, pathogen presence, and species turnover in Antarctic ecosystems.

Sex-specific Migratory Behaviors Lead to Increased Risk Exposure for Female Magellanic Penguins

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For declining populations of long-lived marine predators in which recovery may be constrained by biased sex ratios, identifying the drivers of that bias is essential for effective management. This is particularly true when key life-history stages remain less well understood. Here, we show how sex-specific migration behavior exposes female Magellanic penguins (Spheniscus magellanicus) to greater mortality risk than males in human-influenced seascapes. Punta Tombo, Argentina, hosts a large but declining colony with an increasingly male-biased sex ratio. Adult mortality during the breeding season appears negligible, but previous work has shown that females and males differ in their spatial distribution during migration. How these differences translate into risk exposure remains unclear; however, females tend to swim closer to the coast, where interactions with fisheries are more likely. Using three years of tracking data, we evaluated how sex and marine productivity influence penguin overlap with fished versus unfished areas, and whether selection for or avoidance of fished areas affects access to productive foraging habitat. We found that both sex and marine productivity are strong predictors of overlap with fisheries, with females significantly more likely to use fished areas. Our results demonstrate how human activities interact with biological and environmental factors to produce sex-specific fitness consequences, with important implications for conservation.

Spatiotemporal variation of δ13C isotope values in ancient and modern Adélie penguin bone collagen from the Ross Sea, Antarctica

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The Ross Sea region of Antarctica supports approximately 1/3 of the world's population of Adélie penguins (Pygoscelis adeliae). These penguins are an important marine indicator species and have one of the longest traceable past records of any living seabird, extending to over 45,000 years. Their pebble nesting behavior form ornithogenic soils that preserve paleoecological specimens. Here, we apply stable isotope analyses of δ13C of ancient and modern Adélie Penguin bone collagen to investigate changes in foraging behavior at 5 colonies over the past 5000 years. Collagen from chick bones will have an isotopic signature strictly related to parental foraging during the hatch to crèche period and are readily available at the sampled sites. We are testing two collection methods of these bones to streamline future protocols and investigating any spatiotemporal changes amongst the selected breeding colonies. Our current samples are from active and abandoned colonies located throughout the Ross Sea region and were collected over the past 20 years. Collagen was extracted using a 0.5 M EDTA chelating solution and then analyzed through an elemental analyzer/ continuous-flow stable isotope mass spectrometer. Our results indicate differences in foraging location (polynyas) among the colonies, past and present. The results have also determined how multiple ages of modern samples are required from the same colonies, as they produce different isotope signatures. Therefore, this study will aid in more thorough sampling and future conservation efforts by understanding past/ current changes in foraging locations of Adélie penguins, and how this habitat may be impacted by climate change.

Stable individual spatial strategies and physiological plasticity in foraging chinstrap penguins

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Understanding whether foraging variation reflects stable individual strategies or short-term plasticity is central to penguin ecology, but these processes are rarely disentangled. We combined GPS tracking, blood biochemistry and reproductive data to investigate individual foraging behaviour in chinstrap penguins (Pygoscelis antarctica) breeding at Deception Island, Antarctica. We tracked 51 breeding adults over two consecutive austral summers (2022–2023 and 2023–2024), including 14 individuals monitored in both years, and quantified spatial consistency using a Repetition Index (RI) based on overlap among repeated foraging trips

Foraging traits differed strongly in repeatability. RI and maximum distance from the colony were highly repeatable (ICC = 0.92 and 0.95), indicating stable individual spatial strategies maintained across years. In contrast, trip duration and number of trips showed low repeatability (ICC < 0.2), consistent with high behavioural plasticity. Within a within–between individual modelling framework, uric acid showed a positive between-individual effect on RI, indicating that individuals with higher uric acid consistently foraged in more spatially restricted areas. Chick age had a negative within-individual effect on RI, showing that the same individuals became more exploratory as reproductive demands increased. Cholesterol showed strong within-individual effects on movement performance: higher cholesterol was associated with faster and straighter trips.

These results reveal a dual structure in chinstrap penguin foraging behaviour: stable spatial strategies coexist with physiologically mediated plasticity in movement performance. This distinction matters because it shows that individual resilience to environmental change may depend on the interaction between fixed spatial tendencies and short-term physiological state

Status of Little Penguins in New South Wales, Australia

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A three year study of Little Penguin breeding numbers over 12 of the most significant breeding sites in NSW (11 islands, 1 mainland colony) was completed in 2025. This is the first attempt to quantify Little Penguin numbers in NSW in a systematic and consistent manner. Existing data were also collated for other breeding sites, to provide a statewide population estimate. Historical data were examined to assess population trends. Declines were recorded at almost all sites, however quantifying the scale of decline was difficult due to limitations of much of the historical population data. Over 100 citizen scientists were involved in the surveys. The surveys and subsequent data analysis have identified key knowledge gaps at state and local levels relating to population declines, and variation in timing of breeding, foraging and nest attendance, breeding success and recruitment. Drivers of population change on these island colonies appear to be linked to oceanic variability and long-term changes in ocean conditions, likely impacting foraging and population sustainability. Concurrently, some sites have undergone significant deterioration in quality of breeding habitat.

Storm-driven turbidity and suppressed population growth in little penguins: evidence from Ōamaru, New Zealand

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Research into climate change impacts on marine ecosystems has largely focused on rising sea surface temperatures and their effects on food webs and prey availability. Less well understood are the consequences of increasing storm frequency and intensity associated with climate change. There is little empirical evidence linking storms to population levels impacts, and even fewer studies investigating turbidity as a potential pathway of impact.

At Ōamaru, New Zealand, in 2010-2012, we showed that prolonged periods of elevated wave heights, a proxy for storm conditions, were associated with reduced nightly arrivals and adult survival of kororā/little penguins (Eudyptula minor). Models predicted that increasing storm activity and ocean warming, could affect population growth. More than a decade later, those predictions have been realised: ongoing monitoring revealed suppressed population growth rates, significantly reduced adult survival, lower breeding success, and impaired chick growth particularly following more intense storms.

We hypothesised that a key mechanism was the re-suspension of sediments in the water column, resulting from turbidity associated with increased wave heights. Advances in satellite derived data, have supported this hypothesis. Following a storm in May 2015, satellite imagery showed increased sediment in coastal waters well beyond the penguins' typical foraging range and persisting for weeks afterwards. This coincided with a 25% decrease in adult survival.

This work provides evidence linking climate-driven storm activity to population-level consequences, highlighting sediment-mediated impacts as a critical and escalating threat to coastal ecosystems and the penguins that depend on them.

Survival of Little Penguin adults and chicks is influenced by marine temperatures and rainfall

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A decline in a seabird population can be driven by a decrease in adult survival, breeding participation and chick survival, but identifying the most important demographic factor can be difficult. The range edge colony of Little Penguins in Western Australia has declined by 94% since 2008. Although, the west coast experienced an extreme marine heatwave in 2011, the population estimate in 2011 was only marginally lower than that in 2008. However, since 2011, there have been a number of years with above average sea surface temperatures, periods of terrestrial temperatures far exceeding their thermoneutral zone during the late breeding and moult period and declining rainfall. Using a combination of penguin sightings in regular nest box monitoring and dead recoveries over a 30 year period, as well as mark-recapture across multiple sampling periods in multiple years since 2007, we have modelled the survival of both adults and chicks, while accounting for transitions among life history states, some of which were unobservable. We considered several putative environmental factors that could affect survival. Among these we found that partially lagged summer sea surface temperature had a negative effect on both chick and adult survival, with a stronger effect on winter (i.e. March - October) survival and that lagged winter rain amount after 1994 had a positive effect on winter survival and negative effect on summer (i.e. October-March) survival.

The End of the Empire? Discovery of Antarctic moulting sites in satellite imagery reveals new threat to emperor penguins

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Moult is a critical period in the life cycle of emperor penguin. Like in other stages of their life history they depend upon Antarctic sea-ice as a platform to moult. Our knowledge of where the birds moult is limited to a small number of tracking studies and incidental observations, showing most breeding emperor penguins moult in small groups on sea ice between January and March. Sea ice extent and duration has reduced dramatically over the last decade, and understanding how these declining ice conditions are impacting emperor penguins is crucial to model future population trajectories. We show that groups of moulting emperor penguins can be seen in medium and very-high-resolution satellite imagery. The study concentrates on a specific the area of West Antarctica, identifying the distribution and number of moulting groups over a seven-year period (2019-2025). In 2022 to 2024, reduced fast ice extent resulted in a concentrated distribution of moulting groups and early break-up of the moulting platform before the end of the season.

The heat is on: short-term natural heat exposure leads to physiological alterations in breeding king penguins

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Polar and sub-polar animals evolved to thrive in cold climates and may thus be particularly vulnerable to rising temperatures associated with climate change. Penguins may be especially vulnerable due to their dual habitat, alternating between foraging in cold waters and breeding/moulting on an increasingly warm land. We previously demonstrated that adult king penguins often exhibit behavioural signs of heat stress while breeding on land. Understanding how king penguin physiology is affected by warm environmental conditions on land is of prime importance to help predicting the consequences of warm climate at the individual and population levels. Here, we investigated the physiological consequences of heat exposure by quantifying several physiological markers of stress between king penguin who faced environmental heat or not during their first 48 hours on land. While king penguins facing environmental heat on land exhibited higher body temperature, they did not show clear signs of dehydration (i.e. plasma osmolality) or endocrine alteration (corticosterone levels). However, they exhibited higher levels of a chronic stress marker (heterophil/lymphocyte ratio), higher levels of oxidative damage to DNA, and an increased protein catabolism (i.e. higher plasma uric acid levels). These results suggest that warm conditions on land are unambiguously stressful for king penguins, and may impair body self-maintenance and potentially the ability to fast and thus to reproduce successfully.

The New World of Microplastics: A Field Fraught with issues of Contamination and Accuracy of the Results that We Present to the Scientific Community

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With any new field in science, developing tools and techniques for examination of "what's going on with this new cool thing?" is subjected to the immediacy of diving in and throwing lots of resources at seeing what's happening in the undiscovered territory. Little collaborative work happens at the start and new exploratory data are published with limited checks and balances. This is the case with the new "hot topic" of MICROPLASTICS (MP). While we have determined that MPs are "any manmade plastic less than 5mm in size," where we go from there is a wide-open frontier. Here we present our story from five years of research in setting up a new MP laboratory. We report exploratory data on differences in microplastic contamination in multiple species of captive penguins in aquaria in the eastern USA, and also data collected from wild Magellanic penguins in Patagonia, Argentina. While we show differences in groups of penguins and microplastic levels in these groups, the reliability of these data is in question. We discuss issues of contamination of samples during collecting in the field and processing in the lab. Further, we present data showing that the accuracy of MP values reported from processed samples, related to what was originally present in the collected samples, may suffer from upwards of 60-70% unreliablity. Based on these two factors – contamination and unreliability of accuracy of data – the field of MP research is fraught with questions of how best to accurately examine this important issue.

Tracking river contributions to little penguin diets using sulfur stable isotopes

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Rivers shape coastal prey fields, yet their contributions to marine predator diets remain challenging to trace in mixed coastal systems, where riverine and marine isotopic signals overlap and dietary responses may lag behind hydrological events. As ocean productivity varies under climate change, nearshore seabirds like little penguins (Eudyptula minor) may increasingly rely on river-influenced foraging grounds. We tested sulfur isotopes ($\delta^{34}S$) as a sensitive tracer of river influence, first comparing spatial differences between the river-influenced St Kilda colony and open-coast Phillip Island, then analysing temporal patterns from 2023–2025 using blood (intra-seasonal) and feather (annual) isotopes alongside hydrological data.

Spatially, St Kilda penguins showed significantly lower $\delta^{34}S$ and enriched $\delta^{15}N$ baselines compared to Phillip Island penguins, revealing a detectable input from the river. This pattern coincided with narrower isotopic niches, suggesting potential river-derived dietary niche stabilisation, and chronically elevated nitrogen from anthropogenic runoff. Temporally, blood $\delta^{34}S$ declined modestly with river flow at 1–2 month lags, while $\delta^{13}C$ and $\delta^{15}N$ showed weaker relationships. High flows initially displaced adult prey before triggering juvenile pilchard pulses via short trophic cascades (low $\delta^{15}N$), whereas low flows favoured benthic foraging. Feathers grown after persistent high flows displayed distinctive high-$\delta^{15}N$, low-$\delta^{34}S$ signatures, linking extreme discharge to sustained high-trophic-level prey shifts.

Our findings demonstrate that $\delta^{34}S$ can trace river–marine coupling across spatial and hydrological gradients, offering a powerful tool to monitor river influence on coastal food webs in a changing climate.

Tracking the invisible: Integrating autonomous prey monitoring and biologging to reveal climate impacts on penguins

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Climate effects operate not only directly by modifying individual physiology and behaviour, but also indirectly through changes in habitat or prey distribution affecting food supply. Yet, the difficulty in monitoring marine systems results in a persistent data gap on prey distribution and constrains our ability to quantify how environmental change indirectly affects predators through food supply. We present a holistic approach integrating prey dynamics within the study of environment-predators relationships. In one of the world's fastest-changing marine environment (Bass Strait, Australia), we simultaneously study: 1) the 3D-abiotic environment, 2) prey abundance and accessibility for seabirds by creating a fishery-independent index through the innovative use of an autonomous sailing drone equipped with an echosounder and 3) little penguin foraging behaviour and breeding performances using biologging and an automated penguin monitoring system. 13 years of GPS tracking revealed that little penguins forage within a restricted area to reduce search times, while shifting exact locations (at 2km scale) to adapt to the dynamic environmental conditions and target the most productive areas. Still, trip duration and mass gain vary among and within seasons, resulting in good and bad weeks, which affects breeding success. By mapping pelagic fish distribution over two breeding seasons, we showed that fish accessibility, particularly depth and distance to the colony strongly affected penguin foraging success. Because prey species vary in energetic value, we aim to identify fish species using echo classification validated with eDNA. This non-invasive framework provides a proof of concept for tracking predator-prey interactions and monitoring pelagic ecosystems.

Two Islands, Different Journeys: Pre-Moult Foraging of Erect-Crested Penguins from the New Zealand Bounty and Antipodes Islands

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Erect-crested penguins show strikingly divergent population trajectories across their breeding range, with marked declines on the Antipodes Islands and relative stability on the Bounty Islands, yet the drivers of these differences remain poorly understood. Dispersal during the non-breeding period accounts for more than half of the species' annual life cycle. The pre-moult phase is a particularly critical stage, as penguins must meet the substantial energetic demands of the subsequent moult on land within a constrained timeframe. Between January and March 2024, we tracked 10 adult breeding penguins from each island group, located approximately 210 km apart, using satellite telemetry to characterise pre-moult movements and space use. Tracking data revealed pronounced contrasts between the Bounty and Antipodes colonies, with minimal spatial overlap and clearly distinct foraging strategies. Bounty Island penguins consistently foraged along the southern margins of the Subtropical Frontal Zone to the east of the islands, a region typically associated with enhanced biological productivity, whereas Antipodes birds dispersed more widely southwards into subantarctic waters generally characterised by lower productivity. These contrasting pre-moult strategies provide insight into the divergent population trajectories of erect-crested penguins and highlight important conservation implications. The Bounty Islands may represent the species' future stronghold, but their dependence on a narrow, spatially constrained foraging band offers limited capacity to buffer against intensifying commercial fishing pressure within this zone, rendering their apparent stronghold increasingly precarious.

Unusual breeding strategies by African Penguins on Robben Island

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African Penguins (Spheniscus demersus) are typically monogamous with biparental care. However, this long-term study on individuals of known identity and sex on Robben Island from 2001-2023 revealed several alternative parental care strategies. In rare cases (N = 3, 0.3% of monitored breeding attempts by marked birds), individual penguins were observed incubating eggs and provisioning chicks at two different nests simultaneously. Cooperative breeding occurred in approximately 4% of monitored attempts, where three birds raised chicks at a single nest. In one-third of these cases, all three individuals participated from the incubation stage. Most notably, in 18% of breeding attempts where both pair members were sexed, both individuals were females, suggesting same-sex pairing as a significant reproductive strategy in this population, possibly due to an adult sex-bias ratio in the breeding population.

Updated population estimates for the Endangered Northern Rockhopper Penguin (Eudyptes moseleyi) at Tristan da Cunha in the South Atlantic

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Tristan da Cunha, in the central South Atlantic, is the most important breeding site for Northern Rockhopper Penguins (Eudyptes moseleyi). Lack of recent counts has hindered reassessment of this Endangered species' conservation status. Using hierarchical state-space modelling of counts from Gough Island (since 2008) and the Tristan da Cunha archipelago (since 2010), we estimate ~294,400 breeding pairs (95% CI: 240,900–347,900) for the South Atlantic, representing ~96% of the global population. Gough Island holds the largest population (101,700 pairs; 95% CI: 83,880–120,490), followed by Middle (87,600; 95% CI: 33,290–132,630), Inaccessible (73,400), Nightingale (23,700; 95% CI: 16,280–31,720), and Tristan (8,000).

Previous counts likely underestimated population sizes, and comparisons with updated numbers should be made cautiously due to methodological differences. While our results do not indicate a substantial change in breeding pair numbers we recommend interpreting our estimates as a reassessment of the current South Atlantic breeding population, rather than as evidence of change from earlier counts. Numbers at monitored colonies on Gough Island (~18% of the total population), the species' southern-most breeding site, increased by 6% per year (2008-2021), whereas at Nightingale numbers decreased by 3% per year (2011-2017).

Our review of the long-term dataset highlights the importance of pragmatic monitoring protocols and survey timing for a highly synchronised breeder. We recommend annual censuses of selected colonies, complemented by comprehensive island-wide counts

every 10 years, to ensure observed trends are representative of the regional population. This approach will provide a robust framework for future conservation assessments, including the IUCN Red List re-evaluation.

Validating Automated Penguin Monitoring Systems as indicators of African Penguin foraging success and prey availability

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Trends in seabird foraging metrics are widely used as indicators of prey availability and are increasingly incorporated into an Ecosystem Approach to Fisheries. Metrics such as foraging efficiency are typically derived from biologgers, but their utility is often constrained by small sample sizes and limited temporal coverage. In the Benguela Upwelling Region, competition with commercial fisheries is a major threat to the Critically Endangered African Penguin. Although this species is recognized as a key indicator of forage fish stocks, predator-prey functional relationships have largely been inferred from spatio-temporally patchy biologging datasets. Automated Penguin Monitoring Systems (APMSs) provide a non-invasive alternative by integrating weighing platforms with Radio-Frequency Identification technology to record the body mass of individually tagged birds as they move between the colony and sea. These continuous measurements enable the derivation of fine-scale foraging indicators, including trip duration and chick meal mass, throughout the breeding season. Their utility, however, depends on the accuracy and consistency of repeated mass measurements. Here, we describe the South African APMS network, deployed across six major colonies, designed to generate continuous ecological indicators. We outline ongoing work to evaluate the capacity of APMS-derived metrics to reflect prey availability by benchmarking them against concurrent biologger data and hydroacoustic surveys of local prey biomass. Validated indicators will be incorporated into the open-source “Penguin Alert” platform. By calibrating automated mass-based metrics against independent measures of prey conditions, this work establishes a robust foundation for the use of APMSs as tools for monitoring seabird responses within this dynamic ecosystem.

Variation in body temperature and heart rate of incubating Adélie penguins in response to microclimatic conditions

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Recent global warming has raised concerns about the direct impacts of heat stress on penguins. Penguins are known to exhibit various behavioral and physiological thermoregulatory responses under high temperatures. However, actual changes in body temperature and heart rate of wild penguins under such conditions have rarely been measured. Incubating Adélie penguins (Pygoscelis adeliae) are exposed to intense solar radiation and have limited opportunities for water intake for evaporative cooling, making them potentially vulnerable to heat stress. To assess their heat stress levels in the wild, we measured intragastric temperature (as a proxy for body temperature), heart rate, and activity of 11 Adélie penguins during incubation using biologging devices. Fieldwork was conducted on Mame Island in Lützow-Holm Bay, East Antarctica, from November to December 2025. Portable weather stations were installed at the colony to record air temperature and Wet Bulb Globe Temperature (WBGT), a heat index that accounts for solar radiation and humidity. Penguins' activity during incubation was evaluated using Overall Dynamic Body Acceleration (ODBA), calculated from acceleration data. The results showed that body temperature typically remained around 38°C but increased by up to 1°C when WBGT exceeded 5°C. Mean heart rate was approximately 90 beats per minute and showed little relationship with WBGT, but increased with ODBA, indicating elevated metabolic demand during activity. We suggest that increased body temperature, even under relatively low environmental temperatures, may be linked to the limited heat dissipation capacity of Adélie penguins, potentially imposing heat stress and leading to incubation failures.

Vocal communication in the African Penguin: acoustic cues to identity, size, and health in a critically endangered species

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The African Penguin (Spheniscus demersus) is a colonial and critically endangered seabird whose social behaviour relies extensively on acoustic communication. Over the past decade, we have characterised the vocal repertoire of this species, which includes six discrete vocalisation types, and examined how these calls mediate key social interactions. Within the source-filter theory framework, we investigated how morphological and physiological constraints affect the encoding of biological information at the level of the syringeal source and spectral envelope. We found that fundamental frequency conveys size related cues, whereas formants (corresponding to vocal tract resonances) encode individual specific acoustic signatures. Combined, these acoustic features support mate selection and recognition, neighbour–stranger discrimination, and the evaluation of potential rivals within densely populated colonies. More recently, we focused on chick begging calls, which play a central role in mediating direct parental care. These vocalisations exhibit complex nonlinear vocal phenomena (NLP), that enhance signal detectability, avoid listeners habituation, and encode information about chick condition, health status, and arousal. Building on this body of knowledge, we are currently developing automated call detection and classification tools based on deep learning. These systems are designed to enable reliable large scale passive acoustic monitoring, facilitating long term population assessment and providing robust, non-invasive support for the conservation of this rapidly declining species.

When earlier phenology becomes beneficial: Increasing double brooding in a long-lived seabird

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Extended breeding seasons due to climate change may buffer populations against environmental unpredictability by allowing more breeding events within a season. While this is common in short-lived species, whether multiple breeding can represent an adaptive strategy in long-lived species remains unclear. Using 24 years of data from 2830 breeding events, we examined whether and how little penguins (Eudyptula minor) could increase reproductive output by laying a second brood after successfully fledging the first. Double brooding was virtually absent before 2008 but became common thereafter, shifting from single to frequent double brooding and coinciding with a 6-week earlier onset of breeding. Following this shift, its occurrence varied strongly among years with breeding timing and resource availability, contributing to increased interannual variability in reproductive output. Double brooding conferred clear fitness benefits, with double brooders achieving higher lifetime reproductive success without apparent costs to longevity, while offspring from both first and second broods performed better, or as well as those from single broods. These benefits were not associated with reduced reproductive investment, survival, or future reproduction. This could be explained by the fact that individuals engaged in double brooding only when in favourable conditions, allowing them to avoid the typical trade-off between survival and reproduction. Overall, our results indicate that earlier phenology under climate change can enable reproductive strategies that enhance reproductive output in long-lived seabirds. Future work should investigate whether the increased variability in reproductive success associated with this life-history shift could jeopardize the benefits of earlier phenology for long-term population dynamics.

Where penguins waddle, do oceans warm? A multi-dataset assessment of Emperor (Aptenodytes forsteri) and Adélie (Pygoscelis adeliae) colony exposure to marine heatwaves and sea-ice change

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Emperor (Aptenodytes forsteri) and Adélie (Pygoscelis adeliae) penguins depend strongly on Southern Ocean marine and sea-ice conditions, yet it remains unclear how present-day colonies differ in their local exposure to marine heatwaves and sea-ice change across sea-surface temperature datasets. We combined current colony locations with pixel-wise trends in marine heatwave frequency, total annual duration and annual mean intensity derived from two daily sea-surface temperature products, the Operational Sea Surface Temperature and Sea Ice Analysis and the Optimum Interpolation Sea Surface Temperature dataset, together with annual sea-ice fraction anomaly trends. We identified marine heatwaves south of 50°S using a common 1982 to 2011 climatology. We then quantified colony-scale exposure by averaging these trend fields within 100 kilometre and 250 kilometre buffers around current Emperor and Adélie colonies. We calculated a composite exposure index from standardised marine heatwave metrics and the magnitude of sea-ice change to compare colony settings across species and datasets. Across both datasets, Adélie colonies showed higher average exposure index scores than Emperor colonies, and this pattern remained across both buffer sizes, although the differences were modest and colony rankings agreed only moderately between datasets. Stronger nearby increases in marine heatwave duration drove most of the species contrast, while the magnitude of sea-ice change was broadly similar between species. Adélie colonies also tended to be more exposed in West Antarctica than in East Antarctica. This colony-scale multi-dataset framework provides a circumpolar basis for comparing penguin exposure to changing ocean and cryosphere conditions across Antarctica.

Year-round movement of emperor penguin colonies observed from space

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Emperor penguins are threatened by climate change and their population is predicted to decline rapidly this century in response to changes in Antarctic sea ice. Remote sensing is a key tool for monitoring emperor penguins but analysis has been restricted to spring/summer due to a lack of optical imagery during the polar night. In this study, we use Sentinel-1 synthetic aperture radar (SAR) data to observe the movement of penguin colonies throughout winter for the first time. We combine winter SAR imagery with Landsat 8-9 and Sentinel-2 medium-resolution summer optical imagery to track the year-round movement of colonies at Atka Bay, Coulman Island, and Cape Washington between 2017 and 2024. We find that although emperor penguins are less mobile than during summer, all three colonies exhibit movement in winter, but which varies between years and between colonies. At times, different groups within the colonies synchronously move away from the fast ice edge despite its apparent stability, suggesting that meteorological conditions may be a major influence on their movement. Additionally, we find that SAR can sometimes be used to identify guano on ice shelves during summer. We demonstrate that SAR is an important tool for understanding emperor penguin behaviour throughout their breeding cycle, and particularly their response to environmental forcing and change during winter. The ability to observe the species during winter also offers potential for monitoring and conservation efforts.

Automatic acoustic identification of individual penguins as the basis of population monitoring

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Passive acoustic monitoring (PAM) is a well-established tool in ecological research and conservation management. However, its widespread application has traditionally been constrained by the substantial human effort required to process and interpret recordings. In recent years, advances in artificial intelligence (AI) have enabled automated analysis of PAM data, removing this bottleneck and driving rapid uptake of the method. For many vocalising species, species-level detection and classification—currently the most common application—are approaching a mature and reliable state.

However, most ecological and conservation questions require population-level information, such as relative abundance, population size, spatial distribution, and movement patterns. These metrics cannot be robustly inferred from species-level detections alone.

Recent developments in AI now offer a pathway to address this gap through the automated identification of individual animals from acoustic data. Individual-level acoustic recognition has the potential to replace traditional, often invasive, mark–recapture approaches and enable non-invasive population monitoring.

Here, we present the successful development of individual-level acoustic recognition models for several bird species, including Little Penguins, using data from the St Kilda colony in Melbourne, Australia. We discuss the potential of this approach for population monitoring, as well as its current limitations.

Babesia spp. infection in wild and rehabilitating little penguins (Eudyptula minor): evidence for immune adaptation across life history stages

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Babesia spp. are tick-borne intracellular parasites reported in little penguins (Eudyptula minor) across southern Australia. While infections are typically subclinical in wild birds, their ecological significance, particularly across life stages and seasonal exposure, remains poorly understood. Between 2022-2024, the Melbourne Zoo Veterinary Department admitted numerous wild penguins with intracellular blood parasite infections and polychromasia, prompting a broader investigation of parasite prevalence in the local wild population.

We investigated Babesia spp. infection in both wild and Melbourne Zoo rehabilitating penguins to assess how infection patterns relate to ecology and host condition. Blood samples from individuals across multiple life stages were analysed using smear microscopy and PCR, alongside other indicators of health and immune response.

Distinct immune profiles, through leukogram patterns, were observed across life stages: infected wild chicks and un-infected moulting adults exhibited lymphocyte-dominant profiles, while un-infected chicks and infected rehabilitating birds showed heterophil-dominant profiles. Infection prevalence was highest during warmer months and in land-bound individuals. This suggests that environmental context and stressors may influence host responses.

These findings suggest that Babesia spp. infection in little penguins is shaped by seasonal vector dynamics and life-history constraints, particularly during terrestrial phases when exposure risk is highest. Although overt disease appears limited, infection may carry sublethal costs through altered immune response during energetically demanding periods such as growth and moult. Integrating parasitology and physiological responses with ecological context improves our understanding of host–parasite dynamics in penguins and highlights the importance of considering environmental exposure and life-history stage in wildlife disease studies.

Changes in behaviour of Royal Penguins (Eudyptes Schlegeli) on Macquarie Island over a fifteen-year time frame – observations of an amateur "citizen scientist"

Dr Neisha Wratten

Ecotourism frequently attracts criticism for its impact on the Antarctic environmentand wildlife. But the demand for it continues to rise , as does the cost of doing research in the region. Behavioural observations have limitations, but studies have confirmed that with appropriate training and validation,data collected by non-professionals can be utilized by scientists.

The author was able to visit the Sandy Bay Royal penguin colony of Macquarie Island as a tourist on three occasions over a fifteen-year period- 2011, 2020, and 2026. The 5-metre minimum approach distance was maintained on all occasions if possible. Changes in the behaviour of the Royal penguins were able to be compared at the " penguin highway" leading from the rookery during these episodes. No agonistic behaviour was observed towards humans although vigilant behaviour was observed over the three visits, decreasing in frequency from 2011 to 2026. Avoidnace behaviours were most marked in 2011,with reductions in 2020 and being observed only rarely in 2026. Some penguins in 2026 actively approached human visitors with no sign of aggression or vigilance, appearing to be curious about the intruders.

Photographic evidence in support of the observations is included. Reasons for this potential behavioural change will be discussed.

These findings are presented, in full knowledge of the limitations of behavioural observations as stress predictrs, as a posssible basis for further study. The potential of scientifically useful data collection during ecotourism voyages may stimulate public engagement and ongoing support for conservation efforts.

Effects of Aspergillosis on Vocal Behaviour and Call Structure in Humboldt Penguins

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Humboldt penguins (Spheniscus humboldti) are under increasing threat due to human activities. Consequently, captive populations play an important role in conservation efforts. This creates a responsibility to ensure optimal welfare and breeding success, for which reliable, non-invasive methods to monitor health status are required. Vocalizations play a central role in penguin social communication and have recently been shown to be affected by respiratory disease (i.e., aspergillosis), as has been shown in hand-reared chicks of the closely related African penguin (Spheniscus demersus). In this study, we examine this relationship in adult Humboldt penguins housed in a zoo. Vocalizations were recorded by following the penguins from a distance using a directional microphone to minimize disturbance.

Preliminary analyses indicate that penguins suffering from aspergillosis (respiratory disease) vocalize less frequently than healthy penguins. In addition, differences were observed in the acoustic characteristics of the calls, with disease status influencing spectral properties related to energy distribution and complexity. No clear effects were detected for pitch-related features or vocal tract resonance parameters. Environmental factors, including temperature and cloudiness, also contributed to variation in several acoustic features. These preliminary findings suggest that vocal behaviour and certain acoustic properties vary with health status. While further analyses are ongoing, the observed patterns provide promising evidence that such acoustic data could inform future research into non-invasive monitoring for the early detection of disease.

Evaluating Ross Sea mesopredator habitat use in response to Marine Protected Area implementation and shifting environmental and sea-ice regimes

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The Ross Sea supports globally significant populations of emperor penguins (Aptenodytes forsteri), Adélie penguins (Pygoscelis adeliae), and Weddell seals (Leptonychotes weddellii). Distributions of these mesopredators reflect broader patterns of environmental variability and prey availability, while also serving as sensitive indicators of ecosystem change. The establishment of the Ross Sea region Marine Protected Area (RSRMPA) in 2017 was a landmark international conservation commitment, with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) agreeing on objectives and priorities to assess the effectiveness of the MPA. Compounded by unprecedented declines in Antarctic sea-ice extent coinciding with the MPA designation, evaluating outcomes in a vast, remote, and ice-covered area and separating protection effects from environmental change remains challenging.

For these three mesopredator species, we investigated foraging distributions and core habitat use by integrating multiple years of satellite tracking and dive data, spanning periods before (2000-2017) and after (2018-2025) MPA implementation. We modelled species-specific habitat use in relation to dynamic environmental variables, particularly sea ice, and ocean conditions (e.g., thermocline, mixed layer depth), bathymetry, and modelled potential prey availability.

Our ongoing habitat modelling framework aims to disentangle the relative influence of environmental variability and spatial protection on predator distributions. While analyses are still in progress, preliminary patterns suggest differences in habitat use and foraging effort associated with shifts in sea-ice regimes. These models will provide a valuable baseline for assessing change across successive decades and contribute to refining indicators for long-term MPA monitoring and evaluation within the CCAMLR framework.

Kororā Feather CORT: a novel, minimally invasive monitoring technique for chronic stress levels in New Zealand

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Anthropogenic environmental change is a major threat to penguins, driving chronic stress and population decline. It is important now more than ever to identify and monitor populations of concern. Stress physiology can support management through measuring the primary avian stress hormone corticosterone (CORT) to quantify the impact of threats. In penguins, CORT is primarily measured through plasma CORT, but this is an invasive, technically complicated method that quantifies short-term acute stressors and is not suitable for long-term monitoring. Feather CORT is an increasingly used method over plasma CORT with its ability to quantify chronic stress, while being minimally invasive with practical field advantages, not requiring specialised training, equipment or storage. When applied to chicks, it provides a unique opportunity to assess if populations are facing nutritional stress due to inadequate food availability or quality in the environment. Feather CORT has the potential to be a valuable monitoring tool, yet as only been quantified twice in adult penguins and never in chicks. In a validatory study, we have recently adapted a methodology to extract feather CORT from Australian little penguin (Eudyptula novaehollandiae) chicks for widespread application to kororā. Here, I discuss this novel, minimally invasive methodology, planned future research into South Island kororā populations, and how this method can support the conservation of New Zealand kororā and penguins around the world.

Fishing tips from expert divers: Ascending foraging strategy in wild Adélie penguins

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Penguins are among the most proficient hunters in seabirds, and their remarkable diving abilities have been investigated. However, quantitative information on fine-scale movements immediately before prey capture in the wild remains limited. To address this, we examined the diving behaviour of Adélie penguins before prey captures using animal-borne loggers.

Video, heaving acceleration, and depth data were obtained from free-ranging penguins feeding beneath the fast sea ice in Lützow-Holm Bay, East Antarctica during the summers of 2013 and 2023-24. We defined the 3-s period immediately preceding prey capture as the pre-capture phase. Heaving acceleration, corresponding to flipper beat movement, was used to identify gliding behaviour.

Penguins were ascending in 40 of 42 (95.2%) pre-capture phases, regardless of capture depth, suggesting that they often capture prey after ascending from deeper water. Compared with randomly sampled dive points, capture events occurred at shallower depths and were associated with upward depth changes; both depth and Δdepth fell outside the 95% confidence intervals of the random expectation. Gliding probability increased with more negative Δdepth, indicating that penguins were more likely to glide during steeper ascent.

As air-breathing divers, penguins are constrained by limited oxygen underwater. Prey capture preceded by ascent may be beneficial for penguins in various ways. By gliding upward, penguins may reduce energy expenditure and water disturbance detected by lateral line system of prey fish. Approaching prey from below and capturing them beneath sea ice, where background contrasts with penguin coloration, may enhance countershading and restrict the escape space of their prey.

From fluff to fledgling: chick growth and survival in a dynamic world

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Environmental variability shapes life-history strategies through energetic trade-offs in parental investment, making it critical to understand how such variation influences offspring growth and survival. In seabirds, oceanographic conditions strongly affect diet composition, as sea surface temperature (SST) and primary productivity (chlorophyll-a as proxy) determine prey availability. Terrestrial conditions, particularly air temperatures exceeding the thermoneutral zone of chicks, may further affect growth. We examined how environmental variation and diet may influence chick growth and fledging success in little penguins (Eudyptula minor) at both individual and population levels. From 1995 to 2022, chick mass (n=1366) was monitored on Phillip Island, Victoria. At the individual level, growth parameters of linear growth rate, peak mass, and fledging mass varied significantly between years. Higher SST and Chl-a during chick-rearing increased growth rate, peak mass, and fledging mass. In contrast, more days of air temperatures above 30°C reduced peak and fledging mass. Stable isotope analysis of chick plasma from 2003 to 2022 (n=378) showed annual shifts in the contribution of anchovy (Engraulis australis) and red cod (Pseudophycis bachus) to chick diet, while dietary niche width (SEA-B) remained constant. Mean seasonal δ¹³C decreased and δ¹⁵N increased across years. At the population level, environmental conditions, prey composition, and dietary diversity did not predict chick growth or fledging success. However, linear growth rate increased in seasons with higher mean δ¹³C and δ¹⁵N values. These results suggest that little penguins, as central-place foragers, buffer environment variability through behavioural or physiological mechanisms, sustaining chick growth and fledging success in changing environments.

How much monitoring is enough? Estimating the minimum sampling effort required to detect population change in little penguins

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Long-term monitoring is central to understanding population dynamics and informing conservation management, yet the effort required to reliably detect meaningful population change is rarely quantified. We use a long-term dataset of colony-wide surveys and demographic monitoring of Little Penguins (Eudyptula minor) on the Summerland Peninsula, Milawul (Phillip Island), Australia, to both estimate population size and evaluate sampling requirements for effective monitoring.

Building on established methods (Sutherland and Dann, 2012, 2014) that correct for spatial and temporal variation in burrow occupancy using mark-recapture approaches, we estimate the current breeding population to be approximately 38,000 breeding penguins, representing the largest known colony of the species. This long-term dataset captures substantial interannual variability in breeding participation and population size, driven by ecological processes including variation in recruitment and environmental conditions.

Using this long-term dataset, we explore how ecological variability – particularly asynchronous breeding and recruitment-driven fluctuations – interacts with monitoring design to influence the power to detect population change. We assess how survey frequency affects the capacity to identify biologically meaningful trends, including declines of approximately 20%, under realistic environmental variability. Our study integrates long-term ecological data with a practical evaluation of monitoring design, providing a framework for optimising survey effort in burrow-nesting seabirds. These findings have direct implications for adaptive management, enabling more efficient allocation of limited resources while maintaining the capacity to detect meaningful changes in population dynamics.

Is past prologue: Might historical foraging plasticity buffer king penguins against future climate impacts?

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Climate change is reshaping Southern Ocean ecosystems in ways that may push many penguin species to their limits. Understanding how species respond to these pressures is a growing priority for researchers. Among the changes predicted, the Antarctic Polar Front (APF) is expected to shift southward and deepen, with possible consequences for king penguins (Aptenodytes patagonicus) which are traditionally considered dependent on the APF for foraging. As such, a poleward-shifting APF may lead to longer foraging trips with possible implications for chick survival and population trends. However, king penguins have recently begun recolonizing Tierra del Fuego breeding sites abandoned over a century ago, with birds at these colonies foraging inshore rather than traveling to the APF. Whether this reflects a novel behavioral response to modern conditions, or whether inshore foraging was always part of the king penguin repertoire, is an open question. To address this, we are conducting geochemical analyses of modern (~10 years) and historical king penguin bones from Tierra del Fuego. Optically stimulated luminescence dating of historical bones from Isla de los Estados, sampled in early 2025, ages them at roughly 160 years old, just before regional populations were extirpated. We are comparing carbon, nitrogen, and sulfur stable isotope ratios between historical and modern samples to allow reconstruction of shifts in foraging habitat use over time. Divergence would suggest a recent pivot toward inshore foraging while similarity would imply long-standing plasticity, and either result carries significant implications for king penguin conservation in a warming world.

Little penguins move to coastal refuges to rest overnight under strong sea conditions

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Little penguins (Eudyptula minor) spend most of their lives at sea. While their foraging ranges and spatial use are well described at sea, the fine-scale behavioural strategies penguins use to cope with dynamic ocean conditions on a daily basis remain poorly understood, particularly during nighttime. While little penguins are active and nocturnal once back on land, they often stay at sea overnight. During that time, they do not dive or travel and might have to decide where to spend the night resting.

We investigated the nighttime at-sea behaviour of little penguins from the Phillip Island colony (Victoria, Australia) during the 2021–2024 breeding seasons, using GPS tracking data from bio-loggers combined with modelled environmental data from Copernicus Marine Environment Monitoring Service.

Little penguins consistently moved from offshore foraging areas to coastal zones at night when exposed to strong winds and currents. This behaviour is driven by the interaction between environmental conditions and the birds' daytime distance from the coast, suggesting that little penguins actively avoid energetically costly conditions by seeking sheltered coastal areas to rest when feasible.

These results reveal a previously underappreciated behavioural mechanism by which little penguins manage daily environmental variability at sea. We will present how this strategy may shape their energetic balance under increasing meteorological variability, and its potential implications for foraging efficiency and reproductive success in a changing climate.

Living with uncertainty: Using multi-model large ensembles to assess emperor penguin extinction risk for the IUCN Red List

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Accurately identifying species at risk is critical for conservation under climate change, as current estimates suggest that up to one million species face extinction due to environmental changes. Accounting for multiple sources of uncertainty can enhance the robustness of the IUCN Red List evaluation and provide a more comprehensive understanding of species' risks. Here, we present a framework that incorporates key sources of uncertainty, including measurement error, model structure, natural variability, future climate emissions scenarios, and extreme sea-ice loss events, to assess the extinction risk of the emperor penguin (Aptenodytes forsteri), currently listed as Near Threatened. By combining three ecological models with a multi-model large ensemble (MMLE) of climate projections, we perform Red List assessments at global, regional, and colony levels. Our findings indicate that extinction risk projections are highly sensitive to the choice of ecological model, climate scenario, and extreme event frequency. Under IUCN Criterion A, global risk classifications range from Vulnerable to Critically Endangered, with severe declines expected in the Indian and East Pacific sectors, Dronning Maud Land, and the Amundsen–Bellingshausen Sea. Under Criterion E, 24-100% of colonies meet Endangered status depending on ecological assumptions. This study represents the first application of an MMLE combined with an ecological ensemble approach to assess climate change impacts on a species, capturing a broad spectrum of uncertainties and providing a framework to improve forecasting and conservation decision-making under climate change.

Mixed breeding and interspecific pairing in crested penguins: towards a global compilation of anomalous reproductive events across colonies

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In penguin colonies, individuals are occasionally observed breeding, attempting to breed, pairing, or associating reproductively with heterospecifics. These events include mixed pairs, suspected or confirmed hybridization, solitary individuals of one species displaying or nesting within colonies of another, and breeding attempts that occur with or without a stable pair bond. Despite being reported from multiple taxa and sites, most of these observations remain scattered across the literature or persist only as unpublished field records.

Here we propose a first integrative collection of interspecific breeding-associated events in penguins, bringing together published accounts and field observations from different species and colony contexts. The initiative was initially motivated by the difficulty to access dispersed records of macaroni penguins in heterospecific colonies, but expands to include a broader range of reproductive or breeding-related heterospecific interactions across penguin taxa, including examples involving Magellanic and Humboldt penguins. By considering these cases together, we aim to evaluate whether they represent isolated anomalies or a more widespread but under detected feature of penguin reproductive ecology.

Rather than presenting a closed analytical dataset, this contribution aims to create a live database for penguin researchers to upload their historic or current observations of such behaviours. Such a database could allow us to estimate the taxonomic breadth, geographic distribution, and ecological contexts of interspecific breeding-associated events in penguins. We hope our poster kickstarts a collaborative global compilation, inviting researchers to contribute observations from colonies worldwide via QR code.

Performance of deep learning models to estimate foraging effort in Antarctic Pygoscelis penguins

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Understanding energy gain is essential when studying marine top predators, because environmental change and anthropogenic pressure can strongly affect their food availability. Without accurate estimates of foraging areas and energy intake, it is difficult to assess how these pressures impact their survival and population trends. The combined use of bio-loggers and advanced machine learning methods (deep neural networks) have shown promise in estimating fine-scale behaviours, but clear guidelines on where these methods may work are not well established. Our study evaluates the effectiveness of several deep learning model architectures in estimating prey capture rates of Pygoscelis penguins from accelerometer-depth recordings, validated by bird-borne video loggers. We describe the effects of sample size and data quality on the predictive performance of trained models and propose an analysis workflow to improve model performance. We trained and evaluated our models using a large dataset (130 individuals) from ten breeding sites, comparing predicted prey capture events (PCE) to those observed in video. Due to the imbalanced nature of the data (most points are non-PCE), training data sampling strategies and annotation quality were more important than model architecture. Our best performing models were shallow (< 5 layers), lightweight convolutional neural networks (CNNs), with potential for deployment in edge-computing bio-loggers. Most of the training data came from foraging dives in pelagic waters with clearly defined diving phases (descent, bottom, ascent) and more training data are needed to update models to predict PCE in other circumstances (e.g. foraging under ice or benthic foraging).

Re-assessment of long-term survival and breeding success of African Penguins oiled in the MV Treasure oil spill in 2000

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The MV Treasure oil spill in 2000 was one of the largest environmental catastrophes. Around 20 000 African penguins (Spheniscus demersus) were oiled and a further 20 000 penguins translocated ca. 700km eastwards to prevent them from becoming oiled. More than 21,000 birds affected by the spill (either oiled or translocated) were marked with flipper bands prior to release back into the wild. Initial studies a few years after the spill indicated lower breeding success and changes in breeding and moult phenology in affected birds compared to birds never been oiled. Now much with additional data available, we have undertaken an updated analysis of long-term survival and

breeding success spanning the decade (about 1 generation length) following the spill. Since the MV Treasure spill, the African penguin has been uplisted to Endangered in 2010 and most recently to Critically Endangered in 2024, warranting a re-assessment of the large scale oil spill response and its impacts on the population trajectory. Our updated analyses indicate that, although there was a transitory decrease in encounter probabilities for oiled birds in years directly following the spill, likely due to birds skipping breeding, the long-term breeding success and survival of birds that were oiled and rehabilitated was similar to that of birds that were not affected by the oil spill. This study highlights the importance of long-term assessments and evaluations of effectiveness of interventions over the animals' lifespan and confirms the success of the MV Treasure response in 2000.

Sex-specific variation in pre-molt foraging movements of Magellanic penguins (Spheniscus magellanicus)

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During migration, female Magellanic penguins (Spheniscus magellanicus) remain closer to shore than males. Sex-specific movement patterns increase mortality risk at sea, as traveling closer to shore increases exposure to fisheries, oiling, and pollution. This is particularly important in populations with skewed sex ratios, where the less abundant sex may be more vulnerable. A lesser-explored determinant of overwintering survival is the pre-molt foraging trip ("pre-molt trip"), during which adults prepare for the energetically costly catastrophic molt, when individuals can lose up to half their body mass in two weeks. We report on one of the first assessments of pre-molt trips and spatial relationships between mates. In 2025 and 2026, we deployed 16 and 20 satellite transmitters, respectively, on equal numbers of adult males and females at a colony in Punta Tombo. In 2025, mean trip durations were 34 ± 13 days (females) and 27 ± 5 days (males). Contrary to prior assumptions of a single trip, half of the penguins undertook multiple pre-molt trips >50 km from the colony. Mean trip distance was 304.6 ± 189.52 km for females (range: 99.33 - 754 km) and 179.46 ± 151.47 km for males (range: 58.11 - 535.14 km). Pre-molt tracks were processed using state-space models and variation in trip metrics was analyzed with mixed-effects models. We incorporated 36 tracks from 2025–2026 and 11 historical tracks to examine inter-annual variation, compare pre-molt movements with chick-rearing and migratory trips, evaluate within-pair spatial relationships, and test differences associated with life history and fledging phenology.

Surviving the heat: Increasing ocean temperatures and shifting breeding patterns of little penguins until the end of the century

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For species that rely on environmental cues to time reproduction, the ability to interpret and respond to changing conditions is critical for reproductive success. This is particularly true for little penguins (Eudyptula minor), which use water temperature and associated oceanographic features to time reproductive onset. We focus on a population in southeastern Australia, a climate change hotspot where ocean temperatures are rapidly rising. Using 25 years of data on environmental conditions, breeding phenology and reproductive performance from Phillip Island, we investigated which oceanographic drivers affecting penguins also influence variation in reproductive timing, and the consequences of these shifts. We found that long-term changes in environmental cues, especially increasing ocean temperatures and earlier onset of water stratification, have driven an advance in reproductive timing by over one month in recent decades. The cumulative intensity of marine heatwaves further contributed to these phenological shifts. Breeding responses varied among individuals, with older penguins breeding earlier and achieving greater reproductive success, suggesting that experienced individuals better interpret and respond to changing environmental cues. Projections to the end of the 21st century under IPCC scenarios suggest that little penguins will continue to advance reproductive onset in response to environmental cues. However, ecological or physiological limits may constrain further shifts, and non-linear effects on reproductive performance in response to environmental change could have negative consequences for population trajectories. Our findings highlight the importance of environmental cues in shaping reproductive strategies and underscore the need to consider potential thresholds in predicting species responses to climate change.

The heat is on: behavioural, physiological and reproductive evidence of heat stress in breeding king penguins

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Polar and sub-polar animals evolved to thrive in cold climates and may thus be particularly vulnerable to rising temperatures associated with climate change. Penguins may be especially vulnerable due to their dual habitat, alternating between foraging in cold waters and breeding/moulting on an increasingly warm land. Here, we characterized heat stress occurrence in breeding king penguins through behavioural observations (e.g. panting occurrence) and body temperature measurements. We observed that behavioural signs of heat stress are frequent in king penguins breeding in the sub-Antarctic region (> 20% of observations at mid-day), and that subcutaneous temperatures increase under high heat load, especially in penguins showing behavioural signs of heat stress. Subcutaneous and core body temperatures were moderately correlated and both increased with heat load. Yet, their responses were not parallel since core body temperature is markedly less sensitive to heat load than subcutaneous temperature. Air temperature alone was a poor predictor of heat stress occurrence, whereas the combination of high solar radiation, low wind speed and high air temperatures provided the strongest predictive power. Finally, reproductive failures were more likely to occur on warmer days, suggesting that heat stress may have significant sublethal effects that could ultimately affect population dynamics.

Unique Underwing Plumage Patterns Allow Individual Identification of 350 King Penguins at the Bahia Inútil Colony, Tierra del Fuego, Chile, and most are visiting subadults

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In September 2024, the first author noticed that the underwing patterns of black-and-white appeared to show individual variation that might permit positive ID of birds. Since then, one or two researchers have spent 2-4 days in most months, for a total of 100 person-days, photographing underwing patterns and a similar amount of person-days in analysis of the photos. After 150,000 photos, we have identified 325 different, distinguishable birds, most of whom are subadults. The colony currently has only approximately 100 resident breeding birds, and our photographs show that most birds that appear at the colony are subadults visiting only briefly.

We found that the underwing markings are stable over a period of more than 18 months and probably are fixed for life. Our photo analysis found that the transition lines of black to white on the leading edges of the wings contain so much detail and variation that, when combined with the details of the larger, more obvious black patterns of the distal 25% of the wings, it is possible to distinguish and identify individuals with total confidence.

Photos of the underwings would permit ID of thousands of birds, so it should be possible to identify all the individuals in the colony at Volunteer Point on the Falkland/Las Malvinas Islands. Distinguishing individuals using all the minute details on the underwings, however, would require an immense amount of work best done using custom-designed AI.

Using biologging data to unravel cognitive processes in foraging king penguins: within-trip experience-based decision and across-trip memory

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In wide ranging animals, foraging areas often lie beyond the direct perception range, requiring individuals to utilize encoded spatial information and decision-making strategies to locate and reach profitable areas. King penguins (Aptenodytes patagonicus) forage in a wide, three dimensional and dynamic environment: the Southern Ocean. Navigating this complex environment likely involves two distinct forms of learning: acquiring behavioral strategies and utilizing spatial memory to efficiently locate profitable areas. In this project, we propose to use tracking data of two successive foraging trips of breeding king penguins in order to evaluate whether individuals tend to revisit similar areas or on the contrary avoid specific areas depending on previous foraging success. We use two approaches at two different spatio-temporal scales by (1) evaluate entire foraging trip parameters and compare trajectories of successive foraging trips (across-trip memory), and (2) investigate fine-scale (i.e. patch exploitation) foraging and diving behavior within each foraging trip (within-trip memory). If individuals rely on memory to infer the location of profitable areas, we expect consecutive trip trajectories to be more strongly correlated with previous success than with the predictability of environmental features alone. Finally, if internal factors (previous patch residency time, travel time or number of prey-catching attempts) reveal to play an important role in foraging decision (in comparison to environmental parameters), we can argue that king penguins fine-tune their foraging behavior based on previous experience.

Using Egg Density to Predict Hatching Dates in Gentoo Penguins

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Accurately predicting hatching dates in seabirds provides valuable insights into reproductive phenology and supports efficient fieldwork in remote regions such as Antarctica. This study investigates the relationship between egg density—derived from egg morphometrics (length, breadth, and mass)—and hatching dates in Gentoo Penguins breeding on King George Island. A linear regression model was developed using measurements from 37 eggs in 20 nests monitored during the 2024–25 breeding season. Egg density was significantly correlated with hatching date (adjusted R^2 = 0.2026), with predictive performance of RMSE = 2.13 days and MAE = 1.72 days. Although egg mass loss relative to volume is expected to follow a non-linear trajectory across the full incubation period (~35 days), our dataset primarily represents the mid- to late-incubation phase. Within this range, the relationship was well approximated by a linear model, providing sufficient accuracy for practical field applications. This method offers a low-cost, minimally invasive tool for estimating hatching dates without continuous nest monitoring—an important advantage in logistically constrained Antarctic environments. Beyond operational benefits, such approaches can support detection of phenological shifts under climate change. Future studies incorporating early incubation measurements will allow evaluation of non-linear models and improve predictive performance.

Video evidence of pteropod predation highlights diet flexibility in Adélie penguins

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Understanding how climate-driven changes in the Southern Ocean may alter predator–prey interactions is essential, for evaluating ecosystem-level consequences, yet many trophic relationships remain poorly documented. Shelled pteropods (Thecosomata) are key components of Southern Ocean zooplankton but are highly vulnerable to ocean acidification, and their role as prey for higher predators has rarely been confirmed. Here, we present the first direct video evidence of pteropod predation by chick-rearing Adélie penguins (Pygoscelis adeliae) near Dumont d'Urville Station, East Antarctica. Seven of eight video-instrumented birds consumed pteropods (N = 1,449 captures), predominantly Clio pyramidata, with two individuals relying heavily on them (> 60% of prey). Other prey included krill, fish, and occasionally amphipods. Pteropods were encountered over a wide range of distances from the colony (0.8–47 km), whereas encounters with krill and fish occurred mainly far from the colony (24–50 km and 20–52 km, respectively). Pteropod encounters occurred over a broad depth range (1–82 m), with C. pyramidata most frequently captured at 35–45 m. Although average feeding rates in pteropod-dominated dives were lower than those in krill-dominated dives (6.4 ± 1.4 captures min⁻¹ and 9.5 ± 8.3 captures min⁻¹, respectively), the maximum number of pteropod captures in a dive was high (81 captures), indicating substantial number of prey captures when dense pteropod patches were encountered. Our findings reveal that pteropods can serve as an opportunistic yet substantial prey for Adélie penguins, highlighting an overlooked but potentially significant trophic pathway.

A Coastal Canary? Little Penguins (Eudyptula sp.) signal climate strain on temperate Australia

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In 2024, Australia recorded its warmest sea surface temperatures on record, followed by four consecutive months of unprecedented marine heat during summer 2024/25; waters off New South Wales (NSW) were up to 3°C above long-term averages. These events are already reshaping NSW marine ecosystems, with increased reports of warm-water species such as sea turtles and jellyfish signalling rapid ecological shifts. Against this backdrop, the 2022–2025 Seabirds to Seascapes statewide survey provides the first comprehensive assessment of Little Penguins (Eudyptula sp.) across the NSW coastline. Results indicate an 80% decline in breeding penguin numbers compared to intermittent surveys from the early 2000s. Similar declines have been observed at several sites in South Australia and Western Australia, indicating a possible contraction at the species' northern range edge.

These declines suggest that Little Penguins may be experiencing cumulative impacts from rising ocean temperatures, altered prey availability, and increased exposure to anthropogenic stressors. While rapid, large-scale reductions in greenhouse-gas emissions remain essential, effective adaptation will require integrated, threat-focused management. This includes local actions such as controlling invasive weeds, reducing vessel strikes, and expanding artificial burrow programs to buffer colonies against habitat loss. At a system level, the NSW Government's Marine Estate Management Strategy addresses priority threats identified by the 2017 statewide Threat and Risk Assessment - with climate change explicitly recognised alongside water pollution, coastal development and other pressures - to safeguard environmental, social, cultural and economic values, including targeted measures for threatened and protected species.

Age related changes in foraging behaviour variability of Adélie penguins (Pygoscelis adeliea)

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Behavioural variability, how variable an individual's behaviours are, is thought to be crucial for the ability to adapt to environmental change as it may allow individuals to respond rapidly to changes in environmental conditions. There is evidence that the degree of behavioural variability fluctuates across age classes; juveniles of many species tend to be more variable in their behaviour than adults. However, it remains unclear whether individuals change within their lifetime and how the environment influences the relationship between age and variability. Younger individuals may be more variable because selection has not yet acted on traits or because younger birds were born in more variable years. Here, using 34 years of data from an Adélie penguin population from Béchervaise Island, Antarctica, we use double hierarchical GLMs to explore how within-individual variability in foraging trip duration changes with age and with respect to environmental conditions. We show that behavioural variability decreases as individuals age, and that individuals differ in how their variability changes with age. We also show that the environment modulates the relationship between behavioural variability and aging in complex ways. These results suggest potential evidence of behavioural canalisation. Furthermore, environmental variability alters the pace of behavioural stabilisation, suggesting that increased environmental variability may prolong or contract the period during which penguins experiment with strategies. Finally, individuals that successfully fledge chicks exhibit consistently lower behavioural variability, suggesting a potential fitness advantage to less variable behaviour. This study emphasizes that age-related effects are fundamental to anticipating species resilience to environmental change.

Beyond Euthanasia: Biosecurity and survival during an HPAI outbreak

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Highly pathogenic avian influenza (HPAI) poses a major threat to southern African seabirds, with over 30 000 recorded deaths since 2017. African Penguins (Spheniscus demersus), recently uplisted to Critically Endangered, have been particularly impacted, with more than 1000 HPAI-related mortalities since 2018. Rehabilitation facilities face additional risk due to potential rapid within-facility transmission.

In November 2022, an H5N1 outbreak at SANCCOB's Cape Town facility exposed 330 African Penguins. Given their conservation status, standard mass euthanasia protocols were replaced with monitored quarantine and supportive care. Clinical outcomes showed that 60% of exposed individuals remained asymptomatic. Corneal oedema was the most common clinical sign, observed in 43% of infected birds. Despite concerns regarding disease severity, most penguins recovered and were successfully released, demonstrating that HPAI is not invariably fatal in this species.

These findings highlighted limitations of traditional biosecurity measures. Visual screening and offsite quarantine were insufficient, as asymptomatic individuals were capable of viral shedding. SANCCOB subsequently implemented a proactive prevention model, whereby all new admissions are housed in high-biosecurity quarantine units pending negative PCR results.

By December 2025, 71 confirmed and 16 suspected HPAI cases across multiple seabird species were managed under these protocols, with no facility-wide outbreaks recorded.

Targeted biosecurity, early diagnostics, and species-specific risk tolerance can enable rehabilitation centres to operate safely during a panzootic, providing a viable alternative to blanket euthanasia.

Climate variability shapes mercury exposure in little penguins: insights from a 15-year time series at a global warming hotspot

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Marine ecosystems are increasingly shaped by multiple interacting pressures, including pollution, ocean warming, and extreme climatic events. While each of these stressors has been studied individually, their combined effects on marine wildlife remain poorly understood, particularly regarding contaminant exposure. Mercury (Hg), a highly toxic contaminant, biomagnifies along marine food chains, leading to elevated concentrations in top predators. Consequently, contamination in seabirds is traditionally interpreted through a trophic lens, where diet and foraging ecology are considered the primary drivers. However, whether climate-driven environmental variability can also modulate Hg exposure pathways remains largely unexplored. Here, we investigated how environmental variability associated with climate change influences Hg contamination in a coastal predator, the little penguin Eudyptula minor. Using a 15-year time series (2010–2025) of blood samples from Bass Strait, southeastern Australia, one of the fastest-warming oceanographic regions globally, we combined stable isotope abundance (δ¹⁵N, δ¹³C) and Hg measurements to assess interannual variation in trophic ecology and Hg contamination. We tested the effect of key environmental drivers, including sea surface temperature, chlorophyll-a, and extreme events such as marine heatwaves and ENSO phases. By linking these variables to Hg contamination, we assessed whether climate variability can alter trophic structures and consequently modulate Hg contamination in a top predator. Hence, this study moves beyond traditional diet-based frameworks by integrating oceanographical dynamics into ecotoxicological analyses. Preliminary results suggest that interannual variation in Hg contamination in penguins may be associated with shifts in environmental conditions, emphasizing the need to incorporate these drivers into future assessments under climate change.

Event cameras, a novel tool for studying behaviour: Pilot study monitoring Ecstatic Display on wild penguins

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The ecstatic display (ED) is common in various penguin species, and has been known for long, but its chaotic nature has caused its function and quantitative details in Chinstrap penguins (Pygoscelis antarcticus) to remain unknown. This behaviour influences -and is influenced by- surrounding animals so it requires a complicated study in the time dimension as well in order to understand its "contagiuosness". In this chapter we pilot the use of a novel technology: event (or neuromorphic) cameras to characterise and quantify ED during two weeks within the chick-guard period at Deception Island, Antarctica. Event cameras are completely different from frame-based video recording as their sensors record changes in light intensity at each pixel whenever they occur (emulating retinal receptors), rather than capturing the whole frame at 25 to 30 fps. This change-based recording system plus their inherent microsecond time resolution and extensive dynamic range make these devices ideal for capturing movement. Detected events (pixel changes in light intensity) produced by a specific behaviour can be easily stacked up to show the "shape" of each behaviour. A sample of these shapes can be used to train a machine-learning algorithm. We use this dataset to characterise Ecstatic Display for the first time in Chinstrap Penguins over two weeks, study its occurrence, its contagiousness and differences between individuals. For the first time we are able to hypothesise about the function of ED as a territorial behaviour. Our pilot study proves this technique as an effective new way to monitor behaviour in colonial animals.

Emperor penguin's fossil relatives inhabited subtropical waters

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Fossils can reveal large differences between the geographic range that a species could potentially inhabit and the more restricted realised distribution where individuals presently occur. Extant great penguins (Aptenodytes spp.) include emperor (A. forsteri) and king penguins (A. patagonicus), which have polar and subpolar ranges, respectively. New evidence now reveals that the fundamental niche for great penguins includes much warmer environments. Until recently, the only published record of an extinct great penguin was the poorly dated Aptenodytes ridgeni from Motunau Beach, Canterbury, New Zealand. We report a skull of an extinct great penguin from Taranaki that lived in Zealandia during the Pliocene (~3 million years ago) when global temperatures were ~3°C above those of the preindustrial era. Because estimated sea surface temperatures around Zealandia then were 10–20°C warmer than those experienced by living emperor and king penguins, the reasons that great penguins are not still found around New Zealand might be more complex than climate pressures alone. Land-based predation might be an overlooked factor because Aptenodytes appears to have gone extinct in Zealandia coincident with the arrival of large raptors like Haast's eagle (Hieraaetus moorei).

Estimating 'hot-spots' of little penguin predation by long-nosed fur seals – it's complicated

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In Australia, there is a perception that rapid population recovery of long-nosed fur seals (Arctocephalus forsteri) is contributing to population declines in little penguins (Eudyptula minor). Both species co-exist across Australia and New Zealand and the importance of little penguins in the diet of the fur seal is not well understood. This is a combined consequence of sampling difficulties at remote and offshore islands, the use of different methods and their associated biases as well as the variability in the behaviour of the predators at both local and transoceanic scales. Little penguins can be an important prey item at some fur seal sites in Australia (records dated 1997-2017), but in New Zealand, penguins are near absent from the diet (records dated 1943-2018). To improve standardisation and comparison across south-eastern Australia (SA, Vic, Tas and NSW), we collected scats from 2017-2019 (n=979) at 23 sites, identifying little penguin remains in 0-58% (mean 19%). Scats from six sites contained zero penguin remains, while an equal number of sites were classified as predation hot-spots (penguin remains in ≥30% of scats), half of which were in Victoria. Predation hot-spots were broadly characterised as sites with <10 years of fur seal activity, but there was complexity at the local scale. We highlight the differences between predation patterns across south-eastern Australia and New Zealand and discuss the complexities in such research. The convenience of attributing little penguin declines to a single predator must not substitute research into the multi-faceted relationships between these species and their environment.

From Managed Care to Wild Populations: The Role of The Maryland Zoo in Baltimore in African Penguin Conservation

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The African penguin is a critically endangered seabird endemic to South Africa and Namibia, experiencing rapid population decline driven by reduced prey availability, habitat degradation, pollution, and climate-induced ecosystem shifts. Addressing these threats requires coordinated in situ and ex situ conservation strategies.

This presentation highlights the role of The Maryland Zoo in Baltimore, which has housed African penguins for over 60 years and is the leading breeder within Association of Zoos and Aquariums facilities. As a key contributor to the African Penguin Species Survival Plan, the Zoo supports genetic diversity across managed populations while leveraging its large colony to inform conservation efforts in southern Africa.

The Zoo's applied research includes molt studies and melatonin implant protocols to support feather

regeneration in rehabilitated birds prior to release, as well as avian malaria pharmacokinetic studies and treatment protocols. Standardized chick growth and rearing data have been shared with in situ partners to improve rehabilitation outcomes. The Zoo is also a founding member of the Namibian Foundation for the Conservation of Seabirds (NAMCOB), supporting monitoring programs with island-based rangers in Namibia and contributing to field research. Additional efforts include supplying transponder tags and readers to expand tracking initiatives and introducing artificial nests to Namibian colonies.

Through the AZA SAFE African Penguin Program, the Zoo contributes to oil spill preparedness via training, equipment support, and response planning, demonstrating the value of integrated conservation partnerships

From Research to Practice: An Evidence-Based Handbook for Penguin Conservation through Genetic Resource Banking

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The rapid decline of African penguin (Spheniscus demersus) wild population highlights the urgent need for complementary conservation tools that support the preservation of genetic diversity. Assisted reproductive technologies, including semen cryopreservation and biobanking, represent a promising but still underutilized approach in penguin conservation.

This presentation introduces a practical handbook developed as part of an implementation-oriented PhD project carried out in collaboration between ZOO Wrocław and the Wrocław University of Environmental and Life Sciences. The handbook is based on four years of applied research focused on developing and refining methods for cryopreservation of African penguin semen intended for long-term genetic resource banking.

Rather than presenting a single optimized protocol, the handbook documents key challenges encountered throughout the project, including limitations in semen collection, variability in sample quality, cryoprotectant selection, and post-thaw assessment. It also summarizes lessons learned from working with a relatively large donor group and emphasizes the importance of flexibility and sample-targeted approaches in cryopreservation.

Importantly, the handbook is designed as a practical roadmap for other zoological institutions and research centers interested in contributing to a collaborative penguin cryobank. It provides guidance on organizational, technical, and logistical aspects of establishing cryopreservation activities within zoo settings. By sharing both successes and limitations, this work aims to support coordinated, multi-institutional efforts to safeguard the genetic diversity of African penguins before further losses occur in the wild.

Genome architecture and structural variation reveal evolutionary history of Southern Ocean gentoo penguins

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Speciation in the Southern Ocean has been shaped by a complex interplay of environmental heterogeneity, geographic isolation and historical demographic change. In gentoo penguins (Pygoscelis spp.), strong oceanographic barriers and recurrent glacial cycles have generated deeply divergent lineages distributed across contrasting ecological regions. To investigate the genomic basis of this divergence, we generated a high-quality de novo reference genome and integrated it with population-level whole-genome data to examine patterns of demographic history, genomic differentiation and structural variation across lineages. This framework allowed us to explore how genome architecture may contribute to lineage divergence in a rapidly changing polar system. Our results reveal contrasting evolutionary trajectories among cryptic gentoo lineages, each leaving distinct genomic signatures consistent with their environmental and historical contexts. In addition, structural variants are disproportionately represented in highly differentiated genomic regions, suggesting a potential role in maintaining lineage divergence. These findings provide new insights into how genome architecture, demographic history and environmental heterogeneity interact to shape evolutionary divergence in Southern Ocean gentoo penguins, highlighting the importance of structural variation in the early stages of speciation. They are consistent with a scenario in which genome architecture contributes to the maintenance of divergence despite past connectivity among lineages and suggest that it is not only a consequence of divergence, but an active component shaping evolutionary trajectories in heterogeneous environments.

Handled with care - stress response development, survival, and recruitment of kororā, Eudyptula minor

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Chronic stress during development has the potential to impact individual growth, fledge mass and ultimately the survival and recruitment of young penguins. We investigated the impacts of repeated handling, associated with nest monitoring, on physiological stress responses and subsequent survival and recruitment of kororā (little penguin, Eudyptula minor) chicks. Long term monitoring has been conducted at two breeding colonies in Ōamaru, New Zealand, providing a unique opportunity to assess the impacts of frequent human interaction. In 2016, chicks were assigned to a group with varying handling frequency and age at sampling. Regularly handled chicks were weighed twice weekly to quantify growth rates and body condition. Stress responses were assessed via hypothalamic-pituitary-adrenal axis activity at two, four and six weeks of age for both regularly handled chicks and chicks with no prior handling. Frequent handling did not detectably alter short-term stress response development prior to fledging. To assess longer-term outcomes, these physiological measures were analysed alongside fledge date, fledge mass, and brood type to examine whether such traits determined survival and recruitment over a ten-year period. Results found that early-life traits, including growth and fledging condition, are important predictors of survival and recruitment, while the physiological effects of handling at this rate are not. These findings provide insight into the consequences of intensive monitoring for both individual fitness and long-term population studies for kororā.

Health assessments and pathogen surveillance: How building health data aids in conservation decision making

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Wildlife populations are affected by unprecedented anthropogenic disturbance worldwide. Climate change, habitat disruption, resource exploitation, toxicant introduction, spread of invasive species, and many other human actions contribute to disruption of ecological systems and rising extinction rates. In concert with and exacerbated by these impacts, wildlife populations experience increased exposure to pathogens, emergence of novel pathogens, and susceptibility to infectious and non-infectious disease. Therefore, incorporating wildlife population health into the process of creating, implementing, and evaluating conservation strategies is critical to conservation success. The Humboldt penguin (Spheniscus humboldti) is an IUCN-vulnerable species endemic to the Humboldt current on the west coast of South America. Health assessments have been performed for over three decades in a population of Humboldt penguins at Punta San Juan Reserve, Ica province, Peru. These techniques and approaches have evolved over time to fill gaps in knowledge and respond to emerging threats, such as Highly Pathogenic Avian Influenza and El Niño events. Since 2023, 159 individual penguins have been examined, blood collected, and pathogen detection assays performed. Results have identified new viruses and bacteria not previously known, as well as clarifying epidemiology of pathogens that may impact penguin health. Integrated health assessments allow biologists and veterinarians to understand the complex dynamic in which these animals live, thus improving conservation actions that support good health.

Little Blue Penguin Gut Microbiome: a 2026 Case Study in Disease and Development

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Multiple species of penguin have long been successfully reared from hatch through adulthood under human care. Depending on facility needs and operational considerations, chicks may be left with their parents or hand reared by animal care specialists. Chicks left in the nest are fed partially digested fish via parental regurgitation, while hand-reared chicks are fed a blended formula consisting of fish, invertebrates, and various supplements. Despite efforts to account for nutritional needs, hand-reared chicks have anecdotally reported higher rates of gastric issues, failures to thrive, and other developmental complications.

The original goal was to collect and analyze fecal samples from a full-sibling pair of little blue penguins, one parent reared and one hand-reared. For the first two weeks, there was no observable difference in health and demeanor of either chick, although the parent-reared had a notable, but expected, higher rate of weight gain. At 17 days of age, the hand-reared chick began to decline in health. Multiple interventions were attempted, including fluid therapy, a parental “fecal transplant,” and, ultimately, antibiotic administration. Despite interventions, the hand-reared chick suddenly passed at 48 days. Fecal samples from the mortality chick were banked at multiple stages of treatment, and will be compared through metagenomic sequencing against fecal samples from the parents as well as the parent-reared sibling. The other individuals will act as a baseline to gauge the efficacy of the various interventions, as well as offer a comparison of the developing microbiome between hand and parent reared chicks.

Linking personality to foraging behaviour in chinstrap penguins: a bio-logging approach

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Animal personality has been proposed as a key driver of animal behaviour. The focus of behavioural ecology is turning towards individual differences and their ecological and evolutionary implications. This implies that individuals may take different behavioural strategies driven by their personality, and not only by external factors. Aspects like foraging have long been interpreted as being dependent on prey availability and environmental factors, ignoring intrinsic traits such as personality. In this study, we focused on the shy-bold axis to investigate whether boldness is related to foraging behaviour in the Chinstrap penguin (Pygoscelis antarcticus). During two reproductive seasons, we selected breeding adults at the chick-rearing phase in Deception Island, Antarctica. We first assessed individual personality through a novel object test and then deployed GPS and accelerometers to analyze their foraging trips. Combining both methodologies, we aimed to explore consistency in their foraging behaviour across years and establish a relationship between boldness and their foraging strategies. Our preliminary results show consistent individual differences in personality and foraging parameters: bold individuals tend to show more exploratory behaviour than shy ones, through differences in foraging patterns, such as dive depth and duration. These observations suggest that personality may play a role in shaping foraging strategies in chinstrap penguins, highlighting the importance of studying intrinsic traits to understand individual responses to the environment.

Linking post-moult physiology to migration in chinstrap penguins from Deception Island

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Long-distance winter migration of chinstrap penguins tracked from the northern Antarctic Peninsula has revealed repeated use of the Pacific sector of the Southern Ocean, particularly the Ross Gyre–Amundsen Sea region, where persistent winter hotspots have been associated with elevated chlorophyll, reduced travel speeds and recurring occupancy of productive winter habitat.

Here, we investigate whether post-moult condition is associated with subsequent migration behaviour in chinstrap penguins breeding at Vapour Col colony, Deception Island, Antarctica. Across three field seasons (2022–2023, 2023–2024 and 2024–2025), we sampled 41 newly moulted adults immediately after the fasting period and before entering the water. For each bird, we collected blood to assess biochemical indicators of nutritional state, sampled body feathers, and deployed satellite transmitters.

Results show that birds from Vapour Col migrate towards the Ross Gyre sector, with some individuals performing movements exceeding 4,000 km, and reveal marked inter-individual variability in both migration routes and blood biochemical profiles at departure. By integrating telemetry and physiology, this study addresses a key gap in understanding carry-over effects between moult condition and migration in Antarctic penguins. These results are discussed in the context of climate-driven changes affecting wintering conditions in the Southern Ocean.

Local predation impacts on African Penguins (Spheniscus demersus) based on rehabilitation and mortality records at SANCCOB (2017–2025)

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The African Penguin (Spheniscus demersus) has undergone severe population declines driven by interacting threats including reduced prey availability, climate change, pollution, and predation. In response to shifting prey distributions, penguins have increasingly established mainland colonies, where exposure to terrestrial predators is elevated.

We analysed African Penguin mortality and rehabilitation records from the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB) from 2017 to 2025 to assess patterns of suspected predation. Both dead-on-arrival (DOA) carcasses and live admissions were included and classified by predator type, age class, and colony of origin. These data represent a minimum estimate, as many predation events are undetected.

A total of 656 suspected predation cases were recorded as DOAs at an average of 73 cases a year. Caracal predation was most frequent (261 cases), primarily affecting adults, while mongoose predation was restricted to chicks (221 cases). Seal predation (75 cases) mainly involved adults and juveniles. Most carcasses originated from mainland colonies, particularly Simon's Town (348) and Stony Point (270).

Live admissions comprised 894 suspected predation cases at an average of 99 cases a year. Seal (190 cases) and shark predation (122 cases) dominated and largely affected adults and juveniles, while caracal predation (57 cases) remained adult biased. Mainland colonies again contributed most cases.

Predation represents a substantial and ongoing source of mortality, particularly at mainland colonies, highlighting the need for targeted, site-specific predator management.

Mitigating transponder tag migration risk in Hoiho – testing a new technique

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Individual identification of Hoiho (Yellow-eyed Penguins, Megadyptes antipodes) is crucial to their intensive management within their northern range, and supports research and monitoring objectives for population counts, health screening, life-history and survival analyses in their subantarctic range where these data are deficient. However, the use of neck inserted Passive Integrated Transponder (PIT) tags was suspended following evidence of tag migration into the thoracic inlet and near vital organs. Despite a paucity of documented cases of PIT tag migration in other penguin taxa, discussion with experts highlighted knowledge of the issue following neck implantation with concern for potential adverse effects. The insertion site for several large penguins has been changed to inguinal, lateral leg, or on top of the foot, again with little published literature outlining protocols, detectability, migration risk, or possible adverse effects. We present preliminary results of neck-inserted tag migration of Allflex 23mm HDX and Trovan 11.5mm FDX-B units as well as an Animal Ethics trial of lateral leg implantation of Trovan 11.5mm FDX-B transponders into Hoiho chicks and adults. We aim to develop appropriate and training and monitoring protocols alongside updated marking Best Practice guidelines.

Modelling oil spill risk to African Penguins in Algoa Bay, South Africa (from ship-to-ship bunkering)

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Maritime activities, especially ship-to-ship bunkering (the refuelling of one ship by another at sea) pose a large risk of oil spills. When such activities are taking place near important biodiversity areas, oil spills may affect threatened species, adding to the existing conservation concerns. Ship-to-ship bunkering operations were established in Algoa Bay in 2016, in close proximity to St Croix Island, then the world's largest colony of Critically Endangered African penguins (Spheniscus demersus). Several oil spills have occurred since the commencement of ship-to-ship bunkering activities, affecting several threatened seabird species, including the African Penguin as well as endangered Cape gannets and Cape cormorants. The biggest concern has been around St Croix Island, but the Bird island group further away from anchorage sites and home to the world's largest Cape gannet colony, may also be affected. We modelled the potential for oil spills to affect seabirds in Algoa Bay using the OpenOil Lagrangian particle tracking software, using different scenarios at various times of the year and amounts of oil spilled, including a realistic scenario from a historical bunkering spill. Overlaying the oil spill model results with known foraging areas of African penguins allowed us to identify areas most at risk. The model revealed that even oil amounts considered "below ecological thresholds" may have severe impacts on threatened species. The results of this study may help first responders to focus on priority areas and highlights the high threat that ship-to-ship bunkering represents in the high biodiversity areas.

Niche width impacts phenological match-mismatch of Adelie and gentoo penguins in a changing climate

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Across Antarctica, climate change is evident with the most rapid warming observed along the west Antarctic Peninsula where air and sea temperatures have warmed, sea ice has declined and glaciers have retreated. Amidst these environmental changes, ice-obligate Adélie penguins (Pygoscelis adeliae) have declined and ice-avoiding gentoo penguins (P. papua) have increased. To understand these dynamics, we compared the breeding phenology of Adélie and gentoo penguins from nearby colonies, penguin foraging behavior from GPS-depth loggers, and acoustically derived prey availability over five years. Adélie penguins had a more synchronized breeding period than gentoo penguins, and prey resources in Adélie foraging areas had a narrower peak in abundance earlier in the season than the broader peak of prey in the gentoo foraging area. Adélie penguins had shallower dive depths with limited variation between years that corresponded to a relatively shallow peak of prey. Comparatively, gentoo penguin dive depth was deeper and more variable with prey exhibiting high variability in depth across space and time. Penguin dive depths—particularly for gentoos—and weighted-mean prey depths increased as the season progressed. We observed that Adélie penguins were more specialized than gentoo penguins in their breeding phenology and foraging behavior and yet foraged on prey within a narrower seasonal peak than gentoos. Adélie penguins in our study had a greater mismatch with their prey resources than gentoo penguins. As the climate continues to warm, specialized Adélie penguins may be at a disadvantage over more flexible predators including gentoo penguins.

Novel Candidiasis granuloma in a little penguin (Eudyptula minor)

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Fungal disease is commonly reported in captive avian species. The little penguin (Eudyptula minor) is a key mesopredator in temperate costal ecosystems of southern Australia and New Zealand. As a central-place forager, its health and reproductive performance is closely linked to nearshore productivity, making it an important indicator of marine ecosystem condition.

An 11-year-old female captive little penguin presented with acute illness. Haematology revealed leukocytosis and radiographs identified consolidation of the right caudal lung field. Serum testing showed abnormalities on protein electrophoresis (PEP) and Computed Tomography (CT) revealed a large soft tissue mass within the lateral coelomic cavity compressing the adjacent lung.

Due to the size and dissemination of the lesion, euthanasia was performed. Necropsy identified a 180 gram coelomic mass with multi-organ involvement. Periodic acid–Schiff staining demonstrated septate fungal hyphae with mildly irregular walls and acute to right-angled branching, morphology not entirely consistent with Aspergillus spp., the fungal genus most associated with disease in penguins. Fungal culture of fresh frozen tissue yielded Candida parapsilosis. To our knowledge, this is the first reported case of a Candida-associated granuloma in a captive little penguin.

Increasing anthropogenic pressures on coastal habitats may elevate exposure to environmental fungal pathogens, with implications for wildlife health. This case illustrates the diagnostic utility of CT for detecting space-occupying coelomic lesions not fully characterised by radiography and emphasises the risk of opportunistic fungal disease in captive and rehabilitating penguins. Integration of CT, together with PEP, may support earlier diagnosis and improved clinical decision-making in managed penguin populations.

Pagophilic rather than sea-ice obligate: a review of Adélie penguin molt patterns

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The Adélie Penguin has typically been classified as a 'sea ice obligate' species. It is a member of a pagophilic group of species, its range being largely restricted to the high latitude zone in which sea ice is present, even for just part of the year. However, it nests on snow- and ice-free land, as well as needing open water (polynya) adjacent to the colony. Requiring a stable substrate on which to molt, for decades, the sea ice obligate paradigm required that it find sea ice to do so. However, in a review of the literature, exceptions to that rule are too numerous to still ignore, though largely deemed to be just that: exceptions. We counted molting penguins at Cape Royds, from 2008 to 2023, using a system of cameras taking daily images. Large numbers, ranging 7-30% of colony size, depending on year, were counted as molting, 2 Feb to 17 March (peak 20 Feb-2 March). The peak number of molting penguins varied inversely with colony size and the amount of sea ice present in nearby McMurdo Sound. That result was contrary to observations from a few earlier reports in low latitude Antarctica, where the sea ice season is relatively short, i.e. sea ice gone well before end of the breeding season (after which molt occurs). The indicated plasticity in molting, as well as in other aspects of its life history, likely contributes to the Adélie penguin being one of the most ecologically successful penguin species.

Penguin conservation requires an evolutionary perspective

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The inspiring concept of Evolutionary Significant Unit (Ryder 1986) refers to populations of a species presenting potential different adaptive variation due to specific ecological pressures. These units contain an important component of the evolutionary legacy of the species attending to local adaptation processes, and identifying their adaptive traits is key to understanding the whole process. Rapid environmental change and increasing human activity are reshaping ecological dynamics across Antarctica. Current conservation frameworks largely prioritize species-level status and global population size, implicitly assuming that small or peripheral populations contribute little to species persistence. However, populations at specific ecological and climatic locations may constitute Evolutionary Significant Units, holding disproportionate evolutionary importance, acting as reservoirs of adaptive variation and early indicators of species responses to environmental change. Nowadays, these peripheral populations are increasingly exposed to emerging anthropogenic pressures, often justified by their limited demographic contribution to global population trends. But such reasoning overlooks their potential role in maintaining evolutionary processes, ecological resilience, and future adaptive capacity under rapidly changing conditions. Here, we propose that conservation in Antarctica must adopt the evolutionary perspective, because integrating evolutionary potential into management frameworks is essential to anticipate biodiversity responses in a rapidly transforming Antarctic system. Emperor penguins illustrate this need. Despite their ecological importance, the species is not currently recognized as an Antarctic Specially Protected Species, and some peripheral colonies, particularly the northernmost one, are increasingly subject to emerging tourism pressures. But from an evolutionary perspective, such populations may represent irreplaceable components of the species' adaptive legacy.

Safe in the subs? Population counts indicate a decline in numbers of hoiho at Motu Ihupuku Campbell Island

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Hoiho or takaraka (yellow-eyed penguins, Megadyptes antipodes) are difficult to census due to their nonconformity to colonial breeding and cryptic nest site selection in dense vegetation. Over two seasons, we used a combination of novel and traditional methods to understand the distribution and population size of hoiho on subantarctic Motu Ihupuku (Campbell Island). Transit observations were complemented by longer periods of one to 16 weeks of trail camera monitoring, providing coverage of 62% of accessible landing points where hoiho could be reliably counted at peak times. GPS-TDR data were used to determine foraging trip duration, frequency, and landing point fidelity. Bayesian models indicate a decline in numbers of mature individual hoiho when compared to surveys conducted in 1987 and 1992. These result challenge the assumption that the subantarctic will remain a stronghold as populations of hoiho on mainland New Zealand continue to decline towards localised extinction.

Sentinels of change: understanding resilience of Antarctic seabirds to global warming using ancient environmental DNA

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Antarctic marine top predators are ecological sentinels, providing indicators of environmental change. Their distributions, population sizes, and diets are shaped by external drivers such as climate, sea ice extent, and glaciation through both direct effects (e.g. access to breeding habitat) and indirect effects mediated through food webs. Penguins and petrels exhibit strong natal philopatry, with breeding colonies—comprising tens of thousands of individuals—remaining occupied for millennia. Over these timescales, layers of excreta accumulate to form stratified environmental archives that capture past ecological conditions. Snow petrels (Pagodroma nivea) preserve long records of change as stomach oil (mumiyo) deposits, while Adélie penguins (Pygoscelis adeliae) generate archives through guano accumulation. These deposits retain biological material suitable for ancient DNA analysis. Ancient DNA provides advantages over traditional palaeoecological approaches by enabling: (i) comprehensive reconstruction of past biodiversity across all domains of life; (ii) detection of genetically distinct populations; (iii) quantification of genetic diversity as a proxy for population change; and (iv) investigation of long-term evolutionary and adaptive processes. Here, we will apply ancient metagenomics to environmental archives from abandoned seabird colonies across Antarctica to reconstruct ecosystem responses to past warming, generating long-term baselines to inform conservation and management under ongoing climate change.

Spatial segregation in habitat use by breeding macaroni penguins from a colony in Kerguelen islands is linked to differences in energy requirements and prey depletion halo

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Breeding seabirds are central-place foragers whose foraging behavior is shaped by energetic demands, prey availability, and environmental variability. Macaroni penguins (Eudyptes chrysolophus) exhibit a female-biased provisioning strategy during chick-rearing, imposing different energy and foraging constraints between the sexes. In this study, we investigated the foraging behavior and habitat of both male and female macaroni penguins breeding at Kerguelen Islands, a key breeding area in the South Indian Ocean, using multiple years of tracking data. We compared foraging trip characteristics and oceanic habitat use across incubation, brooding, and crèche stages, and assessed how oceanographic variables shaped adult distribution at sea. Foraging behavior varied markedly across breeding stages and between sexes, with chick-rearing trips being shorter and more spatially constrained than incubation trips. During the chick-rearing phase, males and females adopted distinct strategies: males undertook longer, distant trips likely associated with self-provisioning following an extended fasting period on land, while females prioritized chick provisioning through shorter and more frequent trips. Our results show marked sexual segregation of foraging locations likely linked to differences in energy requirements and breeding duties and further suggest the existence of a halo effect (gradual prey depletion due to intense foraging activity) around the breeding colony. Segregation of foraging locations of males and females may participate in alleviating intra-specific competition both within the population and with other colonies on the island.

Species-Specific Immune Signatures in Antarctic Penguins Under Environmental Change

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Rapid environmental change in the Southern Ocean is reshaping pathogen dynamics and contaminant exposure, directly impacting seabird health. However, assessments of penguins' immune status remains scarce, limiting our ability to detect physiological responses to these stressors. As part of broader projects investigating interactions between contaminants, pathogens, and immune function, we characterised haematological health indicators in sympatric chinstrap(Pygoscelis antarcticus; n=30) and gentoo (P. papua; n=30) penguins breeding on Livingston Island, South Shetland Islands (Antarctic Peninsula). Blood smears were analysed to assess leukocyte counts and heterophil-to-lymphocyte (H:L)ratios, which are established markers of physiological stress and immune response. Haemoparasites were absent in both species, suggesting no recent infections prior to sampling. Total leukocyte counts and H:L ratios were significantly higher in gentoo(leukocytes: 59.6 ± 24.3; H:L ratio: 1.9 ± 1.5) than in chinstrap penguins (leukocytes: 39.7 ± 18.4; H:L ratio:1.4 ± 1.4); this is consistent with a comparatively higher inflammatory profile in gentoo penguins. Gentoo penguins also showed higher eosinophil, basophil, and monocyte counts, while nuclear abnormalities were observed in only one erythrocyte. In contrast, chinstrap penguins displayed higher lymphocyte proportions and more balanced leukocyte profiles, indicative of lower baseline physiological stress. Blood mercury concentrations are currently being analysed to determine whether the immune profiles are associated with relative mercury exposure among individuals and between species. Corticosterone concentrations will also be measured to further assess physiological stress. These findings establish species-specific haematological reference values and highlight the utility of haematological metrics as indicators of penguin health and environmental stress in the Antarctic ecosystem.

The cost of wearing the crown: sustained glucocorticoid exposure impairs reproductive performance in king penguins

Ms Anais Cotton

Parental investment in long-lived seabirds involves trade-offs between self-maintenance and offspring care, particularly under harsh environmental conditions. Hormonal regulation, notably corticosterone (the 'stress' hormone), promotes self-maintenance, while prolactin, believed to act antagonistically, supports parental behaviours and reproductive effort. In king penguins (Aptenodytes patagonicus), breeding occurs under extreme environmental and social pressures, yet the effects of elevated parental corticosterone on prolactin levels and offspring performance remain unknown. To fill this knowledge gap, we implanted wild-caught breeding adult king penguins with 90-day, continuous-time-release corticosterone pellets. We followed parental hormone profiles and behaviour over the breeding season and assessed chick weight, survival until fledging, and relative telomere length (i.e. a potential biomarker of subsequent survival), comparing offspring of treated versus control parents.

Corticosterone treatment significantly elevated parental plasma corticosterone levels for at least one month, after which levels returned to pre-treatment values, likely due to a negative feedback loop. This experimental increase in corticosterone resulted in a durable reduction (> 1 month) in parental prolactin levels in both sexes. Both males and females reduced the duration of their foraging trips at sea during egg incubation. Offspring of implanted parents exhibited lower weight from day 35 onward and lower survival rates than controls. In addition, these same chicks showed shorter relative telomere length at day 35, indicating potential long-lasting effects on their physiology and fitness. These findings highlight how parental stress can directly influence offspring development and survival, with potential consequences for population dynamics in long-lived seabirds.

The effects of environmental variation on the survival and reproductive ecology of little penguins (Eudyptula minor) in an urbanised colony

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Penguins rely on terrestrial as well as marine habitats for breeding and nesting and must therefore respond to environmental changes on land and at sea. In colonies located within sheltered coastal systems, terrestrial conditions may play a disproportionate role in shaping breeding outcomes relative to marine drivers. We examined the effects of environmental variation on the population demographics of an urban colony of little penguins (Eudyptula minor), at St Kilda, Victoria, Australia. We used a long-term dataset collected by volunteers over 29 years, which monitored colony attendance and weight of individual penguins. Penguin demographics, including adult and chick body mass, the timing and duration of the breeding season, and the survival and age at first return and breeding of little penguins, were calculated and compared with marine and terrestrial environmental data.

Adult male body mass was negatively affected by increases in ambient temperature and rainfall, particularly during the moulting period. The timing of the breeding season was affected only by rainfall, with breeding occurring later and over a shorter timeframe when rainfall was higher prior to breeding. Chick survival and age at first breeding were not influenced by any environmental variables, while the age of chicks at their first return to the colony was positively associated with ambient temperature.

Overall, little penguin demographics at St Kilda were more influenced by terrestrial conditions, suggesting that colony constraints may override marine variability. However, the limited influence of most environmental variables indicates this population remains flexible in responding to environmental change.

What drives penguin recovery? Insights from IUCN Green Status of Species and life-history and threat-based analyses

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Understanding the drivers of species recovery is an important but underdeveloped area of conservation science. Previous research on penguins has largely focused on the causes of population decline and extinction risk; however, far less is known about recovery dynamics. It remains unclear how recovered each species is relative to a pre-human impact baseline, and whether recovery is constrained by life-history traits, anthropogenic threat exposure, or interactions between the two. This study has two aims: (1) to assess penguin recovery across the taxon by conducting International Union for the Conservation of Nature (IUCN) Green Status of Species assessments, a relatively new approach that provides a standardised method to quantify species recovery and conservation impact but has not yet been applied comprehensively across penguins. Applying the IUCN Green Status framework across an entire taxon is uncommon and provides an opportunity to directly compare recovery potential among species. (2) Using the findings from the IUCN Green Status assessments, this study investigates the extent to which variation in species recovery status can be attributed to interspecific differences in life-history traits, exposure to anthropogenic pressures, or interactions between them that may constrain recovery. By combining a novel application of the IUCN Green Status framework with life-history and anthropogenic threat data, this research will provide the first comprehensive evaluation of penguin recovery and a predictive framework for understanding resilience, with important implications for conservation planning and resource prioritisation under ongoing environmental change.

Posters

A Geometric Trap: Iceberg-induced Collapse of Access to an Emperor Penguin Colony

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Rapid environmental change in Antarctica highlights that emperor penguin populations are vulnerable not only to regional sea-ice decline but also to localized physical disturbances that disrupt access to breeding colonies. Here, we demonstrate a ~69% decline in spring chick counts at Coulman Island in 2025 using integrated multi-satellite analyses and field surveys. A giant iceberg calved from the Nansen Ice Shelf became grounded in late July along a narrow coastal margin, blocking the colony's primary access corridor prior to chick rearing. Three-dimensional reconstruction revealed pronounced morphological asymmetry forming a "geometric trap": gentle ocean-facing slopes facilitated ascent, while a steep colony-facing escarpment (>20 m) prevented return, funneling penguins into impassable areas. The semi-enclosed geography of Coulman Island further obscured a ~1 km alternative route, limiting effective detours. Very-high-resolution imagery and field observations confirmed near absence of guano staining and widespread chick mortality. These findings indicate a functional collapse of colony accessibility driven by the interaction between iceberg morphology and local topography. As climate change increases ice-shelf instability and iceberg discharge, such stochastic physical barriers are likely to play an increasingly important role, potentially rivaling sea-ice decline, in shaping emperor penguin breeding outcomes.

Aquariums as Platforms for Global Penguin Conservation Engagement

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In Japan, penguins are widely appreciated by the public; however, conservation challenges affecting species from distant ecosystems often remain abstract and difficult to relate to. Since its opening in 2012, Aquarium has exhibited Magellanic penguins (Spheniscus magellanicus) to foster public understanding of global biodiversity. By presenting a species native to South American coastal environments, the aquarium provides opportunities for visitors to engage with ecological and conservation issues beyond Japan's immediate surroundings.

In 2024, the aquarium initiated a field-based project in Argentina, interviewing researchers from the Argentine Institute of Marine and Environmental Research (IBIOMAR-CONICET) and documenting wild breeding habitats. Using these materials, interpretive panels were developed to compare the behavior and seasonal physiology of captive penguins with those in the wild. This approach enabled visitors to better visualize the connection between penguins in the aquarium and their natural ecosystems, which had previously been difficult to convey.

In 2025, the project expanded through renewed collaboration at San Lorenzo, Valdés Peninsula, Patagonia. Utilizing satellite internet technology, real-time live streaming of field activities and researcher commentary was delivered to audiences in Japan. Despite the significant time difference and late-night broadcasts, more than 100 viewers participated and actively engaged through comments. Two-way interaction with field researchers transformed viewers from passive observers into active participants in the conservation experience.

This project demonstrates a practical framework for participatory, aquarium-based conservation education, suggesting the potential of aquariums to connect the public, researchers, and wildlife while fostering sustained interest in global penguin conservation.

A Global Colony Database for All 18 Extant Penguin Species

Mr David Goodman[1], Dr. Tom Hart, Dr. Molly Grace

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Penguins are among the most intensively studied seabirds, yet no taxonomically complete, colony-level database exists for the taxa. Here we present [DatabaseName], the first global database consolidating colony-level information for all 18 extant penguin species. Compiled through a large-scale international collaboration, the database integrates colony location, size estimates, breeding status, and temporal survey records sourced from published literature, unpublished institutional datasets, and long-term monitoring programmes. Collectively, these records constitute the most spatially and demographically comprehensive inventory of penguin colonies ever assembled. The database provides a critical baseline for tracking population trajectories, identifying systematic data gaps, prioritising conservation interventions, and enabling cross-species comparative analyses at a global scale. We describe the database architecture, data harmonisation methodology, taxonomic and geographic coverage, and known limitations, alongside protocols for ongoing community contributions. This freely accessible resource represents a foundational reference for penguin research and conservation science under conditions of accelerating environmental change.

Active Disease Surveillance in the Little Penguin (Eudyptula minor)

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Phillip Island ("Milawul") supports the world's largest colony of little penguins (Eudyptula minor), a population of ecological, cultural, and economic significance. Despite decades of research and targeted conservation by Phillip Island Nature Parks stabilising population numbers, information on current colony health and emerging disease risks remain limited.

Following an interdisciplinary Disease Risk Analysis (Vaughan-Higgins et al., 2024), an active disease surveillance program was implemented in 2025 to address critical knowledge gaps in pathogen presence and prevalence, complemented by ongoing passive surveillance.

The health of 400 wild penguins is being assessed in a cross-sectional study over a two-year period, representing 1% of the population. Physical examinations, clinical pathology and targeted screening for high-risk and emerging pathogens are being undertaken to evaluate current colony health and disease risks. Sampling aligns with critical physiologic timepoints in the little penguin annual cycle, investigating the influence of seasonality and energy demand on both individual disease susceptibility and potential colony-level impacts. The first 18 months of findings will be presented, with detected pathogens and their corresponding impact reported.

The insights from this study will guide future biosecurity planning, risk mitigation strategies and outbreak preparedness supporting the long-term resilience of this globally significant population.

Adélie penguins adjust their social foraging strategy in relation to the recent foraging success

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Colonial animals are theoretically expected to use social information to reduce uncertainty regarding food location and quality; however, few empirical studies have investigated how they acquire and when they rely on such information. Here, we simultaneously tracked 96–116 breeding Adélie penguins, corresponding to 35.6–43.0% of active breeders in a colony, across 653 foraging trips, and examined their movement decisions. We found that foraging site selection was most often predicted by individuals' own previous space use, but in 17.1% of trips, it was better predicted by incorporating the prior space use of conspecifics that departed the colony together. Notably, the simulation with random replacement tests indicated that group departure is a prerequisite for the effects of conspecifics on foraging site selection. Furthermore, penguins with unsuccessful prior trips, quantified as a reduced frequency of foraging dives, changed foraging sites more frequently than those with successful prior trips, relying more on the experiences of conspecifics. These findings suggest that group departure and travel facilitate social information acquisition, particularly for individuals that have recently been unsuccessful in foraging trips. Our study highlights the strategic use of social information and its potential benefits for foraging penguins.

African penguins' behaviour is affected by motor boat airborne noise: an experimental study on wild penguins

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Maritime traffic has expanded exponentially in recent decades, leading to a significant increase in marine noise pollution, a recognized threat to biodiversity. The African penguin (Spheniscus demersus), now classified as Critically Endangered, has experienced a dramatic population decline, with fewer than 10,000 breeding pairs remaining as of 2024. Among the drivers of this decline, noise pollution is suspected to have played an important role, especially near breeding colonies.

This study experimentally assessed the impact of motor boat airborne noise on the behavior of African penguins at the Stony Point colony (South Africa). Playback experiments conducted on land near their colony exposed groups of penguins to three noise levels (low: 61-64 dB, medium: 67-70 dB, high: 73-76 dB), simulating boats at varying distances. Results showed that 100 % of individuals reacted to the noise, primarily through increased vigilance at the expense of resting behaviors such as preening or standing. Although few individuals fled the group, noise exposure significantly altered their activity budget with potential physiological consequences. Penguins returned to baseline behavior after noise cessation.

This study confirms the sensitivity of African penguins to anthropogenic noise and emphasizes the need to implement mitigation measures into conservation plans (e.g. limiting maritime traffic and boat speeds). The findings also suggest that noise impacts are temporary, offering an opportunity for rapid and effective conservation actions.

Annual variation of sea ice conditions and its impact on foraging behavior of Adélie penguins during incubation period

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Antarctic sea ice extent has exhibited a rapid decline since 2016, raising concerns about how apex predators are affected by such rapid marine environmental change. Adélie penguins (Pygoscelis adeliae) are one of the most ice-obligated species, and thus inter-annual comparisons of their foraging behavior may provide clues to understand the mechanisms of their ecological response to environmental change. To evaluate the effects of annual variation in sea ice conditions on foraging behavior, we investigated habitat use of Adélie penguins during the incubation period. A field study was conducted on Mame Island, Lützow-Holm Bay, East Antarctica, from November to December in 2023, 2024 and 2025. We deployed GPS-acceleration-depth data loggers and successfully tracked first trips of 10 to 18 females and males during the incubation period in each year. Over the three years, their foraging habitat was characterized by two sea ice features: on-shelf polynya-like open water, and off-shelf pack ice. Females visited the off-shelf pack ice more frequently than males, whereas males tended to remain in the on-shelf open water, with interannual variation. As a result, mean female trip duration varied from 16 to 27 days depending on the off-shelf pack ice conditions, whereas male trip duration was less variable between 11 and 15 days. We hypothesize that the changes in sea ice conditions during late spring/early summer affect females and males in a different manner, and females are more sensitive to changes in off-shelf pack ice conditions.

Behavioral and physiological assessments of captive penguin density to reconsider welfare standards: A multi-species study

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For the success of ex-situ conservation, effective habitat design is essential for animal welfare, supporting the expression of natural behaviors and the optimal space use. The Japanese Association of Zoos and Aquariums established guidelines for appropriate captive penguin facilities in 2020 based on the care manual by the Association of Zoos and Aquariums. However, the guidelines lack scientific validation, raising concerns about overestimated population densities and potential risks to welfare. This study aims to contribute to evidence-based revisions of the guidelines by identifying the optimal population density for captive penguins through the evaluation of behavioral patterns and physiological stress responses. We focused on seven species: Humboldt (Spheniscus humboldti), African (S. demersus), Northern Rockhopper (Eudyptes moseleyi), Gentoo (Pygoscelis papua), Adélie (P. adeliae), Chinstrap (P. antarcticus), and King Penguins (Aptenodytes patagonicus), housed in 10 zoos and aquariums in Japan. We investigated the relationships between population densities and behavioral and stress parameters by experimentally manipulating population densities. Behavioral data were collected using animal-borne data loggers equipped with tri-axial accelerometers, allowing us to quantify daily activity budgets (e.g., resting, walking, standing, diving) and swimming depth. Fecal glucocorticoid metabolites were measured by ELISA as a non-invasive stress indicator of environmental conditions. Additionally, to clarify the effects of land area and floor material on the incidence of pododermatitis (bumblefoot), lesion severity was evaluated in Humboldt and/or African penguins at each facility. In this presentation, the project's progress and preliminary findings will be reported.

Beyond "Extra Hands": Exploring the Multi-Dimensional Motivations of Penguin Ecotourism Volunteers

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Conservation organisations increasingly rely on volunteers to achieve complex organisational objectives, yet the motivations of visitor experience volunteers in high-traffic ecotourism settings remain under-researched. This study examines the motivations of volunteers at the Penguin Parade (Phillip Island Nature Parks) using a qualitative focus group grounded in the Volunteer Functions Inventory (Clary et. al, 1998), and Generativity frameworks (Ding & Schuett, 2020).

Results confirm that "Environmental Values" and "Understanding" (learning and educating) are the most powerful drivers for penguin visitor experience volunteers, consistent with established literature (Sextus, Hytten & Perry, 2024). Participants perceive themselves as vital "social multipliers", bridging the gap between scientific experts and the public to transform visitors into wildlife advocates. A unique finding from this study is the role of "perceived authenticity" as an advocacy tool; volunteers believe their unpaid status grants them significantly more credibility with the public than paid staff.

The research further highlights a strong "Values Alignment", with participants expressing pride in representing a "brand" that mirrors their personal conservation ethics. Long-term commitment is predominantly sustained by generativity - the desire to leave an environmental legacy for future generations - and social connection, as volunteering facilitates deep integration into the local community. While volunteers noted challenges in visitor management, they expressed a clear preference for interpretive roles over enforcement, finding greatest satisfaction in high-quality educational interactions. These findings suggest that for charismatic species like penguins, strategic recruitment should prioritise intrinsic rewards, messenger authenticity, and community belonging to sustain a committed and effective conservation volunteer workforce.

Beyond the fish buffet: a dietary supplementation experiment on penguin reproduction

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Diet quality is a key factor influencing the life cycle of seabirds. While female metabolism regulates incorporation of many non-essential fatty acids into egg yolk, essential fatty acids such as DHA and EPA are more sensitive to dietary variation, making them potential indicators of prey nutritional quality. To assess prey nutritional quality, we will use a controlled dietary supplementation experiment with breeding penguins in captivity.

This study will investigate supplementation effects on egg composition, chick development, and adult moult. Breeding pairs will be assigned to either a control group receiving the standard diet or a treatment group supplemented with DHA, EPA, and vitamin E. The experiment will be conducted on African penguins, with potential inclusion of additional penguin species through collaborations with zoological institutions. This poster aims to stimulate discussion and obtain feedback on the study design before implementation.

Three approaches will be investigated. Infertile eggs will be analysed using gas chromatography to determine DHA and EPA incorporation into egg yolk fatty acid profile. Fertile eggs and chick development will be monitored through egg morphometrics, chick body mass, structural growth, and plumage development. Moult will be assessed by monitoring moult duration, body mass changes, and plumage quality.

We expect diet supplementation to increase DHA and EPA in egg yolks, improve chick growth and development, and enhance moult quality in breeding adults. Beyond enrichment in captivity, this study will provide insights into how prey nutritional quality influences penguin reproduction and survival, improving understanding of how changing marine food resources affect populations.

CircumPOOlar DNA diet comparison: spatial variation in the diet of Adélie penguin populations at nine breeding sites across Antarctica.

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The Adélie penguin (Pygoscelis adeliae) is a circumpolar species that breeds on coastal areas of the Antarctic continent and surrounding islands. Adélie penguins are sentinel species for Antarctic ecosystem health: they depend on sea ice and are sensitive to the abundance and distribution of their primary prey. The use of DNA metabarcoding to monitor seabird diets is well-established and has been used to study Adélie penguin diet in East Antarctica, the Ross Sea region, and the South Orkney Islands. The aim of this study was to characterise diet across the species' range, in a single season. During the 2023/24 summer, 829 Adélie scat samples were collected from nine breeding sites across Antarctica, by teams from seven countries. Scat DNA was sequenced using a universal 18S rRNA marker for a broad dietary overview, alongside two group-specific 16S genetic markers for species level identification of krill and bony fishes. Results demonstrate spatial variability in diet across the continent. In East Antarctica and the Ross Sea their diet consists of varying proportions of Antarctic krill (Euphausia superba), ice krill (E. crystallorophias), and several fish species. Notably, at one East Antarctic site (Torinosu Cove) a large proportion of their diet is copepods. In contrast, populations along the Antarctic Peninsula rely almost exclusively on Antarctic krill. This research establishes a unique circumpolar dataset and demonstrates the potential of large-scale DNA diet datasets to track how environmental variables, like sea ice extent, impact these vulnerable populations in a changing climate.

Chinstrap's wet winter. GPS and GLS tracking reveals how yearly changes in sea-ice shape winter migration strategies of adults and juveniles and highlights potential new risks in a warming scenario

Dr Ignacio Juarez Martinez[1], Prof Josabel Belliure, Dr Virginia Morandini, Mr Gabriel Lopez-Poveda

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The latest research shows breeding success has not been responsible for the sharp population decreases observed for Chinstrap penguins in Antarctica over the last twenty years. This means we need to look away from the breeding season and into overwinter survival of both juveniles and adults to explain this species' declines. In this study, we tagged adult and juvenile Chinstrap penguins from Deception island with transmitter GPS as well as GLS in order to study their winter migrations over several years. Our results show our penguins migrate further than any previous studies, mostly reaching the Ross Sea and completing migrations of over 10000Km. Our study reveals habitat preferences during the winter period (especially regarding sea-ice) define their wintering areas and are there key to evaluate their vulnerability to climate change. Differences in migratory phenology and overwinter habitat between adults and juveniles are also important regarding their different overwintering survival. Finally, differences across individuals reveal distinct strategies that could offer resilience in the face of potential future environmental change.

Crèche foraging behaviour of breeding southern rockhopper penguins: insights from GPS tracking and camera loggers

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Understanding the spatial ecology of vulnerable seabirds is essential for marine conservation in a rapidly changing environment. The southern rockhopper penguin (SRP) (Eudyptes chrysocome) breeding in the South Atlantic is well-studied, yet foraging behaviour during the crèche period remains under-explored.

In January 2025 and 2026, we investigated foraging movements of breeding SRP on Hummock Island (Falkland Islands) by deploying 23 GPS loggers on breeding adults of both sexes, recording locations at 5-10min intervals. Devices were retrieved 4-20 days post-deployment, yielding usable data from 18 individuals and 72 foraging trips. Two males undertook extended foraging trips to the Patagonian shelf (>800km, 13-18 days), potentially revealing self-maintenance trips for energy replenishment. Excluding these trips, SRP undertook relatively short, typically daily, foraging trips, a behaviour not previously described during crèching. Average trip duration and total distance was ~17/14hr and ~39/36km in 2025 and 2026, respectively. Such behaviour is similar to that of females during the guard stage rather than the crèche behaviour observed at other colonies.

In January 2026, we also deployed four Little Leonardo camera loggers on breeding adults, a first for this species, yielding 12.5hr of footage which revealed low levels of conspecific interactions, diverse prey capture and variable use of water depths. Blood and feather samples were collected for stable isotope analysis to corroborate dietary information. Together, these results provide novel data for this lesser-known component of the reproductive cycle, and highlight the need for multi-colony studies of this period to better characterise behavioural variability in this vulnerable species.

Complementary analyses indicate the breadth of subantarctic hoiho diet

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Using animal-borne cameras, GPS-TDR, and metagenomic sequencing of DNA derived from faeces, we investigated the diet and foraging strategies of adult hoiho from Enderby Island (n = 5) during 2022/23 and Motu Ihupuku/Campbell Island during 2023/24 and 2024/25 (n = 12). Foraging strategies differed markedly between sites: Motu Ihupuku hoiho consumed high-energy benthic species such as opalfish (Hemerocoetes spp.) and larval baitfish over fine sands and gravels, whereas Enderby Island birds captured a greater proportion of low-quality pelagic prey, including salps and jellyfish. Using a mixed method approach improved prey identification without the need for traditional invasive diet methods. Both populations exhibited high capture success rates and short pursuit lengths when targeting preferred prey; however, prey patch richness was considerably higher at Motu Ihupuku. These findings suggest site-specific disparities in prey availability within the subantarctic range of hoiho. Understanding spatial differences in foraging ecology and diving behaviour plasticity is crucial for informing future management and conservation strategies for this endangered and declining species.

Conservation of Humboldt Penguins – Research, Environmental Education, Advocacy

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[1]Sphenisco e.V., Landau, Germany

The population of Humboldt penguins (Spheniscus humboldti) has declined significantly in recent years due to El Niño events, avian influenza H5N1, overfishing and bycatch, and disturbances at breeding sites.

The German non-profit organization Sphenisco and Fundación Sphenisco Chile, together with South American conservationists and scientists, work to protect this endangered species. A key focus is the preservation of the Humboldt Archipelago, a globally important biodiversity hotspot.

Since 2021, both organizations have supported a six-year research project in Chile. A team led by Dr. Alejandro Simeone (Universidad Andrés Bello, Santiago) studies population size, breeding success, and foraging behavior. In Peru, the NGO Acorema has documented breeding success on the Ballestas Islands (Ica Region) since 2021.

"Sphenisco Chile" continuously raises awareness through social media and public events about the causes of threats and measures to protect this endangered penguin species. Particularly strong attention has been achieved through literary competitions, a textbook, and photo exhibitions. In Peru, the NGO Acorema has been conducting educational programs in schools and fishing communities in the Ica Region on behalf of "Sphenisco" since 2010.

Although population decline continues, major conservation successes have been achieved. Large-scale industrial projects threatening the Humboldt Archipelago have been prevented, including three planned coal-fired power plants in 2010. In recent years, legal protection in Chile has been significantly strengthened through the "National Plan for the Conservation of the Humboldt Penguin," the designation of the Humboldt Archipelago as a protected area, and the declaration of the Humboldt Penguin as a natural monument.

Deconstructing predation risk in Magellanic Penguins: drivers of sea lion attacks and penguin behavioral responses in an island system

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Penguin predation by sea lions appears to have increased in recent decades in southern South America, likely following sea lion population recovery. However, how these interactions occur and how penguins perceive and respond to risk remain poorly understood. We investigated predation risk by decomposing the process into two components: (1) drivers of sea lion attack rates and (2) determinants of penguin behavioral responses. Using hierarchical Bayesian GLMMs, we quantified each process separately.

We monitored entrance and exit points in a Magellanic penguin colony, recording penguin movements and predation events. Predator presence overwhelmingly determines the occurrence of attacks, establishing the baseline upon which behavioral and contextual factors modulate attack rates. Attack rates increase with penguin group size in a sublinear manner and vary with movement direction, with arrivals to the colony more likely to be attacked than departures. Behavioral responses also reveal asymmetry between transitions: penguins are more likely to abort departures than arrivals, and departure success increases with group size, indicating that social context shapes decisions under risk.

These results show that predation risk is primarily driven by predator presence and behavioral context, providing a framework to disentangle encounter and outcome processes in sea lion–Magellanic Penguin interactions.

Do icebreaker vessel tracks guide penguin navigation on Antarctic sea ice? Behavioural observations of Pygoscelis adeliae and Aptenodytes forsteri

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Antarctic sea ice strongly limits penguin movement and access to the ocean. On the other it protects penguins from any underwater predators. Icebreaker vessel operations create not only wide, long vessel wakes but also extensive long linear cracks on sea ice, potentially modifying local ice structure and access to open water. However, behavioural responses of penguins to icebreaker tracks remain poorly documented.

We report field observations of penguin behaviour along icebreaker tracks on Antarctic sea ice, focusing on Pygoscelis adeliae (Adélie penguin) and Apttenodytes forsteri (Emperor penguin). Observations were conducted during icebreaker transit under conditions where newly formed tracks provided access to open water, while older tracks persisted as uneven ice irregularities without open water.

Penguins exhibited three distinct behavioural patterns. First, penguins frequently formed liner group movements on flat sea ice, moving parallel to the icebreaker's navigation, suggesting efficient group travel. Second, penguins aggregated near newly formed icebreaker tracks, where access to open water was present. Third, smaller groups were observed walking along older icebreaker tracks despite the absence of open water, suggesting exploratory behaviour. Penguins rarely approached moving vessels but frequently approached stationary vessels and nearby humans on the ice.

These observations suggest that icebreaker tracks may function as temporary movement features on Antarctic sea ice, facilitating access to open water while also eliciting exploratory and curiosity-associated behaviours. Our findings highlight the potential influence of anthropogenic ice features on penguin movement and navigation in Antarctic sea-ice environments.

Determinants of egg mass and its relationship with hatchling mass in three captive Spheniscus penguin species

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Introduction

Penguins of the genus Spheniscus share similar morphology and ecology; however, their reproductive traits under human care have not been fully compared. This study examined factors affecting egg mass (EM)—including laying order, parental age, and body mass (BM)—and evaluated the relationship between EM and hatchling mass (HM).

Methods

Data were collected from three aquariums in Japan: African penguins (S. demersus; n = 32, 710 eggs), Magellanic penguins (S. magellanicus; n = 26, 281 eggs), and Humboldt penguins (S. humboldti; n = 18, 409 eggs). Differences in EM by laying order, effects of parental age and BM, and the relationship between EM and HM were analyzed using linear mixed-effect models and Pearson's correlation.

Results

Egg laying occurred across wide age ranges in all species. Maximum clutch sizes were four in D, two in M, and three in H. EM significantly decreased with laying order in all species ($p < 0.001$). Pre-laying BM positively affected EM in all species ($p < 0.05$). Parental age had a positive effect in African and Magellanic penguins ($p < 0.01$), but not in Humboldt penguins. EM and HM showed strong positive correlations in all species ($r = 0.792–0.951$, $p < 0.01$).

Conclusion

EM is influenced by parental age and BM and strongly predicts HM. Species-specific differences in determinants of EM suggest distinct reproductive strategies. In Humboldt penguins, a gap between maximum lifespan and reproductive age may indicate a post-reproductive phase.

Evaluating the conservation impact of hand-rearing African Penguins

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The African Penguin was recently listed as Critically Endangered, with population declines of ~80% in the last three generations. The Southern African Foundation for the Conservation of Coastal Birds (SANCCOB) does extensive work to rehabilitate penguins for release back into the wild, including hand-rearing of chicks abandoned prior to fledging. Chicks that have not fledged by the time adults commence their obligatory post-breeding moult are abandoned with little chance of survival. These, and eggs and chicks abandoned during extreme weather events are being rescued and hand-reared for release back into the wild. Between 2013 and 2023, over four thousand penguins have been hand-reared from chicks or eggs and successfully released. Before release, each of these was fitted with a passive integrated transponder ('PIT tag'), allowing for subsequent detection by hand-held and stationary transponder readers in the colonies. In addition, over three thousand naturally-raised birds were marked with PIT tags. Here we use this ten-year mark-recapture dataset to estimate the impact these rehabilitation efforts have had on the Africa Penguin population. We show that first-year survival of hand-reared chicks is above estimates for naturally-reared chicks but lower once these birds have reached adult age. Nevertheless, adult survival estimates for hand-reared chicks are within ranges observed in the wild, showing that the rescue and hand-rearing of abandoned chicks and egg is an effective conservation measure to bolster the population. We further present how this data has been incorporated into a risk assessment to inform future conservation interventions for African penguins.

Evidence of Rakali predation on a Little Penguin chick

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The Australian Water-rat or Rakali Hydromys chrysogaster is an opportunistic predator known to feed on a variety of aquatic species, as well as birds' eggs and carrion. Although Rakali often share habitat with Little Penguins Eudyptula minor, documented predation events are rare. Trail cameras were installed in eight Penguin nests along the breakwater in St Kilda, Victoria, over one Penguin breeding season. Cameras recorded one instance of a Rakali killing a Penguin chick that was being guarded by an adult, and another of a Rakali scavenging a dead chick. This represents the first video evidence of Rakali preying on and consuming Little Penguins, and the first recorded instance of an attack on a chick under adult supervision. These observations suggest that Rakali predation on Little Penguins may be more common than previously thought.

Exploring the ontogeny of personality in little penguins

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In animals, consistent differences in behaviour across time and contexts (i.e., personality) can affect survival and, as such be favoured by natural selection—particularly those relating to predator responses (i.e., boldness). However, less is known about the ontogeny of personality, particularly the age at which it first emerges. In this study, we investigated the age at which boldness develops as well as the potential fitness benefits in Australian little penguins (Eudyptula novaehollandiae). We first assessed boldness in adults in response to a simulated nest intrusion to determine its potential as a personality trait[DC1.1]. We then measured boldness in chic[DC2.1]ks weekly from 3 weeks old until fledging (at 8 weeks old). We also examined the relationships in adults among boldness, parental care behaviours and breeding success[DC3.1].. Boldness in adults was highly repeatable across months and years. Boldness in chicks was moderately consistent, and chicks showed increased responses to personality assays as they aged. Boldness however did not predict parental care or breeding success. Our results confirm that inter-individual variation in boldness exists in both adult and juvenile little penguins, and suggest that the development of boldness may be linked to developmental stages (i.e. rapid periods of growth) associated with increasing independence. However, more research on the ultimate effects of boldness is needed to understand how this might affect survival.

Exploring predator–prey dynamics in an urban river-influenced little penguin colony using thermal infrared imaging

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Urban little penguin (Eudyptula minor) colonies provide an opportunity to examine how predator activity impacts breeding outcomes in human-modified landscapes. At the St Kilda colony, Melbourne, Australia, rakali (Hydromys chrysogaster), a semiaquatic rodent typically associated with freshwater environments, have been recorded predating penguin eggs and chicks, yet the frequency and seasonal patterns of this interaction remain poorly understood. The colony's man-made breakwater in proximity to the Yarra River mouth and recent urban waterway modifications, including floating wetland installations, may facilitate rakali access to the colony.

We used thermal infrared imaging to quantify rakali activity across the 2024–2025 breeding season, paired with little penguin breeding success monitoring. Trained citizen scientists annotated video data, with counts validated by expert reviewers. Using the mean laying date (21 July 2024) to define early (1 May – 21 July) and late (22 July – 27 December) breeding periods, rakali activity was 53% higher during the late period (mean = 1.50) compared to the early period (mean = 0.98), but this increase was not statistically significant (Mann-Whitney U = 329.0, p = 0.27) and did not correspond to differences in reproductive success (0.42 vs. 0.82).

These findings suggest that the interaction between little penguins and rakali may reflect a dynamic balance between predator activity and prey vulnerability across the breeding cycle. Even limited predation may have cumulative effects on recruitment, highlighting the importance of this interaction for colony persistence and underscoring the need for continued long-term monitoring.

Exploring the Impact of Translocation on Little Penguin (Eudyptula minor) Conservation

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Translocation is an important conservation tool for seabirds, particularly species with strong natal philopatry such as penguins. However, penguins have rarely been included in such studies, despite facing increasing threats such as invasive predators and often having restricted or declining distributions. Here, we present a large-scale penguin translocation program, focusing on the Little Penguin (Eudyptula minor) colony on Phillip Island, Australia. The program relocated chicks from a remote colony area to a site closer to a major tourist viewing area to enhance the population size and increase breeding distribution. Between December 1988 and January 1994, 1135 chicks within 1 week of fledging were moved up to 2.8km, placed in artificial burrows and hand-fed until they fledged. Of these, 14.8% have returned as adults, closely matching the rates observed in the control group. Over three-quarters of all returned chicks were found in the translocation area to which they were translocated. These individuals showed normal reproductive behaviour and signs of long-term establishment. The pre-fledging chick body mass was identified as a significant predictor for chick survival and subsequent return to the colony. We hope that lessons learnt from the project could be applied to conservation actions such as the need to establish or re-establish breeding colonies due to localised extinction or disaster events such as fire or oil spills.

Exploring the Japanese Affinity for Penguins Through Picture Books

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Abstract: This study explores the cultural and educational significance of penguin-themed picture books (ehon) in Japan. Despite being a "penguin superpower" that houses approximately one-fourth of the world's captive penguins, Japan's deep psychological attachment to these creatures may stem not only from direct observation but also from the influence of literary works.

1. The Role of Picture Books in Japan

Japanese Ehon have evolved from ancient scroll traditions into a sophisticated medium for both early education and adult appreciation. The practice of reading aloud (yomikikase) makes these stories a foundational part of childhood development.

2. The Japanese Affinity for Penguins

Despite their abundance in zoos, penguins in literature are uniquely personified—they dream, fly, and travel. This research questions how these fictional depictions shape our perception of real-life penguins and foster lifelong emotional bonds.

3. Classification and Content Analysis

The study categorizes penguin literature into Scientific/Non-fiction and Narrative/Fiction works. By comparing domestic and foreign titles, I analyze the specific messages and symbolism embedded in narrative-driven stories.

4. Conclusion

Penguins in Japanese picture books are more than "cute" figures; they serve as vessels for dreams and human aspirations. This presentation concludes that these literary representations play a vital role in psychological growth and cultural identity, bridging the gap between imagination and the natural world.

Forty years of little penguin breeding success – spatial variation and habitat change at Summerlands, Milawul (Victoria, Australia)

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Since 1968, breeding success of Little Penguins (Eudyptula minor) has been monitored at multiple study sites across the Summerland Peninsula, Milawul (Phillip Island), with consistent long-term data from 1984 onwards. This study illustrates how breeding success at the site level has varied over space and time. Population trends show high interannual variability and limited synchrony among sites, indicating that local conditions, rather than regional drivers, shape breeding dynamics on land.

Clear spatial structuring is consistent with higher breeding success at the Penguin Parade® contrasting with poorer and more variable outcomes at sites within the former Summerlands housing estate. These patterns suggest persistent differences linked to local habitat conditions and historical land use. While this study focuses on terrestrial breeding habitats, little penguins depend on both land and marine environments, and these changes on land occur alongside changing conditions at sea that likely also influence breeding outcomes.

These findings are considered in the context of habitat change on breeding grounds at the Peninsula. Although little penguins are a highly adaptable species, long-term data indicate that some areas of the Summerlands colony remain vulnerable to population decline, highlighting the need for targeted, site-specific management to support overall population resilience.

Fifteen years of penguin conservation at the end of the world

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At its inception, the King Penguin Nature Reserve was established to protect king penguins from the impacts of unregulated tourism. This effort soon produced unexpected outcomes for the landowners. Thanks to their efforts, the colony has been able to grow from zero fledglings in 2011 to one in 2015, and 22 by 2025. Today, an average of 40 breeding pairs return each year. While the reserve originated as a penguin protection initiative, its mission has since expanded. Ongoing research now encompasses the broader flora and fauna of Tierra del Fuego, with landscape conservation as a main objective. The return of the king penguins to what is believed to be an ancient breeding ground has not only revitalized the local ecosystem but also reshaped the relationship between the environment and the community that observes and values it.

Fiordland First – A Significant Step in Taronga Zoo's Breeding Program

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Fiordland Crested Penguins (Eudptes pachyrhynchus) are native to the harsh rainforest terrains of the western shores of New Zealand's South Island. This is their forest sanctuary and provides a unique habitat when they are not at sea.

The International Union for the Conservation of Nature has classified the Fiordland Crested Penguin as 'Declining'.

Taronga Zoo is the only institution in the world to have Fiordland Crested Penguins currently in care. For over twenty-five years, Taronga Zoo has been involved in the care and breeding of the Fiordland Crested Penguin, in the hope to gain essential information and a deeper understanding about their natural and social behaviors, as well as their breeding cycles.

In 2023, a significant step in Taronga Zoo's breeding program was achieved with the successful hatching of a parent incubated/raised Fiordland Crested Penguin chick in care. The first in the world.

This paper will focus on Taronga Zoo's history of caring for these unique Penguins. It will discuss in detail aspects of husbandry, group dynamics, introductions, breeding, training, and enrichment.

Years of keeper experience, observing and learning from these unique Penguins at Taronga Zoo shaped many changes in how the species is managed in care. With focus around their nesting and breeding season, we will share our successes, the many challenges that shaped management leading up to 2023 breeding season, and the first ever successful Fiordland Crested Penguin chick.

Giving hoiho chicks a head start: artificial incubation and early-life hand-rearing reduce chick disease

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For endangered species, survival during the earliest stages of life can determine whether populations recover or continue to decline. The yellow-eyed penguin (hoiho, Megadyptes antipodes) is one of the world's rarest penguin species, and New Zealand mainland populations are expected to go extinct in the next 2-3 decades, despite ongoing conservation management.

Early chick development is a vulnerable stage when disease and other stressors greatly reduce the chances of chicks surviving to fledge. Two diseases, diphtheritic stomatitis (DS) and respiratory distress syndrome (RDS), contribute significantly to hoiho chick morbidity and mortality during the nestling period.

Artificial egg incubation and hand-rearing of wild-born chicks has been implemented to assist management of disease. Eggs and chicks brought to hospital are artificially incubated and hand-reared until approximately 10 days of age, after which they are returned to the nest.

During the hospitalisation period, observations from chicks are complemented by diagnostic investigations, including haematology, plasma biochemistry, and pathogen screening, to assess chick health and characterise normal physiological development. Clinical observations indicated that the timing of intervention influenced disease outcomes. Chicks brought to hospital within the first 3-4 days of life rarely develop RDS compared with chicks that remained in the nest for longer periods. Early intervention was also associated with milder DS and higher treatment success, whereas chicks left in the nest beyond this period developed more severe disease.

Together, these findings suggest that disease risk in hoiho chicks may be influenced by conditions experienced in the nest during the earliest stages of life.

Gaps in the Antarctic Treaty System for Penguin Conservation: Legal Challenges and Policy Recommendations

Mr Inoue Ayumu

The Antarctic Treaty System (ATS), including the Protocol on Environmental Protection, forms the primary legal framework for the Antarctic region. However, rapid climate change and increasing human activities have exposed significant gaps in protecting penguin species, which are key indicators of Southern Ocean ecosystem health.

This analysis highlights several critical mismatches: (1) delayed designation of emperor penguins as a Specially Protected Species despite clear scientific evidence of population declines; (2) insufficient integration between the ATS and CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) regarding fisheries management that impacts penguin foraging; and (3) inadequate regulation of tourism in penguin breeding areas under changing environmental conditions.

Drawing on international environmental law principles and recent conservation science, this policy-oriented review identifies legal and institutional weaknesses that hinder effective penguin protection. It proposes concrete recommendations, including strengthening the link between legal instruments and ecological data, accelerating species-specific protections, and developing adaptive management frameworks for climate-induced threats.

As a law graduate with ongoing studies in environmental conservation, the author emphasizes the importance of interdisciplinary approaches that bridge legal frameworks and on-the-ground conservation needs. This contribution aims to stimulate discussion on advancing advocacy and policy for penguin conservation at IPC12.

How to Prepare a Penguin Skeleton

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Introduction

I have always liked penguins and became interested in their bones. This led me to create skeletal specimens. In this study, I summarize the workflow of skeletal preparation and describe what I learned through the process.

Methods

The carcasses of two female Humboldt penguins kept at Enoshima Aquarium were used: "Akari" (died at age 21 of ovarian torsion) and "Hikaru" (died at age 21 of malignant melanoma).

Skeletal specimens were prepared through the following steps:

(1) Removal of soft tissue (skin and muscle were removed).

(2) Maceration (bones were placed in enzyme-treated water with aeration to remove remaining tissue).

(3) Cleaning.

(4) Bleaching and drying (discolored areas were partially bleached with chemicals and then dried).

(5) Assembly (bones were connected using adhesive and assembled with wire while confirming their movement).

In addition, their skeletal specimens were compared to identify any differences.

Results

Basic information about penguins and the process of skeletal preparation were organized. During specimen preparation, penguins were found to contain more fat than many other birds, and removing this fat from the bones required considerable time and effort.

In Hikaru, some bones were blackened, fragile, and partially degraded, suggesting the effects of disease.

Conclusion

Penguins have well-developed muscles, which made the removal of soft tissues particularly challenging. The assembly process was also difficult and required more time and careful work than anticipated.

Through creating the penguin skeletal specimens, I learned about the structure of the penguin body and gained a deeper appreciation for penguins.

Insights into the optimisation of egg-rescue, artificial incubation and early chick-rearing protocols for successful population reinforcement in African Penguins

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Supportive breeding interventions are increasingly important for the conservation of Critically Endangered species globally, including for African Penguins (Spheniscus demersus) as their populations continue to decline range-wide. Since 2012, the Southern African Foundation for the Conservation of Coastal Birds (SANCCOB) Seabird Centre in Cape Town has hatched nearly 2000 chicks from eggs rescued from wild colonies (>59% of rescued eggs) at our dedicated incubation facility in Cape Town. On admission, eggs are measured, weighed, candled and placed in incubators, with daily monitoring of mass loss to track embryonic development using specialised software. Embryonic stage and viability are assessed throughout incubation.

This study evaluates the drivers of African Penguin egg and chick outcomes, including successful hatching, embryonic death at different stages, and chick mortality. Using a data-driven framework, we describe how to optimise key incubation parameters (i.e. individual egg temperatures; incubator temperature and humidity) over the ~40 day incubation period. We further assess the influence of intrinsic and extrinsic factors such as initial egg size, origin, seasonality, and eggshell thickness on outcomes.

Post-hatch, observed differences in growth rates and susceptibility to bacterial infections relative to wild-reared chicks are described and highlight potential roles for microbiome transfer and contamination pathways. We present the findings from sterilisation trials examining bacterial loads on eggshells and implications for hatching success and chick survival.

Finally, we compare artificial incubation success rates with natural hatching rates across key colonies (2021 to 2026) and outline future work to quantify natural incubation behaviours to further refine ex situ protocols.

Intra-seasonal variation and factors influencing satellite-derived population indices of Adélie penguins (Pygoscelis adeliae) in the Ross Sea

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Wildlife populations in the polar regions are increasingly monitored via satellite imagery. Adélie penguins (Pygoscelis adeliae) are one such species whose remote populations have been assessed from Very High-Resolution (VHR) satellite imagery using the area of their guano stain. However, this indirect measure of population size shows low sensitivity to interannual changes. We assessed intra-seasonal variation and the factors influencing VHR-derived population indices of Adélie penguins in the Ross Sea. Using supervised object-based support vector machine classifications, we estimated guano area for three colonies: Capes Adare, Crozier, and Hallett. While researchers have previously assumed that estimates from December through February are equivalent, we found large within-season variation with area estimates differing by a factor of 0.9-1.6. Although guano area at all three colonies was highest in February across the 15 within-season images, this pattern was inconsistent in a broader temporal context. To identify additional drivers of these indices, we developed a grid-based count model relating breeding pair locations (determined from Uncrewed Aeiral Vehicle imagery) to VHR-derived guano areas and fine-scale terrain, including slope, the directionality of slope, and terrain roughness, to account for how terrain may adjust the relationship between the number of breeding pairs and guano area (e.g., lower penguin density per area of guano with rougher terrain). Incorporating terrain and nesting density data may improve predictions of breeding pair counts. This work refines the utility of VHR monitoring for a Southern Ocean sentinel and provides a more nuanced framework for interpreting remote sensing data in dynamic polar environments.

Integrating Preparedness and Rehabilitation: NAMCOB's Approach to African Penguin Conservation in Namibia

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The critically endangered African penguin population faces escalating threats from environmental variability, declining prey availability, and human pressures. In response to these intersecting risks, the Namibian Foundation for the Conservation of Seabirds (NAMCOB) was established in 2022 to support government-led seabird conservation through an integrated framework linking oil spill preparedness, rehabilitation, and ecosystem-based management within the Namibian Islands' Marine Protected Area (NIMPA).

Through strategic partnerships between national and international conservation organisations, NAMCOB embeds global best practice within Namibia's local conservation and emergency response systems. A central component of this approach is strengthened preparedness for oil spill events, achieved through the deployment of fully equipped coastal response containers, island-based spill kits, and the training 70-plus first responders. These capacities were recently validated during a multi-agency oil spill response exercise conducted with Debmarine and the Ministry of Works and Transport, Namibia.

Alongside acute threats, NAMCOB' addresses chronic ecological pressures affecting penguin foraging success. Reduced sardine availability, driven by overfishing and environmental change, has negatively influenced breeding performance and chick survival. In response, NAMCOB supports ecosystem-based fisheries management and spatial protection measures within NIMPA, working with partners to promote long-term prey security for seabirds.

These pressures are reflected in rising admissions to NAMCOB's interim rehabilitation centre, where approximately 70% of birds successfully released. Rehabilitation outcomes thus contribute directly to population resilience while providing valuable insights into ecosystem health. Together, these elements demonstrate how integrated preparedness, rehabilitation, and fisheries advocacy can strengthen seabird conservation outcomes and offer transferable lessons across the Benguela Current ecosystem.

It's all white: first record of albinism in Eudyptula minor at the Phillip Island (Milawul) mega colony, Victoria, Australia

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Pigmentation aberrations including leucism, isabellinism, and melanism have been documented across multiple penguin species, yet true albinism remains rare. Penguins with albinism lack all melanin in their feathers, skin, and eyes, and can have a poor survival outlook, as progressive blindness and lack of counter colouring compromise their ability to forage and survive independently.

Since 1968, nest checks have been conducted on the Summerland Peninsula to monitor the mega colony of little penguins (Eudyptula minor). Breeding adults and fledgling chicks are individually identified using passive integrated transponders (PIT), enabling multi-season tracking of individuals, nest site fidelity, pair fidelity and breeding outcomes.

During a routine check in November 2025, an albino chick was discovered in a nest box, entirely white and exhibiting the characteristic features of true albinism. This was the first time this pair had been observed breeding together, also producing a normally pigmented sibling in the same clutch. Albinism is generally accepted to be an inherited trait, meaning one or both parents carry the recessive allele. The pair and their offspring will continue to be monitored in future breeding seasons.

To our knowledge, this represents the first documented case of albinism in little penguins, despite leucism, a partial loss of pigmentation, having previously been observed in the Summerland colony. As colour aberrations are rarely observed in adults in the wild, early detection of this chick provides valuable insight into the occurrence and potential consequences of albinism in penguins and highlights the importance of long-term, fine-scale colony monitoring.

Marine distribution and foraging strategies of hoiho resident on Motu Ihupuku

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In 1995, two depth recorders deployed on hoiho (Megadyptes antipodes) resident on subantarctic Motu Ihupuku/Campbell Island indicated benthic dives to 160m. Some thirty years later, we tracked guard, post-guard, and pre-moult adult hoiho, using GPS-TDR and satellite tags, revealing the foraging locations and strategies at the southern end of their range. Tracking indicated marked differences in foraging range between 2022/23, 2023/24 and 2024/25. Extensive areas of the Campbell plateau were utilised during post-guard and pre-moult, with adults travelling up to 120km offshore. Depth data corroborate a predominantly benthic foraging strategy, with dives up to 164m recorded.

Microplastics in soils from two Adelie penguin colony locations in the Ross Sea region, Antarctica

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Microplastics (<5 mm) have been identified in some of the most remote regions, such as Antarctica; however, the historical accumulation and presence of microplastics in the Antarctic environment have been understudied. While penguins are known to act as vectors for contaminants such as heavy metals and persistent organic pollutants, the role they play in microplastic transport and dispersion is not yet understood. Here we present on the abundance of microplastics in penguin influenced and control soil profiles from two Adélie penguin colonies (Cape Bird and Cape Hallett) from the Ross Sea region, assess whether Adélie penguins act as vectors for microplastics, and determine through dating techniques (^{210}Pb) if Adélie penguin nests act as a natural archive for microplastic accumulation. A total of 75 microplastic particles (35 to 3981 µm) were present in 29 of the 37 soil samples analysed. We identified 12 polymer types, with polyethylene terephthalate (PET; 59%), polyethylene (PE; 13%), and polypropylene (PP; 11%) being the most abundant polymers. Fibres (57%) were the most common polymer morphology, followed by films (27%) and fragments (16%). The three most common colours were transparent (36%), followed by blue (29%) and black (17%). Similar microplastic abundances were observed for control and penguin influenced soil samples, with the average (± SD) microplastic abundance being 0.64 ± 0.56 items/g and 0.42 ± 0.47 items/g, respectively. Our study found that penguin activity does not influence microplastic abundance; however, vertical migration of microplastics within the soil profiles may have influenced the findings.

Molting dynamics in the African penguin (Spheniscus demersus): morphological and behavioral characterization

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Moulting in the African penguin (Spheniscus demersus) represents a critical phase of the life cycle, characterized by the synchronous replacement of the entire plumage, with important implications for thermoregulation, behavior, and survival. This study provides a comprehensive morphological and behavioral characterization of the molting process, while also analyzing potential influencing factors. The data were qualitatively compared with observations collected from wild individuals in South Africa, obtained through a similar photographic approach at the colony level.

Data collection was conducted on 14 individuals housed at Zoom Torino Biopark (Italy) through systematic daily photographic sampling. The collected images allowed reconstruction of molt progression from a morphological perspective and precise definition of its timing. Potential influencing factors, including sex, age, and pre-molt body mass, were analyzed to evaluate their effect on molt duration. The analysis revealed no significant effects of sex, age, or pre-molt body mass on the duration or timing of molting phases, suggesting strong physiological canalization of the process under controlled conditions. Molting was also associated with significant morphometric variations, including increases in bill width, bill depth, and skull width, likely reflecting condition-dependent phenotypic plasticity. Behavioral analyses indicated that molting phase is the primary driver of time-budget variation, with a marked shift toward energy conservation strategies during active feather loss and a gradual recovery of activity in the post-molt period.These results suggest that, despite the lack of detectable effects of individual factors, environmental conditions may influence the morphological dynamics of molt,highlighting the need for further studies to clarify the underlying mechanisms.

Managing the Risk of Marine Spills and Their Impact on Penguin Populations

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Marine pollution events involving petroleum, alternative fuels, and other hazardous and noxious substances (HNS) remain a collective global risk associated with maritime transport and oil and gas activities. Although advancements in technology and maritime management have reduced the frequency of such incidents, the ecological consequences of spills remain severe. Wildlife continues to be impacted, reinforcing the need for sustained and targeted risk mitigation. Central to this is the active maintenance of fit-for-purpose oiled wildlife response capability.

In Australia, proactive and collaborative wildlife response arrangements enable timely access to specialised equipment and trained personnel, including surge capacity during major incidents. This coordinated approach strengthens incident preparedness and response, allowing marine pollution management to move beyond reactive measures and toward building long-term ecological resilience, particularly for vulnerable marine species.

Seabirds are among the most vulnerable groups affected by marine pollution events, with penguins especially at risk. Their high site fidelity, near-surface foraging behaviour, and restricted aquatic range make them particularly susceptible to oil exposure. Penguin mortality linked to hydrocarbon spills has been documented globally, including in Africa, Australia, New Zealand, South America, and Antarctica.

Historical incidents demonstrate this vulnerability. The Iron Baron oil spill resulted in an estimated 10,000 to 20,000 penguin deaths. Localised spills at Phillip Island in 2001 and 2003 affected approximately 438 and 200 penguins respectively. Internationally, the Treasure oil spill and the Rena oil spill further demonstrate how timing and location can drive damaging outcomes for penguin populations.

This presentation highlights that while spill frequency may be declining, the risk to penguin populations remains persistent and significant. Current preparedness frameworks provide a strong foundation, but they must be continuously tested, resourced, and strengthened to remain effective. To meaningfully reduce the ecological impacts of future marine spills, governments, industry, and response organisations must prioritise three key actions:

• Sustain and expand investment in oiled wildlife response capability, ensuring equipment, facilities, and trained personnel are maintained and response ready.

• Strengthen national and international collaboration, enabling rapid mobilisation of expertise and resources across jurisdictions.

• Embed wildlife response into all marine spill preparedness and exercises, ensuring it is treated as a core component of incident management, not a secondary consideration.

Without deliberate and ongoing commitment to these actions, the capacity to respond effectively will diminish, and vulnerable species such as penguins will continue to bear the consequences. Strengthening preparedness today is essential to safeguarding marine wildlife into the future.

Metal exposure and potential impacts on blood health parameters in little penguins (Eudyptula minor)

Ms Jacinta Colvin

Haematology and blood biochemistry are integral tools in veterinary medicine and have shown promise in providing more nuanced information regarding understanding the effects of pollutants in wild seabirds. Toxic metals/metalloids have been known to occur in little penguins (Eudyptula minor), however what negative effects these may be having on these birds at current levels is largely unknown. To that end, the metal content of red blood cells was compared to blood biochemistry and haematological values of adult little penguins located on Phillip Island between 2021and 2025 to better evaluate the risk of toxicity to these birds.

Optimising environmental DNA sampling and extraction in a coastal marine system

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Marine ecosystems are experiencing rapid environmental change, yet resolving fine-scale prey distribution remains a major challenge for understanding predator dynamics. Here, we developed and evaluated an environmental DNA (eDNA) workflow to complement autonomous sailing drone-based acoustic surveys around Phillip Island, Australia. The objective was to optimise sampling, extraction, and quantification procedures to establish a reliable methodological foundation for future assessments of prey availability relevant to little penguins. We compared active filtration and passive membrane deployment across different water volumes and immersion durations, and evaluated multiple DNA extraction protocols, including kit selection, bead-beating, and protocol modifications. Active filtration yielded significantly higher DNA concentrations than passive sampling, with DNA quantity increasing consistently with filtered volume. Although 24-hour passive deployments approached active yields, they were logistically constrained at open-sea stations. Repeatability analyses revealed that sample splitting introduced substantial variability, while non-split samples showed high consistency. Extraction with the Blood & Tissue kit outperformed the PowerWater kit, and bead-beating did not significantly improve yield. A modified protocol incorporating an additional pellet wash, an extra 4-minute centrifugation and 50 µL elution volume achieved the highest DNA purity without compromising concentration. Species-level identification is underway, and results will be presented at the conference. Integrating optimised eDNA workflows with high-resolution acoustic surveys can provide a scalable framework for identifying species composition and characterising prey distribution. This combined approach strengthens our capacity to assess marine food availability and support seabird conservation in dynamic coastal ecosystems.

Overview of the Activities of Penguin Fund Japan

MS Kaoru Shiga, Dr Tomi T. Tsuda, Ms Noriko Suzuki, Ms Ichiyo Ohara

[1]Penguin Fund Japan, Tokyo, Japan

This poster provides an overview of the activities of our organisation.

We are a volunteer group of penguin enthusiasts who work under the motto: Sharing our future with penguins. Since our founding in 1986, we have continued our activities for more than four decades.

Our main activities include:

(1) providing donations to organisations involved in penguin conservation and research; (2) organising seminars to deepen our knowledge of penguins; (3) collecting scientific literature and research materials related to penguins.

Since our establishment, we have held a charity auction every two months to raise funds for donations, which are distributed annually to penguin conservation organisations. We have also been proud supporters of the international penguin conference since its inception.

In recent years, we have collaborated with a partner company to run awareness campaigns on penguin conservation and to collect donations from participants.

We also display our collection of books at a partner company's cafe as the "Penguin Library," helping to promote public interest in penguins and their conservation.

We hold five seminars each year, inviting researchers and other experts as speakers. To advance conservation efforts, we consider it is essential to deepen our understanding of penguin biology and stay informed about the latest research on penguin habitats and environmental conditions.

We will continue our activities with enthusiasm as we strive towards a future in which humans and penguins can coexist.

Post-hoc validation of hunting behaviour using unsupervised machine learning approaches.

Mr Fraser Masterson[1], Dr Akiko Kato[2], **Dr Yan Ropert-Coudert[2]**, Dr Marianna Chimienti[1]

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Unsupervised machine learning (ML) algorithms provide flexible methods for classifying behaviours in wild species. Yet, their interpretation and further use in predictive modelling often remains uncertain in the absence of empirical validation. Here, we use accelerometry data from seven diving Adélie penguins (Pygoscelis adeliae) to develop a validation pipeline that benchmarks behavioural states' classifications against annotated, observable events. These annotations enable post-hoc assessment of partial model performance, providing insights into the behavioural states themselves. By annotating prey capture events (PCEs) for a subset of the penguins' accelerometry data using co-deployed video camera footage, we validated the performance of an Expectation Maximisation (EM) model in defining a 'hunting' behaviour. By performing GLMM modelling with the validation outputs, we show that the probability of a PCE in a given EM-defined 'hunting' sequence can be determined via the sequence's metrics: duration, maximum depth, and associated VeDBA (Vectorial Dynamic Body Acceleration). Sequences with longer durations, deeper sequence depths, and more pronounced VeDBA signals convey more likely prey capture events. For example, a hunting sequence lasting 2.2 s with a maximum depth of 40 m and mean ± SD VeDBA of 0.46 ± 0.09 ms^{-2} has a predicted prey capture probability of 25%; this increases to 75% when the duration, maximum depth, and mean ± SD VeDBA rise to 3.8 s, 60 m, and 0.48 ± 0.10 ms^{-2}, respectively. We therefore provide a way forward to diagnose, interpret, and make post-hoc predictive models from movement ecology studies where a priori information may be limited.

PFAS exposure in Australian little penguins (Eudyptula minor): A coastal contamination signal

Dr Patricia Corbett, Dr Phoebe Lewis, Dr John Leeder

Per- and polyfluoroalkyl substances (PFAS) are globally distributed contaminants, yet data for seabirds in the Southern Hemisphere continues to remain limited, representing a critical blind spot for global PFAS risk assessment and management of marine ecosystems. We investigated PFAS occurrence in two populations of little penguin (Eudyptula minor) inhabiting contrasting coastal environments in Australia, an enclosed urbanised bay and the open Southern Ocean along the southern Australian coastline, to elucidate contaminant exposure at the interface of terrestrial and marine systems. Liver samples were collected from free-ranging individuals (n=10 per location) and analysed for a broad suite of PFAS, including both legacy substances and selected emerging chemistries of increasing regulatory and environmental concern. Distinct spatial differences in PFAS composition and profiles were observed between colonies, suggesting a combination of diffuse urban inputs, regional influences, and potential point sources associated with densely populated coastlines. These patterns highlight the role of coastal retention, hydrological confinement, and foraging ecology in shaping PFAS exposure pathways. Comparisons between colonies demonstrate that little penguins are effective sentinels of nearshore contamination, integrating local PFAS inputs through their foraging behaviour and trophic position. Our findings address a key geographic gap in Southern Hemisphere PFAS data and provide insight into source-to-receptor dynamics relevant to coastal monitoring and management. As climate driven ocean warming and habitat shifts increasingly modify contaminant transport and bioavailability, seabird sentinels such as little penguins offer a valuable model for assessing how PFAS move through and persist within changing coastal ecosystems.

Response of emperor penguins to 40 years of changing ice conditions at three colonies using satellite remote sensing (1984-2024)

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Emperor penguins are highly reliant on stable fast ice for successful breeding, and recent studies project possible quasi-extinction for most colonies by 2100 due to future sea-ice loss. To better understand the future response of emperor penguins to ocean-climate warming, it is essential to better understand how colonies have responded to past changes in ice conditions. In this study, we identify the historical locations of the SANAE, Astrid and Mertz colonies in all available Landsat 4–9, ASTER and Sentinel-2 imagery for the period 1984–2024. We record the location and surface type of the colonies' breeding locations each year while also recording major calving events, early fast-ice breakouts, distance to the fast-ice edge, and colony range within a season. The results show that colonies usually return to approximately the same sites annually, but we observe variations due to major calving events. Following such events at Mertz and SANAE, colonies relocate to different sites, where they may be more vulnerable. In subsequent years, the colonies eventually return to sites close to their original location. Additionally, we observe early fast-ice breakouts that may impact breeding success at Mertz and SANAE colonies. Furthermore, all three colonies move onto the adjacent ice shelf in some years, including when stable fast ice is available, suggesting that this behaviour may be more common than previously thought. Observation of these behaviours contributes to broader understanding of emperor penguins' adaptability and will aid future efforts to model the response of the species to ice loss.

Shifting transponder implantation to the leg following evidence of tag migration

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Rear of neck transponder implantations were suspended by the New Zealand National Bird Banding Scheme in April 2025 after X-ray and post-mortem indicated tag migration in hoiho and kororā. We report on the efficacy of the first season of alternative placement trials of transponders in the left leg of hoiho and crested penguins, including assessment of retention, migration, and efficacy of scanning via manual and automated gate readers.

Solving the Penguin Puzzle: Genetic Rescue through Artificial Insemination and Egg Transport

Master Haruki Tsuchiya, Mrs Kaori Tsuchiya[1]

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Japan's captive penguin population faces significant challenges due to low genetic diversity, which increases the risk of inbreeding depression and poor hatching rates. This study investigates two advanced conservation techniques adopted by Japanese aquariums to successfully introduce new genetic material and improve reproductive success.

My research focused on: 1) Advanced Artificial Insemination (AI), analyzing specialized methodologies for semen collection and concentration developed by institutions (e.g., those applied to species like the Southern Rockhopper Penguin) to optimize fertilization. 2) International Superior Egg Transport, examining the strategy of importing genetically distant eggs from international partners, such as the Taronga Wildlife Park in Australia, to quickly diversify the local gene pool.

These efforts, supported by genetic studbook management, demonstrate that technological innovation and global collaboration are essential tools for ensuring the long-term viability of small, isolated penguin populations worldwide.

Surveillance of influenza A and H5N1 viruses in Antarctic and Subantarctic penguin populations

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The mergence of High Pathogenicity Avian Influenza (HPAIV) A/H5N1 in Antartica in late 2023 marked a significant theat to avian wildlife. To assess whether Antarctic penguins developed subclinical immunity or remained unexposed, an intensive surveillance study was conducted during 2024-2025 and 2025-2026 austral summers.

We sampled 238 apparently healthy penguins and 14 carcassess across five penguin species (Pygoscelis adeliae, P. papua, P. antarcticus, Eudyptes chrysocome and Aptenodytes patagonicus) from South Georgia and 12 sites along the Western Antarctic Peninsula (WAP). Molecular screening (RT-qPCR) for influenza A (IAV) and H5 was performed on swabs, complemented by serological ELISA testing for AIV antibodies.

Results from live penguins identified 17 IAV- positive individuals, all were negative for H5. Seroprevalence analysis revealed 28 individuals with AIV antibodies. Three carcasses were positive to molecular detection of IAV and one was confirmed for H5.

These findings indicate a low prevalence of A/H5N1 in penguin populations during the study periods, even when positive skuas's carcasses were near to the colony. Moreover, we can conclude the simultaneous circulation of ultiple influenza subtypes highlights the potential for viral mutations and reassortments. This data is critical for understanding viral circulations and the differential epidemiological roles of penguins in the Antarctic and Subantarctic regions.

Seabird rehabilitation facilities as early warning systems for high pathogenicity avian influenza (HPAI) in South Africa

Mr Albert Snyman[1], **Dr David Roberts**[1], Dr Lisa Nupen[1]

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High pathogenicity avian influenza (HPAI) has emerged as a major threat to seabirds globally, with three outbreaks recorded in South Africa during 2017–2018, 2021–2023, and 2025. The initial H5N8 outbreak primarily affected Swift Terns (Thalasseus bergii) and African Penguins (Spheniscus demersus), while H5N1 emergence in 2021 caused mass mortality of more than 24 000 Cape Cormorants (Phalacrocorax capensis). Continued viral circulation was confirmed in 2025, with over 1 400 seabird deaths recorded nationally between July and December.

Across all three outbreaks, SANCCOB played a central role in seabird disease surveillance and response. Surveillance in South Africa relies heavily on rapid detection outside formal government monitoring frameworks. SANCCOB operates an integrated system combining colony monitoring, carcass collection, post-mortem examination, molecular diagnostics, and detections through rehabilitation admissions. This framework is supported by trained colony rangers and access to diagnostic laboratories, enabling early warning and rapid response. Through this system, SANCCOB accounts for the majority of suspected and confirmed HPAI detections nationally.

Rehabilitation centres provide a critical surveillance and response platform, particularly for species difficult to monitor at sea. These centres receive affected individuals directly, allowing early detection, clinical assessment, and implementation of biosecurity and response measures.

These findings demonstrate that seabird rehabilitation centres are essential components of wildlife disease surveillance. However, such surveillance is unplanned, resource-intensive, and financially demanding, placing strain on institutional capacity and donor funding during prolonged outbreaks. Sustained investment is required to maintain early warning, response capacity, and conservation decision-making during ongoing panzootics.

Seasonal shifts in foraging behaviour of little penguins in Oamaru, New Zealand

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Little penguins exhibit behavioural plasticity in their foraging patterns, with variation observed between colonies and across years within the same colony. However, most tracking studies focus on the breeding season and do not capture potential shifts in behaviour throughout the year. Given the observed variability, it is likely that little penguins adjust their foraging behaviour in response to changing environmental conditions as well as shifts in breeding stage.

Seasonal variation in foraging behaviour may be linked to breeding phenology, as central-place foragers are constrained by the need to return to nests, limiting their flexibility. Additionally, intra-annual changes in oceanographic processes and environmental conditions may influence prey availability and distribution, further shaping foraging strategies.

Understanding spatiotemporal variation in foraging behaviour is critical for effective conservation planning, as it enables identification of the full range of behavioural patterns exhibited by little penguins. Moreover, examining how environmental variability influences foraging behaviour can improve predictions of how this species may respond to climate change.

We investigated the foraging behaviour and distribution of little penguins in Oamaru throughout the 2024 season, from pre-breeding, and throughout the breeding season, and across different breeding stages. We examined whether birds exhibited any degree of seasonality in their foraging behaviour and at-sea distribution, and whether these changes related to variation in breeding stage and environmental conditions.

Species-wide assessment of climate-related risk to little penguins using fuzzy logic

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Little penguins (Eudyptula minor) are becoming increasingly vulnerable to climate change impacts, with shifts in key environmental drivers impacting their survival and breeding success. Effective conservation requires proactive, targeted management strategies which consider climate-related risks across the species' spatial range. These risks are expected to vary between colonies depending on latitude, oceanic situation, and local climate conditions.

This study evaluated environmental variability and its potential consequences at fourteen E. minor colonies spanning from New Zealand to Western Australia to investigate spatial variation in exposure and vulnerability to climate change impacts. These colonies capture a broad range of environmental conditions, enabling a more comprehensive, species-wide assessment of climate-related risks.

Model and satellite derived environmental data were integrated with fuzzy logic methods (Zadeh 1965) that accommodate uncertainty and "imprecise" datasets to facilitate this broad-scale risk assessment. This approach removed common barriers to conventional analyses and enabled inclusion of colonies irrespective of long-term monitoring status and proximity to weather stations.

An analysis of trends in six important environmental drivers (e.g., storms, marine heat waves), and previous observations of penguin responses were used to inform the development of fuzzy systems that assess localised risk at colonies. Spatial patterns in the exposure and vulnerability of E. minor to climate-related risks were revealed by differences in environmental trends and risk-ratings between colonies.

These findings highlight the importance of assessing and considering local threats when implementing management strategies, providing a foundation for identifying and prioritising conservation efforts based on E. minor vulnerability to climate change impacts.

Stage-specific Effects of Snow on Breeding Success in Pygoscelid Penguins

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Snow accumulation and snowfall are widely recognized as important environmental stressors affecting penguin breeding success, yet the mechanisms underlying these effects in Pygoscelid penguins remain poorly understood. We combined time-lapse camera monitoring and aerial surveys conducted at Narébski Point, Cape Hallett, Inexpressible Island, and Adélie Cove during the 2019-20 and 2025-26 breeding seasons. Our results show that snow effects vary markedly among breeding stages and nest locations. During incubation, breeding failure primarily occurred when melting snow caused nest flooding, leading to abandonment of those subcolonies in subsequent breeding seasons. However, when flooding did not occur, successful incubation was possible even in snow-covered areas, particularly on sloped terrain. In the early chick-rearing period, snowstorms were associated with elevated nest loss and chick mortality, with effects persisting for several days after the storms. Overall, penguins appear relatively resilient to snow-related disturbances, with negative effects occurring primarily under specific conditions such as flooding during incubation or prolonged snowstorms during early chick-rearing. These findings suggest that snow is not uniformly detrimental; rather, it affects breeding success through mechanisms that vary across breeding stages, thereby advancing our understanding of climate-related impacts on Antarctic penguin populations.

Stage-specific foraging distribution of kororā\ little penguins from Pōhatu/Flea Bay, New Zealand

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While breeding stage shifts in penguin foraging behaviour are well established, predicted habitat use is rarely compared across stages or evaluated against the boundaries of existing marine reserves. At one of the largest mainland Aotearoa New Zealand colonies of kororā (little penguins, Eudyptula minor), long term monitoring has documented a sustained population decline over the past decade despite intensive terrestrial management. This has raised concerns about potential marine-based threats affecting kororā, particularly since recent GPS tracking of 44 adults during the 2023 and 2024 breeding seasons indicated they almost exclusively foraged beyond the limited Pōhatu Marine Reserve boundary. Using this novel tracking dataset, we created Maxent species distribution models to quantify stage-specific foraging distributions and identify key environmental variables correlating to penguin space use. During prebreeding and incubation, tracked kororā undertook multi-day, inshore foraging trips exceeding 100 km southwest from the colony. In contrast, chick rearing adults displayed central place foraging behaviour, remaining within 20 km south-southeast of the colony. Species distribution models showed that distance to coast was the dominant predictor of habitat use during prebreeding and incubation, while distance to colony was most influential during guard and postguard stages. These findings demonstrate marked shifts in kororā foraging strategies and identify nearshore habitats outside current reserves as potentially critical for adult survival and breeding success. This study also provides new insight into how New Zealand kororā may interact with dynamic coastal ecosystems, and how improved marine protection is required that better reflects penguin ecology.

Supporting Individual Penguin Observation in Aquarium Exhibits Through Sketching Abdominal Spot Patterns

Ms Yuki Nakagawa[1], Mr Satoshi Nakamura[1], Mr Harumasa Ashikari[2], Ms Eriko Bando[2], Mr Ryota Yokura[2], Ms Kana Watanabe[2], Ms Nanami Iwanaga[2]

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In penguin exhibits at aquariums and zoos, multiple individuals are often housed together, and visitors tend to observe them as a group rather than as distinct individuals. Although some facilities provide names and individual information for each penguin, it remains difficult for visitors to connect the animal in front of them with information displayed on-site.

To address this challenge, we present an interactive approach that supports individual-level penguin observation through visitors' active engagement. Focusing on the unique abdominal spot patterns of penguins, we developed a smartphone-based system that invites visitors to observe the abdominal pattern, sketch it on the interface, identify the individual, and access information about the penguin. By requiring visitors to actively inspect and sketch the pattern, the system is designed not only to identify individuals but also to encourage closer observation.

We deployed the system in collaboration with Sunshine Aquarium in Tokyo and conducted a field study with over 400 visitors across two one-week deployments to examine how the system shaped observation behavior at the exhibit. The results showed that the system increased conversations among visitors, encouraged attention to individual penguins, and increased time spent at the exhibit. Visitors were also observed calling penguins by their names and relating penguin profiles to themselves, suggesting growing familiarity. In addition, some visitors revisited the exhibit, including on multiple days.

These findings suggest that sketch-based identification can serve as an effective interactive approach for promoting active, individual-level observation of penguins in aquarium exhibits and for deepening visitor engagement with animals.

Telomere length variability of Pygoscelis penguins in the Antarctic Peninsula

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Telomeres, the protective caps at the ends of linear chromosomes, are increasingly recognized as indicators of the cumulative effects of environmental stressors on health, longevity, and reproductive success in birds. Understanding the dynamics of telomere length in relation to the ecology and life histories of bird species enhances our knowledge of how sensitive these species and individuals are to environmental changes and stressful conditions. This study aimed to investigate the variability of telomere length among penguin species in Antarctica, a region experiencing rapid environmental change and heightened human activity. Telomere length was measured along a latitudinal gradient in the Antarctic Peninsula, focusing on different populations of the three Pygoscelis penguins: Chinstrap (Pygoscelis antarcticus), Gentoo (P. papua), and Adélie (P. adeliae). At the species level, Chinstraps exhibited the shortest telomeres and the least variability both within and among populations. In contrast, Adélie penguins displayed the longest telomeres and the greatest variability within and among populations. Gentoo penguins occupied an intermediate position between Chinstraps and Adélies. The different populations studied were associated with varying ecological conditions, including temperature, wind patterns, and population densities, as well as differing levels of anthropogenic stressors, such as the presence or absence of tourism and research stations. Understanding how environmental conditions and human activities affect Antarctic wildlife is a primary concern for researchers and is crucial for global wildlife conservation assessments in the region. In this context, telomeres represent a valuable tool for assessing environmental sensitivity across penguin species and health of penguin populations in Antarctica.

The importance of nestling personality for growth in fluctuating environments: a study in the little penguin

Phd Justine Wintz[1], Dr Vincent Viblanc[1], Mr Max Ronan[2], Dr Agnès Saulnier[3], Dr Pierre Bize[3,4], Dr Andre Chiaradia[2,5], Dr Claire Saraux[1]

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Offspring growth represents a critical life stage, strongly influencing later fitness across animal species. Yet, even when raised by the same parents under similar environmental conditions, siblings often exhibit different growth trajectories and survival. Such differences may be related to consistent variations between siblings in personality traits that affect access to food resources.

To test this hypothesis, we measured exploration and aggressiveness on 101 little penguin chicks (Eudyptula minor) over 962 behavioural tests, concurrently measuring changes in body mass during growth. We aimed to identify i) personality and plasticity traits, ii) behavioural syndromes and iii) effects of these traits on growth trajectories at both population and within-nest levels.

Exploratory and aggressive behaviours were repeatable within individuals (38% and 32% for exploration and aggressivity respectively), consistent with personality traits. Behaviour also changed with age with substantial variation among individuals, indicating significant inter-individual plasticity. Behaviours were positively correlated (32% on average), consistent with a behavioural syndrome along a reactive-proactive (shy-bold) continuum.

Contrary to the expectation that proactive individuals would show greater access to food and thus grow more efficiently, our findings highlight a weak advantage of reactive individuals (delayed and high peak at maximum mass). Plasticity however showed no detectable effect on growth trajectories at either the population or within-nest level.

Our results suggest that reactive individuals may be better adapted to fluctuating environments, and emphasize the importance of accounting for personality effects on growth under contrasting environmental conditions.

The Potential of Oil Absorbing Magnetic Particle Technology, "Magnetic Cleansing", in the Rescue and Rehabilitation of Oil-Contaminated Penguins

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This presentation will outline the potential of oil absorbing magnetic particle technology (MPT) in the removal of oil contamination from plumage, particularly that of the Little Penguin. This dry-cleansing approach, dubbed "magnetic cleansing", is an alternative, or an adjunct, to traditional surfactant-based methods and offers potential advantages such as portability, ease of waste disposal and low cost. The development of the most appropriate technology for use in the field, including particle development, the most appropriate magnetic harvesting device(s) and logistics will be discussed. For example, the development of the prize-winning "magnetic wand" and its potential for providing a 'quick clean' upon first encounter will be discussed in terms of its ability to rapidly remove the more toxic and corrosive volatiles from plumage (or fur) upon first encounter, or for animals in holding bays. The potential for incorporating this technology into existing stabilization protocols will also be discussed. In addition, the application of MPT as a quantitative assay for the identification of tailored pre-treatment agents to facilitate the removal of recalcitrant contamination (either by magnetic cleansing and/or surfactant-based methods) will be discussed. New directions, that are currently underway or in the offing, will be outlined.

Translocation of little penguin (Eudyptula minor) chicks to a safe refuge

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[2]Phillip Island Nature Parks, Australia

Translocations are a conservation strategy for seabirds, typically motivated by both species' recovery and restoration goals. They can also be used as a management tool to discourage colony establishment in unsuitable areas by redirecting individuals to safer locations. We describe a translocation management program undertaken to prevent the establishment of new breeding pairs in a high-risk area of the Summerland Peninsula, Victoria, Australia. Penguins occupying a car parking area at the Penguin Parade experienced high levels of disturbance and mortality due to vehicle strikes, warranting their exclusion from the site. Chicks were taken from the source site, reared in captivity and released at fledging into artificial burrows at the designated translocation site. Over 14 years, 353 little penguin chicks were translocated. Of these, 6.8% returned as adults within the study period, comparable to the control group, randomly selected from a long-term mark-recapture dataset. Notably, two-thirds of returning chicks were recruited in the translocation area, while one-third returned to the source site. Recruits at the translocation site showed evidence of long-term establishment and normal reproductive behaviour. These results demonstrate that translocation can be an effective tool not only for establishing or restoring colonies, but also for managing colony distribution in human-impacted environments. This approach may be particularly useful following localised extinction or disaster events such as fire or oil spills.

Understanding thermogenesis process and resilience in king penguins

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Seabirds face ecological pressures that demand exceptional metabolic performances, including seasonal fat accumulation and prolonged diving under hypoxic conditions. To meet these demands, birds have evolved remarkable physiological adaptations that sharply contrast with mammalian metabolism: a phenomenon often referred to as the "bird paradox." A key distinction is the preservation of nucleated red blood cells (RBCs) with functional mitochondria, an ancestral trait lost in mammals. Recent studies show that avian RBC metabolism can respond to nutritional state, environmental conditions, and stress, notably via the modulation of mitochondrial respiration. Increasing evidence suggests that this modulation may contribute to thermogenesis via metabolic heat production, although this hypothesis remains untested. The aim of this study is to investigate the role of RBC mitochondria in heat production and metabolic regulation, and their potential contribution to whole-organism thermogenesis and homeostasis. Using confocal and electron microscopy, we identified novel organelle structural characteristics in king penguin RBCs (Aptenodytes patagonicus), potentially linked to temperature-dependent gene regulation. To test this hypothesis, we will compare gene expression profiles of RBCs exposed to cold (30°C) versus standard (37°C) conditions. This work is conducted in collaboration with Zoo Zürich (Switzerland) and provides new insights into the cellular mechanisms underpinning thermal adaptation in seabirds.

Weekly variation in parental provisioning influences chick growth in little penguins

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In seabirds, parental provisioning of food during the breeding season can influence chick growth. Little penguin chicks (Eudyptula minor) display three growth phenotypes: fast, slow, and light, but whether parental provisioning drives these phenotypes is unclear. We investigated how weekly variation in provisioning influences chick growth using data from 19 breeding seasons and over 1500 little penguin chicks. First, weeks were categorised as high or low depending on provisioning rates, then the proportion of these weeks experienced by each growth phenotype was compared over the post-guard period and before/after peak mass.

Growth phenotypes experienced different proportions of high and low provisioned weeks at different stages. Over the post-guard period, fast chicks were exposed to the highest proportion of high-provisioned weeks (72%), light chicks the lowest (40%), and slow chicks an intermediate proportion (52%). Fast chicks experienced a larger proportion of high-provisioned weeks before peak mass (84%) and a balanced mix after peak mass. Light chicks experienced similar proportions of weeks before peak mass and a low proportion of high-provisioned weeks after peak mass (21%). Slow chicks experienced equal proportions of high/low-provisioned weeks before and after peak mass. Thus, growth trajectories of fast chicks diverged early from slow and light chicks due to higher provisioning while the provisioning after peak mass differentiated light from slow. We found little penguin growth is influenced by the proportion of high and low-provisioned weeks and by their timing during development , suggesting development in this long-lived seabird is sensitive to fine-scale variation in parental provisioning.

What if penguin habitats were grown from fungi?

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As environmental conditions shift, the futures of many penguin habitats become increasingly uncertain. This poster asks how new designs might contribute to conversations about habitat futures.

Through a speculative design project, we explore fictional worlds that deliberately stretch contemporary assumptions. One scenario imagines where in the atmosphere penguins might find thermal comfort. Another envisions ocean nomads travelling with shifting fish populations on floating habitats. These are not predictions or conservation proposals, but provocations that challenge conventional thinking about how penguin habitats might evolve under a changing climate.

From these provocations emerges a material question: could new materials help future-proof artificial penguin habitats?

One candidate is mycelium, the root-like network of fungi, which can be grown into lightweight, biodegradable composites. Its porous structure provides thermal insulation that could reduce heat buildup during extreme weather events, and moulding allows it to be tailored to particular species, sites, and environmental conditions without seams or gaps. Mycelium can be produced with a low environmental footprint, is fire-resistant, and biodegrades at the end of its useful life, offering a regenerative approach to habitat design.

These possibilities raise important questions. How durable and resistant are mycelium habitat structures in exposed coastal environments to moisture and weathering? How would penguins interact with or adopt these structures?

By combining speculative design with material innovation, this poster proposes mycelium not as a finished solution but as a catalyst for exploring and collaborating with scientists on how regenerative materials might help future-proof penguin habitats in an era of climate change.

Where penguins meet people: spatial overlap between foraging habitats and human pressures in coastal ecosystems

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Coastal penguins are among the seabirds most exposed to human pressures, as their foraging activity concentrates in highly productive marine areas that are also intensively used by fisheries, shipping, and coastal development. Despite the rapid expansion of biologging studies, a clear synthesis of how marine habitat use varies across species—and its implications for conservation—remains lacking.

Here, we present a systematic review of marine habitat use during the breeding season in six coastal penguin species (Spheniscus, Eudyptula minor, and Megadyptes antipodes). We compiled spatial metrics, environmental variables, and reported threats to identify comparative patterns and evaluate their relevance for marine spatial planning.

Our synthesis reveals pronounced variability in foraging scale among species, particularly within Spheniscus, where some populations travel hundreds of kilometers from their colonies, while others exhibit more restricted ranges. These differences suggest contrasting exposure to threats: wide-ranging species are more likely to interact with human activities, whereas species with limited ranges may be more vulnerable to local environmental changes.

Habitat characterization consistently relies on a reduced set of variables—primarily bathymetry, sea surface temperature, and proxies of prey availability—highlighting both their ecological importance and the reliance on indirect measures.

Reported threats, including resource competition, fisheries-related mortality, and climate change, frequently overlap with core foraging areas, revealing a spatial conflict between conservation and human use.

Our results emphasize the need to incorporate marine habitat use into conservation strategies. Coastal penguins provide a valuable model for spatially explicit marine planning. This research was supported by Sphenisco.

Will penguins be able to adapt? Projecting future changes in habitat suitability for both penguins and their prey under climate change scenarios

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Climate change is impacting the suitability of environmental conditions across marine ecosystems. The ability of penguins to move may help them cope with habitat loss. However, if suitable environmental conditions are not within a reachable distance or if this redistribution produces a mismatch with their prey, penguins may not be able to adapt. Evaluating how habitat suitability shifts within and near current home ranges, particularly for highly philopatric species, and how these changes affect spatial and temporal overlap with their prey, is therefore key to anticipating responses to global change. We applied Species Distribution Models(SDM) to each of the penguin species and its main prey to project changes in their habitat suitability and potential mismatches until the end of the century, under three different climate scenarios (ssp126;ssp370;ssp585). Results indicate that, by the end of the century, most penguin species will lose suitable habitat within their current distribution. Penguins inhabiting polar regions are the ones more likely to find suitable areas near their current distribution, except the obligate Antarctic Adélie and Emperor penguins. Beyond projecting future changes in penguin habitat suitability, we assess whether shifts in environmental conditions are accompanied by corresponding changes in the distributions of prey species, and thus evaluate the potential for predator–prey mismatches. Persistent food availability within current ranges may enhance resilience to environmental change, whereas suitable and reachable habitat beyond current distributions may promote redistribution. These insights can help identify areas where conservation actions may be most effective, providing a scientific basis for adaptive management policies.

What does conservation and management look like for Little Penguins Eudyptula minor in Tasmania?

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Little Penguins (Eudyptula minor) are a coastal nesting seabird present around much of the Tasmanian and Bass Strait islands' foreshores. Little Penguins require suitable habitat for nesting and moulting. In Tasmania, Little Penguins are present in coastal areas up to at least 1 km inland, where they nest in various natural habitats, including burrows, rock crevices and underneath suitable vegetative cover. In many areas, colonies are peri-urban or even urban where interactions with humans are increasing, often to the detriment of the penguins. Some colonies are restricted to a narrow coastal strip due to infrastructure, such as roads and railways.

Conservation and management strategies and efforts directed towards Little Penguin habitat in Tasmania have both evolved over the last 50 years, drawing on research, knowledge and past management efforts statewide. Conservation actions to ensure the long-term survival of Little Penguins and their habitats require urgent efforts to improve habitats, and mitigating, minimising or eliminating identified threats to colonies. This paper outlines contemporary guidelines regarding the timing of works, survey and assessment protocols, and the identified threats and solutions that have been developed recently. These guidelines have proved an invaluable toolbox used by all coastal councils, commercial developers and relevant government agencies in Tasmania.

What really happens out at sea? Impacts of coastal turbidity on the foraging behaviour of little penguins (Eudyptula minor)

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Storm activity is predicted to increase in both frequency and intensity under climate change, driving elevated turbidity and sedimentation in coastal marine environments. This may have significant consequences for visual predators such as the kororā/ little penguin (Eudyptula minor), yet the effects of reduced visibility on their foraging behaviour remain poorly understood. Traditional biologging tools, including time–depth recorders and GPS devices, have advanced our understanding of dive behaviour, but rely on key assumptions and provide limited insight into the environmental conditions experienced by foraging individuals.

Here, we use animal-borne video loggers to examine turbidity levels and directly link these to observed foraging behaviours in little penguins. Despite challenges associated with deploying cameras on small seabirds, including stability, visibility, and battery constraints, video loggers offer a novel approach to assessing fine-scale environmental conditions that cannot be resolved using traditional methods.

Video loggers were deployed on breeding little penguins in Ōamaru between September 2024 and February 2026, targeting guard-stage adults undertaking single-day foraging trips. Deployments spanned a range of environmental conditions, including both storm and non-storm events. Footage was used to assess turbidity levels and analyse foraging behaviour, with a focus on changes in prey detection across conditions.

Preliminary analyses indicate variation in foraging behaviour across turbidity levels, suggesting impacts on prey encounter rates and foraging efficiency during storm events. By linking fine-scale environmental variability with directly observed behaviour, this study highlights the value of animal-borne video loggers in understanding how climate-driven changes in coastal systems may affect marine predators.

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