22nd Savanna Science Network Meeting

02 – 06 March 2025
Skukuza
Kruger National Park

South African National Parks Scientific Services

Sunday – 2 March 2025	
Registration **14:00 – 17:00**	**Nombolo Mdhluli Conference Centre, Skukuza** *Keys for SANParks accommodation that have not been collected by 17:00 will be left at the Skukuza Camp reception.* *Normal camp reception hours apply.*
17:30 – 19:00 Pre-Conference Mixer @ Skukuza Safari Lodge Welcome drink & snacks (with an additional cash bar) **No dinner is provided on this day.**	

Monday – 3 March 2025			
07:30	**Opening & Welcome**		
07:40	**Housekeeping**		
The value of small vertebrates – knowledge gaps and understanding the factors that structure savanna assemblages			
Sharon Thompson	**Drivers of small mammal communities**		
	07:45	Robert McCleery	Megaherbivores Facilitate Large Grazing Herbivores and Suppress Small Mammals Through Vegetation Structure and Cryptic Pathways
	07:55	Alex Carey	Small mammal responses to fire: genetic insights from a fire experiment on the Tiwi Islands
	08:00	Luciana de Oliveira Furtado	Impacts of woody encroachment and prescribed fire on small mammal communities in a tropical Savanna: contributions for conservation through fire management
	Poster	P J Jacobs	Small mammal responses to climate change: implications for savanna assemblages
	08:10	**Question & Answer session**	
	Small vertebrate diversity in Savannas		
	08:20	Dan Parker	Using acoustic monitoring to assess insectivorous bat richness and activity in a sub-tropical savanna
	08:25	Venessa Motlale	The biodiversity of anurans in ephemeral pans in Kruger National Park varies with climate.
	08:35	Ana Paula Carmignotto	Drivers of Vertebrate Diversity in the Cerrado and Directions for Conservation
	08:40	Bruna de Franca Gomes Gomes	Direct and indirect effects of prescribed fires on small vertbrates in the Brazilian Cerrado
	Poster	Marcio Martins	Effects of woody encroachment on the diversity of frogs and lizards in the southern portion of the Cerrado in Brazil
	Poster	Nina Kruse	Murid rodent haemoparasite prevalence and diversity across an anthropogenic gradient in the Greater Kruger, South Africa
	08:45	**Question & Answer session**	
	Drivers of bird communities		
	08:55	Sharon Thompson	Mirror Mirror on the Wall: Reflecting on 30 years of avian monitoring and research in the Kruger National Park
	09:05	Lucy Kemp	Expanding the potential of the Lowveld for Southern Ground-hornbill conservation
	09:15	Andrew McKechnie	Combined impacts of rising temperatures and humidity on mesic savanna and forest birds
	09:25	Rion Lerm	Bird communities show resilience to the recent extreme drought in KNP
	09:35	Veronica Kucminova	Seasonal variations in bird community structure between wet and dry savanna in Limpopo region, South Africa
	09:40	Mduduzi Ndlovu	Diversity and host specificity of avian haemosporidians in a Afrotropical savanna conservation region
	09:45	**Question & Answer session**	

10:00	**Tea**		
Walking the mammalian tightrope – balancing cost and benefits			
Sam Ferreira	**Letting the elephant out of the room**		
	10:30	Sam Ferreira	Running the gauntlet of honest elephant management
	10:45	Adrian Shrader	Despite potential risks African elephants do not always avoid mountaineering
	11:00	Ryan Huang	Designing Landscapes of Mixed-Uses for Near Zero Elephant Metapopulation Growth
	11:15	Bob Mandinyenya	Differences in habitat use and home ranges by savannah elephants in and outside of Gonarezhou National Park, Zimbabwe
	11:30	Rumbidzai Pamela Magwiro	Human elephant conflict in communities around Gonarezhou National Park, Zimbabw
	11:35	Michelle Henley	Strategies to move human-elephant-conflict to human-elephant-coexistence
	11:50	Michael Clinchy	Deterring elephant impacts by exploiting their demonstrated fear of the human “super predator”
	12:05	Ryan Helcoski	Revisiting the dead: Elephant behavior plays a major role in megacarcass bone distribution
	12:10	Corli Coetsee	A multifaceted approach to identify high elephant impact areas in Kruger National Park
	12:25	Robert Fletcher	Kruger elephants on the move: Predicting benefits and risks
	Poster	Simon Chamaaile-Jammes	Heterogeneity-based elephant management: time for some temporal dynamics?
	12:35	**Workshop & Brainwording**	
13:00	**Lunch**		
Khensani Nkuna	**Invertebrate Drivers**		
	14:00	Lucy Wilson	Termite mounds as refugia for plant communities under varying disturbance regimes
	14:10	Allan Andersen	Active management of pyrodiversity is not required for maintaining ant diversity in an Australian tropical savanna
	14:25	Barbara van Asch	Genetic profiling of Gonimbrasia belina populations in South Africa and Botswana support concerns over the sustainability of the mopane worm harvesting and trade
	14:40	Damien Gergonne	Genetic diversity of Macrotermes termites in Namibia: an update six decades after the National Survey of Isoptera of Southern Africa
	14:55	Tarombera Mwabvu	A millipede (Diplopoda, Spirostreptida)-mite (Acari, Mesostigmata) association in the savanna: More mites are on males
	Poster	Minenhle Ngcobo	Hidden Architects: Contributions to Ecosystem Resilience through Termite Ecology
	Poster	Tristan Charles Dominique	Does it make a difference for plants whether the herbivore has four or six legs? Is there such a thing as a five-legged herbivore?
	Poster	Jack Jansma	The gut microbiota of dung beetles as indicators for biodiversity and environmental quality

	Savannas through time - the role of soils and soil biota		
	Poster	Jussi Baade	Status of ongoing soil moisture measurements in contrasting landscapes across South Africa
	15:10	Kgothatso Mabusela	Effects of woody plant encroachment on soil physicochemical properties and microbial communities in a savanna ecosystem
	15:20	Nathan Lemoine	The dirt on elephants: legacies of megacarcasses on belowground ecosystem function in Kruger National Park
	Poster	Rowan Walker	Intrusion mechanism and magma differentiation of the Timbavati Gabbro
	15:30	Urs Krueter	The Grazing Implementation Index: Quantitatively Integrating Management Factors That Influence Grazing Intensity Across Spatiotemporal Scales
	15:40	Lea Nosalova	Soil microbial diversity across savanna ecosystems: a first worldwide assessment
	Poster	Jussi Baade	Towards a new assessment of RUSLE sheet and rill erosion for the Kruger National Park
16:00 – 18:00 POSTER SESSION with Cheese and wine Nombolo Mdhluli Conference Centre			

Tuesday – 4 March 2025

Dumisani Khosa	**From Source to Sea: Integrated Management of Freshwater Ecosystems**		
	E-flows and Water Resources Management		
	07:30	Gordon O'Brien	Sustainable management and protection of vulnerable African water resources through holistic environmental flow framework determination and implementation.
	07:40	Amina Price	Conceptualising flow requirements for fish recruitment in the Murray-Darling Basin.
	07:50	Karen Bradshaw	Using an agent-based model to inform equitable water usage amongst stakeholders in the Koue Bokkeveld catchment.
	08:00	Troy Meston	Integrating First Nations Water Management Sciences for Climate Resilience across the Water Resources of the Murray-Darling Basin: Australian lessons for international source to sea sustainability.
	08:10	Cesária Huó	The 1st joint basin survey at Limpopo River Basin, gathering data for a sustainable water management.
	Migrations		
	08:20	Angelica Kaiser-Reichel	Multiple stressors including barriers affecting fish migrations in the of the Limpopo Basin, a Source to Sea approach.
	08:30	Vi An Vu	Migrations of giant pangasiid catfishes in the Mekong and Ayeyarwady Rivers, Asia.
	08:40	Lee Baumgartner	Drugs, Guns, and Eels: The Global Decline of Anguillid Eels in East Africa and Beyond
	08:50	Matthew Burnett	The migration of aquatic macrocrustaceans over an artificial barrier in the uThukela River, South Africa.
	09:00	Zain Armien	The Impact of Anthropogenic Barriers on Fish Communities in the uMkhomazi River, South Africa.
	Aquatic Biodiversity and Monitoring		
	09:10	Annelize van der Merwe	Source to sea management considerations of the fishes of the Incomati Basin, southern Africa.
	09:20	Margaret Swift	The present and future of ephemeral freshwater in the Kavango-Zambezi Transfrontier Conservation Area
	09:30	Marcel Kruger	Assessing the Conservation Status and Occurrence Records of Sub-Saharan African Freshwater Molluscs: Gaps and Patterns
	09:40	Nicholas Mandrak	Sampling freshwater fishes in dangerous waters
	09:50	Purvance Shikwambana	Risk Assessment of Microplastics in Major Rivers in the Kruger National Park, South Africa
10:00	**Tea**		
	10:30 - Photo in the parking lot in front of the conference centre		
Dumisani Khosa	10:55	Dumisani Khosa	Rapid establishment and impact assessment of the Redclaw crayfish invasion across the Kruger National Park's major river systems
	11:05	Steven Khosa	Characterisation of wetlands on various landscapes in Marakele National Park, Limpopo Province, South Africa.
	11:15	Nikisha Singh	Testing different means to assess KNP's frog diversity and a discussion of conservation outlook

	Poster	Angelica Kaiser Reichel	Seasonal river in the Kruger National Park contributions to fish communities and migrations.
	Poster	Mmathapelo Fumo	Diatoms as bioindicators of water quality in KNP rivers
	Poster	Josephine Pegg	Do we know enough to make management decisions for Krugers' stillwaters?
	11:20	Dumisani Khosa	Sustainable African Rivers Initiative
Large and largely unexpected patterns in vegetation over time			
Savannas through time			
Corli Wigley-Coetsee	11:30	Mariska te Beest	How do we define and measure ecosystem resilience in savannas?
	Climate change and veg change		
	11:40	Liam Reynolds	Encroaching species are stronger anisohydric "water spenders" under elevated CO2 conditions: Implications for savanna seedling establishment rates
	11:45	Joshua Weiss	Rainfall, peak river flow and flow variability drive spatiotemporal change in the extent of riparian woodland in an African protected area savanna
	11:55	Kimberley Simpson	CO2 fertilization of C4 grasses across experiments, field observations, and models
	12:05	Sarah L Raubenheimer	Competition Mediates CO2 Fertilization Effects in Grassland and Savanna Ecosystems
	12:15	Jonas Trepel	Atmospheric nitrogen deposition and large herbivores shape woody cover change
	12:25	Davi Rossatto	Leaf tolerance to heat on savanna species: what we known and what is missing
	Baobabs		
	12:30	Liam Joseph Taylor	Baobabs (and canaries) in the coal mine: indicators of large-scale tree mortality and avian population threats from an increasing elephant population
	Poster	Steven Khosa	What is the fate of baobabs in our National Parks and what can be done about it? A case study from Mapungubwe
	12:40	Stephan Woodborne	The demise of the Shimuwini baobab in the context of baobab adaptation and climate change
12:50	**Lunch**		
Corli Wigley-Coetsee	**Savannas through time - patterns and drivers of vegetation**		
	14:00	Sally Archibald	Rebranding "sustainable" wood fuel harvesting by estimating historical elephant treefall rates across Africa.
	14:10	Tony Swemmer	Long-term demographic study reveals key role of elephants, and limited impact of drought, in regulating tree abundances in semi-arid savannas in South Africa.
	14:20	Tyler Coverdale	Structural and compositional responses of savanna trees to megaherbivore reintroduction following two decades of experimental exclusion
	14:30	Adam Devenish	Assessing vegetation change in Madagascar's grassy ecosystems: Implications for biodiversity and carbon storage
	14:40	Fabio Attorre	Woody vegetation dynamics in a protected African savanna: insights from vegetation resurvey of the Gonarezhou National Park, Zimbabwe
	14:50	Matilda Mbazo	Quantifying the effects of multiple disturbances on woody plant density in a Marula-Knobthorn savanna
	15:00	Evan Hockridge	Mutualisms as a mechanism of woody encroachment in Congolese savannas

Invasive alien species as a global change driver – from beyond parks to within			
Llewellyn Foxcroft	15:10	Llewellyn Foxcroft	Alien plant invasions in the Kruger National Park: dynamics and impacts
	15:20	Maarten Trekels	AlienRoE: a software package to report on the CBD Target 6 headline indicator
	15:30	Mukhtar Muhammed Yahaya	A workflow for impact indicators of invasive alien species on South African protected areas as case studies

17:00 – 18:30 Rapid Research Rendezvous

18:30 Dinner – Build-a-Burger (Cash bar)

Nombolo Mdhluli Conference Centre

Wednesday – 5 March 2025

Translating science – Moving research outputs to conservation products			
Chenay Simms	07:30	Jody Vogeler	Savannas from space: Informing landscape conservation with remote sensing
	Mapping the Shifting Landscape: Remote Sensing for Monitoring Large-Scale Processes		
	07:50	Randall Boone	Projecting the Future of African Rangelands under Changing Climates using the Af-Range Ecosystem Model
	08:00	Gladness Khoza	Forage Biomass Estimation and Grass Species Composition: A Comparison Between Protected Areas and Communal Grazing Systems Using Machine Learning and Remote Sensing
	08:05	Christiane Schmullius	Spatio-temporal monitoring of vegetation structure and surface moisture within four SANParks regions: Result Updates from Sentinel-1 and -2 Time-Series since 2015
	08:15	Simbarashe Jombo	Modelling above-ground biomass in a semi-arid Mokala national park using earth observation satellite data
	08:20	Reneilwe Maake	Boosting above-ground grass carbon stocks predictions: A multi-parameter coalescing approach
	08:25	Sarah Daly	Patterns of Hydrologic Changes in the Kruger National Park; a Remote Sensing Perspective
	Poster	Christiane Schmullius	Towards Operational Surface Moisture Monitoring with Sentinel-1 in Kruger National Park - Comparison of Six Years of In-Situ Soil Moisture Measurements at Lower Sabie with a Radar Moisture Index, NASA SMAP, ESA SMOS and ESA CCI Soil Moisture Products
	Science-Driven Conservation: Turning Knowledge into Actionable Products		
	08:30	Judith Botha	Consolidating biodiversity occurrence data from different sources to assist conservation decision making.
	08:45	Ritwik Kulkarni	End-to-End Pipeline for an App-Based Machine Learning Tool to Identify Illegal Wildlife Products derived from Ivory, Pangolin Scales and Tiger parts
	08:55	Nicolas Derek Prinsloo	Simulating Photogrammetry of Bird Flight Height to Assess its Accuracy: Through Drone Flight and Computer-Generated Imagery
	09:00	Heather Woollon	Off-road driving: Translating Science into a User-Friendly Format for More Effective Dissemination of Information and Implementation of Responsible Off-roading in Protected Areas
	09:10	Kath Thompson	Pathways and Patterns: Trailblazing elephants and the key landscape features that shape connectivity in Southern Mozambique
	09:25	Annelize Steyn	Saving large trees: to wrap, or not to wrap?
	09:30	Gareth Tate	An eye in the sky: Early detection and rapid response to illegal trade-related wildlife poisoning through the Kruger National Park and broader Great Limpopo Transfrontier Conservation Area.
	Poster	Justine van Heerden	The practical application of the HARP Travelling Museum design: Creating an interactive and informational visitor experience
	Poster	Riani Nieuwenhuis	Available Management Tools, Translating science – Moving research outputs to conservation products
	Poster	Tim Coulson	Why Conservation Often Fails and What This Tells Us
	09:45	**Panel discussion**	
10:00	**Tea**		
Savanna conservation in the age of Artificial Intelligence			
Judith Botha	10:30	Tercia Strydom	Imagining the future of conservation in an AI-driven world: Opportunities and Challenges
	10:45	Declan Hofmeyr	AI or EINA! Are we still driving the tech train, or have we fallen asleep at the wheel?
	11:00	Dane Brown	Penguin Monitoring: Can Transfer Learning Facilitate Context-Agnostic Detection?

	11:15	Theresa Gotz	Exploring AI-developed algorithms to predict elephant movement in a changing climate
	11:25	Minke Els	Testing artificial intelligence's ability to correctly identify elephants and open gates to facilitate elephant movement
	11:35	Paul Allin	Above and beyond the helicopter; using remotely sensed imagery and machine learning to improve the accuracy and precision of wildlife aerial censuses in African savannas
	11:45	Simon Chamaaile-Jammes	Using animal-borne acoustic loggers and deep learning approaches to reveal fine-scale lion behaviour
	Poster	Simon Chamaaile-Jammes	DeepFaune Africa: automatic species classification of large mammals in camera-trap pictures, on your desktop
	11:55	Bettina Schroeder	AI annotation software can ensure compliance of the data protection regulation and improve work efficiency: Examples from two European camera trap projects
	Poster	Dane Brown	Accurate Fish Detection with Oriented Bounding Boxes: A Step Towards Automating Freshwater Monitoring
	12:00	**Interactive Question/ Answer session**	
12:35	**Lunch**		
Savannas through time - as shaped by fire			
Tercia Strydom	14:00	Tsumbedzo Ramalevha	Resilience of herbaceous communities to disturbance: The importance of belowground bud bank and bud-bearing organs in an African savanna
	14:10	Alexander Christianini	The interplay between fire and microhabitat cover drives seed predation in savanna and gallery forests in Brazil
	14:20	Kevin Wilcox	Navigating Extremes in Savannas (NExS): Early results from a co-occurring extreme experiment exploring the consequences for biodiversity at multiple hierarchical scales
	14:25	Tara Massad	Beyond big mammals: How fire and herbivory affect savanna biodiversity broadly
	14:35	Andrew Davies	Fine-scale variability in fire properties interacts with abiotic and biotic drivers to shape savanna vegetation structure and spatial patterning
	14:45	Celeste Mare	Contrasting consumers: Insights from a targeted approach to plant functional traits related to fire and grazing
	14:55	Ricardo Holdo	Does fire reinforce or dilute discontinuities in woody cover?
	15:05	Kalea Nippert	Is extreme fire the key to reversing woody encroachment? A test in the tallgrass prairie.
	15:15	Sivuyisiwe Situngu	Unexpected patterns: Bacterial and Fungal communities are resilient to fire in Savanna systems
	Poster	Sophian Ronan	Extreme fire in a savanna ecosystem: initial grass mortality responses from a simulated fire experiment in Kruger National Park
	Poster	Tercia Strydom	Experimental burning effects on selected soil chemical properties in a semi-arid African Savanna
	15:25	Vania Regina Pivello	The Evolution of Fire Management in the Brazilian Savannas: Integrating Science, Traditional Knowledge, and Policy
	15:35	Riley Wadehra	The effects of fuel moisture of live, senescing, and dead fuels on fire spread in a South African savanna
	Poster	Yani Steyn	Fire's Role in Shaping Savanna Soil Seed banks: Viability and Dormancy Breakthroughs

18:30 – 22:00 Dinner @ Skukuza Golf Club (Own Transport)
Cash bar

Thursday – 6 March 2025

Nikisha Singh	**Savannas through time - dynamic plant responses**		
	08:00	Caroline Lehmann	Quantifying floral diversity in savannas to improve understanding of ecosystem change
	08:10	Emily Wedel	Intraspecific variation drives grass and forb responses to herbivory and rainfall
	08:20	Jakub Wieczorkowski	Madagascar's open ecosystems: patterns of orchid diversity in space and time
	08:30	Jess Rickenback	Herbaceous species responses to tree cover differ by functional group in Southeast Asian savannas
	08:40	Liezel Retief	Nursing the Swazi Lily or throwing shade? Assessing plant-plant interactions between Euclea divinorum and Adenium swazicum in Kruger National Park
	08:45	Nicholus Russo	Seed dispersal to canopy gaps in the Congo Basin and implications for grassy ecosystems
	08:55	Rodrigo Béllo Carvalho	The Role of Megafauna in Seed Dispersal Networks: Insights from Neotropical Savannas and Future Comparisons with African Savannas
	09:00	Courtney Reed	Effects of elephant carcasses on plant communities in Kruger National Park
	09:10	Rosalie Terry	Rethinking grasslands: A synthesis of 252 grassland and savanna sites investigating grass and forb composition and its response to grazing
	Poster	Shelby Williford	Navigating Extremes in Savannas (NExS): How do plant traits alter the effect of global change drivers on ecosystem function?
	Poster	Evan Foster	Population responses of congeneric, range-limited plants to rainfall and herbivory gradients in a Kenyan savanna
	09:20	Peter Scogings	Traits enabling woody plants to persist under large (and largely unexpected) changes in herbivory in savannas
	09:30	Susan Eshelman	Malagasy Grass Flora Dynamics: An Exploration of Environmental Influences on Grassy Functional Traits
	Savannas through time - future distribution		
	09:35	Greg Kiker	Savanna Landscape Engineering: What forms are possible or desirable in an uncertain future?
	09:45	Marco Wolsza	Modelling savanna vegetation structure using Synthetic Aperture Radar and spaceborne lidar: A case study in Kruger National Park, South Africa
	09:50	Samista Rooplal	Assessing the current distribution and predicting the future distribution of the vulnerable Warburgia salutaris under different climate change scenarios in South Africa
	09:55	Vernon Visser	Help us map change in ecological condition in South Africa's savannas.
	10:00	Thabang Maphanga	Bush encroachment with climate change in protected and communal areas: a species distribution modelling approach
	10:10	**Tea**	
Louise Swemmer	**Building sustainable connections to the natural and cultural heritage inside parks**		
	10:40	Louise Swemmer	Session introduction and overview
	10:45	Tim Forssman	Revisiting Thulamela: an ancient southern African kingdom
	10:55	Chante Barnard	Southern African trade networks: Forager participation at Little Muck Shelter, Mapungubwe National Park

	Poster	John Roff	Telling the stories in the stones - making Geoheritage in the Savannah Biome culturally relevant
	11:05	Louise Swemmer	Natural resource use in protected areas – 30 years of transforming policy and practice in SANParks
	11:15	Justice Muvengwi	Illegal hunting and bushmeat trade in a semi-arid savanna: implications for conservation
	11:25	Tim Kuiper	Rhino poachers exploit space-time variation in opportunity and risk
	11:35	Siboniso Thela	Activity patterns of wildlife along the Phalaborwa – Hoedspruit railway line in Balule Nature Reserve, South Africa
	11:40	Andrew Abraham	The uncertainty of large animals as a trustworthy climate solution
	11:50	Montagu Murray	Improved household waste management as an opportunity to add value to protected area conservation
	11:55	Zingfa Wala	A Kruger micro-experience: Microplastics concentration and movement in a protected terrestrial landscape.
	12:05	Jesse Nippert	A critical zone assessment of bush encroachment in grassy social ecological systems
	12:15	**Lunch**	
Sam Ferreira	**Walking the mammalian tightrope – balancing cost and benefits**		
	13:30	Michael Scantlebury	Movements and behaviours of lion in the Kgalagadi
	13:45	Lucy Chimes	Impacts of dehorning on black and white rhinoceros population dynamics across southern Africa
	Poster	Catherine Ressijac	Mapping middens: Using remote sensing to reveal rhino midden spatial patterning
	14:00	Vanessa Duthe	101 podded rhino: insights into drivers of home range size in white rhinoceros (Ceratotherium simmum) and black rhinoceros (Diceros bicornis)
	Poster	Dave Druce	Welgevonden Game Reserve Rhino Rescue Programme: Lessons Learnt for Ranched Rhino
	Poster	C Ferreira	Does size matter? The impact of horn and body size on white rhino territorial success
	Poster	David Homolac	Spatio-temporal activity of African ungulates at water sources in Mogalakwena River Reserve, South Africa
	Poster	Erin Crowhurst	Tall Tales: Giraffe Trends That Stand Out!
	14:15	Gareth Hempson	Seasonal variation and drivers of parasite prevalence in migratory Serengeti wildebeest
	14:30	Jason Donaldson	Exploring disease dynamics in diverse savanna herbivore communities
	14:45	Joel Abraham	Impacts of body size on herbivore diet diversity and variability
	15:00	Osvaldo Abrão	The Richness and Habitat Use by Large Carnivores Returned Naturally in Zinave National Park, Mozambique
	Poster	Tshepo Moatswi	A population assessment of lions in KD1, KD2 & Mabuasheshube (Botswana)
	15:05	Michael Voysey	Hippo pod characteristics and distribution patterns, and their implications for grazing lawn distributions across Kruger National Park's four major perennial rivers
	15:15	Christoffel de Lange	How do large mammals adjust their scanning patterns across space and time?
	Poster	Gianluca Pio Zaffarano	Prevalence at the wildlife/livestock interface of gastrointestinal parasites in cattle (Bos taurus), buffalo (Syncerus caffer) and wildebeest (Connochaetes taurinus) of Maputo National Park area, Mozambique

	Poster	Linnea Worsoee Havmoeller	Importance of prey for the spatiotemporal occupancy of two sympatric carnivores in a diverse landscape in East Java, Indonesia
	15:30	Willem Bonnaffe	Quantifying trophic cascades in systems with large carnivores and herbivores: Lessons from a north american system
	15:45	Martina Muraro	Disease Dynamics in Apex Predators: Implications for Ecosystem Stability
	16:00	Dave Druce	Shifting Dynamics: Herbivore-Driven Management at Welgevonden Game Reserve
	16:10	Cathy Greaver	Wrap Up
Closing And Thanks			
No dinner is provided on this day.			

Megaherbivores Facilitate Large Grazing Herbivores and Suppress Small Mammals Through Vegetation Structure and Cryptic Pathways

McCleery, R.A.[1, 2, 3], Kruger, L.[4, 5], Monadjem, A.[3, 6], Tye, D.[4], Mhlava, P.[7], Zwane, E.[4], Bijl, A.[4], Jones, M.[2], Hartfelder, J.[2], Sibiya, M.D.[2], Coetsee, C.[7, 8] & Fletcher, R.J.[1, 2]

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The decline and extirpation of megaherbivores have had widespread ecological impacts, altering both vegetation and animal communities. We assessed how the exclusion of megaherbivores and large herbivores affects small mammal populations and how the exclusion of megaherbivores influenced large herbivore activity in Kruger National Park, South Africa. Over a six-year exclusion experiment, we evaluated both vegetation-mediated and non-vegetation-mediated pathways. While small mammals responded to changes in grass biomass, the response was non-linear, with numbers decreasing at both the highest and lowest levels of biomass.

Contrary to our predictions, small mammals were suppressed by megaherbivores, independent of changes in vegetation structure. Small mammal abundance was higher in exclusion plots compared to open plots, with no significant difference between plots that excluded only megaherbivores and those that excluded all large herbivores. In contrast, large herbivores, particularly grazers, exhibited increased activity in areas where megaherbivores were present, suggesting facilitation mechanisms beyond vegetation structure. These findings underscore the importance of considering megaherbivores' ability to reshape animal communities through both vegetation structure and more cryptic pathways when developing rewilding and conservation strategies for savanna ecosystems.

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Small mammal responses to fire: genetic insights from a fire experiment on the Tiwi Islands

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Fire management for conservation is an applicable tool across vast savanna landscapes. However, it often lacks a nuanced understanding of the mechanisms species use to respond to fire and persist in fire-prone environments. In collaboration with the Tiwi Rangers, we conducted a fire experiment and collected demographic and genetic data to identify small mammal responses to a fire event and compare among species with differing dispersal and life-history traits and across fire histories. There was no effect of fire treatment on abundance or relatedness patterns for any species. Northern brown bandicoots and northern brushtail possums were more abundant in high-fire frequency plots, whereas black-footed tree-rats were more abundant in low-fire frequency plots.
Related northern brown bandicoots were more dispersed generally, which increased in the six-week post-fire session. Related northern brushtail possums and black-footed tree-rats mostly occupied the same plots with no effect of fire treatment however possum relatedness increased in the low-fire frequency area one-year post-fire. We demonstrate the different but effective responses of three co-occurring mammals to an indigenous-managed, fine-scale, low-intensity, early dry season fire. Management that ensures fires are sufficiently small for dispersing species such as the northern brown bandicoot, and sufficiently low-intensity for sheltering species such as northern brushtail possums and black-footed tree-rats is required. This is crucial mechanistic data that can be built upon to guide landscape-wide management decisions under varying patterns of fire, rainfall, vegetation, and threats.

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Impacts of woody encroachment and prescribed fire on small mammal communities in a tropical Savanna: contributions for conservation through fire management

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Unlike fire-sensitive ecosystems, savannas have evolved with natural fires that shape their biodiversity and maintain open habitats. However, decades of fire suppression have led to woody encroachment in the Cerrado, the largest savanna in the Americas and a biodiversity hotspot. Besides facilitating catastrophic firestorms, woody encroachment has caused biodiversity loss, particularly eliminating open-habitat specialists. We report here, for the southeastern Cerrado: (i) the effects of woody encroachment on small mammal assemblages, (ii) the impacts of a prescribed burn and (iii) the macro and microhabitat preferences of these assemblages. In a single site, after 15 years of woody encroachment, we found small mammals spatially structured across both habitat scales. Although species richness has not changed over time, woody encroachment favored forest-dwellers abundance at the expense of open-habitat specialists.

To extend our findings, we assessed the taxonomic and functional diversity of small mammals across six additional sites undergoing woody encroachment.

Preliminary results have shown a dominance of forest-dwelling rodents in all sites, and lower functional diversity in highly encroached areas. The prescribed fire benefited open-habitat specialists, particularly rodents vulnerable to woody encroachment, while reducing marsupial richness and abundance, though this effect was limited to the first-year post-fire. Our findings support prescribed fire as an effective management tool for mitigating the impacts of woody encroachment on small mammals communities in the Cerrado. Maintaining a mosaic of burned and unburned habitats through fire management may be crucial for reducing the impacts of woody encroachment and for conserving open-habitat specialists in tropical savannas.

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POSTER

Using acoustic monitoring to assess insectivorous bat richness and activity in a sub-tropical savanna

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Both species showed signs of sublethal stress through oxidative damage and reduced antioxidant activity, suggesting potential negative impacts on their survival. Fertility indicators, including testosterone levels and testicular volume, also declined in both species. While overall activity decreased, water consumption increased, with the rodents becoming more active during the hottest parts of the day to drink, possibly increasing their exposure to further heat stress and reducing reproductive success and survival. These findings underscore the vulnerability of rodents to climate change, highlighting the critical role of microclimates and water availability in their survival. The research provides valuable insights for developing strategies to conserve biodiversity and protect ecosystem stability in the face of growing environmental challenges.

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Small mammal responses to climate change: implications for savanna assemblages

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Rodents play essential roles in savanna ecosystems, contributing to seed dispersal, soil health, and food web stability. However, as climate change intensifies, these animals face increasing threats from rising temperatures and dehydration. This study examined how two species - the diurnal four-striped field mouse (*Rhabdomys dilectus*) and the nocturnal Namaqua rock mouse (*Micaelamys namaquensis*) - respond to simulated heat waves, conditions that are expected to worsen with climate change. We evaluated oxidative stress, activity patterns, water consumption, and male reproductive health without the buffering effects of natural microclimates.

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Understanding insectivorous bat diversity and activity is crucial for conservation efforts, particularly in under-researched regions like sub-tropical savannas. Our study assessed bat species richness and seasonal activity (i.e., number of passes) in MalaMala Game Reserve, located in the southern region of the Greater Kruger National Park (KNP), South Africa. We conducted acoustic monitoring using ultrasonic detectors over two distinct seasons: the wet season (January to March) and the dry season (August) in 2022. Species identification was performed using Kaleidoscope software, complemented by manual verification to minimize misidentifications, particularly for species with overlapping echolocation characteristics. Our findings

revealed 16 species across six families, representing 40% of the bat species known in KNP.

The Molossidae family was the most dominant, followed by Vespertilionidae, while the Hipposideridae family recorded the fewest calls, likely due to their high-frequency echolocation calls that attenuate rapidly. Notably, our findings align with previous research indicating the year-round presence of insectivorous bats in savanna woodlands. Seasonal variations in bat activity were observed, with significantly higher activity during the wet season, likely due to increased insect abundance and reduced thermoregulatory costs. Our study provides a critical benchmark for future bat research in the Greater KNP landscape, highlighting the importance of continued monitoring to detect changes in bat populations and inform conservation strategies.

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The biodiversity of anurans in ephemeral pans in Kruger National Park varies with climate

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Ephemeral waterbodies are essential to the lives of various species in semi-arid regions. These waterbodies are threatened by climate change. Projected increases in temperature in South Africa may lead to declines in the capacity and quality of small waterbodies and the diversity of species living in them. Anurans are a group of vertebrates most vulnerable to climate change as their behaviour is largely influenced by temperature and rainfall patterns, however data on the association between native amphibian communities in ephemeral pans and climate change is limited. This study used passive acoustic monitoring (PAM), using Audiomoth recorders, at 12 sites of differing climates within the southern and northern Granite Supersites in the Kruger National Park (KNP) to investigate this issue.

We found variations in amphibian diversity spatially and temporally. More anuran species were found in southern regions than northern sites, which we attributed to less annual rainfall in the north. Pans inundated for extended periods showed higher diversity of amphibians. Pans with high salinity showed decreased amphibian diversity. Additionally, the study revealed previously unknown aspects of anuran ecology with some species documented not to call at certain seasons found calling in pans at those times. The study suggests that under a hotter drier climate anuran and the pan systems they inhabit in KNP will be at greater risk and underscores the need for planning and monitoring around these valuable yet understudied systems.

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Drivers of Vertebrate Diversity in the Cerrado and Directions for Conservation

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The Cerrado of Brazil stands out among tropical savannas by its high biodiversity and the extremely high land conversion, demanding urgent conservation actions. Setting priorities, however, requires criteria. We investigated vertebrate diversity across multiple scales to identify conservation hotspots. For small mammals, we employed standardized sampling across different habitats and regions and explored climate seasonality and rainfall as predictors of diversity. Species richness did not differ among grassland, savanna, and forest habitats. However, a significant species turnover was found between habitats and regions, underscoring the importance of habitat mosaic at local scale, and the large regional species pool in maintaining Cerrado small mammals overall diversity.

For amphibians, squamates, birds, and mammals endemic to the Cerrado, we identified 29 clusters of significantly co-distributed species by integrating field data with scientific collection records, revealing the complex evolutionary history and the role of historical factors in shaping this South American savanna diversity. Regional diversity and endemism were also driven by landscape heterogeneity, particularly topography.
With less than 50% of the Cerrado´s native vegetation remaining, from which only 6.5% are under protection, the northern Cerrado holds the largest priority areas for conservation. In contrast, the southern Cerrado conservation opportunities are confined to the relatively small and isolated remnants embedded in an impermeable matrix. Protecting these small fragments and promoting their connectivity is critical for preserving overall Cerrado vertebrate diversity. Our findings emphasize the need for conservation strategies that account for both local and regional diversity to safeguard the unique ecosystems of the Brazilian savanna.

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Direct and indirect effects of prescribed fires on small vertebrates in the Brazilian Cerrado

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Prescribed burns are used in Integrated Fire Management in protected areas of the Brazilian Cerrado. However, the effect of these burns on animals are still poorly known. We explored direct and indirect effects of prescribed burns on small vertebrates in the Serra Geral do Tocantins Ecological Station (SGTES) in the Brazilian Cerrado. We followed 17 fires and searched for dead animals just after fire. We then surveyed lizards with pitfall traps in unburned and burned areas with time since the last fire (TSLF) from 1 to 5 years.

We found 344 dead vertebrates: 241 lizards, 101 snakes, one bird and one rodent. No dead frog was found. The number of dead reptiles increased with increasing TSLF. We captured 3,264 lizards of ten species in pitfall traps. Lizard richness ranged from two to six species and did not differ between TSLF but was higher in burned than unburned areas (predicted richness of 3.3 and 2.8, respectively). Fire had no effect on total abundance, but the abundance of lizards increases at two years of TSLF caused by one species. The abundance of lizards without *Tropidurus oreadicus* data shows no effect of TSLF. Although direct mortality deserves attention, prescribed burns in SGTES may not be an important threat to lizards. We recommend that savanna managers worldwide pay special attention to prescribed burns in areas with high TSLF (e.g., using low severity burns) as small vertebrates may be negatively affected by higher severity burns.

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POSTER

Effects of woody encroachment on the diversity of frogs and lizards in the southern portion of the Cerrado in Brazil

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The practice of preventing fires in the Cerrado is relatively common and reflects the belief that fire is harmful to the biota. However, fire suppression causes woody encroachment. It is expected that frogs and lizards more adapted to the conditions found in more open vegetation types will decline or disappear with woody encroachment. We test this hypothesis with published and unpublished data obtained in the southern Cerrado in Brazil. We sampled animals with pitfall traps. In the first study (Itirapina Ecological Station, 2001-2005), we found higher richness and abundance of frogs in more open vegetation than in denser vegetation, indicating that woody encroachment would lead to lower diversity in previously open vegetations. Results from a second study (Santa Bárbara Ecological Station, 2016-2018) showed the same trends for frogs and lizards.

In a third study (Assis Ecological Station, 2022-2023), we compared our sampling with that of a previous study (10 years before, when the vegetation was more open), and found the same trend for frogs and lizards. In general, our results provide strong evidence that woody encroachment in more open vegetation types would cause local losses in diversity of frogs and lizards. As fires tend to have little or no effect on the diversity of these animals in this region, an effective way to avoid these losses would be to maintain mosaics of vegetation types through integrated fire management (IFM). In addition, IFM tend to prevent wild and mega-fires, which can be detrimental to Cerrado frog and lizard communities.

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POSTER

Murid rodent haemoparasite prevalence and diversity across an anthropogenic gradient in the Greater Kruger, South Africa

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The western boundary of the Kruger National Park (KNP) borders the populous Bushbuckridge Municipality, fostering a dynamic environment where pathogens can move between wildlife, livestock, and humans. Within this landscape, rodents are widespread both in the protected KNP and in surrounding and peri-urban environments, and may represent important reservoirs of vector-borne, potentially zoonotic, haemoparasites. This study compares the prevalence and diversity of three medically and economically important bacterial groups (*Anaplasma, Bartonella* and hemoplasmas) between rodent populations sampled inside KNP to those sampled in communal rangelands in the surrounding Bushbuckridge Municipality.

In total, 160 bloodspots collected through a pinprick at the base of the tails of five common, indigenous rodent species were molecularly screened for *Anaplasma, Bartonella* and haemoplasma presence. A higher haemoplasma occurrence was detected in rodent populations sampled in the protected KNP whereas, both *Anaplasma* and *Bartonella* had a higher occurrence in the peri-urban rodents conspecifics. This disparity is not due to reservoir rodent specificity but could be attributed

to other reasons, such as vector specificity aiding in the indirect transmission of these haemoparasites, or host specificity of livestock or domestic animals found in these pastoral communities bordering conservation areas with wildlife. This non-invasive method of sampling showed useful in studying disease dynamics in widely distributed reservoir rodents, asymptomatically harbouring pathogens of public health concern.

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Mirror Mirror on the Wall: Reflecting on 30 years of avian monitoring and research in the Kruger National Park

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Birds respond to changes in habitat structure, land-use and climate and serve as indicators for conservation management. The Kruger National Park (KNP) is known to support more than 490 bird species, approximately 57% of the species found in the southern African subregion. KNP has become a focal point for a variety of ornithological studies aimed at understanding and protecting avian populations in the face of environmental change. However, the avifauna of KNP has seldom been thoroughly and systematically surveyed, and even rough census figures are only available for a fraction of the species supported by the park. Key-findings from 45 peer-reviewed articles and 26 registered project final reports document shifts in bird distribution and abundance, with some species showing alarming population declines.

Notably, monitoring programs have focussed on specific species or groups, such as Vultures, Martial Eagles, Southern Ground-Hornbills and waterbirds, providing valuable data on breeding success, prey availability, habitat requirements and movements inside and outside of PAs. The status of migratory species in the region has gained attention and efforts to mitigate threats such as poaching, disease and invasive species are currently being explored. Several important avifaunal populations do not thrive outside large, protected areas like Kruger. A synthesis of the above body of research highlights our knowledge gaps and provides a baseline for developing future monitoring and question-driven research. It is imperative that collaborative efforts between researchers, park management, and local communities shape research outputs that address effective conservation strategies for birds in Kruger National Park.

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Expanding the potential of the Lowveld for Southern Ground-hornbill conservation

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Protected areas alone cannot ensure species survival, particularly for wide-ranging threatened species. We combined citizen science monitoring of Southern Ground-hornbills (Bucorvus leadbeateri) in Kruger National Park with community-based participatory research to inform conservation planning. Our citizen science data revealed that the park has reached carrying capacity for breeding groups of this endangered species, creating an urgent need for expansion zones. To identify viable dispersal areas, we conducted extensive interviews with communities within a 50km buffer zone of the park, documenting local knowledge, perceptions, and cultural connections to these iconic birds. This dual approach demonstrated that successful conservation expansion requires both suitable habitat and community custodianship. Our citizen science monitoring showed saturation of territories within the protected area, while community engagement identified promising areas where local cultural values and ecological requirements align. These findings emphasize that effective conservation planning must integrate biological monitoring with social dimensions. The combination of citizen science and community knowledge provides a robust framework for identifying and securing safe dispersal corridors that will enable young ground-hornbills to establish new breeding groups. This work demonstrates the value of bridging scientific monitoring with local ecological knowledge to create sustainable conservation solutions that benefit both wildlife and communities.

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Combined impacts of rising temperatures and humidity on mesic savanna and forest birds

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Elevated humidity impedes evaporative heat loss, the only mechanism of heat dissipation available to birds when the temperature of their immediate surroundings exceeds their body temperature. Because the capacity of air to hold water vapour increases with air temperature (T_{air}), global heating is expected to lead to more humid wet-season conditions. Comparative analyses reveal

that birds occupying humid lowland habitats have greater hyperthermia tolerance and evaporative cooling efficiencies under hot, humid conditions compared to species from drier habitats. Despite this evidence for physiological adaptation to humid environments, the increases in T_{air} and humidity predicted for coming decades will greatly increase the risks of lethal hyperthermia.

To predict increases in lethal hyperthermia risk for a forest frugivore, we empirically determined the maximum wet bulb temperature ($T_{W\text{-}max}$) tolerated by trumpeter hornbills (*Bycanistes bucinator*) as 31.7 ± 1.0 °C. Taking thermal buffering by vegetation into account, under recent climate hornbills were rarely exposed to $T_{W\text{-}max}$ > 31.7 °C, with a maximum of ~4 d y^{-1} in parts of Mozambique and the eastern DRC. Under an RCP 8.5 scenario, however, projected exposure for the end of this century is 30-50 d y^{-1} in some parts of the species' range. Projected increases in lethal hyperthermia risks are quantitatively similar for blue waxbills (*Uraeginthus angolensis*), the species most prominent during South Africa's first documented heat-related mortality event in northern KZN in late 2020. These findings suggest mesic savanna and forest birds will face a substantial threat of population declines even in conserved areas during coming decades.

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Bird communities show resilience to the recent extreme drought in KNP

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Extreme Weather Events (EWEs) such as drought are exacerbated by climate change. Drought impacts vegetation directly and animals that depend on plants, such as birds. Birds often form a part of Protected Area (PA) biodiversity conservation mandates and monitoring programmes despite disregard for birdlife in continents such as Africa when PAs were gazetted. Thus, we aimed to understand how an extreme drought during 2015/2016 in the Kruger National Park impacted bird community composition, diversity and sensitivity to finer-scale pulse disturbances.

We found that bird diversity significantly increased post-drought, but sensitivities were unaffected, suggesting a resilient bird community occupying this relatively large PA. Our findings support PAs' importance in buffering against EWEs and outside disturbances like land degradation. We urge PA management to monitor their bird communities and continue to support those who take the initiative to detect losses from severe, multi-season EWEs that are expected to become more frequent.

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Seasonal variations in bird community structure between wet and dry savanna in Limpopo region, South Africa

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Water is a vital source of life in the savanna, shaping the nature of habitats and determining the availability of resources. While rivers define the savanna's spatial landscape, seasonal rains transform it over time. Birds, known for their sensitivity to habitat changes, serve as indicators of these variations. This study explored the spatiotemporal differences in bird diversity and abundance between the evergreen riverine woodland and the adjacent drying shrubland. The research was conducted at the Mogalakwena River Reserve in South Africa, where I collected bird data using line transect surveys across two seasons. Overall, I observed and studied 117 bird species. The results suggest that the evergreen woodland serves as a crucial refuge for many species during the dry season, e.g.

The common scimitarbill (*Rhinopomastus cyanomelas*). While bird abundance in the woodland increases two times during this period, the number of species remains stable, despite shifts in species composition. However, the results propose the movement of two species from the woodland to the shrubland, too. Additionally, I examined the influence of habitat and dietary specialization on changes in bird abundance. By analyzing sequences of records of 257 bird species from the Southern African Bird Atlas Project 2 in four pentads, I also estimated long-term abundance trends and compared seasonal stability within and across years. The findings are essential for understanding how birds utilize savanna habitats and for gaining insights into their ecological requirements and behaviors. This knowledge is especially important in the context of ongoing climate change in South Africa.

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Diversity and host specificity of avian haemosporidians in an Afrotropical savanna conservation region

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Afrotropical regions have high bird diversity, yet few studies have attempted to unravel the prevalence of avian haemosporidia in conservation areas. The diversity and host specificity of parasites in biodiversity hotspots is crucial in understanding parasite distribution and potential disease emergence. We test the hypothesis that biodiverse regions are associated with highly diverse parasites. By targeting the cytochrome b (*Cytb*) gene, we molecularly screened 1035 blood samples from 55 bird species for avian haemosporidia infections to determine prevalence and diversity from sites inside and adjacent to the Kruger National Park. Overall infection prevalence was 28.41%.

Haemoproteus, *Leucocytozoon* and *Plasmodium* presented prevalences of 17.39%, 9.24%, and 4.64% respectively. 100 distinct parasite lineages were detected, of which 56 were new lineages. *Haemoproteus* also presented the highest diversity compared to *Leucocytozoon* and *Plasmodium* with variable levels of specificity. *Haemoproteus* lineages were found to be specialists while *Plasmodium* and L*eucocytozoon* lineages were generalists. We also found a positive relationship between avian host diversity and parasite diversity, supporting an amplification effect. These findings provide insight data for host-parasite and co-evolutionary relationship models.

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Running the gauntlet of honest elephant management

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For nearly 200 years, extensive hunting wiped out Kruger's elephants, with none left by 1900. The first sighting after that was in 1905. Another setback came in 1896 with the Rinderpest outbreak, which devastated wildlife. Animal populations rebounded, and elephant numbers grew to nearly 30,000 today, despite culling between the 1960s and 1990s. Elephants now roam beyond Kruger into areas like the Mozambican coast and Gonarezhou, leading to occasional conflicts with people. Debates over elephant management are heated. Pro-cullers criticize Kruger's approach, while anti-cullers argue that problem elephants are killed without reason. Some suggest controlling birth rates to manage populations. However, assuming that elephant impacts depend solely on their numbers is misleading.

Elephant numbers are only one factor affecting the environment. Their impact depends on where they spend time, which is influenced by resources like water, food, and shade. Therefore, effective management should focus on why elephants stay in certain areas and manage the resources that dictate that. Death is part of the outcomes of how elephants respond to resources. Coping with stresses responding to resources and deaths are outcomes of evolutionary processes that depends on the mortality of weaker individuals. In the wild, animals rarely die peacefully, facing challenges like predation, disease, and starvation. Yet, welfarists avoid the reality of natural death processes. An honest approach to managing the influences that elephants have on nature and people should include managing all the vital rates, including death, and processes that influence why and where elephants spend time.

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Despite potential risks African elephants do not always avoid mountaineering

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As herbivores forage, they move across a wide range of topographical features. Yet, they tend to avoid terrain such as steep slopes where there is a risk of falling. Recent studies suggest that African elephants (*Loxodonta africana*) avoid steep slopes (e.g., >15˚) and thus cannot utilise the entire landscape. However, in reserves with undulating topography, elephants may have to use steep slopes to obtain food. To explore this, we investigated elephant slope use in the Ithala Game Reserve, South Africa, where the topography ranges between 400 to 1400 masl. Using 8.5 years of positional data, we examined how slope use varied between herd types (breeding herds and males), habitat type, season (wet vs. dry), and year (average vs. below-average rainfall year).

Elephants primarily used slopes <30˚, with 67% of the locations on slopes <15˚, and 52% on slopes <10˚. Habitat influenced slope use for both herd types, and seasonal differences in slope use occurred only in average rainfall years. However, these slope use differences were minor (i.e., 1.3˚to 9.7˚) and thus unlikely to be biologically meaningful. Nevertheless, elephants in Ithala used steeper slopes than suggested in previous studies, with 5% of the locations occurring on very steep slopes (i.e., >30˚) and 33% on slopes >15˚. Thus, our results indicate that using 15˚as a cut off for landscape

suitability would greatly underestimate the total area available to elephants. Thus, although they may prefer flat terrain, when required, elephants will mountaineer.

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Designing Landscapes of Mixed-Uses for Near Zero Elephant Metapopulation Growth

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The spatial configuration and land use types across a landscape substantially influence the population growth rates of the species that live there. Protected areas are usually intended to promote population growth, whereas areas with extensive human activities often inhibit growth for many species. Traditional metapopulation ecology suggests a landscape with sources and sinks may result in an overall near zero percent population growth rate. The Kavango-Zambezi (KAZA) Transfrontier Conservation Area is one such extensive landscape split into protected areas (sources), trophy hunting concessions (sinks), and community conservancies.

Elephant populations typically grow quickly within national parks but will often disperse out of trophy hunting concessions in response to a landscape of fear. These two sets of competing emigration pressures drive elephant dispersal throughout the larger landscape. Using two coordinated sets of elephant census data in the KAZA region and a dispersal optimization model, we estimate how elephant metapopulation dynamics contribute to a near neutral growth rate. We may then apply these lessons to designing land use configurations across the Greater Limpopo Transfrontier Conservation Area.

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Differences in habitat use and home ranges by savannah elephants in and outside of Gonarezhou National Park, Zimbabwe

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Protected areas (PAs) in southern Africa provide refuge to important megafauna with sections of these often transfrontier conservation complexes, whose objective is to facilitate historic patterns of animal dispersal. Data were derived from satellite collars fitted on 26 savannah elephants from 2016 to 2022 in Gonarezhou National Park (GNP), to investigate seasonal and sex differences in elephants' home range sizes, home range overlap, and their interaction with environmental variables. We also assessed the extent of elephant activity outside of GNP, and the role that season and diel may play in this, and documented habitat used by elephants outside of GNP, including in human dominated landscapes. Differences in size of home ranges between sexes in all seasons were not significant. Both sexes had high site fidelity, retaining 60% of their home ranges between consecutive seasons. Only females, possibly tracking forage quality, showed reduced overlap of home ranges between the hot dry and hot wet seasons.

Males preferred vegetation types dominated by *Colophospermum mopane*, whereas females used more diverse upland vegetation types, preferring higher elevations than males over all seasons. Our results showed that males were more likely to move outside the park than females and dispersed at greater distances. Male elephants moved as far as 60km from GNP, but females typically did not disperse further than 15km. Most of the movement outside of GNP was during the cool-dry season (April to July) and both male and female elephants returned to the park during the hot-wet season (December to March). When outside the park, the male elephants mostly utilised forested land cover types, whilst female elephants remained in shrub land cover types and preferred areas with low human densities.

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Human elephant conflict in communities around Gonarezhou National Park, Zimbabwe

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Human-elephant conflict (HEC) poses a significant challenge to conservation efforts, despite over 250,000 years of shared history between humans and elephants. This study examines HEC patterns around Gonarezhou National Park, focusing on crop-riding incidents documented by the Gonarezhou Conservation Trust between 2017 and 2024. We analysed the seasonal and spatial distribution of HEC incidents, investigating the influence of water sources, household locations, and proximity to park boundaries on conflict frequency. Additionally, we evaluated various mitigation strategies used by local communities. Our findings revealed year-round HEC occurrence with significant spikes during the late hot wet season. Incidents distribution showed

distinct clustering, with highest concentrations in the north (Mahenye and Maparadze area) and south (Sengwe and Chikombedzi area) of the park.

The number of incidents were higher near rivers and homesteads, likely reflecting typical settlement patterns in rural areas of arid and semi-arid regions where communities cluster around water sources. A significant interaction was observed between park boundary proximity and seasonal patterns, with incidents decreasing at greater distances from the boundary, particularly during the late hot wet season. Local communities employed multiple mitigation strategies, including fire, chilli bricks, streamers, lights, and active guarding. While no single mitigation proved universally effective, our analysis highlighted the critical role of spatial planning in HEC management given that proximity of homesteads to park boundaries or rivers was a crucial factor affecting the number of incidents. These finding suggest that incorporating spatial considerations into rural settlement planning could reduce HEC in similar contexts.

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Strategies to move human-elephant-conflict to human-elephant-coexistence

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We are living in the Anthropocene where human action can override natural systems and the nonhuman species they sustain. Although elephants have undergone a drastic continental decline, expanding elephant populations are found within southern Africa where rapid human population growth is co-occurring. As both species compete for similar resources, human-elephant-conflict (HEC) is inevitable outside of protected areas (PAs). As rural, subsistence farmers frequently surround PAs, they are left vulnerable to marauding elephants who nocturnally crop-raid when expanding their range or following corridors which connect PAs over a wider landscape.

To reach global biodiversity targets we need to shift HEC to coexistence where people and elephants intersect and especially along elephant corridors, allowing for increased connectivity at landscape scale resulting in enhanced conservation benefits. Ironically, both subsistence farmers and elephants are necessary to prevent rampant industrialised farming or human development, but coexistence cannot be realised if the livelihoods of already impoverished farmers are continually threatened. We present a HEC mitigation strategy that involves engaging with the community, understanding how elephants move in relation to people, identifying conflict hotspots, ensuring human safety whilst protecting people's assets and assessing the biodiversity value of living with elephants.

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Deterring elephant impacts by exploiting their demonstrated fear of the human "super predator"

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Deterring elephant space-use and impact in identified areas of concern is one of the highest priority actions advised in the Kruger National Park Elephant Management Plan. The unique ecology of humans as predators includes: humans killing prey at much higher rates than other predators – meriting our being termed a "super predator"; and our being one of the only two predators of elephants, the other being lions. We have conducted experiments using automated camera-speaker systems at waterholes, in the Associated Private Nature Reserves adjoining Kruger National Park, and in the heart of Kruger around Skukuza, demonstrating that hearing playbacks of the human "super predator" causes elephants to abandon waterholes, whereas hearing lions does not; indicating that playbacks of humans could provide an effective elephant deterrent.

We tested the deterrent effect of human playbacks on elephants in an experiment in Kenya, using a proven design involving deploying arrays of speakers across two 1.0 km^2 study grids, and broadcasting humans on one and controls (birds) on the other for 5 weeks, and then reversing the treatments and broadcasting for another 5 weeks. Hearing humans reduced elephant detections by half and reduced elephant tree and shrub damage by 2/3s. We will discuss the implications of our results, and the feasibility and benefits of using human playbacks to deter elephant impacts on the survival of especially tall trees and nesting trees used by critically endangered white-backed vultures.

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Revisiting the dead: Elephant behavior plays a major role in megacarcass bone distribution

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The ecological impacts of megacarcasses (>1,000 kg) in terrestrial ecosystems remain poorly understood, especially regarding nutrient cycling and landscape heterogeneity. African elephants, known for their role in life as ecosystem engineers, may also play a significant role as nutrient hotspots after death. In addition, other live elephants play a significant role in redistributing elephant bones across the savanna, thereby shifting nutrient hotspots. Preliminary camera trap studies indicate increased elephant activity observed from 15 days to 500 days post-mortem. This behavior appears to drive a broader spread of bones at female carcass sites compared to male sites, likely due to repeated elephant visits. Additionally, by mapping bone fields and then returning to those same fields, we have found a higher rate of bone distribution in areas that elephants frequent, compared to those only visited by hyenas.

This study aims to quantify bone dispersal patterns and identify drivers of nutrient redistribution by examining 65 carcass sites across varying scavenger and elephant densities in Kruger National Park. Using a line intercept method to measure distance, bone mass, and evidence of scavenger interaction, we analyzed the relationship between bone dispersion and ecological factors. By employing generalized additive models (GAMs) and regression analyses, we are exploring the influence of carcass age, scavenger density, and elephant visitation on bone movement and nutrient patch dynamics. This research provides new insights into the ecological legacy of megacarcasses, highlighting the potential for elephants to shape nutrient distribution long after death, thus creating unique biodiversity patterns across the landscape.

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A multifaceted approach to identify high elephant impact areas in Kruger National Park

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African elephants (*Loxodonta africana*) contribute to the existence of savannas through maintaining high grass:tree ratios and structuring the physical environment with positive consequences for other fauna. On the other hand, elephants threaten biodiversity and contribute to conflict with, and between people. We undertook an exercise to identify potential areas in Kruger National park (KNP) where there could be concerns related to the influences that elephants have. We had two objectives: 1) in order to test the first implication above, we wanted to identify whether areas of high elephant interactions (not only with vegetation) in the KNP were spatially variable, 2) we wanted to understand the mechanisms that give rise to the concerns. We followed different processes to isolate these potential areas of concern. First, we undertook a mapping exercise with various conservation management and other staff members in the KNP. Secondly, we used two different remote sensing products to test whether the changes in woody cover as perceived by personnel were supported by empirical observations.

The areas that were identified by personnel as having large changes in tree cover linked explicitly to elephant impact were mostly focused on areas in south central KNP, north-east to south-east of Satara. Although some of these areas on less fertile soils are aligned with seasonal rivers such as the Timbavati, much of the area occurs on more fertile soils including Thornveld on gabbro and *Acacia welwitschii* thickets on Karoo sediments. There was good overlap between the areas of potential concern identified by KNP personnel and the change detection analyses which used rain use efficiency (RUE) as a metric. The identified elephant impact areas overlapped in many places with the more recent analyses of woody cover change, although the

recent woody cover changes were more widespread than either the longer-term RUE changes or areas identified by KNP personnel.

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Kruger elephants on the move: Predicting benefits and risks

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With over 40,000 elephants roaming the Greater Kruger landscape, there is immense potential for both ecological and socio-economic benefits within and beyond protected areas. Elephants play critical roles in shrub clearing, seed dispersal, and support tourism and cultural values. However, they can also cause ecological damage by over-browsing trees and create conflicts with humans, particularly when they encroach and cause damage in agricultural lands or threaten people's lives. Authorities in the region walk a tight rope – they seek to maximize the benefits while minimizing the risks of elephants. Proactive responses could benefit from prediction about when and where elephants are likely to move to, and where their presence may lead to either positive or negative outcomes both for nature and people alike irrespective of protected area or not.

We present a novel framework for ecological forecasting that advances mechanistic movement and socio-ecological modeling to predict elephant movements and their interactions with the environment. Using elephant GPS tracking data, coupled with environmental variables such as weather patterns, land use, crop growth cycles, and human activity data, we aim to identify areas and time periods of both beneficial ecological impacts and potential human-wildlife conflict. This predictive model allows us to pinpoint hotspots of opportunity or risk, enabling the development of targeted management interventions that mitigate conflicts and enhance the ecological and socio-economic benefits elephants provide. This proof-of-concept model serves as a crucial step towards sustainable elephant management across the Greater Kruger landscape that benefits nature and people alike.

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POSTER
Heterogeneity-based elephant management: time for some temporal dynamics?

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For decades, the management of locally large elephant populations in protected areas has been focused on maintaining a given park-level density. A paradigm shift then somewhat occurred, particularly thanks to critical thinking from Kruger NP scientists and managers, who highlighted that managing heterogeneity rather than numbers *per se* could be key to success. The discussion often focused, and still does, on spatial heterogeneity, in particular during the dry season when water distribution is key for elephants, their impact on trees largest, and aerial census data to assess elephant distribution heterogeneity available.

Here I will argue that the conceptualization of this 'new' way to think about managing elephants and their influence on the ecosystems has somehow stalled and should be developed further. The role of many potential drivers of elephant distribution remain uncertain, heterogeneity during the wet season poorly studied, and overall the temporal dynamics of elephant distribution not so well studied. In this talk I will discuss these issues, present some distribution-driving factors that I believe should be studied in greater depth, discuss the role I envision for modelling, and ultimately develop further the framework of heterogeneity-based elephant management.

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Termite mounds as refugia for plant communities under varying disturbance regimes

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Termites facilitate important soil processes across African savanna ecosystems. Due to their belowground activity, termites cycle nutrients, affect soil hydrology and physically modify the environment, influencing aboveground patterns of plant biodiversity. Termite activity also enhances foliar nutrients on and around termite mounds, which then attracts large mammalian herbivores that consume plant matter. A feedback could exist as herbivory reduces vegetation biomass around mounds which then moderates local fire severity, and thereby protecting plants on termite mounds from fire. Moreover, the enhanced soil fertility and topographical relief of termite mounds could provide favourable growing conditions and a physical buffer against multiple disturbance types, including herbivory and human land use, for sensitive plants.

Termite mounds are therefore likely to provide sites of plant refugia from disturbance and to influence patterns of phytodiversity. Working across Kruger National Park's

experimental burn plots and herbivore exclosures, and in communal areas to the west of the park, we tested whether termite mounds act as refugia for plants across three key disturbance types: fire, herbivory and human land use. Using high-resolution drone-derived LiDAR data, we measured vegetation structural complexity (VSC) on and off termite mounds across the three disturbance types. We found higher levels of VSC directly on termite mounds across the various disturbance types, and suggest that termite mounds modulate plant communities in the face of disturbance. We propose termite mounds can potentially improve conservation efforts and act as nucleation sites for savanna restoration.

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Active management of pyrodiversity is not required for maintaining ant diversity in an Australian tropical savanna

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Does pyrodiversity beget biodiversity? Of course it does, given that different species have different fire requirements! The more useful question is: What level of pyrodiversity is required to maintain biodiversity and, more particularly, to what extent does pyrodiversity need to be actively managed? The latter is especially important because every flammable landscape is inherently pyrodiverse, not just in terms of historical legacy (the 'invisible' fire mosaic) but within any fire scar. Here we address this question for Australian savanna ants, based on results from a long-term, fire experiment that tests six replicated fire treatments varying in frequency and season. We employ an optimization approach used for the selection of conservation reserves that maximises biodiversity representation.

The Australian savanna ant fauna is very strongly arid-adapted and its exceptionally high diversity is promoted by frequent fire. We found that a very low number of treatments was required to represent all species and to maximise geometric mean abundance. We attribute this to high pyrodiversity and vegetation variability within treatment plots. Our results show that highly managed pyrodiversity provides no conservation benefit for ants in our savanna system. We argue that a reserve selection approach is a powerful method for assessing how much pyrodiversity is needed to conserve biodiversity, and that it should be used more widely for identifying the management requirements of diverse communities in fire-prone environments.

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Genetic profiling of Gonimbrasia belina populations in South Africa and Botswana support concerns over the sustainability of the mopane worm harvesting and trade

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Mopane worms are harvested for direct consumption and trade in many rural areas of southern Africa. Ever increasing demand, habitat loss and erosion and, more recently, climate change caused alarm over the sustainability of the species. Although many studies have focused on the socio-economic aspects of mopane worms, genetic data with utility for profiling and monitoring populations was not available. We generated mitochondrial and nuclear sequencing data to estimate the genetic diversity, phylogeographical structure and demographic history of mopane worms sampled in South Africa, Botswana and Namibia. Mitochondrial lineages showed strong phylogeographical structure separating Namibia and the South Africa/Botswana populations, which appear separated by the Limpopo River, with lineage sharing only at the border between South Africa and Botswana.

Haplotype diversity varies between sampling areas but overall is highest in South Africa and lowest in Botswana. Historical demography analyses suggest population expansion in Namibia but not in South Africa and Botswana. Nuclear data revealed some connectivity among populations in the Limpopo River Basin albeit with signs of genetic isolation. All sampling areas exhibit low genetic diversity, small effective population size, and evidence for recent bottlenecks. This study provides the first baseline data for the genetic monitoring of mopane worms and concludes that concerns over the sustainability of the species in Botswana and South Africa are justified.

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Genetic diversity of *Macrotermes* termites in Namibia: an update six decades after the National Survey of Isoptera of Southern Africa

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Namibia exhibits remarkable diversity in flora and fauna due to its wide range of habitats and ecosystems. Mounds built by *Macrotermes* termites are prominent features of trees and shrub savannas, enhancing habitat heterogeneity and facilitating the formation of distinct plant communities. However, the diversity of *Macrotermes* termites in Namibia has not been thoroughly studied for over 60 years, leading to a gap in the understanding of this group in the age of genetic analyses. Additionally, the environmental preferences of *Macrotermes* are still poorly understood. We integrating new genetic data with historical records to infer the composition of the genus in terms of species, and we investigated how environmental factors influence the distribution and occurrence of these species, utilizing both historical and contemporary sampling data for Namibia.

Our findings identified four genetic groups of *Macrotermes*, likely corresponding to *M. natalensis*, *M. vitrialatus*, *M. subhyalinus*, and *M. michaelseni* as noted in the historical National Survey of Isoptera of Southern Africa. Phylogenetic analyses and species delimitation methods indicate that only one genetic group corresponds to the nominal species *M. natalensis*, while the other three genetic groups represent cryptic lineages previously undetected. Additionally, our analyses suggest a possible decline in the abundance of *M. vitrialatus* and *M. subhyalinus*, which may be attributed to the increase in average temperatures in the past six decades.

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A millipede (Diplopoda, Spirostreptida)-mite (Acari, Mesostigmata) association in the savanna: More mites are on males

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Mites in the suborder Mesostigmata are associated with arthropods and vertebrates. The association with arthropods is phoretic, with preference for male hosts reported. To establish if the mites are more abundant on males, we searched for adult *Neomegistus julidicola* on *Doratogonus rugifrons* in a primary woodland of *Vachellia sieberiana* near Mbombela, Mpumalanga. Of the mites that were recorded, 97 % occurred on males, 66 % of these being on the anterior half of the body. Abundance of mites on male and female millipedes was significantly different ($t = 9.52$, $p < 0.001$), and abundance was greater on the anterior half of the body ($t = -2.71$, $p = 0.01$). We concluded that mites preferred males because males are more mobile.

The greater mobility of male millipedes when they are searching for mates makes them ideal phoretic hosts than females and juveniles. However, it can be argued that our observations do not necessarily demonstrate preference for males because being more mobile they are likely to pick up mites. This could be clarified in future studies. Although we did not observe feeding by mites on millipedes, our results could be (mis)interpreted as support for the spermophagy hypothesis. This new record of phoresy suggests that these associations are widespread in the savanna and more could be discovered as habitats are surveyed. Given that associations between mites and millipedes are under-studied and that mites are locality specific, the use of mites as indicators of change in the environment should be explored in future research.

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POSTER

Hidden Architects: Contributions to Ecosystem Resilience through Termite Ecology

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As global environmental changes reshape ecosystems, understanding resilience—the capacity of systems to recover from disturbances—is crucial for sustainable management. Termites, often overlooked but integral to savanna ecosystems, provide critical ecosystem services. They account for 40–64% of soil-dwelling invertebrates and are key ecosystem engineers, influencing soil structure, nutrient cycling, and carbon sequestration. Their role in ecosystem resilience becomes especially important as pressures like habitat loss, bush encroachment, and changing land-use threaten biodiversity. A key area of interest in termite ecology is their impact on soil microbiomes. Through mound construction, termites alter soil properties and host microbial communities with important ecosystem functions, including greenhouse gas mitigation.

The aim of my study, conducted at the Wits Rural Facility in Limpopo, was to explore the functional diversity and activity of microbial communities associated with the mounds of two termite species: *Macrotermes natalensis* (which cultivates fungi) and *Amitermes sp*. Using a community-level physiological profiler (Biolog EcoPlate™) and soil properties such as pH, electrical conductivity (EC), moisture, and organic matter, I found

termite species-specific differences in physicochemical properties and microbial activity between mounds. Soil organic matter and moisture were the strongest drivers of microbial functional diversity, emphasising that termites not only shape soil physical structures but also the biological processes. These findings underscore termites' ecosystem services: enhancing soil fertility, promoting nutrient cycling, and aiding in carbon sequestration. By influencing microbial communities, they indirectly support plant productivity and contribute to the stability of food webs, thus affecting a range of other vertebrate species. Considering increasing habitat degradation and climate change, the disruption of termite-driven processes could have cascading effects on ecosystem resilience. My research emphasizes the importance of conserving termite populations and their habitats to maintain these ecosystem services, which are vital to both biodiversity and human well-being.

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POSTER

Does it make a difference for plants whether the herbivore has four or six legs? Is there such a thing as a five-legged herbivore?

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A fraction tree sapling foliage in Hluhluwe-iMfolozi ends up in the digestive tracts of a relatively low number of large herbivores with four legs (mammalian herbivores) and a very high number of small herbivores with six legs (insect herbivores). How much foliage is removed annually? Who removes more foliage overall: the largest mammalian herbivores or the numerous tiny leaf-eating insects? Do these two types of herbivores exert combined pressure on a pool of universally attractive plant species? Alternatively, do mammals and insects prefer different plants based on their own taste? Is herbivory by four-legged animals significantly different from that by six-legged animals, or can we establish general rules that apply to both, that could be averaged into a hypothetical five-legged herbivore?

To address these questions, we evaluated the fraction of foliage removed by mammalian herbivores (on 158,160 leaves belonging to 55 woody species) and insect herbivores (on 26,244 leaves from 51 woody species) in Hluhluwe-iMfolozi. This analysis revealed the total pressure exerted annually by both four-legged and six-legged herbivores and identified their preferred species. We further investigated whether four- and six-legged herbivores are either sweet tooths (attracted to sugars in leaves) or protein seekers (attracted to proteins in leaves). Additionally, we examined which plant defenses (phenolic content, oxidative capacity, structural defenses of leaves and whole plants) are effective in deterring herbivores, based on their number of legs. Lastly, we will discuss whether four or six legs truly makes a difference and whether herbivory could stand on five legs.

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POSTER

The gut microbiota of dung beetles as indicators for biodiversity and environmental quality

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Dung beetles belong to a highly diverse group of insects and, as ecosystem engineers, contribute significantly to ecosystem functionality. They bury dung underground for feeding and the development of their larvae. As a result, dung beetles provide nutrients for plants and preventing parasites from breeding above ground. Therefore, they play a key role in enhancing biodiversity and improving environmental quality. Dung beetles harbor a variety of microorganisms in their gut, collectively known as the gut microbiota, most of which are bacteria. They have evolved highly specialized intestinal compartments harboring a specific set of microbes involved in fermentation of carbohydrates and the breakdown of other biomolecules such as cellulose and amino acids.

The microbial activity improves the health of the dung beetle and subsequently influences the ecosystem. The gut microbiota is highly specific to each dung beetle species and disruption of this delicate symbiosis impairs dung beetle development and health, consequently reducing their contribution to ecosystem functioning. Alterations in land use, mammalian presence, vegetation, climate change and the use of antibiotics and pesticides negatively affect the dung beetle microbiota. Ultimately, disruption of the dung beetle microbiota may lead to alterations in the ecosystem functioning, negatively affecting the environment. Therefore, identifying key stone species within the microbiota and assessing how environmental changes affect these species and their functioning could serve as indicators for ecosystem health and guide conservation efforts to improve biodiversity and environmental quality of the savanna ecosystem.

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POSTER

Status of ongoing soil moisture measurements in contrasting landscapes across South Africa

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Soils are of fundamental importance to the ecosystem due to the absorption and storage of precipitation water and other ecosystem services. In the framework of the SPACES SALDi project we established soil moisture networks in six sites across South Africa. One aim was the establishment of calibration sites for the retrieval of soil moisture estimates based on remote sensing data, e.g. the Sentinel 1 C-band SAR and SMAP. The six SALDi sites cover the most prominent climate gradient in South Africa from the Overberg region representing the semi-humid winter rainfall region at the SW Cape to the summer rainfall region of the Lowveld in the NE.
The transect further includes sites in the arid NW (Kai !Garib) as well as at Sol Plaatje, Mantsopa and Bonjanala Platinum.

All six sites are characterized by rather low and grassy vegetation facilitating the comparison of the measurements. Four sites are located in protected areas, i.e. the Nuwejaars Wetland SMA in Overberg, the Augrabies Falls National Park in Kai !Garib, the Benfontein Nature Reserve in Sol Plaatje and the southern Kruger National Park in Ehlanzeni. These locations represent benchmark sites providing records with only little human impact. This poster presents information on the location and characteristics of the sites as well as the quality of the in-situ soil moisture records in April 2019. Furthermore, we present first findings on the seasonal and interannual variation of soil moisture across the prominent climatic gradient in South Africa based on more than 5 years of records.

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Effects of woody plant encroachment on soil physicochemical properties and microbial communities in a savanna ecosystem

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Over the past century, woody plant encroachment, defined as the gradual invasion of woody plants into grass-dominated ecosystems, has significantly altered savanna biomes globally, impacting the herbaceous grass layer and soil physicochemical properties. This study investigates the effects of *Colophospermum mopane* encroachment on soil characteristics and microbial communities, including fungi and bacteria, while also aiming to determine the potential mechanisms driving encroachment. Soil samples were collected from six 60x60 m plots in Mthimkhulu Game Reserve in Limpopo, comprising three cleared and three uncleared sites dominated by *C. mopane*, dominant grass species, and bare patches. The research focuses on measuring and comparing soil physicochemical properties, assessing microbial activity, characterizing community structure, and determining the influence of leaf litter volume on microbial dynamics.

Preliminary results indicate that soil beneath *C. mopane* trees contains higher levels of sodium, nitrogen, carbon, and phosphorus compared to adjacent areas. Additionally, microbial activity, particularly of fungi and bacteria, was significantly higher under the *C. mopane* canopy, where leaf litter accumulates, enhancing the presence of beneficial microbes for its growth. The functional diversity of microbial communities differed notably between *C. mopane* and other sites, while preliminary findings suggest that greater leaf litter volume correlates with increased microbial activity. This study highlights the ongoing investigation into the mechanisms of woody plant encroachment and its effects on savanna ecosystems.

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The dirt on elephants: legacies of megacarcasses on belowground ecosystem function in Kruger National Park

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When elephants die, their bodies release enormous quantities of macronutrients like carbon (C), nitrogen (N), phosphorus (P), as well as additional micronutrients, into savanna soils. These nutrients likely feed microbial activity, which in turn can affect belowground functions such as C respiration, N mineralization, P solubilization, and decomposition. To determine the impacts of elephant carcasses on belowground ecosystem function, we collected soil samples at distances 0, 2.5, 5, 10, and 15 m from the center of carcass sites. In each soil sample, we measured microbial activity (C respiration), C degradation (glucosidase), N mineralization (urease), and P solubilization (phosphatase), carbon and amino acid substrate use (EcoPlates), and decomposition rates using tea bags.

We found that carcass nutrients had significant impacts on soil microbial activity, which was highest near the center of carcasses. Carcasses also appeared to suppress glucosidase, urease, and phosphatase activity, but the effect was contingent upon carcass age. We also found that the functional profile of microbial communities was significantly altered by carcass nutrient deposition. Our results therefore illustrate that elephant carcasses not only affect belowground nutrient cycling, but continue to do so for several years post-mortality. Laboratory manipulations of soil C:N ratios confirm that carcass-derived alterations in C:N profiles strongly regulate soil belowground function. Thus, carcasses provide a heretofore unknown source of heterogeneity in belowground ecosystem function.

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POSTER

Intrusion mechanism and magma differentiation of the Timbavati Gabbro

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The Timbavati Gabbro (TG) is part of the 1115 ± 0.4 Ma Umkondo Large Igneous Province (LIP), confirmed by a U-Pb baddeleyite age (Hanson et al., 2004). This voluminous and short-lived magmatic event is characterized by dykes, sills, and remnant lavas that extend across much of the Kalahari Craton (e.g., de Kock et al., 2014). The TG intrudes the granitoid-greenstone basement of the Kaapvaal Craton, forming a ~270 km-long irregular N-S body, with thicknesses ranging from ~200 m in the north to ~480 m in the south, occasionally overlain non-conformably by Karoo strata to the east. The TG has been proposed to consist of shallow (~20–30°) inward-dipping Hertzian 'cone sheets,' resembling saucer-shaped sills (Walraven, 1983), although this model is unverified. Petrological studies show the TG is modally layered, with basal olivine melagabbronorites transitioning into upper quartz gabbro (Walraven, 1984). Mineral chemistry data (Bullen, 2005) indicate the presence of cumulus olivine (Fo68-83), orthopyroxene (En71-82), plagioclase (An39-71), and clinopyroxene. Geochemical traverses (Walraven, 1984) suggest multiple magma injections, while isotopic analyses (Walraven, 1984; Bullen, 2005; Hayes et al., 2024) link the TG's parental magmas to a sublithospheric, spinel-bearing mantle source with significant lithospheric contributions. Despite relatively well-constrained petrology, the TG's structural geometry relies on outdated aerial photogrammetry and limited outcrop mapping by the South African Geological Survey (Walraven, 1986).

Potential inaccuracies in geological maps highlight the need for modern remote sensing imagery (hyperspectral and aeromagnetic data) and ground-truthing to better understand its emplacement mechanisms. The TG's location within Kruger National Park (KNP) and adjacent private reserves further restricts access, necessitating innovative approaches to document limited in situ outcrops. This study aims to re-map the TG to better constrain its geometry, modal layering, and magma differentiation processes. High-resolution satellite imagery will penetrate vegetation and soil cover, while drone surveys will document in situ outcrops along river traverses. Field observations will focus on rock types, contacts, and internal structures, with selected samples analyzed for thin section petrography and scanning electron microscopy (SEM) to investigate cumulus crystal compositions. The primary research objective is to understand how TG magma was emplaced and differentiated. While a saucer-shaped intrusion model has been proposed, alternative mechanisms, including a dyke-and-sheet complex, warrant exploration. The WNW-ESE trending TG segments align with a coeval diabase dyke swarm across the Kalahari Craton, consistent with a major 1.1 Ga back-arc rift system (Klausen, 2020). This study aims to resolve these emplacement scenarios, contributing to a broader understanding of mid-Proterozoic tectonics.

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The Grazing Implementation Index: Quantitatively Integrating Management Factors That Influence Grazing Intensity Across Spatiotemporal Scales

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The debate about the ecological efficacy of alternative grazing management approaches has persisted since the 1950s. A primary reason for the disagreements is the inadequacy of parameters used to differentiate grazing impacts and the lack of a rigorous approach for quantifying grazing intensity. While this applies primarily to livestock production, the question of grazing intensity

effects on the herbaceous layer is also relevant for wildlife management. This paper presents a composite index to serve as a standardized approach for more accurately quantifying grazing intensity. The Grazing Intensity Index (GII) is comprised of six traditional indicators and two novel indicators of grazing intensity that comprehensively account for the complex management parameters involved in grazing systems.

Using data from a survey of 870 ranchers in North and South Dakota and in Texas, we applied a principal components analysis to converge the eight grazing intensity indicators into three factors that describe the effects of rest (*Paddock/Herd Ratio, Effective Resting Rate/Effective Stocking Rate, Rest Period Length*), grazing (*Grazing Event Length, Re-grazing Frequency, Effective Stocking Rate/Stocking Rate*), and the animal/land relationship (*Stocking Rate/Carrying Capacity, Stock Density*). The rest factor explained 36% of the variation across grazing systems, the grazing effect factor explained 30%, and animal/land relationship factor explained 23%. Application of the GII to previous grazing studies showed less disparity among systems where no ecological differences were reported than studies where significant ecological differences were found between grazing management practices. Importantly, these findings did not neatly align with traditionally defined continuous and rotational grazing systems.

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Soil microbial diversity across savanna ecosystems: a first worldwide assessment

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Tropical savannas are unique diverse ecosystems, covering 1/7 of terrestrial habitats, but they are also associated with areas of higher population density. Tropical savannas and local human populations are constrained by soils characterized by low nutrient availability and must face multiple disturbances, including drought, heavy rainfall with associated nutrient leaching, herbivory, fire and ongoing climate change. Despite all these negative pressures, the primary productivity of savanna ecosystems can be as high as that of tropical forests. Among the resource conservation processes involved in savannas, one of the most emerging is BNI (Biological Nitrification Inhibition) i.e. the ability of some plants (mainly perennial grasses) to inhibit soil nitrification, the microbial oxidation of ammonia to nitrate, thus making the ecosystem less prone to lose nitrogen.

To further explore the functional relationship between savanna grasses and soil microbiota, and to get a first insight of global soil microbial diversity in savannas, we have carried out the first worldwide sampling of savanna soils: more than 250 soil samples from South Africa (2 different sites), Colombia, Namibia, Burkina Faso, and Ivory Coast with different conditions of climate, geology, herbivory, etc., were analyzed in terms of soil biogeochemistry and microbial composition using metabarcoding. We have described the total bacterial, archaeal and fungal soil biodiversity and evaluated the difference in microbial diversity between grasses that inhibit nitrification and those that do not. Furthermore, we studied the relative influence of the sites, and of the grass species (5 to 12 species per site) on the observed diversity, with the first results showing similarities among the sites of West Africa compared to other studied sites.

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POSTER

Towards a new assessment of RUSLE sheet and rill erosion for the Kruger National Park, South Africa

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Soil erosion is considered one of the most important land degradation processes. Features associated with soil erosion include the loss of topsoil, gullies and the siltation of dams. However, erosion is a natural denudation process in the context of weathering over geological timeframes. Although soil erosion is a concern in KNP, not much data is available for evaluation. The first national assessment of soil erosion based on the Revised Universal Soil Estimation (RUSLE) (LeRoux et al. 2008) provided a mean soil loss for the 18,780 km² Kruger National Park (KNP) of about 7.0 t ha^{-1} yr^{-1}.

Evaluating the 2008 RUSLE assessment based on mainly reservoir siltation mapping providing multi decadal mean values, indicated much lower values of sediment yield (0.26±0.06 t ha yr^{-1}) for the southern part of KNP. In the framework of the South Africa Land Degradation Monitor (SALDi) we addressed this obvious discrepancy. We recalculated RUSLE soil loss based on updated and higher resolution open access input data quantifying rainfall erosivity (R), soil erodibility (K) as well as the land cover and management factor (C) and the topographic factor (LS). This poster presents an updated wall-to-wall map on RUSLE-based sheet and rill erosion for the entire KNP and discusses the spatial patterns as well as ways forward to include more local scale input data.

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Tuesday

Sustainable management and protection of vulnerable African water resources through holistic environmental flow framework determination and implementation

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Africa is one the world's most biologically diverse and socially important developing regions of the world. From source to sea we dam, abstract, change, add and or disturb our rivers, lakes, floodplains, wetlands and estuaries. African nations themselves have not adequately considered the protection of biodiversity, ecosystem processes and ecosystem services required for sustainability. Today African nations are working together through water commissions in particular to establish sustainable development strategies including environmental flows (e-flows). E-flows include river flows required to sustain ecosystems. While ecosystem focused, sustainable flows have a range of social and economic benefits. E-flows are evidence based and can consider multiple spatial and temporal dynamics of ecosystems.

Holistic e-flow assessments take a source to seas approach and consider what is required from a flow, and non-flow management perspective to achieve the sustainable balance between the use and protection of water resources. In Africa we have numerous case studies of e-flows and their contribution to water resource sustainability. We explore e-flow considerations and contributions in South Africa including all of the rivers in the Kruger National Park to the Nile and its source to sea journey. We finally describe the new directions e-flow determination and management is taking and the new consideration of e-flows, not just to maintain rivers and or aquatic ecosystems, but indicator species. This includes for example migratory species such as Anguillid eels that represent connected rivers and their water, sediment and biological flows on a source to sea scale all towards regional sustainability.

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Conceptualising flow requirements for fish recruitment in the Murray-Darling Basin

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The Murray-Darling Basin (MDB) is Australia's largest and most complex river system and supports diverse ecosystems, agriculture, and human communities. The alteration of aquatic ecosystems, particularly through flow regulation, has significantly impacted aquatic ecosystems within the MDB. Native fish populations have declined significantly and consequently, restoring native fish populations is a key management goal. Environmental flows (e-flows) are an important management strategy within the MDB, however, designing appropriate e-flow programs to benefit native fish, links between watering parameters and fish responses need to be clearly understood. This requires knowledge of the processes that maintain fish populations, the key drivers of these and their interaction with flow.

Despite a good conceptual understanding of the high-level drivers of fish responses to flow within the MDB, effective management and restoration of fish populations has proved difficult due to the complexity of, and the associated uncertainty around relationships between flow modification and fish recruitment. The situation is further complicated by the inter-related effects of non-flow related stressors, such as invasive species, habitat alteration and fragmentation. A 5-year research program, focussed on fish recruitment, sought to improve our understanding of the key drivers and functional processes of successful recruitment of native fish. This presentation will describe the work undertaken to conceptualise fish recruitment in the MDB. This conceptualisation can contribute to the sustainable management of rivers on multiple spatial scales from micro or patch scale to basin scale, towards the identification of recruitment hotpots and the provision of connectivity for sustainability.

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Using an agent-based model to inform equitable water usage amongst stakeholders in the Koue Bokkeveld catchment

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Equitable sharing of freshwater resources is a contentious issue in many river catchments in Southern Africa, more so in areas with lower rainfall. Understanding how increased use by any one stakeholder can impact downstream stakeholders, might help facilitate a water management plan acceptable to all stakeholders (including the ecological reserve required to ensure sustainability of the fish species in the river). This understanding of water use within a catchment becomes even more important during times of drought, when "normal" water use needs to be curtailed. Agent-based models (ABMs) have been widely used in understanding complex socio-ecological systems, such as predator-prey interactions and firewood collectors' impact on natural resources, amongst others.

These models function by having autonomous agents (with appropriate behaviours) interact with one another and the environment in which they exist. An ABM of the Koue Bokkeveld catchment area was developed to model the water use by the different stakeholders, including large- and small-scale farmers, emerging farmers, residents and the ecological reserve. The accuracy of the model was validated by using both informal and documented historic data. A variety of future scenarios were simulated to predict the water shortages both at the individual farm level and for the catchment as a whole under the RCP 4.5 and 8 climate change scenarios. Additional scenarios were simulated to determine, amongst others, the effect that increased cultivation or expanded dam storage might have on water availability. The findings showed that increasing dam capacities, and strategic water releases from instream dams were beneficial in managing water stress and satisfying the ecological reserve requirements.

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Integrating First Nations Water Management Sciences for Climate Resilience across the Water Resources of the Murray-Darling Basin: Australian lessons for international source to sea sustainability

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Water is essential to life and deeply intertwined with the identity, culture, and spirituality of First Nations peoples in Australia. The health of rivers, creeks, and wetlands, especially in the Murray-Darling Basin, sustains not only ecosystems but also the wellbeing of Indigenous communities and Country. Despite its critical role in Australia's agriculture and economy, Western water management practices in the Basin have adversely affected First Nations communities, intensifying the degradation of vital water sources and endangering biodiversity, ecosystem processes, and cultural health. This presentation highlights collaborative research between the Gulbali Institute and the One Basin Cooperative Research Centre, a 10-year, AU$150 million program involving over 95 industry partners.

The initiative seeks to address the impacts of climate change on agricultural production in the Murray-Darling Basin, using cutting-edge ecological science and technology. Central to One Basin's approach is the integration of First Nations knowledge with water management sciences, emphasising the indispensable role of Indigenous voices in Basin governance. This research underscores that sustainable water resource management must prioritise the needs of vulnerable communities and ecosystems. Involving First Nations peoples in every stage of water management is essential to achieving lasting solutions that honour both ecological and cultural dimensions.

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The 1st joint basin survey at Limpopo River Basin, gathering data for a sustainable water management

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The Limpopo River Basin (LRB) is a transboundary system covering four riparian countries, South Africa, Botswana and Mozambique where it drains into the Indian Ocean. The basin is currently home to an estimated 18 million people and hosts some of the world´s biodiversity hotspots. The basin supports diverse socio-economic activities including agro-industry, large scale irrigation, mining, eco-tourism. However, these activities and the environmental services they rely on are threatened by increasing water scarcity and hydrological variability, exacerbated by climate change, water quality and land degradation, and increasing pressures on groundwater resources.

To consolidate existing information and gather specialist input for identifying the capacity needs of the four riparian countries, an effort was made to build the necessary skills for the integrated management of water and natural resources in the LRB. This initiative involved the first joint basin survey, which collected and analyzed data on water quality, ecosystems, and socio-economic conditions. The survey evaluated the current ecological status by considering selected river health indicators from various riverine sites within the basin. The survey revealed significant variations among the sampling sites, from the drier upper Limpopo to the wetter middle and lower sections. This variation underscored the need for collaboration in the catchment management. Effective coordination is essential to ensure that water is released from dams in the upper to maintain environmental flows, support ecosystems diversity downstream, and conserve the integrity of the entire Limpopo River.

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Multiple stressors including barriers affecting fish migrations in the of the Limpopo Basin, a Source to Sea approach

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Freshwater ecosystems and their fish are heavily utilized globally and now vulnerable and/or threatened. Despite providing valuable and often irreplaceable services to vulnerable human communities our fish are out of sight and out of mind. They face numerous threats including overexploitation; pollution; habitat destruction; altered flow regimes; invasive species and climate change which causes declines in the biodiversity, ecosystem processes and services of these ecosystems. The Limpopo River Basin has high aquatic biodiversity attributed to its historical connection with the Zambezi River. Although important, the water resources of the basin have been heavily used and today it is unclear if the rivers in the basin are able to maintain the historical fish communities. Many attributes of the fish communities in the Limpopo River Basin have been affected including the opportunity to access habitats and migrate in the region. This study considered the multiple stressors to the fish communities of the Limpopo Basin, and in particular the river connectivity and migratory requirements of species. Eighteen sites were selected in the Limpopo River Basin from source to sea and sampled extensively during high and low flow periods.

Multiple statistical, biotic lines of evidence (LoE) and otolith micro-chemistry analyses were used to evaluate the relative shifts in the community structure, migratory requirements and potential changes from the historical frequency of occurrence of species. During this comprehensive study only 37 (47%) of the expected 77 fish species were collected and significant changes in the fish communities from historical conditions were identified and described. The fish community structure is in a moderately modified ecological state, with deteriorating water quality, altered flows and habitat alterations identified as drivers of change of the fish communities. Many fish in the basin have migratory requirements which have been disrupted through barrier formation, pollution and flow alterations including changing the perennial Limpopo River mainstem and many tributaries in the basin into seasonal and or ephemeral rivers. The excessive use of the water resources and more than 101 reservoirs on the Limpopo River has caused significant change that have potentially caused many populations of fishes to become locally extinct in the basin. This constitutes an ecosystem and biodiversity crisis that needs to be urgently addressed.

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Migrations of giant pangasiid catfishes in the Mekong and Ayeyarwady Rivers, Asia

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The Mekong and Ayeyarwady Rivers in Asia are especially significant rivers because many migratory fish species provide substantial food security and economic benefits to >1 billion people, which is expected to decline in the near future. Understanding fish migration ecology is vital to prevent fish stock reductions or even extinctions of key species. Particularly, connectivity between rivers and the ocean is globally critical for many fishes. But migrations of fish species for spawning and feeding still remain a mystery for many fish species in the two river basins. In this study, migration of key pangasiid catfish species was examined by otolith or ear-bone chemistry in two different river basins: the Mekong and Ayeyarwady Rivers.

By investigating distribution of key trace elements in sectioned otoliths using two methods (Laser Ablation – Inductively Coupled Plasma Mass Spectrometry and Scanning X-ray Fluorescence Microscopy), we found that at least four pangasiid catfish species exhibited anadromous traits (spending most of their lives in marine water, but migrating to freshwater to breed) in both river basins: the Mekong (*Pangasius krempfi* & *P. mekongensis*) and the Ayeyarwady (*P. pangasius* & *P.* sp.). They migrate over 1000 km between feeding and spawning grounds. Multiple migration strategies were found for the catfishes in this study. It is required free flowing rivers to protect these long-distance migratory and highly economic-value species from declining or disappearing in the future.

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Drugs, Guns, and Eels: The Global Decline of Anguillid Eels in East Africa and Beyond

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The global decline of Anguillid eels (genus *Anguilla*) presents a critical challenge to biodiversity. The complex and migratory life cycle of these eels, from their enigmatic oceanic spawning to their migration into and out of freshwater systems across the Western Indian Ocean (WIO) region is still poorly understood. The ecological and economic importance of eels in East African communities, and globally, will be highlighted, noting their role in supporting food security, local livelihoods, and cultural traditions. Recent eel population declines have been driven by multiple factors, including habitat degradation, overfishing, and the obstruction of migration pathways, with these challenges further compounded by the illegal trafficking of glass and silver eels.

The presentation will also investigate the intersection between eel exploitation and organised crime, where glass eels have become a lucrative commodity in international black markets. Particular focus will be placed on the threats to eel species in the WIO and other populations around the Indian Ocean, alongside potential conservation strategies to address the impacts of unsustainable fishing and trafficking. Raising prominence to this important issue, and describing solutions, is of significant relevance to sustainable catchment management across the globe.

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The migration of aquatic macrocrustaceans over an artificial barrier in the uThukela River, South Africa

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Diadromous macrocrustaceans need connectivity between the ocean, estuary and river to complete their life cycle. Instream barriers in lower reaches of rivers threaten upstream migrations of diadromous macrocrustaceans. Varuna litterata migrate upstream after a spawning event out at sea. These migration events have been poorly documented. We documented the presence V. litterata and Macrobranchium spp. at a vertical slot fishway and a rock ramp on the Lower Thukela River Bulk Water Supply Scheme Weir, KwaZulu-Natal, South Africa, during 2021- 2022. We found Macrobrachium spp. and V. litterata made use of the rock ramp. However, the vertical slot fishway did

hinder the migration of V. litterata significantly, as found in other studies.

Our research demonstrates the need to consider any and or all ecological components of ecosystems appropriate to its location and dynamics towards holistic sustainability. In the lowland rivers of southern Africa fish and macroinvertebrates require river connectivity and management for survival. Fishpass facilities are important and rarely considered in our region but when they are constructed careful attention to what needs the fishpass should be given. For sustainable water resources management new information on the migratory requirements of aquatic animals and how to meet their requirements is needed in southern Africa.

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The Impact of Anthropogenic Barriers on Fish Communities in the uMkhomazi River, South Africa

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Anthropogenic instream barriers such as weirs and dams may produce significant drawbacks for large scale migratory aquatic species. Here we aimed to assess the effect of four weirs and their impact on fish communities and African freshwater eels. The study was conducted in the uMkhomazi River in KwaZulu-Natal, South Africa, using electronarcosis to catch the individual fishes including African freshwater eels (*Anguilla* spp.). We found that the KwaZulu-Natal yellowfish *Labeobarbus natalensis* was the most abundant fish species caught and species abundance and diversity decreased as altitude increased.

There was a significant level of unevenness between communities in the respective river fragments separated by the existing weirs potentially restricting the longitudinal movement of fish. In addition, we found that the eels were present in all river fragments except the most upstream river fragment. We suggest that all existing weirs should be retro-fitted with a suitable and effective fishways, and that the proposed weirs and dams for the river have fishways included, in order to maintain a strong level of connectivity, to better protect and conserve the migratory fish within the system.

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Source to sea management considerations of the fishes of the Incomati basin, southern Africa

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Freshwater ecosystems are threatened worldwide and face multiple stressors that affect ecosystems and the services they provide to us. The Incomati Catchment is one of the most ecologically important water resources in South Africa. Land use changes resulting in altered flows, water quality and habitat affect the basin from source to sea. In addition, invasive species and migration barriers exacerbate regional impacts. These LoEs include the use of biological indices (e.g. Fish Response Assessment Index), multivariate statistical methods and Bayesian Network (BN) in ecological risk, probability models. The aim of this research is to implement LoEs to determine the state of the fishes of the Incomati Basin, what is driving the fish communities and how to manage the rivers to restore or maintain sustainable populations and communities.

Of the expected 77 fishes in the basin, 64 were collected from 54 sites from the source of the Incomati to the Indian Ocean. Most of the catchment is developed and moderate to high impacts have affected fish communities. Environmental drivers of change where attributed to flow reduction, water pollution, habitat loss and barriers. Fish communities are generally in a moderately modified but sustainable state with communities shifting towards more tolerant species throughout the catchment. The risk assessment suggested that low to moderate risk is expected for fishes in the Incomati Catchment. Regional water resource and environmental management of the rivers and fish in the basin using good global practice, with fisheries development options are available and need to be considered.

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The present and future of ephemeral freshwater in the Kavango-Zambezi Transfrontier Conservation Area

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Across southern African savannas, terrestrial wildlife depend on freshwater resources to access the vast, vegetated landscapes between permanent rivers. Small pools of ephemeral surface water, which fill in the wet season and shrink or disappear in the dry season, provide drinking water, support access to vegetation far from rivers, and facilitate seasonal migrations. Despite their importance, these widespread resources often go overlooked. Global surface water products accurately delineate large, permanent rivers, but maps of ephemeral waterholes are difficult to create using static remote sensing techniques. This omission leaves a critical gap in our understanding of how freshwater

resources drive animal movements across savanna landscapes, and how these resources might change on a warming and drying landscape under climate change.

For the first time, we present seven years of data (2018-2024) for over 2 million ephemeral waterhole locations and seasonal sizes in the world's largest transboundary conservation area, the Kavango Zambezi Transfrontier Conservation Area (520,000 km^2). Using an Otsu thresholding technique on refined Sentinel-2 data, we found that waterhole persistence and stability depended on ecoregion, rainfall inputs, and topography, as well as individual waterhole characteristics. In addition, preliminary data show that the driest year (2023) saw waterholes shrink to less than half their average size. This project provides not only the largest ephemeral surface water dataset in southern Africa to date, but a dynamic perspective offers insight on the fate of seasonally drying water sources in a region predicted to lose 10-20% of its annual rainfall under 2°C of global warming.

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Occurrence Records of Sub-Saharan African Freshwater Molluscs: Gaps and Patterns

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Freshwater molluscs serve as vital bioindicators of ecosystem health but have lacked research in terms of their conservation status. The Mollusca phylum ranks third on the IUCN Red List in Africa with 656 freshwater species. Among these, 39.6% are least concern, while 12% are critically endangered. Alarmingly, 22.4% are data deficient indicating more research is needed to confirm their conservation status. Thus, this research aimed to analyse the availability of freshwater Mollusca occurrence records and molecular data (barcode data) in sub-Saharan Africa, highlighting gaps in data and challenges in conservation assessments. Using Global Biodiversity Information Facility (GBIF), occurrence data for African Freshwater Mollusca were retrieved.

The data was filtered to include only mainland sub-Saharan Africa and then sorted taxonomically by species with taxonomy being confirmed via Molluscabase. The IUCN Red List status was matched to each species. Additionally, cytochrome oxidase I (COI) barcode availability for these species was assessed using The Barcode of life Data System (BOLD). The analysis of the 43 Sub-Saharan African countries revealed significant disparities in data availability. A total of 36,927 records were identified, with South Africa (6,683 records) and Tanzania (4,299) having the highest number of occurrence records. Most records were concentrated in Central and Southern Africa. Out of these 15% of Sub-Saharan molluscs are regarded as endangered/ critically endangered. Additionally, only 94 species had COI barcodes available. This research highlighted how freshwater Mollusca research and conservation is lacking in Africa, even though Mollusca is seen as the most at-risk freshwater taxa globally.

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Sampling freshwater fishes in dangerous waters

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Freshwater fishes are sampled for a variety of reasons including biodiversity surveys, fisheries assessments, and as indicators of aquatic ecosystem health. Conventional sampling uses active (e.g. seine nets, electrofishing) or passive (e.g. traps) gears deployed by wading into the waterbody or from a boat. However, this may be challenging in waterbodies with physical (e.g. fast-flowing waters, sunken trees) and biological (e.g. aquatic megafauna) hazards. Collection of environmental DNA (eDNA) water samples using unmanned-aerial-vehicle sampling presents unique opportunities for sampling remote waterbodies and where densities of dangerous megafauna are higher (e.g. isolated hippo pools). This approach has been successfully tested and validated for several regions (e.g. Smith et al., 2024).

However, water samples alone may not be sufficient in areas of high endemism, such as South Africa, as sequences may not exist for locally endemic species, as has been found for the Cape Fold Region (VanNynatten et al. 2024). Therefore, it may be necessary to collect additional samples to confirm species. We are developing methods to set GoPro cameras and small fish traps underwater using a drone to overcome these challenges; however, underwater images may not be sufficient to confirm endemic species. Fishes caught in traps could be used in conventional barcoding and subsequent phylogenetic studies and also to develop primers to analyze eDNA samples. We are planning conducting a pilot study in Kruger National Park to collect eDNA, underwater images, and specimens using a drone to identify fishes present in remote pools in intermittent waterbodies.

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Risk Assessment of Microplastics in Major Rivers in the Kruger National Park, South Africa

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Plastic is a versatile material that is accessible and convenient to humans. However, it has become an ecological and environmental hazard as it degrades into microplastics; plastic particles of <5 mm in their longest dimension. Microplastic risk assessment studies in South African river systems remain limited. Accordingly, microplastic concentrations were determined from Olifants and Sabie River water samples. We further conducted a microplastic risk assessment of the Olifants and Sabie rivers and derived microplastic particle estimates for the five major Kruger National Park (KNP) rivers. We calculated the Microplastic Risk Index score using the association between the polymer risk index (Hi) and the polymer hazard score. Microplastic risk assessment (derived from the Microplastic Risk Index score) was done based on four risk categories. Namely, <150 (I) low, 150 – 300 (II) moderate, 300 – 600 (III) high, 600 – 1200 (IV) very high, and >1200 (V) dangerous.

The Olifants River water was categorized at a dangerous level of risk (level V) and the Sabie River water was at very high risk (level IV). Microplastic particle flux estimates were calculated using the association between microplastic concentration and river runoff. The Olifants River had the highest estimated microplastic particle flux (1.55×10^6 n/month) compared to the other major rivers. This means that the Olifants River water has high microplastic particles that could be bioavailable. Furthermore, the water is contaminated by microplastic polymer types that are very toxic to aquatic life and have long-lasting effects. Finally, rivers need management from their headwater into the sea, thus the microplastic risk and particle flux observed in the KNP rivers require local and international interventions.

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Rapid establishment and impact assessment of the Redclaw crayfish invasion across the Kruger National Park's major river systems

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Freshwater biodiversity is declining six times faster than terrestrial biodiversity. A major driver of decline is negative impacts caused by non-native invasive species. Africa has no native crayfish, thus the rapidly spreading invasive Redclaw crayfish (*Cherax quadricarinatus*) is phenotypically novel and likely to cause severe ecological damage. Redclaw crayfish are NEM:BA Category 1b species and mandated to be managed and not spread between water bodies. Determining establishment extent, mechanisms of spread and impact are pre-requisites to management actions. We document the spread of Redclaw crayfish in Kruger National Park (KNP) rivers since the initial report in 2017, assess their impact on fish and macroinvertebrate biodiversity, and suggest management priorities.

The invasion is established in the Crocodile River, spreading downstream at 3.96 km/yr and upstream at 2.64 km/yr from the Van Graan Dam (invasion core). We identified a previously unreported invasion in the Sabie – Sand River, but currently there are no crayfish at detection threshold in the Olifants, Letaba or Luvuvhu rivers. There were no signals of spatial sorting or morphological changes along the invasion gradients and there were no discernible effects of crayfish presence on freshwater crab presence/absence nor on fish assemblages. This is likely due to the invasion still being in its infancy with abundances within the park being far lower than in other invasion cores. Crayfish presence/absence is significantly affecting macroinvertebrate community assemblage most likely through predation. Flow regimes and biotic resistance within the KNP could be suppressing impacts and spread rates.

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Characterisation of wetlands on various landscapes in Marakele National Park, Limpopo Province, South Africa

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Marakele National Park (MNP) situated in the Waterberg Mountains and adjacent plains, in Limpopo Province, supports a range of wetland types across various

landscapes. These diverse wetlands in MNP are shaped by its variety of landscapes, elevation, temperature, and rainfall patterns. These wetlands significantly contribute to the park's biodiversity, with smaller wetland systems primarily found in higher elevation areas that receive more rainfall, while larger floodplain systems are located in the lower northwestern plains. This presentation aims to share preliminary findings from our study characterising the wetlands within MNP. Our main objective is to assess the ecological value and functions of these wetlands across the landscape level. We selected three distinct wetlands situated in various landscape settings for this research.

Soil sampling was systematically conducted across designated Hydrogeomorphic (HGM) wetlands, targeting two units per site. For hydrological assessment, well nests were installed in soil pits, with water samples analysed for pH, electrical conductivity, total dissolved solids, and radiocarbon content. Vegetation sampling used the Braun-Blanquet approach, and floristic data were organised in Excel, then exported to JUICE software (version 7.1) for analysis. A 2D Top Drive groundwater model illustrated groundwater flow patterns across transects. This study aims to enhance understanding of HGM wetland types across landscapes by examining soil, hydrology, and vegetation, contributing insights into their ecological functions and supporting conservation efforts within MNP.

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Testing different means to assess KNP's frog diversity and a discussion of conservation outlook

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The Kruger National Park (KNP) is home to thirty-four known frog species. However, the last comprehensive frog survey was conducted four decades ago by Dr U. de V. Pienaar. Studies specifically relating to new frog records, conservation and monitoring in the Kruger National Park have since been limited. Thus, there is a need to update the literature and inform monitoring and conservation efforts. Frogs and their tadpoles are important indicator species for rivers and wetland ecosystems, making them a focal point for various monitoring programs.

Five survey methods (tadpole traps, drift fences, dip netting, eDNA and acoustic monitoring) were used to detect amphibian and tadpole species occurring in the Olifants and Letaba Rivers at four different sites (Lonely Bull, Balule, Vyeboom and Klip Koppies) during the dry season 2024. The sites form part of the KNP annual freshwater monitoring program, but frog data is not currently collected as part of this monitoring programme. Acoustic monitoring using AudioMoth devices proved to be the most effective method for detecting adult frog species compared to other survey methods. The advantage of this is that it is a low cost but effective monitoring tool which could be implemented into the freshwater monitoring program.

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POSTER

Seasonal river in the Kruger National Park contributions to fish communities and migrations

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Seasonal rivers have a significant impact on broader aquatic ecosystems, including the recruitment, migration, and germination of aquatic biota. These factors play an important role in freshwater systems in providing the essential ecosystem services on which we depend. With a limited understanding of seasonal rivers and how ecological indicators such as fish communities are structured, we must understand the diversity to identify flagship species that can be used to conserve these important ecosystems and bridge the knowledge gap. The study aimed to investigate the diversity of fish communities and assess the general community structure within seasonal rivers of the southern Kruger

National Park. Thereby providing preliminary data on these systems within the global south context. Fish were sampled using a multi–method approach in the Biyamiti, N'waswitsontso and Nsikazi Rivers between January 2020 and August 2021.

The study found a high fish species richness, but low abundance, particularly during the winter months due to unique ecological and hydrological conditions. The low rainfall received during the summer of 2020 resulted in low water flows and a low number of pools that formed within these systems. The dominant fishes were Oreochromis mossambicus, *Enteromius trimaculatus*, *Micralestes acutidens*, *Enteromius viviparus*, *Brycinus imberi* and *Labeo ruddi*. These fishes are the main drivers and pioneer species of the seasonal rivers sampled at the Kruger National Park. The current study highlighted that aspects of temporal and spatial environmental fluctuations, such as seasonality, exerted strong controls on fish biodiversity, as highlighted by differences in richness numbers over three seasons. Understanding the influence of seasonality, predictability, and spatiotemporal dynamics of physico–chemical variable oscillations on fish diversity within seasonal rivers will provide a clear understanding of their community structure and enable the better management of these fish species and associated river systems in protected areas.

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POSTER

Diatoms as bioindicators of water quality in KNP rivers

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Diatoms are valuable bioindicators for assessing water quality in aquatic ecosystems. Their sensitivity to various ecological parameters makes them particularly useful for monitoring changes in environmental conditions. Their presence or absence can indicate levels of pollution, organic matter, and overall ecosystem health. This study aims to assess water quality within KNP rivers using diatoms as bioindicator and to determine species tolerance, evenness, abundance, dominance, diversity, SPI scoring and ecological status of each river. Water quality parameters TDS, pH, temperature, and EC were recorded at various sites within the KNP rivers. Diatom samples were collected, processed, and analysed. Water quality and diatom counts were analysed using a Principal Component Analysis.
The results indicated that sensitive and tolerant species were separated according to the different physicochemical parameters they inhabit.

PCA revealed that TDS and EC were the primary drivers of diatom community composition. The Olifants river had a high species dominance, with dominating species being *Gomphonema venusta*. This species' dominance indicates that it thrives under the specific conditions of this river, particularly the elevated levels of TDS and EC. High species diversity, abundance and evenness was observed at the Luvhuvu River. This indicates a well-balanced diatom community, predominantly consisting of sensitive species that thrive under less disturbed conditions. The Letaba River demonstrated the lowest species richness as well as the least diversity among the rivers studied. This may indicate unfavourable conditions that limit the variety of diatom species able to thrive in this environment. Further analysis is still underway to determine SPI scoring and river eco-status.

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POSTER

Do we know enough to make management decisions for Kruger's' stillwaters?

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Sound baseline knowledge is key for effective management, but in systems with limited data, modelling can provide insights and help guide decision-making. Whilst Kruger National Park's lotic systems are historically well studied allowing for informed current management, the lentic and temporary waters are relatively data poor. This project used available literature and Bayesian modelling to shine light on knowledge gaps regarding lentic and temporary water bodies in Kruger National Park.

Current published research on these systems was synthesized and used to build a model on which the potential outcomes of various future scenarios, such as climate change impacts and large mammal management strategies, could be explored. By highlighting the possible consequences of different management actions, this study provides a basis for management decision making. The findings underscore the need for targeted research to fill critical knowledge gaps, allowing for more refined and effective conservation planning in Kruger National Park's dynamic aquatic environments.

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The Sustainable African Rivers Initiative (SARI) - towards the conservation and sustainable development of southern Africans freshwater ecosystems

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Southern Africa's freshwater ecosystems are biologically diverse and provide ecosystem services that many human communities depend on for their survival in the region. Our freshwater ecosystems are important and they are being developed for the social upliftment and national/regional economic development. Multiple anthropogenic stressors associated with the development and excessive use of our freshwater ecosystems, threaten their sustainability. These stressors affect our biodiversity and people who depend on our ecosystems. Stakeholders of the region have established national and regional, trans-boundary programmes including strategies, policies and some legislation towards balancing the use and protection of our resources. These programmes require knowledge of our ecosystems, biodiversity, ecosystems processes and their sustainability requirements, and ecosystem services needs, and how stressors affect these ecosystems.

Charles Sturt University (CSU) and southern African partners with funding from the Oppenheimer Generations, Research and Conservation programme and leverage and scholarship funding from CSU are launching the Sustainable African Rivers Initiative (SARI). The SARI is a research initiative that aims to make a noticeable contribution to our understanding of our ecosystems, biodiversity, ecosystems processes, ecosystem services and the threat of stressors affecting ecosystems. With regional and international support SARI will grow and make a real contribution to the sustainable use and protection of our vulnerable ecosystems in southern Africa.

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How do we define and measure ecosystem resilience in savannas?

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Climate change and biodiversity loss are affecting ecosystems across the globe. Savannas are no exception. The theme of this year's conference is 'Re-imagining conservation: healthy, sustainable, climate resilient savannas that benefit people'. But what are climate-resilient savannas? And how can the concept of resilience be defined in a savanna context? Resilience theory is well developed mathematically and theoretically, with resilience defined as the amount of environmental change or disturbance a system can withstand before it 'tips' to another state. Different indicators of ecosystem resilience are used but many consist of some spatial patterning of key vegetation states (e.g. soil versus vegetated patches, woody versus non-woody states, etc.).

However, savannas are disturbance-driven ecosystems, where different vegetation and ecosystems states and spatial patterns (i.e. differing tree-grass ratios) can co-occur under the same environmental conditions for a very long time, depending on the disturbance regime. This leads to questions such as; if and how can resilience theory be applied to savannas? What indicators could we use to define and measure savanna resilience? We will explore these questions and focus on both compositional and structural indicators along environmental gradients. We will also present how a new research program will try and find answers to these questions using data from a long-term woody vegetation monitoring program in Hluhluwe-iMfolozi Park (HiP) and from the SEOSAW (Socio-Ecological Observatory for Studying African Woodlands) network. Finally, we will discuss our findings in the light of resilience theory to address the question how do we define and measure ecosystem resilience in savannas?

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Encroaching species are stronger anisohydric "water spenders" under elevated CO_2 conditions: Implications for savanna seedling establishment rates

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Plant water transport systems play a fundamental role in the productivity and survival of terrestrial plants due to the vascular architecture placing a physical limit on metabolic function. Savannas have high variability in rainfall, leading multiple studies to suggest that plant water-use strategies are key mechanisms affecting seedling establishment rates. Many savannas are seeing a directional shift towards an increase in the abundance of certain woody species through a process known as bush encroachment, which has been largely attributed to the fertilising effect of rising atmospheric [CO_2] on C_3 trees. These species are classified as encroachers. While there have been multiple studies investigating changes in the physiology of savanna species under elevated CO_2 (eCO_2), few have examined how climate and eCO_2 affects the fundamental water-use strategies in the seedling stage, a crucial demographic bottleneck. Here, I provide valuable insights into the mechanisms behind bush encroachment in the context of eCO_2 using results from a pot experiment at the Rhodes University Elevated CO_2 facility and a field experiment.

All species showed water use strategies characteristic of anisohydric "water-spenders", however, the vulnerability to embolism and rates of water-use were different

between encroachers and non-encroachers. Encroachers are better at taking advantage of water pulses, particularly under eCO_2 and grass competition. This comes at the cost of higher xylem vulnerability during drought, leading to reductions in conductance when exposed to heavy water stress. The response of the photosynthetic parameters mirrored this, with encroaching species had higher rates of photosynthesis and photosystem II quantum yield than non-encroachers under the well-watered treatments. Field experiments revealed that small trees are particularly vulnerable to drought stress, when compared to medium and large trees. The outcomes of this complex response will largely depend on the extent of changes to biotic and abiotic factors across spatial and temporal zones caused by climate change. This research highlights potential hydraulic mechanisms contributing to the increase in bush encroachment, as well as providing important insights into the determinant factors that make a savanna species capable of encroachment.

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Rainfall, peak river flow and flow variability drive spatiotemporal change in the extent of riparian woodland in an African protected area savanna

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Verbal accounts, supported by limited ground-based and satellite images, reveal decreasing riparian woodland and a loss of large trees along the rivers of the Kruger National Park (KNP, South Africa) over the last century. A multi-decadal analysis was conducted to identify trends in extent and possible drivers of riparian woodland change. Aerial and satellite imagery (1936–2018) were used to quantify changes in the extent of riparian woodland at 18 sites on 14 rivers in KNP. These changes were compared in a multivariate time-series with river flow and local rainfall. Particular attention was paid to cumulative flow effects, as well as the frequency and magnitude of large infrequent disturbances such as droughts and floods. Riparian tree cover fluctuated over the time period, and the trajectory of change varied between sites.

Most (11) sites experienced a decrease in overall riparian tree cover over 80 years, with these declines being significant at six sites. Peak flow and maximum rainfall events were strongly associated with these decreases, indicating that flood events are potentially the biggest driver of tree loss from the system. Indeed, the mega-flood event of 2000 and subsequent large floods have resulted in substantial declines in riparian woodland extent in recent decades. Alternatively, flow variability and cumulative rainfall significantly influenced woodland expansion in isolated cases. With global change models predicting more erratic rainfall and an increased likelihood of large infrequent disturbances, together with increasing demands to abstract more water, the long-term future of these dynamic habitats and their associated biota here is uncertain.

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CO_2 fertilization of C_4 grasses across experiments, field observations, and models

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Rising atmospheric CO_2 concentrations are impacting the global terrestrial biosphere through indirect climate effects and direct effects on plant performance. In tropical forests, long-term monitoring indicates CO_2 fertilization of tree productivity and a net carbon sink. However, in C_4-grass-dominated tropical savannas, covering ~20% of the land surface and contributing ~30% of terrestrial net primary production, equivalent long-term analyses of CO_2 responses are lacking, with unclear outcomes for carbon dynamics. Here, by combining a meta-analysis of 70 CO_2-addition experiments, 32 years of *in situ* field observations from Kruger National Park, South Africa, and vegetation simulations via the Community Land Model, we show a clear and consistent result: CO_2-fertilization of wild C_4 grasses is widespread, especially in dry conditions.

In experiments, grasses reduced their stomatal aperture under higher CO_2, limiting water loss while increasing carbon gain. In the field, improved water use efficiency translated into increased C_4 grass productivity, observed across three decades of observations. This trend is predicted by regional vegetation modelling to continue into the future. CO_2 fertilization of C_4 grasses has major implications for savanna ecosystem function,

since productivity gains were concentrated aboveground and may not lead to greater carbon storage but be lost to decomposition or disturbance.

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Competition Mediates CO_2 Fertilization Effects in Grassland and Savanna Ecosystems

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Savanna ecosystems, characterized by the coexistence of grasses, shrubs, and trees, are particularly sensitive to rising CO_2 levels, which drive changes in both plant productivity and community composition. Elevated CO_2 (eCO_2) can stimulate plant growth by enhancing physiological performance, but these effects are often moderated by competitive interactions for limited resources. We hypothesized that in savanna and grassland ecosystems—where shifts in species composition are already underway—the response of plants to eCO_2 is determined not only by their intrinsic growth potential and eCO_2 responsiveness but also by their susceptibility to competition from other species.

By analyzing data from eCO_2 enrichment studies conducted across grassland and savanna ecosystems worldwide, we found that competitive interactions, especially between different plant functional groups, can diminish or negate the positive effects of eCO_2 on plant growth. Our results suggest that competitive ability plays a crucial role in determining plant responses to eCO_2, while eCO_2 itself does not ameliorate the negative impacts of competition. Notably, traits associated with rapid growth and invasion/encroachment potential conferred a competitive edge under eCO_2, indicating that future climate conditions may intensify plant invasions and encroachments in savannas and grasslands. These findings underscore the critical role of competitive dynamics in predicting ecosystem responses to climate change, as they strongly influence how plant communities respond to eCO_2. Moreover, this research reveals the complex nature of plant responses in savanna and grassland ecosystems and points to the potential for significant shifts in community dynamics, including increased invasions, under future climate scenarios.

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Atmospheric nitrogen deposition and large herbivores shape woody cover change

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The increase of woody plant cover ("woody encroachment") is leading to marked changes in many open ecosystems, which has important consequences for biodiversity, ecosystem functioning and climate feedbacks. In addition to abiotic factors such as precipitation and temperature, herbivores are thought to be a key factor influencing woody cover dynamics. However, their impact has been difficult to evaluate at large scales due to a lack of accurate data on herbivore densities and functional composition and generally low herbivore densities globally. Moreover, given that an increase of woody cover occurs across climatic and biogeographic gradients, a frequently discussed global driver of woody cover change is the elevated atmospheric CO_2 concentration. The effect of CO_2 fertilization on plant growth, however, is strongly limited by nutrient availability, raising the question about the impact of atmospheric nitrogen (N) deposition on woody cover change.

To investigate the impact of large herbivores (>10 kg) and N deposition on woody cover dynamics, we gathered a large spatially explicit dataset of mammal communities (n = 396), distributed across bioclimatic gradients in South Africa. As environmental heterogeneity is a strong driver of biodiversity, we also investigated the impact of large herbivores on heterogeneity in the woody layer. We found that functionally diverse herbivore communities at high densities were associated with slightly slower rates of woody expansion and increased heterogeneity in woody cover. Moreover, we found that an increase in woody cover is strongly linked to atmospheric N deposition. Based on these results, we suggest ambitious megafauna restoration to help slow down an increase of woody cover and increase biodiversity potential of increasingly woody systems. However, consequent additional measures (i.e., a reduction of N and CO_2 emissions) are required to maintain open ecosystems.

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Leaf tolerance to heat on savanna species: what we known and what is missing

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According with the IPCC, the rising world temperatures have begun to influence function of tropical species, especially at seasonal systems as savannas. This implies significant challenges for plant persistence, pushing them beyond the optimal threshold for critical physiological functions. We produced curves of heat tolerance in 30 tree typical savanna species (from Cerrado, Brazil), using temperatures ranging from 25 to 60ºC in in a thermo-static bath. A four-parameter sigmoidal logistic curve was fitted to the Fv:Fm data (photosynthetic parameter) at different temperatures to obtain T_{50} :the temperature at which the Fv:Fm of leaf is reduced 50% of its initial (pre-treatment) value. We found that T_{50} ranged from 46 to 58ºC, with an average of 49.9±2.62º. When analysing for phenological groups (evergreens and deciduous) no statistical differences were found (50.33± 2.20, 49.47±3.05, respectively).

Thus, leaf phenology does not affect leaf heat tolerance. These values are higher than those reported for forest environments (values from 42-48ºC), showing that savannas are especially tolerant to heat. These values show that savanna woody component is very tolerant to heat, but nothing is known for heat tolerance of herbaceous species, especially forbs and grasses, which are the main components of savannas. We recently approved a grant (FAPESP 2023/16620-0) that will assess these aspects on herbaceous stratum, aiming to understand if fire regimes can induce higher heat tolerances. We aim to fill the gaps of heat tolerance aiming to the understanding on how savanna species will respond to temperature increases reported by the IPCC.

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Baobabs (and canaries) in the coal mine: indicators of large-scale tree mortality and avian population threats from an increasing elephant population

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With the proclamation of Mapungubwe National Park (MPNP, South Africa) in 2004 and the removal of the border fence came the return of elephants to this landscape across the Limpopo River from Zimbabwe and Botswana. Farming activity and fences erected during the previous century meant that there was an extended period of elephant absence in the area. Environmental concerns, from other studies, have been raised as the increasing presence and number of elephants is leading to the mortality of many trees through ringbarking, goring, and pushing over. This raises questions about the ecological repercussions on other biodiversity, especially nesting birds, including IUCN threatened species, that require such habitat for breeding.

A study conducted in June/July and November/December 2023 investigated the impact of elephants on large trees, particularly baobabs, and woody vegetation more broadly, including smaller trees and shrubs, in both riparian and non-riparian habitats of MPNP. Extensive and severe damage to large trees were documented and modelled to spatial and physical tree characteristics, and multiple mortality events recorded. Avian nesting assemblages threatened by the loss of large trees include entire guilds of species, from cavity nesters to large raptors (biodiversity 'losers'). Further findings showed that physical characteristics make much of the remaining woody vegetation unsuitable as alternative nesting habitats, e.g. shrubs are too short or thin. This study lays the groundwork for a historic-change GIS analysis, highlights the undocumented threats to the avian population and the remaining large trees in MPNP, and proposes management actions for conservation planning.

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POSTER

What is the fate of baobabs in our National Parks and what can be done about it? A case study from Mapungubwe

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Baobabs (*Adansonia digitata L.*) play a crucial role in the ecosystems of Mapungubwe and Kruger National Park by providing food, shelter, and nesting sites for various bird, mammal, and reptile species. These iconic trees have thrived in these landscapes for millennia, with some individuals dating back to the Mapungubwe and Thulamela eras. However, in the past five years, numerous baobabs have been severely damaged or killed by elephants, leading to significant losses in biodiversity and cultural heritage. Traditional deterrents, such as beehives, chili bags, and rock or log barriers, have proven ineffective in protecting these trees. To address this challenge, a trial was initiated in 2021 to assess the efficacy of meshing baobabs with diamond mesh as a protective measure.

After two years of observation, results from 2023 indicated that all meshed trees remained unharmed by elephants, while control trees without mesh suffered extensive damage, resulting in many fatalities. This study demonstrates that tree meshing is a viable and sustainable strategy for protecting baobabs from elephant damage. Given the importance of these trees for ecological integrity and cultural significance, it is essential that future management plans incorporate

budgeting for tree meshing initiatives to ensure the continued presence of baobabs in our parks. Effective conservation strategies are vital for protecting these magnificent trees and the biodiversity they support for generations to come. The primary aim of this presentation is to showcase the results of employing diamond mesh wire as an alternative tool and solution for the protection of iconic species.

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The demise of the Shimuwini baobab in the context of baobab adaptation and climate change

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The death of the Shimuwini baobab highlights a debate about baobab adaptation and climate change. The Shimuwini baobab was dated using radiocarbon to 1000 years, and it patently survived climate cycles such as the Medieval Warm Period and the Little Ice Age. Attention must be given to mechanisms that link climate to baobab adaptation and deaths. The Shimuwini baobab suffered internal rot that propagated outward from the core until its structural integrity was compromised. The pathology is widespread among baobabs in southern Africa from Namibia through to Madagascar, and may be why several superlative baobabs in the region have collapsed or died. Initial observation fed a misinformed media frenzy suggesting the possible extinction of baobabs because of climate change.

The cause and impact of core-rot on baobabs is difficult to assess because visual assessments of extant baobabs cannot determine its prevalence, while growth and environmental adaptation data have been misrepresented. Assessment of baobab buttressing, hollowing and stem fusion, suggests that core-rot events have occurred at multiple times in the past. These architectural features are concentrated in southern African baobabs, and while core-rot may lead to the demise of certain individuals, like the Shimuwini baobab, it is also a mechanisms that may allow other individuals to reach ages in excess of 2000 years. Climate is the likely cause of the core-rot, but it will not cause baobabs will go extinct. Indeed, short term threats such as elephant damage present a far greater threat to populations in protected areas.

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Rebranding "sustainable" wood fuel harvesting by estimating historical elephant treefall rates across Africa

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Elephants are one of the major drivers of tree stem loss in African ecosystems, yet they are now spatially constrained and no longer topple trees across the continent. Thus, most African landscapes lack a key ecological agent. Rewilding with elephants is often not feasible or desirable, but if we can quantify their impact we could replicate it through fuelwood harvesting and other human activities. We collated empirical data on treefall rates in ecosystems with and without elephants and used this to predict past tree loss (and associated uncertainty) spatially across Africa.

We compare this to estimates of human woodfuel harvesting rates to assess where this activity might be considered an ecologically appropriate rewilding tool. Although the maximum human woodfuel use can be four times what we expect elephants to have achieved we identified 5.01 Mkm^2 (or 21%) of sub-Saharan Africa where treefall due to human activities is within the range expected for elephants. This method provides an alternative approach to assessing degradation and setting standards for carbon-capture projects in Africa.

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The decline of African riparian forests - what are the real causes, and is restoration feasible?

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Demographic processes of savanna trees regulate the response of ecosystems within the Kruger National Park (KNP) to both local drivers (herbivores and fire) and global ones (climate and atmospheric CO_2). While some short-term research has been conducted on tree demography, there are few long-term studies that test the role of these drivers. This is a gap, as savanna trees are often long-lived and recruit episodically. To address this, a long-term demographic study was initiated inside and outside of KNP. 2 984 individual trees and shrubs were tagged in permanent plots at 5 sites. Elephants were absent from 1 site, and all large herbivores excluded from half the plots at another 2 sites. Individuals taller than 30cm were measured and tagged, and monitored annually.

Seedlings were counted annually. From 2012 to 2023 annual mortality varied from 0 to 9.1%, with only a week effect of rainfall (despite a severe drought from 2016-2019). Tree size and elephant were better predictors of mortality, with mean rates 2-3 times higher at sites with elephant. Annual height increases were higher at sites with higher rainfall or no elephants. Seedling recruitment was highly variable, with a clear reduction during the drought. Over 12 years, tree density and height were stable or declined in plots exposed to elephants, but

increased significantly for those protected from elephants. These results show a key role of elephant in regulating the abundance of both short and tall trees. Any increases in recruitment or growth in response to increased atmospheric CO_2 or larger rainfall events were negated by elephant impacts.

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Structural and compositional responses of savanna trees to megaherbivore reintroduction following two decades of experimental exclusion

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African savannas support the world's greatest density and diversity of large mammalian herbivores, which collectively shape vegetation abundance, composition, and structure. The effects of herbivores on savanna vegetation are well documented, in large part due to an informal network of herbivore exclosure studies. By simulating savannas without large herbivores, exclosure studies have shown that wild browsers and grazers are critical for preventing woody encroachment and maintaining plant diversity, among other direct and indirect effects. Less commonly—but no less important given the growing interest in wildlife restoration throughout the continent—the *removal* of long-standing herbivore exclosure fences can provide crucial insights into the impacts of reintroducing large herbivores after prolonged defaunation and the resilience of savanna vegetation more broadly.

To this end, we report the results of a long-term (1999-2017) herbivore exclosure study at Mpala Research Centre (Kenya), including recent (2017-2024) changes that occurred after exclosure fence removal. The most notable effect of exclusion was a near doubling of tree cover in the absence of herbivores over approximately two decades. Importantly, this change was driven by species-specific shifts in tree structure, density, and recruitment rather than universal increases in tree size or abundance. The reintroduction of herbivores resulted in the reversal of some, but not all, of the changes associated with long-term defaunation. Despite concentrated herbivory in the period immediately following fence removal, our results suggest that some shifts caused by defaunation may be recalcitrant and underscore the need for further research on vegetation responses to wildlife restoration in Africa.

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Assessing vegetation change in Madagascar's grassy ecosystems: Implications for biodiversity and carbon storage

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Madagascar's Central Highlands, known for their unique biodiversity and cultural importance, are undergoing rapid change. The landscape, composed of savanna grasslands and Tapia (*Uapaca bojeri*) woodlands, is being reshaped by agricultural expansion, including rice cultivation, and the spread of invasive pine (Pinus spp.) species. Here we combine land cover data from 2014 to 2023 with data from our recently established plot network (n = 180) to explore how these shifts are affecting biodiversity and carbon storage in this biodiversity hotspot.

Analysis reveals considerable land cover change, with Tapia woodlands decreasing by 21% and dry grasslands shrinking by nearly 7% in our study area. Meanwhile, over the last decade agricultural areas have grown by 24%, driven by a 14% increase in rice fields. Intensifying agricultural pressure and invasive pine encroachment, pose significant challenges to both carbon storage and ecosystem resilience, greater than those presented by fire on which conservation tends to focus. Projecting these land cover changes into the future, we evaluate potential social-ecological impacts, highlighting an urgent need for targeted land management strategies that balance ecological integrity with community needs in Madagascar's Central Highlands.

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Woody vegetation dynamics in a protected African savanna: insights from vegetation resurvey of the Gonarezhou National Park, Zimbabwe

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In the protected areas of the African savanna, the dynamics of woody vegetation are mainly driven by the fire regime and the density of mega-herbivores such as the elephant (Loxodonta africana). Acting alone or in combination, fire and elephants can exert significant effects on the environmental template, defined by the precipitation regime, soil characteristics, and geo-topographical features. To assess changes in woody vegetation cover, richness, diversity, and species composition in Gonarezhou National Park (GNP), a total of 313 woody vegetation plots sampled in 2010 were resurveyed in 2022/2023. Analyses were conducted for the entire park as well as for the main ecoregions and vegetation types.

Results indicate that GNP is undergoing significant simplification of woody vegetation, transitioning to less complex vegetation types due to the combined effects of elephants and fire. This simplification is accompanied by a modification of woody species composition, particularly among tree species. An ongoing structural transformation towards shrubbier vegetation is also evident. To halt or reverse this process, which can have significant cascading effects on many other components of biodiversity in the park, appropriate actions must be implemented.

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Quantifying the effects of multiple disturbances on woody plant density in a Marula-Knobthorn savanna

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Savannas are particularly susceptible to a rapidly changing climate, with woody plant densification and biome shifts occurring over a period of decades being documented globally. The National Department of Science & Innovation has identified savanna biomes as a research priority under the Global Change Grand Challenge. Current biodiversity conservation concerns in the Kruger National Park (KNP) include changes in woody plant cover, particularly the loss of large trees. This study investigates the single and interactive impacts of fire, herbivory, and drought on woody plant density in KNP. Remote sensing and Geographic Information System techniques were employed to quantify woody plant dynamics in response to these stressors. The study utilised existing replicated, long-term fire manipulation trials and browser exclusion plots in Marula-Knobthorn savanna to determine woody plant density pre- (2015) and post (2018) extreme drought. High-resolution aerial imagery (50 cm) from the National Geo-spatial Information portal was processed using supervised classification models (Random Forest, Support Vector Machine) and the Normalized Difference Vegetation Index to categorize vegetation classes (woody vs. non-woody) and quantify change in density over time.

The study results show a decline in tree density across the fire manipulation trials. The annual fire trial indicates a significant decrease in woody plant cover, followed by the triennial fire trial, with the unburned trial showing the least decrease post-drought. Areas open to browsing show a significant reduction in woody cover. This is attributed primarily to elephant-induced damage such as uprooting, pollarding and debarking. Additionally, the data suggest that these elephant impacts are exacerbated during drought. Managing fire frequency and herbivore density are key tools for controlling woody vegetation in savannas. While their individual impacts are well understood, it is crucial to comprehend the interactive effects of multiple factors, as shown here, for effective management of woody plant density and savanna integrity.

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Fine scale community level interactions drive woody encroachment in Congolese savannas despite abiotic conditions that favor savannas

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While pervasive across open ecosystems, woody encroachment is a highly variable global change process across space and time. Factors considered principally responsible for encroachment in one system can be unimportant in another, and the ways in which multiple drivers of woody encroachment interact to create the complex patterns observed among open ecosystems are not well understood. For these reasons, the ability of ecologists and conservation practitioners to generalize and predict patterns and processes of woody encroachment across ecosystems is limited. To investigate the mechanisms of woody encroachment holistically, we used repeat survey drone-based lidar, satellite remote sensing, controlled burns, and vegetation plots across a chronosequence to understand the interacting multiscale mechanisms of woody encroachment in Congolese savannas.

We found that fire alone is insufficient to halt a biome shift to forest because of mutualistic relationships among forest tree species that facilitate growth of woody rainforest species and diminish the probability of burning. Moreover, we found evidence that animals may drive the expansion of forest species due to a shift in disperser syndrome in later successional stages with encroachment. While course-scale factors such as climate and fire frequency did play a role in the conversion of savannas to forests, we found that fine-scale species interactions within and between trophic levels governed the pattern of encroachment we observed. We conclude that fine scale community level interactions can play a crucial role in determining the outcome of woody encroachment and provide a possible explanation for why course scale abiotic factors are not consistent explanatory drivers of woody encroachment among open ecosystems.

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Alien plant invasions in the Kruger National Park: dynamics and impacts

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A recent assessment of plant invasions in the Kruger National Park (KNP) identified 79 naturalized plant species, of which 21 are invasive. Using sampling of 60 sites across the KNP repeated after 4–5 years, we found that of the 25 alien species recorded in total, five significantly increased in frequency and two decreased. Further, we assessed the invasion dynamics and impacts on plant communities, soils and herbivores of three of the most invasive alien plant species in KNP: *Parthenium hysterophorus*, *Xanthium strumarium* and *Datura innoxia*. Out of the three target alien species, only *P. hysterophorus* reduced soil bacteria species richness and altered soil chemical characteristics. However, all three studied species impacted plant, and soil bacterial and fungal community composition. *Parthenium hysterophorus* also reduced native plant richness, while the impacts of *D. innoxia* and *X. strumarium* range from suppressive to facilitative, resulting in some natives being more abundant and frequent in the invaded vegetation. Strong dominance of alien species does not neccessarily mean low diversity of native species. We also tested whether animals avoid or utilise invaded areas and found that elephant, buffalo or waterbuck avoided areas invaded by *X. strumarium*, whereas hippo, impala or kudu did not differentiate between invaded and uninvaded sites. The contribution of the three invasive plants studied to the diet of the five above-mentioned animals was very low. Overall, *P. hysterophorus* presents, unlike the other two species, a substantial threat to native species because of its high impact and tendency to spread outside riverbeds.

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AlienRoE: a software package to report on the CBD Target 6 headline indicator

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The historic Kunming-Montreal Global Biodiversity Framework, which supports the achievement of the Sustainable Development Goals and builds on the Convention on Biological Diversity's (CBD) previous Strategic Plans, sets out an ambitious pathway to reach the global vision of a world living in harmony with nature by 2050. Among the Framework's key elements are 23 targets for 2030. In order to track the progress on the targets, a number of indicators were agreed upon for each target. The AlienRoE software provides a technical solution to track Target 6: "*Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their Impact.*" It mainly focusses on the headline indicator: rate of invasive alien species establishment, but can provide input to some of the complementary indicators.

Decision makers at local, regional, national and international levels need accurate and reliable information about status, trends, threats, and they need data presented in an actionable and understandable format, with measures of uncertainty. Furthermore, we need synthesized data products that can be combined with other environmental data, such as climate, soil chemistry, land use, altitude... AlienRoE is built upon the concept of data cubes developed in the Horizon Europe Biodiversity Building Blocks for Policy project (b-cubed.eu). I used the solid foundations of the GBIF infrastructure, where tools such as the GBIF Taxonomic Backbone and the Global Registry of Introduced and Invasive Species are available by default. It uses readily

available occurrence data to determine and estimate accurately the rate of introduction of alien species.

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A workflow for impact indicators of invasive alien species on South African protected areas as case studies

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The impact of invasive alien species is recognised as one of the leading drivers of biodiversity loss, significantly disrupting native ecosystems and threatening conservation efforts worldwide. This study presents a comprehensive workflow designed to assess the impact of invasive alien species on protected areas in South Africa, utilising Kruger National Park as a focal example. By integrating species occurrence data from the Global Biodiversity Information Facility (GBIF), the workflow generates a species-by-site matrix, detailing the presence of invasive alien species across various sites within the park. Using the Environmental Impact Classification for Alien Taxa (EICAT) scoring system, each species "impact score" is aggregated across different mechanisms, allowing for standardised evaluation of invasive species' effects on protected ecosystems.

The workflow provides users with the ability to compute and visualise temporal trends in alien species impact, providing conservationists, stakeholders, and policymakers with critical insights into the evolving threat posed by invasive species. The monitoring and analysis of invasive species impacts over time, is vital for adaptive and effective management of conservation frameworks. By quantifying impact indicators and visualising long-term trends, the workflow supports proactive responses to invasive threats, optimising resource allocation for management strategies. As demonstrated through case studies across South Africa, this approach equips stakeholders with scientific evidence to mitigate biodiversity loss, promote ecosystem resilience, and formulate policies.

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Wednesday

Savannas from space: Informing landscape conservation with remote sensing

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South Africa's Greater Kruger National Park (GKNP) region has been undergoing rapid changes from urban expansion and rewilding efforts, which have had profound consequences for the ecosystem structure and function of this landscape. Understanding these changes across GKNP to inform conservation management is challenging with field studies alone because of its size, variety of vegetation types, and diversity of landowners. Fusion of recent spaceborne remote sensing systems such as GEDI, Landsat, and PALSAR has demonstrated the capability of accurately mapping vegetation structure and change across broad savanna regions. These advances may enable a synoptic view of how urbanization and rewilding have influenced vegetation structure in the region and support the investigation of additional ecological responses (e.g., wildlife habitat connectivity).

While remote sensing can inform conservation management, the success of these efforts is based on local end-user engagement, driving the development of spatial products and integration into decision-support systems. Our ongoing NASA Ecological Conservation project serves as a case study to present some of the recent advances and remaining challenges of informing cross-boundary landscape conservation with remote sensing. Through input from local partners, we have developed a suite of remote sensing products, including annual vegetation structure and urbanization-driven land cover change, which are now being incorporated in ecological applications. In addition to reporting initial project results, we will further discuss key elements of product testing, data accessibility, and communication for the successful integration of remote sensing products within local conservation efforts.

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Projecting the Future of African Rangelands under Changing Climates using the Af-Range Ecosystem Model

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Global forecasts of semi-arid and arid landscapes under changing climates highlight Africa as the region of the largest and most concerning changes, such as reduced annual net primary production and declining percentages of ground cover. Also, the human population of Africa is projected to grow more rapidly in the coming decades than in other regions, putting additional strain on the rangeland resources of the continent. To provide a platform for experimentation and scenario analysis for a broad scientific community, Boone applied the open-source/open access L-Range ecosystem model (l-range.com) to Africa, yielding Af-Range. The application has been assessed through several comparisons to observed data and will be updated regularly as improvements by us or others are made.

The tool represents herbs, shrubs, and trees in several spatial and structural categories and is spatially explicit, with cell-based data used at 20 km and 10 km resolutions. The tool was modified to include up to 10 herbivore populations in each landscape cell. The population dynamics of wild and domestic herbivores may be tracked as forage availability changes through time. We used the model to assess changes in net primary production, cover, soil carbon, herbivores and other metrics using CMIP6 climate change scenarios. Changes in rangelands, the proportion of rangelands likely to exhibit non-equilibrium dynamics, and the numbers of domestic and wild herbivores supported over the long-term are among results reported. Moreover, we will introduce the availability of Af-Range to Savanna Science Network Meeting participants.

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Forage Biomass Estimation and Grass Species Composition: A Comparison Between Protected Areas and Communal Grazing Systems Using Machine Learning and Remote Sensing

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Grasslands in savanna ecosystems are crucial for ecological balance, supporting biodiversity, and providing essential nutrients for both domestic and wild grazing herbivores. While higher biomass indicates more available food, the diversity of grass species also affects nutrient content, digestibility, and palatability, influencing overall nutritional value, making it important to understand their interplay for sustainable rangeland management, as grazing practices can affect species diversity and ecosystem resilience. However, the current understanding of how different grazing practices influence grass species diversity, biomass, and nutritional value of savanna ecosystems is severely limited. This study aims to quantify the relationship between grass species diversity and biomass in protected and communal grazing areas while evaluating the impact of grazing practices on the nutritional quality of grasslands in savanna ecosystems.

Advancements in remote sensing, machine learning, and UAVs have transformed monitoring and conservation in savannas. UAVs facilitate high-resolution assessments of difficult-to-reach areas, supporting data-driven conservation strategies. This study uses machine learning models and integrates UAV data with ground measurements to compare grass biomass and species composition between protected areas (Kruger National Park and Manyeleti Nature Reserve) and communal grazing lands. Preliminary results indicate that the Kruger National Park shows higher biomass while communal areas show reduced species diversity and lower biomass due to overgrazing, with a Cohen's d >1 and a p-value <0.05**.** These findings underscore the need for tailored grazing management practices to enhance rangeland productivity and support sustainable land use in savanna ecosystems.

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Spatio-temporal monitoring of vegetation structure and surface moisture within four SANParks regions: Result Updates from Sentinel-1 and -2 Time-Series since 2015

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This presentation illustrates an update of operational mapping possibilities with the European Sentinel satellite fleet, that guarantee high-resolution spatial, spectral and temporal monitoring since 2015 and until 2040. Synergistic retrieval of innovative degradation indices is illustrated with focus on the following National Parks: Agulhas, Augrabies Falls, Mokala and Kruger as a follow up to the many years of the SANParks CO-LD-EMS project. A joint EO and in situ strategy for selected SANParks management needs will be outlined. Data cubes have been established and Jupyter Notebooks generated, which contain a portfolio of Python scripts for production of various vegetation indices, bare soil maps, vegetation height, woody cover and surface moisture.

The data cubes allow to exploit the synergy of radar and optical remote sensing data over meanwhile six years. The dense time series reveal intra- and inter-annual variations of unexpected land surface phenoma. Machine learning applications help to analyze the big amount of data, but training and accuracy assessments require also in-situ data and feedback from local experts. Therefore, we are using own soil moisture measurements in each SANParks region and interaction with regional scientists and stake holders for interpretation and validation. This assembly of in-situ and Earth observation products represent a treasure case for evidence-based climate-change studies.

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Modelling above-ground biomass in a semi-arid Mokala national park using earth observation satellite data

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Aboveground biomass (AGB) has important roles in specific ecological tasks including storing carbon and preserving species, especially in protected areas in the semi-arid zones. This research aims to assess AGB in Mokala National Park, South Africa from satellite synthetic aperture radar (SAR) and multispectral data against ground truth. This study entailed ten experiments using Sentinel 1 and Sentinel 2 datasets applying background regression techniques and the random forest model. Preliminary findings indicated relatively high levels of AGB heterogeneity in the park, the highest being 130 Mg/ha. The AGB was 46 Mg/ha and 81 percent of the study area signified as low. It was also found that SAR backscatter values with VV polarization yielded better AGB estimates than VH polarization. This model resulted in a coefficient of determination (R^2) of 0.91 and a root mean square error (RMSE) of 0.23 Mg/ha, indicating a high level of precision in biomass estimates.

This study also showed that the Green Normalized Difference Vegetation Index (GNDVI), Normalized Difference Red Edge (NDRE) 1, and Normalized Difference Vegetation Index (NDVI) are the significant vegetation indices for producing a relationship with AGB. The GNDVI and NDRE1 improved the accuracy of AGB estimates, demonstrating their effectiveness in biomass assessment. The study brings into focus the use of satellite technology along with statistical models in the determination of the AGB in sub-arid regions and evolved the impact of biomass equations in the determination of ecologic health from the conservation point of view. The combination of SAR and multispectral data is regarded as a promising method for developing AGB estimations for better nature reserve management and subsequent conservation strategies. This work shows that AGB can be improved using more sophisticated technologies and models, thereby facilitating nature reserves' sustainable utilisation and protection.

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Boosting above-ground grass carbon stocks predictions: A multi-parameter coalescing approach

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Global warming has sparked studies on ways to limit the accumulation of carbon dioxide in the atmosphere. Monitoring terrestrial carbon stocks and changes over time grounds many climate change discourses. This study tested whether coalescing texture matrices with Synthetic Aperture Radar (i.e. linear polarization matrices) enhances the accuracy of predicting above-ground grass carbon stocks in savannah ecosystems. With Kruger National Park as the experimental site, we examined the potential of sentinel-1-derived linear polarization matrices and the Gray Level Co-Occurrence matrices.

The preliminary results indicate that coalescing the Gray Level Co-Occurrence Matrix with the linear polarization (i.e., VH) improves the accuracy and (R^2 = 0.77, RMSE = 0.52, and MAE = 0.03) compared to when used alone (R^2 = 0.38, RMSE = 8.86 and MAE = 8.8). The most influential variables for predicting include dissimilarity, homogeneity, mean and the maximum GLCM. In conclusion, utilizing both sentinel-1-derived linear polarization and Gray Level Co-Occurrence matrices shows potential for predicting above-ground grass carbon stocks in the complex Savannah ecosystems.

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Patterns of Hydrologic Changes in the Kruger National Park; a Remote Sensing Perspective

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As climate change impacts global weather patterns, southern African savannas have experienced shifts in their historic seasonal trends of distinct wet and dry seasons. These shifts raise questions about how savanna ecosystems will respond to altered precipitation patterns. Rainfall, fire, and herbivory are the primary natural drivers of the ecosystem, all linked through the hydrologic cycle. Satellite remote sensing provides freely accessible global products of various components of the hydrologic cycle such as precipitation, surface water, soil moisture, total water storage, and evapotranspiration, and allows for monitoring of water resources. Data from current and new sensors from space agencies around the world such as NASA, ESA, JAXA, ISRO, and CNES, can significantly improve understanding of spatio-temporal variations in hydrologic and vegetation patterns.

Satellite products are particularly useful in regions with limited and cost-prohibitive monitoring infrastructure, such as southern Africa. In southern Africa, satellite remote sensing has been widely utilized in hydrological studies; however, these efforts often focus on individual aspects of the hydrologic cycle, creating a significant gap in a comprehensive understanding of water and vegetation dynamics. Towards an understanding of such dynamics, this presentation will integrate hydrologic products from various satellite missions such as Sentinel-1, SMAP, SMOS, MODIS, Landsat, SWOT, GRACE, and ECOSTRESS. The study will be conducted for the Kruger National Park, as representative of the heterogeneous southern African savannas. The analysis will help identify the drivers of spatio-temporal hydrologic changes, essential for effective resource management, particularly as savanna ecosystems face increasing seasonal variability.

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POSTER

Towards Operational Surface Moisture Monitoring with Sentinel-1 in Kruger National Park - Comparison of Six Years of In-Situ Soil Moisture Measurements at Lower Sabie with a Radar Moisture Index, NASA SMAP, ESA SMOS and ESA CCI Soil Moisture Products

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Soil moisture is one of IPCC's Essential Climate Variables (ECVs). Hence its measurement with adequate spatial and temporal resolution is a prerequisite for understanding hydrological conditions and their impact on vegetational cycles. Since radar signals are highly sensitive to the water content of the land surface (whether vegetation or soil), efforts have been ongoing since decades to generate an operational soil moisture product. Three global soil moisture products exist: ESA's CCI Soil Moisture based on active sensors and the SMAP- and SMOS-products based on passive microwave satellite data. These three products however have very low spatial resolutions between 10 km and 50 km.
In the framework of the formerSPACES South Africa Land Degradation Monitor (SALDi) and SANParks COLD-EMS projects, we installed in March 2019 an in-situ instrument with 8 Time-Domain Devices south of Lower Sabie, which measures every 30 minutes temperature and soil moisture in 10 cm depth. This data set represents a unique reference source for related soil moisture product developments from remote sensing.

With the launch of Sentinel-1, new time-series became available to better estimate the impact of the vegetational development on a possible soil moisture retrieval. This presentation compares 20 m Surface Moisture Indices (SurfMI), that we developed from Sentinel-1 time-series, with the above-mentioned global products and our in-situ measurements for the Lower Sabie region. The results indicate very good correlations to SMAP products and great sensitivity of the Sentinel-1 SurfMI-product to both, phenology and precipitation, allowing to develop a model that takes both surface parameters into account. It was found, that SurfM does not share SMAP's tendency to underestimate soil moisture in wet seasons - especially when precipitation is high. Instead, SurfMI displayed high susceptibility to moist conditions and rough surfaces, therefore mostly overestimating soil moisture. Optical vegetation indices demonstrated great agreement and a contrarian relationship to a Bare Soil Index.

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Consolidating biodiversity occurrence data from different sources to assist conservation decision making

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With the expansion of Citizen Science platforms and apps developed for logging data from different interest groups, obtaining large volumes of occurrence data for a diverse range of taxa has become relatively easy to do. Combining Citizen Science data with datasets collected by Conservation agency staff could be useful in assisting conservation agencies with tasks like generating species

lists for various taxonomic groups, especially for low priority taxa.

A graphical user interface that allows the selection of parks and sections of parks and allows users to select taxonomic groups without experience with databases or Geographical Information Systems makes this process more accessible. Pulling data from other platforms using APIs limits the amount of manual work that is needed to obtain this data and ensures that the formatting is consistent. This talk will focus on how the Biodiversity Information Management System that has been developed for SANParks will assist with the actions mentioned above and inform conservation decision making.

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End-to-End Pipeline for an App-Based Machine Learning Tool to Identify Illegal Wildlife Products derived from Ivory, Pangolin Scales and Tiger parts

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Global biodiversity is under serious threat from unsustainable wildlife trade, now increasingly prevalent in digital marketplaces and on social media. With the sheer volume of digital content, the need for automated methods to detect wildlife trade listings is growing. In response, we developed machine learning-based object recognition models that can identify specific target products, such as elephant ivory and pangolin scales, within images and highlight them. The data consists of images from products being sold or confiscated in China, identified by wildlife trade authorities. The data covers wildlife products derived from three species and intended for sale on the market, including elephant ivory and skins, pangolin scales and claws (raw and crafted), and tiger skins and bones.

We investigated various combinations of training strategies and two loss functions to identify the best model to use in the automatic detection prohibited target products. Models were trained for each species while also developing a single model to identify products from all three species. The best model showed an overall accuracy of 84.2% with accuracies of 71.1%, 90.2% and 93.5% in detecting products derived from elephants, pangolins and tigers respectively. We further demonstrate that the machine learning model can be made easily available to stakeholders such as government authorities and law enforcement agencies by developing a smartphone based application. The application can be used in real time to click images and help identify potentially prohibited products of target species. Thus, the proposed method is not only applicable for monitoring trade on the web but can also be used in physical markets.

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Simulating Photogrammetry of Bird Flight Height to Assess its Accuracy: Through Drone Flight and Computer-Generated Imagery

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Expanding tall infrastructure, including green energy installations like wind turbines and solar towers, is posing an increased collision risk to birds. Effective collision risk models rely on accurate, species-specific flight height data and detailed quantification of micro-avoidance behaviour. A previous stereophotogrammetric study on bird flight height provided constrained accuracy for structural height and limited precision for bird flight height above a visible, flat ground plane. Here, we advanced this approach by producing a 5 m resolution digital elevation model (DEM) that accounts for dense vegetation obscuring the ground and improves accuracy for uneven terrain. We also simulated photogrammetry through drone flights (DJI Mavic 2) and computer-generated scene encompassing the same DEM and bird models (Unreal Engine 5) with 10–100 m height and 100–500 m distance arrays to assess measurement accuracy using three cameras spaced 2–90 m apart.

Wider camera spacing, limited by wireless trigger range for synchronous shutter-release, and a more distant subject *bird* proxy improved accuracy for height measurements. Correlating accuracy between corresponding flight measurements in our real and simulated scenes eases further optimisation potential by simulating different cameras, faster moving birds, or other unconsidered scenarios. Additionally, aligned videos from this setup measured velocity, acceleration, and trajectory, which compared well to heights calculated from in-built GPS and barometer data, despite windblown camera shake; more stable camera bases were identified as a potential improvement. This photogrammetric approach holds strong potential for generating accurate flight height and motion data, necessary for quantifying micro-avoidance that refines collision risk models.

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Off-road driving: Translating Science into a User-Friendly Format for More Effective Dissemination of Information and Implementation of Responsible Off-roading in Protected Areas

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In a competitive tourism industry, recreational off-road driving (ORD) in protected areas for charismatic species is common practice aimed at optimizing game viewing. With evidence of ORD causing subsurface compaction, surface crusting, and affecting soil productivity, it significantly impacts soils, invertebrates, vegetation, and predators. As such, ORD is environmentally unsustainable with long-lasting and potentially irreversible effects on ecosystems and biodiversity. Despite this evidence, there remains a lack of accessible and science-based resources to aid in better managing and implementing ORD in game reserves in southern Africa.

In the form of a comprehensive, scientifically supported guide for ORD in game reserves, we present the booklet "Sustainable Game Drives and Off-road Driving: Management, Principles and Rehabilitation". In this digestible format, the booklet explores the impacts of ORD, principles of ORD, current research gaps, suggests management strategies and rehabilitation of affected areas, and proposes a significance formula which can be utilized to quantify the impact of ORD on a given game reserve. Serving as a valuable tool, this booklet can be utilized by reserve management for more informed decision making and in training field staff for the implementation of best practices for responsible off-road driving to promote ecological preservation in protected landscapes.

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Pathways and Patterns: Trailblazing elephants and the key landscape features that shape connectivity in Southern Mozambique

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Human modification of landscapes poses a significant threat to wildlife and ecosystems at large, particularly in Africa where population growth and land conversion are expected to increase. Ensuring connectivity is an important mechanism for the long-term persistence of animal populations and the ecology across landscapes. In recognition of the importance of connectivity, the identification of corridors has become a core objective in wildlife conservation and management globally. As the largest remaining megaherbivore, African savanna elephants are particularly effective at connecting fragmented landscapes owing to their extensive home ranges, high mobility, and natural role as 'ecosystem engineers'.

Our study objectives were to first empirically quantify connectivity across Southern Mozambique using GPS tracking data on wild African savanna elephants (39 elephants across 5 years), and second to assess the landscape features (i.e. biotic or human-made) influencing connectivity and corridor types. We used approximate Bayesian inference to produce corridor maps and a predictive model. Based on a measure of 'betweenness', we identified different types of corridors and examined how landscape features differed across these corridors. The model indicated that there is greater connectivity where landscapes were more modified by people, outside of protected areas, at night and in areas with lower tree density. Our results suggest that focusing management efforts on these corridors will be important to reduce human elephant conflict and maintain ecosystem connectivity and services.

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Saving large trees: to wrap, or not to wrap?

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Elephant has shown a noticeable increase in the targeting of specific large trees in recent years on Kingstown, and Sabie Sand Nature Reserve at large. Large trees provide nutrient islands or hotspots throughout the landscape; they are a valuable food source for many animals; they have aesthetic as well as iconic value; provide a micro habitat, and a home for many smaller birds and animals. Many conservation management plans focus on reducing elephant numbers in order to reduce impact, however, focussing on the protection of large trees bears ecological importance, as they are fruit and seed bearing which can in turn be distributed to other areas through natural processes. Research projects have shown several available techniques, and wrapping wire netting around the trunk of a tree is one such technique being deployed by several other landowners in SSNR.

No other property has implemented this strategy on the scale we have embarked upon with 8 000 trees wrapped to date. Results after 2 years have concluded that this method does not decrease frequency of branch breaking, snapping main stems or uprooting of trees, but

it does reduce proportion & severity of all types of elephant impact and mortalities, and contributes to survival of trees. While a small number of trees were uprooted, wire-netting was particularly effective against bark-stripping, with no tree experiencing total bark stripping or fence removal up to date. This strategy is effective for managers and landowners to maintain these iconic and valuable large tree species as elephant densities continue to increase.

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An eye in the sky: Early detection and rapid response to illegal trade-related wildlife poisoning through the Kruger National Park and broader Great Limpopo Transfrontier Conservation Area

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GPS-tracking technology has revolutionized the study of animal behavior, shedding new light on foraging ecology, ranging behaviour and habitat selection. Vultures are highly mobile scavengers that display unique spatial signatures when locating and feeding on carcasses. Using GPS-tracked individuals, we have developed a remote live-monitoring and carcass detection system that harnesses vulture spatial signatures to trigger alerts at feeding events. Using onboard GPS-device activity sensors, the system also triggers immobility alerts - when vultures have been killed through natural or unnatural causes. This alarm system alerts response units to the location of potentially poached and poisoned carcasses, which pose a further threat to wildlife. The Endangered Wildlife Trust initiated work in the Great Limpopo Transfrontier Conservation Area in 2021, to establish a network of GPS-tracked vultures to survey this vast landscape for carcasses and poison sources.

We currently have 123 tracked vultures deployed and since our project's inception, our system, which we call the *Eye in the Sky* system, has triggered 4,558 vulture activity events and detected 1,878 carcasses and 37 poison sources. Using our tracking data, and the training dataset from ground-based follow-ups, we have refined the algorithms to improve the classification of various vulture activity into specific categories of interest. This has allowed us to significantly improve carcass detection rate and identify when vultures are at risk. We present our findings and unpack the valuable applications of using GPS-tracked vultures to aid in the conservation of vultures and other species within the Kruger National Park and broader GLTFCA.

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POSTER
The practical application of the HARP Travelling Museum design: Creating an interactive and informational visitor experience

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Several members in society can find it challenging to access their country's heritage, even more so if the heritage of communities is not properly researched or represented in a manner that is accessible to the public. This is the case with the heritage of hunter-gatherer communities who resided in the area that is now the Mapungubwe National Park. The Hunter-gatherer Archaeological Research Program (HARP) developed an interactive travelling museum to increase public access to hunter-gatherer heritage from the middle Limpopo Valley, to create an interactive, tactile experience, and to communicate the research findings of HARP with the public. An associated master's study aimed to examine the effectiveness of this design in achieving these three objectives.

This poster not only presents the final findings of the study and the ultimate effectiveness of the travelling museum but also explores the practical application of the overall design in the various facets of ecology and conservation. A specific focus is placed on the ways in which the limitations and shortcomings that the public's feedback identified with the original design can be mitigated. The poster finally highlights the benefits of the application of this design in SANParks programs focusing on visitors and public access to the national parks, for example SANParks Week. The design is ideal to increase public awareness of endangered and threatened animals, knowledge about the national parks, and conservation in general, as well as specific conservation programs such as the SANParks ground hornbill census accomplished with the assistance of visitor sightings.

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POSTER
Available Management Tools
Translating science – Moving research outputs to conservation products

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The Wild2Earth app and cloud based platform is an innovative innovative decision support system designed to bridge the gap between scientific research and practical conservation and environmental management. With a focus on translating complex scientific data into actionable insights, the app empowers conservationists, researchers, and land managers to implement and monitor wildlife, environmental, and land-use projects effectively. Its key features include real-time data collection, wildlife management tools, environmental monitoring, and task tracking for field operations. By integrating satellite imagery, drone monitoring, and environmental sensors, the app and cloud-based platform provides users with a comprehensive view of ecological and environmental dynamics.

Wild2Earth's commitment to "Translating Science" is reflected in its approach to transforming raw research outputs into user-friendly conservation and environmental management products. These include biodiversity assessments, habitat restoration plans, species monitoring protocols, and environmental sustainability strategies. By streamlining the flow of information from researchers to field practitioners, the app and cloud based platform enhances decision-making processes and improves the effectiveness of conservation and environmental management actions. Beyond wildlife management, the the decision supports system assist with supports fire management, and pest control, ensuring its research-driven outputs are applied across diverse conservation and environmental sectors. Ultimately, Wild2Earth is revolutionizing how scientific knowledge informs conservation and environmental management, creating a vital link between research and practical, real-world outcomes.

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POSTER

Why Conservation Often Fails and What This Tells Us

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Research on natural ecosystems has revealed they tend to settle to fairly stable states. The first conservation challenge lies in deciding what we want these states to be. Once that is decided, the second challenge is to work out how to achieve this state. Usually this involves removing threats to species that are seen as desirable or removing those that are deemed undesirable.

If this can be achieved, ecosystems tend to look after themselves. However, this second challenge is often profoundly difficult due to competing demands on uses of the land we are attempting to conserve. I will give examples of success and failure in achieving these aims and will attempt to draw general conclusions.

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Imagining the future of conservation in an AI-driven world: Opportunities and Challenges

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In today's rapidly evolving technological landscape, humanity is navigating an unprecedented high-tech environment. With advances in computer science and engineering, the world of Artificial Intelligence (AI) has made huge advances and became a regular part of everyday life. AI can be defined as a computerised system which is capable of working equal to or better than a human being and has been adopted across various sectors such as business, healthcare, industry, education and tourism. While AI has shown promise in conservation applications such as animal surveying, data management and anti-poaching, the use of AI is still in its infancy and its potential has not been fully exploited just yet. Considering that we have access to information at our fingertips like never before, an AI-driven world will be our new normal.

However, this shift comes with certain challenges which society would need to be cognisant of. AI has been exploited as a tool for generating misinformation, disinformation and deepfakes and when sufficiently controversial, this false information can become globally trending topics and have further reach. This downside of AI has even been identified as one of the top threats to society according to the World Economic Forum's Global Risks Report 2024. Misinformation and misleading narratives about conservation efforts and conservation agencies could have dire consequences for public faith and trust in the conservation sector. This presentation will envision the future of conservation, examining the possible opportunities and challenges which may arise from integrating artificial intelligence into conservation initiatives.

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AI or EINA! Are we still driving the tech train, or have we fallen asleep at the wheel?

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Large Language Models and other rapidly developing artificial intelligence interfaces are here to stay but for artificial intelligence to truly support nature conservation and environmental management, it needs to be integrated thoughtfully and ethically. Human oversight remains essential, especially in ensuring that artificial

intelligence complements conservation goals without undermining environmental sustainability. Finding the balance between technological advancement and respect for nature, while making sure artificial intelligence is a tool for healing ecosystems rather than contributing to their degradation through, *inter alia,* the out of proportion resource use that some artificial intelligence models require, will become a very real challenge for future protected area managers but is it a threat to the environment or to conservation?
While trying to understand the role and nature of technological advancement in conservation management and environmental protection we consider the implications of an over-reliance on technology. Does this undercut traditional, field-based management practices while distancing conservationists and environmental managers from nature? We also consider what technological advancement has meant in conservation with particular emphasis on advances witnessed by Gen X, who currently make up a significant portion of senior conservation managers and are probably the last group to have started their careers without a cell phone on their hip. In so doing we consider whether we are on a nice, safe artificially intelligent ride to global conservation resilience or is it time grab the steering wheel and unplug?

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Penguin Monitoring: Can Transfer Learning Facilitate Context-Agnostic Detection?

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Monitoring penguin populations across different environments is often hindered by the need for environment-specific models, which are resource-intensive and inefficient. This study investigates whether transfer learning—a machine learning approach that adapts pre-trained models to new domains with minimal additional training—can effectively generalise penguin detection across vastly different real-world and synthetic habitats. Specifically, we evaluate its performance in detecting penguins within their natural rocky environments and in artificial savanna landscapes, where such species would not naturally occur. This work is part of a larger AI-based species monitoring initiative aimed at improving wildlife detection under varying occlusions and lighting conditions.

We employed a convolutional neural network pre-trained on rocky habitat data, demonstrating the model's ability to detect penguins in both environments with minimal performance loss. Transfer learning enables robust detection across diverse ecological conditions without requiring extensive re-training or bespoke datasets.This adaptability has significant implications for conservation, particularly where habitat-specific data is difficult or costly to obtain. Our study highlights the potential of AI systems to support cross-ecosystem species monitoring, offering scalable and efficient solutions for biodiversity preservation across diverse landscapes without starting each application from scratch.

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Exploring AI-developed algorithms to predict elephant movement in a changing climate

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Elephants and people living in the same landscape compete for space, access to water, and productive land. Modelling predicts climate change with an increase in extreme climatic events that will affect the distribution and quality of these resources. Such changes have consequences for how elephants use landscapes beyond protected areas and collectively stands to increase contact with people. In the Greater Limpopo TFCA, elephant numbers have increased by about 4.9% per year (for 24 years: 1995-2020), and in Kruger alone at 6.2% per year over the past decade (2010-2020). Alongside increasing densities, elephants are increasingly moving beyond formally protected areas – especially from Kruger and Gonarezhou into Limpopo and interstitial local communities in Mozambique and Zimbabwe. An improved understanding of elephant movement patterns under a changing climate beyond protected areas can inform future land use planning across the GLTFCA.

We use state-of-the-art deep learning technologies to model elephant movement using tracking data from 70 collared individuals collected over 25 years. We correlate these outcomes with high-resolution downscaled modelled climate data for the GLTFCA from 1961 to date. Specifically, we use two approaches: Long Short-Term Memory [LSTM], which predicts temporal

movement, and Transformers, which handles long-range dependencies, to highlight behavioural changes during extreme climate events and 'normal' modelled climate changes compared to the historical and current movement patterns. The outcomes of this project will provide information in a scenario-sketching environment to advise policymakers on securing people and their livelihoods presently and in the near future.

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Testing artificial intelligence's ability to correctly identify elephants and open gates to facilitate elephant movement

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Across South Africa, fences restrict the movements of large mammalian herbivores. Consequently, these restrictions may lead to negative impacts on local vegetation. One way to reduce these impacts would be to allow herbivores to move freely between properties. However, some landowners resist removing fences as they may lose valuable wildlife. One solution would be to install gates operated by artificial intelligence (AI) that open to allow specific species to move between adjacent properties. Prior to our study, an AI system was created to identify and open gates for elephants.
To explore the potential limitations of the system, we conducted several experiments to try and trick the AI.

First, we had single and groups (4-6 individuals) of elephants walk in front of the gate. We then drove vehicles, vehicles under a grey car cover, and covered vehicles with large ears attached, in front of the gate. In addition, we used a remote-controlled car to drive stuffed toy elephants in front of the gate. Finally, we monitored the AI's ability to correctly distinguish wildebeest and ostrich from elephants. The AI system correctly identified the elephants, vehicles, and was not fooled by the stuffed elephants. However, it was unable to consistently distinguish the covered vehicles (with or without ears) and wildebeest from elephants. Moreover, it regularly incorrectly identified ostrich as elephants. Ultimately, the AI system tended to consider large grey objects as elephants. Yet, with further improvements, this system could provide a novel way with which to manage elephant movements and impacts.

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Above and beyond the helicopter; using remotely sensed imagery and machine learning to improve the accuracy and precision of wildlife aerial censuses in African savannas

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Reliable wildlife censuses are key to making informed conservation decisions. However, methods for censuses have remained largely unchanged since the 1970's and are not only time consuming and costly, but also fraught with error. Advances in machine learning have been shown to outperform humans in numerous instances, especially in detection and counting of objects in imagery. The combination of machine learning applied to remotely sensed imagery paves the way to automate the process of performing wildlife censuses, increasing their accuracy and precision. We conducted a comparative analysis between helicopter censuses and remotely sensed imagery obtained from a drone with a RGB camera flown over 23 breeding camps with variable tree canopy cover densities and known populations of seven different ungulate species.

All camps were flown three times within a five day period by a helicopter and drone at the end of the dry season and the counts compared to the known population. Average accuracy and precision for the helicopter count were 75.3% and 77.2%, respectively, but both displayed large variance depending on the species and canopy cover. Generally a greater body mass and more open vegetation yielded higher results. The remotely sensed imagery were labelled and split into training, testing and validation datasets, which were then used to train multiple algorithms. The best performing algorithm, YOLOv8-obb, had a precision of 89.2% and a recall of 80.3%. These results are better than human observers and thus show great potential, specifically as replicability is much greater as well as lower total costs.

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Using animal-borne acoustic loggers and deep learning approaches to reveal fine-scale lion behaviour

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In recent years, the use of wildlife tracking technologies in ecology has become common, enabling us to improve our understanding of animal movements and behaviors throughout their lives, including when they are not directly observable. However, analysis of tracking data can only provide a partial view of the animal's behaviour, i.e. revealing only the main behavioral modes. Fine-scale behaviors that can often be essential for understanding ecological processes (e.g., mating, interspecific interactions or hunting) remain inaccessible. Here we

present the use of animal-borne acoustic loggers, which continuously record the sounds emitted by tagged individuals as well as those from the environment surrounding it.

We present how soundtracks can then be automatically converted into behavioral classes using a deep-learning-based approach. We apply this approach to African lions, *Panthera leo*, describe the performance of the models, and discuss how this new tool opens up interesting prospects for understanding the dynamics of predator's hunting efficiency and inter-specific interactions, which can all be relevant for conservation and management.

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POSTER

DeepFaune Africa: automatic species classification of large mammals in camera-trap pictures, on your desktop

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The DeepFaune initiative (https://www.deepfaune.cnrs.fr) aims at (i) developing AI-based models for automatic species classification in camera-trap pictures and videos, and (ii) making these models immediately available to scientists, managers, and any users of camera-traps. It does so by developing an easy-to-use software that can run the models locally (i.e. without having to upload the picture to a cloud-based platform) and on a standard computer.

DeepFaune is now used by tens, maybe hundreds, of organisations in Europe - the European fauna was originally the focus of the initiative. We are however in the process of developing a version focused on the large mammals of African savannas. First benchmarks are encouraging and this presentation will demonstrate the performance of the best model available in march 2025. It will also provide a demonstration of the software functionalities. Overall, we will present a new tool available to African camera-trappers to save crucial time during the analyses of their medias.

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AI annotation software can ensure compliance of the data protection regulation and improve work efficiency: Examples from two European camera trap projects

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Laws and regulations concerning data protection rights present challenges for efficient data annotation in camera trap projects. Examples from Europe show that the EU General Data Protection Regulation (GDPR), which protect individuals' right to protection of their personal data, lead to modifications of study design and required demanding efforts to ensure compliance with the regulations when annotating images. For instance, the UK "National Hedgehog Monitoring Programme", which aims to have over 500.000 camera trap images annotated by the public as part of a citizen science project, must first sort and remove images of humans before volunteers can begin species identification. Another example comes from a 2024 camera trap study conducted in a biodiversity-certified forest in Denmark. This project investigated the impact of habitat types and forestry activities on spatial and temporal patterns of the mammal community.

However, due to GDPR concerns, no camera traps were placed near trails or areas accessible to the public, limiting the study's ability to assess effects of human activity on wildlife species, and potentially reducing its contribution to future conservation strategies and management. AI based solutions can contribute to more efficient data annotation while ensuring compliance with data protection regulations. Data from the Danish project show that open-source AI annotation software can effectively sort out images of humans, achieving a precision rate of 93.07%. Thus, AI can be a useful tool for increased work efficiency in future camera trap project - not only in Europe but in any region where high-value camera trap data must be balanced with data privacy.

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POSTER

Accurate Fish Detection with Oriented Bounding Boxes: A Step Towards Automating Freshwater Monitoring

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Lake Tanganyika, one of the world's oldest and deepest lakes, sustains a diverse array of endemic fish species while being bordered by expansive savanna regions, creating a complex ecosystem vulnerable to multiple stressors, including pollution, invasive species, and sediment runoff from surrounding land use. Before integration management can be streamlined, a robust fish detection model is necessary for a reliable process later in an automated pipeline. Therefore, this study

evaluates whether an oriented bounding box (OBB) detection model—designed to account for the angle and movement of objects—can enhance fish detection and tracking accuracy in this unique aquatic environment. Image data were obtained in collaboration with SAIAB and initially processed using our generalised foundational fish detection model.

The subsequent application of the OBB model demonstrated its effectiveness in detecting tight bounding boxes around different fish species in underwater videos. It serves as a fundamental step for tracking population changes across varying conditions, including low visibility, high turbidity, and diverse aquatic vegetation. Results show that the OBB model consistently improves detection precision and adaptability across locations, facilitating accurate species identification even when fish are partially obscured by vegetation or other structures. This improvement in detection accuracy enables better monitoring of fish populations, behaviours, and responses to environmental changes over time, which is critical for managing Lake Tanganyika's unique biodiversity amidst increasing anthropogenic pressures.

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Exclude the fire, and watch the forbs in the Cerrado say goodbye

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Fire-prone ecosystems have evolved alongside fire, and excluding fire can lead to significant changes in vegetation composition and structure. The alternate stable state approach suggests that frequent historical disturbances, such as fires, maintain an open ecosystem, creating positive feedback loops with flammable grasses while preventing woody species from establishing. When fire is excluded, woody plants can thrive, shading the herbaceous layer dominated by sun-loving plants. This shift results in a decline of grasses, transforming the ecosystem from flammable to non-flammable. But what happens to forbs? Forbs, along with graminoids, are a crucial component of the herbaceous layer in the Cerrado, playing a key role in the savanna's resilience to fire due to their specialized belowground bud-bearing storage organs.

We examine the effects of fire exclusion on forb communities, both above and belowground. Forbs are typically the first to decline in cover and richness when fire is suppressed, likely due to increased shading from C4 tussocks. In the open savannas of the Cerrado, this decline can occur in less than ten years of fire exclusion. However, many forbs remain dormant in the belowground bud bank and can resprout when aboveground conditions improve, such as after a fire or severe drought. While the duration of dormancy for these plants in the bud bank is not fully understood, we do know that their viability can be compromised after 15 years of fire exclusion. This highlights the need for further research into forb communities to better understand their dynamics and resilience.

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Resilience of herbaceous communities to disturbance: The importance of belowground bud bank and bud-bearing organs in an African savanna

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African savannas are driven by fire and herbivory, and the absence of these drivers can lead to the loss of plant diversity. These ecosystems are characterised by an herbaceous layer that is co-dominated by forb and grass species. Post-disturbance regeneration of the herbaceous layer occurs mostly by resprouting from the belowground bud banks. Assessing the response of belowground bud bank density and bud-bearing organ composition to disturbance is critical in predicting plant community resilience. This study aimed to assess these attributes at a community level to individual and interactive effects of fire and herbivory. Ten 0.5m x 0.5m quadrats were sampled to a depth of 10 cm across each of annual, triennial and exclusion fire treatments, with and without herbivory.

Mean bud bank density was lower in the presence of herbivores when fire frequency was reduced and when fire was excluded, as well as in the absence of herbivores when fire frequency was high. Grass and forb bud bank density responded differently across fire and herbivory treatments. Non-woody rhizome, root crown, stolon, bulb, woody rhizome, and root tuber were the belowground bud bearing organs on which buds were identified. Triennial fire frequency, particularly in the absence of herbivores, displayed both high bud-bearing organ density and high bud bank density. The results indicate that intermediate fire frequency and low herbivore pressure, which maximize resprouting potential, might provide the right balance of disturbance to sustain diverse and resilient herbaceous communities in this savanna.

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The interplay between fire and microhabitat cover drives seed predation in savanna and gallery forests in Brazil

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Fire may have distinct effects on the fauna inhabiting savannas and forests, because the former have evolved under occasional occurrence of fire, while natural caused fire tends to be rare in tropical forests. Fires may differentially cascade to plant-animal interactions in these vegetation. We investigated the effects of wildfires on post-dispersal seed removal in Brazilian Cerrado with the aid of selective exclosures, allowing us to measure the relative contribution of ants and vertebrates to seed removal. We used plots in savannas and nearby gallery forests surrounding streams hit by a wildfire and unburned controls to assess the effect of fire and microhabitat cover on seed removal. Fire increased removal of small and palatable seeds by ants, while decreasing seed removal by vertebrates, regardless of seed palatability and habitat (savanna or forest).

Vertebrates removed more seeds in covered microhabitats, while the opposite happened for ants. Vertebrates contributed more to seed removal in gallery forests than in savannas. Changes in seed removal after fire seems to be mediated by changes in microhabitat cover. It is likely that plants whose seeds are often preyed upon by vertebrates benefit in the short-term from fire to escape predation, while the opposite would be true for those removed by granivorous ants (e.g. seeds < 1 g). Therefore, fire may create pulses of opportunities for certain plant species to recruit, while constraining others. It remains to be investigated how different fire intensities and frequencies affect wildlife, seed removal and ultimately plant regeneration.

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Navigating Extremes in Savannas (NExS): Early results from a co-occurring extreme experiment exploring the consequences for biodiversity at multiple hierarchical scales

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Extreme ecological events – such as exceptional drought, severe fire, and heavy herbivory – are occurring more frequently and in tandem with one another. Understanding the ecological impacts of these compound extremes, and how they differ from effects of single extremes, is critical for predicting future states of savannas. We present findings from the first year of the Navigating Extremes in Savannas (NExS) experiment in the Satara Experimental Burn Plots, Kruger National Park, where we are simulating an exceptional drought to match that seen in 2016-17, severe fire that may occur in areas of low disturbance frequency after dry years, and heavy herbivory events observed during drought when forage is limiting. In this talk, we address the following questions: (1) how do compound extremes effect individuals, populations, and communities different than single extremes? (2) Which plant traits control responses to compound extremes?

First, we found that single extremes had null or positive effects on plant performance, but compound extremes showed consistent negative effects. Interestingly, the effects of compound extremes were stronger on individual bunchgrasses compared with whole communities. Second, we found that grasses with greater specific root length (longer, thinner, less dense roots) were more negatively affected by compound extremes, while species with greater specific leaf area were less affected. Based on this, we suggest that root traits may be more important than leaf traits in determining bunchgrass responses to compound extremes. Ultimately, these results highlight the importance of considering impacts of multiple extremes when determining the future of savannas.

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Beyond big mammals: How fire and herbivory affect savanna biodiversity broadly

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Most research in savannas focuses on fire and large mammal herbivores (LMH), and management concerns typically focus on LMH. However, this approach to savanna ecology overlooks the majority of biodiversity. In response, a more comprehensive examination of fire and the presence of LMH has been undertaken in Gorongosa National Park. This experiment was also uniquely designed to educate students in the Gorongosa Master's in Conservation Biology Program. During four years of LMH exclosures and two cycles of controlled

burns in a fully factorial experiment, biodiversity ranging from plants to insects, reptiles and amphibians, birds, and small and large mammals has been quantified by students.

Data show a one-size-fits-all approach to fire management does not support biodiversity broadly and that multiple taxa change in response to LMH. Herbivorous and scavenging beetles were more species rich where LMH were present, and predatory beetles were more species rich in the absence of fire. Amphibian richness was also higher where LMH were present, and their richness declined with cold burns. In contrast, insectivorous bird richness was highest after a cold burn. Granivorous birds were more species rich with LMH. Small mammal (rodents and shrews) richness was, however, higher in the absence of LMH. Effects of fire on LMH foraging varied over time. In sum, this experiment demonstrates the value of leveraging large-scale experiments to understand savanna biodiversity broadly and further illustrates that education and capacity building complement, rather than detract from, research. We expect this experiment will run for many years and welcome collaboration.

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Fine-scale variability in fire properties interacts with abiotic and biotic drivers to shape savanna vegetation structure and spatial patterning

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Fire is an essential ecosystem process with profound influence on the structure and functioning of most terrestrial biomes. Yet it is unclear how variability in fire properties among individual fires and across spatial scales interacts with other drivers such as rainfall, geology and herbivores to affect vegetation structure and patterning. Working across a variety of fire experiments in Kruger National Park, we collected drone-based LiDAR of vegetation structure in response to fires varying in frequency, size, and intensity. We combined these data with thermal images collected during fires to relate fine-scaled variation in fire intensity to changes in vegetation.

By working across experiments (the experimental burn plots, Satara fire experiment, and southern basalt time-of-day fire experiment), we were able to disentangle long- and short-term fire effects. Across the experiments, fire had strong influence on vegetation structure and spatial patterning. Fires altered aboveground biomass, created grazing lawns that, due to feedbacks with mammalian herbivores, persisted several years after fires were applied, and varied in their effect on grass biomass depending on factors that determined variability in fire properties and intensities. Our results show how savanna managers can use small-scale fires as a tool to manipulate vegetation structure according to desired outcomes.

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Contrasting consumers: Insights from a targeted approach to plant functional traits related to fire and grazing

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Plant functional traits reflect the ecological strategies of plant species and provide insight to how plants interact with their environments. In African savannas, fire and herbivory are the main consumers of plant biomass and interact to shape vegetation composition and structure. By targeting specific plant traits related to either fire or herbivory (or both), we can improve our understanding of how these disturbances shape plant communities, and link this to ecosystem processes, such as carbon storage. For this, it is important to include belowground plant functional traits. Here, we focussed on savanna grass communities and selected key traits related to the resistance and/or tolerance of fire and grazing.
We identified the dominant grass species in areas that differed in wildlife grazing impact and fire frequency and sampled aboveground and belowground functional traits. Belowground traits were selected to reflect variation in root form (e.g., root diameter and branching frequency) related to resource acquisition (i.e., opportunistic vs. conservative). Dominant grasses in areas with a long history of wildlife grazing impact showed traits related to grazing (i.e., higher grass bulk density) and conservative resource acquisition strategies (i.e., thicker roots). Areas with less grazing impact and more fires were dominated by species with fire-adapted traits (i.e., higher leaf dry matter content) and opportunistic resource acquisition strategies (i.e., high root branching). These differences in aboveground and belowground plant functional traits will have consequences for the amount of carbon stored in the soil, and released into the atmosphere during seasonal fires.

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Does fire reinforce or dilute discontinuities in woody cover?

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It is often suggested that fire can generate strong spatial discontinuities in woody cover as a result of feedbacks between woody cover and fire intensity. As tree cover increases, grass biomass and fire impacts decline within a localized neighbourhood, providing opportunities for tree establishment or recruitment. Beyond this neighbourhood, the open grassy state can be reinforced by a pervasive fire trap. In practice, it is often difficult to disentangle the effects of fire from potentially confounding effects of abiotic factors associated with patchy tree cover distribution. A key question is: can woody spatial clustering and tree cover discontinuities be generated by fire when the underlying abiotic template is homogeneous? Several factors are likely to be important in determining the spatial dynamics of fire effects, including the size and magnitude of tree neighbourhood effects, the relative magnitude of systematic and stochastic variation in tree growth rates, and the rate of turnover of mature, fire-suppressing trees.

I present a simulation model parameterized with data from the savanna literature to examine how tree cover discontinuities respond to fire over time. I tested the model across contrasting values of fire frequency, the size of neighbourhood, and variation in tree growth. Results indicated that the persistence of discontinuities is unlikely under a broad range of realistic conditions, and highly sensitive to variation in tree growth rates and the magnitude of neighbourhood effects. This suggests that efforts to identify the sources of spatial patterning in fire-prone woody ecosystems should include factors other than fire.

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Is extreme fire the key to reversing woody encroachment? A test in the tallgrass prairie

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Woody encroachment, the expansion of woody plants at the expense of herbaceous species is one of the largest conservation threats to grasslands and savannas globally. Factors such as increases in atmospheric CO_2, reduced fire frequency, herbivory, and increased propagule sources are increasing the rate of woody encroachment, leading to the decline of many vital ecosystem services. In the region where our study takes place (the western extent of tallgrass prairie) historic fire intervals (every 3-5 years) were typically enough to keep woody plants at bay; however, this interval is no longer sufficient to slow woody encroachment. To reverse this problem, managers have looked towards extreme fire which is characterized by high-intensity fires with erratic behavior that can potentially increase mortality of woody plants.

Using an accidental wildfire that occurred in April 2021 on Konza Prairie Biological Station (KPBS), Manhattan, Kansas, USA, we analyzed the use of extreme fire to control woody encroachment on a landscape level. Ground surveys of the woody plant community were completed on KPBS in two watersheds and supplemented with LiDAR imagery in 2020, 2022, and 2023. Results showed a decline in woody cover one-year post-fire in the extreme fire treatment and no change in height in the prescribed treatment. Two years post-fire, both watersheds had completely recovered with woody cover increasing by 31.9% in the extreme watershed and by 20.3% in the prescribed watershed from 2022 to 2023. These findings display that a single extreme fire alone is not sufficient to reverse woody encroachment.

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Unexpected patterns: Bacterial and Fungal communities are resilient to fire in Savanna systems

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Savanna ecosystems are characterized by a unique interaction between soil physicochemical properties, vegetation, and disturbances in the form of fire and herbivory. In these systems, the intricate relationships between soil microorganisms and plant roots are well documented; with fire being an important factor in shaping vegetation heterogeneity and ecosystem stability. However, a gap remains in our understanding of how fire affects microbial community structures, and more specifically, the interactive effects of grass species, fire, and herbivory in shaping microbial communities. This study investigated the influence of fire on bacterial and fungal communities associated with four grass species. We collected soil samples in fire treatment plots at the Kruger National Park, South Africa. One-square-meter enclosures were erected in the centre of each subplot to exclude herbivores.

The enclosure soils were also sampled. DNA sequencing data determined the diversity and abundance of bacterial and fungal communities associated with the grasses. Our preliminary results show that Actinobacteriota were the most abundant bacterial taxonomic units, while Ascomycota were the dominant fungal units associated with both the grass species and the burned and unburned sites. However, there were significant differences in carbon and nitrogen levels between burned and control sites. These results

suggest that the grass species do not harbour unique microbial assemblages and, more importantly, that fire and herbivory do not significantly alter microbial communities in these systems. These findings indicate that the use of fire as a management tool in these ecosystems does not negatively impact soil microbial communities, even in the presence of grazing pressure.

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POSTER

Extreme fire in a savanna ecosystem: initial grass mortality responses from a simulated fire experiment in Kruger National Park

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Fire has shaped the evolution of savanna vegetation, driving vegetation composition and functional trait diversity of savanna ecosystems. However, as global change drivers such as drought and heatwaves increase in frequency and magnitude, historical fire regimes are becoming more severe (extreme fire). Understanding how grasses respond to extreme fires will be critical for our ability to forecast and manage savanna ecosystem services in the future. Here I will present results from a severe fire treatment within the Navigating Extremes in Savannas (NExS) experiment in Satara, Kruger National Park, where we simulated dry high biomass conditions during a fire event. Using this treatment, I address the questions: 1) how does severe fire impact temperature down the soil column, and 2) what are the effects on mortality of bunchgrass species across different taxonomic lineages?

We found that soil temperatures three cm from the surface were remarkably buffered under the typical management fire, reaching a peak of only 35 °C, yet soils in our extreme fire treatment reached 50 °C at three cm. These increased temperatures may lead to meristem mortality of some bunchgrass species, previously evidenced by substantial reductions of cover of *Bothriochloa radicans*, a fire-resistant species, due to severe fire. I will share grass mortality and recovery of eight other grass species after our severe fire treatment. Based on these initial findings, we suggest that maintaining low fuel loads is important for limiting fire severity in a changing climate and sustaining critical diversity found in savanna ecosystems worldwide.

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POSTER

Experimental burning effects on selected soil chemical properties in a semi-arid African Savanna

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Soil fertility is driven by the optimum range of various soil nutrients required for plant growth. These nutrients, categorized as macro- and micro-nutrients, are crucial for plant uptake. Globally, fires have been found to have varying effects on soil macro nutrients but locally within South Africa, there is a paucity of studies investigating fire effects on soil nutrients, particularly exchangeable cations.The Kruger National Park (KNP) has conducted a long-term fire experiment for nearly 70 years, providing a unique opportunity to study how various fire treatments impact soil properties. Our research focused on sandy, granite-derived soils in southern KNP, examining both short- and long-term effects of burning on selected soil nutrients and the influence of different vegetation types.

In the short term, burning increased exchangeable cations like calcium (Ca) and potassium (K) in the month following a fire, likely due to ash deposition; however, magnesium (Mg) levels decreased. Over seven decades of annual burning, Mg and K decreased significantly compared to unburned soils. Exchangeable Ca and Mg concentrations were significantly lower in the open, grass-dominated areas compared to soils below tree and shrub canopies which could be acting as "fertility islands" which enrich the soils below their canopies. In essence, some soil chemical properties are more susceptible to fire impacts or vegetation-induced changes over time. Therefore, factors such as vegetation type, fuel load and time since last burn are important considerations when investigating fire effects on soil chemistry.

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The Evolution of Fire Management in the Brazilian Savannas: Integrating Science, Traditional Knowledge, and Policy

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Brazil stands as South American leader in advancing wildfire research and developing a comprehensive framework for fire management, especially in its savanna ecosystems (Cerrado). Understanding fire both as an evolutionary and ecological factor that promotes biodiversity and as a threat to the biodiversity itself and to human safety is essential, particularly under the pressures of global climate change. In July 2024, Brazil

enacted the National Integrated Fire Management Policy, a landmark effort combining science and traditional knowledge to guide decision-making across various sectors, particularly in protected areas. But how did the country reach this policy? The journey spans over 130 years, rooted in scientific advancements and policy shifts to an integrated fire management.
Key elements in this process included: a) building a solid scientific understanding of the Cerrado fire ecology and dynamics, b) embracing and respecting the fire-management practices of traditional peoples, and c) weaving together these scientific and traditional "knowledges" into legal frameworks. This process mirrors international experiences, such as South Africa's fire management evolution in Kruger National Park, positioning the Cerrado as a testing ground for diverse fire-management strategies. The transition from fire suppression to integrated fire management is a critical part of this history. We will provide an analysis of the historical, scientific, and cultural trajectory leading to Brazil's recent integrated fire management policy. Achievements and challenges of the new policy will be discussed, drawing comparisons to previous fire management techniques and exploring how this holistic approach can enhance both biodiversity conservation and human safety.

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The effects of fuel moisture of live, senescing, and dead fuels on fire spread in a South African savanna

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The majority of the world's burned area falls within tropical savannas, characterized by low intensity, grass-fueled fires. The behavior of these fires is affected by the grass moisture content, with higher moisture favoring slower, cooler, or less intense burns. Moisture content is determined by both external factors like precipitation, and internal factors like fuel curing. However, studies often do not differentiate between curing status or focus on dead fuels when evaluating the effect of moisture on fire, especially in the context of fire modeling. Therefore, we quantified how the moisture of live, senescing, and dead grasses drive fire behavior, and compare that to the role of overall fuel moisture. To do so, we sampled 90 experimental burns in Kruger National Park and used multiple linear regressions to model fire average temperature, maximum temperature, rate of spread (ROS), duration, and intensity.

We found that fuel moisture varied between categories; live fuel contained the most moisture, followed by senescing then dead fuel. Of all the predictors, senescing fuel moisture most consistently dampened fire, decreasing average and maximum temperatures, ROS, and intensity. Dead fuel moisture increased average and maximum temperatures and live fuel moisture increased ROS and intensity, with different categories affecting different aspects of fire behavior. Overall fuel moisture only decreased duration. Generally, the moisture of individual curing categories was more predictive of fire behavior than overall fuel moisture, especially that of senescing grass. Thus, these relationships may be important to incorporate into fire modeling to more accurately represent burning across savannas.

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POSTER

Fire's Role in Shaping Savanna Soil Seed banks: Viability and Dormancy Breakthroughs

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Studies on soil seed banks in response to fire frequency in African savannas are limited. In a semi-arid savanna in Kruger National Park (KNP), we assessed the impacts of three fire frequencies (annual, triennial, and fire exclusion) on seedling emergence from soil seed banks collected at the N'wanetsi and Satara experimental burn plots in central KNP. Results showed that frequent (annual) fire depleted the soil seed bank relative to less frequent fire treatments. Further, fire frequency influenced the grass-to-forb emergence ratio, with more grass seedlings emerging from the fire exclusion and triennial burn treatments. Fire also affected the composition of the seed bank, with frequent fire increasing the proportion of emergent annual forbs by 50% compared to other fire frequencies, whilst fire exclusion led to the highest forb species richness (n ~ 20).

Tetrazolium viability tests revealed that fire influences seed viability, and that the proportion of viable seeds among herbaceous species is highly variable (7-99%). Dormancy tests indicated that most species exhibited dormancy traits; forb seeds typically exhibited physical dormancy and grass seeds physiological dormancy. The effect of fire-related dormancy cues – namely heat shock and smoke/ash water exposure, on breaking dormancy were positive and appeared highly species-specific. Our study provides insight into how fire frequency affects sexual recruitment attributes, which partly structure above-ground plant communities. The role of seedbanks in biodiversity conservation should therefore be considered.

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Thursday

Underground trees inhabit varied environmental extremes across the Afrotropics

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Underground trees are a distinctive feature of Afrotropical open ecosystems, surviving recurrent disturbances by resprouting subshrub branches from large belowground woody structures. Despite independently evolving in at least 40 African plant families, the environmental determinants of underground tree biogeography are poorly understood. To quantify variability in the niche of underground tree species, occurrence records for four African woody genera, *Parinari* (Chrysobalanaceae), *Ozoroa* (Anacardiaceae), *Syzygium* (Myrtaceae) and *Lannea* (Anacardiaceae), and nine climate and disturbance variables were used to compare environmental distributions among underground trees and their tree/shrub congeners in open and closed ecosystems.

Along multiple environmental gradients and in multidimensional environmental space, underground trees inhabit significantly distinct and extreme conditions relative to open and closed ecosystem congeners. Niche overlap is low among underground trees and their congeners, and also among underground trees of the four genera. *Parinari* underground trees inhabit hotter, drier and more seasonal environments where herbivory pressure is greatest. *Ozoroa* underground trees occupy relatively more fire prone environments, while *Syzygium* underground trees sustain the highest frost frequency and occur in relatively wetter conditions with seasonal waterlogging. *Lannea* underground trees are associated with the lowest temperatures, highest precipitation, and varying exposure to disturbance. While underground trees exhibit convergent evolution, diverse environments shape the ecology and biogeography of this iconic plant functional group. The multiplicity of extreme environments, especially related to fire, frost, herbivory and waterlogging, that different underground tree taxa occupy should be recognized in the management of African open ecosystems and their resilient biodiversity.

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Quantifying floral diversity in savannas to improve understanding of ecosystem change

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Understanding of savanna vegetation dynamics and change centres around trees and grasses. Together, these components of the flora generally comprise around 20-30% of total floral diversity at a given site. Most surveys of vegetation take place once within a year, either in the dry season when woody plants are easy to measure and cured grass biomass can be sampled as a flammability or productivity proxy, or in the late wet season when larger grasses are flowering and thus identifiable. At a fire experiment in central Zambia, we made six repeat measures of ground layer floral composition through the course of the wet to dry seasons. One off sampling not only vastly under-estimated diversity, it also biased the taxa observed of different plant families in different months.

Nascent biodiversity and carbon markets are developing seeking to "increase biodiversity", and there is perennial debate about appropriate restoration methods to support biodiversity. Yet amid this, science still has a poor handle on floral diversity and composition of savannas, let alone the functional diversity and the ecosystem services these other 70% of plant species likely support related to pollination, C storage and cultural and spiritual importance. Increasing use of and reliance on modelling to impute richness and functional diversity at scale will always be limited by poor field observations. Here, we discuss optimising field sampling to better quantify floral diversity and how increased sampling of these *other* species can improve scientific understanding of savanna persistence and change.

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Intraspecific variation drives grass and forb responses to herbivory and rainfall

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Large herbivore declines throughout Africa have caused fundamental but unpredictable shifts in plant community structure and composition. The effects of these declines on plant communities is dependent on individual species responses, which likely shift across productivity gradients. Many of the phenotypic traits we use the categorize plant responses show adaptive shifts in

response to resource availability and disturbance, and we currently lack an understanding of how within species variation can mediate population and community level changes. Here, we assessed intraspecific variation in plant biomass and leaf traits of four forb and four grass species along a rainfall gradient (450-650 mm/year) and size-selective herbivory gradient at Mpala Research Centre (Laikipia, Kenya). We assessed if intraspecific trait variation differs between grasses and forbs and whether this variation is constrained by rainfall or herbivory.

Forbs responded more strongly to the herbivory and rainfall gradients than grasses and had higher intraspecific variation in total biomass and leaf traits than grass species. Intraspecific variation tended to be higher in the wetter site, suggesting a more competitive environment may increase trait variation. The effects of herbivore presence varied by species but, in general, herbivores increased variation in forb species and had minimal effects on grass species. The species with the lowest intraspecific trait variation, *Pennisetum stramineum*, also had the lowest change in abundance in response to herbivory. These results suggest that magnitude of individual-level variation differs among common plant species and may correlate with species-level changes in abundance.

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Madagascar's open ecosystems: patterns of orchid diversity in space and time

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Orchids, constituting nearly 10% of Madagascar's plant diversity, are commonly associated with Madagascan forests rather than open ecosystems. However, while all ecosystems are endangered by land-use conversion, open ecosystems are omitted from conservation agendas. Here, we analysed ecosystem types of all orchid species in Madagascar and divided them into closed (forest) or open (savanna, grassland, marsh, Tapia, scrub, rocky outcrop). We used the resulting data to analyse spatial and temporal collection and distribution patterns, and environmental niches to shed light on Madagascar's open-ecosystem biodiversity. We find that >30% of species occur in open ecosystems, and 17% of species are found exclusively there.

Orchids occupy a similar environmental space across all types of open ecosystems and are associated with precipitation seasonality, high diurnal temperature range, and fire, while closed ecosystem species are associated with high precipitation and annual temperature. However, despite some differences in distribution patterns of open vs closed ecosystem orchids, diversity for both groups is concentrated in the Central Highlands as a result of (1) local heterogeneity in topography creating fine-scale mosaics of grasslands and forests; but also (2) biased collection efforts. As for temporal patterns, open-ecosystem species flower mostly across January-March in contrast with closed species flowering year-round. Furthermore, taxonomic collections are much older for open than closed ecosystems. Our results highlight Madagascar's open-ecosystem orchids as a distinct but underappreciated source of biodiversity and demonstrate that (1) research needs to be inclusive of species phenology and past spatial/temporal bias; (2) conservation efforts should expand beyond the Madagascan forests.

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Herbaceous species responses to tree cover differ by functional group in Southeast Asian savannas

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The savannas of Southeast Asia are some of the most poorly known in the world and are threatened by accelerating climate change, conversion to agriculture and afforestation schemes. Studies of Asian savannas have primarily focussed on their tree component but understanding of the composition, function, and resilience of these savanna ecosystems is hampered by a lack of understanding of the richness and composition of their herbaceous flora. We conducted field surveys across 50 sites in four savanna ecosystems across Cambodia and Thailand to characterise the grass and other herbaceous species composition, and to investigate the impacts of increasing tree cover on the species richness of the ground flora. Tree cover was negatively related with herbaceous richness among savanna types.

However, when total richness was decomposed in five taxonomic/functional groupings, variable patterns and quantitative relationships between tree cover and richness emerged. We used generalized linear mixed models to predict the effect of increasing tree cover on total species richness disaggregated into five non-overlapping groups of 1) C4 grass species richness, 2) C3 grass species richness, 3) sedge richness, 4) non-graminoid monocot richness, and 5) herbaceous dicot

richness. Species richness declined under increasing tree cover across savanna ecosystems in C4 grasses, sedges, and non-graminoid monocot herbaceous groups, with monocots experiencing the largest declines. Surprisingly, monocots and dicot herbs displayed opposing responses to increasing tree cover. We suggest that future studies should avoid categorising herbaceous plants together to better predict ecosystem-level patterns.

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Nursing the Swazi Lily or throwing shade? Assessing plant-plant interactions between *Euclea divinorum* and *Adenium swazicum* in Kruger National Park

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Adenium swazicum, a vulnerable succulent endemic to southern Africa, typically inhabits sodic sites, where *Euclea divinorum*, an evergreen tree or shrub, is prevalent. *Euclea* species provide understory habitat to multiple succulent species. However, the nurse-plant syndrome, where one plant species facilitates the establishment/growth of another, has not been investigated between *E. divinorum* and *A. swazicum.* We assessed a) if *A. swazicum* grows closer to *E. divinorum* than expected under random distribution and b) if *A. swazicum* growth patterns, reproductive output and herbivory incidence are influenced by *E. divinorum* proximity and percent coverage. Total height, canopy height, canopy width, number of stems and number of flowers and buds were recorded for 303 *A. swazicum* plants from four sodic sites.

For each *A. swazicum* sampled, distance to closest *E. divinorum,* percentage cover of *E. divinorum* and the presence/absence of herbivory were recorded. *Adenium swazicum* was found to be growing in closer proximity to *E. divinorum* than if the plants were randomly distributed, suggesting a potential nursing relationship. However, *Adenium swazicum* plants were shown to have increased height and canopy height, a lower number of stems, lower reproductive output, and no change in herbivory presence with increased proximity and percentage cover of *E. divinorum* plants. This suggests that, while *E. divinorum* may aid initial *A. swazicum* establishment through seed trapping, proximity may incur a reproductive cost, as a result of energy diversion towards shade avoidance.

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Seed dispersal to canopy gaps in the Congo Basin and implications for grassy ecosystems

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Vegetation structure influences the ecological niche space available to animals, shaping many aspects of behaviour and reproduction. In turn, animals perform ecological functions that shape vegetation structure. We tagged black-casqued (*Ceratogymna atrata*) and white-thighed hornbills (*Bycanistes albotibialis*), great blue turacos (*Corythaeola cristata*) and hammer-headed bats (*Hypsignathus monstrosus*) in southern Cameroon with solar-powered GPS tags and tracked their movements within a UAV-LiDAR study area.

We used Step Selection Functions to investigate 3D vegetation structure as a predictor of movements and found canopy height to be a strong predictor of movements for all species. In addition, individual hornbills and turacos varied in their preference for large canopy gaps such as inselberg grasslands, while bats preferred them at the population level. These results point to the importance of both large and small frugivores as seed dispersers from rainforest regions into open, grassy ecosystems. Because each of these species is widespread in the rainforest zone, such canopy gap specialists may be a contributing factor to woody encroachment in forest-savanna mosaics.

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The Role of Megafauna in Seed Dispersal Networks: Insights from Neotropical Savannas and Future Comparisons with African Savannas

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Seed dispersal is a vital ecological process threatened by the decline of large-bodied frugivores. Through a literature review and frugivory network analysis, we investigated the contemporary dispersal network (DN) of the Brazilian Cerrado, South America's largest savanna. We uncovered a slightly nested and strongly modular structure, dominated by small- to mid-sized generalist frugivores (*e.g.*, passerines, marsupials, mesocarnivores). However, large frugivores, like the lowland-tapir, play a crucial role in maintaining Cerrado DN integrity due to their large foraging area and dispersal of small *and* large seeds. Beyond the legacies of the Pleistocene defaunation, the ongoing defaunation is disrupting Cerrado's frugivore assemblage, with potential negative consequences for large-fruited species and overall network stability. African savannas, in contrast, retain their historical megafauna yet face contemporary defaunation.

This contrast inspired future research to examine seed dispersal dynamics played by extant megafauna through a comparative analysis between Neotropical and African savannas. Via experimental paired-control exclosures plots in Emas National Park (ENP; Brazil) and Kruger National Park (KNP), we aim to assess how frugivore defaunation (historical *and* contemporary at ENP; contemporary only at KNP) influences seed dispersal, seedling/sapling establishment, plant community structure and diversity. Additional transplant manipulations will help elucidate dispersal limitation vs. establishment limitation. This cross-continental comparative approach seeks to assess the evolutionary and ecological consequences of defaunation in Neotropical and African savannas and its impact on ecosystem functioning. We aspire that insights gained from this research might inform strategies aimed at fomenting the integrity of savanna ecosystems-locally and globally- considering the ongoing biodiversity crisis.

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Effects of elephant carcasses on plant communities in Kruger National Park

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When elephants die, their bodies release enormous quantities of nutrients into soil, where they are available for uptake by plants. The impacts of these nutrients on plant community composition are likely dependent on plant physiological traits (e.g., ammonium tolerance). To determine the impacts of elephant carcasses on soil and plant nutrient concentrations, we visited 28 elephant carcass sites ranging from 0-7 years since death. At each, we collected soil and grass (*Urochloa trichopus*) samples and recorded plant species composition at distances 0, 2.5, 5, 10, and 15 m from the center of the carcass site and quantified nutrient concentrations in each sample. We also performed lab experiments testing the impacts of soil nutrient composition on physiological traits for 3 common grass species. We predicted that we would see differences in plant community composition based on physiological responses to changing soil nutrient concentrations.

Consistent with our hypothesis, we found that soil ammonium, nitrate, and phosphorus increased with proximity to the carcass center, as did foliar nitrogen concentrations. Plant community composition differed significantly at the center of carcass sites relative to further distances, with one grass species (*U. trichopus*) tending to colonize carcass sites earlier than other sympatric grasses. Plant physiology experiments revealed differing levels of ammonium tolerance as one of the mechanisms underlying these trends in plant community composition. Together, these results reveal the long-term impacts of elephant carcasses on local plant community composition and the physiological mechanism by which these changes occur.

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Rethinking grasslands: A synthesis of 252 grassland and savanna sites investigating grass and forb composition and its response to grazing

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In grassland and savanna research, we frequently make generalizations about plant community composition. For example, that grasses make up the majority of plant abundance (i.e., biomass, cover) in the understory, while forbs are responsible for biodiversity. My preliminary research shows that while this grass/forb composition assumption is true for many sites, it varies significantly across the globe, with climate predictors and productivity poorly explaining this variation. Similarly, there is an assumption that herbivory will decrease grass cover and increase forb cover, potentially even leading to "forbland." I hypothesize that this assumption will be true globally, but I expect that the response to grazing will show considerable site-level variation, driven more by grazer characteristics than climate.

I synthesized data from large-grazer-exclusion experiments in 252 sites spanning continents and large gradients in mean annual precipitation (MAP; 45-1511 mm), production (ANPP; 13-1204 g/m^2), and site-level richness (species number; 3-179 species). Globally, grazing has a significant positive effect on forb abundance but no effect on forb richness. Interestingly, grazing also significantly increases graminoid richness. However, there is wide variation in the response of grass/forb composition to grazing, and this response is not well explained by climate predictors or productivity. Surprisingly, grazing intensity and grazer species richness do not explain the composition response to grazing. Ecoregion and browser presence explain some but not all of the response of grass/forb composition to grazing. This work highlights that while global averages may support common assumptions about grassland and savanna communities, they mask significant site-specific variability.

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POSTER

Navigating Extremes in Savannas (NExS): How do plant traits alter the effect of global change drivers on ecosystem function?

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Extreme ecological events – such as drought and intense herbivory – are increasing in frequency and will very likely occur concurrently in the future. Understanding the future of savanna ecosystems requires understanding the effects of these compound extremes on ecosystem function, as well as the factors that control resistance to them. Here, we will present findings from the first year of the Navigating Extremes in Savannas (NExS) experiment, where we have simulated extreme drought and extreme herbivory – singly and in conjunction – in the Satara region of Kruger National Park. Specifically, we will focus on how population and community diversity of plant traits contribute to the resistance of plant above and belowground primary productivity in savannas and if communities see synergistic or antagonistic responses during these compound extremes.

We found substantial variation of plant traits across space, which corresponded with dominance of different grass clades. The magnitude of primary productivity responses seen across experimental plots were related to this gradient of plant traits, with plots having plant traits on the 'slow' end of the plant economic spectrum being more resistant to drought than those on the 'fast' end. We will then compare the responses of communities facing one extreme event to communities facing a compound extreme event. By identifying if the compound event has a synergistic, or additive negative effect, or an antagonistic effect, where the second driver mitigates the negative effect of the first, we will be able to better predict how different plant communities respond under compound extreme events.

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POSTER

Population responses of congeneric, range-limited plants to rainfall and herbivory gradients in a Kenyan savanna

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African savanna plant communities are strongly shaped by both climate and herbivory. While the independent and interactive effects of these drivers on plant diversity, abundance, and structure are well understood, comparatively little research has investigated their effects on plant distribution and range boundaries. Using a combination of long-term herbivore exclosure plots, demographic modeling, and reciprocal transplants—all of which are replicated across a steep rainfall gradient at Mpala Research Centre, Kenya—we show that the distributions of three congeneric (*Barleria*), physically defended subshrubs are controlled by both climate and herbivory. Latitudinal transect surveys over ~30km revealed that each species occupies a largely unique range along the rainfall gradient (440-640mm). Within their respective ranges, piecewise herbivore exclosure plots reveal that the abundance of each species is further modified by top-down control.

Excluding herbivores >5kg (e.g. dik-dik) results in two- to threefold differences in abundance, although the direction of this response was not consistent across species. To test whether climate-herbivory interactions also contribute to the observed range limits for two of the *Barleria* species, we initiated a reciprocal transplant experiment within the herbivore exclosure plots spanning the rainfall gradient. Ongoing demographic monitoring of transplants will be used to compare the effects of herbivory and rainfall on focal species. Preliminary results suggest that herbivory and climate interact to determine the range limits of savanna plants. These findings are highly relevant for predicting the future distribution and abundance of savanna plants under changing climatic conditions and shifting herbivory regimes.

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Traits enabling woody plants to persist under large (and largely unexpected) changes in herbivory in savannas

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Change in large mammal herbivore (LMH) abundance is an important driver of vegetation change in savannas. Reduction in abundance of large herbivores can result in woody plant encroachment and savanna-to-forest biome shifts, as in South America after late-Pleistocene megafaunal extinctions. Removing extant mammalian browsers and mixed-feeders from savannas leads to rapid increases in woody plants and herbivore-naïve plants. Such changes result in altered plant functional traits that affect herbivory. Structural traits limit LMH access to nitrogen and limit bite rate or mass. Digestibility-reducing compounds limit nitrogen availability and limit daily intake. Limited short-term intake rate can be overcome by switching between plants, but compensation for limited long-term intake requires extensive searching. Individual plants produce dozens of secondary metabolites (SMs) to minimise damage by herbivory through reducing LMH abundance (deterring or repelling herbivores, or reducing their survival and reproduction).

Both structural and chemical traits are usually only assumed to be detrimental to herbivore fitness or beneficial for plant fitness because survival and fecundity are difficult to measure in large, long-lived organisms. Structural traits in relation to LMH damage have been studied in detail because they are easy to measure. Chemical traits (especially SMs) have mostly been measured using general assays that are easy to do, but have low resolution. Hence, correlations between LMH and SMs are often weak or non-existent. Individual SMs and the richness and diversity of SMs are rapidly gaining recognition as important plant functional traits. Determination of richness and diversity of SMs in plant species and communities before and after defaunation or refaunation, using high performance liquid chromatography, gas chromatography and mass spectrometry, offers a metabolomic approach to understanding large changes in savanna vegetation related to LMH. It's time to stop beating about the bush and start applying eco-metabolomic techniques in the savanna science community.

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Malagasy Grass Flora Dynamics: An Exploration of Environmental Influences on Grassy Functional Traits

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Madagascar is home to at least 550 grass species, of which almost half are endemic - a surprisingly high percentage for an island of its size. Recent evidence indicates that Malagasy grasslands pre-date human arrival on the island and are instead part of the wide expansion of C_4 grasslands in the late Miocene. This in combination with Madagascar's relatively recent megafaunal extinction in the last millennia, the subsequent transition to livestock grazing, and its complex history of fire and fire suppression, raises questions around its landscapes and ecosystem dynamics. In particular, greater understanding is needed with regards to how different biotic and abiotic aspects of Malagasy environments combine to shape the structure of extant grass flora across the island.

Using measurements of plant functional traits related to growth (e.g. plant height, culm diameter, leaf dimensions) and resource acquisition (leaf C:N) for approximately half of the Malagasy grass species, we explore how grass traits vary in relation to the environment. We construct a series of phylogenetic generalised linear mixed models (PGLMMs) to assess correlations between plant functional traits and combinations of environmental predictor variables. Optimised models - developed through multi-model inference - are then used to produce island-wide trait maps, and test predictions about the influence of temperature, precipitation, human disturbance, and soil characteristics. Our explorations of the links between environment and the grassy flora provide valuable

insight into community assembly of Malagasy grasslands, and contribute fresh evidence for the argument about their ancient-ness.

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Savanna Landscape Engineering: What forms are possible or desirable in an uncertain future?

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Savanna vegetation contains a wide variety of functional, structural and compositional forms that vary with environmental and anthropogenic drivers. Historically, natural resource managers work to keep their savanna areas within generally accepted historical limits. These levels are now under pressure from multifarious and repeated shocks stemming from climate change or competing land use objectives. Managing ecosystem resilience within these emerging vegetation changes demands a more holistic view beyond traditional, conservation-based metrics. A functional management question emerges from these issues; *what kind of savanna landscapes can we expect in an uncertain future and what can we do to influence these changes to our desired outcomes?*

Using the open-source/open-access L-Range family of models (https://l-range.com/), different structural and spatial configurations of grass, shrubs and trees were simulated under longer-term GCM simulation and ecosystem management scenarios. While global savanna/rangeland model results exist at 1 degree (55 km) grid resolution, more localized versions have been configured at 20 km, 10 km and 1 km resolutions that explore more SANParks-specific management alternatives. These results show that some vegetation/ecosystem features are more responsive to management-instigated changes (grass/shrub biomass) while other features such as woody and shrub cover are less susceptible to human influences. The results also highlight significant trade-offs among additional ecosystem features that are not usually included in more management-focused objectives.

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Modelling savanna vegetation structure using Synthetic Aperture Radar and spaceborne lidar: A case study in Kruger National Park, South Africa

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Savanna ecosystems play a crucial role in the global carbon cycle, serving as important yet increasingly sensitive biodiversity hotspots. Recent studies have emphasized the importance of monitoring the spatial and temporal dynamics of the vegetation layer to better understand changes that alter its composition and structure. However, the dynamic and heterogeneous nature of savanna vegetation presents unique challenges for satellite remote sensing applications. This study aims to address some of these challenges and presents our progress towards the development of a framework for monitoring woody vegetation in savanna ecosystems. We integrate Synthetic Aperture Radar (SAR) data from Copernicus Sentinel-1 with spaceborne lidar data from the Global Ecosystem Dynamics Investigation (GEDI) to model vegetation structural variables across the Kruger National Park, South Africa. Our analysis focuses on GEDI-derived variables, particularly relative height (98th percentile), canopy cover, foliage height diversity index, and total plant area index.

To address savanna-specific challenges, we apply an extended quality-filtering workflow for GEDI shots, incorporating MODIS Burned Area data and a Copernicus Sentinel-2 derived permanent bare vegetation mask. Preliminary results demonstrate the effectiveness of this multi-sensor approach. Clustering of GEDI vegetation structural variables from the leaf-on period reveals distinct structural classes, with corresponding SAR backscatter time series showing high separability during dry season months. Additionally, the study highlights the superior capacity of radar in distinguishing structural characteristics compared to optical vegetation indices. This research contributes to the development of an open-source, reproducible framework for wall-to-wall mapping of vegetation structure variables over time in heterogenous savanna landscapes.

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Assessing the current distribution and predicting the future distribution of the vulnerable *Warburgia salutaris* under different climate change scenarios in South Africa

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Understanding the climate drivers of where species occur and predicting where they may migrate due to climate change is essential in conservation biogeography. *Warburgia salutaris*, commonly known as the pepper-bark tree, faces a decrease in suitable habitat due to the threat of climate change. The currently disjunct range of the species and over-harvesting for traditional medicine in South Africa has raised concern about the persistence of the species. This study characterized the current and future (2070, RCP4.5 and RCP 8.5) environmental niches of *W. salutaris*, using species distribution models (SDMs) to project both current and future distributions and to identify the most influential climatic variables governing the species' distribution. The study also examined how the environmental niche of *W. salutaris* shifts under climate change scenarios.

The most influential climatic variables of the distribution of *W. salutaris* were those that impact water-stress (e.g., monthly precipitation of the wettest, driest, and warmest quarters) and sensitivity to frost (e.g., annual temperature range, mean temperature of the wettest and coldest quarters). The environmental niche of *W. salutaris* is narrow but geographically widespread along the eastern part of South Africa. This niche will be largely conserved. However, the species distribution will decrease by 2070 under both scenarios. Critically, current protected areas (PAs) overlap poorly with its present or potential future distributions. The results show ecologically-informed conservation strategies, such as establishing new PAs and migration corridors, in addition to identifying areas for possible cultivation, are necessary for the conservation of *W. salutaris* in the near future.

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Help us map change in ecological condition in South Africa's savannas

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Declining ecological condition, also known as land degradation, has been recognised globally as a growing environmental concern due to factors like overgrazing, bush encroachment, invasive species, climate change, and altered fire regimes. However, unlike land-cover change mapping, which is relatively easy to do using remote sensing, the mapping of ecological condition is far more challenging. This is largely because ecological condition is determined by the interplay of various aspects of ecosystem structure, function and composition, which in themselves may be difficult to map. Despite these challenges, mapping ecological condition is essential to understanding the extent of the issue so that decision-makers, planners, and researchers can make informed decisions regarding the sustainable use of ecosystems and conservation thereof to prevent further degradation and implement restoration.

The Ecological Condition Mapping component of the Spatial Biodiversity Assessment Planning and Prioritisation (SBAPP) project in southern Africa is developing national spatial databases of ecological condition for South Africa, Namibia, Mozambique, and Malawi. This talk will outline the approach being used in South Africa, which is based on mapping and interpreting key indicators of pressures that contribute to declining ecological condition, using the Savanna biome as an example. Our approach aligns with guidelines established by the IUCN Red List of Ecosystems. Remotely sensed layers are critical to this approach, but we also highlight the essential need for contextual (often ecosystem-specific) interpretation of these layers. The approach outlined here for South Africa holds the potential to be replicated in other resource-constrained countries.

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Bush encroachment with climate change in protected and communal areas: a species distribution modelling approach

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Savanna rangelands have lost vast tracts of grasslands to bush encroachment causing concerns to conservationists and rural communities. Climate change

has the potential to exacerbate terrestrial ecosystem shifts particularly in South Africa. This work therefore aims to model the distribution of invasive species in protected and communal environments under long-term climate change. Three machine learning Species Distribution Modeling (SDM) techniques, namely, Random Forest (RF), MaxEnt, Boosted Regression Trees (BRT) and their respective ensemble model were used to predict the potential distribution of native woody encroachers in both protected and unprotected areas. The current and future bioclimatic variables, environmental and Sentinel-2 Multispectral Instrument satellite data were used to fit the models to predict areas at risk of bush encroachment in the Kruger National Park and surrounding communal areas.

The combined variables explained over 90% of the habitat suitability model under the current climate with Bio 2 being the most important variable (95%-53.5%) for RF and MaxEnt respectively. The future projections have also shown that slope, precipitation and temperature some of the key climatic variables were good predictors for the suitable areas for encroachment for both RCP 2.6 and RCP 8.5. Moreover, the overall predictions using the ensemble model demonstrated an increase in areas suitable for encroachment under RCP 8.5 but a decrease in the bush encroachment rate under RCP 2.6. These findings underscore the critical need for proactive management strategies to mitigate bush encroachment, particularly under high-emission scenarios, ensuring the sustainability of semi-arid savanna rangelands in the face of climate change.

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Revisiting Thulamela: an ancient southern African kingdom

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In the mid-1990s, Thulamela was revered by politicians and local authorities, and touted as one of South Africa's flagship cultural heritage sites in the post-apartheid era. A spate of research ensued that lasted the decade, but since then very little focussed archaeological work has taken place and the materials excavated have not been analysed. Thulamela has largely been forgotten. Making matters worse, gold retrieved form Thulamela was stolen from the Skukuza Stevenson-Hamilton Library, Kruger National Park, in December 2016. Renewed interest in the site and its declaration as a National Monument has highlighted the lacuna of information regarding Thulamela.

In beginning to remedy this, presented here is a summary of archaeological research activities to have taken place between 1990 and 1998. In doing so it provides context of the finds and outlines some of the other activities to have taken place, such as the rebuilding of the stone walls. In presenting the archaeology of Thulamela, the paper places the previously published work on the human remains and gold into a broader perspective. This contextual data includes site maps, surface collection and excavation locations, stratigraphy, radiocarbon results, and artefact analysis. It therefore provides the necessary information to properly understand and interpret the site and account for scrutiny. The paper concludes by summarising a recently initiated research programme that revisits Thulamela.

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Southern African trade networks: Forager participation at Little Muck Shelter, Mapungubwe National Park

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Southern African trade has primarily been examined through farmer archaeological sequences. One reason for this approach is emerging trade opportunities along the East African coastline, and the subsequent appearance of trade wealth, particularly glass beads, across the interior. These opportunities, alongside other factors, are thought to have prompted structural and socio-political changes within farmer communities across the Mapungubwe National Park. Because glass beads were not locally produced, individuals gradually monopolised these items to reflect status and power within their respective communities. In turn, this contributed towards the creation and maintenance of socio-political complexity, class differentiation and elite identities. Although glass beads did not have a similar significance within forager communities, it is important to acknowledge that foragers had access to local trade networks and so, these beads.

Foragers at Little Muck Shelter, in particular, appear to have actively participated in these networks as evidenced by the 496 glass beads recovered from the site. In comparison, surrounding shelter sites present a significantly low number of beads (Dzombo - 18; Balerno Main – 1). Analysis of the beads shows that Little Muck's foragers were economically resilient and actively participating in the local market throughout the first millennium AD by functioning as a trade centre with variable access to wealth. Challenging doctrines surrounding foragers allows for a more nuanced, regional perspective and presents an opportunity to understand the role that southern Africa's indigenous communities occupied within a broader socio-economic

network and the impact that these new trade relations might have had on the physical landscape (i.e. increase in ivory trade during this time).

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POSTER

Telling the stories in the stones - making Geoheritage in the Savannah Biome culturally relevant

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Geoheritage is a term applied to geological features with significant scientific, educational, cultural, or aesthetic value. Culturally significant geoheritage sites are places where geologic features or landscapes have played a role in cultural or historical events. Many geoheritage sites can be tourist destinations and provide local and regional economic benefits (*following from draft definition from the Geological Society of America, 2011*). Geoheritage education is a powerful way of helping people value and connect with the Savannah biome. Kruger National Park (KNP), the flagship representative of the Savannah biome, comprises over 3 billion years of iconic geological history, including abundant evidence of human activity during the last 1.5 million years. The interrelationships between the diverse geological history, ancient landscapes and rivers, rocks, soils, flora and fauna have supported prehistoric human life in the region, paving the way for modern Southern African societies to flourish.

People relied strongly on the geology, soils and mineral deposits of the Kruger Park for building stone and masonry, and for minerals such as iron used for trade, smelting and manufacture of spears and basic implements for tilling fields. Extensive gold mining and trading was active across the northern parts of KNP and adjacent Zimbabwe, Botswana and Mozambique. Collectively, hundreds of exceptional geoheritage sites (holding great value for geology, archaeology and anthropology) offer key opportunities for unlocking geotourism in the KNP. This will contribute significantly to expanded tourism and job creation opportunities, and help people associate value, and connect with, the Savannah Biome.

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Natural resource use in protected areas – 30 years of transforming policy and practice in SANParks

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The establishment of what is arguably the first national park (NP) in the world in 1872, (Yellowstone NP, Wyoming, USA) set the scene for the protectionist approach to conservation that was subsequently adopted globally. Early days of the Kruger National Park (KNP), in South Africa, similarly aimed primarily at securing vast tracts of land that were deemed wilderness as a result of their perceived absence of impact by people. Natural resources that were used in the KNP at the time were those that enabled generating revenue and maintaining park infrastructure. However, the acknowledgement of the need for conservation to be more inclusive, alongside the development of international, and national supporting conventions, agreements, legislation, policies and programmes over the past 30 years have facilitated broader opportunities for various stakeholders to benefit from tangible resources harvested sustainably from within park boundaries.

Going forward, SANParks acknowledges the sustainable use of natural resources within national parks as a key requirement for park sustainability in that illegal, uncontrolled and unpermitted extraction of natural resources in both marine and terrestrial environments, continues to threaten species and ecosystems, while legal, permitted resource use contributes to ecological integrity, economic viability and building broader societal relevance. This presentation aims to celebrate the opportunities associated with legal resource use, and explore the challenges of illegal resource use from protected areas in the context of sustainability linked to both human wellbeing and biodiversity conservation.

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Illegal hunting and bushmeat trade in a semi-arid savanna: implications for conservation

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Illegal bushmeat hunting is increasingly becoming a severe threat to the wildlife populations. Despite indications that it c
onstitutes a serious conservation threat, little information exists on the dynamics of the bushmeat trade in sub-Saharan African savannas. In this study, we conducted

interviews with 133 illegal hunters and 40 anti-poaching field rangers in Southeastern Zimbabwe, using semi-structured questionnaires. We aimed to understand the characteristics of illegal hunters, motivations for illegal hunting, methods commonly used for illegal hunting, bushmeat sales, wild animal species commonly hunted illegally, the prevalence of illegal bushmeat hunting, perceptions on Save Valley Conservancy (hereafter SVC) wildlife law enforcement and strategies to curtail illegal bushmeat hunting in the conservancy.

Overall, illegal bushmeat hunting in SVC is mainly done by less educated and unemployed young to middle aged men (15-40 years old). The motives behind illegal bushmeat hunting mainly included household consumption (96%), the desire to raise income (96%), unemployment (78%), retaliation for wildlife induced losses (62%), culture (29%) and poor benefit sharing (8%). The common hunting methods reported were hunting with dogs (87%), and snaring (65%). Targeted animal species included impala (96%), wildebeest (53%), eland (53%), African buffalo (51%) among other 12 animal species. Illegal bushmeat hunting was conducted all year round. The law enforcement penalties were considered less deterrent, and most of the hunters intended to continue with illegal hunting. Measures suggested to minimize illegal bushmeat hunting in the SVC included investing and strengthening wildlife law enforcement, provision of community-conservation based incentives and enhancing environmental education and awareness.

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Rhino poachers exploit space-time variation in opportunity and risk

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Human behaviour shapes both our impact on nature as well as the success of solutions to safeguard it. We used crime opportunity and deterrence theory, together with methods from epidemiology, to link space-time patterns in 560 rhino poaching incidents to poacher and ranger behaviour in a South African rhino stronghold. Poaching activity was significantly associated with proximity to ranger camps, which together with supplementary evidence suggests that criminal syndicates collude with some rangers to facilitate poaching.

Poachers repeatedly targeted specific regions of the reserve for set periods before shifting, mirroring the 'near-repeat' behaviour observed for other crimes. Poachers also avoided tourist activity and minimized time on the reserve. Results suggest poachers strategically leverage space-time variation in opportunity and risk. Solutions based on these behavioural insights include early response to space-time clusters of poaching, spatially targeted implementation of rhino dehorning, and bolstering ranger resilience to the influence of criminal syndicates.

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Activity patterns of wildlife along the Phalaborwa – Hoedspruit railway line in Balule Nature Reserve, South Africa

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The rapid increase in human population and economic growth necessitates the expansion of transport infrastructure for passenger travel and the movement of goods. Globally, there are more than 1.3 million kilometers of railway lines with an expected increase of 30% by 2050. However, the development of transport infrastructure is considered one of the leading causes of biodiversity loss. Rail ecology studies show that wildlife is negatively affected by human activity following the development and operation of railways, resulting in wildlife mortalities, barrier effects, habitat loss, and disturbances. Wildlife may adjust their spatiotemporal activity to minimize encounters with human activity. This represents serious concerns for the management of wildlife populations in protected areas where railways bisect important wildlife habitats as sensitive species avoid exploiting areas adjacent to the infrastructure.
In this study, we investigated the activity patterns of six medium-large sized mammals on the landscape bisected by the railway line to determine whether the distance from the railway line, season, and rail-side habitat affect their activity around the railway line. African buffalo and elephant activity decreased with increasing distance from the railway line. Giraffes, impala, and lions are less active around the railway line in the wet season than in the dry season. Spotted hyaenas are more active around the railway in both open grassland and woodland compared to the mixed shrubland habitat intersecting the railway. We suggest that management intervention needs to be species-specific, consider species of conservation concern and high railkill rate. More research work needed to understand contributing factors of wildlife activity in proximity to the railway line.

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The uncertainty of large animals as a trustworthy climate solution

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Global climate change and biodiversity loss are the most important environmental crises today, generating support for nature-based solutions to climate change. Until recently, natural climate solutions have focused on vegetation restoration and tree planting; however, large animal conservation and restoration are increasingly cited as viable climate mitigation strategies through their potential to sequester carbon. On one hand, this can focus attention and financial resources towards protected areas by attributing value to wildlife and their potential carbon services. However, on the other, it may generate incentives to manage ecosystems in a way that maximises carbon sequestration at a cost to alternative outcomes e.g., biodiversity goals. For example, how do we value species that do not align with carbon sequestration?

In this talk, I will explore the state of the science with regards to the potential of large savanna mammals for mediating the carbon cycle in protected areas, with particular reference to the timing and magnitude of carbon sequestration. I will then discuss the relevance of this knowledge for present-day and future climate mitigation, conservation management and carbon-based monetization of savanna ecosystems. While large mammals may play significant roles in savanna carbon cycles at local and potentially regional scales, these roles require further examination before being deemed robust enough for incorporation into climate management strategies. Valuations of large savanna mammals in protected areas should instead emphasize the diverse ecosystem functions these animals provide beyond carbon, including enhancing ecosystem resilience and adaptation to ongoing climate change.

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Improved household waste management as an opportunity to add value to protected area conservation

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If current trends continue until 2050, more than half of the world's demographic growth will take place in Africa, where the population will roughly double. It is to be expected that this increase in population, will result in an increase in domestic waste generation. If not properly managed, the larger volume of waste is likely to give rise to an escalation in negative environmental and health impacts such as contamination of surface and groundwater, soil and air pollution, disease transmission, and an in increase in visual pollution. Where local authorities do not render waste removal services, households are obliged to find alternative methods to dispose of their waste, which include the dumping and burning of domestic waste.

It is important to find solutions for domestic waste management where services are lacking, especially in communities around protected areas. The Nova Institute has recently developed, tested, and implemented an innovative domestic waste service model incorporating separation at source. The results of the monitoring and evaluation of the impact of this waste model will be presented. Suggestions will be made for how improved household waste management can add value to protected area conservation.

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A Kruger micro-experience: Microplastics concentration and movement in a protected terrestrial landscape

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Microplastics pollution is one of the leading global conservation issues. Microplastics is recognised as an emerging environmental problem that needs to be monitored. Few studies have focused on microplastics occurrence in terrestrial ecosystems with most studies focused on marine and freshwater ecosystems. Past studies conducted in Kruger National Park (KNP) found high levels of microplastics pollution in perennial rivers,

suggesting possible anthropogenic sources of water contamination outside the park which travels into the protected areas of KNP. Building upon previous research concerning the prevalence of microplastics pollution in urban areas and marine environments which largely focus on abiotic microplastics cycling, this study investigated microplastics concentrations and movement in a conserved terrestrial area.

We examined the presence of microplastics in ephemeral pools and elephant fecal matter within the Sabie River catchment. The minimum microplastics concentration in pool sediment was 71±18 NMP/200g and the maximum was 180±18, whereas in dung we found a minimum of 320±189 NMP/200g and a maximum of 1493±189 NMP/200g. Altogether, we found higher concentrations of microplastics in three of the sediment samples and all six dung samples, compared to their respective controls. In five of the six sites, microplastics were more concentrated in dung than sediment. Overall, elephants could serve as a vector for microplastics dispersal throughout the landscape, suggesting that other terrestrial organisms may fulfil the same role. Additionally, while microplastics are present in ephemeral pools, these water bodies are less contaminated by microplastics than perennial rivers within KNP.

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A critical zone assessment of bush encroachment in grassy social-ecological systems

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Bush encroachment is a global phenomenon, and now represents the most widespread threat to grassland conservation after conversion to row-crop agriculture. The aboveground consequences of encroachment are well studied. For example, bush encroachment typically results in reduced plant and animal biodiversity, loss of suitable habitat for obligate small mammals and birds, and increased threat of diseases carried by ticks. Alterations in aboveground ecosystem structure also reduces forage availability for range management, with cascading consequences on local economies. The consequences of encroachment on belowground ecosystem dynamics are less well known. Shifts from grass-dominated to shrub- or tree-dominated at the landscape-scale disrupts C, water, and nutrient cycling throughout grasslands. Ecohydrology studies have shown that woody encroachment alters catchment water budgets and recharge rates, runoff generation mechanisms and amounts, the relative contributions of deeper flow paths to streams, and stream discharge and intermittency.

Moreover, the replacement of a grassy ecosystem with a woody ecosystem has uncertain impacts on C sequestration due to alterations in soil carbon dioxide fluxes, increased bedrock weathering rates, and changes in labile soil organic carbon accumulation. In this presentation, I will use examples from the Konza Prairie (Manhattan, KS) that illustrate linkages between above- and below-ground ecosystem processes following encroachment. This research shows the mechanisms by which woody vegetation accelerates water cycling and alters the distribution of C within the soil profile. Coarse woody roots create larger soil macropores that speed up rates of infiltration to the groundwater, a process that alters belowground C distribution, reduce water residence time in surface soils and along with higher ET, result in longer-term drying trends in grassland ecosystems. The results from Konza Prairie illustrate how the replacement of grass with woody species in grasslands magnifies water loss above and belowground leading to greater water scarcity.

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Movements and behaviours of lion in the Kgalagadi

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African lions have historically occupied vast regions across non-forested Africa, the Middle East and Southern Asia. Today, their distribution has contracted by 94%, and this decline appears to be accelerating at an alarming rate. Of the remaining stable populations, several are located in southern Africa, either within protected areas, or in regions with few human inhabitants due to the harshness of the environment. The greater Kgalagadi Transfrontier Park, encompassing 38,000 square kilometres of the southern Kalahari Desert, serves as a crucial lion stronghold despite its arid climate and low prey density. However, this region is highly susceptible to climate change, posing significant threats to lion survival. Therefore, critical questions remain.

Can lions maintain their populations in this area under increasingly arid conditions? Will they be compelled to expand foraging ranges and travel greater distances to fulfil energy requirements? Will this mean they become

increasingly into contact with people? To date, there is a paucity of information on the behavioural profiles of free ranging lions, their corresponding energy requirements, and the future impact of climate change scenarios in arid regions. The current study aims to examine movements and behaviours of lions at a high resolution, in terms of what resources they require from the environment and how these might change over time. Results are relevant in terms of understanding current and future habitat requirements and whether there is preferential use of certain features (e.g. riverbeds, fencelines).

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Impacts of dehorning on black and white rhinoceros population dynamics across southern Africa

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High, persistent poaching is one of the primary threats to both African rhinoceros (*Diceros bicornis* and *Ceratotherium simum*; hereafter rhino) species, particularly in southern Africa. In an attempt to deter poachers, dehorning, the controlled removal of a rhino's horns, is becoming widespread in southern Africa. However, to ensure that this conservation intervention is both effective and does not adversely impact rhino population dynamics, it is essential to have a clear understanding of its effects. Using historical data from 440 black and 1,258 white rhinos across 11 southern African protected areas, including 1,392 dehorning events, we compared measures of population dynamics between dehorned and horned individuals, including age-at-first-reproduction, inter-calving interval, calf survival, cause of death and population growth rate.

Based on preliminary analyses, no notable detrimental effects of dehorning were found in any of these parameters. For example, calves of horned and dehorned mothers had an average survival rate of 95.3% (n = 603) and 95.7% (n = 268) respectively in white rhinos, and 83.5% (n = 147) and 90.5% (n = 67) respectively in black rhinos. The proportion of poaching-related deaths in both species was lower in dehorned than horned individuals and fighting-related deaths were only recorded in horned individuals. Although additional sites will still be added, these preliminary results suggest minimal detrimental impacts of dehorning on rhino reproduction, thus providing reassurance for the continued use of dehorning as an anti-poaching strategy. However, further research to better understand the effectiveness of dehorning on a global scale is essential.

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POSTER

Mapping middens: Using remote sensing to reveal rhino midden spatial patterning

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Communal defecation sites, or dung middens, are used by many species for territory marking, social communication, and disease prevention. In African savannas, both black (*Diceros bicornis*) and white (*Ceratotherium simum*) rhinos defecate in middens used by individuals of all ages and sexes. Rhinos rely on olfactory investigations at communal middens to gather critical population information, such as sex, age, territorial status, and oestrous state, and thus middens likely play a key role in rhino movement and space use. Although it has been observed that middens tend to be found around animal paths, water points, and territory boundaries, rhino midden locations have never been mapped at the landscape scale.

We used high-resolution imagery from remotely sensed RGB, thermal, and LiDAR data to detect and map rhino middens across five sites in Kruger National Park, South Africa. We then assessed how multiple environmental factors were associated with the distribution of rhino middens across all sites. We found that rhino middens are not randomly distributed across the landscape, but that their locations are influenced by terrain, vegetation cover, and proximity to animal paths. We anticipate that understanding midden spatial distribution will yield insights into rhino spatial behaviour and its influence on ecological processes such as nutrient redistribution, while simultaneously providing home range and habitat use information critical to conservation management and anti-poaching strategy.

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101 podded rhino: insights into drivers of home range size in white rhinoceros (*Cerathium simmum*) and black rhinoceros (*Diceros bicornis*)

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Animal home range size provides vital information for the management and conservation of species. While home range size is often linked to environmental variation, demographic factors and social interactions also play significant roles, making the relationship more complex than it might seem, especially for species difficult to observe and follow. This study investigates habitat use patterns of white (*Ceratotherium simum*) and black rhinoceros (*Diceros bicornis*) using GPS data from more than 100 tracking devices, in the form of high fix rate horn pods, across four protected areas in South Africa.

The analysis focuses on understanding home range sizes, patterns and the key factors influencing spatial use by both species. Home range sizes varied considerably between individuals of different sex and age and across locations for both species. Key drivers of home range size included seasonality, habitat type and annual rainfall, where average area increased with aridity, particularly for white rhino. Home range areas decreased with population density and for females with young calves and increased with distance to water. Immature animals occupied smaller ranges. Further understanding these patterns can help inform management strategies ensuring the conservation of both rhino species in increasingly fragmented and changing landscapes.

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POSTER

Welgevonden Game Reserve Rhino Rescue Programme: Lessons Learnt for Ranched Rhino

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As part of a program aimed at creating grazing lawns and increasing herbivore density at Welgevonden Game Reserve in Limpopo Province, South Africa, white rhinos were "rescued" from reserves and ranches unable to meet their security needs. While Welgevonden offered a safe haven for these rhinos, the rapid increase in their population also contributed to the reserve's management goals of developing and maintaining short grass grazing areas, thereby enhancing herbivore numbers. The relocations occurred between 2016 and 2022, with most taking place from 2016 to 2019. Some rhinos came from game reserves where they were not supplemented with feed, while others originated from ranches that provided supplemental nutrition. Despite taking all necessary precautions, several relocated rhinos did not survive, and the reasons for these losses will be discussed.

Most adult females that survived the initial introduction successfully settled into the reserve, establishing distinct home ranges and giving birth to calves. Home range analysis and calving history will be presented. However, some of the "rescued rhinos," as well as a few of the original residents, required supplemental feeding during dry winters. This necessity has implications for their landscape use and thermoregulatory capabilities. Numerous lessons were learned from supplementing the white rhino population at Welgevonden through these relocations, particularly in the context of the region's sourveld conditions. These insights can be applied to the rewilding of ranch-raised rhinos.

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POSTER

Does size matter? The impact of horn and body size on white rhino territorial success

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White rhino (*Ceratotherium simum*) bulls are territorial and make use of the assessment behaviours during resource competition and defence, allowing them to evaluate both their own fighting ability (i.e. resource-holding potential) and that of their opponent. Asymmetries in both weaponry (e.g. horns) and body size have been shown to influence assessment behaviours and, ultimately, the outcome of contests. However, the role of horn and body asymmetries in white rhino populations remains unexplored. Using NDVI values collected over a period of six months and photogrammetry for body and horn measurements, it was possible to establish the relationship between forage quality and horn and/or body size. The average forage quality value within each bull's territory was calculated for both the wet and dry seasons.

Bulls with both larger body and horn sizes maintained territories with higher forage quality (as indicated by higher NDVI values) compared to those with both smaller horn and body sizes. Bulls with smaller horns and larger bodies held higher quality territories than those with larger horns and smaller bodies. These findings suggest that asymmetries in physical traits influence assessment behaviours and, consequently, resource-holding potential. Ultimately, these results provide insight into the role of horn and body size disparities in white rhino populations and may contribute to future conservation decisions, such as those regarding dehorning.

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POSTER

Spatio-temporal activity of African ungulates at water sources in Mogalakwena River Reserve, South Africa

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Few studies have examined the circadian activity of large African mammals, particularly in small, fenced reserves lacking a complete predator guild. This study focuses on the spatio-temporal activity of ungulates at water sources in the Mogalakwena River Reserve, South Africa. Using camera traps positioned along the river and at waterholes, I assessed the circadian activity patterns of 15 ungulate species at these resources, and investigated spatial preferences and the effects of biotic and abiotic factors. Results indicate that ungulate activity at water sources is significantly influenced by maximum daily temperature and body size. Species ranging from 10–100 kg visited water sources primarily during daytime, while larger species, excluding giraffes, showed no significant differences between day and night activity.

The presence of juveniles affected the circadian activity, notably in larger species, likely driven by predator avoidance behaviours. Spatial segregation was also observed, with waterbucks, nyalas, kudus, and bushbucks preferring river over water holes. Temporal avoidance patterns were evident, with species exhibiting lower activity overlap when at least one member of a pair was a mix-feeder or omnivore, compared to pairs of pure browsers or grazers. This research provides insights into how ungulates in predator-limited environments adapt their activity to environmental pressures, offering important implications for wildlife management in fenced reserves.

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POSTER

Tall Tales: Giraffe Trends That Stand Out!

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Kruger National Park has adopted different management approaches over the years. These approaches have varied in intensity and have influenced the trends of several species, including the giraffe (*Giraffa camelopardalis*). Giraffes require regular access to water, which they mostly obtain directly from water sources. Based on changes in management, we expect to observe patterns in the trends and spatial distribution of the giraffe population. Census data was used as the basis for the trend and distribution analysis. This data includes both historical total counts (1977–1997) and sample-based estimates (1998–2023). The sightings of giraffes were mapped to determine if distribution was affected by management interventions.

Using abundance estimates obtained during aerial censuses, we were able to determine the population trend of the species and predict possible changes in the giraffe population over the next three years. In the late 1970s, the giraffe population abundance in Kruger was approximately 1,700, after which it increased to around 4,500 individuals. The population fluctuated for several years until the late 2010s, when growth accelerated, leading to the current estimated population size of ~12,000. The distribution pattern of giraffes has remained relatively stable in recent times, with the only noticeable change being associated with the increasing population size. Even so, management within and beyond protected areas must adapt strategies to sustain giraffe dynamics and distributions.

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Seasonal variation and drivers of parasite prevalence in migratory Serengeti wildebeest

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Gastro-intestinal nematodes (GIN) are a ubiquitous parasite group infecting ruminant herbivores that typically impose non-lethal effects on their hosts. Nonetheless, parasite effects on herbivore body condition, due to direct nutritional losses and altered foraging behaviour or movement capacity, should scale-up to influence population demographic rates. Migratory herbivore populations may be at particular risk from GIN effects, because migration supports high population densities and incurs movement costs, although periodic large-scale movement may allow populations to escape parasites by moving to ‘clean’ areas. Here we examine

seasonal variation in GIN prevalence in 35 GPS-collared female migratory wildebeest in the Serengeti ecosystem over a 22-month period. GIN prevalence was assessed longitudinally via faecal egg counts (FEC) on samples obtained from collared wildebeest (n=347).

These data reveal higher FEC in the wet season and for animals with calves, suggesting that conditions may be more favourable for GINs to complete their life cycle at this time (humid conditions for larvae, immunosuppression of lactating females). Also, fires, which are restricted to areas used in the dry season, may effectively clean parasites from landscapes, thereby reducing wildebeest infection levels. We then use integrated Step Selection Analysis to simultaneously assess the role of parasites in shaping habitat selection and animal movement, and to test the hypothesis that wildebeest that make greater use of recently burned areas have reduced parasite burdens. Together, these analyses reveal the potential for GINs to have seasonally-varying effects on herbivore body condition, which are shaped by habitat selection and a possible interaction with fire.

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Exploring disease dynamics in diverse savanna herbivore communities

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Wildlife populations across broad regions of Africa continue to lose habitat, putting populations at risk of collapse while increasing the frequency of interactions with livestock at protected area boundaries. Parasites can have profound effects on wildlife populations with knock-on consequences for adjacent rangeland livestock production when they share parasites (e.g., gastrointestinal nematodes that infect wild ruminant species and livestock). Thus, understanding parasite dynamics in African savanna systems represents an important challenge, but multiyear studies that capture the effects of seasonal drought/rewetting cycles and fire on parasite dynamics in diverse wildlife communities are rare. We collected four-years of gastrointestinal nematode (GIN) infective larvae densities in the environment and GIN burdens from five host species (wildebeest, buffalo, Grant's gazelle, topi and hartebeest) in the Serengeti National Park.
Here, we use this dataset to explore how interactions between abiotic factors (rainfall, temperature, and fire) and host foraging decisions shape parasite dynamics. We found that host species display distinct peaks in GIN burdens through the season, and smaller species consistently have higher eggs per gram in their fecal samples than larger species. In line with previous work, we found that wild ruminant body size had a strong effect on habitat selection. We extend this by showing that this habitat selectivity resulted in smaller-bodied herbivore species being exposed to greater infective GIN larval densities in the environment than larger species. However, this effect was complicated by season and fire, which change host habitat selection and the distribution of infective larvae across the landscape.

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Impacts of body size on herbivore diet diversity and variability

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The role of herbivore body size in mediating diet selection and species interactions remains unresolved. On the one hand, small body size might be a competitive asset within large herbivore communities in the face of unpredictable environments, if lower forage and water requirements enable individuals to persist through periods of scarcity. On the other hand, small-bodied herbivores may be competitively inferior due to greater dietary constraint: whereas large-bodied herbivores can extract energy from both high and low quality foods, small-bodied herbivores are thought to require high-quality forage to meet mass-specific energetic demands. Here, we use a 9-year-long time series of herbivore diet data from Kruger National Park to investigate dietary diversity and niche overlap of herbivores of different sizes across environmental contexts. Our dataset includes species ranging in size from Sharpe's grysbok (Raphicerus sharpei; ~10kg) to elephants (Loxodonta africana; ~4000kg) and spans extreme dry (2016) and extreme wet (2021) years.

We find that (1) individual-level diet diversity is quite stable across environmental contexts within populations, with no significant effect of annual rainfall or body size. At the population level, we find that (2) dietary diversity does increase with increasing annual rainfall but again does not depend on body size—that is, populations become more generalized as rainfall increases regardless of body size. Accordingly, we find that, (3) within a species, individuals' diets diverge as rainfall increases and larger species have more compositionally similar diets across individuals. Lastly, we find that (4) body size and rainfall interactively structure diet differences between species: while increasing body mass discrepancy and increasing annual rainfall both increase between-species diet dissimilarities (i.e., species with larger body size differences and within high rainfall contexts have more dissimilar diets), these two factors interact negatively, such that diets of small- and large-bodied species converge in high rainfall years. Thus, while we did not detect an effect of body size on diet diversity in this assemblage, body size does structure diet variability within species and, interactively with rainfall, niche differentiation between species.

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The Richness and Habitat Use by Large Carnivores Returned Naturally in Zinave National Park, Mozambique

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Large carnivores are threatened due to habitat loss, illegal trade of parts for the black market and traditional purposes, direct persecution and retaliation due to conflicts with humans and attacks on livestock as well as the decimation of natural prey due to poaching. In many protected areas of Mozambique, the large carnivores were almost totally extirpated locally due to a prolonged civil war (1976-1992) and even after conservation efforts it is difficult to see the large carnivores in aerial surveys. To determine the richness and abundance of large carnivores in a recovering area, a grid of 40 camera traps was installed, with a separation distance of 4 km between them, distributed over an area of about 432 km^2 that includes the inside and outside sanctuary, covering different habitats such as: mopane forests, miombo forests, riverine forest, savannas and flood plain.

Four species of large carnivores such as lions, leopards, brown hyenas and spotted hyenas were detected. Other species of medium and small carnivores such as jackals, caracals, civets, genets and African wild cat were also detected. As expected, the richness of species was greater within the sanctuary than outside sanctuary. Collars were placed on lions and spotted hyenas to evaluate the use of habitat and possible spatial overlap. Lions tended to use two ends of the sanctuary in miombo forest, while spotted hyenas used more mopane forest.

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POSTER

A population assessment of lions in KD1, KD2 & Mabuasehube (Botswana)

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Kalahari Research and Conservation (KRC) has been involved in wildlife conservation in the Kalahari region of Botswana since 2010. Our overarching objectives are to ensure that the important WMAs of KD1 & 2 remain intact for the use of lions and other wildlife in the region. In addition, they continue to act as effective buffer zones and provide a link between the Kgalagadi Transfrontier Park and the CKGR. To monitor whether this objective is being fulfilled, we initiated rigorous and long-term monitoring of the lion population within this area. We estimated lion density, abundance, and other state variables in two WMAs (KD1 & KD2) and a section of the KTP (Mabuasehube) using unstructured spatial sampling combined with Bayesian spatial capture-recapture models for analysis.

Over the 106-day survey period we intensively searched the study area for lions. Owing to the vast landscape and relatively low density of lions, our fieldwork focused on finding fresh lion tracks. When tracks were found, we followed them until the lions were found. We then attempted to take individual identification photographs of all lions present. This resulted in 123 detections of 71 individuals over the age of 1 year. Using the search encounter data, combined with a resource selection-based SCR model, lion density was estimated at 0.71 (PSD=0.1) individuals per 100 km2 within the study area. Lion abundance was estimated to be 153 (PSD=23). This comprises of 57 (PSD=12) lions in KD1, 49 (PSD=8) lions in KD2 and 48 (PSD=8) lions in Mabuasehube. Our estimates are for lions over the estimated age of one year. We anticipate that the results of this survey will help inform the management of this important lion population and the habitat within which it resides.

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Hippo pod characteristics and distribution patterns, and their implications for grazing lawn distributions across Kruger National Park's four major perennial rivers

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Megagrazers facilitate grazing lawn establishment which during the growing season supports a diversity of other species. Grazing impacts of hippos specifically are considered an important driver of savanna grassland structure near permanent water. During the dry season, however, high grazer concentrations near perennial water sources, together with intensive hippo grazing can lead to forage depletion together with the conundrum of how to manage hippo numbers appropriately to avoid negative impacts on other species. Nonetheless, crucial to our understating of how hippos engineer savanna grasslands, and to anticipate how future drought events might intensify these impacts, is an understanding of how hippos distribute and aggregate themselves along perennial river systems and how these patterns of aggregation vary across seasons. Benefiting from their habit of residing in water and foraging from a central place, we conducted drone-based aerial counts of hippos while simultaneously collecting structural measures of grasslands adjacent to water using high resolution Light Detection and Ranging (LiDAR) across the four major perennial rivers in Kruger National Park. Mean pod size increased in the dry compared to the wet season and mean inter-pod distance also increased, indicating a spatial aggregation of hippos during the dry season. Overall, mean pod size was highest on river sections surveyed on basalt compared to the granite geology, and was significantly predicted by mean river discharge. Furthermore, the distribution of grass heights differed significantly between low, medium, and high-hippo density regions. Similarly, the volume of short grass on the landscape responded strongly to hippo density together with distance away from water. High-hippo density regions showed larger and more homogeneous short grass patches, and was the strongest predictor of short grass cover.

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How do large mammals adjust their scanning patterns across space and time?

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Many animals respond to variations in perceived predation risk by adjusting their vigilance behaviours. In mammals, one of the most common metrics used to study this is the amount of time that individuals spend vigilant. However, despite strongly influencing predator detection and food-safety trade-offs, adjustments made to underlying scanning patterns are often overlooked. Thus, the aim of our study was to investigate how impala (*Aepyceros melampus*) adjusted their scanning patterns in response to spatial and temporal variations in perceived risk. To do this, we observed impala in Hluhluwe-iMfolozi Park, and tested whether their time spent vigilant, scan durations, interscan interval durations, and scan frequencies differed between habitat types (defined by tree cover) and times of day (index of predator activity).

We found that impala first decreased and then increased their time spent vigilant as tree cover increased. Moreover, contrary to expectations, the impala adjusted the time they spent vigilant by adjusting their interscan interval durations while keeping their scan durations constant. Consequently, scan frequency also decreased and then increased as tree cover increased. Surprisingly, the impala did not adjust their time spent vigilant or scanning patterns in response to time of day. Ultimately, our results suggest that mammals may increase their time spent vigilant by adjusting only their interscan interval durations (i.e., scanning with constant durations more frequently), likely to balance food-safety trade-offs. However, this might limit the detection of cryptic and concealed predators.

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POSTER

Prevalence at the wildlife/livestock interface of gastrointestinal parasites in cattle (*Bos taurus*), buffalo (*Syncerus caffer*) and wildebeest (*Connochaetes taurinus*) of Maputo National Park area, Mozambique

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Maputo National Park, like most conservation areas in Mozambique, is inhabited not only by wild animals, but also by domestic animals and human populations. This type of interface, where living space, pastures and the water sources are shared, creates the possibility of wildlife participating as a reservoir for parasitic infections and the existence of a cross-cycle, which may pose a risk to public health. Among the main characteristics of this ecosystem are the presence of several lagoons with different salinity gradients interspersed with extensive plains suitable for grazing that create an ideal habitat for the development of the biological cycle of various parasites.

In this study, a total 203 faecal samples were collected from domestic cattle, 104 from buffaloes and 129 from wildebeest using simple probabilistic random sampling, where samples were randomly selected from different

areas of Maputo National Park and the adjacent buffer zone. For parasite identification, two different copro-microscopic techniques were used in parallel: MiniFlotac® and Sedimentation. Positive samples were subjected to copro-culture for larval identification. In all animal species, the Strongylida order was found in most of the samples, cattle (93% and 73%), buffalo (89% and 74%) and wildebeest (81% and 80%) in the sedimentation and mini-FLOTAC tests respectively. Eggs belonging to the order Enoplida, class Coccidia and family Paramphistomatidae were also observed. The coproculture technique identified larvae of the genera *Haemonchus*, *Trichostrongylus*, *Cooperia*, *Oesophagostomum* and free-living nematode larvae.

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POSTER

Importance of prey for the spatiotemporal occupancy of two sympatric carnivores in a diverse landscape in East Java, Indonesia

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Competitive interactions between large carnivores are difficult and costly to study over long time periods. Camera trapping has revolutionised the ability to gather data cost-effectively over extended time periods, however, modelling interactions and how ecological factors affect these has remained limited. In this study, we used a novel spatiotemporal multispecies occupancy model to investigate factors affecting dhole (*Cuon alpinus*) and leopard (*Panthera pardus*) co-occurrence within Baluran National Park, Indonesia, while simultaneously accounting for imperfect detection. We found that dholes and leopards appeared to use the same sites more often than expected by chance, especially where prey was scarce, though this relationship was not statistically significant. Although the species tended to co-occur, we found evidence that leopards shifted their activity patterns to be less active in the early morning hours in the presence of dholes, when dholes are most active, suggesting temporal partitioning between the two carnivores. We also found that leopards were significantly more likely to be detected at a site soon after a dhole detection at the same site, inconsistent with fine-scale temporal avoidance of dholes by leopards but possibly indicating leopards scavenging on dhole kills. Our study suggests temporal partitioning, potentially mediated by high prey abundance, is a possible mechanism of coexistence between these two sympatric carnivores in a small national park with high human disturbance.

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Quantifying trophic cascades in systems with large carnivores and herbivores: Lessons from a North American system

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A key question in ecology is whether perturbations we observe in the state of ecosystems, often from anthropogenic origins, are reversible, or not (hysteresis). Detangling the top-down influences of predators and bottom-up effects from vegetation and nutrient dynamics remains challenging. This requires a precise understanding of the feedback mechanisms between predators, herbivores, vegetation, and nutrient recycling, which are also contingent on abiotic environmental factors. Addressing this, we developed a bioenergetic integral projection model (IPM) incorporating two large carnivores, two large herbivores, two functional vegetation types, and an explicit nutrient recycling architecture.

Our framework systematically simplifies the model, allowing us to identify critical ecosystem components that drive observed dynamics in the field. By simulating various management scenarios, we explore which aspects of vegetation and nutrient recycling are most likely to cause irreversible changes following the loss of large carnivores and/or herbivores. Using case studies from North American systems, we discuss the model's applicability and parameterization requirements for savannah ecosystems. This framework offers new insights into how ecosystem resilience can be maintained or restored through effective population management strategies.

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Disease Dynamics in Apex Predators: Implications for Ecosystem Stability

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Pathogen outbreaks, such as those caused by the canine distemper virus (CDV), pose significant challenges to the stability of ecosystems. In North America, the dynamics of wolf populations have been notably altered by CDV, similarly, in savanna ecosystems, CDV has contributed to the decline of lion populations. This work explores how the spread of pathogens among large carnivores influences food web dynamics and evaluates the effectiveness of different management strategies to mitigate these impacts on savannah ecosystems, using case studies from Yellowstone National Park. We developed a bioenergetic integral projection model (IPM) incorporating disease dynamics within a framework that includes two large carnivores, two large herbivores, and functional vegetation types.

The model explicitly accounts for disease transmission pathways and their effects on predator-prey interactions and nutrient recycling processes. By simulating various pathogen outbreak scenarios and evaluating intervention strategies—such as vaccination, culling, and habitat modification—we assess their impacts on carnivore populations and broader ecosystem stability. Our findings highlight the intricate ways in which the spread of pathogens among apex predators and their management influence food web dynamics, affecting herbivore populations, vegetation composition, and nutrient cycling. This work underscores the importance of integrated management approaches that consider the interconnectedness of species interactions and disease dynamics in maintaining ecosystem health.

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Shifting Dynamics: Herbivore-Driven Management at Welgevonden Game Reserve

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Welgevonden Game Reserve, established in 1993 in Limpopo Province by consolidating farms, focuses on private use and commercial tourism within the nutrient-poor Waterberg region. Historically, the area was fire driven, but management shifted to an herbivore-driven system through a three-phase approach. Initially, old agricultural lands were transformed into nutrient-rich short grass grazing lawns, old kraal sites were developed into herbivore nutrient hotspots, and the herbivore density, especially bulk grazers, was increased, while monitoring and adapting vis the effectiveness of these changes. Experiments with fertilization, mowing, and controlled burns aimed to optimize the conversion of tall bunch grass to short grass with higher nutritional value. A 1-hectare plot, mowed three times a year and treated with nitrogen, was most effective. Additionally, clearing shrubs reduced predation risk, promoting grazing on lawns, and facilitating safer corridors between grazing areas.

Through supplementing herbivore populations, including white rhinos and zebra, and maintaining low lion densities, herbivore biomass nearly doubled over three to four years, while fire incidents significantly decreased. Five years post-supplementation, herbivore numbers had peaked and were maintained through strategic annual additions, while grass biomass declined by about one-third, maintaining this level despite rainfall fluctuations. The study also compared herbivore behaviour before and after these interventions. Through these planned medium-term interventions, and ongoing adaptive management, including for unintended consequences, a nutrient poor area has been transformed into a high-value herbivore-driven landscape, with increased tourism. Although the reserve has been through dry times, no major drought related impacts have been noted.

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