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13th OPPENHEIMER RESEARCH CONFERENCE

◆ SCIENCE BEYOND BOUNDARIES ◆



ORC

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Randjesfontein
Cricket Ground,
Midrand

9-11 October

Cover photo: Rhino Guardians at Londolozi Game Reserve; Expert trackers assisting anti-poaching teams to protect rhinos, using their specialised skills to track both wildlife – especially rhino and poachers. Photo credit: Scott Ramsay

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Welcome note

The Oppenheimer Research Conference was initiated in 2010 and has grown into an important, significant event on the global academic calendar. What is unique about this conference is that unlike other conferences it showcases research from various environmental and natural science fields. One of its great successes is this conference's diversity. Usually, one attends a conference focused on single specialisations such as ornithology, entomology or archaeology, however, it all happens here, creating an opportunity for scientists to mix with other scientists from various fields.

The work presented here is cutting-edge, innovative scientific research, that provides a platform to foster engagement and collaboration. By so doing, we are contributing to placing African voices in global conversations on environment, conservation, and sustainability. The conference engages researchers in an interdisciplinary and multisectoral manner, and across scale, from the microscopic, landscape and global level. The conference is not only about scientists talking to other scientists, but to create a movement for nature in a way that creates sustainable, long-lasting impact. We need to move from pure discussion into translating our findings to address global challenges and together providing the answers.

It represents an opportunity to celebrate and explore diverse ways of knowing about Africa's needs, challenges, and contributions, and to discuss and reflect on how this knowledge is created and utilized. The Oppenheimer Research Conference embraces a "community of knowledge builders" which includes Oppenheimer-funded researchers and partners, African and global researchers, NGOs, policymakers, land-use decision makers, business, the media, and the broader public. Through this showcase of excellence, we offer opportunities to learn and to build new networks to galvanise action based on solid research, creating impact, and asking the right questions. This will guide action towards mapping out solutions to mitigating environmental and conservation tipping points across the continent and beyond.

We are confident that you will be inspired over the next three days by the various cross-cutting presentations and posters, which include topics such as biodiversity loss, rewilding and reintroduction of critically endangered species, landscape ecology, archaeology, climate change and wildlife economies, as we work towards catalysing groundbreaking research that promotes and ensures the meaningful application of science beyond boundaries.

Thank you for joining us.

Nicky and Jonathan Oppenheimer

Introduction

The Oppenheimer Research Conference (ORC) continues to bring together select individuals and organizations operating and interested in the fields of natural and environmental science. It offers a uniquely diverse and multi-disciplinary programme, that takes the form of plenaries, presentations, posters and panel discussions.

The conference aims to contribute to the conservation of ecosystems, biodiversity and heritage by creating an inclusive and encouraging platform for quality presentations, discussions, networking and collaboration. Since its inception in 2010, the conference has grown into an event which we can proudly say is a highlight on the science calendar. The conference is hosted by Oppenheimer Generations Research and Conservation (OGRC).

Through this showcase of excellence, ORC offers opportunities to learn and build new networks and to encourage action based on solid research, which can provide solutions to mitigate environmental and conservation tipping points, focused on the following five areas:

Biodiversity loss – How can we mitigate biodiversity loss in Africa?

Landscape ecology – How do we prioritise ecosystem interventions in Africa? What gets used, protected and rehabilitated?

Climate change – How will climate change affect Africa, on land and along its coastline? What should be done to mitigate or adapt to the massive upheavals already well underway?

Wildlife economies – How do we grow inclusive economies that enable both the use and preservation of ecosystems for future generations?

Heritage – How can we take learnings from the past to inform the future?

The ORC provides a platform to showcase African research, and to amplify the voices of African scientists to ensure that sustainable solutions are forged, not only for Africa, but for the world.

Day 1: Wednesday, 9 October 2024

Session 1: Chair | Duncan MacFadyen

- 08:00 – 09:00 Registration/ Networking/ Refreshments
- 09:00 – 09:10 Welcome and Introduction **Nicky Oppenheimer**
- 09:10 – 09:20 Keynote address by **His Excellency Hailemariam Desalegn Boshe**
- 09:20 – 09:50 Global impacts of climate change on natural systems and consequences for conservation of biodiversity
PLENARY by **Camille Parmesan**
- 09:50 – 10:20 Tipping points – making some uncomfortable trade-offs
Full Presentation **Howard Hendriks**

10:20 – 10:50 Morning tea

Session 2: Chair | Rendani Nenguda

- 10:50 – 11:05 Land Reform and Biodiversity: Bridging the Gap and Potential for Integration
Results Presentation **Bulelwa Mabasa** and **Thomas Karberg**
- 11:05 – 11:35 The future of the grassy biomes
Full presentation **William Bond**
- 11:35 – 11:50 The Functional Benguela Microbiome: a closer look at upwelling dynamics and marine microbial diversity and function
Results Presentation **Yameen Badrodien**
- 11:50 – 12:05 Continental-scale disturbance regimes and tree resprouting responses
Results Presentation **Fezile Mtsetfwa**
- 12:05 – 12:35 Patterns of natural and human-induced climate change on Madagascar through recent geological time
Full presentation **Steve Goodman**
- 12:35 – 12:50 Unlocking the wildlife economy in the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA)
Results Presentation **Irene Mhlanga**

12:50 – 13:00 Conference Photo

13:00 – 14:00 Lunch

Session 3: Chair | Ashleigh Fynn-Munda

- 14:00 – 14:30 Trophy hunting: from public furore to published figures
Full presentation **Amy Dickman, Lovemore Sibanda** and **Darragh Hare**
- 14:30 – 14:45 African species of *Dipcadi* (Asparagaceae, subfamily Silloideae) discussed relative to ITS sequence data
Results Presentation **Christopher Chapano**
- 14:45 – 15:00 Leveraging Traditional Ecological Knowledge (TEK) for Conservation: Baka indigenous people and hunting in Central Africa
Results Presentation **Fanny Marcelle Djomkam**
- 15:00 – 15:15 Strategic dissonance, climate change and conservation
Results Presentation **Guy Midgley**
- 15:15 – 15:30 When will the extinction crisis begin? Notes from the Namib Desert frontline.
Results Presentation **Wendy Foden**

15:30 – 16:00 **Afternoon tea**

Session 4: Chair | Bongani Bingwa

- 16:00 – 17:00 The Business of Conservation
One-on-one Interview **Jonathan Oppenheimer**
-
- 17:00 – 17:30 **Break | Painted Wolf Wines – wine tasting**
- 17:30 – 17:45 Movie introduction
- 17:45 – 19:00 **Movie Screening: WildEarth Live Safari**
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- 19:00 Venue close

Day 2: Thursday, 10 October 2024

Session 1: Chair | Peter Makumbe

08:00 – 08:30	Registration/Networking/Refreshments
08:30 – 09:00	Transforming spaces of research PLENARY by Winnie Kiiru
40 minutes	SPEED PRESENTATION SESSION
09:00 – 09:05	Crouching Leopard, Hidden Camera: Comparing Methods for Estimating Leopard Density in an Enclosed Reserve Speed presentation Robi Watkinson
09:05 – 09:10	Black rhino trophic rewilding: A test case in a semi-arid savanna Speed presentation Olivia Jones
09:10 – 09:15	The effects of elevated atmospheric CO ₂ levels on dung beetle species (Coleoptera: Scarabaeinae) Speed presentation Nthabiseng Mathikge
09:15 – 09:20	Perceptions of the importance, value, and role of nearby Southern Mistbelt Forests held by nearby communities in KwaZulu-Natal, South Africa Speed presentation Siboniso Magoso
9:20 – 09:25	The role of zebra stripes: Testing possible drivers of geographical variation in stripe patterns Speed presentation Amy Chen
09:25 – 09:30	Call Library Development for Small Mammals on Telperion Nature Reserve Speed presentation Thato Mathoko and Georgia Muller
09:30 – 09:35	The Influence of hydrology on vegetation dynamics in fynbos wetlands Speed presentation Mpho Havhi
09:35 – 09:40	Speed presentation group Q&A session

Poster session

09:40 – 11:00	Morning tea and POSTER SESSION in Poster Gallery
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Session 2: Chair | Bailey Corder

- 11:00 – 11:15 Human Exposure to Microplastics and Plastic-related Chemical Contaminants
Results Presentation **Gideon Idowu**
- 11:15 – 11:45 The African elephants (*Loxodonta africana*) in their newfound home, the Central Kalahari Game Reserve, Botswana
Full presentation **Shimane Makhabu**
- 11:45 – 12:00 Rethinking Natural Resources Governance for a Low Carbon Future
Results Presentation **Zainab Usman**
- 12:00 – 12:30 The future of Ethiopian wolves: habitat loss, extinctions and a role for conservation translocations
Full presentation **Claudio Sillero**
- 12:30 – 12:45 A transformative tool for monitoring biodiversity using a combination of traditional ecological knowledge with leading-edge analytics and AI
Results presentation **Zoe Jewell**
- 12:45 – 13:00 Handling the Heat: Managing Microclimates for Nesting Desert Hornbills
Results presentation **Obakeng Pule**

13:00 – 14:00 Lunch

Session 3: Chair | Andre Tranquilini

- 14:00 – 14:15 Intra-African Collaboration in Natural Product Sciences through NABSA
Results Presentation **Berhanu Abegaz Molla**
- 14:15 – 14:30 Biodiversity and Climate Seeds of Zambia: How bottom-up initiatives contribute to global and national biodiversity and climate commitments
Results Presentation **Mulako Kabisa**
- 14:30 – 15:00 Getting Africa's grasslands on the map: building the science and policy case for priority conservation
Full presentation **Sally Archibald**
- 15:00 – 15:15 How small diurnal mammals cope with heat and cold in the Kalahari: a study of ambient heat load, animal behaviour and body temperature
Result Presentation **Chanel Rampartab**
- 15:15 – 15:30 Impact of rainfall variation and fire on acacia demographics at Tswalu Reserve
Results Presentation **Susanne Vetter**

15:30 – 16:00 Afternoon tea

16:00 – 17:00 Panel discussion – The Oppenheimer Programme in African Landscape Systems (OPALS): Supporting more sustainable interactions between people and the environment across Africa
Panel Members:
Tom Powell
Enimhien Akhabue
Antony Emenyu
Milcah Kirinyet
Alan Nare, Minda Cossa
Tapiwa Gumbo
Chafika Phiri

17:00 – 17:30 **Break**

17:30 – 18:30 NEW JWO RESEARCH GRANT RECIPIENT AWARD PRESENTATION
Jonathan Oppenheimer

18:30 for 19:00 **Cocktail function**

Day 3: Friday, 11 October 2024

Session 1: Chair | Dylan Smith

- 08:00 – 08:30 Registration/Networking/Refreshments
- 08:30 – 09:00 Personalised ecology
PLENARY by **Kevin Gaston**
- 09:00 – 09:15 Changing the conservation narrative: Aligning conservation and development in Africa
Results Presentation **Leigh-Ann Kant**
- 09:15 – 09:45 Developing Regional Capacity for Marine Research in the Western Indian Ocean
Full presentation **Arthur Tuda**
- 09:45 – 10:00 The multiple dimensions of information in animal vocalisations and the implications for understanding group dynamics
Results presentation **Marta Manser**
- 10:00 – 10:15 Elephant movements as a driver of landscape level conservation
Results presentation **Morgan Hauptfleisch**
- 10:15 – 10:30 The overlap of protected and conservation areas with centres of bryophyte endemism in the flora of southern Africa region
Results Presentation **Nonkululo Phephu**

10:30 – 10:40 JWO Research Grant 2023 Snapshot

Bryophytes of the high mountains of Madagascar: a comparative analysis of diversity and distribution patterns

Lova Marline

10:40 – 11:10 Morning tea

Session 2: Chair | Pumla Dlamini

- 11:10 – 11:25 Rock Art of the Waterberg: Journeys of Transformation
Results Presentation **Lyn Wadley**
- 11:25 – 11:40 Reproductive phenology variations of chacma baboons (*Papio ursinus*) in southern African biomes.
Results Presentation **Locadia Dzingwena**

11:40 – 11:55	Early results from SEOSAW: a network of people, plots and methods to understand global change impacts in southern Africa Results Presentation Justice Muvengwi
11:55 – 12:25	100 Years of Biodynamic Agriculture: A Model for Sustainable Farming, Climate Mitigation, and Future Opportunities in Africa Full Presentation Helen Van Zyl and André Tranquilini
12:25 – 12:40	Reducing vector borne disease risk by optimizing artificial light expansion across Africa Results Presentation Bernard Coetzee
12:40 – 12:55	Durrell-Drones for Conservation in Madagascar Results Presentation Andriatsitohaina Rakotozoely
12:55 – 13:10	Evolutionary overcompensation for climate change protects butterflies for decades ahead Results Presentation Michael Singer
13:10 – 13:40	Exponential Roadmap for Africa Full Presentation Conservation International (CI) and Future Ecosystems for Africa (FEFA)
13:40 – 14:00	CONFERENCE AWARDS Nicky Oppenheimer AND CLOSE Duncan MacFadyen
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14:00 – 15:00	Lunch
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Poster session schedule

Adriaana Jacobs and Eduard Venter	The fungal Agrobiodiversity in South African soils	1
Aidan Bossert* , Sophie von der Heyden, Andrew Ndhlovu and Katie Watson	Ex situ mariculture supports the restoration of Africa's endangered seagrass, <i>Zostera capensis</i>	2
Alex Faria* , Guy Midgley, Charlene Janion-Scheepers and Heidi Hawkins	Rewilding for Richer Soils: The Impact of Reintroduced Megafauna on Soil Health	3
Alexandra Howard* , Peter Taylor, Ara Monadjem and Wanda Markotter	What makes bats buzz on apple farms? Acoustic analysis of insectivorous bats foraging in agricultural areas of central South Africa	4
Angela Effiom* and Marion Bamford	LM and SEM studies of Southern African <i>Vachellia</i> and <i>Senegalia</i> pollen	5
Annah Mabidi , Matthew Bird and Renzo Perissinotto	Increasing salinity drastically reduces hatching success of crustaceans from depression wetlands of the semi-arid Eastern Cape Karoo region, South Africa	6
Aphiwe Mtolo* , Sindiso Nkuna and Caswell Munyai	Grassland Transformation Negatively Impact Ant Diversity and Evenness in Peri-Urban Area of KwaZulu-Natal	7
Astri Leroy , Jean-Marie Leroy and Thembile Khoza	Thirty-two Years of Spider Records	8
Benjamin Melamdowitz* , Francesca Parrini, Wendy Panaino and Andrea Fuller	Temminck's pangolin distribution and habitat use in a dryland environment	9
Benjamin Schoville , Robyn Pickering, Luke Gliganic, Jayne Wilkins, Irene Esteban, Kelly Kerstin, Alex Blackwood, and Precious Chiwara-Maenzanise	The Importance of Tswalu Kalahari Reserve for Human Evolution	10
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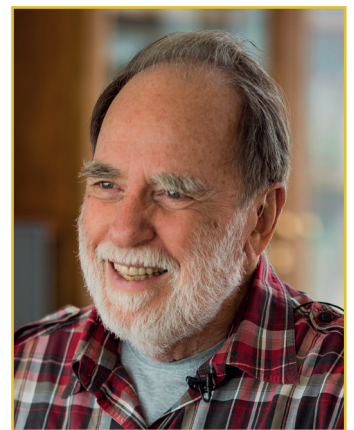
Thilivhali Rasimphi* , David Tinarwo, Beata Kilonzo and Pertinah Nyamukondiwa	Domestic Biogas Technology Role in Achievement of The Sustainable Development Goals: Evaluation and Challenges in Rural Areas of Limpopo	90
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Abstracts and Biographies

Day 1: Wednesday, 9 October 2024

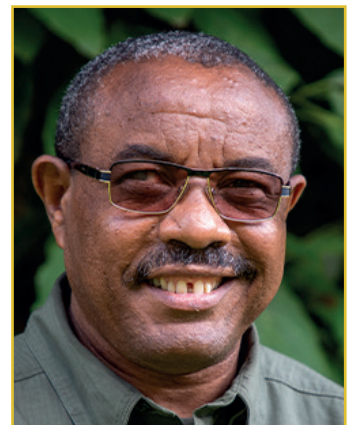
Welcome: Nicky Oppenheimer

Nicky Oppenheimer – a South African businessman and conservationist – was educated at Harrow School London and the University of Oxford, where he studied Politics, Philosophy and Economics. He continues his long and respected legacy of environmental and conservation leadership by serving on the board of Tswalu Kalahari Game Reserve. Nicky is also a keen supporter and sponsor of the Oppenheimer Research Conference, which brings together pre-eminent individuals and organisations from the natural and environmental science industries across the world. In 2005, Nicky and Jonathan established the Brenthurst Foundation, to reflect the family's contribution to the debate around strategies and policies for strengthening Africa's economic performance. As a trustee of the Oppenheimer Memorial Trust, Nicky strongly believes in investing in education and advocates that every South African has the right to a high standard of education at all levels. He holds an honorary Doctorate in Technology from Technikon Witwatersrand in South Africa, making him the first recipient from both the public and private sectors, and also holds an Honorary Fellowship from the London Business School. Additionally, Nicky is a recipient of the Presidential Order of Honour from His Excellency Mr Festus Gontebanye Mogae, the president of the Republic of Botswana.



Keynote address: His Excellency former Prime Minister of Ethiopia Hailemariam Desalegn Boshe

Hailemariam Desalegn was the Executive Prime Minister of Ethiopia from 2012 to 2018. He previously occupied the positions of Deputy Prime Minister and Minister of Foreign Affairs; Minister of Social Affairs and Government Chief- Whip. He was also Governor of the Southern Regional State for six years. With a master's degree in water and environmental engineering from Tampere University of Technology in Finland and a second master's in organisational leadership from Azusa Pacific University in California, he served in various academic and administrative capacities, including the Dean of the Water Technology Institute of Ethiopia. After leaving office,



Desalegn co-founded and has served as the chairperson of The Hailemariam & Roman Foundation – an organisation focused on maternal and child healthcare, prevention of non-communicable diseases, nutrition and climate-smart agriculture and conservation-based ecotourism. He is passionate about protecting and restoring biodiversity, as well as championing climate change mitigation and adaptation policies. He serves on the boards of several international organisations such as the Alliance for a Green Revolution in Africa (AGRA), Tourism Ethiopia, International Crisis Group (ICG), the Campaign for Nature (CfN), the African Parks Network (APN), and the African Wildlife Foundation (AWF). He also serves as a Special Envoy to the International Fund for Agricultural Development (IFAD).

Plenary: Camille Parmesan

Camille Parmesan is Director of the CNRS Station for Experimental and Theoretical Ecology (SETE, in Moulis, France) and was brought to France as a “Make Our Planet Great Again” laureate. Her research focuses on the impacts of climate change on wild plants and animals, and spans from field-based work on butterflies to synthetic analyses of global impacts on a broad range of species across terrestrial and marine biomes. Her 2003 paper in *Nature* was ranked the most highly cited paper in the field of climate change (Carbon Brief, 2015), and she was named the 2nd highest cited author on climate change (T. Reuters). She is an elected Fellow of the European Academy of Sciences, Fellow of the Ecological Society of America and Honorary Fellow of the Royal Entomological Society. She received the Conservation Achievement Award from the National Wildlife Federation and was named “Outstanding Woman Working on Climate Change” by IUCN. She has worked with the Intergovernmental Panel on Climate Change (IPCC) for over 25 years and shares in the IPCC’s Nobel Peace Prize (2007) and Gulbenkian Prize for Humanity (2022). She was a Coordinating Lead Author for the IPCC’s 6th Assessment Report (2022). Professor Parmesan also has affiliations with the University of Plymouth (UK) and the University of Texas in Austin (USA).



Session 1

Global impacts of climate change on natural systems and consequences for conservation of biodiversity

Camille Parmesan

Station for Theoretical and Experimental Ecology (SETE), CNRS, camille.parmesan@sete.cnrs.fr

Climate change is but the latest in a series of ever-increasing anthropogenic pressures on natural systems, yet there are fundamental differences between this relatively new threat and traditional anthropogenic stressors that have challenged ecological research over the past century. I will give an overview of observed impacts of recent climate change in natural systems, stemming from the most recent IPCC 6th Assessment Report, for which I was a Coordinating Lead Author. Wild species have been affected globally, and we are starting to see negative impacts for the most vulnerable species. Changes at the

ecosystem level are beginning to cause positive feedback to the climate system, shortening the window of time available for taking actions to avoid “dangerous” climate change. Preservation of biodiversity in the face of anthropogenic climate change will require novel forms of management and unconventional measures of “success”. Some conservation options bring up ethical issues that question the philosophical foundation of traditional conservation.

Tippling points – making some uncomfortable trade-offs

Howard Hendriks

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We should be concerned about tipping points because of the crossing of environmental thresholds. Tipping points lead to abrupt and possibly irreversible shifts between alternative ecosystem states, and to potentially high societal costs. If correctly managed, addressing tipping points could make the difference between significant environmental deterioration versus a more sustainability-driven path for South Africa. These tipping points, in order of importance, are: water, land degradation, greenhouse gas emissions and non-renewable resources. This paper argues for key actions to be taken. These may require making some uncomfortable trade-offs in the future if South Africa is to avoid crossing certain environmental thresholds, including: (1) the food-water-energy nexus, (2) renewable energy and changing the energy mix, (3) the green/blue economy and (4) ecological infrastructure.

Session 2

Land reform and biodiversity: Bridging the gap and potential for integration

Bulelwa Mabasa and Thomas Karberg

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In the first section, we aim to give a broad overview of land reform in South Africa and discuss the three different pillars of land reform, being restitution, redistribution and tenure security reform. We will broadly assess the perceived successes and failures of South Africa’s land reform programme over the last 28 years of democracy. In the second section, we will assess the recent shifts towards expropriation without compensation, the passing of the new Expropriation Bill and the Land Court Act, as well as court judgments dealing with evictions and alternative accommodation. We will also share insights from recent academic collaborations. Our concluding section will focus on the value of land reform as part of the project of nation building in South Africa. We will also consider several examples of successful land claims which created opportunities for community integration in business ventures such as nature conservation, including examples from our own practice. We will explore options for integrating Sustainable Development Goals into land reform and lay out international learnings that may be useful in the integration of land reform and biodiversity.

The future of the grassy biomes

William Bond¹ and Nicola Stevens²

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²University of Oxford

We suggest that the future of grassy ecosystems will differ within different climate settings, depending on changing disturbance regimes and global change impacts on plant growth rates, including direct CO₂ effects. The largest areas of grassy vegetation occur in climates that also support forests. Current and future trajectories suggest a global shift from grassy to woody vegetation in these regions. In extreme climates, too dry or too cold for tree growth, shrublands are shifting to grasslands, driven by native and non-native grasses. These introduce novel fire regimes, which rapidly transform fire-naive arid ecosystems to near monospecific grasslands. Invasive grasses are also driving change at the other climate extreme in humid forests. Here, deforestation and road building allow grasses to colonise fire-naive forests. We touch on mechanisms, models and ecological drivers which are informing these vegetation changes. But ultimately, the biggest uncertainty will be human ability to manage our very uncertain future.

The functional Benguela microbiome: A closer look at upwelling dynamics and marine microbial diversity and function

Yameen Badrodien, Emma Rocke and Nicole Dames

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This project sought to delineate picoplanktonic communities in the Benguela Upwelling System using genomic data from the Mission Microbiomes Expedition undertaken during May 2022. Picoplankton (0,2-3 µm) comprise the archaea, bacterioplankton and picoeukaryote groups, and are involved in several critical marine processes. Samples were collected from St Helena Bay (southern Benguela, seasonal upwelling), Walvis Bay (northern Benguela, semi-permanent upwelling) and Lüderitz (intense, permanent upwelling). Samples were taken inshore on the continental shelf, offshore and at various depths to document microbial community fluxes related to water mass type and upwelling stages. Microorganisms were isolated using size-fractionated filtration, and genomic DNA sequenced on the Illumina Novaseq 4 000 platform. Sequences were quality-filtered, trimmed, co-assembled and mapped. Contigs and indexed BAM files were analysed using the Anvio Metagenomic Workflow to create a contigs database for resolving microbial taxonomy and function. This analysis, combined with physico-chemical water column metadata, enhances our understanding of microbial roles at various depths in these environments.

Continental-scale disturbance regimes and tree resprouting responses

Fezile Mtsetfwa and Sally Archibald

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Fire is recognised as an important control on woody plants in the tropics. Cyclones, elephants, drought, frost and tree harvesting also damage woody structures, causing top-kill or mortality, depending on the resprouting abilities of the species affected. Here we set up expectations for resprouting adaptations found in woody plant communities across tropical Africa, by integrating spatio-temporal information

on disturbances with ecological information on their impacts. Frost and fire affect smaller trees (< 4 m), while elephants and cyclones affect medium to large trees, and human impacts are diverse. Across most of the continent, trees evolved with both short fire-return intervals and high elephant densities, with implications for their resprouting abilities. Moreover, cyclone toppling seldom occurs with frost or drought. A considerable part of the region has lost a key top-kill agent – elephants – while human impacts have spread. However, ~21% of areas that have lost elephants have not replaced this important ecological agent.

Patterns of natural and human-induced climate change in Madagascar through recent geological time

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²Association Vahatra

The extinction – and its causes – of numerous land vertebrates known in recent geological time in Madagascar is one of biodiversity's unsolved mysteries. After a brief introduction to Madagascar and its ecosystems, we will examine different case studies from different areas and ecosystems of the island and will review palaeontological, archaeological and biotic data to determine for each site whether the root causes were natural climate change, human-induced changes or a combination of these factors.

Unlocking the wildlife economy in the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA)

Irene Mhlanga, Sue Snyman and Kudzai Mpkairi

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Traditionally viewed as inputs rather than assets, wildlife resources receive limited investment, highlighting the need to demonstrate their economic contributions and develop a management framework for the wildlife economy. The KAZA TFCA is the largest terrestrial transfrontier conservation area in the world, spanning parts of five southern African countries. Through our research, we developed a wildlife economy framework for the KAZA TFCA, highlighting key opportunities to unlock and grow the wildlife economy. We developed case studies on the state of the wildlife economy for all five partner states, in partnership with local stakeholders and the KAZA Secretariat. The key results indicate huge potential in tourism, wildlife ranching, fisheries and aquaculture, amongst others. However, there are also challenges that inhibit wildlife economy growth; these relate to illegal wildlife trade, land tenure and lack of value-added wildlife products. The Wildlife Economy Investment Index (WEII) for each country highlights KAZA's wildlife economy investment potential, and overall the research raises the profile of the wildlife economy in the KAZA TFCA.

Session 3

Trophy hunting: From public furore to published figures

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²International Institute for Environment and Development

Trophy hunting is one of the most contentious topics in wildlife management and conservation, attracting intense public and political attention. However, there is surprisingly little information on some of the core elements of this topic, including how the term is defined, the number of countries that use it, the diversity and conservation status of species involved, and the impacts on wildlife ecology and socio-economics, in particular whether it seems to help or hinder wildlife conservation. This will be the first presentation of information from a global draft situation analysis, collating available information on each of those topics, as well as providing an overview of some additional key aspects, such as diverse ethical viewpoints and multiple case studies from around the globe. This will be one of the most comprehensive examinations of the topic to date, and the information provided should provide a stronger knowledge base for the IUCN, NGOs, policymakers and multiple other stakeholder groups to help navigate this challenging issue.

African species of *Dipcadi* (Asparagaceae, subfamily Silloideae) discussed relative to ITS sequence data

Christopher Chapano^{1,3} Solveig Bua Løken² Shakkie Kativu³ Clemence Zimudzi³ Charlotte Sletten Bjora² and Brita Stedje²

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We have evaluated species circumscriptions in the genus *Dipcadi* based on both morphological and molecular data, with emphasis on African taxa. We extracted DNA and amplified the ITS region for 33 *Dipcadi* accessions, and an additional 18 ITS sequences were obtained from GenBank. Phylogenetic analyses based on Maximum likelihood (ML) and Bayesian Inference (BI) were congruent, confirming monophyly of African *Dipcadi*. The species *D. marlothii* and *D. glaucum* are recovered as monophyletic, and their status is also supported by morphological data. Other species are either paraphyletic (*D. viride*), polyphyletic (*D. longifolium*, *D. serotinum* and *D. erythraeum*) or in unresolved clades with other taxa (*D. gracillimum* and *D. platyphyllum*). Future studies should include additional loci and more material to improve the resolution of species relationships and to properly delimit non-monophyletic taxa.

Leveraging Traditional Ecological Knowledge (TEK) for conservation: Baka indigenous people and hunting in central Africa

Fanny-Marcelle Djomkam and Ruksan Bose

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Decades of initiatives aiming to reduce pressure on biodiversity attributed to bushmeat hunting in central Africa have not yielded the expected impacts. This is partly due to a lack of consideration for socio-cultural aspects, perceptions of hunting, and varying understandings of what is at stake. In the context of the current shift toward more inclusive conservation, the moment is ripe for testing new tools to regulate the pace of hunting. Our work examines the potential for leveraging Traditional Ecological Knowledge (TEK) for conservation strategies, focusing on the indigenous Baka people. Through centuries of interaction with their environment, Baka have developed a deep understanding of local ecosystems, animal behaviour and sustainable resource use. Their insights could prove to be critical to conservation efforts. We combined participatory mapping, ethnographic fieldwork, serious games and an analysis of local communities' hunting offtake. With the hypothesis that a collaborative approach could reduce the impact of hunting while preserving livelihoods, we expect findings to highlight the role of TEK in understanding increasing hunting and in minimising impacts of hunting on biodiversity.

Strategic dissonance, climate change and conservation

Guy Midgley

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Strategic dissonance in business is described as a misalignment between an entity's actions and intent when an inflection point is passed where established models of success become ineffective. In this talk, I will elaborate on how recognising strategic dissonance in conservation practices is urgent, in the context of climate change and other anthropogenic pressures. I will explore the extent of this risk and suggest some potential solutions to address dissonance in a changing environment.

When will the extinction crisis begin? Notes from the Namib Desert frontline

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Estimates of global climate change-driven species extinctions range from <5% to 70%, but only two species extinctions have been documented. When and where will the extinction crisis begin? Once considered tolerant of warming climates, desert species are increasingly shown to be highly vulnerable. We reveal an imminent extinction crisis in the highly biodiverse Namib Desert region, outlining large climatic changes and their impacts on species and ecosystems. We present early results from a 22-year study of Quiver Trees (*Alouidendron dichotomum*), revealing climate change-driven mortality and reproduction patterns, but not range expansion. North America's Joshua Trees (*Yucca brevifolia* and *Y. jaegeriana*),

functional equivalents in the Mojave and Sonoran deserts, have also experienced marked impacts from climate change. Exploring inter-species similarities and differences, we highlight how species-focused research provides insights into mechanisms of climate change impacts. The gap between conservation needs and the tools available to address them is large and alarming. We stress the need for innovation in adaptation responses and highlight examples trialled in desert systems.

Session 4 – One-on-One Interview

The Business of Conservation

Bongani Bingwa (Facilitator) and Jonathan Oppenheimer

Can conservation only be done according to business principles, and by paying its way? Is it the job of private enterprise to underwrite a public good which is essential to the future sustainability and biodiversity of the planet? Join Jonathan Oppenheimer in conversation with radio host Bongani Bingwa for insights into how good business is good for the environment.

Bongani Bingwa

Bongani Bingwa is the host of *The Breakfast Show* on 702. He is the former *Afternoon Drive* show host. Before joining 702, he was a presenter and journalist on *Carte Blanche*. For the last ten years, he has been a presenter and journalist for South Africa's longest running investigative television programme, *Carte Blanche*. He has interviewed thought leaders, senior politicians, captains of industry, authors, celebrities and highflyers on the global stage. Not a few wrongdoers have come under the glare of his probing questioning for the show. Bongani Bingwa's passion for broadcasting began at a young age in 1993, when he worked as a presenter for children's television on SABC'S TV1. He quickly progressed to hosting adult content on shows like *Your Own Business* and on DSTV's Channel O. His career as a journalist began in 2005 on Talk Radio 702 as a news anchor, and he quickly progressed to hosting his own show, *Talk at Nine*. He is a recognised industry leader and was highlighted among a select few journalists and media specialists for *Vanity Fair's* July 2007 Africa feature. He studied politics and holds a Bachelor of Arts degree from UNISA.



Jonathan Oppenheimer

Jonathan Oppenheimer is a South African businessman, conservation philanthropist and social impact investor. He began his career at NM Rothschild & Sons, before moving to Anglo American and subsequently De Beers, where he held several senior management roles in southern Africa and London over two decades. He completed his education at Harrow School London and the University of Oxford,

where he studied Politics, Philosophy and Economics. As executive chairman of Oppenheimer Generations, Jonathan is actively involved in all aspects of the family's private, commercial and thought leadership activities, including Oppenheimer Partners, Oppenheimer Generations Asia, Nianova, Shangani Holistic, the Brenthurst Foundation, the Oppenheimer Generations Foundation, and Oppenheimer Generations Research and Conservation. In January 2018, Jonathan joined the Board of Trustees of the Carnegie Endowment for International Peace (CEIP). CEIP is the oldest international affairs think tank in the United States and is committed to advancing the cause of peace through its global network of policy research centres.



Day 2: Thursday, 10 October 2024

Plenary: Winnie Kiiru

Dr Winnie Kiiru is a highly accomplished research scientist and wildlife biologist, with over 25 years of experience in wildlife management, environmental policy and global environmental advocacy. She is a thought leader in the wildlife and environmental space, known for her strategic leadership and dedication to conservation in East Africa. Dr Kiiru has excelled in governmental and non-governmental roles, focusing on organisational leadership, strategic planning, resource mobilisation and financial management. She's also been a mentor for women in conservation leadership, promoting gender equality and diversity. Since February 2023, Dr Kiiru has served as the executive director of Mpala, where she continues to advance research, environmental policy and cross-sectoral conservation partnerships. She was on the inaugural Board of Trustees of the Wildlife Research and Training Institute, and she contributed immensely to the establishment of the institute. Additionally, she has chaired the Board of Karura Forest for the last seven years, preserving the legacy of Professor Wangari Maathai. In recognition of her contributions to conservation, Dr Kiiru received the Order of the Grand Warrior Award in 2022 and the Woman of Excellence Award in 2016. She earned her Doctorate in Biodiversity Management from the University of Kent in 2012, focusing on human-elephant conflict around Amboseli National Park in Kenya.



Session 1

Transforming spaces of research

[Winnie Kiiru](#) and Nina Wambiji

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Research is crucial for addressing global challenges and advancing scientific knowledge, with funding and legislative regulatory frameworks playing pivotal roles. Transformational leadership is key in transforming research spaces to support collaboration between the natural resources-rich Global South and the financially connected scientific communities of the Global North. This approach aims to enhance diversity, equity and inclusion in research, bridging the gap between regions with abundant natural resources and those with substantial financial resources for research. By embracing transformational leadership, we can co-design research initiatives with all relevant parties, ensuring that research topics are relevant and that collaborative efforts are effective. This collaboration will help harness the strengths of both regions, ultimately leading to a more inclusive and impactful global research community.

Crouching leopard, hidden camera: Comparing methods for estimating leopard density in an enclosed reserve

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²Conservation CATalyst

There is a lack of understanding as to the merits and shortfalls associated with different density estimation methods for elusive, wide-ranging species such as leopards (*Panthera pardus*). I compared density estimates produced by three different survey methods running concurrently on an enclosed Namibian reserve, against the known population size and density. I applied SECR models to capture histories from a baited camera trap array, a non-baited camera trap array and a novel type of spoor survey, the WildTrack FIT method (using AI and morphometric analyses). This work compares the economic and logistical merits and shortfalls of each method, and applies ecological theory to understand patterns in detection biases. Whilst the baited camera array detected the greatest number of individuals and produced a density estimate that augured closest to the known density, the non-baited array produced better quality data for SECR analysis. The FIT results will be presented at the October conference. Baited arrays are best suited for small-scale, single population surveys, whilst non-baited arrays are best suited for range-wide density estimations that aim to inform conservation policy.

Black rhino trophic rewilding: A test case in a semi-arid savanna

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During the Late Pleistocene and Holocene Epochs, key natural drivers that maintained trophic organisation have been disrupted globally, resulting in ecosystem degradation. This has predominantly been due to anthropogenic impacts, now coupled with climatic shifts. Largely intact trophic cascades have persisted only in sub-Saharan Africa and southern Asia. Rewilding theory argues that species reintroductions into degraded areas, especially of megafauna, should stabilise ecosystem functioning and promote biodiversity. Although this is a topic of emerging popular interest, there is a considerable lack of evidence and empirical analyses of rewilding outcomes. This study utilises remote sensing techniques to investigate whether black rhino (*Diceros bicornis*) reintroduction, after decades of their absence, has altered the vegetation density in the Tswalu Kalahari Reserve, South Africa. In addition, field- and lab-based experiments have been conducted to investigate how black rhinos may be affecting the recruitment of woody species, focusing on selected demographic bottlenecks. We assess whether black rhinos are facilitating the germination and establishment of *Vachellia erioloba* in the Tswalu Kalahari Reserve.

The effects of elevated atmospheric CO₂ levels on dung beetle species (Coleoptera: Scarabaeinae)

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Numerous studies have shown a global decline in insect populations due to factors such as intensified agriculture, pesticide use, invasive species, and climate change, with the latter being a key contributor. Research on the effects of elevated atmospheric CO₂ (eCO₂) on dung beetles has revealed negative outcomes, such as prolonged development, reduced body size, and increased mortality rates, though the mechanisms remain unclear. This PhD study investigated these mechanisms by comparing the brood ball microbiome of *Euoniticellus triangulatus*, reared under ambient atmospheric CO₂ (aCO₂) (400 ppm) and eCO₂ (800 ppm) conditions. Using an infrared gas analyser (IRGA) system and Biolog ecoplates, the results showed that exposure to eCO₂ increased the CO₂ flux of the brood ball microbiome and improved reproductive fitness, as indicated by a higher number of brood balls produced. The microbial community in the brood balls under eCO₂ showed greater metabolic potential, species richness, and functional diversity compared to aCO₂ conditions. These findings suggest that eCO₂ impacts the brood ball microbiome, potentially affecting larval development through changes in the microbial composition.

Perceptions of the importance, value and role of nearby Southern Mistbelt Forests held by nearby communities in KwaZulu-Natal, South Africa

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Globally, forests are threatened by several disturbance factors, such as deforestation driven by poverty and population expansion. In eastern South Africa, most rural communities are located near natural forest patches; if not, they are within travelling distance. Therefore, community members rely on forest resources, especially in places like KwaZulu-Natal. Using structured questionnaires, we surveyed selected communities residing near the forests in southern KwaZulu-Natal, to document (1) their perceptions, and the value and use of the forests, (2) the impact of forest disturbance on the nearby community, and (3) the conservation implications. We conducted 361 questionnaires across five selected communities during 2023-2024. We then used R software to run the Generalised Linear Mixed Models. Our results showed that forests are highly valuable to these rural communities. Local community members benefit from forest resources such as firewood and traditional medicine. They use forest resources to build houses and fences, and to generate sales. The use of people's perceptions is crucial to provide a better understanding of the use of forests and their value for rural communities.

The role of zebra stripes: Testing possible drivers of geographical variation in stripe patterns

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Zebra exhibit one of the most striking patterns in the natural world, yet the adaptive function of their stripes remains undetermined. These stripe patterns, although unique to each species, do also vary geographically. For instance, plains zebra (*Equus quagga*) have more defined and darker stripes in the northern regions of their range. Multiple hypotheses have been proposed to explain the adaptive functions of zebra stripes, including roles in social interactions, thermoregulation, predator avoidance and protection against biting flies. To investigate the potential drivers of stripe variation, we analysed images of zebra from GBIF and Google. We measured features such as the number of stripes, the proportion of dark stripes and the presence or absence of shadow stripes. Our study aims to determine whether environmental factors (such as solar radiation and rainfall), lion density or biting fly density can explain the geographical variation in stripe patterns between two zebra species, *Equus quagga* and *Equus zebra*. Understanding the environmental drivers of stripe variation could provide valuable insights into the evolutionary significance of this distinctive feature.

Call library development for small mammals in Telperion Nature Reserve

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Bioacoustics approaches are efficient and effective, low-cost methods for assessing biodiversity. Typically used for the identification of bats, birds and frogs, acoustic monitoring for small mammals is in its infancy. We are developing a call library to assess acoustic approaches for identifying small mammals in Telperion Nature Reserve. We are studying three orders of small mammals: Eulipotyphla (shrews), Macroscelidea (elephant shrews) and Rodentia (rats and mice). Using ultrasonic and audible range recorders, we collect vocalisations of captured wild animals. We use spectrograms to visualise call shapes and employ these as a basis to describe the species-specific vocalisations and develop call libraries. Preliminary results demonstrate the potential to distinguish morphologically similar species, *Aethomys ineptus* and *Micaelamys namaquensis*, using their disparate calls. Additionally, *Elephantulus myurus* has a unique, complex “dialect”. Our call libraries will be used to test whether acoustic methods can be used to identify small free-roaming mammals. We will then verify the viability of this approach to establish distribution and occupancy of small mammal species.

The influence of hydrology on vegetation dynamics in fynbos wetlands

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The hydrology of fynbos wetlands is an important determinant of plant species coexistence and biodiversity characteristics of the Cape Floristic Region. I tested the hydrological niche theory on a long-term

dataset obtained from a seep in the Steenbras Nature Reserve to analyse vegetation dynamics under natural hydrological fluctuations. This work showed that over the duration of a post-fire successional trajectory, the seep divided into areas that are either wet or dry, or variably both wet and dry. The species identified also segregated into distinct wet and dry areas within the confines of the established hydrological niche. Species were classified as wet or dry condition specialists, or as facultative species that are found in varying degrees of wet and dry conditions. The dry condition specialist species were also recommended as potential indicators of changes in soil moisture conditions at the seep; contraction or expansion of their hydrological niche range could imply that hydrological conditions have been altered to an extent that destabilises plant community structure. This work could inform implementation of appropriate vegetation management and conservation strategies.

Session 2

Human exposure to microplastics and plastic-related chemical contaminants

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Global annual plastic production currently stands at over 450 M metric tons (mt), and it is projected to reach 590 M mt by 2050. Microplastics, the tiny particles that emanate from gradual plastic degradation, have infiltrated virtually all matrices and continue to be a source of concern, especially for their role in biodiversity loss and their potential effects on human health. Similarly, many chemicals used as additives in plastic production are endocrine-disrupting compounds (EDCs), with the ability to interfere with hormonal functions and disrupt reproduction in animals and humans. We have now demonstrated that EDCs could be released from various plastic types under normal tropical African climatic conditions. The study has led to the identification of specific plastic polymers responsible for the release of some individual EDCs. As part of efforts to understand human exposure to microplastics and plastic-related EDCs in Africa, we have also investigated microplastics and plastic-related EDCs in 17 fish species, various drinking water sources, carbonated soft drinks and alcoholic beverages. This presentation will share results and insights from our various investigations.

African elephants (*Loxodonta africana*) in their newfound home, the Central Kalahari Game Reserve, Botswana

Shimane Makhabu and Keoikantse Sianga

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African elephants (*Loxodonta africana* (Blumenbach)) have recently inhabited the Central Kalahari Game Reserve (CKGR), part of the Kalahari Desert. Artificial water points are the only source of water during the dry season. Questions are unanswered on where the elephants came from and their ecology in CKGR. To answer some of these questions, we collared ten elephants (eight bulls and two cows) with GPS-enabled satellite collars to record their locations for six hours. We did the vegetation assessment around boreholes to establish which plant species the elephants browse most and which are not browsed. We also monitored the elephants' activities at water points. We found that elephants in CKGR

moved in different directions when they wandered from the reserve, going as far as the Okavango Delta and to the edge of Hwange National Park in Zimbabwe. As for the diets of the elephants in CKGR, they browsed the plant species in the genera *Vachellia*, *Senegalia*, *Terminalia* and *Combretum*. The study has shown that elephants are now part of the Kalahari ecosystem, since most no longer move from it, and those who do move return. Maintaining migratory routes to permanent water sources is necessary.

Rethinking natural resources governance for a low-carbon future

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More than two dozen African countries are endowed with hydrocarbons and mineral resources that are central to the global transition to low-carbon economic systems. The imperative of global decarbonisation to address the climate challenge will cause long-term structural shifts toward the demand and geographies of global commodities markets – declining demand from advanced economies for unprocessed hydrocarbons, rising global demand for “critical minerals” as inputs for clean energy technologies, and the demand for both hydrocarbons and minerals for domestic industrialisation and economic diversification strategies. Fully harnessing the opportunities presented by these structural shifts in demand and geographies, requires a radical rethink of natural resource governance. The prevailing approach to natural resource governance has sought to counter the “resource curse” by focusing on fiscal stabilisation and transparency in resource revenue management. A new approach to natural resource governance should be attuned to these impending structural shifts by envisioning institutional arrangements, institutional capabilities and their sequencing in ways that facilitate the processes of economic transformation.

The future of Ethiopian wolves: Habitat loss, extinctions and a role for conservation translocations

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Rare Ethiopian wolves are endemic to an archipelago of isolated Afroalpine islands, surrounded by hard agriculture borders, people and dogs. Small wolf populations become vulnerable to stochastic effects, inbreeding, hybridisation, competition with domestic dogs, and diseases, with concomitant extinction risks. Over three decades, we recorded habitat thresholds for population extinctions, with a small population recently eradicated by back-to-back rabies and canine distemper epizootics. With fragmentation and increasing isolation, opportunities for recolonisation are few. However, rare events of successful dispersal within and across patches have unveiled prospective mechanisms for conservation translocations as a tool to avert new extinctions. The future of the Afroalpine ecosystem and the wolves is linked to suitable land use and governance models, including habitat restoration. We need to support sustainable livelihoods, new community conservation areas, and better management and funding of national parks. The future of Africa’s most threatened carnivore is conservation-dependent, and conservation translocations emerge as a necessary and promising tool for their survival.

A transformative tool for monitoring biodiversity using a combination of traditional ecological knowledge with leading-edge analytics and AI

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We will showcase a multidisciplinary African initiative to deliver a potentially transformative tool for monitoring biodiversity, using small mammal (mice, shrews and sengi) tracks. As humanity struggles to address biodiversity loss, climate change and habitat fragmentation, this tool will provide data-driven insights and solutions at scale. Small mammals are key indicators of ecosystem integrity and change. Currently, biodiversity monitoring requires many highly trained experts in the field, which is costly, time-consuming and limited in scale. In addition, animal welfare is inevitably compromised by the need to trap or kill. In this presentation, we'll journey from the ethos and conception of WildTrack's award-winning Footprint Identification Technology (FIT), available for a wide range of species, to fieldwork in South Africa. We will showcase the unique intersection of traditional ecological knowledge with leading-edge analytics to identify species from their footprints captured on track plates. These hugely varied and often overlooked species constitute >20% of all South African mammalian species and could now play a key role in biodiversity and ecosystem integrity monitoring.

Handling the heat: Managing microclimates for nesting desert hornbills

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Anthropogenic climate change poses a major conservation threat to organisms globally. Over the last decade, rising temperatures in the Kalahari Desert, South Africa, have caused serious declines in the breeding success of southern yellow-billed hornbills (*Tockus leucomelas*). We analysed a long-term dataset (2008-2021) on chick growth and breeding success for a nest box breeding population of hornbills as a function of air temperature. During the study period, nest boxes were changed from an uninsulated (2008-2018) to an insulated (2019-2021) design. Because nest box type was confounded with breeding season in the long-term dataset, we also conducted an experiment (2022-2024) where nest boxes were modified to either uninsulated or insulated designs at egg laying, ensuring both types were used in the same breeding seasons. Nest success and chick growth were significantly higher in insulated boxes in both historical and experimental datasets. Additionally, insulated boxes were consistently cooler than uninsulated boxes. This study highlights that insulated nest boxes could be used as a conservation tool to mitigate the impacts of rising temperatures on hornbill breeding success.

Session 3

Intra-African collaboration in natural product sciences through NABSA

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Research in Africa is often challenging – a fact that is clearly reflected by publication metrics. Yet this is far from the full story on a continent that has youth on its side, a cultural link to science through its strong interest in animals, plant and indigenous medicine, and an increasing number of ways forward. Reports typically relate how little Africa contributes to global science (only about 1% of global research output, according to a 2020 report, www.jogh.org | doi: 10.7189/jogh.10.010321), often stressing that the two major players are Egypt and South Africa, with the remaining 52 countries of the African Union making insignificant contributions. Those numbers are indeed true. But is this the full story? Doesn't such a low output arise from a similarly low input? And while assessing inputs – infrastructure, human resources and enabling policies – one should consider both quality and quantity. Before deeming a research output “insignificant”, we must remember that Africa hosts a relatively small scientific workforce, many of whom are faced with challenging circumstances. It has been suggested that all stakeholders, particularly the young people and future scientists of Africa, as well as our development partners and research collaborators overseas, keep this in mind when looking at raw numbers such as citation data. Looking towards the future, Africa possesses one invaluable asset: its youth.

Biodiversity and climate seeds of Zambia: How bottom-up initiatives contribute to global and national biodiversity and climate commitments

Mulako Kabisa and Laura Pereira

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Achieving global and national level commitments to tackle climate change and biodiversity loss requires a new way of understanding the knowledge and capacities available for transformative change. The Seeds of Good Anthropocenes framework is used in this study to identify and characterise bottom-up initiatives that inspire hope in addressing these challenges in Zambia. We determine their contribution to biodiversity and climate commitments at the national and global levels using content and thematic analysis. We uncover the depths of their contributions to social-ecological systems transformation using the Leverage Points Framework. Our study identifies 50 seed initiatives that represent all six seed archetypes. The seeds address all goals and strategies at the national level and address the majority of the targets and goals at the global level. On systems transformation, 59% of seed activities function at shallow leverage points. Agroecological production methods (13%) and alternative livelihoods and associated enterprises (13%) comprise the most activities. For the deeper leverage points, environmental awareness and campaigns (10%) are the most common activities.

Getting Africa's grasslands on the map: Building the science and policy case for priority conservation

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²University of Edinburgh

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African grasslands are often classed together with savannas or seen as habitat mosaics within forest landscapes, and therefore their extent and biogeography are not well understood. The grassland biome in South Africa is known for its high biodiversity, carbon storage and water provision, but similar recognition in grassland habitats across Africa is often lacking, and they are at risk from agriculture and plantation forestry. High-altitude grasslands are associated with cold and frost, but grassland habitats stretch across the tropical parts of Africa and cover up to 15% of the landscape. Their determinants are still a conundrum for ecologists, with arguments about the importance of frost versus edaphic factors. Here we present new maps of African grasslands at various spatial scales and develop theory to explain their occurrence. We also assess their transformation rates and the carbon and biodiversity consequences of losing grasslands. Policy and funding mechanisms to avoid degradation were often not designed with grasslands in mind: we discuss mechanisms that the Future Ecosystems for Africa programme and its partners are exploring to enable their conservation.

How small diurnal mammals cope with heat and cold in the Kalahari: A study of ambient heat load, animal behaviour and body temperature

Chanel Rampartab¹, Edward Snelling², Tobias Wang³, Andrea Fuller¹, Marta Manser⁴, Tim Clutton-Brock⁵, Leith Meyer², Jessica Briner⁶, Glenn Tattersall⁷, Christine Cooper⁸ and Philip Withers⁹

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Small mammals are vulnerable to increasing ambient heat loads and reduced food and water availability associated with climate change. To understand the mechanisms underlying this vulnerability better, we implanted core body temperature and activity data loggers into meerkats (*Suricata suricatta*), Cape ground squirrels (*Xerus inauris*) and yellow mongooses (*Cynictis penicillata*) in the Kalahari of South Africa. We observed the behaviour of these habituated animals for one year while measuring a suite of environmental variables. We also used infrared thermography to understand how surface body temperature relates to ambient heat load, behaviour and core body temperature. Our analyses indicate that these species use thermoregulatory behavioural strategies to avoid heat and respond to cold, which may limit foraging time to replenish food and water. We also assess the seasonal shifts in activity patterns

and compare core body temperature patterns of all three species, including during the breeding season. These findings will help us understand how small mammals in dryland environments respond to ongoing climate change, and inform appropriate mitigation and conservation strategies.

Impact of rainfall variation and fire on acacia demographics in the Tswalu Kalahari Reserve

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² University of Pretoria

Climate change will impact the vegetation of arid savannas directly and via altered fire regimes. High rainfall episodes drive woody plant recruitment and woody encroachment in arid savannas, but also promote the build-up of grassy biomass that can fuel extensive fires. Severe droughts can cause mortality and die-back of adult trees, while wet conditions can stimulate recruitment pulses, potentially increasing woody cover; high grass biomass in wet years may also constrain tree recruitment and growth through interspecific competition and increased likelihood of fires. *Senegalia mellifera* and *Vachellia erioloba* are dominant species in the Kalahari, with contrasting ecologies: *V. erioloba* is slow-growing and long-lived, while *S. mellifera* is fast-growing, short-lived and a common encroacher. Using three years' data tracking of individually marked specimens, we use matrix population models to assess the effects of rainfall variation and fire on the recruitment, size-specific survival and population growth rate of these two species. Our long-term aim is to model how climate change and altered fire regimes affect key woody species in the southern Kalahari.

Session 4 – Panel discussion

The Oppenheimer Programme in African Landscape Systems (OPALS): Supporting more sustainable interactions between people and the environment across Africa

Andrew Cunliffe, Tom Powell, Enimhien Akhabue, Antony Emenyu, Milcah Kirinyet, Alan Nare, Minda Cossa, Tapiwa Gumbo and Chafika Phiri

Africa's diverse landscapes and communities face significant social-environmental challenges that are exacerbated by climate change. OPALS supports sustainable human-environment interactions across the continent, through applied research in partnership with African organisations who are leading in conservation and research. Our key focus is to empower African researchers. OPALS scholars are co-producing science-based solutions to understand, mitigate and adapt to environmental change. We work closely with our partners to strengthen and integrate a more connected network of practitioners, communities, land managers and researchers. While OPALS is large in its ambition, it is small relative to the scale of these challenges. We therefore embed systems thinking approaches throughout OPALS to work "smarter", seeking to identify and influence the levers that can affect systemic shifts in socio-economic systems, to promote more sustainable outcomes for nature and the people nature supports. The University of Exeter is a leading institution in environmental research globally. OPALS was initiated through catalytic support from Oppenheimer Generations Research and Conservation (OGRC), and

represents a major focus of Exeter's research capacity to contribute across a range of African landscape contexts, from grasslands to farmland and from forests to urban environments. This session will showcase the vision and early achievements of OPALS and invite new connections to amplify our social and ecological impact further. We strive to be agile in responding to emerging challenges and opportunities, developing coalitions and promoting connections.

Andy Cunliffe – Facilitator

Andy Cunliffe is an Oppenheimer Associate Professor of Geography and Director of OPALS at the University of Exeter. He is an environmental scientist leading an applied research agenda to improve understanding of how landscapes function and are managed for broader societal benefit. Andy's work centres on terrestrial ecosystem science and services, building on a background in earth surface processes and spatial ecology to develop and share insights into sustainable ecosystem function across scales. He extensively uses geospatial tools and systems thinking to transcend scales from individual plants to entire continents, and champions open science and inclusive and supportive research culture.



Tom Powell

Tom Powell is an Oppenheimer Research Impact Fellow at the Global Systems Institute, University of Exeter. Tom has a broad background in ecology, geography and systems thinking, spanning food systems and land use change, natural climate solutions, environmental monitoring and payments for ecosystem services, and community-led responses to environmental degradation. Tom helps facilitate engagement with our partners to co-design our research and maximise its real-world impacts.



Enimhien Akhabue

Enimhien Akhabue is an Oppenheimer-Turvill Doctoral Scholar at the University of Exeter, focusing on (i) assessing the information needs of decision makers in African contexts regarding the resilience of landscape function under climate change, (ii) improving the representation of African landscapes in land surface models, and (iii) the perspectives of African researchers within these modelling frameworks. These models are used to understand global ecosystems, including the balance of processes that sustain life on earth, for example, publications by the Exeter-led Global Carbon Budget and the Intergovernmental Panel on Climate Change.



The aim is informing policies that enhance adaptation to, and where appropriate mitigation of, climate change in Africa.

Antony Emenyu

Antony Emenyu is an Oppenheimer-Turvill Doctoral Scholar working to improve the resilience of smallholder farming systems in African landscapes to climate change shocks. Antony researches the uptake of regenerative farming practices by smallholder farmers, primarily drawing lessons from The International Small Group and Tree Planting Program (TIST) in East Africa. TIST is a farmer-led programme promoting tree planting and conservation agriculture, that has supported and impacted over 200 000 smallholder farmers across East Africa. Antony focuses on understanding the factors and processes that have enabled TIST to effectively scale and impact so many lives in contexts where most programmes struggle.



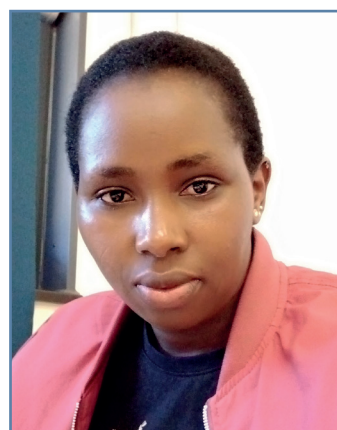
Tapiwa Gumbo

Tapiwa Gumbo is an Oppenheimer Doctoral Scholar at the University of Exeter. He is developing evidence-led practical solutions to managing bush encroachment on holistically managed rangelands in partnership with Shangani Holistic Ranch, Zimbabwe. Solutions embedding systems thinking are needed to address the worsening bush encroachment that threatens the economic viability of the ranch, the largest beef producer in the country. Treatment interventions that could be upscaled for landscape-level deployment are being tested at replicated sites across the affected landscape.



Milcah Kirinyet

Milcah Kirinyet is an Oppenheimer Impact Scholar working on implementing payments for ecosystem services to support more sustainable management in African landscapes. She works with Sustain East Africa and Enonkishu Conservancy in the Kenyan Mara, to co-develop more robust frameworks for ensuring that the community shares the benefits from ecologically and financially more sustainable land management practices. Co-creating auditable wildlife and ecosystem health data structures to leverage biodiversity credits, enhances conservancies' financial resilience. This approach reduces dependency on tourism, diversifies revenue streams and



helps landowners appreciate conservation's long-term value over other ventures. This holistic approach empowers communities while preserving ecosystems.

Chafika Phiri

Chafika is a Few and Far Doctoral Scholar in OPALS, studying the distribution and sustainable utilisation of baobab trees (*Adansonia digitata*), focusing on how their unique role in providing ecosystem services for people in African landscapes might be better safeguarded for future generations. His work is continental in scope, with a particular focus on the Soutpansberg mountains in northern South Africa. It includes examination of the (un)sustainability of different practices, crowdsourced collaboration, and machine learning to map baobabs, to develop our understanding of what controls baobab populations.



Alan Nare

Alan Nare is an Oppenheimer Master's Scholar enrolled at the Botswana University of Agriculture and Natural Resources, studying the sustainable use of rangelands with fine-scale remote sensing. His work has been developing innovative techniques using fine-scale drone remote sensing to assess rangeland condition across grazing-intensity gradients. These tools contribute to a stronger evidence basis for testing frameworks around sustainable utilisation of rangelands by livestock, ultimately providing key data to communities, land managers and policymakers.



Minda Cossa

Minda Cossa is an Oppenheimer Impact Scholar working on adaptation to climate-related hazards in Maputo, Mozambique, focusing on the role of urban planning in improving resilience for informal settlement communities. Her work aims to improve adaptive capacity to climate change-related hazards in coastal environments, in partnership with the African Climate and Development Initiative at the University of Cape Town. She is focusing on the communication of changing risks associated with sea level rise and cyclones in urban planning policy spaces in Maputo, Mozambique.



Day 3: Friday, 11 October 2024

Plenary: Kevin Gaston

Kevin is an ecologist and conservation biologist who has worked extensively on global patterns in biodiversity, their determinants and consequences, and the two-way relations between nature and people. Present areas of interest are common ecology and the consequences of reducing the abundances and distributions of common species; night-time ecology and the impacts of anthropogenic activities on the night-time, particularly through the effects of artificial light (from streetlights and other sources); and personalised ecology (the set of direct sensory interactions that each of us has with nature) and its implications for people and for nature. Kevin's research has been highly interdisciplinary, including collaborations with architects, economists, engineers, geographers, mathematicians and social scientists. Kevin is Professor of Biodiversity and Conservation at the Environment and Sustainability Institute (ESI) on the Penryn Campus of the University of Exeter. He first moved there in 2011 as founding director of the ESI, a post he held until 2017. Kevin's contributions have been recognised with a number of awards, including his election to the Academia Europaea, the British Ecological Society Marsh Award in Ecology and the International Ecology Institute Excellence in Ecology Prize.



Session 1

Personalised ecology

Kevin Gaston

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Each of us has a personalised ecology, a unique set of direct sensory interactions with nature. It changes through our days, our seasons and our lifetimes. It is shaped by the opportunities we have for interacting with nature, as well as our capabilities and motivation for so doing. For some of us, our personalised ecology may be something we very consciously work to influence, and may play an important role in how we think of ourselves. Nonetheless, for many people and populations, personalised ecologies have been in decline, often severely (the 'extinction of experience'). Much attention has been paid to the health and well-being consequences of nature interactions, and the links between declines in these interactions and current epidemics of some chronic health conditions. However, personalised ecologies have also long been held to have significant implications for the future of nature and biodiversity, particularly through the way these influence attitudes and behaviour towards nature. The past, present and future of personalised ecologies may thus be important conservation issues, and ones that attention needs to be paid to.

Changing the conservation narrative: Aligning conservation and development in Africa

Sosthene Habumuremyi, Sue Snyman, [Leigh-Ann Kant](#), Kudzai Shaun, Mpakairi Christella Umuganwa, Daniel Ujoh, Frank Onyema Orji, Hanisani Nleya, Kingdavid Chukwumere, Kinsley Budu, Sulaiman Barrie and Vanson Cyuzuzo

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The narrative around conservation has traditionally focused on protection and excluding people. There is, however, a growing recognition of the need to integrate economic development into conservation efforts and not to see the two as mutually exclusive. The overall ALU SOWC wildlife economy research project encourages public and private investments in natural landscapes to improve conservation outcomes and support economic development, while also seeking to position wildlife as a key strategic asset for all stakeholders, especially governments. One key project is the Wildlife Economy Investment Index (WEII), which, following a series of stakeholder engagements, includes 280 indicators, organised into two sub-indices, five categories and 18 subcategories. The WEII scores countries on a scale from 0 to 100 based on their wildlife asset base and investment-enabling environment. The WEII results, which will be presented, highlight both opportunities and areas for improvement across Africa. Overall, the WEII recognises wildlife as a key strategic asset which can drive policy and practice improvements and encourage investment in the wildlife economy and its related conservation endeavours.

Developing regional capacity for marine research in the Western Indian Ocean

[Arthur Tuda](#)

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Over the past three decades, ocean research in the Western Indian Ocean (WIO) region has experienced significant growth. The number of marine scientists has increased tenfold, with a primary focus on coastal ecosystem research. While social science in marine studies remains limited, it is showing signs of improvement. The establishment of supportive research institutions, along with increased research funding and an emphasis on multidisciplinary approaches, has fostered greater collaboration among countries, institutions and individuals. The research network has evolved from being dominated by key central researchers to a more decentralised network that facilitates communication and exchange. Emerging central researchers, particularly early-career scientists, are increasingly taking on principal investigator roles in research projects. There has been a notable rise in publications on fisheries and coral reef research, indicating progress in these areas. However, significant gaps remain in ocean governance, climate change, social studies and deep-sea research. Addressing these gaps requires capacity building and additional funding to support the region's blue economy and the protection of biodiversity both offshore and in areas beyond national jurisdiction (ABNJ). My presentation will highlight the evolving landscape of marine research in the WIO region, underscoring the importance of continued investment in research infrastructure and capacity building. By addressing the existing gaps and fostering a more inclusive and collaborative research environment, the WIO region can further enhance its contributions to global marine science and the sustainable management of its marine resources.

The multiple dimensions of information in animal vocalisations and the implications for understanding group dynamics

Marta Manser

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To coordinate activities, social animal groups rely on efficient communication at the local or global level, depending on their cohesion. The information call types, conveyed in their acoustic or temporal structure, correlate with their function and allow us to gain insight into the social dynamics within or between groups. Meerkats (*Suricata suricatta*), small cooperatively breeding carnivores, live in cohesive groups, and rely heavily on vocalisations to coordinate their activities. I first present the vocal patterns, including the acoustic and temporal structure of the different call types that are used in relation to different behavioural contexts. I then discuss the multidimensional expressions within four call types, including alarm, sentinel, contact and social calls, focusing on indexical, emotional and referential information. Finally, I discuss the potential and the limitations of recent frequently applied remote techniques to record vocalisations on all group members simultaneously, and also what knowledge of social living species we can gain for conservation purposes.

Elephant movements as driver of landscape-level conservation

Morgan Hauptfleisch^{1,2}, Reece Alberts³, Kenneth Uiseb⁴, Francois Retief³, Claudine Cloete⁴, Claudine Roos³, Dirk Cilliers³ and Denise Tembo²

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⁴Ministry of Environment, Forestry and Tourism

In Namibia's arid north-west, elephants are expanding beyond protected areas into multiple land use environments, leading to socio-economic impacts, both positive and negative. We followed the movements of eight collared elephant herds across multiple land management and tenure systems to the south and west of Etosha National Park for one year. Of these herds, seven have home ranges spanning multiple park-communal-commercial land areas, often crossing fences of management or disease significance. We identified 1 300 fence breaches, of which 147 were of the veterinary cordon fence, which intends to prevent the spread of foot-and-mouth disease to commercial livestock farms to its south. Most fence breaches (n=719) were between individually owned commercial farms. The removal of fences as barriers has resulted in movement of other wildlife species, resulting in economic benefits to land-owners and communal conservancies through eco-tourism opportunities, hunting and general wildlife conservation. Cooperative landscape-level conservation has resulted in some parts, and conflict elsewhere. We propose policy and management interventions which would stimulate more landscape-level conservation.

The overlap of protected and conservation areas with centres of bryophyte endemism in the flora of the southern Africa region

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The vulnerability of bryophytes to disturbances in their habitats is often more pronounced compared with vascular plants. This, along with their specific environmental requirements, makes them more suitable candidates for indicating habitat disturbance and effective monitoring of environmental changes that may compromise the integrity of protected areas. Currently, there is no existing comprehensive conservation plan for bryophytes in South Africa. The primary objectives of this chapter are to highlight the ecological importance of bryophytes within the ecosystem, to evaluate whether protected areas contain localised regions displaying significant bryophyte endemism, and to evaluate whether the presence and distribution of endemic bryophytes can be utilised as determining factors when selecting areas for protection. This chapter further seeks to advocate the protection of areas with high levels of endemic bryophytes and the preservation of bryophytes in their natural habitats. The centres of bryophyte endemism were superimposed on the Protected Areas (PAs) and Conservation Areas (CAs) of South Africa. All five centres of bryophyte endemism (Kamiesberg, Cederberg, Southwestern Cape, Outeniqua

Bryophytes of the high mountains of Madagascar: A comparative analysis of diversity and distribution patterns

Lovanomenjanahary Marline

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Madagascar's high mountain massifs are remarkable for having a higher degree of regional endemism, often localised to an individual massif. Madagascar's exceptional biodiversity has not been evenly studied, and many groups of organisms, like bryophytes, remain poorly known. Here we analysed bryophyte communities along elevational gradients on three high mountains in Madagascar: Tsaratanana (NW), Andohahela (SE) and Marojejy (NE), to better understand the impact of climate variation on species diversity and distribution. Preliminary observation shows a diverse and abundant community of bryophytes. Overall, species richness is exhibiting a hump-shaped pattern along elevation gradients, peaking at mid-elevation. We found that most species have a narrow range of elevational distribution and are specialised to a particular microhabitat. At higher taxonomic rank, many genera and families also have a narrow range of elevational distribution and microhabitat preferences. This implies that microhabitat preferences are taxonomically structured. This investigation constitutes a significant biodiversity resource that will be used in a range of contexts, such as the taxonomic revision of the many understudied groups of bryophytes that are likely to be misidentified.

Session 2

Rock art of the Waterberg: Journeys of transformation

Lyn Wadley

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After the Middle Stone Age ended, perhaps 30 000 years ago, the Waterberg plateau was people-free, until small groups of Bushmen hunter-gatherers, Bantu-speaking farmers and possibly Khoekhoe herders trickled onto the landscape between about 2 000 and 1 600 years ago. After about 1600, people flooded Waterberg's river corridors. The rock art must be read in the context of the interaction between these immigrant hunter-gatherers, herders and farmers. Each group was aware of, and influenced by, the worldview of the other. All groups comprised audiences that, on separate occasions, viewed serial artistic performances on the rock stages. The performances were almost certainly mutually intelligible. Northern Sotho boys were initiated in secluded, riverside rock shelters, and finger-painted art was a visual part of their instruction. Bushman iconography suggests independently that their boys were initiated, too. In both Northern Sotho and Bushman ceremonies, "a great mystery" was revealed to initiates. Bushmen boys were subjected to night-time wails, reportedly from a fearsome, unseen creature that longed to lick their blood.

Reproductive phenology variations of chacma baboons (*Papio ursinus*) in southern African biomes

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Reproductive phenology refers to the timing and frequency of reproduction through the annual cycle, and it often varies among populations exposed to different environmental conditions. Despite this variability, there is a lack of evidence of this for the same non-human primate species inhabiting a macro-geographical scale. An ideal model for such a study is the chacma baboon (*Papio ursinus*), a flexible, social but persecuted species that has managed to reproduce successfully despite unique challenges posed by a variety of habitats found throughout southern Africa. The aim of this study is to investigate variations in the reproductive timing and juvenile abundance of the chacma baboon across southern African biomes, and to identify the factors driving this variation, by using camera trap data collected between 2016 and 2022 from 29 sites spanning six biomes in South Africa and Zimbabwe. This study represents the first systematic analysis utilising camera trap data to explore reproductive phenology variations among populations of the same non-human primate species inhabiting diverse environments, thereby providing insights into how different abiotic and biotic conditions influence reproductive patterns.

Early results from SEOSAW: A network of people, plots and methods to understand global change impacts in southern Africa

[Justice Muvengwi](#)¹, Kyle Dexter², Penny Mograbi², Casey Ryan³ and Sally Archibald¹

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²SEOSAW

³University of Edinburgh

The Socio-Ecological Observatory for Studying African Woodlands (SEOSAW) is a long-term regional network aiming to understand the ecology of African savannas, woodlands and dry forests, including the impacts of global change on the region's vegetation. Our early results are presented here: 1) An analysis of regional patterns in tree growth rates, aiming to inform sustainable utilisation of the woodlands, shows a mean diameter increment of $1,7 \pm 0,3$ mm/yr across the region. 2) An analysis of the drivers of the tree alpha diversity across the region shows that precipitation plays a primary role in determining patterns of tree richness and composition. Meanwhile, higher richness leads to higher carbon storage, an effect which is modulated by tree density. 3) A floristic clustering analysis reveals seven distinct savanna-woodland types in the region, largely synonymous with White's (1983) categorisation and Linder's (2012) regionalisation. Further analysis of the dataset is underway, and new data is continuously added according to standardised protocols (herbaceous vegetation, recruitment, human dimensions, coarse woody debris). The network continues to grow and welcomes new participants.

100 years of Biodynamic Agriculture: A model for sustainable farming, climate mitigation and future opportunities in Africa

[Helen van Zyl](#)¹ and André Tranquilini²

¹Biodynamic Agricultural Association of Southern Africa

²Waltham Place Farm

In 2024, we celebrate 100 years of Biodynamic Agriculture, with the realisation that this work is more relevant now than ever as a model for food production, soil and water management and habitat conservation, and as a template for living communities. Biodynamic farming is the oldest and longest practised form of quality assurance in sustainable agriculture, and is practised by more than 7 000 farmers with about 230 000 ha in 65 countries on all continents. The main concepts of biodynamic agriculture will be introduced, focusing on its relevance for climate change mitigation. This will include results from the DOK experiment, which since 1978 has been conducting comparative trials between conventional, organic and biodynamic agriculture. Finally, we will focus on the importance of this farming method for the African continent and future opportunities.

Reducing vector-borne disease risk by optimising artificial light expansion across Africa

Bernard Coetzee

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The interactions of vector-borne diseases with artificial light have, until now, hardly been studied. We find that artificial light at night can alter the biology of *Anopheles* mosquitoes, the main malaria vector in Africa, in particular, by reducing their biting propensity. By combining the lab data collected on the impact of light on mosquitoes, with field data on how artificial light is used across exemplar study sites in South Africa, Mozambique and Uganda, our project modelled how artificial light modulates vectorial capacity – the potential for the transfer of disease. The model shows that the impact of artificial light in real-world systems is smaller compared with interventions such as bed nets and indoor residual spraying, and suggests that artificial light should be used in conjunction with other vector control strategies to lessen the disease burden across Africa. Our work has provided globally novel science to argue that artificial light must be considered a modulator of mosquito-borne diseases, and offers practical guidelines to help reduce disease transfer.

Durrell drones for conservation in Madagascar

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Durrell Wildlife Conservation Trust Madagascar is currently pioneering the use of drones for conservation in Madagascar to protect our biodiversity, unrivalled in endemism, and to fight back against the spiralling anthropogenic threats facing our country. Our first-of-a-kind drone lab and staff trained in the UK are now conducting work on a range of urgent topics, where drones will help tip the balance as we strive to protect the species we share our country with and their habitats. Alongside training over 85 other Malagasy people, including our Ministry partners, in drone flying for conservation, we have three main workstreams which I will provide updates on during my talk: 1) the development of semi-automated techniques for drone-based monitoring of reforestation, 2) the development of semi-automated processing of drone-based thermal infra-red imagery for the detection and population monitoring of the critically endangered Alaotran gentle lemur, and 3) early detection of fires in critical habitats to enable fast reaction firefighting efforts, essential in reducing fire spread and damage to often site-endemic species.

Evolutionary overcompensation for climate change protects butterflies for decades ahead

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Evolutionary responses to current climate change are expected and observed but typically lag behind the change itself, creating “climate debt”. We describe the opposite phenomenon, driven by evolutionary overshoot. Two montane populations of *Euphydryas editha* butterflies in California have independently overcompensated for rising heat stress, protecting their most thermally-vulnerable life stage – the eggs – for decades ahead. In placing their eggs the butterflies face a harsh trade-off between risk of incidental predation by deer and risk of encountering temperatures above their heat tolerance limit. Traditional microhabitat choice, laying eggs near the hot ground, protected them from grazing but risked exposing them to lethal temperatures. Choice behavior has evolved, increasing predation risk while cooling eggs by more than three times the amount needed to keep up with regional warming. Egg placement behavior is bimodal and its simple Mendelian genetic control, with the novel trait dominant, has allowed evolution to surge ahead of environmental change rather than lag behind.

Exponential roadmap for Africa

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A safe and just climate is out of reach without the rapid reversal of human emissions from land and nature, from 10 Gt CO₂ e/yr globally to net zero by 2030, and a 7 Gt sink by 2050. While Africa can provide nearly 20% of this global need by protecting, restoring and improving the management of natural and productive ecosystems, international climate mitigation finance invested in the continent will be sustainable only if it delivers improved livelihoods, food security, resilience and biodiversity. The Africa Roadmap partners (CI, FEFA and AGNES) will present a summary of the collaboration’s theory of change, direction, partners, workstreams, timeline and opportunities for engagement. They will then present initial results from a novel analysis of Africa’s NCS mitigation opportunity, which adapts the global standard NCS pathways to the African context.

Poster session abstracts

1 The fungal Agrobiodiversity in South African soils

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Agriculture is the foundation of developing economies. As one of these economies, South Africa needs to ensure a healthy agricultural industry that contributes to the country's gross domestic product, food security and job creation. Ecosystems provide essential agricultural services, such as the increased provision and purification of water; protection against natural hazards; pollination and grazing; increased soil fertility, and regulation of the world's climate. Land transformation has left 34% of South Africa's ecosystems threatened. Of these, 21 critically endangered. Studies that encompass all micro and macro scale soil biodiversity is critical. This contributes towards assessing the total environmental impact of specific agricultural systems on soils. Soil health is of strategic importance as to boost agricultural productivity, improved conservation planning, manage global climate change and maintain ecosystem services. This project represents a combined approach to develop a platform for the accurate identification of different fungal taxa associated with soil based on next generation screening technology in South Africa. The establishment of an advanced point of care system will support the country's fourth industrial revolution ensure the competitive lead of South African agriculture and its exports.

2 Ex situ mariculture supports the restoration of Africa's endangered seagrass *Zostera capensis*

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Seagrasses provide valuable ecosystem services, including climate change mitigation, but anthropogenic pressures hinder their capacity to perform these functions. Restoration practices form a crucial part of coastal management to reverse ongoing global seagrass declines. Here we provide the first assessment of ex situ seagrass mariculture of the endangered *Zostera capensis* to support seagrass restoration in Africa. Under controlled laboratory conditions, we monitored changes in seagrass leaf length and shoot density and investigated the effect of core size (\varnothing 5 cm and \varnothing 10 cm). Seagrass cores of the \varnothing 5 cm size showed an average increase in shoot density, from 12 to 41 shoots (241,7% increase), and leaf length, from 12,9 cm to 34,6 cm (167,3%), over 100 days. Comparatively, the average shoot density and leaf length of the \varnothing 10 cm cores increased from 15 to 60 shoots (300% increase) and from 14,1 cm to 35,9 cm (154,4% increase) over the same time period. This study demonstrates that mariculture provides an ecologically sustainable means of upscaling seagrass meadow restoration, to combat climate change, by increasing the amount of plant material available for transplantation.

3 Rewilding for richer soils: The impact of reintroduced megafauna on soil health

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³ Conservation South Africa

This study examines the impact of reintroduced megafauna, particularly elephants, on ecosystem health through the process of rewilding. The research focuses on nutrient cycling, soil health, vegetation and invertebrate species, specifically dung beetles, within the Sanbona Reserve in South Africa. By measuring changes in soil properties, dung beetle richness and vegetation health, the study aims to understand how megafauna presence influences ecosystem health. The investigation is conducted across two distinct vegetation types, divided into areas with varying concentrations of megafauna. Initial findings suggest that megafauna reintroduction enhances ecosystem well-being and improves both nutrient cycling and soil health. This research underscores the critical role of megafauna as ecosystem engineers and their potential to restore degraded landscapes, offering insights into sustainable conservation practices and the integration of rewilding into broader climate change mitigation strategies. The study's results could inform conservation policies, highlighting the importance of context-specific approaches in the Global South.

4 What makes bats buzz on apple farms? Acoustic analysis of insectivorous bats foraging in agricultural areas of central South Africa

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Natural pest control services provided by bats have been demonstrated in crops in other regions; however, the trophic link between bats and fruit crop pests remains largely unknown in South Africa. Three SM4 bat detectors (Wildlife Acoustics) were deployed at three fixed sampling points (mid-orchard, orchard edge and nearest water body) on six apple farms for a minimum of three nights during four sampling periods to determine the bat species richness and foraging activity. The recorded sonograms were analysed in Kaleidoscope Pro to identify the species and foraging guilds of bats present, and relative activity levels determined by the number of echolocation "passes" and the subset of "feeding buzzes" indicating active foraging of bats. In total, more than 65 000 passes were recorded, representing a minimum of eight species of bats, with the clutter-edge guild dominating. Preliminary results indicate higher species diversity and foraging activity at the control site. Molecular diet analysis is the next step to determine the pest suppression services provided by bats in this agroecosystem.

5 LM and SEM studies of southern African *Vachellia* and *Senegalia* pollen

Angela Effiom* and Marion Bamford

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A palynological study is currently being carried out on *Vachellia* and *Senegalia* in order to document the morphological pollen characters that delimit the two African genera and species, which will contribute to the taxonomy of the *Fabaceae* family and will also aid in the identification of fossil pollen during palaeoenvironmental studies. Flowers of eight species consisting of six *Vachellia* and two *Senegalia* species were collected from the Moss Herbarium, Wits University. The pollen samples were subjected to the acetolysis method of Erdtman, and light and SEM microscopic study is currently ongoing. Preliminary results show that pollen characters of these *Senegalia* species (*S. galpinii* and *S. caffra*) vary from those of the *Vachellia* species (*V. davyi*, *V. abyssinica*, *V. Arenaria*, *V. karoo*, *V. grandicornuta*, *V. hebeclade* and *V. nebrownii*). The latter possess colporate apertures and reticulate to perforate exine sculpture, with a conspicuous undulating exine in the peripheral monads, forming furrows. In contrast, the *Senegalia* species are porate, having psilate to foveolate exine sculpture with no furrows. All the studied species retain 12 to 24 monads, but vary in size and exine thickness.

6 Increasing salinity drastically reduces hatching success of crustaceans from depression wetlands of the semi-arid Eastern Cape Karoo region, South Africa

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Salinity is an important factor affecting freshwater aquatic species distribution and diversity. The semi-arid Eastern Cape Karoo region of South Africa has been earmarked for shale gas development through hydraulic fracturing. The process uses large amounts of water and produces briny wastewater. When not managed properly, these wastewaters may lead to salinisation of surface freshwater bodies in the region. Therefore, the effect of salinity on the hatching success of crustacean resting eggs was examined using sediments from four depression wetlands found in the region. The sediments were exposed for 28 days to salinity levels of 0,5g/L, 2,5g/L, 5g/L and 10g/L. There was a significant decrease in the emerged taxa richness and abundance at salinities of 2,5g/L and above. Anostraca, Notostraca and Spinicaudata hatchlings were abundant at salinities of 0,5g/L and below, while Copepoda, Daphniidae (Cladocera) and Ostracoda were observed in the highest salinity, but with lower densities. Given the importance of large branchiopods in the trophic balance of depression wetlands, their loss may alter the ecological balance and function of these ecosystems.

7 Grassland transformation negatively impacts ant diversity and evenness in peri-urban area of KwaZulu-Natal

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The rapid transformation of natural landscapes due to human activities threatens global biodiversity, especially in peri-urban areas experiencing urbanisation and diverse land use changes. This study examines the impact of grassland transformation on ant diversity in peri-urban areas of KwaZulu-Natal. Ants are key indicators of environmental change and were sampled using standardised pitfall traps in settled, cropland and grassland habitats. A total of 13 219 ant specimens representing 60 species, 22 genera and five subfamilies were collected. *Myrmicinae* was the most diverse subfamily, with *Pheidole* spp. the most dominant species across all habitats. Grassland had the highest ant species diversity and was more even as compared with settled habitats and croplands. This study highlights the importance of ants in biodiversity conservation in rapidly transforming peri-urban landscapes and emphasises the need for further research to inform conservation strategies.

8 Thirty-two years of spider records

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From 1991 to 2017, spiders were collected at the Walter Sisulu National Botanical Garden (WSNGB), formerly the Witwatersrand National Botanical Garden, with permission from the incumbent curators at the time, and deposited in the National Collection of Arachnida (NCA). These specimens have been identified. Ad hoc collecting has been carried out by various arachnologists, including the authors at the Pretoria National Botanical Garden, and the data from these collections will be compiled. Certain specimens not deposited in the NCA were identified by visiting arachnologists and by the first author. Thereafter and up to the present day, observations and photographs have been used to compile a preliminary checklist requested for the WSNGB. Many species of spiders are known to occur in both gardens, but as we were unable to collect in the intervening years, they have neither been accessioned into the NCA nor verified by professional taxonomists. This means that further collecting and verification will be carried out.

9 Temminck's pangolin distribution and habitat use in a dryland environment

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²Tswalu Kalahari Reserve

Tswalu Kalahari Reserve is home to a population of Temminck's pangolin (*Smutsia temminckii*), yet detailed knowledge of their fine-scale habitat use and factors influencing their distribution in the north-western areas of South Africa is limited. This study aims to fill the gap by investigating the habitat preferences of pangolin within Tswalu Kalahari Reserve and assessing their ability to occupy areas with varying vegetation quality. In addition, at the regional level, we aim to investigate the extent of their distribution to explore the potential of them being present beyond the current known range, in line with

fossil evidence. Our research will provide insight into the habitat requirements and distribution patterns of Temminck's pangolin, and will be instrumental in guiding decisions on the optimal locations for re-leasing rehabilitated pangolins, ensuring their long-term survival and contributing to their conservation.

10 The importance of Tswalu Kalahari Reserve for human evolution

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Arid and semi-arid environments played an important role in the evolutionary history of our species. Many key technological developments over the past one million years are found in environments that are drylands today. Here we present an analysis of Pleistocene behavioural adaptations at Witberg 1 and Sonstraal, two new excavations located on the Tswalu Kalahari Reserve. Together, these two sites document the transition from the Earlier to the Middle Stone Age, the critical time period when our species emerged as a distinct lineage. Through a multidisciplinary analysis of phytoliths, diatoms and lake sediments, we show how important adaptations to water availability were in the past, foreshadowing the importance of water security today.

11 Bringing the black rhino back: Key factors for reintroduction success

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We studied the post-release behaviour of the critically endangered black rhinoceros, *Diceros bicornis minor*, reintroduced to the Gonarezhou National Park in 2021, using daytime sighting data collected from 21 rhinoceros for 1,5 years, to investigate survival and reproduction, movement patterns and habitat selection after release. Rhinos showed progressive and consistent changes in movement patterns and habitat selection, shifting from large-scale movements during the early stages of release to smaller-scale movements after home ranges were established. We found that rhinos released in the larger area had larger activity areas, with less overlap between individuals, and moved further away from the release site than the individuals released in the smaller area. These findings confirm the great capacity of black rhinos to adapt to occupying large ranges when given the opportunity, but populations with smaller ranges can also be viable. We stress the importance of long-term monitoring and believe that reserve size, rhino density, fencing, food and water availability, familiarity between conspecifics and human disturbance are key factors that should be considered in future reintroductions.

12 Safari wildlife tourism: Identifying moments that matter

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Wildlife tourism operators face the challenge of providing activities which create a memorable guest experience while securing the welfare of wildlife. Electrodermal activity (EDA) accurately captures a person's physiological response to environmental stimuli in real time, compared with responses to their own recollections, which are more prone to bias. We present the novel use of EDA to monitor responses of people to game viewing, and examine the thresholds under which these measurements can be accurately interpreted in the field. Sadness, contentment and relief are associated with decreased EDA and were captured most frequently immediately following a sighting which could be considered a "close encounter", or while viewing animal carcasses. Amusement, joy and excitement result in increased EDA and were noted by an increased baseline EDA signal throughout reserve visits, and when viewing charismatic animals or species indicated to be of interest. Our results serve as a novel and reliable means to identify key species and game viewing scenarios which elicit a psycho-physiological response in safari-goers, while providing guidelines for minimising the anthropogenic impact on species viewed.

13 The platanna (*Xenopus laevis*) as a global invasive species: The impact of temperatures on its fitness as invasive

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Xenopus laevis, the African clawed frog, is a significant invasive species in Europe with the potential to disrupt ecosystems. Understanding how temperature affects its development is crucial for predicting and managing its impact on native fauna and habitats. This study examines how different temperatures (17°C, 20°C, 23°C, 26°C and 29°C) influence the growth and survival of *Xenopus laevis* in a controlled environment. The research aimed to identify the optimal temperature range for the frog's growth and viability. Results showed that growth and survival were best at 20°C, 23°C and 26°C, with individuals at these temperatures displaying enhanced developmental outcomes compared with those at 17°C and 29°C. These findings highlight the critical role of temperature in the development of *Xenopus laevis*, offering insights into the environmental factors influencing its success as an invasive species. Understanding these temperature ranges can help predict the spread of *Xenopus laevis* in different climates and develop strategies to mitigate its impact on native ecosystems.

14 Allocating responsibility for maintaining carbon sinks

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Under the Paris Agreement, nations have agreed to pursue efforts to limit the global temperature increase to 1,5°C above pre-industrial levels, which has resulted in commitments to reach net zero anthropogenic emissions by mid-century. At the time of reaching net zero, the resulting stabilisation of temperatures will be partly maintained by an ongoing uptake of carbon dioxide by carbon sinks, like the biosphere. To halt warming, these carbon sinks must equal 0,3% of cumulative global emissions per year at the time that net zero is reached. However, currently the responsibility for ensuring that the carbon sinks are the requisite size does not lie with any one party, and indeed the carbon sinks are often committed by countries for use as credits under Article 6.4 of the Paris Agreement or for use as carbon dioxide removal to reach net zero targets. Here we estimate the size of each country's share of the carbon sink at 2050, based on estimated contribution to the cumulative emissions by 2050. This allows for the setting of clear responsibility for the protection of carbon sinks.

15 A preliminary mapping of 21 ecological regime shifts across 23 global ecosystems

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Regime shifts are substantial and persistent changes in the structure and function of ecosystems and pose substantial risks to nature, human societies and economies. We estimated which locations and people are exposed to 21 different known ecological regime shifts. We mapped the areas of detected ecological resilience loss for 23 terrestrial, aquatic and marine ecosystems that indicate parts of ecosystems possibly undergoing critical changes in their system dynamics and approaching a tipping point. Our findings indicate that approximately 30% of global terrestrial ecoregions exhibit signs of resilience loss, affecting roughly one quarter of the world's population. Marine and freshwater ecosystems show similar patterns of stress in about 20% of marine and 26% of freshwater regions. We also mapped areas where more than one regime shift may be possible, totalling more than half of all ecosystems signalling resilience loss, thus identifying potential hotspot areas. Overall, we estimate that 3,3 billion people, 41% of the global population, are currently living in areas of ecological resilience loss and are at risk of being impacted by at least one ecological regime shift.

16 Nonlinear form-function relationships in ruminants highlight the need for evolutionary adaptation in wildlife conservation

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The diet niche of ruminants is constrained by morphophysiological traits, especially craniodental anatomy and ruminal morphophysiology. To understand these constraints, we aim to resolve the mechanisms underlying complex nonlinear relationships between form and function. Preliminary analysis of existing

data on M3 enamel crown height to width ratios – the hypsodonty index (HI) – shows an asymptotic increase in HI with the mean percentage of grass in species' diets. This suggests that only minor shifts towards grazing drove significant hypsodonty evolution; beyond this point, diverse dietary options became possible without further HI increases, explaining the success of many grazer species in varied environments. However, polytony in the muzzle width-diet niche relationship implies that grazing species of intermediate form are likely compromised outside their primary habitat types. These examples highlight that niche constraints of ruminants are still poorly understood, but that range shifts due to factors like climate change, translocation and preserving maximal species richness in protected areas put many species at risk of adaptive fitness losses.

17 Climbing the hierarchy: The longitudinal hormone profile of Damaraland mole-rats (*Fukomys damarensis*)

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The Damaraland mole-rat (*Fukomys damarensis*; DMR) is renowned for its social structure in which the group comprises one breeding pair and their offspring. Previous studies have focused on the reproductive hormones of this species, trying to determine their reproductive strategies. However, these studies were conducted over short-term periods. Therefore, in this study, we assessed the plasma hormone concentrations using cortisol, testosterone, oestrogen and progesterone enzyme immunoassays from a population of DMRs sampled over nine years. Overall, testosterone levels are higher in males, and no difference in concentration is found between breeding and non-breeding males. Significant increases in progesterone and oestrogen levels were recorded after females were paired with males. There were higher levels of testosterone and cortisol in solitary individuals, potentially as a defence mechanism. The results suggest induced ovulation by copulation; however, the exposure to a male is not sufficient to stimulate ovulation. This study has given further insight into the reproductive strategies implemented and provides a better overview of the hormonal profile of this species.

18 Arthropod communities along a gradient of land use intensities in Gauteng

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Gauteng is the industrial hub of South Africa. With only 0,8% of its grasslands currently protected, Gauteng grasslands are vulnerable to urban development. Different land use intensities within Gauteng have created a mosaic of urban to natural areas. How this affects arthropod composition in the province remains understudied. We compared arthropod communities in areas of different land use intensities in the city of Tshwane. We used preservative pit traps to collect arthropods across four sites. We selected beetles (Insecta: Coleoptera) and spiders (Arachnida: Araneae) as the target taxa. They are diverse, occupy various trophic levels, and are taxonomically relatively well studied, making them good proxies

for assessing the impacts of land use. We included the arachnid orders scorpions (Scorpiones), solifuges (Solifugae), false scorpions (Pseudoscorpiones) and harvestmen (Opiliones), as they are often neglected in ecological surveys. Little is known about how these taxa react to disturbances. We will provide an overview on species richness, abundance, diversity and taxonomic composition. Such data is relevant for town planning to mitigate the impact of urbanisation on biodiversity.

19 Analysing the Growth and Sustainability of Zambia's Legal Game Meat Industry: A Case Study on Production Trends, Economic Contributions, and Industry Challenges

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The consumption of game meat in Zambia has become a significant cultural and economic phenomenon, with its demand steadily rising, particularly within the local market. This paper investigates the growth and sustainability of the legal game meat industry in Zambia through a case study design employing both quantitative and qualitative methods. Utilising purposive and stratified random sampling techniques, a diverse range of participants from various stages of the value chain, including producers, processors, distributors and policymakers, will be selected for the study. A sample size comprising 50 game ranches, 15 butcheries/retailers, five transporters and five government officials who are industry experts will be surveyed across Lusaka, Central and Southern Provinces. By examining the industry's evolution, production trends and impact on wildlife populations, this research aims to investigate Zambia's legal game meat value chain in order to understand its production costs, economic contributions and existing challenges. Ultimately, the findings will contribute to a deeper understanding of the dynamics shaping the game meat industry.

20 The potential of SABAP2 in long-term population monitoring

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There is a growing concern for the well-being of animal populations across the globe, prompting an increase in population monitoring schemes to document species declines and inform conservation efforts. However, Africa remains underrepresented, with few schemes generating data to monitor changes. To combat this issue, I utilised the Southern African Bird Atlas Project 2 (SABAP2) to test the viability of detecting changes in the relative abundance of different species groups that were highly characteristic of the various biomes found in South Africa. These group trends were analysed using multi-species generalised mixed effect models. Significant declines were observed in species within the fynbos and grassland biomes, while increases were noted in the savanna and coastal biomes. However, across the board, a substantial proportion of species across all biomes were found to be in decline, indicating that while biome net trends appear to be stable, large numbers of species are in decline. SABAP2 demonstrates great potential as a dataset for use in population monitoring in South African ecosystems.

21 Effect of cultural variations and geographical location on ethnomedicinal plant usage in the Lowveld and Highveld of Zimbabwe

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Indigenous ecological knowledge systems integrated with modern science can positively impact the management and conservation of ethnomedicinal plants. We explored whether and to what extent cultural variations and geographical location influence knowledge of ethnomedicinal plants in the Lowveld and Highveld of Zimbabwe. Low Szymkiewicz–Simpson coefficient of similarity values of 0,429, 0,200 and 0,267 for uses in “both human and livestock”, “human only” and “livestock only” respectively showed differences in types of ethnomedicinal plants for these uses. Jaccard indices for species similarity for these uses in the two areas were also low (13,6, 8,7 and 10,5% respectively). In the Highveld, *Cissus quadrangularis* was the most prominent ethnomedicinal plant (Salience Index = 0,284). Roots were the most used plant part (27%). Methods of administration of the medicines included infusions (47,2%) and cold-water extracts and poultices (1,39%). In the Highveld, high informant consensus factor values were 0,97 for wounds and 0,98 for ectoparasites. This information indicates the need for localised strategies in the management and conservation efforts for genetic plant material.

22 Have you seen the woodpecker and what else is new? The birds of Suikerbosrand Nature Reserve 50 years on

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A comprehensive survey of the birds of Suikerbosrand Nature Reserve was undertaken in the early 1970s prior to the opening of the reserve. While land use within the reserve transitioned from cultivation and livestock grazing to conservation and tourism, the broader landscape saw intensive urban and industrial growth. Fifty years on, the now expanded reserve continues to serve as an important outdoor recreation destination. But what of the birds? During 2018-2023, we resurveyed the original reserve and the northern extension. Sightings and calls were logged using the BirdLasser App, and this data was then used to plot the distribution of each species and calculate reporting rates. The observer teams and approaches used in the original survey, in the subsequent Birds in Reserves Project and in our assessment were different. Comparison between time periods should therefore be treated with caution, and further work is still required to define meaningful thresholds of potential concern (TPC). Using a provisional TPC (increase or decrease of 10% or more), our preliminary analysis suggests that 6% of species are now less commonly recorded, 48% are unchanged and 46% are recorded more often.

23 The ecological role of Temminck's pangolins in a dryland ecosystem

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The global threat to biodiversity is directly affecting ecosystem stability as the ecosystem services that organisms provide are compromised. It is often assumed that rare species have little influence on the functionality of the broader ecosystem, yet they often are the most in need of conservation efforts. One such species is Temminck's pangolin (*Smutsia temminckii*). Based on studies of other pangolin species, it has been suggested that Temminck's pangolin may impact its ecosystem through its role in nutrient cycling, soil turnover and the accumulation of biodiversity in dig sites. Our study aims to quantify the role of Temminck's pangolin by investigating aspects of its foraging practices. We hypothesise that pangolin foraging behaviour will increase the rate of nutrient cycling of the environment and allow for the increased accumulation of biodiversity. Six pangolins at Tswalu in the Kalahari will be tagged with VHF tracking transmitters and observed during their active phase for one year. Quantifying the ecosystem services provided by Temminck's pangolins will allow for the prioritisation of conservation efforts for this rare and vulnerable species.

24 Aerial wildlife snare detection at scale using synthetic aperture radar

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Snaring poses a significant threat to large animal biodiversity in Africa, ranking as the second most significant danger, and is the primary cause of the disappearance of lions, leopards, cheetah, hyena and wild dogs. There are currently no efficient methods for locating snares on a large scale for effective removal. Even in well-managed reserves, only one to five percent of snares are detected, resulting in the death of millions of animals annually. Manual detection of snares is not only inefficient, but consumes considerable time and conservation resources. We are developing an airborne detection system utilising synthetic aperture radar. This system will scan a 1 km-wide swathe of land, flying at an altitude of 120 m and at 135 km/h. As a result, it can cover and identify all snares within a 135 km² area each hour with an accuracy of 5 m, irrespective of the terrain. This technology will facilitate regular snare removal efforts. We anticipate that this innovation will change the economics of snaring, leading to a substantial reduction. Wildlife conservation efforts will be significantly enhanced, while the need for punitive policing, we report the results of our initial trials.

25 Botha's lark: South Africa's most threatened terrestrial bird species?

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Botha's lark (*Spizocorys fringillaris*) is a highly range-restricted and endemic bird species. The population was estimated at 20 000 individuals in 1983, and in 2015 had declined to <2 500. Recent surveys indicate that the population is 340 individuals (200–650 CI). Advanced remote sensing analyses indicate a 29% reduction of suitable habitat within the areas of its historical distribution, triggering its uplisting to Critically Endangered. In response, we propose a Species Action Plan to engage landowners and promote awareness throughout its historical distribution areas, to introduce Biodiversity Stewardship and a Protected Environment, and to understand, support and champion sustainable land use practices that allow for both economic and ecological viability. Line-transect surveys across seasons and within novel localities, and standardised and simultaneous camera-trap surveys across the distribution areas at artificial waterbodies, will aid in refining population estimates. The risk of climate change to breeding and other ecological behaviours, and the species's ability to track its shifting climatic niche, will be assessed. A synthesis of the above will coordinate conservation efforts and measure and monitor success.

26 Assessing the influence of artificial light at night (ALAN) on the activity and species composition of insectivorous bats in Gauteng, South Africa

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Artificial light at night (ALAN), brought on by rapid urbanisation, is one of the greatest threats facing nocturnal ecosystems in the 21st century. This ongoing study aims to investigate the impact of ALAN on the activity patterns and species composition of insectivorous bats in Gauteng, South Africa, providing insight into how anthropogenic factors influence bat habitat selection across the study area, and how this varies seasonally and geographically. To achieve this, the vocalisations of bats at 54 sites of varying ALAN levels are being recorded over a one-year period using passive ultrasonic sensors, with ALAN levels at each site estimated via remote sensing and ground-based measurements. The study also aims to utilise periodic loadshedding to investigate whether reduced ALAN levels alone impact species composition and activity patterns, regardless of other urbanisation factors. Preliminary results from the first month of data collection suggest a reduction of up to 49,8% in ambient light levels during loadshedding events in a suburban area ($p < 0,001$), and a suggestive but inconclusive moderate negative relationship between bat activity levels and ALAN levels ($r = -0,635$, $p = 0,067$).

27 Frog diversity according to elevation in the Soutpansberg

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Elevational gradients can provide an understanding of biodiversity patterns in the context of climate change impacts. This study investigates elevational patterns of frog diversity in the Soutpansberg mountain range, as a South African biodiversity hotspot. Here, we build on previous research that identified four common patterns of species richness with elevation: decreasing richness, low plateau, low plateau with a mid-elevation peak, and mid-elevation peak. These patterns have been documented for other taxonomic groups, but frogs might exhibit unique elevational distribution patterns due to their distinct habitat requirements. The study aims to address this knowledge gap by specifically focusing on frog distribution patterns in the Soutpansberg and analysing their distribution patterns along an elevational gradient using a digital elevation model. This contributes to our understanding of montane frog diversity. Furthermore, a case study will determine the elevation range of two species of limited distribution within the study area, *Breviceps sylvestris* and *Ptychadena uzungwensis*, to potentially develop targeted conservation strategies for these range-restricted species.

28 The Complete Guide to Indigenous Garden Plants of South Africa

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South Africa is widely recognised as a global biodiversity hotspot. The varied topography, geology and climatic regimes – across seven major biomes – have all contributed to a remarkably rich flora. It has one of the highest densities of plant species in the world (relative to the size of the country) and an exceptionally high percentage of species endemic to the region. Although South Africa is famous for giving the world many great garden plants, such as the protea, strelitzia, agapanthus, gerbera, gladiolus, plumbago, “geranium” and many more, there are still countless species that are not yet widely known to gardeners, local and international. The extraordinary diversity and beauty of local plant species, when teamed with qualities such as drought resistance, adaptation to local climatic conditions, non-invasive tendencies, support of local wildlife and, in some cases, cold or frost resistance, are characteristics which are exactly what gardeners need. Around the world, there is a strong swing towards a more natural, low-impact lifestyle – and gardens – and the increasing pressure to cope with global warming and a more water-restricted world. The book will inspire all gardeners, horticulturists, landscapers, landscape architects, and restoration and rehabilitation practitioners.

29 *Vicia sativa* and *V. villosa* improve soil enzyme activities, bacterial composition and chemical properties of the KwaZulu-Natal small-scale sugarcane plantation soils

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Vicia sativa and *V. villosa* are nitrogen-fixing legumes used as forage and cover crops. They exhibit increased N₂-fixing efficiency, soil N contributions and enzyme activities, particularly under nutrient-deficient conditions. This makes them valuable cover crops, with potential use as green manure, enhancing soil health in sugarcane plantations owned by small-scale growers (SSGs). This study investigated the chemical and biological contributions of *V. sativa* and *V. villosa* to nutrient-deficient SSG plantations in KwaZulu-Natal. Soils from five plantations were analysed for nutrients, N- and phosphorus (P)-cycling bacteria and their associated enzymes pre- and post-*V. villosa* and *V. sativa* harvest. Post-harvest, soil pH levels increased across all plantations. Both legumes increased the number of N- and P-cycling bacteria, with *Pseudomonas*, *Arthrobacter*, *Burkholderia* and *Paraburkholderia* being more prevalent. The number of P-solubilising bacteria and acid phosphatase activities also increased. This study showed that *V. sativa* and *V. villosa* improved soil health in small-scale sugarcane plantations by enhancing nutrient-cycling bacteria, soil pH and enzyme activities.

30 Consistency in provision of nutrients in dung beetles (Coleoptera: Scarabaeinae): Seasonal changes in nutrient levels

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The nutrient content of dung is important for the growth, development and activity of dung beetles. The nutrient content changes with seasonal changes, mainly because of temperature and moisture content fluctuations, and this can affect factors like activity and egg production. In this experiment, we investigated how dung beetles respond to changes in nutrients across seasons when nesting and feeding. Maternal gift from the brood balls laid by *Euoniticellus intermedius* was compared monthly with that of the dung. It was detected that the nitrogen and carbon content with the CN ratio of the dung changed with seasons. The nitrogen content of the maternal gift and the foregut content increased throughout the seasons, while the carbon content hardly changed compared with that of the dung. Furthermore, the CN ratio of the dung corresponded with the nitrogen and carbon content throughout the seasons, while that of the foregut and maternal gift remained relatively the same. The dung beetle nutrient provision appears not to be driven by nitrogen alone, but by both the carbon and nitrogen content.

31 Innovative approaches to sustainable *Cannabis* cultivation and production: Evaluating tissue culture techniques and pharmacological properties

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The cultivation of *Cannabis* is essential for its medicinal, industrial and recreational applications. As demand for *Cannabis* products increases, there is a critical need to enhance propagation protocols. Methods such as in vitro germination and propagation show potential for improving cultivation techniques, but selecting appropriate source materials is crucial for successful outcomes. This research aims to develop effective and consistent tissue culture methods for the sustainable production of *Cannabis sativa*. Specifically, it seeks to determine the best source material for in vitro germination and propagation, improve propagation protocols and ultimately enhance the efficiency and reliability of *Cannabis* cultivation. The study will evaluate in vitro germination and propagation efficiency, as well as the content of CBD, THC and other medicinal properties. Additionally, it will assess the pharmacological properties of *Cannabis*, including antibacterial and anti-acetylcholinesterase activities. The expected outcomes include identifying the best methods for *Cannabis* cultivation and improving cultivation techniques, leading to sustainable production.

32 Uncertainty quantification for probabilistic machine learning in earth observation using conformal prediction

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Machine learning is applied to earth observation (EO) data to derive datasets that are used to characterise, comprehend and conserve natural resources, contributing to progress towards international accords. However, the derived datasets contain inherent uncertainty and need to be quantified reliably to avoid negative downstream consequences. In response to the increased need to report uncertainty, we bring attention to the promise of conformal prediction within the domain of EO. Conformal prediction is an uncertainty quantification (UQ) method that offers statistically valid and informative prediction regions while concurrently being computationally efficient, model-agnostic, distribution-free and able to be applied in a post-hoc manner without requiring access to the underlying model and training dataset. We assessed the current state of uncertainty quantification in the EO domain and found that only 20% of the reviewed datasets incorporated a degree of uncertainty information, with unreliable methods prevalent.

33 Digital soil mapping enables informed decisions to conserve soils within protected areas

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Protected areas are regarded as pristine land, but often they require rehabilitation and effective management to prevent increased land degradation. Soil management requires soil maps, which are difficult to create in protected areas due to their large size, limited accessibility, little available soil data and limited budgets. This paper shows a novel digital soil mapping (DSM) method to map soils of areas with protected areas' limitations. The study is situated at the 9 900-ha Benfontein conservancy. Soil landscape rules were used to determine virtual soil observation locations, which were added to the training dataset used by a machine learning algorithm to create a soil an acceptable associations map. Soil properties and interpreted soil indices were assigned to each soil association at 0,1, 0,5 and 0,9 percentile levels to indicate the range of properties at an 80% certainty. Results show that Benfontein has large carbon sequestration potential, the soils are relatively stable against water erosion, and off-road driving should be prohibited on approximately half of the area. DSM can create useful soil maps to inform management decisions in the unique settings of protected areas.

34 Call library development for small mammals in Telperion Nature Reserve

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Bioacoustics approaches are efficient and effective, low-cost methods for assessing biodiversity. Typically used for the identification of bats, birds and frogs, acoustic monitoring for small mammals is in its infancy. We are developing a call library to assess acoustic approaches for identifying small mammals in Telperion Nature Reserve. We are studying three orders of small mammals: Eulipotyphla (shrews), Macroscelidea (elephant shrews) and Rodentia (rats and mice). Using ultrasonic and audible range recorders, we collect vocalisations of captured wild animals. We use spectrograms to visualise call shapes and employ these as a basis to describe the species-specific vocalisations and develop call libraries. Preliminary results demonstrate the potential to distinguish morphologically similar species, *Aethomys ineptus* and *Micaelamys namaquensis*, using their disparate calls. Additionally, *Elephantulus myurus* has a unique, complex "dialect". Our call libraries will be used to test whether acoustic methods can be used to identify small free-roaming mammals. We will then verify the viability of this approach to establish distribution and occupancy of small mammal species.

35 Classical weed biological control in the Zimbabwean conservation matrix: Progress and future prospects

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In Zimbabwe, both terrestrial and aquatic ecosystems are severely impacted by invasive alien plants, compounding conservation challenges in several biodiversity-rich ecosystems. Despite the evident impacts on native biodiversity and human well-being, the management of invasive alien species in Zimbabwe is limited, mechanically based and poorly funded. Classical biological control is globally recognised as a sustainable and cost-effective management option. Biological control has successfully been implemented in Zimbabwe since the 1960s. Nine biological control agents were intentionally released on five weeds until 2009, and 10 other biological control agents released in neighbouring countries have naturally dispersed into the country, substantially suppressing some problematic weeds. A recent study identified 19 invasive alien plants that could be successfully managed through classical weed biological control, and for 12 of these, this could be achieved at minimal cost, as agents are available within the region. Here we demonstrate the impact of two recently introduced biological control agents, *Megamelus scutellaris* against water hyacinth and *Cyrtobagous salviniae* against Kariba weed.

36 Designing a food production system for Tswalu Kalahari Reserve

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Vegetable cultivation is a fundamental component of agriculture and plays a crucial role in meeting global nutritional and food security needs. A conservation endeavour that embodies South Africa's largest privately protected area can be seen from the southern Kalahari to the Korannaberg mountains. With access to fresh produce being rare and expensive, Tswalu Kalahari Reserve is searching for a more sustainable solution. Focusing on hydroponic systems, the project aims to optimise resource utilisation, streamline processes and address logistical challenges. Environmental factors, nutrient management and efficient energy consumption are analysed to enhance the system's performance. As an industrial engineering initiative, the project navigates the challenges of high set-up costs and technical expertise, aiming to establish a cost-effective, technically viable and environmentally conscious fresh produce production system that aligns with the reserve's conservation goals and community well-being.

37 Monitoring of biological impacts of climate change

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Anthropogenic climate change is a certainty, and the debate should now be around by how far we will exceed the proposed 1.5°C limits, what consequence this will have for us and how we should adapt to the new future. Climate change has profound impacts on biodiversity and how we manage our biodiversity. Biomes and species distribution that we have historically managed as if they are static in space, will in

fact move over the landscape, in some cases forming new assemblages of species, and in other cases leading to species extinctions. As a country, we need to start considering how we take these changes into consideration as components of our national resource monitoring. SANBI, in conjunction with many partner organisations, has started a process to consider how best to monitor these inevitable changes to both our biomes and our biodiversity. This paper will consider international and local experience in trying to develop indicators to monitor climate change impacts on biodiversity. This varies from specific species responses to measures for based on entire taxa. What remains extremely complex is how best to track the signal of fundamental shifts in the spatial locations of biomes.

38 Baseline vocalisation library for the vlei rat, *Otomys auratus*

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The monitoring of biodiversity is crucial to the management of ecosystem health. Rodents are important indicator species in many ecosystems. Small mammals are commonly monitored by physical trapping, but this is ineffective for trap-shy and cryptic species. Bioacoustics, the monitoring of animal sounds and vocalisations, represents a potential solution. To identify individual species acoustically, reference libraries of species-specific vocalisations are required. The vocalisations of a wetland indicator species, the south-east African vlei rat, *Otomys auratus*, were studied. Their vocalisations were recorded in several social settings, the frequency and duration of these vocalisations were analysed, and the variety and complexity thereof described. Previously, vlei rats were known to make audible vocalisations, and this research has confirmed that they also make ultrasonic vocalisations, the repertoire of which is described in this study. Vlei rats emit multiple ultrasonic calls with structures that vary in complexity. The call library that is a result of this study can be used for behavioural studies and field identification of this species.

39 Amphibian One Health in South Africa

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One Health is a concept based on simultaneously managing the health of animals, humans and the environment. Human-amphibian interactions have One Health implications, as contact with amphibians exposes people to potential disease agents, and people link spiritual significance to amphibians, thus producing implications for mental health. In turn, people may affect amphibians' environmental health by harvesting amphibians, which could result in overharvesting, and people may have an impact on their habitats. However, One Health implications of contact between humans and amphibians are yet to be categorised. This study provides an overview of amphibian One Health in South Africa based on different human-amphibian interactions, ranging from contact through harvesting for consumption or medicinal use, to ecotourism and interactions for cultural reasons. This overview highlights amphibian One Health implications that require attention to reduce their impacts on amphibian, human and environmental health. The highlighted aspects of amphibian One Health will need further studies to verify the One Health implications of human-amphibian contact.

40 The socio-economic context and anthropogenic pressure on carnivores, specifically brown hyena, at Telperion and Loskop Dam Nature Reserves

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Between 2014 and 2020, 36 186 ha (14%) of the natural land in the area surrounding Telperion Nature Reserve (TNR) and Loskop Dam Nature Reserve (LDNR) in Mpumalanga, South Africa, have been altered. Furthermore, rising levels of illegal wildlife persecution through snaring, trapping and poisoning have been reported regionally, with poaching being a major biodiversity threat. Despite the historical presence of brown hyena on TNR and LDNR, a study carried out during 2022 and 2023 found very limited evidence of brown hyena presence on TNR, whereas evidence of their presence on LDNR remains consistent. A questionnaire was developed to investigate the influence of anthropogenic pressures on carnivores, specifically brown hyena, on and around both reserves. The questionnaire was distributed to landowners, employees and residents on properties neighbouring both reserves. The aim of the questionnaire was to investigate the demographics of the area, knowledge about and perceived threats from predators, as well as persecution activities. Furthermore, the questionnaire was used to gain insight into whether respondents have noticed a change in brown hyena presence over the past few decades.

41 A practical alternative livelihood creation: Multiple land use, multiple revenue stream Community Conservancy planning, development and management model

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Conservation in Africa requires an entire rethink by the conservation sector, including how it is financed, planned, developed and managed. Drawing from over 60 years of combined private sector experience in property development, consumer goods, front line conservation and community engagement, we have made it our stated goal to convert land surrounding game reserves and national parks in Africa into multiple land use, multiple revenue stream, resilient and sustainable Community Conservancies, following first principles related to the planning, financing, development and management of a typical property development, including the incubation and setting up of conservation-based businesses within and around these Community Conservancies. The initial comprehensive communal planning (CCP) process usually takes three to five years and involves extensive community engagement and workshopping, with this collaborative process; then, working with an appointed group of professionals, it provides the basis of what we term a Spatial Development Framework for the Community Conservancy, which, when completed, is owned by the oversight NPO entity that is set up to manage the Community Conservancy.

42 Safeguarding South Africa's threatened sharks, rays and chimaeras

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South Africa is home to more than 20% of the global chondrichthyan (sharks, rays & chimaeras) biodiversity, with ~194 species. Appropriate legal protection and effective management will ensure South Africa acts as an important “lifeboat” against a backdrop of negative trends globally and in African waters. Many South African populations are negatively impacted by various fisheries and disturbances to their critical habitats. To improve and secure the protection of threatened species, WILDTRUST, together with the Shark Conservation Fund and several partners, have implemented a project which aims to increase the knowledge of species, build appreciation by decision makers, and secure relevant legal provisions that protect chondrichthyans through amendments to current provisions in the relevant fishery and biodiversity statutes. The Sharks Under Attack campaign underwrites this project by highlighting the plight of South Africa's chondrichthyans and actively attempts to shift negative perceptions and inspire positive action. The presentation aims to highlight the objectives and progress of this collaborative project.

43 Local management and governance improve natural resource incomes of communal conservancies in Namibia

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Governance of communal institutions is critical to financial sustainability of wildlife economies. I evaluated effects of natural resource management and institutional governance on income earned by conservancies in Namibia during 2011-2022. I compiled income and performance scores using accounting and “event book” monitoring data. Conservancies earning >\$0 generated a median annual of \$60 518 from 2011. Income increased with conservancy age, higher management performance, NGO presence and AGM occurrence. Income earned during 2019-2022 also increased with higher governance performance. Median management and governance performances across conservancies were only about 50% of maximum scores, indicating higher income potential with improved performance. Conservancies remained financially dependent on NGOs, and AGMs were important functions. Local management and governance facilitated income generation by Namibia's conservancies, but more investment in benefit distribution could increase their socio-economic impact. I recommend that Namibia's conservancies, particularly those established recently without an NGO, prioritise improving performance to develop more sustainable wildlife economies.

44 Temporal dynamics of Diptera at carrion bait

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Carrion flies have roles in public health, forensic investigations and ecosystem services such as nutrient cycling and pollination. However, methods used to sample carrion flies are inconsistent, meaning that it is difficult to be certain that they capture a representative sample of target communities. Species of Calliphoridae, Muscidae and Sarcophagidae are attracted to carrion at different stages of decay, so baits that use decomposing animal remains likely change in their attractiveness to certain species over time. This study determined how the assemblage of carrion flies attracted to chicken liver-baited traps changed over time, and as a consequence, the time required to catch a representative sample of carrion flies in the South African Highveld. Trapping was done in grassland, shrubland and woodland habitats using 120g food grade chicken liver exposed for three, six, nine and 12 days. Surveys found more than 40 species arriving at bait at different rates between habitat types. Species accumulation curves show more than 12 days are needed for a representative sample to be obtained in all habitats and all seasons. Species responsiveness to traps was found to differ between habitats and seasons.

45 Spatio-temporal environmental heterogeneity within savannas is driven by the local variation in landscape factors and dynamic processes

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Environmental heterogeneity is linked to biodiversity and ecosystem function, making it crucial for protected areas to manage habitat variability. This study examines the patterns and drivers of spatio-temporal environmental heterogeneity in the Kruger National Park, South Africa. We quantified per-pixel habitat heterogeneity using Rao's Q from EVI imagery, and used variation partitioning of linear models to analyse the impact of landscape characteristics, climate and dynamic processes on spatial and temporal variation in Rao's Q over 23 years. Spatial heterogeneity was primarily influenced by stable landscape features (increasing with slope variation) and dynamic processes (lower near water sources and roads). Temporal variability in heterogeneity was higher with increased fire frequency and decreased near water sources and roads. Monotonic trends in heterogeneity were driven by landscape and climatic factors: areas with high aspect, variable soil clay content and cooler, wetter conditions showed decreasing heterogeneity over time. The study concludes that different factors drive spatial and temporal heterogeneity patterns.

46 Reducing the burden of scorpion stings in southern Africa: A novel approach

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Jonathan Leeming offers a new and innovative framework for reducing the burden of scorpion stings in southern Africa. This scorpion sting first response framework is based upon the latest science and is easy to understand and put into practice across all levels of society. It reduces the burden of scorpion stings across southern Africa by answering two very important questions: 1) How can we reduce the chance of being stung by a scorpion? 2) If a sting does occur, how can we ensure the best possible outcome for stings in humans and animals?

47 Temperature modulation of activity in vlei rats

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Global temperatures are increasing and can impose thermal stress on homeothermic animals. Wildlife respond to these challenges by either migrating or modifying their behaviour. Larger species can move away more easily, whereas smaller species tend to alter their behaviour. We evaluated the effect of temperature on the activity patterns of the vlei rat, *Otomys auratus*. The animals were subjected to a fluctuating temperature cycle followed by a 5°C increase in the entire cycle, and an inverted temperature cycle so that the warmest temperature was during the night. The activity profiles did not change after the introduction of the temperature cycle; the general activity reduced when the overall temperature increased, and decreased again when the temperature cycle was inverted. In contrast, the running wheel activity showed an opposite trend. Decreased activity in response to heat is expected, and the increased wheel activity could indicate that the animals are more stressed and could represent escape behaviour or a search for refuge. Global warming has implications for biodiversity; therefore, it is critical to investigate the response capacity of wildlife.

48 Stuck in a rut: Variation in reproductive behaviour, spatial patterns and endocrine activity in impala (*Aepyceros melampus*)

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Reproductive success is linked to how animals respond to environmental and social changes. To understand these responses better, this study assessed reproductive, spatial and hormonal activity in impala (*Aepyceros melampus*) during the pre-rut, rut and post-rut. In dominant territorial males, faecal androgen metabolites (fAM), faecal glucocorticoid metabolites (fGCM) and reproductive behaviour peaked during the rut. This may have stimulated female oestrus and the increase in female fAM and fGCM during this period. When dominant males were establishing territories during pre-rut, subordinate bachelor males had the highest fAM and the highest fGCM during the rut due to competition for females. As territories collapsed post-rut, bachelors increased their time with females and attempted to mate. This led females to increase their home ranges and use of space to avoid harassment. This study identifies

factors contributing to reproductive challenges in a keystone species and underscores the ecological and social dynamics shaping impala behaviour. This may inform conservation strategies to support impala populations and ecosystem sustainability.

49 A collaborative, systems-led approach to building skills and capacity for managing South Africa's critical biodiversity

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Environmental professionals have a significant role to play in addressing South Africa's social-ecological challenges, yet we face high levels of scarcity in the very skills that support the related research, namely the monitoring and management of ecological services and systems. The Biodiversity Human Capital Development Strategy (2010-2030) presents strategic pathways for developing suitably qualified specialists, researchers and leaders to implement the country's expanding, complex environmental mandate. The strategy calls on organisations and institutions involved in research and implementation to collaborate on activities that build our collective capacity to achieve our environmental mandate. In this presentation, we will discuss a systems-led approach to environmental skills development in South Africa, presenting key elements of the updated BHCDS, reporting on scarce and critical skills needs, and indicating how organisations can get involved in and benefit from joining the network, which seeks ultimately to build biodiversity leadership capacity within our sector to enhance our collective impact on the management of South Africa's natural assets.

50 Experiences of livestock predation and attitudes towards leopards (*Panthera pardus*) across the Western Cape, South Africa: Using knowledge to inspire innovative solutions

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Declines in suitable habitat and prey availability result in people and carnivores sharing agricultural areas, which frequently leads to predation of livestock and retaliatory killing of carnivores. Using leopards as a focal species, 309 interviews were conducted with farmers across the Western Cape, South Africa, to explore experiences of livestock predation and attitudes towards leopards. Leopards were ranked as the most damage-causing animal by only 9% of participants, compared with 57% and 21% of participants who ranked black-backed jackal and caracal as the most problematic predators respectively. Although 66% of participants had a positive attitude towards leopards, frequent and severe losses attributed to mesocarnivores exacerbated negative attitudes towards all carnivores and increased reluctance towards having leopards on their properties. Leopards were threatened as by-catch in proactive and reactive lethal methods implemented to reduce depredation by mesocarnivores. Implementing holistic non-lethal methods will prevent depredation and protect livelihoods, but mitigation tools need to be affordable and easy to employ, thus inspiring the Cape Leopard Trust's Mabi-kraal project.

51 Temporal changes in home ranges of breeding bearded vultures (*Gypaetus barbatus*)

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Rapid human population growth and urbanisation have threatened numerous raptor species, with vultures being particularly vulnerable. Bearded vultures face significant declines in southern Africa and are classified as critically endangered due to poisoning, human persecution and collisions with infrastructure. A number of birds were tagged with GPS trackers to record their location, speed and elevation during the day, and a total of 49 breeding seasons were covered for various birds. By investigating home range dynamics of bearded vultures using GPS data, we aim to determine potential successful breeding events. Investigating temporal patterns in home range size of breeding adults throughout the breeding season, may show smaller home ranges when young chicks are present, as they are heavily reliant on their parents. As the chicks grow older, the home ranges of the adults may increase again. Since breeding behaviour and parental care are important characteristics of their ecology, an understanding of the foraging behaviour through home range dynamics is critical for effective conservation strategies.

52 Progress in achieving restoration targets for meeting environmental biodiversity commitments

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Environmental change, driven by climate change and anthropogenic activities, profoundly affects South Africa, leading to the emergence of local land restoration and Ecosystem-based Adaptation (EbA) projects. These initiatives combat land degradation through actions such as invasive alien clearing, re-wilding, wetland restoration, etc. However, the extent of these projects in South Africa remains largely unknown, due to insufficient data and monitoring programmes. In response to the UN's Decade of Restoration declaration, South Africa is aligning its restoration targets with global frameworks and climate adaptation goals. This study aims to consolidate data on the extent of restoration efforts, evaluating projects such as Land Care, and working for programmes to assess their progress towards restoration targets. Key findings reveal widespread restoration projects, with invasive plant clearing being highly practised. The Western Cape, the Eastern Cape and Mpumalanga have the highest number of projects. Recommendations include improving data management, adopting a national approach to data collection, and conducting thorough assessments of restoration extent to inform restoration strategies.

53 Desert footprints: Human land use and survival strategies in the Namib and Kalahari, southern Africa

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Understanding human adaptation to extreme and unpredictable environments is invaluable, not only in comprehending the history of our species, but in contemplating strategies to face a looming climate crisis. In southern African deserts, namely the Namib and Kalahari, seasonal transhumance utilising foraging and small-scale livestock-keeping has been a dominant and successful lifeway into the present era, though it has greatly diminished since the mid-19th century. This has resulted in open-air, ephemeral, low-density artefact scatters, with few built features, on loose sand prone to deflation and disturbance, which are notoriously challenging to identify and analyse. I will discuss sampling strategies and some preliminary results from my PhD fieldwork in the Bushmanland region of South Africa in 2023 and 2024, and how similar strategies may be employed in other inland desert regions. I explore potential opportunities provided by a detailed survey of conservation areas such as the Kgalagadi Transfrontier Park, |Ai-|Ais/Richtersveld Transfrontier Park and Tswalu Kalahari Reserve as areas of high archaeological and ecological preservation.

54 Evaluating the performance of wildlife economy projects: Social, economic and biological dimensions

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South Africa has a history marked by social injustices and discrimination, leading to income, ownership and power disparities. This context calls for innovative conservation strategies addressing ecological concerns alongside economic and social justice. Many national parks, established during colonial times, displaced communities and worsened poverty. In response, the government promotes wildlife to foster economic growth and job creation. The Wildlife Economy Program, with support from South African National Parks, aims to transform the industry and promote local development. Aligned with the Biodiversity Economic Strategy, SANParks offers wildlife loans to disadvantaged households, empowering emerging game farmers. This study focuses on the programme's impact, assessing social and economic well-being, including species growth, revenue, staff diversity and job creation. Its significance lies in understanding how the wildlife economy can alleviate rural poverty and inequality. Findings will inform policymakers and practitioners, refining strategies for inclusive growth and conservation.

55 Climate change and cyanobacteria: How construction of artificial waterholes can influence bloom potential in a semi-arid system

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As surface temperatures increase and rainfall becomes increasingly unpredictable due to climate change, surface water continues to diminish, and wildlife in semi-arid fenced reserves will become completely reliant on artificial water sources to meet their physiological requirements. Under hotter, drier conditions, wildlife water visitation rates are likely to increase, resulting in nutrient loading from animal excreta and creating ideal conditions for toxic blue-green algal blooms. The aim of this study was to assess how waterhole construction influences water quality and temperature, sediment deposition and animal drinking behaviour in a semi-arid system. Preliminary results indicate higher soluble nutrients and more acidic conditions in large sediment-lined waterholes, compared with smaller concrete structures. Zebra, hyena and warthog wade into waterholes, contributing to nutrient loading, while kudu, lion and rhino may be at higher risk of toxin effects given their drinking behaviour. Information from this study could inform wildlife management about initial construction of artificial water sources and conservation management of at-risk species to reduce bloom-related mortality events.

56 The impact of artificial light on mosquito community ecology

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The use of Artificial Light at Night (ALAN) is expanding globally. ALAN has been shown to alter mosquito feeding and activity, and so may impact the transmission of vector-borne diseases, like malaria. The change in innate mosquito feeding behaviour by ALAN may result in population- and, ultimately, community-level changes in ecosystems. Here, we assess the strength of the relationship between various environmental variables, including the characteristics of the light environment and the mosquito community structure, in Jozini, South Africa. The newly described Environmental Light Field method was used to characterise the artificial light environment, producing intensity as well as spectral information. We anticipate that mosquito community structure is significantly influenced by environmental variables, such as distance to nearest water source and distance to known breeding site, as well as light characteristics, such as the intensity and blue-light content of the nearest outdoor light. Therefore, the inclusion of ALAN as a predictor variable would allow for a more holistic understanding of factors that influence species distribution and community composition.

57 Surveying the terrestrial small mammal assemblage of Telperion Nature Reserve, South Africa: Insights from owl pellets

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Owl pellet analysis is a cost-effective and non-invasive method of surveying terrestrial small mammals. In this context, opportunistic sampling of owl pellets from two barn owl (*Tyto alba*) roosts at Telperion Nature Reserve began in 2019. Individual pellets were macerated in 70% ethanol, after which skeletal remains were removed, cleaned, dried and counted. Crania and mandibles were examined microscopically and identified taxonomically to genus or species level, using identification keys and museum reference collection material. So far, seven of the 21 small mammal taxa recorded on the reserve have been identified: Afrosoricida (*Amblysomus* spp.), Eulipotyphla (*Crocidura* spp.) and Rodentia (*Dendromus* spp., *Gerbilliscus leucogaster*, *Mastomys* spp., *Mus* spp. and *Otomys auratus*). Unsurprisingly, most of these taxa are nocturnal, with *G. leucogaster* and *O. auratus* representing the most frequently recorded species. *Amblysomus* (golden mole) taxa were not sampled in previous live-trapping studies; however, a single species was recovered from owl pellets. This study demonstrates the utility of owl pellet analyses in compiling a comprehensive small mammal inventory for Telperion Nature Reserve.

58 Spatio-temporal dynamics of Afromontane forests in KwaZulu-Natal, South Africa

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We investigated Afromontane forest extent and composition from 1940 to 2022 in KwaZulu-Natal, South Africa. We examined 30 patches (10 ~1 hectare, 10 ~100 hectares and 10 ~1 000 hectares) at three time periods (1940, 1980 and 2020). Aerial photographs were used for their high spatial resolution and temporal extent. Georeferencing and digitising were done in QGIS. The results indicate that patch size influences forest extent change, with smaller patches decreasing over time, larger patches remaining stable and medium patches having an inconsistent response. These results are likely due to smaller patches being more vulnerable to the effects of fire and land clearing, and medium patches, which have a larger range of sizes, having a wider range of responses. Most forests' composition changed from being predominantly indigenous vegetation to being a combination of indigenous and invasive species. Overall forest expansion is likely linked to regrowth, reforestation and decreased fire in the landscape, while contraction is likely due to logging, exotic plantations and fire. The results of this study could be used to inform decisions around prioritisation efforts for forest conservation.

59 Spatial planning and conservation action in South Africa's Strategic Water Source Areas

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Strategic Water Source Areas (SWSAs) are areas that supply a disproportionate amount of mean annual surface water runoff in relation to their size. Only 11% of SWSAs are formally protected in South Africa. This makes them, and the multitude of threatened species within them, vulnerable to unsustainable or irresponsible development activities. Formal protection of the remaining natural areas is widely agreed to be the best option for increasing national water security in the longer term. This is even more alarming when future pressures on water resources are considered – the demand for water is predicted to escalate exponentially, and many parts of the country are expected to become drier due to climate change. In 2023, the Endangered Wildlife Trust undertook a spatial planning exercise to identify land within SWSAs that best lends itself to protected area expansion for threatened species and water conservation. In 2024, we have begun working to secure these priority areas in the Waterberg, Wolkberg, Soutpansberg, Amatholes and Drakensberg. We will present the results of this spatial exercise and our ongoing efforts to secure SWSAs with partners across the country.

60 International perspectives on acceptable forms of militarised conservation

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Target 3 of the Global Biodiversity Framework proposes more protected areas (PAs) by 2030. But critics warn that this will stimulate a proliferation of militarised strategies which could conflict with rights-based conservation. Therefore, research to identify acceptable PA management strategies that align with diverse values is imperative. We measured acceptability of militarised ranger activities among people living in the United Kingdom (UK), the United States (US), urban locations of sub-Saharan Africa (SSA) and five rural locations in SSA. Acceptability depended on the ranger activity (carrying guns, stopping and searching people, monitoring people's movements, or arresting people), the motive behind the ranger activity (protecting people from wild animals, preventing illegal grazing, preventing poaching, or preventing illegal resource harvesting) and whether the activity would occur inside or outside a PA. Acceptability was higher among respondents living in the UK, US and urban SSA, who are less exposed to the realities of militarised conservation than those from rural SSA, underscoring the need to incorporate perspectives of those most affected into conservation decisions under Target 3.

61 Re-evaluation of the River Eco-status Monitoring Programme in KZN rivers after 10 years

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Rivers are increasingly threatened by human activities, emphasising the urgent need for sustainable management and monitoring of these vital ecosystems. In KwaZulu-Natal (KZN), South Africa, the River Eco-status Monitoring Programme (REMP) has been instrumental in monitoring and assessing the ecological health of rivers in the region. As part of this programme, Evans et al. (2022) conducted a study that examined fish community structures across KZN during a severe drought. The study highlighted various challenges, such as limited species distribution knowledge and the impact of non-native invasive fish species, particularly bass (*Micropterus* spp.), on native fish populations. One key recommendation from the study was to re-evaluate fish communities in KZN rivers after several years of anticipated above-average rainfall to assess the recovery of fish species and targeted species not captured in the Evans et al. (2022) study. In response to this recommendation, REMP is undergoing a comprehensive re-evaluation after 10 years to bridge the gaps identified in the previous study, assess changes in fish communities and river health, and recommend strategies for enhancing conservation and management.

62 Evaluating diatoms, macroinvertebrates and water quality following a severe pollution event in the uMsunduzi River, KwaZulu-Natal

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Monitoring abiotic and biotic conditions to assess water quality provides a holistic approach to managing freshwater ecosystems. A mixed-product chemical spill from the Willowton Group Ltd facility in August 2019 negatively impacted the uMsunduzi River, Pietermaritzburg, KwaZulu-Natal, South Africa. We assessed the post-recovery of water quality using physico-chemical parameters and water chemistry and biotic indices quarterly to assess the water quality, including benthic diatoms and aquatic macroinvertebrates, using the South African Scoring System version 5 (SASS5). We found that water quality had improved, given the remedial assimilation of pollutants and dilution as the pollutants moved downstream, such that further downstream sites had improved significantly. The pollution-sensitive taxa (diatoms and macroinvertebrates) were starting to colonise the downstream sites, Grimthorpe (FR2) and Inkanyezini (FR3), indicating recovery in water quality.

63 Tech meets ecology: Google Street View can be used to detect and analyse the urban tree invasion of *Ailanthus altissima*

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Cities are increasingly susceptible to invasive species, with the tree of heaven, *Ailanthus altissima*, being a prominent example. However, the heterogeneous and dynamic nature of urban landscapes limits our ability to monitor and understand such invasions adequately. This study used Google Street View (GSV)

to: (i) detect *A. altissima* across different spatial and temporal contexts, and (ii) assess the tree's invasion patterns within Johannesburg, South Africa. Virtual surveys conducted on a subset of roads previously surveyed by car showed a greater (31%) probability of *A. altissima* detection on GSV images compared with field surveys (19%). Additionally, detection increased over time, with the proportion of GSV images containing *A. altissima* rising steadily from 2009 to 2023. GSV images also revealed the trees' contrasting invasion patterns, i.e., lower numbers along residential roads, characterised by solitary reproductive trees, but more common presence along major road types, facilitated by its vegetative growth and probable spread. These findings demonstrate that GSV is a useful and accessible tool for improving our knowledge of various aspects of urban invasion ecology.

64 Sustainability – mapping the impact of environmental decisions

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Sustainability is driven by decisions taken that impact the environment and society. Currently, we can use data to inform decisions or measure their impact after the environment has changed (degradation of biodiversity and ecosystems, etc.). What if we could measure the impact of our decisions before the impact is felt (before the first spade hits the ground)? This work, using the Environmental Impact Assessment decisions, shows that we can do just that. Starting in 2016, with refinement over the years, this work shows how, with the use of spatial environmental information (and others) and the location of positive and negative environmental decisions and incorporating type of development, we can inform the degree to which “decisions” are sustainable. This work does not focus on any single decision, but measures on a yearly basis the cumulative impact of all decisions. The work focuses on the Gauteng province and measures the potential impact of decisions made on biodiversity, ecosystems and hydrology. It also measures the potential impact of lost agricultural land (food security) and health impacts (proximity of development to pollution sources), thus giving a holistic overview of sustainability.

65 The elusive echo: The mystery of Africa's sparse bat fossil record

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The scarcity of bat fossils in Africa presents a significant challenge to scientific inquiry and conservation efforts. Despite the crucial ecological role bats play and their global diversity, the evolutionary history of African bats remains elusive due to sparse fossil records. Through informed speculation, this talk explores potential reasons behind this scarcity, ranging from environmental factors to the delicate nature of bat bones and limitations in fossil discovery. Addressing this knowledge gap is crucial for tracing the evolutionary trajectory of bats, understanding their historical ecological roles, and informing effective conservation strategies. This study emphasises the necessity of increased investment in African palaeontological research and the cultivation of local expertise to address this imbalance. By unravelling the mystery of Africa's bat fossil scarcity, we can enhance our understanding of these fascinating mammals and contribute to their conservation in a rapidly changing world.

66 Monitoring a polyphagous shot hole borer infestation in an urban forest using Google Street View in the city of Johannesburg, South Africa

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Google Street View (GSV) proved to be a useful method for mapping and monitoring the polyphagous shot hole borer (PSHB) infestation on plane trees in Johannesburg, suggesting that it could serve as a viable alternative to field surveys. Mapping and monitoring an invasive pest like the PSHB (*Euwallacea fornicatus*) using GSV is a cost-effective approach that can yield valuable data for urban forest management. The efficacy of using GSV imagery to map and monitor the spread of PSHB infestation on trees in the city of Johannesburg was therefore evaluated. A total of 1 137 trees were surveyed for PSHB infestation using GSV images from 2010 to 2022. A General Linear Model for binomial logistic regression showed no significant difference between field surveys and the GSV method for detecting PSHB infestation on *Platanus x acerifolia* and *Platanus racemosa*. Findings from this study showed that a PSHB infestation was present in the city of Johannesburg in 2017.

67 The ecological importance of rhino middens and hyena latrines to secondary species

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Megaherbivores (e.g., black and white rhino) and large carnivores (e.g., brown and spotted hyena) are keystone species that shape savanna ecosystems. They create and maintain communal defaecation sites for olfactory communication between conspecifics. These sites are nutrient hotspots that provide feeding and mating opportunities to several insect species, which consequently attracts a variety of secondary species. As knowledge regarding the species community at these sites is limited, this pilot study aimed to identify which species in a semi-arid system visit the sites and why. Preliminary results show that several herbivore species actively feed on vegetation around middens and latrines. Rhino middens are used by black-backed jackal, springbok and zebra for olfactory communication between conspecifics, while hyena latrines are visited by armoured ground crickets and leopard tortoises that practise coprophagy to meet nutritional requirements. Findings from this study emphasise the value of these keystone species, given their contribution to savanna biodiversity. They also highlight the species and processes that would be affected if these keystone species were to vanish.

68 The future of conservation leadership in Africa

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This research addresses the gap in conservation education and employment for youth near the Kruger National Park, South Africa. Our study revealed that four out of five local youth had never seen wildlife, due to high costs, transport limitations and historical exclusion. This disconnect leads to a lack of valuing conservation and limited access to careers in the field, resulting in few local youth becoming conservation leaders. To address this, we developed Vumba, a community-driven education system, to bridge the gap between the local workforce and the conservation industry. Vumba operates on three levels: 1) providing youth with digital access to a high quality conservation curriculum, 2) empowering nonprofits and educational institutions to measure their impact, and 3) connecting top-performing graduates with employment opportunities through an online marketplace. Launched in June 2024, Vumba currently reaches over 10 000 students and involves eight nonprofits along the Kruger National Park's western boundary. Through scaling partners across Africa, Vumba aims to educate emerging African talent and connect them to the wildlife economy, fostering a sustainable future for African people and wildlife.

69 Visitor impact on honey badgers: How this tough mustelid copes in captivity

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Natural behaviour in wildlife species is restricted in captivity. Additionally, depending on the setting, individuals may be subjected to high visitor numbers, which can result in elevated adrenocortical activity and increased stress-related behaviours. As knowledge of honey badger physiology and behaviour is limited, developing the tools to monitor welfare in captive individuals is essential. This study aimed to establish a non-invasive method for quantification of faecal glucocorticoid metabolites, as a physiological biomarker of stress, and to assess stress-related behaviours of honey badgers housed at Johannesburg Zoo. Preliminary results indicate that higher visitor numbers are correlated with an increase in faecal glucocorticoid metabolite concentrations, as well as increased stereotypical stress-related behaviours. Establishing effective methods for monitoring stress responses in captive honey badgers can be used to inform management and welfare practices in captive facilities. Additionally, information can be applied to the assessment of free-ranging populations.

70 Assessing the conservation value of South Africa's Urban Protected Areas

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Global biodiversity loss is increasing at an alarming rate, and urban sprawl exerts significant pressure on natural habitats. Urban Protected Areas (UPAs) are meant to mitigate some of the negative wildlife impacts associated with urbanisation. This study aims to evaluate the effectiveness of Urban Protected

Areas (UPAs) in Johannesburg, Durban and Cape Town for amphibian conservation. Firstly, historical frog distribution data and UPA boundaries were used to assess how well amphibian populations are represented within these protected areas. Subsequently, field surveys will target UPAs identified as having low frog representation to confirm whether they have amphibian conservation gaps, or whether frog presence within these areas is merely not reflected in existing biodiversity data. Habitat quality assessments will be conducted alongside the surveys to understand the suitability of these UPAs for frog populations. At its conclusion, the study will provide an understanding of UPA conservation value for frogs, along with recommendations for improvements.

71 The conservation and protection of biodiversity in agro-ecosystems using biological control in South Africa: Perspectives of the Integrated Pest Management research group at Stellenbosch University

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Current conventional agricultural practices and methods are placing enormous strain on conservation efforts in South Africa. Biodiversity, ecosystem functioning, food production, farm worker health, water systems and soil health are all under threat from unchecked and unregulated synthetic pesticide and fertiliser use across all crop types. In recent years, biological control and the promotion of microbial soil diversity using micro- and macro-organisms such as bacteria, fungi, nematodes and parasitoid insects to control important agricultural pests and promote plant growth through ancient symbiotic processes, has gained traction as a means of maintaining crop yields sustainably, and simultaneously protecting the environment. However, research in South Africa to understand these processes and promote biological control better, has been slow and has not been given as much attention as other areas of conservation research. Here we demonstrate the enormous potential of biological control in South Africa using native organisms, highlight research progress at the Department of Conservation Ecology and Entomology at Stellenbosch University, and discuss future needs and requirements.

72 Nature experiences, personal virtues and well-being

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Personal virtues are characteristics valued as promoting collective and individual greatness. Virtue is essential for happiness and well-being. Some factors determining a person's happiness level are those under one's voluntary control, such as the activities one chooses to engage in, such as nature experiences. These experiences may be linked to the three core elements of happiness: positive emotions (experiencing and savouring pleasures), engagement (losing the self in engaging activities) and meaning (participating in meaningful activities). Econarratives, the "stories" told by participants (n=40) of their experiences in nature, were analysed for themes to identify elicited virtues. Six virtues were identified – wisdom, courage, transcendence, humanity, justice and temperance. Visits to nature may thus contain profound eudaemonic experiences – a person visiting nature has time to reflect on life and to discover

meaning, virtues and the self. Because an individual's happiness level is determined by activities we choose to engage in, we can assume that visits to nature will play a role in the increased happiness and well-being of individuals.

73 Small mammals as an indicator of habitat change in the Kalahari, South Africa

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Small mammals (mice, shrews and sengis) are a most important component of environmental assessments and biodiversity monitoring protocols in southern Africa. They are a key component in most terrestrial ecosystems and compose a major contribution to a significant part of carnivore, raptor and reptile diets. The group understandably offers multiple advantages as bioindicators: their density and species composition react relatively quickly to environmental change, they typically are adapted for survival in relatively small areas, and “specialist” species are found in very specific environments. Small mammal community structure reflects, amongst other things, features such as habitat structure and diversity, changes in primary productivity, and disturbances such as over- and undergrazing, trampling and the presence of exotics. This contribution briefly discusses the extensive, long-term Kalahari Endangered Ecosystems Project, the aims and sampling protocol of the small mammal component, its relationship with vegetation parameters, and the results of the first four years of sampling.

74 *Eragrostis curvula* cultivars improve bacterial diversity, extracellular enzyme activities, and nutrition in grassland ecosystem soils

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The wide distribution of *Eragrostis curvula* in South African grasslands is enabled by its growth in marginal lands and tolerance to adverse environmental conditions. Though *E. curvula* cultivars have been studied extensively due to their primary use in pastures and potential utilisation as a food source, the role of *E. curvula* cultivars in soil nutrient cycling in nutrient-poor grassland ecosystems is understudied. This study investigated the effects of *E. curvula* cultivars on soil bacterial communities, associated enzyme activities, and soil characteristics in soils collected in grassland ecosystems in Heidelberg, Gauteng, South Africa. Soil bacterial communities were isolated and identified in pre-planting soils and post *E. curvula* harvest. Over four months, soil characteristics and enzyme activities were determined for pre-planting and post *E. curvula* harvest. *Eragrostis curvula* cultivars improve the bacterial diversity, associated enzyme activities, soil nitrogen concentration and pH of grassland ecosystem soils. This study's findings highlight how *E. curvula* cultivars shift the microbial profile over time while increasing pH in grassland ecosystem soils.

75 Effect of constant light on photosynthesis of Afromontane lichens

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Lichens from open habitats are exposed briefly to moderate light levels before they dry out. In contrast, “shade” lichens, e.g., those that grow on a canopy floor, will experience much lower or average light levels. While receiving less light, they are exposed to rapidly changing light levels. These brief periods when lichens are exposed to high light levels are known as “sunflecks”. The aim of the present investigation was to simulate the effects of projected climate change on Afromontane lichens by exposing thalli to long periods of moderate illumination for 3 d on photosynthetic activity. Detailed gas exchange measurements of Kershaw (1985) have shown that the photosynthetic apparatus of lichens can readily adapt to changes in light availability. More recently, studies have shown that chlorophyll fluorescence can measure a wider range of photosynthetic parameters, such as NPQ. Here we show that sun species respond to long exposure to moderate light by increasing NPQ, while for shade species already possessing relatively high NPQ, such exposure has little effect. It seems likely that a response of sun lichens to climate change in KZN will be a general increase in NPQ.

76 A rapid, affordable, non-destructive method for assessing nitrogen content of different tree species

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The SPAD-502 meter is a simple tool that measures the greenness or the relative chlorophyll concentration of leaves. The agricultural industry has made the most progress in testing the SPAD-502’s usefulness as an index of leaf nitrogen in crop species, i.e., it has been found to be useful for assessing differences in nitrogen content between individuals within a species, but it is not clear whether it can be a reliable measure of nitrogen content when comparing between different species. Eight species were selected to represent as wide a range of plant functional types found in a South African savanna as possible. Three leaf samples were chosen on each individual tree species selected, and measured using the SPAD-502. Significant differences were found between all selected species, including between the compound-leaved *Vichellia tortillis* and *Burkea africana*, as well as between the simple-leaved *Terminalia sericea* and *Ziziphus mucronata*. This study has demonstrated that the SPAD-502 meter can be used to determine leaf nitrogen in the field.

77 Developing a 30-by-30 landscape planning tool for South Africa: Balancing the need for conservation, agriculture and renewable energy

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This project aims to use best science to support decision making towards South Africa's 30-by-30 targets by considering the competing land needs for conservation, renewable energy and sustainable agriculture. We will introduce and provide an update on a national spatial plan that will consider these competing agendas and best inform their placement across the landscape. This will provide a model to achieve the national 30-by-30 targets, as well as reaching the 2030 Renewable Energy Development Goals – a critical step in allowing South Africa to reduce its national carbon footprint – with minimal impact on biodiversity, the environment and food security. Working closely with partners, we aim to use several information products related to threatened species distributions, key biodiversity areas, renewable energy resource maps, protected area expansion plans and protected agricultural land maps to inform the spatial plan, which we will ultimately make available as an interactive online tool. We also aim to provide clear guidelines for protected area expansion priorities within a multi-stakeholder landscape to assist in meeting the 30-by-30 targets.

78 Faecal survey of gastrointestinal parasites of rusty-spotted genets (*Genetta maculata*) living in two contrasting habitats

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Habitat features can influence the population and community dynamics of parasites through differences in environmental conditions across geographic areas. The primary objective of this study was to evaluate the effects of habitat differences on the gastrointestinal parasite community of *Genetta maculata*. We visited latrines to collect genet scats at Telperion Nature Reserve (Highveld grassland, Mpumalanga, South Africa) and Mbuluzi Game Reserve (Lowveld savanna, Eswatini). Faecal samples were examined in the laboratory using sedimentation and floatation techniques. Parasite eggs, oocysts and larvae were identified from their characteristic morphology. Common parasites identified included helminths (nematodes and cestodes) and protozoans. Genets from both sites hosted similar parasite communities, but parasite prevalence differed. This is likely due to habitat type differences that may enable persistence and prevalence of some parasite taxa. Latrines in cool, moist habitats may provide suitable conditions for the development of free-living larvae. Furthermore, defaecation patterns and scent-marking behaviours can influence contamination by directly transmitted parasites.

79 Unique cell lines for people and planet: Wildlife cell ranching – supporting innovation in Africa’s bioeconomy

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Climate change, natural habitat and biodiversity loss, land transformation and food insecurity threaten the well-being of Africa’s people and animals. There is a dire need to identify and implement innovative projects that mitigate against such threats, and more so, projects that at the same time have the potential to uplift people through skill development and business opportunities. Wildlife cell ranching has such a potential. In the same way that silicon (sand) is used to develop semiconductor microchips, the essential building blocks of the multi-trillion-dollar digitech industry, so cell lines are derived harm-free from wildlife and developed into sustainable, fit-for-purpose cell lines, the essential building blocks for the animal protein (cell-cultivated meat) and multi-billion-dollar biomedical industries. Cell ranching, and the follow-on agtech business opportunities, requires a multidisciplinary academic and business R&D input that will stimulate innovation that uplifts people and communities, while sustaining Africa’s valuable natural wildlife and biodiversity resources.

80 Assessing signals of mesopredator release under two apex predator regimes in Tswalu Kalahari Reserve, South Africa

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Predators influence the structure and functioning of ecosystems. The eradication of top predators causes cascading effects on biological assemblages. Mesopredator release is one such effect. The Tswalu Kalahari Reserve (TKR) provided a unique opportunity to test this hypothesis in an arid savanna, as it comprises two sections, Korannaberg and Lekgaba, under different predator management regimes. During my study, Korannaberg supported wild dogs (*Lycaon pictus*) and cheetah (*Acinonyx jubatus*) as top predators (no lions), and Lekgaba supported lions (*Panthera leo*). Both areas have similar assemblages of mesopredators and their prey. I assessed relative abundance and diversity of mesopredators and ungulates using camera traps, small mammals using live trapping transects, and birds using point counts. There were no significant differences in relative abundance or diversity of the mesopredators ($p > 0,05$), ungulates ($p > 0,05$), small mammals ($p > 0,05$) or birds ($p > 0,05$) between Korannaberg and Lekgaba. My results show no support for mesopredator release on the TKR, and they align with an increasing body of knowledge that mesopredator release may not manifest in all systems.

81 Intestinal obstruction and liver damage in *Oreochromis mossambicus*: Cause and effect?

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During the standard necropsy procedure of an experimental group of *Oreochromis mossambicus* that had been chronically exposed to cadmium chloride, one fish was found to have a sizeable intestinal blockage after ingesting some silicone lining from its tank. That same fish also was found to have a liver in terrible condition, even compared with the fish from the same group. Morphological and histological examinations of the relevant liver were done to investigate a possible link between the intestinal blockage and the liver condition. Widespread microvesicular and macrovesicular steatosis was observed in the liver histologically. This indicated possible malnutrition, as a lack of protein, in particular, has been shown to limit lipid processing within the liver and can cause steatosis. This case shows possible harm to fish and other organisms that encounter intestinal blockages from ingesting plastics and other items polluting the environment due to anthropogenic activities.

82 Quantifying the cultural value of birds across the urban and socioeconomic landscapes of South Africa

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Urban landscape structure and socioeconomic status significantly impact bird community structures. This can lead to an “extinction of experience” by altering human-nature relationships and cultural values associated with these species. Using a novel Cultural Ecosystem Services Index (CESI), we investigated influences of urbanisation and socioeconomic status on the accessibility of avian cultural ecosystem services within South Africa. The CESI combined bird likeability scores with the probability of species occurrence within urban landscapes, drawing from bird observation records from the SABAP2 citizen science project and accounting for climatic influences on species distributions for our selected bird species. Our CESI represents a spatially explicit measure of cultural ecosystem services across a country-level urban and socioeconomic gradient. The CESI showed variation along these gradients, where high-urban-high-income areas host birds with higher CESI scores compared with low-urban-low-income areas. Patterns of CESI may be context-specific, with urban landscapes, income status and personal experience influencing individual cultural perceptions of ecosystems and their services.

83 Trade under the CITES lens: Uncovering the sungazer lizard market

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The illegal wildlife trade targets thousands of species and is considered a major threat to species survival globally. With exotic pets making up the highest proportion of live animal trade, certain species have been commercially bred in captivity successfully. Wild specimens are still sought after for species such as the endemic South African sungazer lizard (*Smaug giganteus*). This species is popular within international trade, having the highest market value of all Cordylidae exported from South Africa. Most sungazers are legally exported under the source code “captive-bred”, but there are only three recorded captive breeding events internationally, suggesting wildlife laundering. Evidence shows that multiple countries outside of its natural range registered more legal exports than imports. There is no evidence for legal imports of *S. giganteus* to Congo, but in 2013, 10 wild-caught animals were exported to Korea. In 1983, Germany exported *S. giganteus* to Italy, but the first legal export of the species from South Africa was only in 1990. This behaviour has raised concern as to how countries attained these specimens with no evidence of legal movement out of their natural range.

84 Nutritional value of food products fortified with edible insects: A systematic review

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Edible insects have been recommended and promoted by the Food and Agriculture Organization (FAO) as sustainable protein and food sources which can assure food security. This review aimed to evaluate the effect of enriching common food products with edible insect meal with regard to nutritional composition and consumer acceptability. We systematically searched Web of Science, Google Scholar and Scopus to retrieve literature on food products fortified with edible insect meal across the world. Our search resulted in 61 eligible papers, which listed 26 insect species that are incorporated into 12 different food products. Compared with the control (0% edible insect meal), the food products enriched with edible insect meal contained double the quantity of protein, iron and zinc. However, the carbohydrate concentration decreased by one third with the addition of edible insects. Pastry products are mostly used for masking the insect component and increase acceptability.

85 *Cannabis* tissue culture chronicles: Cultivation challenges and optimisation of tissue culture protocols for improved growth and compound biosynthesis

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This systematic review focuses on the vital role of developing effective and consistent tissue culture methods for advancing *Cannabis sativa* production. The goal was to gain an in-depth knowledge of the advantages and disadvantages of using plant tissue culture techniques for *Cannabis sativa*. The review includes quantitative research on *Cannabis sativa* L. tissue culture, with topics including

micropropagation, protocol optimisation, in vitro propagation, clonal propagation and the application of plant growth regulators. The inclusion criteria were stringent, excluding studies deemed out of scope or lacking measurable results regarding tissue culture, propagation or plant growth regulators in *Cannabis sativa* L. Identification of relevant studies utilised specific search terms in databases like Google Scholar, EBSCOhost, PubMed and Scopus. The review rigorously evaluated the risk of bias in in vitro studies using the QUIN tool. Ultimately, this pioneering review, encompassing 28 selected studies, offers a comprehensive exploration of global *Cannabis sativa* tissue culture, tackling issues such as the absence of standardised protocols and genotype-specific challenges.

86 Are the labels on commercial honey and beeswax deceiving you?

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Honey adulteration has been practised for many centuries and is achieved in three main ways: directly by the addition of sugar syrups to increase sweetness, indirectly by feeding bees with industrial sugars and chemicals to increase honey production, and through blending (mixing of honeys of different qualities). Another beehive product that is a subject of adulteration is beeswax. Adulterated beeswax influences the composition of honey. Pesticides lead to the contamination of honey and beeswax directly (treatment of beehives with pesticides) or indirectly (pesticides that are spread in the environment are transported by the bees back to their hive). The aim of this study was to develop fingerprints and chemical profiles for commercial honey and beeswax, as well as to detect contaminants and adulteration. Four extraction and sample preparation methods were used: Solvent Extraction, Solid-phase Extraction, Quick Easy Cheap Effective Rugged and Safe, and Solid-phase Micro Extraction. Thereafter, Gas Chromatography (GC) and GC–Mass Spectrometry (GC–MS) were used to determine the profile of the honey and beeswax extracts as well as the contaminants therein.

87 Empowering young people to be environmental stewards: Using the theory of engagement in a South African capacity building initiative

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Environmental degradation continues to receive urgent attention from environmental scientists, with calls to establish effective, meaningful ways of protecting biodiversity. Additionally, there is a growing movement to incorporate perspectives from youth and local and indigenous groups, whose voices typically receive less recognition as environmental stewards. Since youth have received significant attention as agents of change for environmental issues, the theory of engagement was used to frame this study of a South African capacity building outreach in the Greater Kruger region of South Africa. The research aim was to explore the influence of an outreach working within historically marginalised communities by teaching youth about conservation through building photographic skills. Photovoice and thematic analysis guided the exploration of the participants' experiences. Key themes of exclusion, long-term engagement, representation and the importance of skills development were raised. The outreach's aims and activities offer important lessons for youth initiatives working on environmental issues.

88 The Shangani Holistic Nkone

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The Nkone breed embodies more than just its physical characteristics; it symbolises a profound intersection of cultural heritage, economic viability and environmental sustainability. Rooted in rich history, it serves as a lead to our African ancestry, reminding us of our societal roots. Beyond its historical significance, the Nkone breed also offers a unique opportunity for fostering sustainable livestock enterprises, given its remarkable performance in various contexts. This abstract captures the knowledge and insights derived from hands-on experience with Nkone cattle. At Shangani Holistic, the primary focus areas are fertility and carcass traits, both of which serve as indicators of the resilience and adaptability of the breed. Our strategies include stringent selection, introduction of new genetic lines, meticulous culling practices and comprehensive record-keeping. The outcomes have shown positive trends, with significant improvements observed in the overall herd performance. A combination of practical and empirical observations provides valuable guidance for livestock practitioners aiming to optimise the potential of Nkone cattle.

89 Value chain enterprise networks: Opportunities and challenges in the African game/wild meat sector

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The growing interest in the value chain of African wild meat, particularly concerning ungulate species, represents a significant area of both enterprise opportunity and challenge. This study dissects and unpacks the intricate network of potential business ventures within the game/wild meat production value chain. A systematic review of literature and empirical evidence was conducted to assess value chain stages – from production, sustainable sourcing and processing, to distribution/marketing and final consumption – to unpack the complex, multifaceted dynamics that characterise the industry. Atlas Ti version 8.1 was utilised to facilitate the thematic assessment and create network diagrams of potential business ventures. The study demystifies existing and potential wild meat and associated business opportunities and facilitates participation and entry of entrepreneurs in the wild meat sector. The findings are expected to provide a roadmap for stakeholders, including local communities, conservationists, entrepreneurs and policymakers, offering insights into optimising the value chain for enhanced economic benefits while ensuring the preservation of Africa's rich biodiversity.

90 Domestic biogas technology role in achievement of the Sustainable Development Goals: Evaluation and challenges in rural areas of Limpopo

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Domestic biogas technology will play a significant role in achieving several Sustainable Development Goals (SDGs). The world faces unprecedented human development and growth, and human activities expand to all the environmental elements. However, natural resources and human activities must be managed responsibly and sustainably to preserve nature and human life. To control climate change, there is a need to transform fossil energy quickly into clean, sustainable and renewable energy resources. Therefore, this paper covers a detailed explanation of how biogas technology contributes to achieving SDGs in rural areas. Most earlier studies focused on improving biogas technology and linking biogas to a specific SDG. Moreover, most earlier studies still need to propose a method or guideline to enhance the contribution of biogas to the SDGs. Therefore, this work aims to analyse biogas's technology contribution to all the related SDGs, i.e., SDGs 1, 2, 3, 5, 7 and 13, and propose a set of indicators to improve the contribution of biogas in achieving them.

91 The wax and wane of African phytobiomes and ecotones in future climates

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Climate change is anticipated to alter phytobiome characteristics through compositional shifts. These changes are posited to become most pronounced at their boundaries, termed ecotones. To gain a more nuanced understanding of the spatial structures and complexities of the phytobiomes and ecotones in future climates, we utilised a species dataset of more than 23,000 plants in mainland sub-Saharan Africa to present a more holistic assessment of the effects of climate change for the periods 2050 and 2070. Relying on modern-day machine learning techniques and spatial analytics we show that even with modest climate change, phytobiomes in Africa may undergo compositional changes. A greater reliance in fossil fuels could result in aridification in southern Africa, probing range expansions of desert phytobiomes. African rainforests may be resilient to climate change, whereas grasslands in South Africa already under duress could face a continued threat. At the ecotones, we can anticipate gradual transitions of the phytobiomes, structured largely by mean annual precipitation, the geographic extent of adjacent phytobiomes and the length of ecotones.

92 What works against rhino poaching and how much does it cost?

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⁹ Mala Mala Game Reserve

¹⁰ Sabi Sand Nature Reserve

¹¹ Balule Nature Reserve

¹² Timbavati Private Nature Reserve

¹³ Klaserie Private Nature Reserve

¹⁴ Umbabat Private Nature Reserve

¹⁵ Karingani Private Nature Reserve

¹⁶ Thornybush Private Nature Reserve

Poaching continues to drive declines in African rhino populations, despite decades of conservation efforts. We used five years (2017-2021) of data to disentangle multi-layered relationships between poaching and anti-poaching interventions across 11 South African reserves (together protecting the world's largest rhino population). Although ~\$76 million was invested in their protection, 1 734 rhinos (~37%) were poached. Proactive horn removal to reduce poacher reward was associated with significant reductions in poaching. Most other interventions focused on apprehending poachers (such as AI cameras and tracking dogs), helping achieve numerous arrests, but greater intensity of these interventions was not associated with reduced poaching. Detecting and arresting poachers is critical but not enough to subvert wildlife crime when consumer demand, socio-economic inequality and corruption combine to incentivise even high-risk poaching.

93 Epidemiology and diversity of gastrointestinal tract helminths of wild ruminants in sub-Saharan Africa: A review

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The review summarised studies reporting on the distribution, diversity and prevalence of GIT helminth infections in wild ruminants in sub-Saharan Africa. The key findings: 109 GIT helminth species/complexes were recorded across 10 countries, with South Africa reporting the highest number. Gastrointestinal nematodes were the most prevalent, with 88 species or complexes reported from 30 wild ruminant species across eight countries. *Trichostrongylus* and *Haemonchus* were the most widely distributed genera. Fifteen GIT trematode species or complexes were reported from seven countries, with *Paramphistomum* and *Calicophoron calicophoron* being the most common. Six GIT cestode species or complexes from

one family were found in 14 wild hosts across seven countries, with *Moniezia* spp. being the most widely distributed host range geographically. Impala, nyala and greater kudu harboured the highest number of GIT nematodes, trematodes and cestodes, respectively. The prevalence ranged between 1,4-100% for nematodes, 0,8-100% for trematodes and 1,4-50% for cestodes. Findings indicate that wild ruminants are infected by a wide range of GIT species of conservational and zoonotic importance.

94 Feeding through the ages: Revisiting the diet of meerkats

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We investigated the diet and feeding behaviour of the meerkat (*Suricata suricatta*), a group-living mongoose, over one year in the southern Kalahari. Insecta constituted the highest percentage of prey eaten (88.4%), followed by Arachnida (5.7%), Diplopoda (4.3%), and Reptilia (1.1%). Within Insecta, Coleoptera (70.4%) was the most dominant prey order, followed by Lepidoptera (7.5%), and Hymenoptera (5.4%). There was seasonal variation in the diet of meerkats, with the three main Coleoptera families eaten year-round by meerkats, and with a higher consumption of Coleoptera adults in the wet season than in the dry season. We found that old adult meerkats (> 24 months) ate the most large and medium-sized prey, while sub-adults (6-10 months) had a higher prey count of small adult Carabidae beetles. Yearlings (15-24 months) had the highest percentage of Hepialidae caterpillars in their diet. Whether the high representation of Coleoptera in the diet reflects dietary opportunism associated with their relative abundance, or specialisation in the meerkat diet regardless of abundance, remains to be determined. The findings contribute to our understanding of meerkat diet ecology and highlight the importance of age-related differences in prey consumption.

95 Diversity, composition and distribution patterns of spiders in sand forest, savanna and an ecotone in Phinda Private Game Reserve, South Africa

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Spiders are the dominant representative of the top predator guild in many terrestrial ecosystems, but their diversity and distribution in forests in South Africa are still understudied. This study aimed to determine ground-dwelling spider diversity, composition and distribution patterns in both sand forest and savanna (and their ecotone) using pitfall traps, and to provide a spider species checklist for these three habitats in Phinda Private Game Reserve. A total of 410 individuals from 64 species and 20 families were recorded from the three habitat types. The Lycosidae family and *Pardosa* sp. were the most dominant family and species. Spider abundances were similar between sand forest and the ecotone, but lower in savanna. However, species richness was similar across habitats. Spider species assemblages were similar between sand forest and the ecotone, but differed from the species assemblages in savanna. The structure of the sampled habitats may influence spider diversity and distribution in Phinda Private Game Reserve.



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