15th Savanna Science Network Meeting

12 – 16 March 2017
Skukuza
Kruger National Park

South African National Parks Scientific Services

WELCOME TO THE *15TH* ANNUAL

SAVANNA SCIENCE NETWORK MEETING

The Meeting

The Savanna Science Network Meeting is the most important annual event for the SANParks Scientific Services Department. It provides an opportunity for SANParks to gauge how effective our research programmes are and also to assess the progress in meeting SANParks' objectives for biodiversity conservation. This meeting is intended to encourage researchers and prospective researchers to share ideas, their research findings and to provide a platform for dialogue between scientists. Scientific Services has a strong team of scientists working in different fields who, together with external scientists, conduct research in many topics. These include, for example, biodiversity monitoring, population studies, fire behaviour, vegetation monitoring and aerial game census techniques. Please visit http://www.sanparks.org/conservation/scientific/ for more information.

Meals and General Arrangements

- All meals and teas are for registered delegates and invited guests only.
- Mugs have been provided in your Network Bags, without this mug you will not be able to have tea / coffee during the regularly scheduled tea-breaks.
- Lunches will be served at the Conference Centre.
- All dinners will be held at the Skukuza Golf Club except for Wednesday when it will at the Conference Centre. Delegates need to arrange their own transport to the Golf club which is only accessible by vehicle.
- There will be an information board setup in the auditorium foyer for news / events and updates. Please feel free to post any announcements on this board.

Connect with us

Social media can be exploited at conferences to ensure that key messages are conveyed beyond the immediate audience at the event. The potential for wider outreach was realized at the Savanna Science Network Meetings in 2014 and 2015. More than 63% of the Twitter users who participated in the *#ssnm* hash tag were not present at the conference. These external "delegates" were from five different continents, including North America, Europe and Australia, and spanned a range of professions, from musicians, journalists and even florists!

Join us again this year to **#SpreadtheScience**

Connect: @SSNM_KNP and Share #SSNM

SUNDAY 12 MARCH 2017		
TIME	**EVENT**	**DETAILS / VENUE**
14:00 to 17:30	Registration	Nombolo Mdhuli Conference Centre, Skukuza **All delegates are requested to bring an electronic copy of their presentation please. These will be loaded into the correct slot on the programme to prevent any delays to presentations**
18:00	**DINNER- Skukuza Golf Club: Registered delegates only (This venue is not accessible by foot, delegates need to provide their own transport.)**	

MONDAY 13 MARCH 2017			
CHAIR	**TIME**	**PRESENTER**	**TITLE**
	08:00	Botha JM	**Welcome**
SOCIAL-ECOLOGICAL SYSTEMS			
Wendy Annecke	08:10	Lehmann CL	Tropical savannas: linking ecology, human use and conservation
	08:40	Guerbois C	Times of crises highlight the multiple dimensions of services provided by Protected Areas and their role in socio-ecological resilience
	08:55	Fritz H	Village locations condition dependency on 'provisioning' ecosystem services for people living inside Niassa National Reserve (Mozambique)
	09:10	Bailey K	Adaptation to drought among smallholder farmers in a savannah landscape
	09:25	Swemmer L	The social and economic impact of the Kruger to Canyon Biosphere - Environmental Monitor Programme
	09:40	Annecke W	'It opened my mind to possibilities': Learning and behaviour change among contractors in the BSP Cape Cluster
	09:55	Hofmeyr M	The SANParks Warburgia salutaris Conservation Programme: Interdisciplinary initiatives addressing extinction concerns.
	POSTER	Hannweg K	Development of Guideline Materials for planting Pepperbark (Warburgia salutaris) trees in local communities neighbouring KNP
	POSTER	Ryan C	A Socio-Ecological Observatory for the Southern African Woodlands
10:10			**TEA**
GLOBAL CHANGE			
Purvance Shikwambana	11:00	Williams M	Challenges and opportunities in modelling savanna ecosystems
	11:15	Stevens N	Hotter savannas: Is this a benefit for trees?
	11:30	Woodborne S	Climate reconstructions from trees give confidence in climate model skill, but are tall trees doomed?
	11:45	Te beest M	Climate-vegetation feedbacks in savannas and grasslands: how does vegetation affect albedo?
	POSTER	Sikhwivhilu T	Climatic controls on the distribution of plant species: A case study from the Waterberg Massif, Limpopo Province, South Africa

	POSTER	Brade T	The response of African savannas to global change: disentangling the effects of land use and changing atmospheric CO2 concentration
	POSTER	Herbst M	Our world is changing – should we change too?
	POSTER	Wilson SA	The climate regulation service offered by miombo woodlands
	POSTER	Palmer A	Carbon and water fluxes in the Albany Thicket
DROUGHT			
Purvance Shikwambana	12:00	Riddell E	Perennial Rivers During Drought in the KNP: Management Actions, Biotic Responders, and Co-learning
	POSTER	Shikwambana P	Are diatom community structures responding to drought conditions in the KNP Rivers?
	12:15	Peel M	Consolidation of the wildlife estate: management challenges at differing spatial scales with special reference to drought
	12:30	Trisos M	Disturbing resource hotspots: drought impacts on vegetation and insect communities around termite mounds
	12:45	Janecke B	The effect of the 2016 drought on vegetation structure and animal presence on the granite catena in the Kruger National Park
	POSTER	Strydom T	The effect of multiple droughts on maintaining Kruger National Park's long-term fire/herbivory experiment
	12:50	Smit I	Management plan 2017
13:05		LUNCH	
SOIL PROCESSES			
	14:00	Baade J	Reservoir siltation and contemporary erosion in Kruger National Park
	POSTER	Baade J	Gully erosion in Kruger National Park – A first assessment
MACROINVERTEBRATES AS INDICATOR SPECIES			
Hendrik Sithole	14:15	Andersen A	Responses of ant communities to disturbance: a predictive understanding of a dominant savanna faunal group.
	14:30	Sithole H	Ant diversity and composition at sites undergoing restoration and rehabilitation at Mountain Zebra and Mokala National Parks
	14:45	Hlongwane Z	Response of soil macroinvertebrates in different disturbances in the Sandstone Sourveld in Kwa Zulu-Natal.
	14:50	Mhlongo N	Non-volant Macro-invertebrate Richness and Diversity in Disturbed KwaZulu-Natal Sandstone Sourveld
	14:55	Mwabvu T	Short-term changes in surface active non-volant soil macroinvertebrate assemblages in unburnt and burnt sandstone sourveld grassland
	15:00	Munyai C	An inventory of epigeal ants of the western Soutpansberg Mountain Range, South Africa
	POSTER	Mulalo M	A trait-based approach in understanding ant community assembly in the Soutpansberg Mountain, South Africa
	15:05	Ferreira S	"Charming African mammals need policies other than CITES listings"

BIOME TRANSITIONS AND BISTABILITY			
Izak Smit	15:20	Bond W	Savannas on the move: a conservation threat to our shrubby biomes?
	15:35	Lu M	The role of nutrients in the bi-stability of the Fynbos-forest system: A nutrient manipulation field experiment
	15:50	Hedin L	Evidence of bi-stability of the Fynbos-forest system: Observations and a dynamical fire-nutrient model
	16:05	Cardosa AW	How fire and forest elephants are affecting forest-savanna transitions in tropical Africa.
	16:20	Parr K	Testing the link between pyrodiversity and biodiversity across African savannas
	16:35	Sankaran M	Montane forest-grassland mosaics in the Western Ghats, India: history, dynamics and an uncertain future
18:00		**DINNER- Skukuza Golf Club : Registered delegates only (Own transport)**	

TUESDAY 14 MARCH 2017			
HUMAN-WILDLIFE CONFLICT			
Sam Ferreira	08:00	Kansky R	A review and synthesis of factors driving tolerance of people towards damage causing mammalian wildlife
	08:30	Vogel S	The role of elephant movement decisions and foraging choices in crop consumption
	08:45	Isden J	Elephants for Africa, the social ecology of male elephants in a bull-dominated area, and implications for community based conservation
	09:00	Songhurst A	Land Use Planning at the Community-Elephant Interface"
	09:05	Richardson R	Remotely operated virtual fences: a successful new approach to baboon management
	POSTER	Richardson P	Remotely operated virtual fences: a successful new approach to baboon management
	09:20	Mabika C	The Current Status of HWC in Hwange Communal Area after 6 years
DISEASE			
Danny Govender	09:25	Jolles A	Dynamics of foot-and-mouth disease in African buffalo (Syncerus caffer):
	09:40	Beechler B	Bovine Tuberculosis alters pathogen community structure in African Buffalo
	09:45	Sisson D	Subclinical infections of Anaplasma marginale and A. centrale in African buffalo (Syncerus caffer) from Kruger National Park, South Africa
	10:00	Couch C	Serum chemistry panels as indicators of health: Establishing normal ranges for African Buffalo & assessing variability across season, age and sex.
	10:05	Forsmann K	Linking animal personality and immune profiles and their roles in conservation
	10:10	Glidden C	Estimating acute pathogen exposure in African buffalo (Syncerus caffer)
	POSTER	Beechler B	Natural history of schistosome infection in a free-living mammalian host population
	10:15	Pori T	Avian haemoparasite prevalence in Kruger national park, South Africa
	10:20	Schrama M	Understanding the anthropogenic and ecological pressures underlying the rapid spread of vector borne diseases

10:35		**TEA**	
WOODY VEGETATION STRUCTURE			
Tony Swemmer	11:00	Staver C	Patterns in spatial heterogeneity in tree cover are consistent across diverse savannas in Kruger
	11:15	Ryan C	Widespread degradation and boosted deforestation offset by extensive regrowth in African woodlands: a high-resolution sub-continental analysis based on radar and field data
	11:30	Mathieu R	Woody cover and biomass change (2007-2015) in the South African Lowveld with radar and LiDAR imagery
	11:45	Schmullius C	A multi-sensor and multi-temporal approach to vegetation structure mapping – Results from the Ars AfricaE experiment at the Skukuza flux tower
	POSTER	Schmullius C	First high resolution leaf-on/leaf-off vegetation comparison at the Skukuza flux tower using TLS
	POSTER	Singh J	Insights into savanna woody vegetation structure and dynamics from long-range terrestrial LiDAR
MULTIPLE DRIVERS OF VEGETATION STRUCTURE			
Dave Thompson	11:50	Case M	The complicated relationship between savanna tree cover and rainfall intensity across Africa
	12:05	Nippert J	A new paradigm for plant water uptake and use in grasslands and savannas.
	12:20	Swemmer T	What do 60 years of fire trials tell us about changes to the woody layer of the Kruger National Park? Disentangling the effects of fire, elephants and CO2
	12:35	Taylor R	Fire, utilization by elephants and temperature drive demographics of the baobabs of the Kruger National Park.
	12:50	Attorre F	Disentangling the effect of management and environment on forest cover and structure of African savannas
12:55		**LUNCH**	
INFLUENCE OF VEGETATION STRUCTURE ON BIODIVERSITY			
Chenay Simms	14:15	Loggins A	Small Mammal Communities Respond to Elephant-Induced Changes to Savanna Vegetation
	14:30	McCleery B	Conflicting effects of landscape heterogeneity on biodiversity in agricultural mosaics: a multi-scale and multi-taxon approach
	14:35	Cromsigt J	Conserving Africa's Mega-Diversity in the Anthropocene: the Hluhluwe-iMfolozi Park Story
LONG-TERM MONITORING			
Chenay Simms	15:05	Scholes B	The Enhanced Freshwater and Terrestrial Observation Network
	15:20	Botha J	Long Term Monitoring in the Kruger National Park
	POSTER	Ramoelo A	Analysis of temporal changes in climate and grass biomass in and around Kruger National Park
	15:35	Ratnam J	Savannas of Asia: history, biogeography and management concerns
	15:50	Zambatis G	Interesting discoveries in some of the arid Parks

TECHNOLOGICAL ADVANCES FOR IMPROVED CONSERVATION MONITORING AND MODELLING			
Chenay Simms	16:05	Le Roex N	DNA from Dung: Non-Invasive Genetic Monitoring of Isolated Black Rhino Populations
	16:10	Marchal A	Age and sex identification from digital 3D models of lion tracks using geometric morphometrics
	POSTER	Postma M	Automated camera-trap photogrammetry of Impala in Kruger National Park
	POSTER	Traeholt C	Using drones for animal counting and trophy assessments in small national parks and game reserves
	POSTER	Clemen T	A collaborative platform for conducting large-scale modelling and simulation studies in the Kruger National Park
POLLUTION			
	16:15	Pienaar JJ	Atmospheric concentrations and dry and wet deposition estimates of nitrogen and sulphur in Kruger National Park
18:00		**DINNER- Skukuza Golf Club : Registered delegates only (Own transport)**	

Wednesday 15 MARCH 2017			
	08:00	Carruthers J	NATIONAL PARK SCIENCE: A CENTURY OF RESEARCH IN SOUTH AFRICA
HERBIVORY (EXCLUDING ELEPHANTS)			
Angela Gaylard	08:30	Hempson G	Ecological implications of distorted African herbivore communities
	08:45	Thompson D	Changes in dominance drive global variation in herbivore effects on savanna grassland diversity
	09:00	Dabengwa A	Millennial-scale climate variability and herbivore interaction in the development of shortgrass patches in a wetland key resource area at Hluhluwe Umfolozi Reserve, South Africa
	09:15	Shrader A	Grass features governing seasonal shifts between grassland types by white rhinos in the Hluhluwe-iMfolozi Park
	09:30	Voysey M	Do grazing lawns attract browsers?
	POSTER	Van Coller H	Disentangling the herbaceous layer: palatable grasses and forbs respond differently to long–term herbivore treatments in a semi–arid sodic savanna
	09:35	Wigley B	Browser effects on woody plant traits and growth in an East African savanna
	09:50	Mudzengi C	Screening key browse species in a semi-arid rangeland
	09:55	Scogings P	Responses of Sclerocarya birrea saplings to 6 intensities of simulated browsing
10:00		**Tea**	
ELEPHANT MANAGEMENT AND IMPACT			
Michele Hofmeyr	11:00	Chamaillé-Jammes S	Revealing a partial migration in the Hwange elephant population
	11:15	Kiker G	Landscapes, multi-agents and massive agents: a comparison of Kruger Park elephant distribution and vegetation impact as simulated by the SAVANNA, QnD and MARS models.
	11:30	Henley M	Examining Human Perception of Elephants and Large Trees for Insights into Conservation of an African Savanna Ecosystem

	11:35	Cook R	African honeybees as a mitigation method for elephant impact on marula trees in the Greater Kruger National Park
	11:50	Ransom C	Contrasting elephants and humans as agents of disturbance in Miombo woodlands
	11:55	Combrink-Cilliers A	Elephant versus mesobrowser effects on savanna woodland regeneration
	12:10	Davies A	Megafaunal effects on vegetation structure throughout the densely wooded Addo landscape
	12:25	Mumby H	Genetic relatedness of elephants in the Associated Private Nature Reserves
	12:30	Linden H	The Impacts of Fence Removal on Vegetation Dynamics within the Kruger to Canyons Biosphere Reserve, South Africa
12:35		LUNCH	
FRESHWATER			
Eddie Riddell	14:00	Palmer T	Empowering catchment management forums as institutions for deepening democratic natural resource management, co-learning and participatory governance.
	14:30	Stirzaker R	Maximising benefits in the buffer zone: water stewardship and co-learning opportunities in an integrated agro-ecological land use system around protected areas
	14:45	Kruger F	Time and the river: approaching a socio-hydrological history of the Sabie catchment
	15:00	Lerm R	Almost a decade of waterbird monitoring on the Olifants River, Kruger NP
	POSTER	Woodborne S	Re-assessment of the trophic status of fish communities in the Olifants River Gorge
	15:15	Holland A	Macroinvertebrate diversity survey along selected rivers of the Kruger National Park
	POSTER	Smit I	A new phylum for Kruger National Park: Freshwater jellyfish in the Shingwedzi river
	15:20	February E	Effects of groundwater abstraction on trees in the Kgalagadi Transfrontier Park.
	15:35	Strydom T	The use of geophysics in understanding groundwater dynamics along the Letaba River
	POSTER	Petersen R	Long-term groundwater monitoring in Kruger National Park
	15:50	Petersen R	Hydrological dynamics in Mapungubwe National Park

POSTER SESSION WITH CHEESE & WINE DINNER - Nombolo Mdhuli Conference Centre (Registered delegates only)

Thursday 16 MARCH 2017			
FIRE			
Tercia Strydom	08:00	Donaldson J	Fire season and size influences pyric-herbivory pressure with repercussions for grass community responses in the Kruger National Park
	08:15	Skhosana F	Community, functional, and ecosystem responses to combined high fire and grazing pressure in a Highveld Grassland
	08:20	Smit I	Herbivore culling fuels veld fires: Evidence for direct impacts of herbivore densities on fire patterns in a large protected savanna
	08:35	Alvarado ST	Assessment of management impact on fire occurrence: Comparison of fire regime of tropical savannas in protected areas
	POSTER	Batista E	The risk of passivity: what may happen with the fire regime in protected areas of Brazilian savanna in light of the current fire suppression policies? An example of Canastra National Park, Southeast Brazil
	08:50	Humphrey G	'Fire Intensity: exploring FRP estimates between human fires and the savanna – woodlands in north-east Namibia"
	09:05	Pellegrini A	Meta-analysis reveals large long-term effects of fire on soil carbon and nutrients in savanna ecosystems
	09:20	Nieto Quintano P	Investigating the effect of fire dynamics on aboveground carbon storage in the Bateke landscape, Congo
	09:35	Scholtz R	Social and ecological challenges in understanding fire dynamics and woodland expansion in the Great Plains, USA
	09:50	Fidelis A	Flowering after fire in the Cerrado: an example of Bulbustylis paradoxa
09:55		**TEA**	
PREDATION			
Marna Herbst	11:00	Le roux E	Fear-triggered trophic cascades in a megaherbivore dominated system
	POSTER	Palmer M	Fear by Moonlight: Ungulate Responses to Periodically Fluctuating Predation Risk
	11:15	Jackson C	Did researcher intervention really drive the extinction of African wild dogs on the Serengeti plains?
	11:30	Everatt K	Landscape scale occupancy of lions in the Greater Limpopo Lion Conservation Unit; What limits lions in human-disturbed systems?
	11:45	Wahyudi HA	Population density and habitat preference of Javan leopard in savanna ecosystem in Baluran National Park, Indonesia
	POSTER	Wentzel J	Carnivore population dynamics on two reserves, comparable or not?
TOURISM AND ECONOMICS OF PROTECTED AREAS			
Marna Herbst	11:50	Chidakel A	Institutions, Governance, and the Economic Performance of Protected Areas in Southern Africa
	12:05	Douglas A	Understanding sustainable tourism development and responsible tourism practices in the Kruger National Park: measuring visitor perceptions and experiences against sustainability assessment outcomes
12:10		**LUNCH**	

INVASIVES			
Thabang Sibiya	14:00	Foxcroft L	Biological invasions in South African National Parks
	14:15	Sibiya T	Patterns of alien plant invasion within geomorphic features of the Sabie River, Kruger National Park.
	14:30	Damasceno G	When should we burn to control invasive species? An example from Cerrado
	14:45	Tye D	Population dynamics and ecological impacts of Tarebia granifera in the Sabie River, Kruger National Park
VEGETATION STUDIES			
Thabang Sibiya	15:00	Archibald S	Leaf display strategies across savannas
	15:15	Whitecross M	Early-greening linked to herbivory avoidance, not longer growing seasons for two savanna trees.
	15:30	Teegalapalli K	Linking tree growth rates and functional traits in savannas
	15:45	Greve M	An investigation of seed size variation across southern Africa: patterns and drivers
	15:50	Segalla R	Natural history of *Zamia boliviana* (CYCADALES, ZAMIACEAE) from Brazilian cerrado savanna
	POSTER	Lenfers UA	Studies to detect the potential distribution of Sclerocarya birrea in the southern part of the Kruger National Park
15:55		**Wrap Up- Norman Owen-Smith**	
16:15		**Closing and thanks - Izak Smit**	
18:00		**DINNER- Skukuza Golf Club : Registered delegates only (Own transport)**	

ABSTRACTS

Tropical savannas: linking ecology, human use and conservation

Lehmann, C.E.R.[1] & Parr, C.L.[2]

[1]School of GeoSciences, University of Edinburgh, Edinburgh EH9 3FF, United Kingdom
[2]School of Environmental Sciences, University of Liverpool, Liverpool L69 3GP, United Kingdom

caroline.lehmann@ed.ac.uk; Kate.Parr@liverpool.ac.uk

Historically extensive across the global tropics, tropical savannas and grasslands are now changing rapidly through high rates of land clearance, increasing land use intensity, woody encroachment, climate change and disruption of the disturbance regimes that maintain ecosystem function. These biomes were the cradle of human evolution, and in our contemporary world, they support the livelihoods and wellbeing of over one billion people. With the population of Africa alone set to treble by 2050, the continuing pace of climate change, increasing atmospheric CO_2 concentrations, and increasing agricultural development, there is an urgent need to develop realistic predictions of the direction and extent of change in tropical savannas, as well as the consequences. Here, we synthesize current understanding in four strands of research and how these can be combined to develop realistic predictions of tropical savannas in the Anthropocene: defining and characterizing tropical grassy biomes; complex ecology; drivers and patterns of change; and, human use and value of tropical grassy biomes. Today, there still remains ambiguity around "what is a savanna" that hinders both management and conservation. Provision of clarity on the definition of tropical savannas will raise awareness of the unique threats faced by tropical savannas, but also serve to highlight the biodiversity value of savannas and current human dependency on this biome. Our capacity to effectively predict the degree of vegetation change across savannas and grasslands into the Anthropocene is dependent upon understanding the cascading and interacting effects of ecological, socioeconomic and global drivers across contrasting contexts. However, this is no easy task even from a purely ecological perspective as these systems are characterized by vegetation – environment feedbacks that govern ecosystem structure and ecosystem dynamics are context dependent across the savanna biome.

Quantifying and understanding the value of TGBs to humans is challenging because in many regions, particularly in Asia, data on the value of TGBs to human livelihoods are limited. TGBs are sometimes described as "unused" or "degraded", although these systems provide fundamental resources and ecosystem services supporting the livelihoods of many. Further, the people of these regions are among the world's poorest and most vulnerable, and global change will inevitably affect ecosystem services and resource availability. To manage and converse tropical savannas the future, we must look beyond a simplified view considering only the tree layer, to a perspective that embraces the complexity of the grassy ground layer and the unique functions associated with this. Only with this broader perspective will we be in a position to consider the range of trajectories and possible states that are likely across the disparate savanna regions and how the influence of key drivers may vary. To apply the most appropriate conservation and management efforts in the right place, field studies are needed to characterize and determine the antiquity and value of TGBs more broadly. Additionally, field studies and plot networks will help us understand how the multiple pathways for structural (and compositional) change links to the functioning of these biomes. Experiments manipulating global change drivers (e.g. water availability, temperature, and CO_2) will help unravel the complexities of savanna process and dynamics so we are in a stronger position to understand how different savannas may respond to future change. Much needed are examinations of the biophysical and biogeochemical consequences of woody encroachment and land cover change at regional scales, such as albedo and nutrient cycling. Finally, as scientists we must work with land managers and politicians to ensure that processes critical to the healthy functioning of tropical savannas (i.e. fire, herbivory) are recognized and maintained. This will mean revisiting carbon mitigation initiatives, taking a more nuanced approach to applying REDD+ in savannas, and ultimately recognizing savannas are wholly different to forests in terms of ecosystem function. People and institutional structures strongly influence and affect tropical savannas - their biodiversity, functioning and services. As a savanna science community, we can build on the lessons learned from the tropical forest ecology community and work with policy organisations and governments.

Times of crises highlight the multiple dimensions of services provided by Protected Areas and their role in socio-ecological resilience

Guerbois, C.[1], Bunding-Venter, C.[2] & Fritz, H.[3]

[1]*NMMU, SRU, South Africa*
[2]*World Bank, Pretoria, South Africa*
[3]*CNRS, LBBE, France & Hwange LTER – Zone Atelier, Zimbabwe*

chloe.guerbois@nmmu.ac.za; carlibv@gmail.com; herve.fritz@univlyon1.fr

Protected areas (PAs) often cristalise social tensions around land use issues. However, in the current context of their increasing involvement in rural development, one of their underestimated strength is to contribute to buffer social, political or climatic crises through providing a diversity of social and ecological services. This becomes crucial when the ecosystem services are no longer or weakly provided by the neighbouring land use types. These services are often perceived as threats or disregarded when assessing the sustainability of protected areas, though they can be key in promoting the social-ecological system resilience.

Here we draw from our long-term research around Hwange National Park (Zimbabwe) to illustrate the multiple dimensions of services provided by PAs in a context of environmental changes and socio-economic and political crises. We studied two contrasted PAs and their use, the National Park (highly restricted access) and the adjacent Sikumi Forest Area (controlled access), and show how different types of services may play a role in sustaining well-being in response to crises. We analysed perceived trends in resources and discuss the determinants of both access to and sustainability of resources. Based on the analysis of a crisis-induced stakeholder's forum, we illustrate a self-generated attempt for adaptive co-management of key resources and infrastructures at the PAs interface, and discuss the role of PAs as catalyst of such initiative. We finally reflect on the influence of adequate management of PA interfaces, and associated services, in the sustainability and resilience of the PAs themselves and of their socio-ecological systems.

Village locations condition dependency on 'provisioning' ecosystem services for people living inside Niassa National Reserve (Mozambique)

Fritz, H.[2], Prin, T.[1] & Guerbois, C.[3]

[1]*CNRS, Chuilexi Conservancy FFI Mozambique*
[2]*CNRS LBBE, Zone Atelier Hwange, Zimbabwe*
[3]*LTER, SRU NMMU, CNRS, South Africa*

thprin@gmail.com; herve.fritz@univlyon1; Chloe.Guerbois@nmmu.ac.za

Protected Areas (PAs) mandates now extend to providing conditions for local development, potentially conflicting with conservation objectives, particularly where livelihoods are dependent on natural resources (NRs) and associated ecosystem services (ES). We conducted semi structured interviews to assess livelihood options, food security and reliance on 'provisioning' ES in villages inside a PA, Niassa National Reserve (NNR). We also explored the potential impacts of humans on conservation, as well as attitudes towards the PA.

Livelihoods were based on subsistence farming and NRs harvesting. High level of food insecurity characterized households and wildlife damage was mentioned as one of the main cause for insufficient harvest. Provisioning services include material for building, energy (firewood) and nutrition. NRs also generated diversified sources of income. The spatial location of households had a strong impact on livelihood options and constraints, with varying reliance on ES. The environment seemed generally more profitable near rivers and/or close to business center. More remote villages had fewer options, less protein intake and were more reliant on bush meat as a protein source.

Interestingly, fish consumption was positively correlated with household wealth across villages whereas bush meat was not, indicating either a buffer dietary option for poor households and/or a cultural role. The village communities consistently differ in their attitudes towards the PA, but all in ways to improve their livelihood options. As villages are heterogeneous in their reliance on NRs, we discuss the need to incorporate understanding of the diversity of people's relationships with their environment in order to achieve adaptive PA management.

Adaptation to drought among smallholder farmers in a savannah landscape

Bailey, K.[1], McCleery, R.M.[2] & Barnes, G.[3]

[1]*University of Florida, School of Natural Resources and the Environment*
[2]*University of Florida, Department of Wildlife Ecology and Conservation*
[3]*University of Florida, School of Forest Resources and Conservation*

Karen.bailey@ufl.edu; ramccleery@ufl.edu; gbarnes@ufl.edu

In savanna landscapes, people are increasingly impacted by on-going shocks and stresses caused by population growth, land-use change, climate change, and other regional and global processes. In response to these shocks and stresses, households adapt in different ways in an attempt to maintain their health and wellbeing. The aim of this research was to understand what factors contribute to successful adaptation. Our research focused on families traditionally engaged in small-scale farming in the Lowveld of Swaziland who have been increasingly impacted by drought.

We collected data on household adaptive capacity (measured as availability and quality of natural, social, financial, physical, and human capital) and adaptive willingness (measured as perceptions of risk, self-efficacy, and efficiency related to adaptation), and found that successful adaptation was influenced by access to natural resources, perceived risks associated with adaptation, and human capital. We also found that communities located near protected areas have very different adaptation strategies than those further away, despite similar livelihood traditions. Our research highlights the importance of natural resource management, improved information on adaptation strategies, and access to education as critical to improving future adaptation to change.

The social and economic impact of the Kruger to Canyon Biosphere - Environmental Monitor Programme

Swemmer, L.K.[1] Uys, M.T.[2], Marshall, T.[2], Malepe, M.[2], Muroa, S.[2], Mahanga, S.[2], Murale, K.[2] & Mafogo, T.[2]

[1]*Social and Economic Research, Savanna and Arid Research Unit, SANParks*
[2]*Kruger to Canyon Biosphere, Environmental Monitor Programme, SANParks*

louise.swemmer@sanparks.org

The Environmental Monitor (EM) programme was started by the National Department of Environmental Affairs (DEA) in response to challenges of high levels of unemployment adjacent to conservation areas, coupled with increases in illegal wildlife trade. The programme aims to increase conservation capacity within South African National Parks (SANParks), provincial and private reserves and adjacent areas towards area integrity (through monitoring, patrols and environmental education) while simultaneously improving well-being. SANParks' Biodiversity Social Projects (BSP) runs the programme, and at the end of October 2015 there were 1441 EM's employed, 19.5% of which are working in the K2C area.

This study aimed to assess the social and economic impact of the Programme within the K2C Biosphere at both an individual, household and community level, in order to enable reporting on outcomes in support of an adaptive approach towards more effective management and to leverage further support for the programme from multiple levels. The assessment took a collective learning approach, including several workshops, focus groups and semi-structured questionnaires and a total of 108 EM's participated in the study. The study revealed significant positive well-being outcomes on a personal and family level as well as positive impacts on ecosystem integrity. We conclude that when implemented using the approach taken by the K2C Biosphere, the EM model for ecosystem integrity maintenance, capacity building and well-being improvement can be highly successful in contributing towards achieving objectives of national and global importance.

‘It opened my mind to possibilities’: Learning and behaviour change among contractors in the BSP Cape Cluster

Annecke, W.

Wendy.annecke@sanparks.org

The clearing of alien plants by the Biodiversity Social Projects (BSP) teams in SANParks has been closely scrutinised and heartily critiqued. However this is only one aspect of the BSP programme. The other, equally important and under-evaluated component is the skills training. This is one of the few studies that examine the social dimensions of the programme. The objective was to assess the social and economic benefits to contractors of being part of the BSP. The leadership was particularly concerned with what impact of skills training has on personal behaviour and the ability to exit the programme as an independent small business.

The take home message is that the skills development days, 2 days for every 22 days of work, are arguably the most valuable component of the BSP. Unexpectedly the so-called social days contribute significantly to behaviour change and that most desirable and elusive notion of social cohesion. A second message from this study is that there is a deep thirst for knowledge and training and a conviction that with sufficient skills in computer literacy, construction, financial planning and management, the use of machinery and herbicides, first aid, health and safety, that most of the contractors could exit the programme and develop careers of their own. A key finding is about the resilience of the contractors given the opportunity to learn.

The SANParks *Warburgia salutaris* Conservation Programme: Interdisciplinary initiatives addressing extinction concerns

Hofmeyr, M.[1], Hannweg, K.[2], Froneman, W.[3], Swemmer, L.[4], & Neary, T.[5]

[1]*SANPARKS Conservation Services, Private Bag X402, Skukuza, 1350*
[2]*Agricultural Research Council – Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200*
[3]*South African National Biodiversity Institute – Lowveld National Botanical Garden, Nelspruit, 1200*
[4]*SANPARKS Scientific Services, Phalaborwa*
[5]*SAPPI Pty (Ltd), Braamfontein, Johannesburg*

Michele.hofmeyr@sanparks.org; Karin@arc.agric.za; W.Froneman@sanbi.org.za; Louise.swemmer@sanparks.org; Tim@neary.co.za

The SANParks *Warburgia salutaris* Conservation Programme seeks to address the threat of pressure on local populations that could become locally and eventually regionally extinct in the wild, with negative implications for biodiversity conservation and socio-economic wellbeing. *Warburgia salutaris*, or Pepperbark tree, is an important medicinal plant. It is used widely to treat a number of different ailments and as a result is under threat due to overharvesting. The Pepperbark tree is currently listed as an endangered species and is only found in isolated populations in the wild in the eastern regions of South Africa. It is highly sought-after on the traditional medicine markets and is therefore becoming an expensive product since supply does not keep up with demand.

The KNP populations face increasingly intensive illegal harvesting even though they are relatively isolated from any other wild population/s and as a result there is concern for the local extinction of these populations. While field rangers are employed to monitor illegal harvesting activities, several interdisciplinary initiatives have been implemented to address this concern. These include not only monitoring of existing population size and stability, but also the identification of 'new' populations; the use of alternative sustainable sources of material (i.e. leaves) for harvesting; various propagation studies including an investigation of reproductive limitations and making use of vegetative and reproductive material for propagation; distribution of propagated trees to traditional healers and associated communities and projects, as well as workshops with traditional healers and development of information dissemination tools for associated communities.

POSTER

Development of Guideline Materials for planting Pepperbark (*Warburgia salutaris*) trees in local communities neighbouring KNP

Hannweg, K.[1], Hofmeyr, M.[2], Froneman, W.[3], Swemmer, L.[4] & Neary, T.[5]

[1]*Agricultural Research Council – Tropical and Subtropical Crops, P/Bag X11208, Nelspruit, 1200*
[2]*SANPARKS Conservation Services, Private Bag X402, Skukuza, 1350*
[3]*South African National Biodiversity Institute – Lowveld National Botanical Garden, Nelspruit, 1200*
[4]*SANPARKS Scientific Services, Phalaborwa*
[5]*SAPPI Pty (Ltd), Braamfontein, Johannesburg*

Karin@arc.agric.za; W.Froneman@sanbi.org.za; Tim@neary.co.za

Warburgia salutaris (Family: Canellaceae), or Pepperbark tree, is one of the most widely-used medicinal plant species in south-eastern Africa and South Africa is no exception. In fact, the tree has become extinct in some parts of South Africa. As a result of habitat loss and unsustainable harvesting of the bark, the primary plant part used in traditional medicines, the species is now listed as endangered in the IUCN Red List of Threatened species and is a protected species in South Africa. Poaching of wild populations of Pepperbark within the world-renowned Kruger National Park has resulted in the establishment of the 'Kruger Pepperbark Initiative'.

This programme seeks to address threats to the species by ensuring that not only are the trees protected within the Park, but that known populations are monitored, new populations identified and trees propagated and distributed to neighbouring communities. Regular engagement activities with traditional healers and other members of neighbouring communities are carried out. Concomitant with these engagements, training materials in the form of posters and handouts were developed for information dissemination purposes. The "Planting and Caring for your Tree" learning materials will be made available in English and several vernacular languages and are versatile enough for application to any tree species planted at homesteads.

POSTER

A Socio-Ecological Observatory for the Southern African Woodlands

Ryan, C.M. & McNicol, I.M.

School of GeoSciences, University of Edinburgh, UK

casey.ryan@ed.|ac.uk

Deforestation and forest degradation alter the resources available to rural communities, and can contribute to climate change. Currently, the rates and locations of degradation are unknown and deforestation and subsequent regrowth rates uncertain. In the miombo and mopane woodlands that dominate southern Africa, the (presumed) drivers of degradation are abundant, but no regional assessment of degradation rates and associated carbon emissions exists. We address this with the first sub-continental assessment of the rates and locations of degradation, deforestation and (re)growth. Carbon stocks for the years 2007-10 are estimated at 25 m resolution using radar and field data, and used to estimate the area affected by each land cover change and associated carbon stock changes.

Degradation affected 13% of the study region over three years, 3.5x the area deforested. Deforestation rates (3.7%/yr) are double previous estimates, partly due to a more realistic definition of "forest loss" suited to the practices of small-scale agriculturalists. Most of the woodland increased in biomass, particularly in low biomass areas, leading to no region-wide net change in woody carbon stocks over the study period. Carbon losses from degradation exceed deforestation substantially (0.24 *vs* 0.08 PgC), which is not reflected in current climate mitigation policy or practice. The location of degradation hotspots suggests that trans-boundary flows of timber and woodfuel are important causes. The widespread increase in biomass probably reflects the response of the woodlands to past disturbance and illustrates their resilience; it may also indicate that elevated atmospheric CO_2 is increasing tree growth rates.

Challenges and opportunities in modelling savanna ecosystems

Williams, M.[1], Whitley, R.[2], Beringer, J.[3], Hutley, L.B.[4], Abramowitz, G.[5], De Kauwe, G.M.G.[2], Evans, B.[6], Haverd, V.[7], Li, L.[8], Moore, C.[9], Ryu, Y.[10], Scheiter, S.[11], Schymanski, S.J.[12], Smith, B.[13], Wang, Y.P.[7] & Yu, Q.[8]

[1]*University of Edinburgh*
[2]*Macquarie University*
[3]*University of W Australia*
[4]*Charles Darwin University*
[5]*University of New South Wales*
[6]*University of Sydney*
[7]*CSIRO*
[8]*University of Technology Sydney*
[9]*Moash University*
[10]*Seoul National University*
[11]*BKF Frankfurt*
[12]*ETH Zurich*
[13]*Lund University*

rhys.whitley@gmail.com; jason.beringer@uwa.edu.au; lindsay.hutley@cdu.edu.au; gabsun@gmail.com; mdekauwe@gmail.com; bradley.evans@sydney.edu.au; Vanessa.Haverd@csiro.au; Longhui.Li@uts.edu.au; caitlin.moore@monash.edu; ryuyr77@gmail.com; Simon.Scheiter@senckenberg.de; stanislaus.schymanski@env.ethz.ch; ben.smith.lu@gmail.com; Yingping.Wang@csiro.au; Qiang.Yu@uts.edu.au; mat.williams@ed.ac.uk

Climate change is projected to result in significant changes to the savanna floristic structure, with increases to woody biomass expected through CO_2 fertilisation in mesic savannas and increased tree mortality expected through increased rainfall inter-annual variability in xeric savannas. The complex interaction between vegetation and climate that occurs in savannas has traditionally challenged terrestrial biosphere models (TBMs). In this review, we examine whether TBMs are able to adequately represent savanna dynamics and what implications potential deficiencies may have for climate change projection scenarios. We highlight three dynamic processes that we believe directly affect the water-use and productivity of the savanna system, namely: phenology; root-water access; and fire dynamics. We discuss how these processes are represented in TBMs and whether they are suitable for simulating savanna dynamics.

We give an overview of how eddy-covariance observations in combination with other data sources can be used in model benchmarking and inter-comparison frameworks to diagnose the performance of TBMs and formulate roadmaps for future development. Our investigation reveals that many TBMs systematically misrepresent phenology, effects of fire and root-water access (if they are considered at all) and that these should be critical areas for future development. Furthermore, such processes must not be static (i.e. prescribed behaviour), but be capable of responding to the changing environmental conditions in order to emulate the dynamic behaviour of savannas. Without such developments, however, TBMs will have limited predictive capability in making the critical projections needed to understand how savannas will respond to future global change.

Hotter savannas: Is this a benefit for trees?

Stevens, N.[1], Archibald, S.A.[2] & Scholes, R.J.[3]

[1]*Department of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa*
[2]*School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Private Bag 3, WITS, Johannesburg 2050, South Africa*
[3]*Global Change and Sustainability Research Institute, University of the Witwatersrand, Private Bag 3, WITS, Johannesburg 2050, South Africa*

nicolastvns@gmail.com; Sally.Archibald@wits.ac.za; Bob.Scholes@wits.ac.za

The average global temperature on Earth has increased, and will continue to do so. This fundamental change in the climate has led to scientists examining how plants, animals and ecosystems will respond to changing climates. A lot of the early understanding of this response came from bioclimatic models which used the existing climate niches of species to predict where they would be located in the future given changing climates. Certainly studies from many temperate systems demonstrated that changing temperatures will cause significant changes to species ranges. This concept is often used as the guiding framework to predict current and future patterns of change, yet it is not a particularly useful concept for understanding change in savannas.

In savannas, plant growth and productivity are most strongly limited by water availability. Savanna structure and function is also strongly modified by the fire and herbivory. This is a well understood by the savanna community and as a result the role of temperature in structuring the ecology of savannas in not well understood. This means that we are unable to predict how warmer climates in the future will interact with the primary drivers of savanna structure and function. This talk therefore aims to provide an overview of what we know about the role of temperature in structuring savannas, particularly woody plants. We explore how changing temperatures will change woody plant success across each demographic stage from seedlings to adult plants. We use this framework to synthesise our current knowledge on the subject and highlight important research gaps.

Climate reconstructions from trees give confidence in climate model skill, but are tall trees doomed?

Woodborne, S.[1,3], Patrut, A.[2], Hall, G.[3], Gandiwa, P.[4], Finch, J.[4], Razanatsoa, E.[5] & Zhang, Q.[6]

[1]*iThemba LABS, Private Bag 11, WITS, 2050, South Africa*
[2]*Department of Chemistry, Babes-Bolyai University, 400028 Cluj-Napoca, Romania*
[3]*Mammal Research Institute, University of Pretoria, Private Bag X20, Hatfield, South Africa*
[4] *Discipline of Geography, School ofAgricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, South Africa*
[5]*Plant Conservation Unit, University of Cape Town, Private Bag, Rondebosch, South Africa*
[6]*Department of Physical Geography, Stockholm University, Stockholm, Sweden*

Swoodborne@tlabs.ac.za; Apatrut@gmail.com; Grant.Hall@up.ac.za; Patience.Gandiwa@gmail.com; Jemma.Finch@gmail.com; estellebota@gmail.com; qiong.zhang@natgeo.su.se

Climate reconstruction for the last 1000 years have been produced at Pafuri, Mapungubwe, the Linyati and Epupa. Several other tree species have been analysed and show that the approach is broadly applicable. The emerging space/time matrix of past climate change has been used to test climate models by comparing the rainfall proxy with a 1000-year palaeoclimate simulation. Over a broad spatial and temporal scale there is a high level of consensus between the tree records and the palaeoclimate model simulation. The importance of bringing climate simulations into future management strategies is emphasised by the observation that past climate change has seldom been gradual.

The method involves the physiological control of CO_2 uptake at leaf-level in response to water availability, and can be expressed in terms of c_i, the internal leaf concentration of CO_2. These indicate that contemporary trees during dry periods have c_i values that exceed c_i during wet periods prior to the anthropogenic increase in atmospheric CO_2. The balance between water transpiration and photosynthetic activity is no longer in equilibrium and higher c_i values may be facilitating photosynthetic activity, nutrient and water demand when the leaves are supposed to be senescent. Elevated atmospheric CO_2 may be driving established trees beyond their phenotypic adaptation through water deficits that are experienced daily and seasonally. The mechanisms observed in baobabs likely also apply to other established tree species, and may contribute to the observed loss of tall trees across the savanna

Climate-vegetation feedbacks in savannas and grasslands: how does vegetation affect albedo?

te Beest, M.

Wageningen University, The Netherlands

Savannas and grasslands have important climate benefits that are currently not recognized due to our limited understanding of processes regulating land-atmosphere interactions in these ecosystems. Whereas biogeochemical processes related to carbon have received considerable attention, especially in forested ecosystems, biophysical processes related to changes in water and energy, e.g. through surface albedo and evapotranspiration are much less understood.

Notwithstanding this knowledge gap, large-scale climate change mitigation programs focusing on carbon sequestration via re- and afforestation are being implemented across the southern hemisphere, endangering savannas and grasslands. Unwanted effects may arise from planting trees in the wrong places, not least of which would be climate warming instead of cooling due to the reduced surface albedo of forests and, hence, increased absorption of solar radiation. It matters where in the world trees are planted in terms of climate regulation and we need to start thinking about developing biome-specific mitigation policies rather than transporting one-size-fits-all solutions that might have little or even counteractive effects.

POSTER

Climatic controls on the distribution of plant species: A case study from the Waterberg Massif, Limpopo Province, South Africa

Sikhwivhilu, T.[1], Thompson, D.I.[2, 3] & Scholes, B.J.[4]

[1]*National Zoological Gardens of South Africa (NRF/NZG), PO Box 754, Pretoria 0001, South Africa*
[2]*South African Environmental Observation Network (NRF/SAEON), Ndlovu Node, Private Bag X1021, Phalaborwa 1390, South Africa*
[3]*School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa*
[4]*Global Change and Sustainability Research Institute, School of Plant, Animal and Environmental Sciences, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa*

dave@saeon.ac.za

By the end of the 21st century temperature increase due to anthropogenic global warming may approach 3°C on the coast and 5°C in the northern interior of South Africa. Here we assessed the distribution patterns of plant communities along an altitudinal gradient between 1560-1790 masl on north- and south-facing slopes of the Waterberg massif. The aim was to gain greater understanding of how temperature and rainfall, which vary quantifiably and predictably with altitude, determine the distribution of plant species and vegetation communities; especially at the boundaries between the low-altitude savanna and forest biomes, the mid-altitude *Protea* grasslands and the high-altitude montane grasslands. Herbaceous species were sampled using contiguous 0.5m^2 quadrats; the tree and shrub community in 5m wide belt transects sited perpendicular to the slope.

The abundance of individual plant species showed full or truncated bell-shaped curves in relation to climatic parameters, as inferred from altitude, with the limits to the distribution of individual plant species and communities reflecting realised, rather than fundamental niches. Trees were the only life-form that included some species with insufficiently fast rates of migration to track the anticipated climate velocity; such species face extirpation under future climates through niche incompatibility. In contrast, forb and grass species were likely able to keep up with climate change, but in many instances will run out of the altitudinal space needed to do so. Species respond to climate individualistically, so new vegetation communities and biome boundaries will emerge over time.

POSTER

The response of African savannas to global change: disentangling the effects of land use and changing atmospheric CO_2 concentration

Brade, T.

Woody encroachment has been observed across savanna regions and in numerous parts of Africa. Understanding the causal factors driving encroachment will help develop management policies that maintain the environmental heritage of these ecosystems and the provision of ecosystem services to the disparate communities who derive energy and income from savannas. Rising atmospheric CO_2 concentrations have been posited widely as a factor causing woody encroachment in savannas and the expansion of forests globally. Regional and local environmental and anthropogenic forcing (such as variation in climate conditions and changes in land management/agricultural practice and fire regimes) also have significant but highly spatially variable impacts on savanna vegetation dynamics.

The spatial complexity of savanna vegetation change makes it difficult to disentangle the relative importance of rising CO_2 in driving woody encroachment. The aim of this research is to accurately quantify spatial patterns of change in woody biomass in southern African savannas and to develop an understanding of the drivers of observed change in this region. Radar remote sensing will be used to develop an accurate estimation of spatial variation in woody biomass change in selected locations in Mozambique, Tanzania, Zimbabwe and South Africa. A spatial model of human impact on savannas and known differences in land management (for example comparisons of national park reserves and adjacent non reserve land) will then be used to disentangle the roles of local (e.g. land use change), regional (Climatic variation) and global (atmospheric CO_2) forcing

POSTER

Our world is changing – should we change too?

Herbst, M. & van Wilgen, N.

Our environment is changing and the change is evident on a global scale that will have local impacts on biodiversity, ecosystems services and subsequently for human well-being. Protected areas were declared as areas of pristine natural land, thought to be unaffected by drivers of change in the surrounding landscapes. This is no longer true. The role of PAs has changed and becoming increasingly inclusive of social perspectives and people's role in natural ecosystems.

The Global Environmental Change project assessed climate change, alien species, pollution, disease, overharvesting, fragmentation and destruction of habitats inside and outside parks and found they are all real threats for biodiversity today. The Global Environmental Change assessment, engages the available knowledge at hand to increase our understanding of the different drivers. It highlights the possible threats in our parks and makes recommendations to assist in future scenario planning and actions for SANParks in a changing world.

POSTER

The climate regulation service offered by miombo woodlands

Wilson, S.A.[1] & Scholes, R.J.[1]

[1]*Global Change and Sustainability Research Institute, University of the Witwatersrand, Johannesburg, South Africa, 2000*

12wilsonsa@gmail.com; bob.scholes@wits.ac.za

Occupying approximately 3.6 million km2 and spanning several countries from Angola to Mozambique, the African *miombo* woodland (a type of savanna, in the broad sense) is among the world's largest unexploited but potentially arable land resources, located on a subcontinent where population growth remains high and the demand for food security is pressing. Since there are insufficient resources for general intensification of agriculture, forms of shifting cultivation are expected to expand. Policy efforts like Reducing Emissions from Deforestation and Forest Degradation (REDD) seek to limit land use changes which add to climate forcing, thereby preserving the climate regulation service offered. This service has mostly been presented in terms of the terrestrial carbon stored in biomass and soils.

In reality, there are several mechanisms through which the landscape interacts with the global climate system, including exchanges of carbon dioxide, methane, nitrous oxide, radiatively-active particles, radiant energy and sensible heat. This study aims to quantify the tradeoff between agricultural development of various types and the climate regulation service provided by the *miombo* landscape. To achieve this, net radiative forcing and its carbon dioxide emission equivalent over a one century horizon will be calculated for an intact ('historical') miombo landscape; one developed through extensive subsistence farming and charcoal cutting; one developed using intensive, large-scale commercial farming techniques; and one developed using 'eco-agriculture' smallholder techniques. To calculate forcing, net carbon dioxide, methane, and nitrous oxide emissions from all significant sources (e.g. fires, cultivation, ruminants, termites) and changes in surface reflectance (albedo) will be assessed.

POSTER

Carbon and water fluxes in the Albany Thicket

Palmer, A.R[1, 2], Ripley, B.[3], Gwate, O.[2] & Mantel, S.[2]

[1]*Agricultural Research Council-Animal Production Institute, Grahamstown*
[2]*Institute for Water Research, Rhodes University, Grahamstown*
[3]*Department of Botany, Rhodes University, Grahamstown*

palmert@arc.agric.za; b.ripley@ru.ac.za; s.mantel@ru.ac.za

The Albany Thicket (AT) biome has been subjected to excessive herbivory by domestic livestock during recent times, with resultant transformation of large areas. Efforts to restore the AT are linked to its ability to store C efficiently. In order to determine whether AT is a viable sink for atmospheric carbon, we established an eddy covariance system at a site with a recent history of judicious management and low stocking of wild herbivores. The site is located in *Portulacaria afra*-dominated thicket on the Ezulu Game Reserve, Eastern Cape, South Africa. A Campbell Scientific eddy covariance system, comprising a CSAT sonic anemometer and an IRGASON infra-red gas analyzer, were established at the study site in September 2015.

Associated instruments provide 30 min values for radiation (Kipp Zonen CR2 Lite Net Radiometer), soil heat fluxes, soil moisture and soil temperature. An adjacent scientific grade automatic weather station provides radiation, temperature, relative humidity and rainfall. The eddy covariance system provides 30 min fluxes for C and H_2O, which are corrected for site specific parameters using EddyPro. The daily CO_2 fluxes of the site are comparable with those being experienced by other semi-arid regions in southern Africa, with maximum midday rates of 25-30 □mols m^{-2} s^{-1} being recorded. Results for 12 months from October 2015 and September 2016 indicate that during this time the AT has been a net C sink, accumulating 1.44 gC m^{-2} day^{-1}. These results were compared with the MODIS NPP product, and data from other African flux towers. Annual C gain for this site for 2015/2016 was 519.7 gC m^{-2}.

Perennial Rivers during Drought in the KNP: Management Actions, Biotic Responders, and Co-learning

Riddell, E.S.[1], Petersen, R.[2], Sithole, H.[2], Shikwambana, P.[2], Govender, D.[2], Venter, J.[2] & Strydom, T.[2]

[1]Conservation Management, Skukuza, Kruger National Park, eddie.riddell@sanparks.org
[2]Scientific Services, Skukuza, Kruger National Park

The present drought conditions linked to the current El Nino Southern Oscillation have had important impacts on both terrestrial and freshwater systems within the Kruger National Park (KNP). The previous major drought of 1991-1992 was successfully utilised by the KNP to develop a new research and management agenda for freshwater ecosystems both within the KNP and nationally. This eventually influenced the drafting and promulgation of the National Water Act (1998), through which the KNP tracks the implementation of the ecological reserve for flow and quality in its rivers.

We present the current drought conditions experienced in the five perennial rivers draining through the KNP in a comparative manner to the previous two major droughts of 1982-83 and 1991-1992. This is done with a specific focus both on challenges and management actions with a view to their effects on river flow, quality and importantly biotic responses. To this end we analyse the present situation in the context of the past droughts and review what has worked and what has not, and how has the KNP along with other catchment stakeholders have learnt from this experience.

POSTER

Are diatom community structures responding to drought conditions in the KNP Rivers?

Shikwambana, P.[1], Govender, D. [1, 3], Sithole, H.[1], Petersen, R.[1] & Taylor, J.C. [2]

[1]*Scientific Services, SANParks, Kruger National Park*
[2]*School of Biological Sciences, North-West University*
[3]*Department of Paraclinical Sciences, University of Pretoria*

Water forms the basis of life and it is the most valuable natural resource. South Africa is known to be a water scarce country with the Kruger National Park (KNP) receiving only 537mm annual average rainfall. The year 2016 marks 2 years of drought in most regions of South Africa. Although the 5 major rivers flowing through the KNP are characterised by continuous flow, some of the rivers experience lentification during the drought. Extreme weather conditions such as high temperatures also accelerate water flow changes. Drought conditions may result in habitat change, decreased water flow and possible water quality deteriorations.

Diatoms are highly successful distinctive group of unicellular algae. They can be found in all aquatic habitats including damp surfaces; therefore they can be successfully used as ecological indicators during low flows. Additionally; diatom community structures can be used to track changes in salts, nutrients and toxicant inputs. River Eco-status Assessments were conducted in 2015 and 2016 where diatom samples were collected in the 5 major rivers in KNP. Diatom community structures will be used to describe the effects of drought conditions along the 5 KNP major Rivers.

Consolidation of the wildlife estate: management challenges at differing spatial scales with special reference to drought

Peel, M.J.S.[1, 2, 3] & Anderson, J.L.[4]

[1]*Agricultural Research Council-Animal Production Institute, Rangeland Ecology*
[2]*Research Associate, APES, University of the Witwatersrand*
[3]*Research Associate, UNISA*
[4]*International Conservation Services*

mikep@arc.agric.za; conserva@global.co.za

Large private nature reserves (referred to as Adjacent Private Protected Areas - APPAs) bordering the Kruger National Park (KNP) have embraced the basic philosophies of the KNP management approach since the removal of the fences between them in the 1990's, have similar general objectives but function at different spatial scales. In the APPAs, movement is possible but due to management actions such as the provision of artificial water points these areas function at a different spatial scale to the KNP. This presents a unique set of management challenges.

We illustrate this by comparing the density of water points in the APPAs with that of a 10km buffer within the adjacent KNP. We further examine the effect of the apparent 'over-supply' of water within the APPAs on the density and type of animals found and their potential effect on the forage resource particularly during periods of drought. Proactive management scenarios are presented for the APPAs bearing in mind that these management actions are implemented within a larger system (including the adjacent KNP). The latter further highlights the need for an integrated approach to management within these areas.

Disturbing resource hotspots: drought impacts on vegetation and insect communities around termite mounds

Trisos, M., Parr, C.L., Picker, M.D., Leitner, M., Davies, A.B. & February, E.C.

Department of Biological Sciences, University of Cape Town

trisosm@gmail.com; Kate.Parr@liverpool.ac.uk; Mike.Picker@uct.ac.za; Monica.Leitner@zoology.up.ac.za; adavies@carnegiescience.edu; Edmund.February@uct.ac.za

Drought is a disturbance that can have substantial ecological impacts, yet the impact of drought on the savanna biome is poorly understood. Over the 2014/15 and 2015/16 growing seasons southern Africa experienced an El Niño Southern Oscillation induced drought. In particular, during the 2015/16 growing season the Kruger National Park experienced the worst drought since 1991/92. By examining the spatial and temporal changes in vegetation, ant, and grasshopper communities of termite mounds, we ask whether these naturally occurring resource hotspots act as drought refugia for both primary producer and primary consumer trophic levels in the semi-arid KNP.

In 2012 we sampled both the vegetation and insect communities on termite mounds relative to a paired savanna matrix site. We repeated this sampling in 2016 and compared the two datasets using taxonomic and functional trait analyses. The sampled termite mounds were split between a relatively higher rainfall site at Pretoriouskop and a lower rainfall site near Skukuza. The drought and mammalian herbivory significantly reduced grass biomass especially on the termite mounds where grass is more palatable with a lower carbon to nitrogen ratio. The grasshopper community collapsed yet the ant community demonstrated remarkable resilience.

The effect of the 2016 drought on vegetation structure and animal presence on the granite catena in the Kruger National Park

Janecke, B.B.

Department of Animal, Wildlife & Grassland Sciences, University of the Free State, PO Box 339, Bloemfontein, 9300, South Africa

janeckbb@ufs.ac.za

Research has already been done by a team of multidisciplinary researchers on the granite hillslope within the Stevenson-Hamilton Supersite to try and determine the bottom-up determinants of heterogeneity and biodiversity along the catena that in turn determines the suitability of these habitat-zones to mammals. In some areas, the drought has been described as the worst drought in human history. When comparing results from the previous year to the extreme drought year of 2016, certain changes in the vegetation structure have been observed in the catena / hillslope, some caused by the impact of the drought itself and others by animals, especially elephants. This has changed the habitat in such a way as to impact on specific animal species' presence. In the course of a year, the cover and frequency of herbaceous species declined drastically along all four plant communities identified on the hillslope gradient from the crest to the stream bed. After a rainfall event at the end of the year caused some of the grass tufts to sprout again, it was targeted by grazers to such an extent that it was almost impossible to identify them. The majority of these grass tufts were grazed down to <2cm height along the entire hillslope. The forbs and shrubs, however, died and were not revived after the rainfall at the end of the year.

The uprooting of trees by elephants, especially on the slope, occurred at a larger scale than what was noted in the previous year of field work and many of those trees died as well. At the beginning of 2017, some good rainfall was experienced in the park, but the changes that could have been brought about in the vegetation structure by these events are not included in this presentation. The changes in vegetation structure, that was evident at the end of 2016, impacted mammal presence, mostly because of minimum cover, shelter and food being available. However, some animals were present in the catena system regardless of the extreme drought conditions, while other species were not observed in the catena area during the drought or after the first flush of grass and probably moved off in search of some other green pastures somewhere else… if there was still something like that available in the park at the end of 2016! It is known that during times of food shortages, i) some animals migrate to other areas in search of food and water, as well as that ii) larger animal herds break up into smaller groups that disperse over wider areas in their home range to make it easier for all the individuals to find food.

POSTER

The effect of multiple droughts on maintaining Kruger National Park's long-term fire/herbivory experiment

Strydom, T.[1], Govender, N.[2], Thompson, D.[3] & Mpanza, N.[1]

[1]*South African National Parks, Scientific Services, Skukuza, South Africa*
[2]*South African National Parks, Conservation Services, Skukuza, South Africa*
[3]*SAEON, Ndlovu Node, Phalaborwa, South Africa*

tercia.strydom@sanparks.org; navashni.govender@sanparks.org; dave@saeon.ac.za; nokukhanya.mpanza@sanparks.org

The long-term fire/herbivory experiment in Kruger National Park was developed in the early 1950s and replicated in four major vegetation landscapes. These experimental fire/herbivory plots are spread across the two dominant geology types and across a rainfall gradient of between 451 and 705 mm/annum. Maintaining a total 208 plots and ensuring that they burn based on their individual schedules is imperative to ensure the integrity of the experiment. However, there are instances where some burn plots are unable to burn or sustain a fire. Depending on the season, this may be due to high fuel moisture content (green fuel), high Fire Danger Index, accidental fires or the lack of fuel. Often, the lack of fuel is attributed to below average rainfall and drought conditions impeding fuel regrowth after the last prescribed burn or increased herbivory on the plots.

Droughts are regarded as two or more consecutive years of below average rainfall whereby a deficit of 25% of normal annual rainfall is considered as a severe drought. Nonetheless, even a shortfall of 20% can lead to dry conditions inhibiting fuel accumulation. In addition to low fuel loads resulting from a drought, herbivory exacerbates conditions by consuming the little fuel remaining on these experimental plots. This presentation aims at evaluating the effect of multiple droughts over the last six decades on fuel availability and ultimately whether a scheduled burn was implemented or not. In some vegetation types, there are lag effects after a drought until the vegetation and fuel load recovers, such that the treatment can be applied.

Reservoir siltation and contemporary erosion in Kruger National Park

Baade, J. & Reinwarth, B.

Department of Geography, Friedrich-Schiller-University Jena, 07737 Jena, Germany

jussi.baade@uni-jena.de; bastian.reinwarth@uni-jena.de

In the 20th century a number of reservoirs were constructed to enhance water availability to wild life in Kruger National Park (KNP). These impoundments provide a unique opportunity to assess erosion under current climatic conditions in a pristine Savanna environment at the catchment scale. Over the past three years we mapped reservoir siltation in 15 dams in the southern part of KNP extending from Hartbeesfontein in the northwest to Mpanamana in the southeast.

Field work comprised high resolution mapping of the impoundments using dGNSS (differential Global Navigation Satellite System) and TLS (Terrestrial Laser Scanning), establishment of soil auger transects and sediment sampling for the determination of dry bulk density, among others. This contribution reports on the findings and final results concerning reservoir siltation and sediment yield from catchments in the southern KNP. Taking into account reservoir specific assessments of trap efficiency and catchment specific sediment delivery ratios we will present final assessments of contemporary erosion rates in KNP.

POSTER

Gully erosion in Kruger National Park – A first assessment

Baade, J.

Department of Geography, Friedrich-Schiller-University Jena, 07737 Jena, Germany

jussi.baade@uni-jena.de

Despite overall low erosion rates in the pristine Savanna environment of Kruger National Park (KNP) gully erosion features representing hotspots of erosion are present. Due to the fact that gullies are characterized by a knickpoint at the gully head, they are very dynamic features and tend to extent upslope as long as overland flow from the upslope catchment gets concentrated at the gully head.

Preliminary reconnaissance survey impressions suggest that gully features are quite often associated with roads, either tourist roads, like along the S65, or (decommissioned) management roads, like north of Silolweni Reservoir or upstream of Newu Reservoir. Although mentioned as a concern in the management plans data on gully erosion in KNP is difficult to find. In 2015 two gully erosion sites were mapped using Terrestrial Laser Scanning (TLS). This poster presents the results and discusses the feasibility to monitor gully erosion dynamics by repeated TLS mapping campaigns.

Responses of ant communities to disturbance: a predictive understanding of a dominant savanna faunal group

Andersen, A.N.

Charles Darwin University, Darwin, Australia

Alan.Andersen@cdu.edu.au

Ants are an ecologically dominant faunal group in tropical savannas throughout the world, and are widely used as bio-indicators in land management. I provide a framework for a predictive understanding of responses of ant communities to habitat disturbance. Following Grime, disturbance is defined as any factor that removes biomass, and is distinguished from stress, which describes factors limiting growth in biomass (productivity). The ground-nesting habits of most ant species mean that habitat disturbance often causes little loss of ant biomass, such that the main effect is indirect through changes in habitat suitability and therefore environmental stress. From an ant's perspective, a key feature of disturbance is that it increases habitat openness, and understanding ant responses to habitat openness is fundamental to understanding ant responses to disturbance.

The same disturbance will have a greater effect in closed and complex habitats (by creating openness and reducing complexity) than it will in habitats that are already open and simple. Similarly, ant species adapted to shady and complex habitats will be more sensitive to disturbance than are species adapted to open and simple habitats. Indeed, in complex habitats the latter are often promoted by habitat disturbance. Ant community responses to disturbance therefore vary predictably in relation to habitat structure and the functional composition of the fauna. Such variation in ant responses occurs not only along gradients of habitat complexity, but also between different regions with functionally different ant faunas, including the same biome occurring in different continents.

Ant diversity and composition at sites undergoing restoration and rehabilitation at Mountain Zebra and Mokala National Parks

Sithole, H.[1], Tantsi, N.[1], Bezuidenhout, H.[1], Munyai, C.[2] & Munyai, L.[1]

[1]*South African National Parks, P. O. Box 110040, Hadison Park, Kimberley, 8306*
[2]*University of KwaZulu-Natal*

hendrik.sithole@sanparks.org; caswell.munyai@gmail.com

When the South African National Parks (SANParks) was expanding some of its parks, it acquired some farms with varying degrees of degradations in them. SANParks has implemented some rehabilitation projects to some of these farms in order to restore them as close to their natural ecological status as possible. The empirical ant data from sample sites were collected and compared with the ones from the un-degraded sites. An inventory list of each site was compiled for future assessments and the determination of changes of ant compositions in those sites.

The data show that most of the degraded sites had lower: abundance, species richness, Shannon-Wiener diversity index, common species and exclusive species relative to their specific control sites. The data also show that there is relatively less disparity of diversity indices between the degraded sites with older rehabilitation age and their controls than sites with younger rehabilitation age. They further show that different degradation activities (or intensity of them) have different impact degrees to ant ecosystems. The degradation severity and rehabilitation age could also influence ant species ecosystems as sites with less intense degradation and longer rehabilitated age has better ant species ecosystem that the one with more severe degradation and short rehabilitation age.

Response of soil macroinvertebrates in different disturbances in the Sandstone Sourveld in Kwa Zulu-Natal

Hlongwane, Z.[1], Mwabvu, T.[2] & Tsvuura, Z.[1]

[1]*School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa*
[2]*School of Biology and Environmental Science, University of Mpumalanga, Private Bag X11283, Mbombela,1200, South Africa*

nolwazihlongwane20@gmail.com

Soil macroinvertebrates are used as bioindicators to assess the state of the environment and how the environmental conditions change over time as a result of anthropogenic and natural forces. There is no data on the effect of different disturbances on soil macroinvertebrates diversity and assemblages in different vegetation types in the sandstone sourveld, which is a species-rich and threatened grassland that is restricted to the interior of KwaZulu-Natal (KZN) Province in South Africa.

The aim of this study is to develop a bioindicator tool for monitoring ecological conditions of the KZN sandstone sourveld by determining the relationship between habitat conditions to soil macroinvertebrates assemblages. Disturbed and undisturbed sites will be identified and sampled for soil macroinvertebrates in the dry and wet season using pitfall traps in sandstone sourveld grassland. Vegetation characteristics and composition will be measured using plot based methods. Preliminary results of soil macroinvertebrates and vegetation dynamics will be discussed in terms of abundance, diversity, composition and vegetation cover in less human impacted (undisturbed) and strongly human impacted (disturbed) site.

Non-Volant Macro-invertebrate Richness and Diversity in Disturbed KwaZulu-Natal Sandstone Sourveld

Mhlongo, N., Tsvuura, Z. & Munyai, C.

University of KwaZulu-Natal, School of Life Sciences, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa

n.mhlongo93@gmail.com

Invasive alien plants (IAPs) alter the functioning of the invaded ecosystems such as nutrient cycling, thereby affecting the long-term stability of ecosystems. Invertebrates, particularly non-volant soil macro-fauna are most affected by drastic changes and disturbances such as IAPs in the environment due to their limited dispersal abilities. The Sandstone Sourveld found in the KwaZulu-Natal province of South Africa, is a threatened ecosystem with a substantial disturbance caused by land transformation and IAPs. The impact of IAPs on non-volant macro-invertebrates in this ecosystem is poorly understood. Therefore the aim of this study was to assess non-volant macro-invertebrate diversity along the disturbance gradient (low, medium and high invasion) and to understand the impact of IAPs on non-volant macro-invertebrates diversity.

Sampling was done in Springside, Tanglewood and Giba Gorge Nature Reserves. Pitfall traps were used to sample non-volant macro-invertebrates across sites in June 2016. Vegetation structure and species composition were also assessed. Species diversity indices, namely, species richness, Simpson's evenness and Shannon-Wiener diversity indices were compared within the site along the disturbance gradient. This study will provide a comprehensive understanding on the biodiversity of non-volant macro-invertebrate in relation to IAPs in the Sandstone Sourveld. This knowledge would be useful to guide the necessary IAPs management interventions that would enhance non-volant macro-invertebrates diversity to create a more functional and stable ecosystem.

Short-term changes in surface active non-volant soil macroinvertebrate assemblages in unburnt and burnt sandstone sourveld grassland

Mwabvu, T.[1,] & Nkemzi A.Q.[2]

[1]*School of Biology & Environmental Sciences, University of Mpumalanga, P. Bag X11283, Mbombela 1200, South Africa*
[2]*School of Life Sciences, University of KwaZulu-Natal, P. Bag X54001, Durban 4000, South Africa*

tarombera.mwabvu@ump.ac.za

Flightless terrestrial macroinvertebrates, as soil engineers, are important in litter decomposition and soil transformation. However, data on species composition and the impact of burning are scarce. As such, a survey of surface active flightless soil macroinvertebrates was conducted using pitfall trapping at a burnt and adjacent unburnt site in sandstone sourveld grassland in Tanglewood Private Nature Reserve, Durban, South Africa. We recorded 85 arthropod species (burnt = 57, unburnt = 64). Thirty six species occurred at both sites, 21 were recorded at the burnt site only (37 %) and 28 species (42 %), including a large spirostreptid millipede *Doratogonus cristulatus*, were found only at the unburnt site. Species richness did not differ between the sites. Formicids were the dominant taxa at both sites.

Species abundance was significantly different between September and May ($p < 0.014$), and February and May ($p < 0.006$). Species richness was weakly correlated to percentage vegetation cover and vegetation density ($r = 0.221$). However, species abundance was strongly correlated to vegetation density ($r = 0.616$) and negatively correlated to vegetation cover ($r = -0.267$). Burning caused changes in abundance, dominance and species composition but not in species richness because many taxa are exclusive to one site and they have different activity patterns. As such, when assessing the impact of burning focusing on individual species rather than overall species richness is more informative. Given that species lists and long-term monitoring of flightless soil macroinvertebrates responses are required; this study provides valuable baseline data for future conservation research.

An inventory of epigeal ants of the western Soutpansberg Mountain Range, South Africa

Munyai, T.C.[1] & Foord, S.H.[2]

[1]*School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209. South Africa*
[2]*Centre for Invasion Biology and South African Chair for Biodiversity, value and change, Department of Zoology, University of Venda, Thohoyandou, 0950, South Africa*

Munyaic2@ukzn.ac.za; stefan.foord@univen.ac.za

The distribution, abundance and sensitivity of invertebrates to habitat change are largely unknown. Long-term monitoring of ecological gradients with standardised and comparable protocols can form the basis of a better understanding. Altitudinal gradients are particularly relevant within this context. Here we provide a check list and baseline data for ant species collected over a 5-year period across the Soutpansberg Mountain Range, South Africa.

Standardised pitfall surveys across 11 sites yielded a total of 133 species in 38 genera and 6 subfamilies. Sample coverage of epigeal ants was 0.98 for the transect as a whole. Of these species, 21% were restricted to the southern slope of the mountain and 14% to the northern slope. Extrapolated richness estimates reached an asymptote for all, except for three sites. Observed richness was the highest at a low-altitude mesic site that is exposed to considerable disturbance by megaherbivores and mechanical clearing of woody vegetation.

POSTER

A trait-based approach in understanding ant community assembly in the Soutpansberg Mountain, South Africa

Mulalo, M.

Understanding how communities are assembled and structured is central to ecology and conservation science. A number of conceptual advances suggest that the use of taxonomic diversity alone is insufficient to understand biodiversity patterns and processes and incorporating functional diversity provides additional insights into species assemblages. Trait-based approaches have become important tools for understanding species assemblage and their responses to climate change. Ants are an ideal study system because they are geographically widespread and their change in abundance will have consequences for ecosystem processes. Here, I aim to quantify thermal tolerance and water loss for dominant ant species along an elevational gradient in the Soutpansberg Mountain in Southern Africa, use this to predict response to climate change and quantify functional diversity of all species previously collected across this gradient.

Ant species will be collected using bait for thermal tolerance assays while their behavioral niches will be driven from previous studies. Morphological traits will be measured for all species previously collected while other behavioral and life history traits will be derived from the literature. Generalized Linear Mixed Models (GLMMs) will be used to analyze the response of functional diversity to habitat type, elevation and aspect. Multiple linear regressions models will be used to analyze the relationship between thermal tolerance, thermal niche and timing of activity. I expect that functional diversity will decrease with elevation but will also be significantly affected by habitat. Thermal tolerance ranges of dominant ant species will relate to their timing of activity as well as distribution across the mountain, larger thermal tolerance will result in larger distribution ranges and thermal range will increase with elevation. Species with higher water content will have broader thermal tolerance ranges while habitat will play a significant role in affecting thermal tolerance.

“Charming African mammals need policies other than CITES listings”

Ferreira, S.

The Sandton Convention Centre is silent. Four-and-a-half-thousand CITES delegates left. They mulled over trade listings of species, used wine and food at lobbying side-events, and left an unknown carbon footprint. Was it worth it? Delegates reached consensus on most proposals at CoP17. Listings changed for several plants and the pangolin is now on Appendix I banning all international trade. Charismatic African elephants, rhinoceroses and lions, however, challenged parties. Poaching is one of the key drivers of continent wide declines for these species, especially outside southern Africa. CITES canned an elephant ivory trade decision-making mechanism, but retained the listing of southern African elephants on Appendix II allowing controlled trade. Still, parties endorsed the closure of domestic ivory trade markets! In addition, side events for listing proposals by the African Elephant Consortium highlighted local lawlessness as a key challenge. Even so, delegates debated a listing mechanism to curb poaching! CITES also rejected a proposal to trade in Swaziland rhinoceros horn. The proposal to list all lions on Appendix I failed. The consortium of West African countries showed in a side event that lion prey is also declining.

Problems for lions are thus firstly local and not at some distant market for lion bones in Asia. I explore how CITES proposals address drivers. Perfect poaching storms of elephants and rhinoceroses come from trade traditions, inelastic demand, profit potential, inadequate law enforcement, unclear rights and human-wildlife conflict. Ecological threats for lions come from bad law enforcement, unclear rights and human-lion conflict, while economic threats also have trade histories, inelastic demand and profit potential as drivers. The dichotomous trade or no trade debates at CoP17 on elephants, rhinoceroses and lions focused only on a few drivers and distract authorities from addressing all drivers. Several resolutions recognized that disrupting organized crime and fixing social injustices may be more important than a CITES species listing for the conservation of charming African mammals and the role they play in ecosystems. John Scanlon, Secretary General of CITES, announced that the Cape Mountain Zebra is not on Appendix II anymore and congratulated South Africa for the outstanding conservation of the species. The Cape Mountain Zebra provides a message in the now silent corridors of the Sandton Convention Centre. Trade listings are not solutions to threats – trade is an opportunity if authorities have dealt with threats.

Savannas on the move: a conservation threat to our shrubby biomes?

Bond, W.[1, 2], Munyai, N.[2], Tucker, C.[2], February, E.[2], Hoffmann, T.[2] & Masubelele, M.[3]

[1]SAEON, P/Bag X7, Claremont 7735
[2]Dept Biological Sciences, UCT, Rondebosch 7701
[3]Cape Research Centre, Scientific Services, SANParks, P.O. Box 216, Steenberg 7947

Savannas and related grasslands cover some 60% of South Africa dominating the summer rainfall areas. The shrubby biomes to the west and south-west can be seen as occupying those regions where conditions are hostile for savanna grasses. This talk reports studies on the interface between the grassy versus the shrubby world. Savanna grasses are moving westwards into fynbos and the Karoo causing catastrophic changes in the growth form mix, biodiversity and ecosystem function.

The causes of the grass shift westwards are poorly understood and attributed variously to changes in rainfall amounts and seasonality and/or to increasing atmospheric CO_2. The switch to grasslands also appears to be strongly linked to grazing management. We suggest that these incipient biome shifts deserve more attention from researchers, conservation planners and protected area managers.

The role of nutrients in the bi-stability of the Fynbos-forest system: A nutrient manipulation field experiment

Lu, M.[1], Sheffer, E.[2], Bond, W.J.[3, 4], Cramer, M.D.[3], Allsopp, N.[4] & Hedin, L.O.[1]

[1]*Princeton University, Department of Ecology and Evolutionary Biology, New Jersey 08544, United States*
[2]*The Hebrew University of Jerusalem, The Robert H. Smith Institute of Plant Sciences and Genetics in Agriculture, Rehovot 7610001, Israel*
[3]*University of Cape Town, Department of Biological Sciences, Rondebosch 7701, Cape Town, South Africa*
[4]*South African Environmental Observation Network, National Research Foundation, Private Bag X7, Claremont 7735, South Africa*

mingzhen@princeton.edu

A long-standing puzzle is that the hyper-diverse South African Fynbos biome coexists side-by-side with indigenous temperate forests in locations that share the same climate and geology. This Fynbos-forest system offers a unique opportunity to resolve the mechanisms by which nutrients interact with plants, soils, and recurring fire to generate bi-stability at the biome scale. We transplanted tree species that are representative of Afro-temperate forest biome into intact areas of Fynbos vegetation, and subjected them to factorial nutrient fertilization and root competition exclusion treatments. We demonstrate that the native vegetation responds to nutrient fertilization, but that the limiting nutrient surprisingly is nitrogen (rather than phosphorus).

Transplanted forest species grow exceedingly slow on fynbos soil following fire, possibly limited by the availability of nutrients and belowground competition with Fynbos plants. Vegetation response was disrupted by the historical drought that hit the experiments in 2015-2016, implying potentially critical role of water resource availability in maintaining this bi-stable condition. Our findings will guide management and conservation efforts of the endangering hyper-diverse Fynbos ecosystem, which is of particular urgency given the predicted high sensitivity of the Cape Floristic region to future climate change (and therefore also to biome shifts/change).

Evidence of bi-stability of the Fynbos-forest system: Observations and a dynamical fire-nutrient model

Hedin, L.O.[1], Lu, M.[1], Sheffer, E.[2], Bond, W.J.[3, 4] & Cramer, M.D.[3]

[1]*Princeton University, Department of Ecology and Evolutionary Biology, New Jersey 08544, United States*
[2]*The Hebrew University of Jerusalem, The Robert H. Smith Institute of Plant Sciences and Genetics in Agriculture, Rehovot 7610001, Israel*
[3]*University of Cape Town, Department of Biological Sciences, Rondebosch 7701, Cape Town, South Africa*
[4]*South African Environmental Observation Network, National Research Foundation, Private Bag X7, Claremont 7735, South Africa*

lhedin@princeton.edu

The Fynbos is well known as a hyperdiverse biome that is adapted to low soil nutrient concentrations. Less known, however, is why fynbos vegetation coexists side-by-side with indigenous temperate forests in locations that share the same climate and geology. One possibility is that the fynbos-forest coexistence offers an example of bistability within the same landscape, such that either biome can dominate a given location once established. We here evaluate the alternative feedback mechanisms that can generate and maintain this sustained dichotomy in biome distribution over ecological and evolutionary time.

First, we will evaluate field observations of the soil-plant nutrient and water cycles in fynbos vs. forest patches within the Oranjekloof valley of the Table Mountain Reserve. We combine these observations with a 70-yr record of high-resolution aerial photos to quantify forest-fynbos dynamics in a valley-wide fire exclusion experiment. Second, we use a plant-soil dynamical model to examine the potential for feedback mechanisms to explain the observed patterns, focusing on the combined influence of soil nutrients and fire on competitive dynamics in both fynbos and forest plant communities.

How fire and forest elephants are affecting forest-savanna transitions in tropical Africa

Cardoso, A.W.[1], Malhi, Y.M.[1], Abernethy, K. A.[2], Oliveras, I.[1] & Bond, W.J.[3]

[1]*Environmental Change Institute, School of Geography and the Environment, University of Oxford*
[2]*African Forest Ecology Group, Biological and Environmental Sciences Department, University of Stirling / Agence Nationale des Parcs Nationaux (ANPN, National Parks Agency of Gabon)*
[3]*South African Earth Observation Network / Biological Sciences Department, University of Cape Town*

anabellecardoso@gmail.com; yadvinder.malhi@ouce.ox.ac.uk; k.a.abernethy@stir.ac.uk; imma.oliveras@ouce.ox.ac.uk; william@saeon.co.za

Tropical savannas contribute significantly to global ecosystem productivity and biodiversity but in many regions are currently threatened by forest encroachment (the expansion of forests into savannas). Although the balance of forests and savanna is dynamic through time and space, the loss of savanna as a result of forest encroachment has been occurring at an unprecedented rate in recent years and has already been documented across Africa, including central Africa. Fire and elephants are two important factors that can decrease tree cover in savannas and therefore could be integrated into management policies to control forest encroachment. Fire has been shown to reduce but not always prevent forest encroachment, while savanna elephants have been shown to decrease tree cover and maintain open canopies in savannas.

How forest elephants, now recognised a distinct species, affect tree cover and how their effects are interacting with fire at forest-savanna transitions is unknown. In order to address this knowledge gap, the aim of this study was to better understand the effect of varying fire regimes and forest elephant population densities, and their complex interaction, on the degree of forest encroachment that occurs at forest-savanna transitions. This study also aims to provide insight into improving management of forest encroachment across central Africa and explore whether rapid loss of elephants may be fuelling forest encroachment across the region. This research was conducted within the forest-savanna mosaic of Lopé National Park, Gabon.

Testing the link between pyrodiversity and biodiversity across African savannas

Parr, K., Beale, C., Hempson, G. Morrison, T., Courtney-Mustaphi, C., Archibald, S., Probert, J., Donaldson, J., Dobson, A. & Anderson, T.M.

Fire is a dominant form of disturbance in savanna ecosystems, shaping a range of ecological processes, from carbon storage to species interactions to changes in woody cover. Savannas cover a fifth of the Earth's surface and are dominant in Africa where they cover more than a third of the continent. A widely held view is that in savannas, and elsewhere, a diversity of fire characteristics in space and time (i.e. pyrodiversity) is thought to result in high levels of heterogeneity, which in turn promotes biodiversity; in other words, that 'pyrodiversity begets biodiversity'. However, while the pyrodiversity-biodiversity hypothesis is intuitively appealing, studies across savanna sites and within other biomes (e.g. mallee woodland in Australia), and across a variety of taxa (e.g. birds, ants, termites, spiders) have found little relationship between pyrodiversity and biodiversity.

I will report on a study which aimed to investigate to what extent pyrodiversity determines mammal and bird diversity across untransformed savanna areas (using protected areas) in Africa. We used a combined value of five fire characteristics: fire return interval, intensity, season, fire size and total area burnt. We predicted there will be high pyrodiversity at low rainfall but a limited effect on biodiversity because there is little long term change in vegetation structure. Conversely in more mesic areas (e.g. >750mm/yr), although we expected pyrodiversity would be lower, it would have a greater effect on biodiversity because vegetation structure has greater potential for change.

Montane forest-grassland mosaics in the Western Ghats, India: history, dynamics and an uncertain future

Sankaran, M.[1, 2], Joshi, A.[1]& Ratnam, J.[1]

[1]*National Centre for Biological Sciences, GKVK Campus, Bellary Road, Bangalore, India 560065*
[2]*School of Biology, University of Leeds, Leeds LS2 9JT, UK*

Forest-grassland mosaics, characterized by abrupt boundaries between the two contrasting vegetation types, are an enigmatic and puzzling feature of many landscapes. In contrast to savannas, forest-grassland mosaics are a mixed tree-grass ecosystem where coexistence between trees and grasses only occurs at a landscape scale, but not local scales. Although traditionally believed to be artifacts of human activity, paleo-ecological evidence has revealed that many of these mosaics are in fact ancient ecosystems that predate human presence, often supporting unique biodiversity. They have been documented from diverse array of sites across the globe, ranging from the tropics to temperate regions.

Their occurrence under these diverse climatic and biotic conditions has made it challenging to derive general theories for the mechanisms creating, structuring and maintaining these mosaics. Here, I discuss some of our ongoing work in one such forest-grassland mosaic, the iconic montane shola-grasslands of the Western Ghats: from their history, to the factors maintaining these mosaics, the conservation challenges they face, both currently and in the face of future climate change, and the implications of our results for a broader understanding of what structures these mosaics globally.

A review and synthesis of factors driving tolerance of people towards damage causing mammalian wildlife

Kansky, R.[1], Kidd, M.[2] & Knight, A.T.[3]

[1]*Department of Conservation Ecology and Entomology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa*
[2]*Centre for Statistical Consultation, Department of Statistics and Actuarial Sciences, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa*
[3]*Department of Life Sciences, Imperial College London, Silwood Park Campus, Buckhurst Road, Ascot, Berkshire, SL5 7PY, United Kingdom*

kanskyruth@gmail.com

As development and human populations increase and encroach on the remaining areas of wildlife habitats, contact between humans and wild animals increases. Problems arise when the impacts of wild animals on human lives and livelihoods are unacceptable resulting in disagreements between stakeholders on how to manage wild animals, as well as unsustainable impacts on wildlife populations. This area of research typically called "human-wildlife conflict" is an emerging research area. Human Wildlife Conflict is increasing and recognized as a major priority as it can incur large costs to rural lives and livelihoods as well as decrease support for conservation in general. While the main focus of research in human-wildlife conflict has been finding technological and financial solutions to mitigating the tangible impacts of wildlife for humans so as to increase tolerance of stakeholders towards wildlife, recent work suggests this approach may be an oversimplification of the problem and a focus on the human dimensions of the problem requires more attention.

There is sufficient evidence in the Human Wildlife Conflict literature to conclude that individuals differ widely in their attitudes and tolerance towards wildlife. For example, some stakeholders remove wildlife species despite not encountering any problems, while others with problems will not remove species. Some stakeholders will implement mitigation measures to prevent or reduce damage, while others will not and some farmers will forgo different numbers of livestock to different species of wildlife. Determining the extent of stakeholder tolerance and the factors driving this tolerance is therefore critical to design policies for HWC management, particularly in light of increased requirements for stakeholder participation in conservation management. Here we present a global review of the factors that were examined by researchers as drivers of tolerant behavior by people living with four groups of mammalian wildlife groups; carnivores, ungulates, elephants and primates. We then synthesize this body of work and present a Wildlife Tolerance Model that can be used as a diagnostic tool for conservation managers to understand the drivers of tolerance towards damage causing mammalian wildlife.

The role of elephant movement decisions and foraging choices in crop consumption

Vogel, S.M.[1,2], Coulson, T.[1], Lambert, B.[1], Stronza, A.[2,3], Songhurst, A.[1,2] & McCulloch, G.[2]

[1] *University of Oxford*
[2] *The Ecoexist Project*
[3] *Texas A&M*

susanne.vogel@zoo.ox.ac.uk; tim.coulson@zoo.ox.ac.uk; ben.lambert@some.ox.ac.uk; astronza@tamu.edu; anna.songhurst@hotmail.com; gpmcculloch1@gmail.com

Elephants pose an economic threat to subsistence farmers through crop raiding. The primary focus of much research is on finding ways to prevent crop raiding. Much less work has investigated on what motivates particular elephants to forage in agricultural fields. Using GPS collar data from 20 elephants in Botswana's Okavango Delta and hierarchical Bayesian models; we show that elephant movement patterns can be classified into different types. These movement types are characterised with a combinations of the distance moved, and angle turned, between consecutive fixes. We are able to identify two classes of movement: rapid, directional movement, as elephants travel towards a goal, and slower, less predictable, movement, which we associate with elephants foraging within an area.

Our analyses reveal that these movement types correlate with habitat features including agricultural fields and proximity to the Okavango River or landscape corridors. These corridors are frequently used by elephants to move between areas where humans are primarily absent and those where they practice agriculture. Next, we couple these findings with information on the nutritional requirement of elephants and the nutritional availability of naturally occurring vegetation and crops. Finally, we show how shifts in nutrients, fibre and secondary compound content of browse; graze and crops play a role in the timing crop consumption behaviour. Our insights could help design more effective mitigation strategies than are currently being used in areas of the Okavango Delta.

Elephants for Africa, the social ecology of male elephants in a bull-dominated area, and implications for community based conservation

Isden, J.[1], Stevens, J.[1, 2], Allen, C.[1, 2], Chamberlain, A.[1, 2] & Evans, K.[1]

Botswana has rapidly become a safe haven for Southern Africa's elephant population and, coupled with an expanding human population, there is a greater need than ever before to understand the social and ecological requirements of elephants and successfully mitigate human-elephant conflict. The Boteti River region in the Makgadikgadi Pans National Park (MPNP) is dominated by bull elephants, with <4% of sightings being females. Such large congregations f bulls, in the near-absence of females, provides an unusual opportunity to explore the social requirements of a healthy bull society; an aspect of research that lags behind what is currently known about breeding herds. Elephants for Africa (EfA) has been investigating the social interactions between the bulls in the MPNP since 2012, and are using this data to inform future management practises based on the importance of bull attributes in maintaining social cohesion, dominance hierarchies and information exchange.

Human-wildlife conflict alongside the MPNP is an increasing problem, and reflects similar conflicts in regions across the world. EfA, and our associated students, have been investigating the extent and nature of crop-raiding, and we are now conduction trials to find the the simplest and most effective solution for subsistence farmers. Through questionnaires and field- measurements, we show that farmers value wildlife as a national and economic resource, but tolerance is often low. Crop-raiding is mostly carried out by older bulls, in contrast to the general demographic structure of the bull population within the protected area, and appears to be non-random in nature. Trials of mitigation methods, including using chilli-pepper, have had positive results for some farmers, but drawing robust scientific conclusions is challenging in an environment where farmers rely on positive outcomes for their livelihoods. EfA advocates networking and collaboration between similar researchers and NGO's across Southern Africa, to address the rising need to understand and mitigate wildlife conflict.

Land Use Planning at the Community-Elephant Interface

Songhurst, A.[1], McCulloch, G.[1], Stronza, A.[1], Radifalana, F.[2], Radithladi, G.[2], Yakenge, R.[2], Mauano, R.[2], Brooks, C.[3] & Burger, K.[4]

[1]*Ecoexist Project, Botswana*
[2]*Tawana Land Board, Botswana*
[3]*Southern African Regional Environment Program, Botswana*
[4]*GIMS, Botswana*

anna.songhurst@hotmail.com

Finding ways for people and elephants to coexist requires affording both parties access to critical resources and space. Appropriate land use planning is necessary to develop acceptable and practical solutions for conflicts that arise from sharing space and resources. We combined data collected through long-term research on and monitoring of elephant movement, combined with local knowledge and experience from key community and government stakeholders. The result is an evidence-based, participatory land use plan that mitigates future conflicts between people and elephants in the eastern panhandle of the Okavango Delta.

We used a GIS-based modeling process called the Land Use Conflict Identification Strategy (LUCIS), which incorporates stakeholder preference into traditional land use suitability classification methods. Thirteen critical elephant corridors with development free buffer zones were identified and incorporated into a land use plan by the land authority. In addition, zones with good soils were demarcated for future arable development and village expansion. This land use planning approach is part of a holistic strategy of the Ecoexist Project, an initiative aimed at finding ways for people and elephants to coexist. The conservation success of transboundary wildlife corridors and wildlife dispersal areas (WDA) depends on protecting local movement corridors through human-dominated landscapes and addressing conflicts that occur between people and wildlife.

Remotely operated virtual fences: a successful new approach to baboon management

Richardson, P.R.K.[1,2], Conradie, E.C.[1], Olivier, P.A.[1], Rode, S.C.[1], Loubser, B.[1], Shutte, C.[1], Khoury, R.E.[1] & Wittridge, H.M.[3]

[1]Human Wildlife Solutions, P.O. Box 31150, Tokai, Cape Town, 7966
[2]Department of Biological Sciences, University of Cape Town, Rondebosch 7701, Cape Town
[3]Environmental Resource Management Department, Biodiversity Management Branch, City of Cape Town, PO Box 68, Gordon's Bay 7151

phil@hwsolutions.co.za

Current baboon management practices in Cape Town, using rangers with paintball markers, are labour intensive and expensive. Virtual Fencing (VF) is an alternative, cost effective strategy for deterring baboons from entering urban or agricultural spaces, particularly in remote terrain. HWS has recently developed a VF to control baboons from entering specific urban areas in the Western Cape. The VF is based on the principal of creating a "landscape of fear" which baboons are reluctant to cross, for fear of the consequences (predation, exposure to unpleasant stimuli) that might follow. The VF is comprised of hidden, waterproof, remotely operated, action stations which are capable of firing bearbanger flares and producing a selection of sounds, including predator calls, alarm calls and cries of animals in distress.

The element of "fear" is increased by the temporal unpredictability of the system. Using a wide variety of stimuli adds to the fear, and reduces habituation. The system is operated remotely using a hand-held controller or smart phone. GPS radio-collared animals can be tracked in real time using relay stations and a gateway router to one's GSM network. This provides an early warning system via sms, or the internet, and allows remote activation of the fence from anywhere. The VF has been in operation outside Gordon's Bay since January with 100% success and saved 3,500 man hours in labour during its first three months of operation. This system can be modified to manage other damage causing animals, whilst the tracking component has great potential for research.

The Current Status of HWC in Hwange Communal Area after 6 years

Mabika C.T.[1], Mundy, P.[2], Kativu, S.[3] & Le Bel, S.[4]

[1]*RP-PCP (DREAM Project), Zimbabwe Parks and Wildlife Management Authority*
[2]*National University of Science and Technology, Zimbabwe*
[3]*University of Zimbabwe*
[4]*CIRAD*

tcmabika@gmail.com; peter.mundy@nust.ac.zw; skativu@gmail.com; sebastien.le_bel@cirad.fr

Human Wildlife Conflict is recognised as a threat to wildlife conservation as it undermines the peaceful cohabitation between people and wild animals. This results in people turning antagonistic towards problem animals. Several mitigation measures have been employed in conflicts between people and different wild animals. Some of these have become ineffective in the long run as the animals get habituated with time. Again solutions have been targeted on mitigating direct conflicts with wildlife, while neglecting to address the root causes of these conflicts (Dickman, 2010).

The focus of this study is to understand the current dynamics and complexities behind how HWC occurs, how people attempt to mitigate it, and the effectiveness of the mitigation measures employed in comparison with the status of the same areas in 2010. 386 questionnaires were administered in 9 wards in Hwange Rural District. Data was captured in a Microsoft Access Database and analysed using R Statistical package. The data shows that Human Wildlife Conflict typology and level of impact in the areas has not significantly changed despite the different mitigation measures that are being used. Elephant (25.6%) related conflicts were listed highest followed by hyena (19.4%), lions (9.1%) and baboons (40%) in summer. 39.9% of the respondents did not name any problem animal during summer

Dynamics of foot-and-mouth disease in African buffalo (*Syncerus caffer*)

Jolles, A.[1], Gorsich, E.[1], Beechler, B.[1], Charleston, B.[2], Juleff, N.[2], de Klerk-Lorist, L.[3], Maree, F.[4], Perez, E.[2], Rushmore, J.[1], Scott, K.[4], van Schalkwyk, L.[3], Zhang, F.[2] & Medlock, J.[1]

[1]*Oregon State University, Corvallis, Oregon, 97333, U.S.A*
[2]*The Pirbright Institute, Ash Road, Woking, Surrey, GU24 0NF, United Kingdom*
[3]*State Veterinary Services, P.O. Box 12, Skukuza, 1350, South Africa*
[4]*Transboundary Animal Disease Programme, ARC-Onderstepoort Veterinary Institute, Private Bag X05, Onderstepoort 0110, South Africa*

In sub-Saharan Africa, African buffalo act as maintenance host for FMD, complicating disease control. However, surprisingly little is known about the dynamics of FMDV transmission in its maintenance host. We used empirical data to parameterize a stochastic, individual-based mathematical model of FMD transmission. During an experimental infection FMD was transmitted readily from acutely infected animals to naïve hosts, and recovery occurred within 4-6 days, resulting in estimates for R_0 of 2.3 (SAT3), 3.5 (SAT2), and >3.5 for SAT1.

Using a longitudinal cohort study we determined that births occurred predominantly between November and March, giving an inter-birth interval of 5 months. Our models using this data show that FMDV is unlikely to persist in buffalo populations with calf to calf transmission alone. We then investigated the role of carrier animals, and were able to demonstrate transmission from carrier to naïve buffalo in an experimental setting. We will use this data to parameterize a similar stochastic, individual-based mathematical model of FMD transmission that includes carrier transmission to evaluate whether persistence in buffalo populations is likely with carrier animals.

Bovine Tuberculosis alters pathogen community structure in African Buffalo

Beechler, B.R., Boersma, K.S., Ezenwa, V.O., Gorsich, E.E., Henrichs, B.S., Siepielski, A.M., & Jolles, A.E.

Tuberculosis (TB), caused by *Mycobacterium tuberculosis* and *M. bovis*, is notoriously hard to prevent reliably, eradicate fully from human and animal populations and even to treat in individual hosts, especially since the advent of MDR and XDR TB. Despite massive investment in its control in human and animal populations, the World Health Organization reports there were still 1.5 million people killed by TB in 2015 and 9.6 million cases were reported. We followed 317 free-living buffalo in Kruger National Park for 4 years to monitor bovine tuberculosis incidence and progression.

We have previously demonstrated that buffalo suffer health consequences, including declines in condition and increased risk of mortality – but that this risk can be prevented with the removal of gastrointestinal helminths. In this presentation we will also demonstrate that TB dramatically changes the host's microbial infra-community, increasing the prevalence and diversity of co-infecting parasites and pathogens and restructuring the animals' upper respiratory microbiomes. The information we have gleaned from this longitudinal study of African buffalo is pertinent not only to understanding the spread of BTB in bovids (buffalo and cattle), but also as a model for understanding control strategies in humans.

Subclinical infections of *Anaplasma marginale* and *A. centrale* in African buffalo (*Syncerus caffer*) from Kruger National Park, South Africa

Sisson, D.R.[1], Jabbar, A.[1], Jolles, A.E.[2], Beechler, B.[2] & Hufschmid, J.[1]

[1]*Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Werribee, Victoria, Australia*
[2]*College of Veterinary Medicine, Oregon State University, Corvallis, USA*

dsisson@student.unimelb.edu.au; jollesa@science.orgeonstate.edu; jabbara@unimelb.edu.au; breebeechler@gmail.com; huj@unimelb.edu.au

Subclinical infections in wildlife remain understudied compared to domestic animals. Knowledge about infections in wildlife is not only important to understanding wildlife health, but also essential for management decisions in areas where wildlife and domestic animals interface. *Anaplasma* species are obligate intracellular bacteria that infect different cells in different hosts with varying levels of pathogenicity. *Anaplasma marginale,* can cause the disease 'anaplasmosis' in domestic livestock, but little is known about *Anaplasma* spp. infections in wildlife. This is even more difficult when infections remain subclinical, as with *A. marginale* and *A. centrale* in African buffalo (*Syncerus caffer*). Using a longitudinal dataset, we followed the changes in *A. marginale* and *A. centrale* infections, two economically important parasites, assessing their impact in African buffalo.

Repeated samples were taken every two to three months from approximately 60 buffaloes in a 300 ha enclosure in Kruger National Park, South Africa. Conventional PCR was run with extracted DNA using major surface protein 1 beta (*msp1β*) and heat-shock protein *groEL* for *A. marginale* and *A. centrale* respectively. Agarose gel electrophoresis and DNA sequencing of PCR amplicons revealed that of the 747 samples from 103 individuals examined from 12 captures over two years, 129 (17.3%) and 98 (13.1%) were positive for monospecific infections with *A. marginale* and *A. centrale*, respectively, while 113 (15.1%) were positive for co-infection with both species, and only 17 remained uninfected with *Anaplasma* spp. throughout. These data will be used to understand infection dynamics throughout the sampling period, and health and fitness of African buffaloes.

Serum chemistry panels as indicators of health: Establishing normal ranges for African Buffalo & assessing variability across season, age and sex

Couch, C.[1], Movius, M.[2], Jolles, A.[1, 2], Gorman, E.[2], Rigas, J.[5] & Beechler, B.[2]

[1]*Oregon State University, Department of Integrative Biology, Corvallis, OR 97331*
[2]*Oregon State University, College of Veterinary Medicine, Corvallis, OR 97331*
[3]*Odum School of Ecology, University of Georgia, Athens, GA 30602*
[4]*Department of Infectious Disease, University of Georgia, Athens, GA 30602*
[5]*Utah State University, School of Veterinary Medicine, Logan, UT 84322*

couchc@oregonstate.edu; momovius@gmail.com; aejolles@gmail.com; elena.gorman@oregonstate.edu; johanna.rigas@gmail.com; breebeechler@gmail.com

This study established serum biochemistry normal reference ranges for 12 biochemical parameters in African buffalo in Kruger National Park, and then compared the results between a wild and semi-wild herd to investigate whether captivity alters biochemical parameters. Several important differences were identified between the wild and semi-wild herds, reflecting different physiological stressors related to management. Biochemical parameters related to overall nutrition were higher in the wild population, perhaps because the enclosure inhibits animal migration in search of adequate resources. Enzymes released as a result of organ stress as well as indicators of inflammation were elevated in the captive population, which may be related to poor nutrition, animal crowding, or other management techniques.

These findings have implications for management of this and other species, which are often maintained on smaller game parks that artificially limit the normal migration of these animals. Surprisingly, animals' sex had very little influence on the parameters studied, while age related changes were consistent with previous literature on cattle and other mammals. Season was the parameter which had the largest influence on biochemical parameters, due to a combination of changing nutrient availability and shifting disease burdens in the wet versus the dry season. Understanding the physiological changes due to these different factors and the resulting effects on animal health may have dramatic implications for management strategies and disease transmission affecting humans and domestic species.

Linking animal personality and immune profiles and their roles in conservation

Forssman, K.

Department of Veterinary Tropical Diseases, Onderstepoort, University of Pretoria

kathpotgieter@gmail.com

Individual differences in personality in the animal kingdom are a widely recorded occurrence, but have, historically, been considered unimportant, non-adaptive expressions. As a consequence, this phenomenon has not been properly considered by researchers. Instead, adaptive average behaviour that occurs throughout a population has been the focus. Recent work suggests that individual differences in personality play an important ecological and evolutionary role with implications for aspects such as population persistence, demography, adaptive potential, community dynamics and, relevant to this study, disease transmission, immunity and infection risk.

It is vital to recognise the role that personalities play in disease ecology and the impact that they have on infectious disease prevalence and transmission throughout a population in order to better understand disease outbreaks and how to control them. I studied individual personalities and disease profiles in African buffalo in the Kruger National Park to assess these relationships. I found that individual personalities are consistent over varying contexts and that behavioural types, such as bold versus shy or curious versus non-curious behaviours, can be linked to individual immune profiles. Recognising this link between behaviour and disease can add an arrow to the quiver of species conservation when considering vaccination programs, selective removal of individuals and reintroductions.

Estimating acute pathogen exposure in African buffalo (*Syncerus caffer*)

Glidden, C.[1], Beechler, B.[2], Perez, E.[3], Marree, F.[4], Charleston, B.[3] & Jolles, A.[2]

[1]*Department of Integrative Biology, Oregon State University, Corvallis, OR, 97330, USA*
[2]*College of Veterinary Medicine, Oregon State University, Corvallis, OR, 97330, USA*
[3]*The Pirbright Institue, Ash Road, Pribright, Woking, GU24, UK*
[4]*Onderstepoort Veterinary Institute, Onderstepoort, Pretoria, 0110, South Africa*

gliddeca@science.orgeonstate.edu; breebeechler@gmail.com; eva.perez@pirbright.ac.uk; mareef@arc.argic.za; bryan.charleston@pirbright.ac.uk

Animal and human sera are frequently collected biological samples, in medical, disease surveillance and research settings; yet, as a resource for tracking and understanding the changing infectious disease landscape, serological data are underutilized. The potential of this resource is beginning to be recognized: serological data can provide information on the fractions of susceptible and immune (immunized/recovered) hosts in populations of interest. This is invaluable information when trying to identify which populations are at risk of disease outbreaks, and where efforts for disease surveillance and prevention should be focused. In addition to antibodies, animal sera contain many non-specific markers of infection and inflammation (NSMI), such as acute phase proteins and pro-inflammatory cytokines. These proteins are produced rapidly in response to pathogenic challenge, and can remain elevated for days to weeks after the infection is cleared.

As such, NSMI can help identify hosts that are experiencing current infections but have not yet mounted a protective antibody response; and they can allow detection of outbreaks by pathogens that are not under routine surveillance, including emerging pathogens for which appropriate specific antibodies have not yet been defined. Here, we evaluated the utility of haptoglobin, serum amyloid A, TNF-α and IFN-γ in detecting pathogen exposure in African buffalo (*Syncerus caffer*) by (i) tracking how long each NSMI remained elevated past viral clearance in a herd of 24 FMDV experimentally infected buffalo; and (ii) using generalized linear models to assess the strength of NSMI as predictors for incidence of five respiratory viruses in a herd of 70 wild-managed buffalo in KNP, ZA. We found that NSMI can indeed be useful in detecting pathogen exposure in wildlife, with haptoglobin demonstrating the strongest utility.

POSTER

Natural history of schistosome infection in a free-living mammalian host population

Beechler, B.R.[1], Jolles, A.E.[1, 7], Ezenwa, V.O.[3, 4], Smith, M, Spaan, R.S.[2], van Damme, G.J.[5] & Steinauer, M.[6]

[1]*College of Veterinary Medicine, Oregon State University, Corvallis OR 97333*
[2]*Department of Fish and Wildlife, Oregon State University, Corvallis, OR 97333*
[3]*Odum School of Ecology, University of Georgia, Athens, GA 30602*
[4]*Department of Infectious Disease, University of Georgia, Athens, GA 30602*
[5]*Department of Parasitology, Leiden University Medical Center, Leiden, The Netherlands*
[6]*College of Osteopathic Medicine of the Pacific - Northwest, Western University of Health Sciences, Lebanon, OR*
[7]*Department of Integrative Biology, Oregon State University, Corvallis OR 97333*

Brianna.Beechler@oregonstate.edu; Anna.Jolles@oregonstate.edu; vezenwa@uga.edu; Robert.Spaan@oregonstate.edu; G.J.van_Dam@lumc.nl; msteinauer@western.edu

Neglected tropical diseases (NTD's) are a group of communicable diseases that primarily affect over 1 billion people living in poverty throughout the world and have proven difficult to control despite focused efforts and programs run by organizations like WHO or OIE. Schistosomiasis is one of these NTD's, caused by a trematode that affects millions of people, livestock and wildlife worldwide. Despite the availability of effective treatments, schistosomiasis has proven difficult to control, and there is a paucity of longitudinal studies investigating the dynamics of natural infections in mammalian host populations, in the absence of intervention. As a consequence, despite decades of research on schistosomiasis, our understanding of its natural history in free-living host populations is surprisingly limited. We investigated natural variation in schistosome dynamics in 312 free-ranging African buffalo over a period of 4 yrs. Specifically, we asked (i) What are the spatial and temporal patterns of schistosome infections in our study population; (ii) how do parasite burdens vary over time within individual hosts; and (iii) what host and environmental factors explain patterns of schistosome gain and loss in the buffalo? Schistosome infections were common among buffalo, and parasite burdens were highly aggregated among hosts, with spatial population structure explaining some of the variation in parasite burdens among hosts. Overall, parasite burdens ratcheted up over time, with gains in schistosome abundance in the dry season only partially offset by losses in the wet season.

Schistosome acquisition in the buffalo was strongly seasonal, but none of the host demographic, physiologic and immunologic parameters we measured affected the rate of schistosome gain. This suggests that variation in schistosome acquisition may be driven by factors related to parasite exposure, such as behavioral traits or spatial habitat utilization, rather than the physiological and immunologic traits we investigated. By contrast, variation among hosts in the clearance rate of schistosomes was associated with both immunologic and nutritional factors, as well as co-infection with other helminth parasites. Seasonal waves of exposure to schistosomes, combined with variation among hosts in the ability to clear parasites, were reflected in increasing variation in schistosome burdens with host age. Our study demonstrates that schistosome infections are surprisingly dynamic in a free-living mammalian host population, and points to a role for host physiological factors in driving variation in parasite clearance, but not parasite acquisition. Higher, more variable parasite burdens in older hosts imply that older animals may contribute disproportionately to parasite transmission dynamics, in contrast to what is seen in most mouse and human studies which tend to identify younger hosts as central to schistosome transmission. As such, our study highlights the importance of studies in natural host populations for understanding disease dynamics, and targeting interventions for disease control.

Avian haemoparasite prevalence in Kruger National Park, South Africa

Pori, T.[1], Ndlovu, M.[1, 2], Markus, M.[1] & Govender, D.[3]

[1]*School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Private Bag 3, Wits 2050, South Africa*
[2]*Department of Zoology and Entomology, University of the Free State, P. O. Box 339, Bloemfontein 9300, South Africa.*
[3]*Scientific Services, Skukuza, Kruger National Park, South African National Parks*

tinopori@gmail.com

The determinants and impact of avian haemoparasite infection on wild birds is difficult to estimate, especially in areas where infections are endemic and the host-parasites have co-evolved. Most avian haemoparasites are protozoal and of little clinical significance, however some infections become pathogenic in naïve hosts or when hosts are subjected to stressful environmental conditions. Our study evaluated the prevalence of avian haemoparasites in birds caught within and near the Kruger national park. We documented the effects of parasite infection on bird immunity and body condition. We also assessed the role of the environment and the bird's life history traits on parasite prevalence. A total of 623 birds from 71 species were sampled. Preliminary results show 27.55 % infection prevalence by either *Plasmodium or Haemoproteus*.

Highest prevalence was recorded during the wet season and mostly in the southern regions of the park, with minor influences of host life history traits on infection. Location and seasonal variation in prevalence suggests that parasitemia is mediated by, and coincides with high mosquito abundance. Infected birds had a significantly lower body condition. Further screening of blood slides for other haemoparasites is currently in progress. To date we have also detected infections of *Trypanosoma*, *Babesia*, *Rickettsia*, *Aegyptianella* and *Leukocytozoon spp*. This study will document parasite prevalence and diversity of infections in areas of southern Africa that have never been sampled before.

Understanding the anthropogenic and ecological pressures underlying the rapid spread of vector borne diseases

Schrama, M.[1], Gorsich, E.E.[2], Ndlovu, M.[3] & Beechler, B.[2]

[1]*Centre for Environmental Sciences, University of Leiden, Einsteinweg 2, 2333CC Leiden, The Netherlands*
[2]*College of Veterinary Medicine, Oregon State University, Corvallis, OR 97333, USA*
[3]*Organization for Tropical Studies, School of Animal Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa*

m.j.j.schrama@cml.leidenuniv.nl; eringorsich@gmail.com; mdu.ndlovu@wits.ac.za; breebeechler@gmail.com

Vector-borne diseases remain a leading cause of human mortality and livestock mortality, despite tremendous efforts. In order to be able to halt the rapid spread of mosquito-transmitted viral diseases and facilitate more effective management, a better understanding of the ecological conditions under which mosquito populations thrive is needed. Nowhere is an understanding of zoonotic and livestock diseases more important than at the human-livestock-wildlife interface. Despite the intimate connections between human pressures, ecological context and disease vector populations, very little is known about the effect of habitat destruction on the ecology of mosquito community composition and subsequent consequences on disease risk.

In this study we used Kruger National Park and the contrasting rural border area as a model system to study vector borne diseases and how these are related to human-wildlife conflicts. In this study, mosquitoes were sampled at 4 different locations: Shingwedzi, Phalaborwa, Skukuza and Malelane and we sampled water quality parameters and predators of mosquito larvae inside and outside the park. Our results reveal major differences between these sites in terms of abiotics, predator diversity and abundance and diversity of mosquito communities. Results of this study yield the first lines of evidence that environmental changes can trigger changes in mosquito community composition, which are likely to feed through to disease dynamics. The results of this study are currently used to set up a much larger field sampling on many more locations on the border of Kruger.

Patterns in spatial heterogeneity in tree cover are consistent across diverse savannas in Kruger

Staver, A.C.[1], Rodriguez-Iturbe, I.[2], Knapp, D.[3], Smit, I.[4], Levin, S.[5] & Asner, G.[3]

[1]*Department of Ecology and Evolutionary Biology, Yale University, New Haven, CT, USA*
[2]*Civil and Environmental Engineering, Texas A&M University*
[3]*Department of Global Ecology, Carnegie Institute for Science, Palo Alto, CA, USA*
[4]*Scientific Services, South African National Parks, Skukuza, South Africa*
[5]*Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA*

carla.staver@yale.edu

Savannas are heterogeneous systems, and predicting heterogeneity in vegetation structure, especially in the tree layer, remains a major challenge. Our understanding of vegetation structure, to date, has focused on scales at which we can collect field data – *i.e.*, the plot scale – but work on scaling these relationships up to landscapes suggests that savannas may be more predictable than we think at scales larger than our typical scales of observation. Here, we present results from an analysis of LIDAR-derived tree cover across Kruger National Park, which is both high resolution (< 1 m^2) and spatially extensive over large landscapes (10 landscapes of 7000 ha each).

We included landscapes ranging from the high rainfall around Pretoriouskop to the drier northern plains, on both granitic (sandy) soils and basaltic (clayey) ones. Surprisingly, although tree cover varies substantially, the spatial structure in the heterogeneity of tree cover was constant across landscapes. That is to say, the probability distribution of tree clump size is constant, regardless of underlying environment. These results have radical implications for understanding how savannas are heterogeneous, and suggest that we have focused to date on predicting savanna vegetation structure at the wrong spatial scale. We also discuss implications for Kruger's management plan, which includes as a core principle the management of heterogeneity.

Widespread degradation and boosted deforestation offset by extensive regrowth in African woodlands: a high-resolution sub-continental analysis based on radar and field data

Ryan, C.M. & McNicol, I.M.

School of GeoSciences, University of Edinburgh, UK

casey.ryan@ed.ac.uk

Deforestation and forest degradation alter the resources available to rural communities, and can contribute to climate change. Currently, the rates and locations of degradation are unknown and deforestation and subsequent regrowth rates uncertain. In the miombo and mopane woodlands that dominate southern Africa, the (presumed) drivers of degradation are abundant, but no regional assessment of degradation rates and associated carbon emissions exists. We address this with the first sub-continental assessment of the rates and locations of degradation, deforestation and (re)growth. Carbon stocks for the years 2007-10 are estimated at 25 m resolution using radar and field data, and used to estimate the area affected by each land cover change and associated carbon stock changes.

Degradation affected 13% of the study region over three years, 3.5x the area deforested. Deforestation rates (3.7%/yr) are double previous estimates, partly due to a more realistic definition of "forest loss" suited to the practices of small-scale agriculturalists. Most of the woodland increased in biomass, particularly in low biomass areas, leading to no region-wide net change in woody carbon stocks over the study period. Carbon losses from degradation exceed deforestation substantially (0.24 *vs* 0.08 PgC), which is not reflected in current climate mitigation policy or practice. The location of degradation hotspots suggests that trans-boundary flows of timber and woodfuel are important causes. The widespread increase in biomass probably reflects the response of the woodlands to past disturbance and illustrates their resilience; it may also indicate that elevated atmospheric CO_2 is increasing tree growth rates.

Woody cover and biomass change (2007-2015) in the South African Lowveld with radar and LiDAR imagery

Mathieu R.[1, 2], Main, R.[1], Naidoo, L.[1], Wessels, K.[3, 2], Cho, M.[1], Asner, G[4] & Smit, I.[5]

[1]*Ecosystem Earth Observation, Natural Resource and the Environment, CSIR, Pretoria, South Africa*
[2]*Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, SA*
[3]*Remote Sensing Research Unit, Meraka Institute, CSIR, Pretoria, SA*
[4]*Department of Global Ecology, Stanford University, Stanford, CA, USA*
[5]*Scientific Services, SANParks, Skukuza, SA*

rmathieu@csir.co.za; rmain@csir.co.za; lnaidoo@csir.co.za; mcho@csir.co.za; kwessels@csir.co.za; gpa@carnegiescience.edu; izak.smit@sanparks.org

Savannahs and woodlands account for 35-45% of the land in southern Africa. Excessive harvesting of woody plants and land use changes can threaten the sustainability of the provision of raw materials to poor rural communities. In addition, bush encroachment is increasingly seen as a major regional threat for food security and biodiversity. In South Africa tree cover is believed to have increased at a rate of 5-6% per decade and to encroach in grasslands; bush encroachment affects 10-20 million ha. Despite these drastic changes there are yet limited information on spatial patterns and change of woody vegetation in the country. We mapped woody cover and above ground biomass over the northern section of the South African Lowveld (6.5M ha) with Synthetic Aperture Radar and LiDAR airborne data.

Field plots were used to calibrate and validate extensive LiDAR-based maps of structural metrics, which were then used to upscale the metrics at satellite level (individually processed scenes of ALOS PALSAR 1 & 2) using random forest for the year 2007, 2010, and 2015. The maps were produced at 1ha pixel size and are a significant improvement on global products which are the only available datasets in the region. Changes in savannahs and woodlands will be reported and analysed considering the land use (conservation versus commercial) and environmental conditions. We will discuss the uncertainty associated with the detected changes (real changes vs likely error) linked to error accumulation from field to satellite levels.

A multi-sensor and multi-temporal approach to vegetation structure mapping – Results from the Ars AfricaE experiment at the Skukuza flux tower

Schmullius, C.[1], Berger, C.[1], Onyango, V.O.[1], Lueck, W.[2] & Baade, J.[1]

[1]*Friedrich-Schiller-University Jena, Institute of Geography, Loebdergraben 32, 07743 Jena, Germany*
[2]*Forest Sense cc, Cape Town, Republic of South Africa*

c.schmullius@uni-jena.de; Christian.berger@uni-jena.de; victor.onyango@uni-jena.de; wolfluck@mweb.co.za; jussi.baade@uni-jena.de

Ars AfricaE aims to deepen the knowledge on the functional role of structural elements in ecosystems such as species content or biomass. One of the objectives is to combine a multi-agent-based simulation model with information about spatio-temporal land surface dynamics derived from remote sensing, historical aerial photography, UAV acquisitions and Terrestrial Laser Scanner in-situ data. The overall goal is to support distinction between 'disturbances' (variation with subsequent recovery) and 'degradation' (sustained loss of function) with operational monitoring systems. The final procedures contribute to the Ars AfricaE management concept which is being developed in close cooperation with SANParks Scientific Services under the Research Agreement SCHCC 1235 “Spatio-temporal Earth Observation contribution to the BMBF/SPACES-project “Adaptive Resilience of Southern AFRICAn Ecosystems”.

For the Skukuza flux tower, a space-time cube has been generated with a lateral dimension of 5 x 5 sqkm and a temporal dimension reaching back to the first available remotely sensed scenes (i.e. aerial photographs from the 1920ies, Corona spy satellite images from the 1970ies). Up- and downscaling techniques for the different spatial and spectral resolutions of data and products over time have been tested, adapted and/or developed to innovatively exploit the physical interactions behind reflectance and backscatter characteristics from the observed land surfaces. This presentation describes the flexible and semi-automated ARS AfricaE data-cube concept for deriving woody vegetation cover and its change over time. The data-cube can now be used with input data of different spatial, temporal and spectral resolutions for classification and regression purposes. The test case is the quantification of woody vegetation cover at the Skukuza flux tower site using TLS data as a reference.

POSTER

First high resolution leaf-on/leaf-off vegetation comparison at the Skukuza flux tower using TLS

Schmullius, C., Baade, J., Berger, C. & Onyango, V.O.

Department of Geography, Friedrich-Schiller-University Jena, 07737 Jena, Germany

jussi.baade@uni-jena.de; c.schmullius@uni-jena.de

High resolution Terrestrial Laser Scanner (TLS) surveys were conducted around the Skukuza FluxTower in Sept. 2015 and March 2016 representing leaf-off and leaf-on conditions. Based on 25 scan positions a core area of about 0.5 km² was covered from multiple angles providing an almost complete 3D representation of the terrain and canopy in a 132 GB data set. In this poster we present first results from the comparison of these two acquisitions and show to which extent the differences in above ground biomass are represented in the TLS acquisitions.

Vegetation structure and dynamics play a fundamental role in any ecosystem. The joint German-South African BMBF/SPACES ARS AfricaE project aims to deepen our knowledge on the functional role of structural elements in ecosystems such as species content or biomass. The project is supported by the SANParks Research Agreement SCHCC 1235 “Spatio-temporal Earth Observation contribution to ARS AfricaE”. The basic research rationale is the investigation of “Adaptive Resilience of Savanna Ecosystems” and a central task is to quantify the vegetation structure and longer term dynamics in the footprint of the Skukuza Eddy-Covariance flux tower.

POSTER

Insights into savanna woody vegetation structure and dynamics from long-range terrestrial LiDAR

Singh, J.[1], Levick, S.R.[1], Guderle, M.[1], Schmullius C.[2] & Trumbore, S.[1]

[1]*Department of Biogeochemical Processes, Max Planck Institute for Biogeochemistry, Hans-Knöll-Str 10, 07745 Jena, Germany*
[2]*Department of Geography, Chair of Earth Observation, Friedrich-Schiller- University Jena, Loebdergraben 32, 07743 Jena, Germany*

jsingh@bgc-jena.mpg.de; slevick@bgc-jena.mpg.de; mguderle@bgc-jena.mpg.de; c.schmullius@uni-jena.de; trumbore@bgc-jena.mpg.de

Savannas are a globally extensive biome prone to vegetation structural instability in response to erratic rainfall, changing megafaunal populations, altered fire regimes and land use patterns. Rapid and accurate assessments of savanna vegetation structural metrics are critical elements for improving forecasts of the trajectories of these unstable systems under global change. Canopy height and stem volume are key vegetation structural metrics that explicitly capture the carbon dynamics of the system. However, vegetation structure and carbon stock estimations in savannas still depend on the acquisition of allometric data at local/regional scale, which are often unavailable or imprecisely estimated in most regions. In this study, we present an approach that facilitates rapid and robust assessment of the savanna vegetation structure with Terrestrial Laser Scanning (TLS).

A growing number of studies in savannas have utilized airborne LiDAR for measuring vegetation structure but, airborne instruments often fail to observe significant aspects of the lower canopy and stem architecture. We investigate the potential of long range scans (>2000 m),acquired from topographic vantage points, with sub centimeter resolution from TLS to derive woody tree structure and canopy characteristics across four different landscapes with contrasting vegetation heterogeneity in Kruger National Park, South Africa. Vegetation attributes derived from long range scans are assessed and compared against co-registered 1 ha plot scans within the footprint of the long range scans. A change matrix with respect to distance from the scanner is produced which highlights the differences in the geometric configuration of canopy and woody elements. Our study highlights the huge potential of this approach for vegetation monitoring with national parks and we discuss scaling implications long-range scanning for training and validating spaceborne RADAR imagery for larger area monitoring.

The complicated relationship between savanna tree cover and rainfall intensity across Africa

Case, M.F.[1] & Staver, A. C.[1]

[1]*Yale University, Department of Ecology and Evolutionary Biology*

madelon.case@yale.edu; carla.staver@yale.edu

The influence of rainfall on plant communities depends not only on mean annual rainfall, but also on how that rainfall arrives. Altering the frequency and intensity of rainfall can fundamentally shift the composition and productivity of plant communities by changing the temporal dynamics of soil moisture. Previous experimental work by researchers in Kruger National Park found that delivering rainfall in larger pulses enhanced tree growth and disadvantaged grass, as water moved deeper in the soil where trees could better access it via deeper roots. Such results suggest that shifts to less frequent, more intense rainfall, one predicted outcome of climate change, could accelerate woody encroachment in savannas.

However, this mechanism does not map clearly to larger-scale vegetation patterns, as continental-scale analyses have found tree cover in Africa is actually lower where rainfall is typically less frequent and more intense. But past analyses did not consider the possibility of interactions between rainfall and soil texture (which can influence the extent of infiltration), nor how rainfall climatology is related to differences in fire regimes. Here, we present results from a new analysis of tree cover, rainfall climatology, soil texture, and fire frequency across savannas in sub-Saharan Africa. We find that although less frequent, more intense wet-season rainfall is generally associated with lower tree cover for a given mean annual rainfall, soil texture and fire both mediate this relationship. Predicting savanna vegetation change will require considering not only direct effects of climate change, but also how soils and fire feedbacks interact with rainfall.

A new paradigm for plant water uptake and use in grasslands and savannas

Nippert, J. [1], Swemmer, A.[2] & Holdo, R.[3]

[1]*Division of Biology, Kansas State University, Manhattan, KS USA*
[2]*Ndlovu Node, SAEON, Phalaborwa, Limpopo, South Africa*
[3]*Department of Biology, University of Georgia, Athens, GA USA*

nippert@ksu.edu

Within most grassland and savanna ecosystems, water availability is a key regulator of ecosystem dynamics. Species persistence in these ecosystems require tradeoffs that balance competitive efficiency for resources, and an ability to tolerate (or avoid) frequent periods of low water availability. General patterns of water use differ among grasses and woody species as grasses often exhibit fixed water-use from surface soils regardless of availability while woody plants show dynamic water use from multiple depths as patterns of soil moisture change. Maximum rooting depth is often an ineffective predictor of competition for water because root type, distribution by depth, and functional conductivity vary. For this reason, more effective traits related to water uptake and use are required.

Here, we present a conceptual overview linking the physiological and morphological characteristics among C4 grasses and C3 woody plants using long-term data from the Konza Prairie LTER, Kruger Park, and experimental manipulations at Wits Rural Facility. Based on a dynamic template of water availability, grasses and woody plants exhibit distinct physiological traits when competition for water is high compared to coexistence when water is plentiful. Ultimately, these hydraulic traits and ecohydrological strategies among grasses and woody plants influence landscape patterns, ecosystem processes, and susceptibility to drought in many grasslands and savannas. These traits may prove useful for successful management of woody encroachment by utilizing management strategies that increase woody plant stress and maximize the likelihood of mortality during prescribed fires.

What do 60 years of fire trials tell us about changes to the woody layer of the Kruger National Park? Disentangling the effects of fire, elephants and CO_2

Swemmer, A.M.[1] & Wigley-Coetsee, C.[2]

[1]*SAEON (South African Environmental Observation Network), Phalaborwa, South Africa*

[2]*SANParks, Skukuza, Kruger National Park, South Africa*

tony@saeon.ac.za; Corli.Coetsee@sanparks.org

Increasing cover of small trees and shrubs, as well as losses of tall trees, remains a management concern for the Kruger National Park (KNP), as well as many other savannas around the world. Local-scale factors, such as fire and herbivory, have traditionally been considered as the primary determinants of tree cover, and results from the KNP Experimental Burn Plots support for this. More recently, elevated atmospheric CO_2 has been proposed to reduce the impacts of fire on woody plant growth, particularly in mesic savannas. Determining whether such effects are occurring, as well as any effects of any other global-scale drivers, is crucial for future management.

These factors are beyond the control of park management and may reduce the effectiveness of manipulating local-scale factors (fire regimes and herbivore distributions). In an attempt to disentangle the effects of rising CO_2, the woody layer of four treatments of the Experimental Burn Plots was resampled at all for sites of the experiment, in the summer of 2015-16. Elephant impacts were also recorded, for the first time in the history of vegetation sampling in the EBPs. These data are compared to historical data collected in the 1950s, 1970s and 1990s, to determine whether previously identified trends of increased cover are continuing (as would be expected in response to rising CO_2) or not. Changes in the abundance of dominant woody species will also be presented.

Fire, utilization by elephants and temperature drive demographics of the baobabs of the Kruger National Park

Taylor, R.W.[1], Thompson, D.I.[2, 3] & Witkowski, E.T.F.[1]

[1]*School of Animal, Plant & Environmental Sciences, University of the Witwatersrand, South Africa*
[2]*South African Environmental Observation Network (SAEON), Ndlovu Node, South Africa*
[3]*School of Geography, Archaeology & Environmental Studies, University of the Witwatersrand, South Africa*

dave@saeon.ac.za

The African baobab (*Adansonia digitata*) has specific moisture requirements for recruitment, slow life history, low dispersal capabilities, and endures destructive utilization by elephants and humans. These characteristics reduce its ability to respond to environmental change. However, during extended unfavourable periods populations survive through persistence of established individuals. Within the Kruger National Park (KNP), South Africa, perceived failing recruitment and high numbers of dead large individuals in the early 1990s suggested population decline. In 2013 we resampled 758 baobabs sampled previously in 1995/6 and/or 2001; the resultant data set spanning 18 years and the dominant vegetation and climatic zones of the species KNP range. Temporal and spatial changes in the demographics of, and damage to, these baobabs were used to define those factors threatening local persistence. Using 0.5m stem diameter size-classes, baobabs showed a healthy inverse J-shaped population distribution.

However, no seedlings were observed during active searches and growth was only noticeable in sub-adult trees. Annualised mortality increased three-fold between 1995/6-2001 (0.25%) and 2001-2013 (0.79%). We speculate that this reflects the cumulative effect of increased elephant damage and below average rainfall from 2002. Trees that had previously sustained severe/very severe damage contributed the highest proportion (32%) of mortality. Further, the majority of mortality (61%) occurred in the <1m stem size-class. However, a high proportion of large trees (21% of the 4-4.5m and 29% of the 5-5.5m stem diameter trees) died from unknown causes. With no seedling recruitment and little progression between size classes, mortality alone did not significantly change the baobab population structure between 1995/6, 2001 and 2013. Spatially, maximum fire return interval, and mean annual temperature had significant impacts on the size-class distribution of baobabs; healthy J-shaped population distributions were seen only in areas with long (>30 years) maximum fire return intervals and high (23°C) mean annual temperatures.

Disentangling the effect of management and environment on forest cover and structure of African savannas

Attorre, F.[1], Messina, M.[1], Testolin, R.[1], Cunliffe, R.[1], Ribeiro, N.[2], Smit, I.P.J.[3], Govender, N.[3] & Vitale, M.[1]

[1]*Sapienza University of Rome, Rome, Italy*
[2]*Universidade Eduardo Mondlane, Maputo, Mozambique*
[3]*South African National Parks, Kruger National Park, Skukuza, South Africa*

Fabio.attorre@uniroma1.it; maerio.messina@gmail.com; riccardo.testolin@gmail.com; robvivzim@yahoo.co.uk; joluci2000@yahoo.com; izak.smit@sanparks.org; navashni.govender@sanparks.org; marcello.vitale@uniroma1.it

In African savanna protected areas the woody vegetation cover, structure and composition are influenced by the complex and multi-scaled interplay of environmental factors such as water and nutrient availability, fire, herbivory and, where occurring, direct disturbance by people. In this paper we conducted a comprehensive and comparative analysis of the spatial variation of tree cover and density in three neighbouring Southern African National Parks (Kruger, Limpopo, and Gonarezhou), characterized by similar environmental but different management conditions.

A total of 3386 by 0.5 ha plots were sampled across the three parks using an innovative methodology defined as augmented visual interpretation, based on a free and open source software, Collect Earth, which allows access to very high spatial and temporal resolution imagery archives. Significant differences emerged among the three parks and between the two bioclimatic regions characterizing them (semiarid and dry sub humid). Kruger National Park and the dry sub humid zone were characterized by the lowest values of tree cover and density. Such differences were ascribed to management, within a general pattern defined by the environmental template (fire frequency, annual precipitation and soil characteristics) characterizing African savannas.

Small Mammal Communities Respond to Elephant-Induced Changes to Savanna Vegetation

Loggins, A.[1], McCleery, R.[2] & Monadjem, A.[3]

[1]*Interdisciplinary Ecology, School of Natural Resources and the Environment, University of Florida*
[2]*Wildlife Ecology and Conservation, University of Florida*
[3]*Department of Biological Sciences, University of Swaziland*

aloggins@ufl.edu; ramccleery@ufl.edu; aramonadjem@gmail.com

Elephants change the vegetative structure of savannas and at high densities they can substantially reduce woody cover. The absence of elephants alternatively leads to increases in woody cover. Throughout southern Africa, savannas are shifting in two directions, toward grass-dominated systems and dense shrub-encroached habitats. These vegetation changes likely impact biodiversity and wildlife communities, including small mammals. As small mammals are critical components of savannas, our objective was to understand how they respond to these vegetation changes and what conditions are optimal for biodiversity. Using Kruger Park (elephant presence) and Swaziland reserves (elephant absence) as study sites, we assessed how variation in vegetation structure influences small mammal community composition. Our study grids in Kruger were open with limited shrub and tree canopy cover (0-30% range), high grass biomass, and low small mammal species diversity.

Swaziland grids had higher levels of woody cover (10-90% range), lower grass biomass, and higher species diversity. We used multi-species occupancy modeling to examine how vegetation structure shapes small mammal communities across this cover gradient. We found species-specific responses to changing cover and grass biomass that likely scale to community-level shifts. One common species in Kruger responded positively to grass biomass but negatively to shrub cover, matching Kruger's vegetation. However, most species' occupancies increased with both grass biomass and woody cover, suggesting more diverse habitat requirements. Some species declined in occupancy at high levels of woody cover, indicating that mid-range cover levels may maximize diversity. We are now testing whether predation risk influences small mammal habitat use.

Conflicting effects of landscape heterogeneity on biodiversity in agricultural mosaics: a multi-scale and multi-taxon approach

McCleery, R.[1], Reynolds, C.[2], Fletcher, R.[1] & Monadjem, A.[3]

[1]*Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611-0430, USA*
[2]*Percy FitzPatrick Institute of African Ornithology (PFIAO), DST/NRF Centre of Excellence, University of Cape Town, Rondebosch, Cape Town 7701, South Africa*
[3]*Department of Biological Sciences, University of Swaziland, Kwaluseni M201, Swaziland*

A key challenge for the developing world is reconciling biodiversity conservation with the growing demand for food. A primary hypothesis for promoting biodiversity in agricultural landscapes is the habitat heterogeneity hypothesis. Two major components of landscape heterogeneity are compositional and configurational heterogeneity. Disentangling the roles of each component is important for biodiversity conservation because each represents different mechanisms underpinning variation biodiversity. We identified *a priori* independent gradients of compositional and configurational landscape heterogeneity within an extensive agricultural mosaic in north-eastern Swaziland.

We then tested how bird, dung beetle, ant and meso-carnivore diversity responded to compositional and configurational heterogeneity across six different spatial scales. Compositional, not configurational, heterogeneity explained diversity in each taxonomic group, with the exception of meso-carnivores. Bird and ant diversity was positively correlated with compositional heterogeneity at fine spatial scales < 1000 m, whilst dung beetle diversity was negatively correlated to compositional heterogeneity at broader spatial scales > 1500 m. A diversity of strategies are likely key to conserving biodiversity in agricultural mosaics, and we have demonstrated that a landscape management strategy that only manages for heterogeneity at one particular scale will likely fall short of management objectives.

Conserving Africa's Mega-Diversity in the Anthropocene: the Hluhluwe-iMfolozi Park Story

Cromsigt, J., Archibald, S. & Owen-Smith, N.

Centering on South Africa's Hluhluwe-iMfolozi Park, this talk synthesizes a century of insights from the ecology and conservation management of one of Africa's oldest protected wildlife areas. At a mere 950 km^2, the Park is relatively small in comparison with well-known protected areas elsewhere in Africa. Moreover, its boundaries are completely fenced. Despite these constraints HiP may be viewed as a successful example of how Africa's mega diversity can be conserved within a remnant of formerly vaster ecosystems. Its story is therefore of great interest to the many other parks increasingly facing similar issues.

HiP covers a wide range of environmental conditions: rainfall ranging from 600mm to almost 1000mm over only 35km, vegetation representative of four biomes, and a diversity of substrates and soils. Moreover, HiP is the only park in Africa with a full representation of mega herbivores species at ecologically meaningful densities, together with a diversity of other ungulates and smaller organisms. This, combined with the presence of all five large mammalian carnivores, provides an exceptional natural laboratory for research on savanna ecosystem functioning, and the role of top-down and bottom-up determinants of ecosystems. We will discuss how science has guided 'process-based management' interventions such as re-introduction of elephants and large carnivores, ungulate population management, applications of fire, disease control programs and eradication of invasive plants. Besides this we will dive a bit more deeply into the following topics.

The Enhanced Freshwater and Terrestrial Observation Network

Scholes, R. J.[1]

[1]*Global Change and Sustainability Research Institute, University of the Witwatersrand, South Africa*

bob.scholes@wits.ac.za

The Minister of Science and Technology announced in October 2016 the funding of ecological research infrastructure worth tens of millions of Rands, starting in 2017 and continuing for over a decade. This will help South Africa to remain competitive in a range of research fields, as well as generating capacity and understanding for addressing important local, national and global issues. The paper outlines the design considerations and innovations in the EFTEON system, to be implemented in about six landscape-scale regions nationwide.

A key feature is the high level of integration between terrestrial ecosystem science, freshwater ecology and hydrology, biodiversity studies and social-ecological systems. While cutting edge instrumentation, unaffordable to most individual projects, is an important part of the infrastructure, an equally important element is seamless access to open-source access to high-resolution databases of climate, land cover and other ecosystem attributes, both for the present and the past several decades. EFTEON will become a multi-institutional ecological research platform, hosted by the South African Environmental Observation Network, serving the next generation of researchers.

Long Term Monitoring in the Kruger National Park

Botha, J.M.

Scientific Services, South African National Parks

judith.botha@sanparks.org

Protected areas are under increasing pressure from a range of external and internal threats. As SANParks has a primary mandate to conserve biodiversity, monitoring is an important component of gauging conservation effectiveness. In 2011 a Framework for Biodiversity Monitoring (McGeoch *et al.* 2011) was developed which included the articulation of SANParks' Biodiversity Monitoring System (BMS). The BMS categorises monitoring into one of 9 biodiversity monitoring programmes and assists in prioritizing monitoring resources within and across parks.

Monitoring efforts support the two key monitoring steps of the adaptive management cycle, namely (i) baseline/inventory monitoring to inform current understanding and thereby design and implement management actions, and (ii) monitoring implemented management actions to evaluate effectiveness and outcomes of those actions, and make adjustments to the management actions if needed. The KNP has a long history of monitoring with some of the programs that started in the 1940's. This talk will look at what was historically conducted and how this has adapted over time to help us address the current threats facing protected areas.

POSTER

Analysis of temporal changes in climate and grass biomass in and around Kruger National Park

Ramoelo, A.[1], Imperio, S.[2], Cho, M.[1], Provenzale, A.[2] & Smit, I.[3]

[1]*Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa*
[2]*Institute of Geosciences and Earth Resources, CNR, Pisa, Italy*
[3]*Kruger National Park Scientific Services, Skukuza, South Africa*

aramoelo@csir.co.za; abel.ramoelo@gmail.com

In the framework of the European H2020 Project "ECOPOTENTIAL: Improving future ecosystem benefits through Earth Observations", there was a launch for the analysis of the changes in climatic drivers and ecosystem conditions taking place in an ensemble of Protected Areas participating in the project. Kruger National Park (KNP) is one of such selected areas; here we study the temporal changes in climate (temperature and precipitation) and grass biomass in the last 16 years using MODIS datasets.

We will develop an empirical, data-based model relating monthly changes in grass biomass to climatic variability during growth to peak productivity period, with specific attention to the effects of drought. The grass biomass models are based on the leaf area index (LAI) generated using physically-based models. Future extensions of this study will take into account the role of herbivores and fire over space and time.

Savannas of Asia: history, biogeography and management concerns

Ratnam, J. [1], Tomlinson, K. [2], Rasquinha, D. [1]& Sankaran, M. [1, 3]

[1]*National Centre for Biological Sciences, GKVK Campus, Bellary Road, Bangalore, India, 560065*
[2]*Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun 666303, Yunnan, China*
[3]*Faculty of Biological Sciences, University of Leeds, Leeds LS2 9JT, UK*

jratnam@ncbs.res.in; kyle.tomlinson@xtbg.org.cn; mahesh@ncbs.res.in

The savannas of Asia have long been overlooked by the vegetation scholars of this region. In this talk, I will describe the historical reasons for this bias, and how it has resulted in both a misclassification of Asian savanna systems and a misunderstanding of their functional ecology. I will use a bioclimatic approach to outline where the savannas of Asia potentially exist, and then focus on the Indian region to describe what we know and understand of the vegetation types that exist within this climatic envelope.

Drawing on what we know from savannas elsewhere in the world, I will consider how the functional traits of these different Indian savanna communities are indicative of strategies shaped by their distinctive environments. I will conclude with a consideration of the key conservation and management challenges for these ecosystems in India.

Interesting discoveries in some of the Arid Parks

Zambatis, G.[1]

[1]*Scientific Services, SANParks, KNP, Skukuza, 1350*

Guin.Zambatis@sanparks.org

Hmmm, why should I send my publications to SANParks?? Every researcher working in SANParks is requested to send metadata, duplicate collections and publications relevant to their project to Skukuza on completion of a project. Although this is perceived to be a tedious exercise for the researcher, it is of huge benefit to SANParks.

One of the exciting benefits will be shared with you in this presentation. Most researchers spend a great deal of time in the field and as a result they occasionally discover exciting finds. Sit back, relax, and spend a few minutes with me as we travel to various parks to share researchers "Eureka" moments.

DNA from Dung: Non-Invasive Genetic Monitoring of Isolated Black Rhino Populations

Le Roex, N.[1], Paxton, M.[2], Adendorff, J.[2], Hofmeyr, M.[3], Zimmerman, D.[4], Gaylard, A.[5] & O'Riain, M.J.[1]

[1]*Department of Biological Sciences, University of Cape Town, Cape Town, South Africa*
[2]*Conservation Management, South African National Parks, Addo Elephant National Park, South Africa*
[3]*Veterinary Wildlife Services, South African National Parks, Skukuza, South Africa*
[4]*Veterinary Wildlife Services, South African National Parks, Port Elizabeth, South Africa*
[5]*Scientific Services, South African National Parks, Knysna, South Africa*

nikki.leroex@uct.ac.za; michael.paxton@sanparks.org; john.adendorff@sanparks.org; markus.hofmeyr@sanparks.org; david.zimmerman@sanparks.org; angela.gaylard@sanparks.org; justin.oriain@uct.a.za

The black rhinoceros (*Diceros bicornis*) has suffered enormous population size and range declines during the 20th century, with numbers decreasing to just a few thousand animals. With the dramatic increase in poaching, understanding the breeding dynamics and genetic viability of the remaining black rhino populations has become crucial for effective rhino management in South Africa. Traditional monitoring techniques can be difficult when assessing elusive species, and cannot provide fine-scale population information. Thus we developed a non-invasive monitoring protocol using faecal DNA sampling to estimate population size, breeding success and genetic viability.

Fresh faecal samples were collected and storage, transport and DNA extraction protocols were optimised. Fluorescent genotyping was used to identify the number of individual animals and sex ratios within the population. Genetic diversity, inbreeding statistics and parentage/breeding success were also determined in order to inform future metapopulation management. This information will be vital for maximising the breeding potential and long-term viability of black rhino populations in SANParks reserves, in accordance with national conservation objectives.

Age and sex identification from digital 3D models of lion tracks using geometric morphometrics

Marchal, A.[1, 2], Lejeune, P.[2] & de Bruyn, N.[1]

[1]*Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa*
[2]*Forest Resources Management, Department of Biosystems Engineering, Gembloux Agro-Bio Tech, University of Liege, Belgium*

marchal.ant@gmail.com; pjndebruyn@zoology.up.ac.za; p.lejeune@ulg.ac.be

The ecological monitoring of threatened species is vital for their survival as it provides the baseline for conservation, research and management strategies. In the absence of sightings, tracks are often used as a non-invasive approach to gain information on elusive species. Previous studies involving track measurements were limited to two-dimensional (2D) recording techniques (e.g. drawings and photographs), therefore missing information on depth. Furthermore, the feature extraction was limited to traditional morphometrics, which implies basic measurements such as distances, angles and areas. Such measurements provide limited information about the geometric structure, and fail to quantify subtle variations along curves and surfaces. The objective of this research is to identify the age and sex from digital three-dimensional (3D) models of lion *Panthera leo* tracks using landmark-based geometric morphometrics.

We sampled 141 hind left tracks belonging to 10 individuals (3 adult males, 5 adult females and 2 sub-adult males) by using digital close-range photogrammetry. The form (i.e. size and shape) variables were extracted by means of three landmark scenarios: 20 fixed landmarks, 20 fixed landmarks with 130 curve-sliders, and 20 fixed landmarks with 130 curve- and 130 surface-sliders. The landmark coordinates were superimposed through Generalized Procrustes Analysis (GPA). Form variables were then used in Linear Discriminant Analysis (LDA) with jack-knifed prediction to assess the accuracy of the identification of the age-sex category. The accuracy of prediction reached a maximum of 85.1% when using fixed landmarks with curve- and surface-sliders. Identifying the age and sex from tracks would have major implications in monitoring programs.

POSTER

Automated camera-trap photogrammetry of Impala in Kruger National Park

Postma, M.[1], Hofmeyr, M.S.[2] & de Bruyn, P.J.N.[1]

[1]*Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa*
[2]*Veterinary Wildlife Services, South African National Parks, Kruger National Park, Skukuza, 1350, South Africa*

mpostma@zoology.up.ac.za, pjndebruyn@zoology.up.ac.za

Wildlife researchers increasingly require indirect monitoring methods to assess physical characteristics of wild mammals and their populations. Body size is one such important physical parameter, which influences a range of individual life history characteristics. Given the various difficulties (including ethical considerations) in assessing body size and related characteristics (e.g. mass) of large mammals through direct measuring means, researchers have turned towards the use of photogrammetric methods to remotely assess such measures. We use an integrated multidisciplinary methodology approach (camera-trap technology, volume, and stereo photogrammetry techniques) to measure body metrics (volume, mass, horn length, shoulder height and back length) of Impala (*Aepyceros melampus*).

Repeated individual sampling (multiple measurements of the same individual in different postures) showed negligible variation. The multidisciplinary methodological approach accurately estimated the horn length, shoulder height, and back length regardless of animal orientation and posture. However, animal orientation and posture may influence volume and mass estimation, depending on the severity of animal contortion. The methods represent an innovation in the use of camera trapping and photographs to create calibrated three-dimensional imagery for accurate quantification of mammalian metrics.

POSTER

Using drones for animal counting and trophy assessments in small national parks and game reserves

Traeholt, C.[1], Dahlen, B.[2] & Arinal, I.[3]

[1]*Copenhagen Zoo, Research and Conservation Division, Southeast Asia Programme*
[2]*Green Harvest Sdn Bhd*
[3]*Copenhagen Zoo Indonesia Programme, Baluran National Park, Jl. Raya Situbondo KM 35 Situbondo, East Java, Indonesia*

ctraeholt@gmail.com

Whereas drone technology has been used in warfare for decades, private drones have become an increasingly mainstream technology for filmmakers, action sports and personal selfies. Some units have become sufficiently advanced to be used in wildlife management for a range of essential tasks. This study demonstrates how a DJI Phantom 4 drone can be used to estimate wildlife populations in open woodland and savannas, assess potential hunting trophies and make high resolution georeferenced aerial maps and 3D models, using open source GIS- and Photogrammatic software.

Because it is portable in a small backpack, it should become a permanent fixture in every wildlife managers and patrol teams' toolkit, along with GPS and binoculars. With costs below US$ 2500 per unit including extra batteries, filters and software, it can replace the expensive use of helicopters in many circumstances, and provide important savings in parks and reserves on tight budgets.

POSTER

A collaborative platform for conducting large-scale modelling and simulation studies in the Kruger National Park

Clemen, T.[1], Bradshaw, K.[2] & Lenfers, U.[1]

[1]*Dept. of Computer Science, Hamburg University of Applied Sciences, Germany*
[2]*Dept. of Computer Science, Rhodes University, South Africa*

thomas.thiel-clemen@haw-hamburg.de; k.bradshaw@ru.ac.za; ulfia.lenfers@haw-hamburg.de

Currently, almost every modelling- or simulation-based research project starts from scratch. Thus, arduous tasks like setting up the infrastructure, including necessary environmental data such as GIS data, are often repeated. An additional problem is obtaining the necessary hardware to support the rapid realization of simulation results; especially where these are used in decision support. MARS KNP (http://www.mars-group.org/) is a cloud-based modelling framework, hosted by the Hamburg University of Applied Sciences, Germany, that supports the entire process of model design and implementation through a web interface. No software is uploaded to the local computer and access is possible from almost anywhere. Furthermore, by centralizing model execution, performance optimization using e.g. graphical processing units, may be possible.

Using MARS KNP, geographically distributed teams can work on the same model sharing the same environmental base e.g. digital elevation model or vegetation coverage. Moreover, a new species can be incorporated into an existing KNP model merely by specifying its interaction with other – existing – species and the environment. MARS KNP is thus, well suited to providing a standard modelling and simulation environment for simulation studies within the Kruger National Park, as once the basic environmental layers have been configured, multiple fauna/flora studies can be supported with minimal extra modelling effort. This joint German-South African research initiative (forming part of the ARS AfricaE project, http://www.ars-africae.org/) is supported by regular workshops on socio-ecological modelling, thereby contributing to the growth of a network of modellers and model users in South Africa and abroad utilizing large-scale multi-agent simulation.

Atmospheric concentrations and dry and wet deposition estimates of nitrogen and sulphur in Kruger National Park

Pienaar, J.J.[1]; Conradie, E.H.[1]; Beukes, J.P.[1]; Van Zyl, P.G.[1]; Swartz J.S.[1], Mkhatshwa, G.[2] & Ramandh, A.[3]

[1]*Atmospheric Chemistry Research Group, School of Physical and Chemical Sciences, North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, South Africa*
[2]*Eskom Holdings, Resources and Strategy Division, Rosherville, Johannesburg, South Africa*
[3]*Sasol Technology Research and Development, Sasolburg, South Africa*

Kobus.Pienaar@nwu.ac.za; Elne.Conradie@nwu.ac.za

The concentrations of selected atmospheric species (sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ammonia (NH_3) and ozone (O_3)) and the chemical composition of rain water has been monitored since 2000 in KNP. The importance of atmospheric deposition as a source of nutrients, i.e. nitrogen, sulphur, carbon and base metals, is widely recognised, while it could also be a source of toxic species. The risk of S deposition to the environment is, apart from the acidification of ecosystems, that S can stimulate microbes to methylate mercury (Hg), a process that introduces Hg into the food chain. The long term data set of SO_2 in KNP indicate rather low values of around 0.5 ppb for 2000 – 2004 where after a steady increase to 1.5 ppb in 2008 and 2009 was observed.

These concentrations results in S deposition estimates of 3 to 7 kg S/ha/yr. Atmospheric N deposition is of particular importance to ecosystems as it, in addition to acidification, may result in alterations of nutrient balances causing a cascade of effects. The effects can range from fertilization that stimulates plant growth and carbon storage to nutrient imbalances that reduce productivity and even diminish biodiversity. The total dry N deposition (only from NO_2) varies between 1 to 4 kg N/ha/yr while the five year wet deposition average for 2009 -2014 was 1,1 kg N/ha/yr. It has been reported that a decline of the biodiversity of grasslands begins to occur at atmospheric N loading of about 5 kg N/ha/yr in Minnesota and Europe.

NATIONAL PARK SCIENCE: A CENTURY OF RESEARCH IN SOUTH AFRICA

Carruthers, J.[1]

[1]*History Department, University of South Africa*

j.carruthers@mweb.co.za

In 2012 and 2013 I presented preliminary ideas for a book that was in its initial stages. As a consequence of the SSNM presentations many scientists generously gave their time and knowledge. The book, supported by the Mellon Foundation, is now complete and it will be published by Cambridge University Press during 2017 in the series Ecology, Biodiversity and Conservation with the provisional title *National Park Science: A Century of Research in South Africa*. The aim of my presentation is briefly to explain the organisation and contents of what has become a substantial work, comprising about 180 000 words, arranged into 14 chapters, well referenced within the text and that includes a wide-ranging bibliography and some 50 illustrations.

The leitmotif of the book is the following quotation from *Thomas Mellon and his Times*, 338, as quoted in David Cannadine, *Mellon: An American Life* (London: Allen Lane/Penguin, 2006), 583.

> 'In the short voyage of a lifetime, we can see the eddies and ripples upon the surface, but not the under-currents changing the main channel of the stream. History alone can determine the deep seated causes which have been at work to bring them about.'

Although the title of the book highlights the science conducted within SANParks, the material is dealt with in the overall intellectual context of the growth of conservation biology in South Africa generally (not only in national parks) and also in the international frame. The presentation will focus on discussion of the conclusions, reflecting on some of the key questions that have guided my research:

- To what extent were changes in scientific research driven by external or internal circumstances, including the political environment?
- Who have been the 'scientists' in SANParks over the course of its history, what was their range of expertise and their scientific contribution?
- What partnerships and collaborations have been generated over the years?
- How have the scientific outputs of national park research been communicated? and
- To what extent has SANParks been influenced by scientific developments in the broader national and international community?

Ecological implications of distorted African herbivore communities

Hempson, G. P.[1, 2], Archibald, S.[2] & Bond, W. J.[3]

[1]*South African Environmental Observation Network (SAEON), Ndlovu Node, Private Bag x1021, Phalaborwa, Kruger National Park, South Africa*
[2]*School of Animal, Plant & Environmental Sciences, University of the Witwatersrand, Wits, 2050, Johannesburg, South Africa*
[3]*South African Environmental Observation Network (SAEON), care of the Department of Biological Sciences, University of Cape Town, Private Bag X1, Rondebosch, 7701, South Africa*

ghempson@gmail.com; sally.archibald@wits.ac.za; william.bond@uct.ac.za

Native large mammal herbivore populations have been severely depleted across the globe, with profound consequences for ecological dynamics. Rewilding initiatives and inadvertent pathways like livestock farming have re-established large mammal herbivores in many regions, however, distortion of the historical biomass and functional type composition of herbivore communities may have radically altered ecosystem processes. We explore how African herbivore communities have been transformed over the last ~1000 years, by contrasting livestock-dominated current day herbivore communities with reconstructed historical herbivore communities. This reveals pronounced biomass losses in wetter areas and marked functional type turnover in arid regions. The ecological consequences of these shifts in the form and intensity of herbivory include alterations to biogeochemical cycling, fire prevalence and woody plant dynamics across the continent.

Methane emissions and nutrient diffusion capacity are likely lower than historical levels, most notably in mesic systems. Increased grazer biomass appears to have reduced fire prevalence over much of the continent, which coupled with the net effect of shifts in herbivore community composition, is likely to have released demographic bottlenecks for woody vegetation. Shifts in herbivore community composition will also hold consequences for population-level survival rates through drought events, and subsequent impacts on vegetation. Quantifying the changes that have occurred in African herbivore communities provides significant context for understanding a range of important ecosystem processes. Furthermore, it emphasizes the necessity of incorporating feedbacks from large mammal herbivores into projections of the ecological trajectory of African ecosystems.

Changes in dominance drive global variation in herbivore effects on savanna grassland diversity

Thompson, D.I.[7,8], Koerner, S.E.[1], Smith, M.D.[2], Burkepile, D.E.[3], Avolio, M.L.[4], Collins, S.L.[5], Knapp, A.K.[2], Lemoine, N.P.[2], Forrestel, E.J.[6] & The Grazing Exclosure Consortium

[1]*Nicholas School of the Environment, Duke University, Durham, NC, USA*
[2]*Department of Biology and Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO, USA*
[3]*Department of Ecology, Evolution, and Marine Biology, University of California, Santa Barbara, CA, USA*
[4]*National Socio-Environmental Synthesis Center (SESYNC), Annapolis, MD, USA*
[5]*Department of Biology, University of New Mexico, Albuquerque, NM, USA*
[6]*Arnold Arboretum, Harvard University, Cambridge, MA, USA*
[7]*South African Environmental Observation Network (NRF/SAEON), Ndlovu Node, Private Bag X1021, Phalaborwa 1390, SA*
[8]*School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, SA*

dave@saeon.ac.za

Herbivores play an essential role in regulating biodiversity in many of the world's most extensively managed and natural ecosystems. Yet both the magnitude and the direction of herbivore effects on plant diversity can vary. Prevailing theory predicts that herbivores should enhance diversity at high productivity while reducing diversity under low productivity. However, empirical support for the role of site productivity is equivocal. Here we test a new mechanism – that herbivore-induced changes in plant species dominance regulate plant diversity - by synthesizing data from herbivore exclusion studies at 252 grassland sites across the globe.

Our analysis demonstrates that the effect of herbivore-induced changes in dominance is twice as important as site productivity in explaining herbivore effects on diversity. Indeed, across a 20-fold range in site productivity encompassed by this global dataset, changes in dominance strongly regulated changes in diversity. Given that dominance by one or a few species characterizes most ecosystems, managing abundance of these common species through herbivory represents a potential strategy to conserve biodiversity in grasslands globally.

Millennial-scale climate variability and herbivore interaction in the development of short grass patches in a wetland key resource area at Hluhluwe Umfolozi Reserve, South Africa

Dabengwa, A.[1], Bond, W.[1] & Gillson, L.[1]

[1]*Biological Sciences, University of Cape Town, Private Bag X3, Rondebosch, 7700, South Africa*

abrahamdabengwa@gmail.com; Lindsey.Gillson@uct.ac.za

Climatic and seasonal pulses in rainfall regulate the availability of grazing in key resource areas (KRAs) that are important for maintaining herbivore and human populations. KRAs have been extensively studied in contemporary ecological and sociological studies because of their ecological resilience and role in providing forage for herbivores and fertile land for floodplain agriculture. However, very few studies have investigated the resilience of these systems at millennial timescales. A local-scale palaeoecological investigation was conducted on a sediment sample from a floodplain grassland in Hluhluwe Umfolozi Reserve, KwaZulu-Natal covering the period ca. 2050-950 cal BP to investigate the interactions among herbaceous biomass, vegetation signal, herbivore activity, fire activity and soil disturbance, using soil organic carbon, stable isotopes, dung spores, charcoal and x-ray fluorescence spectroscopy respectively.

The site was considered ideal because it was proclaimed a game reserve in the late 19th century but also has a history of human settlement by Iron Age communities from AD 400-1840. Wetter climatic conditions occurred in the region from ca. 2050-1900 cal BP and at ca. 1700-1600 cal BP; drier conditions happened from ca. 1900-1700 cal BP, and at ca. 1400-1200 cal BP. There was an inverse relationship between charcoal abundance and dung spore abundance suggesting that increased local presence of herbivores suppressed local fire activity by reducing local herbaceous biomass and/ or delaying its recovery. Synchronous changes in dung spores and charcoal from ca. 1710-1740 cal BP that were followed by decreases in soil organic carbon further suggest the development of a shortgrass system. Our results show that the climate, fire and herbivory interact in the formation and maintenance of productive short grass and/ or mixed floodplain grasslands whose management is critical in semiarid rangelands.

Grass features governing seasonal shifts between grassland types by white rhinos in the Hluhluwe-iMfolozi Park

Shrader A.M.[1] & Owen-Smith, N.[2]

[1]*School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, South Africa*
[2]*School of Animal, Plant & Environmental Sciences, University of the Witwatersrand, Private Bag 3, Wits, 2050 South Africa*

shrader@ukzn.ac.za; Norman.Owen-Smith@wits.ac.za

White rhinos concentrate their grazing within short grass areas or "grazing lawns" for much of the year. However, during the dry season they are forced to shift towards taller grasslands due to reduced food availability in the grazing lawns. This switch between grassland types entails a trade-off between the higher nutritional quality of short grasses and the greater intake rate obtained on taller grasses. We consider the factors governing this switch comparing two periods (1) 1966-70 while the rhino density was exceptionally high in the Hluhluwe-iMfolozi Park, and (ii) during 1999-2000 after the rhino density had been substantially reduced by rhino removals. Rainfall conditions were also more favourable during the latter period.

During the earlier period, white rhinos largely abandoned short grasslands in favour of taller Themeda-dominated grasslands during the peak dry season period from June through September, whereas in the later period they continued grazing in short grasslands throughout the dry season. The influential factors we considered included the height of the available foliage, the amount cropped (pre- versus post-grazing height) and contents of nitrogen, phosphorus and sodium in the material ingested. Our findings suggest that the rhinos tended towards selecting higher quality forage rather than simply maximizing their ingestion rate of a target nutrient. However, the longer digestive handling time associated with taller more fibrous grass could have been the overriding influence. Finally, we consider the implication for the relative use of different grassland types by these mega-grazers under different conditions of rainfall and population density.

Do grazing lawns attract browsers?

Voysey, M.D.[1, 2], Archibald, S.[2], Donaldson, J.[2] & Greve, M.[1]

[1]*Department of Plant and Soil Sciences, University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa*
[2]*The School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Private Bag 3, Braamfontein, 2050, South Africa*

mick.voysey@gmail.com; sally.archibald@wits.ac.za; michelle.Greve@up.ac.za

In African savannas, grazing lawns represent the most heavily grazed portion of the landscape. However, the effect of heavy grazing on woody plant density appears to be influenced by herbivore assemblage: heavy grazing by cattle, combined with the absence of browsers, tends to increase woody dominance in savanna rangelands, but grazing lawns in wildlife areas have lower densities of woody plants than adjacent tall grass communities. This may be driven by predator-avoidance behaviour driving increased use of short-grass by browsers, or could simply be that indigenous grazers only create grazing lawns in systems with few trees (again, for predator avoidance). To test these two alternatives, we compared browser density on short vs. tall-grass in a fire-induced short- and tall-grass mosaic in the Satara region of Kruger National Park.

Dung counts, a proxy for browser density, of six browser species were conducted in short and tall grass areas over a 12-month period using a belt transect approach. Thereafter, hurdle and linear mixed effects models were run to test the effect of grass height (tall vs. short) on browser density. In addition, a preference index was created to compare the preference for short grass between browser species, and the relationship between body size and preference index tested. Impala was the only browser species to select short over tall grass as preferred browsing sites, while the largest browsers, elephant and giraffe, preferred tall grass. Preference for short grass scaled negatively with browser body mass. This relationship points towards predator avoidance being a key factor driving smaller bodied browsers to utilize grazing lawns. Furthermore, our results support the hypothesis that browsers, specifically impala and small-bodied mixed feeders, are responsible for maintaining the open physiognomy of grazing lawns.

POSTER

Disentangling the herbaceous layer: palatable grasses and forbs respond differently to long–term herbivore treatments in a semi–arid sodic savanna

Van Coller, H.[1], Scogings, P.F.[2], Ellis, S.[1] & Siebert, F.[1]

[1]*Unit for Environmental Sciences and Management, North-West University, Private Bag X6001, Potchefstroom, 2520, South Africa*
[2]*School of Life Sciences, University of KwaZulu-Natal, Private Bag X01, Scottville 3209, South Africa*
[3]*Faculty of Natural Sciences, Department Statistical Consultation Service, North-West University, Private Bag X6001, Potchefstroom, 2520, South Africa*

21119465@nwu.ac.za; scogings@gmail.com; Suria.Ellis@nwu.ac.za; Frances.Siebert@nwu.ac.za

Despite strong recognition of the response of grasses to environmental disturbances in savanna systems, few studies have quantified the response of all components of the herbaceous layer separately, thus including forbs. A fire and herbivory exclusion experiment was used to investigate temporal response patterns of the herbaceous layer in a sodic patch of a semi-arid savanna. Vegetation monitoring was implemented in 2001 when a baseline survey was conducted. Monitoring was repeated nine and fourteen years after the baseline survey, i.e. 2010 and 2015 respectively. Data from surveys were analysed to determine how various drivers of savanna heterogeneity, i.e. herbivory and fire, would affect abundances of grasses and forbs. Dominant herbaceous species were identified based on frequency data.

Species were assigned to functional groups based on life form (forb or grass), life history (annual or perennial) and forage value (palatable or unpalatable). A 4-way type ANOVA Hierarchical Linear Model with unrestricted covariance matrix was used to assess the effects of time, fire and herbivory on forb and grass abundances. Palatable forbs and grasses are dynamic in their responses to fire and herbivory. Palatable forbs may provide redundancy with respect to provisioning of food to herbivores, especially mixed feeders. Results presented here are the first to disentangle the herbaceous layer of a sodic zone, and determine the effects of herbivory and fire on herbaceous functional groups respectively. Our results suggest that forbs can be considered functionally important in savanna systems, reinforcing the importance of further exploration of this functional group.

Browser effects on woody plant traits and growth in an East African savanna

Wigley, B., Sankaran, M., Augustine, D. & Ratnam, J.

Centre for Biological Sciences, Tata Institute of Fundamental Research, GKVK, Bellary Road, Bangalore, 560065, India

benwigley@gmail.com

Herbivore exclosures were initially set up in 1999 at three semi-arid savanna sites with varying rainfall and high herbivore densities at the Mpala Research Station in Kenya. Several traits relating to plant growth, leaf quality and defence of the dominant woody species were sampled in both the control plots and exclosures seventeen years later in 2016. Significant differences were found for most of the measured plant traits and growth rates when herbivory was excluded. These results will be presented and discussed.

Screening key browse species in a semi-arid rangeland

Mudzengi, C.P.[1, 2], Murwira, A.[1], Zengeya, F.M.[1] & Murungweni, C.[3]

[1]*Department of Geography and Environmental Science, University of Zimbabwe, P.O. Box MP 167 Mount Pleasant, Harare, Zimbabwe*
[2]*Department of Research and Specialist Services, Division of Livestock Research, Grasslands Research Institute, P/Bag X 3701, Marondera, Zimbabwe*
[3]*Department of Animal Production, Chinhoyi University of Technology, Pvt. Bag 7724, Chinhoyi, Zimbabwe*

clarice.mudzengi@gmail.com; murwira@alumni.itc.nl; fmz@classicmail.co.za; Chrispen.Murungweni@gmail.com

Rangeland productivity in semi-arid areas is adversely affected by increased variability in precipitation and frequency of droughts, coupled by increased livestock numbers. Knowledge on key rangeland resources that have capacity to increase resilience of livestock based rural livelihoods is critical for ensuring their sustainability. In this study, we identified key browse species used by livestock during the dry season, and determined their multiple uses in a semi-arid rangeland. We used random sampling to select 138 respondents for participating in individual qualitative questionnaires, and 7 key informants for a focus group discussion (FDG).

The Cultural Significance Index (CSI) was calculated to determine the importance of the key browse species identified. We also introduce an index to determine risk associated with competitive use of key browse species based on individual species uses and relative abundance as an indicator for species sustainability. We identified 28 key species used as browse by livestock and wildlife but also used for ethnoveterinary and human medicines. Species that were common to all uses constituted 25 % (n=7) of the total. We found no species (n=0) that had a single purpose only. There were also no species (n=0) used for both medicines and firewood / timber.

Responses of *Sclerocarya birrea* saplings to 6 intensities of simulated browsing

Scogings, P.F.

School of Life Sciences, University of KwaZulu-Natal, Pvt Bag X01, Scottsville 3209, South Africa

scogingsp@ukzn.ac.za

Marula (*Sclerocarya birrea*) is an iconic tree species in the savannas of southern Africa. Its leaves, fruit and bark are widely used by wildlife, people and livestock as forage, food and medication. In spite thereof, very little attention has been given to understanding its responses to utilisation. Given its high use as forage, e.g., by elephants, the effects of browsing on Marula were determined by simulating browsing on 300 saplings growing in an experimental orchard. Five months after simulated browsing (0%, 25%, 50%, 75% or 100% branches clipped, or 100% removal of leaves only), stem diameter was not significantly affected until >50% of branches were clipped, then it declined significantly ($P=0.001$). Clipping significantly increased the number of new shoots ($P=0.001$), with completely clipped plants having the most new shoots.

However, leaf biomass was significantly reduced by simulated browsing ($P<0.001$). Complete defoliation significantly reduced both stem diameter ($P=0.001$) and number of new shoots ($P=0.001$). Simulated browsing had no significant effect on leaf nitrogen ($P>0.05$). A significant interaction ($P=0.046$) between browsing and stem diameter, included as a covariate, meant that for thinner-stemmed plants, simulated browsing tended to decrease CT concentration, but for thicker-stemmed plants it tended to increase CT concentration. These results imply that severe browsing has detrimental effects on Marula sapling growth, and under certain conditions can lead to forage of lower palatability.

Revealing a partial migration in the Hwange elephant population

Chamaillé-Jammes, S.[2], Tshipa, A.[1, 2], Valls-Fox, H.[3], Collins, K.[1], Fritz, H.[4], Sebele, L.[5] & Mundy P.[2]

[1]*Wilderness Safaris, Botswana & Zimbabwe*
[2]*National University of Science and Technology, Bulawayo, Zimbabwe*
[3]*Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, Montpellier, France*
[4]*Laboratoire de Biométrie et Biologie Evolutive, CNRS, Villeurbanne, France*
[5]*Zimbabwe Parks and Wildlife Management Authority, Scientific Services, Hwange Main Camp Research, Hwange National Park, Zimbabwe*

winstontshipa@gmail.com; hugo.valls.fox@normalesup.org; kaic@wilderness.co.bw; Herve.Fritz@univ-lyon1.fr; slovelater@gmail.co; peter.mundy@nust.ac.zw; simon.chamaille@cefe.cnrs.fr

Migration is a fascinating phenomena with important ecological and conservation implications. Simultaneous migration of whole populations is rare, but in recent years it has been recognized that partial migrations, when only some of the individuals of a population migrate, are common. In partial migration systems, timing and routes of migration also often vary widely between individuals. Characterizing and quantifying this variability is challenging and there is no established practice yet. Here we present an approach based on the identification of a 'migration axis', on the distance migrated and on the seasonality of migration, combined with standard multivariate and clustering techniques.

We then show the application of this approach to movement data of 33 GPS-tracked African elephants, monitored in Hwange National Park (Zimbabwe). The analysis reveals clusters of individuals which were distinguished primarily by the distance migrated, and secondly be the seasonality of the migration. Long-distance migrants moved out of the Park and in a neighbouring country in the wet season. We discuss these results in the context of the emergence of Transfrontier Conservation areas, and we question the origin this migration which would not have made ecological sense a 100 years ago.

Landscapes, multi-agents and massive agents: a comparison of Kruger Park elephant distribution and vegetation impact as simulated by the SAVANNA, QnD and MARS models

Kiker, G.A.[1, 5], Huning, C.[2], Thiel-Clemen, T.[2], Bunting, E.L.[3] & Fullman, T.J.[4]

[1]*University of Florida, Gainesville, FL USA*
[2]*Hamburg University of Applied Sciences, Hamburg, Germany*
[3]*The Wilderness Society, Anchorage, AK, USA*
[4]*United States Geological Survey--Southwest Biological Science Center*
[5]*School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal*

gkiker@ufl.edu; Christian.Huening@haw-hamburg.de; thomas.thiel-clemen@haw-hamburg.de; bunterin@ufl.edu; timfullman@tws.org

Recent research on elephant distribution in the Kruger Park de-couples population density from vegetative impact and cautions against simplistic notions of elephant management. However, questions remain as to how elephant populations select habitat and occupy space within temporal periods. These questions provide useful context for simulation models to test habitat selection theories and to assess potential management alternatives under varying climatic conditions. Potential elephant distributions and subsequent impact on vegetation was simulated over the Kruger Park by three, spatially-explicit models operating on three different spatio-temporal scales. The SAVANNA landscape ecology model simulated elephant distributions and detailed vegetative impacts on a 5 km^2 grid resolution with a weekly time step. The QnD agent-based model simulated local grass, tree and elephant herd interactions using algorithms adapted from Baxter & Getz (2005) at 10 km^2 grid resolution and a monthly time step.

The MARS massive agent model simulated all Kruger elephants and selected tree species as individual agents, localized XY positions with a 1 hour time step for elephants and a 1 month time step for trees. All three models were simulated under historic conditions (1990-2010) with extensive field-based data for fire locations, climate stations, borehole location, and river/surface water availability. All three models had quite close agreement in estimating elephant densities near river and water point areas with increasingly divergent results in terms of potential impacts as the distance from water increased. As expected within each model, elephant residency vs. potential vegetation impacts were influenced significantly by elephant movement assumptions and model algorithm designs. Overall, each of these models can be expanded to simulate management-focused elephant/vegetation dynamics in different ways to address elements of interest within savanna ecology from intra-herd dynamics in massive agent models to mechanistic CO_2 effects within landscape models.

Examining Human Perception of Elephants and Large Trees for Insights into Conservation of an African Savanna Ecosystem

Henley, M.[1, 2], Edge, A.[3], Daday, J.[4]& Schulte, B.[3]

[1]*Applied Behavioural Ecology and Ecosystem Research Unit, School of Environmental Sciences, University of South Africa*
[2]*Elephants Alive, Transboundary Research Programme, Hoedspruit*
[3]*Department of Biology, Western Kentucky University*
[4]*Department of Sociology, Western Kentucky University*

michelephant@savetheelephants.org; adam.edge665@gmail.com; jerry.daday@wku.edu; bruce.schulte@wku.edu

In savanna ecosystems, African elephants (*Loxodonta Africana*) and large trees have ecological and human value, yet elephants impact such trees, motivating conservation strategies. Using a self-administered questionnaire, we examined perceptions of tourists and residents in South Africa towards elephants, large trees, and elephant management endeavours in the Associated Private Nature Reserves, greater Kruger National Park to develop viable management approaches. We used pictures of elephants of different age classes, group sizes and sex, and varying degrees of elephant impacted vegetation.

Respondents reported high attractiveness rankings for all elephant types and favored non-impacted tree photos over those with visible impact, revealing conflicting perceptions. Residents favored more intrusive elephant management methods than tourists with environmental manipulation representing the most supported and balanced option for both interest groups. Respondents advocated management that focuses on ecosystem functioning more so than elephant population control helping to reveal an equilibrium between economic and environmental values.

African honeybees as a mitigation method for elephant impact on marula trees in the Greater Kruger National Park

Cook, R.M.[1], Parrini, F.[1], King, L.E.[2, 3], Witkowski, E.T.F.[4] & Henley, M.D.[5, 6]

[1]Centre for African Ecology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Private Bag 3, Wits 2050, South Africa
[2]Animal Behaviour Research Group, Department of Zoology, Tinbergen Building, South Parks Road, University of Oxford, Oxford, OX1 3PS, UK
[3]Save the Elephants, P.O. Box 54667, Nairobi 00200, Kenya
[4]Restoration and Conservation Biology Research Group, School of Animal, Plant, and Environmental Sciences, University of the Witwatersrand, Private Bag 3, Wits 2050, South Africa
[5]Applied Behavioural Ecology and Ecosystem Research Unit, School of Environmental Sciences, University of South Africa, Private Bag X5, Florida 1710, South Africa
[6]Elephants Alive, P.O. Box 960, Hoedspruit 1380, South Africa

robinmichaelcook@gmail.com; francesca.parrini@wits.ac.za; lucy@savetheelephants.org; ed.witkowski@wits.ac.za; michelephant@savetheelephants.org

Concern has been raised in South Africa over the effects of the potentially high African elephant (*Loxodonta Africana*) population density on the abundance and diversity of large tree species. In Kenya, research has shown that elephants actively avoid contact with swarms of African honeybees (*Apis mellifera scutellata*), evading crop fields surrounded by beehive fence-lines and moving away from the playback recordings of swarming honeybees. We investigated whether or not African honeybees could be used as a novel method to deter African elephants from impacting Marula trees (*Sclerocarya birrea*). Fifty active beehives were hung from fifty Marula trees, with fifty dummy (inactive) beehives hung off the opposite ends of each tree's main stem.

Another fifty Marula trees were wire-netted (a method used to prevent ring-barking by elephants) and a further fifty Marula trees were used as control trees. Elephant impact on all one hundred and fifty trees was measured prior to the addition of treatments and then post-treatment addition for nine months. 54% of the control trees received some form of elephant impact, in comparison to 28% of the wire-netted trees and only 2% of the beehive trees. Wire-netting protected Marula trees against bark-stripping but did not prevent elephants from breaking primary and secondary branches. Beehives, both active and inactive, proved efficient at preventing elephants from impacting Marula trees in any form. These results indicate that beehives could be used as a non-lethal method for mitigating elephant impact on Marula trees, whilst providing additional honey and pollination services for local communities.

Contrasting elephants and humans as agents of disturbance in Miombo woodlands

Ransom, C.[1] & Archibald, S.[1]

[1]*School of Animal, Plant and Environmental Sciences, University of the Witwatersrand*

caitlin.ransom@gmail.com; sally.archibald@wits.ac.za

Woody plant dynamics of the Miombo woodlands are affected by three interacting disturbance factors; people, elephants and fire. Since the end of the 18th century the Miombo woodlands have undergone dramatic changes that extend beyond land transformation for agriculture: across much of the region elephants (as a result of reductions in their abundance and distribution) have been replaced by increasing human populations. Humans and elephants can have similar (but not identical) ecological impacts, as they both remove above-ground woody biomass. This raises the question of whether people, through their harvesting of fuelwood and logging, are performing a similar functional role to elephants in the Miombo woodlands?

The aim of this study is to compare elephants and people in their removal of woody biomass in the Miombo woodlands. Literature, biomass maps created from RADAR imagery and historical data will be used to: i) map the potential spatial impacts of historical elephants and current people within the Miombo region; ii) quantify rates of tree loss across gradients of human and elephant use; iii) and estimate ecologically relevant/ acceptable rates of tree loss. Because human impacts are concentrated near roads and cities and elephant impacts are highest near permanent water, the spatial patterns of biomass removal are likely to have been quite different in the past. When making decisions on how to allow access by people to vital woodlands resources it is important to assess the level of woody biomass disturbance from elephants that these systems evolved with.

Elephant versus mesobrowser effects on savanna woodland regeneration

Combrink, A.[1], Siebert, F.[1] & Botha, J.[2]

[1]*Unit for Environmental Sciences and Management, North-West University*
[2]*Scientific Services, SANParks, Skukuza*

Frances.Siebert@nwu.ac.za; Judith.Botha@sanparks.org

Seedlings are fundamental to healthy regeneration. The development of woody seedlings into established trees may be affected by various environmental factors, such as herbaceous biomass, herbivores and fire. Woody encroachment is a concern for both rangeland and protected area managers of savanna ecosystems. The challenge for land-users is to manage bush control without negatively affecting desirable non-encroaching species. The Nkuhlu exclosures provided the opportunity to test how the presence of, or release from herbivory and fire affected woody community changes, by (i) comparing abundances of woody encroacher and non-encroacher species, and (ii) assessing woody species composition changes between 2002 and 2015 for both seedlings and established trees. Hierarchical Linear Modelling was used to test for significant interaction effects between herbivore and fire treatments over time for woody species abundances.

Non-Metric Multidimensional Scaling and ANOSIM were used to assess species composition change after 13 years of herbivore exclusion. Seedling abundances increased in almost all treatments of herbivory, with or without fire. The significance of these increases were dependent upon catenal position. In the riparian bottomlands, a strong meso-browser effect was observed, while elephants were responsible for changes in seedling abundance on the uplands. Encroacher seedlings were more sensitive to both herbivory and fire than non-encroachers. Established trees of both encroacher and non-encroacher species revealed strong elephant effects on the crest. Meso-herbivores were primarily responsible for changes in species composition between seedlings and established trees, with highest effects revealed in the riparian bottomlands.

Megafaunal effects on vegetation structure throughout the densely wooded Addo landscape

Davies, A.B.[1], Gaylard, A.[2] & Asner, G.P.[1]

[1]*Department of Global Ecology, Carnegie Institution for Science, Stanford, U.S.A*
[2]*Scientific Services, South African National Parks, PO Box 2780, Knysna, South Africa 6570*

adavies@carnegiescience.edu; gpa@carnegiescience.edu; angela.gaylard@sanparks.org

Megafauna strongly affect vegetation structure and composition, but the extent of their influence across large-scales and varying ecosystems remains largely unknown. Using high resolution airborne Light Detection and Ranging (LiDAR), we investigated landscape-scale changes in vegetation height and three-dimensional (3D) structure across landscapes of varying elephant densities and in response to surface water distribution and terrain variability in Addo Elephant National Park, South Africa. Vegetation height and 3D structure differed significantly among elephant density treatments, with elephants causing up to a 4-fold reduction in mean vegetation height and altering the vertical profile of the vegetation.

Variability in vegetation height increased with increasing elephant densities, and mean height increased with elevation and distance to water, with these effects stronger where elephant densities were high. Slope had opposing effects on vegetation height in relation to elephant density, with height increasing with slope when densities were high, but decreasing when they were low. We contend that elephants are the primary agents of vegetation change in thicket, but reveal that the strength of their effects varies across the landscape, highlighting the necessity of landscape-level studies on megafaunal effects. Our findings suggest that the manipulation of water provisioning be applied as a potentially effective management tool to limit impacts.

Genetic relatedness of elephants in the Associated Private Nature Reserves

Mumby, H.S.[1, 2, 3, 4], Henley, M.[2, 3], Santos, T.L.[1, 4, 5] & Dawson, D.A.[4, 6]

[1]*Department of Zoology, University of Cambridge*
[2]*Elephants Alive! South Africa*
[3]*Applied Behavioural Ecology and Ecosystem Research Unit, University of South Africa*
[4]*NERC Biomolecular Analysis Facility, University of Sheffield*
[5]*Department of Biology, University of Lisbon*
[6]*Department of Animal and Plant Sciences, University of Sheffield*

hsm29@cam.ac.uk; michelephant@savetheelephants.co.za; teresalnsantos@gmail.com; d.a.dawson@sheffield.ac.uk

Although the effect of season, sexual state and age on elephant associative patterns has been investigated, less is known of the genetic relatedness underlying social bonds in male elephants. In females, the role of kinship is key in associations, however, the range of affiliative and competitive behaviours exhibited by male associates mean that the overlap may not be as straightforward for them. In this study, we collected faecal samples (n=279 samples across over 100 male and female individuals). We then extracted DNA from the samples and sequenced a total of 16 microsatellite markers in each sample.

After checking for evidence of selection in the dataset, we test for the relatedness in this population using pairwise tests across the sample and also assign the most likely genetic relationship between each individual (parent-offspring, full sibling, half sibling) using Cervus, R and MLRelate to compare relatedness estimates produced by different techniques. We will discuss what these results tell us about the population genetics of this population in terms of genetic diversity and population structure. We will also differences in patterns between males and females and what our next steps should be in terms of analysing the role of genetic relatedness between male spatial and social associations. As well as improving our understanding of elephant behavioural ecology, this study provides important information for managing the elephant population in terms of maintaining diversity and social bonds.

The Impacts of Fence Removal on Vegetation Dynamics within the Kruger to Canyons Biosphere Reserve, South Africa

Linden, H.[1], Rittenhouse, C.[1], Smit, I.[2] & Ortega, I.[1]

1Wildlife and Fisheries Conservation Center, Department of Natural Resources and the Environment, University of Connecticut, 1376 Storrs Road, Storrs, Connecticut 06269-4087 University of Connecticut, USA
[2]Scientific Services, South African National Parks, Skukuza, South Africa

helaine.linden@uconn.edu; chadwick.rittenhouse@uconn.edu; izak.smit@sanparks.org, morty.ortega@uconn.edu

Fence removal in the mid-1990's across reserves adjacent to Kruger National Park (KNP) was an important conservation achievement, expanding the landscape and enabling movement patterns within the Kruger to Canyons Biosphere Reserve. Although connected now, sections of the landscape are managed differently depending on ownership and divergent management objectives. In order to determine how the ecosystem responded to increased connectivity and diverse management regimes, we compared vegetation dynamics pre- and post- fence removal. We used satellite images from 1985 to 2015 in the TIMESAT program to derive four vegetation metrics: maximum level of photosynethic activity, range of measurable photosynethic activity, total vegetation production, and seasonally active vegetation. We then compared the mean and standard deviation of each vegetation metric of KNP to the private reserves before and after they became connected using Welch's two sample t-tests.

Eight of the ten reserves analyzed became significantly less similar to KNP post-fence removal. Of those reserves, vegetation metrics significantly decreased in five and increased in three reserves compared to KNP after the fences were removed. Nine reserves changed from having similar variation in vegetation metrics to having less variation compared to KNP post-fence removal. A possible reason for these findings is the artificially high waterhole densities that occur in many of the private reserves. After the fences were removed, animals may have surged from the KNP landscape to areas with greater water availability, thus resulting in increasing herbivory, especially of water-dependent herbivores like elephant. This would explain the apparent homogenization of the vegetation within the private reserves. If this is the case, the high density of artificial waterholes on private reserves may be an important contributor to losing landscape heterogeneity in the Kruger to Canyons Biosphere Reserve.

Empowering catchment management forums as institutions for deepening democratic natural resource management, co-learning and participatory governance

Palmer, C.G.[1] & Munnik, V.[1]

[1]*Institute for Water Research, Rhodes University, PO Box 94, Grahamstown, 1640*

tally.palmer@ru.ac.za

Our research group has just completed a four–year WRC project entitled: IWRM in South Africa: towards practising a new paradigm. The aim of the TPNP project was to move systemic and complexity thinking into practice in the South African water sector. The goal was to use this approach in an action research mode to exemplify loosening a range of water's intractable problems. The challenge was to demonstrate progress in addressing water resource protection, eutrophication and microbial pollution. In each case the new paradigm foundational understanding is that people in catchments exist as complex social ecological systems (C-SES). Therefore using appropriate complexity- and systems-based approaches and methods could result in a deeper embedding of an equitable, sustainable and adaptive Integrated Water Resource Management (IWRM) PRACTICE in South Africa.

In summary systemic analysis indicated that interventions to loosen the three challenge areas should focus on 1) actively supporting the DWS Green Drop programme and 2) to support the emergence of functional Catchment Management Agencies (CMAs) and Catchment Management Forums (CMFS).This paper provides practical examples where interventions and accompanying materials with an institutional and governance focus proved catalytic: 1) General introductory materials: the handbooks "How to think in a way that makes IWRM practically possible"; and "How to establish and run a catchment management forum"; 2) Crocodile River CMF engagement, pioneering application of the water quality/quantity integration model WQSAM; and the handbook "How to engage with the Green Drop Programme". 3) Olifants River: partnership with AWARD: further development of applied WQSAM; how it integrates water quality and quantity in a CMA; learning from USAID RESILIM project; 4) Upper Komati Forum: How to engage with water resource development, for example coal mining. The handbook takes a forum step by step through the process of evaluating and accepting/contesting development option. We view CMFs as nexus institutions in the emerging practice of a deliberative democracy.

Maximising benefits in the buffer zone: water stewardship and co-learning opportunities in an integrated agro-ecological land use system around protected areas

Stirzaker, R.[1] Riddell, E.[2] & Pocock, D.

[1]*CSIRO, Australia*
[2]*Conservation Management, Skukuza, Kruger National Park*

eddie.riddell@sanparks.org

Protected area management in the 21st century is increasingly required to be outward looking, using benefit sharing approaches to ensure their continued viability within the broader landscape. Accordingly there are a number of exciting potential approaches to achieve protected area integration with their surrounding landscapes presently underway in Africa. The Kruger National Park has the opportunity to develop creative partnerships with small scale farmers on the park boundary by focussing on their vested interests in the governance of shared water resources.

This paper presents a conceptual approach for benefit sharing in the buffer zone of the KNP through the water resources management lens. This draws upon experiences in other parts of the continent, where co-learning tools have been applied to small scale agriculture schemes managed by semi-literate farmers which have led to increased water and yield productivity within a short space of time. Furthermore this also led to a concomitant reduction in conflicts over water availability. The proposed concepts are discussed in their potential application to the KNP to develop water stewardship projects linked to small-scale farmer schemes on the parks periphery.

Time and the river: approaching a socio-hydrological history of the Sabie catchment

Kruger, F.[1] & Bennett, B.[2]

[1]*OTS, Skukuza, 1350, South Africa and Centre for Environmental Management, University of the Free State, Bloemfontein, 9301, South Africa*
[2] *Western Sydney University, Penrith, NSW 2751, Australia, & University of Johannesburg, Auckland Park, 2006, South Africa*

fkruger.za@gmail.com; B.Bennett@westernsydney.edu.au

All rivers have a history, but it is the history of their catchments that counts the most. And it is the interaction between people, institutions, land and water that determines that history. Today's options for finding desired changes to these connections are subject to the legacy of that history. The Sabie River, an important governor of the functioning of savanna ecosystems within its hinterland in the Kruger National Park, has had a remarkable history, which throws light on the resilience of the catchment and the river, as well as the key interactions between people, institutions and resources that have governed developments within the catchment over the past 150 years.

In the upper catchment, this history reflects the successive and progressive influence of mining, afforestation, human migration and displacement, and the emergence of modern resource-management institutions from the 1970's onward. The river in the Park has recovered from a sterile, arsenic-polluted state in the 1920s, to the almost-pristine state that we find it in today. Socio-hydrological history is the discipline that employs the methods of history to uncover the interactions that determined the present-day status of the catchment and its river, a situation that constrains today's options, and reveals opportunities for improvement. This paper will outline the socio-hydrological method being applied in a study of the Sabie catchment, and highlight salient features of the biophysical and institutional history of the upper Sabie as it affects the ecosystems of the Park.

Almost a decade of waterbird monitoring on the Olifants River, Kruger NP

Lerm, R.[1], Swemmer, T.[1] & Botha, A.[2]

[1]*South African Environmental Observation Network (SAEON)*
[2]*Birds of Prey Programme, Endangered Wildlife Trust*

rion@saeon.ac.za; tony@saeon.ac.za; andreb@ewt.org.za

River systems are dynamic where both biotic and abiotic drivers can shape the landscape and its communities across relatively short temporal scales. Floods for example, have long-term effects on the system's geology, plant composition and -structure. Thus, animal communities reliant on these are also expected to show changes in abundance and composition. The Endangered Wildlife Trust's Pel's Fishing Owl Survey initially focused on recording this endangered species but, eventually all water-dependent birds were recorded from 2007-2015 inside the Kruger National Park along a ~80 Km stretch of the Olifants River. Nearly 10 000 water-dependent birds were recorded across the project's life apart from hippopotamus and Nile crocodile abundances that closely matched the census results from aerial surveys.

In an attempt to understand the drivers that shape this water-dependent bird community we compared the geo-tagged records to that of environmental factors such as water cover, sand cover, riverine vegetation cover, hippo abundances and crocodile abundances along the river. The former three were derived from satellite imagery. There was a significant increase in water-dependent birds since 2007 but, only two of the 18 species included in the models showed significant relationships with environmental factors over a three-year period from 2013-2015. Egyptian Goose abundance was positively correlated with hippopotamus abundance and are to be expected as commensalism between these two species has been recorded elsewhere. Results showed that there are possibly other, untested factors that shape the Olifants River's water-dependent bird community as a whole, making the conservation of Red Data species particularly difficult.

POSTER

Re-assessment of the trophic status of fish communities in the Olifants River Gorge

Woodborne, S. [1,3], Huchzermeyer, K.D.A., Hall, G. [3], Myburg, A.[4], Pietersen, R.[5], Govender, D.[5] & Pienaar, D.[5]

[1]*iThemba LABS, Private Bag 11, WITS, 2050, South Africa*
[2]*Sterkspruit Veterinary Clinic, Lydenburg*
[3]*Mammal Research Institute, University of Pretoria, Private Bag X20, Hatfield, South Africa*
[4]*Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield, South Africa*
[5]*Scientific Services, SANParks, Skukuza*

Swoodborne@tlabs.ac..za; huchzermeyer@telkomsa.net; Grant.Hall@up.ac.za; U12034542@tuks.co.za; Dpienaar@sanparks.org; Dannyg@sanparks.org

A survey of the trophic status of aquatic organisms in the Olifants Gorge in 2012 showed that a pansteatitis epidemic at that time was associated with an altered trophic structure in the foodweb. Since the organisms that were found at the Olifants/Letaba confluence were the same as those found in other rivers in Kruger National Park, the altered trophic cascade was presumed to be caused by an exotic fish species not represented in the sample. The raising of the Massingir Dam sluice gates was argued to have facilitated the invasion of silver carp into the gorge. The El Nino drought of 2015/2016 reduced the flow in the Olifants and Letaba rivers and lowered lake levels in Massingir.

The trophic structure was reassessed and it was found to have normalised, and importantly, there was zero prevalence of pansteatitis. Reconsidering the evidence form high and low flow conditions it is possible to determine at which trophic level the foodweb structure was altered. All trophic levels above the filter feeding guild were found to have changed between the two observation periods. Results from a fish health survey in Lake Massingir done in 2014, show that both silver carp and Mozambique talapia had abnormally high trophic levels at that time. This proves that an exotic fish species is not required as a vector of the disease, and instead the episodic occurrence of algal blooms in the Olifants Gorge during high flow conditions is the cause of the disease.

Macroinvertebrate diversity survey along selected rivers of the Kruger National Park

Holland, A.J.[1] & Barber-James, H.M.[1, 2]

[1]*Albany Museum, Department of Freshwater Invertebrates, Grahamstown, South Africa*
[2]*Department of Zoology and Entomology, Rhodes University, Grahamstown*

A.Holland@am.org.za; H.James@ru.ac.za

South Africa's Kruger National Park (KNP) is world renowned as one of the largest and most impressive natural reserves in Africa. As such, South Africa has obligations to provide the KNP, with water of both adequate quantity and quality. Unfortunately, all of the major rivers arise upstream of the park and are severely impacted by many different forms of land use, including forestry, farming and extensive mining in some cases, before reaching the western boarder of the KNP. As the park's freshwater resources are not only limited internally, but also internationally shared with Zimbabwe and Mozambique, they are in high demand and need to be protected from degradation and pollution by appropriate management strategies. At present, only routine biomonitoring of river health using the rapid South African Scoring System (SASS) technique is implemented once a year.

However, as this approach is very coarse and only considers taxa at family level, much of the detail required for a proper understanding of the freshwater fauna diversity is being missed. Thus, surveys of selected rivers using the rapid South African Scoring System (SASS5) are continuing alongside a more in depth biodiversity assessment approach. Macroinvertebrate taxa from preserved SASS5 and additional specially-collected samples are being identified to species level and enumerated to derive commonly used measures of species diversity (richness and community composition), abundance and spatial distribution. This presentation reports on progress and preliminary results of the Foundational Biodiversity Information Programme (FBIP) funded project being carried out in the Kruger National Park.

POSTER

A new phylum for Kruger National Park: Freshwater jellyfish in the Shingwedzi River

Smit, I.P.J.[1, 2], Bills, R.[3], Barber-James, H.[4,5] & Zambatis, G.[1]

[1]*Scientific Services, South African National Parks, Skukuza, 1350*
[2]*Centre for African Ecology, School of Animal, Plant and Environmental Sciences, Wits, 2050*
[3]*South African Institute for Aquatic Biodiversity, Somerset Street, Private Bag 1015, Grahamstown 6139, South Africa*
[4]*Albany Museum, Grahamstown, 6139, South Africa*
[5]*Department of Zoology and Entomology, Rhodes University, Grahamstown, South Africa*

izak.smit@sanparks.org; r.bills@saiab.ac.za; h.james@ru.ac.za; guin.zambatis@sanparks.org

Cnidaria (medusa, anemones, corals and other polyps) consists of thousands of marine species but only about 40 freshwater species. The freshwater species belong to four phylogenetically distinct groups, one of which is the freshwater medusa (jellyfish). The worldwide number of accepted freshwater medusa species is uncertain (ranges from 6 to 16), with two genera occurring in Africa (one cosmopolitan and one indigenous). During October 2016 a group of SANParks scientists discovered and subsequently collected indigenous freshwater medusa in northern Kruger National Park (KNP).

Limnocnida tanganjicae (Great Lakes jellyfish) is disc-shaped (1-2 cm diameter) with about 300 marginal tentacles of different sizes and a gonad sac spread around the bell. This poster will introduce this new phylum for KNP to the research and especially freshwater community of KNP, describe the habitat in which they were found and showcase some photos (and videos). Genetic studies are planned to compare with specimens from further north in Africa where the species is more common. More generally, this study illustrates that freshwater monitoring should not only focus on perennial rivers, but should also consider ephemeral or disconnected water bodies.

Effects of groundwater abstraction on trees in the Kgalagadi Transfrontier Park

February, E. & Shadwell, E.

Department of Biological Sciences, University of Cape Town, Private Bag, Rondebosch, 7701, South Africa

Edmund.February@uct.ac.za; Eleanor.Shadwell@uct.ac.za

In arid systems with no surface water, deep boreholes provide water for humans and animals. With continually increasing infrastructure development for tourism in arid parks such as the Kgalagadi Transfrontier Park in southern Africa, we ask what effects increased abstraction may have on two iconic tree species. We do this above and below a low water use borehole in the Auob River and a high water use borehole in the Nossob River. At each site we determine seasonal fluctuations in the water table while also determining the water source for the trees using stable water isotope analysis. We then determine the extent to which the trees are physiologically stressed using leaf $\delta^{13}C$ analysis, xylem pressure potentials, specific leaf area and an estimate of canopy death. Our results show that the trees are indeed using deep groundwater in the wet season and that this is the same water that is being abstracted.

In the dry season trees in the Auob downstream of the active borehole become detached from the aquifer and use more isotopically enriched water. In the Nossob in the dry season, all trees use isotopically enriched soil water, and downstream of the active borehole use stomatal regulation to maintain leaf water potentials. These results suggest that trees in the Nossob are under more water stress than those trees in the Auob but that trees in both rivers demonstrate physiological adaptation to the change in water source through smaller heavier leaves?, no significant canopy dieback and in the dry season in the Nossob stomatal regulation of leaf water potentials. We propose that any decrease in available water will add to the physiological stress demonstrated in our study. To fulfil a biodiversity conservation mandate, the managers of the Kgalagadi Transfrontier Park have to establish upper and lower thresholds for groundwater abstraction.

The use of geophysics in understanding groundwater dynamics along the Letaba River

Strydom, T.[1], Riddell, E.[2], Swemmer, T.[3], Nel, J.[4] & Raubenheimer, R.[5]

[1]*South African National Parks, Scientific Services, Skukuza, South Africa*
[2]*South African National Parks, Conservation Services, Skukuza, South Africa*
[3]*SAEON, Ndlovu Node, South Africa*
[4]*GCS Consulting, Pretoria, South Africa*
[5]*University of the Free State, Bloemfontein, South Africa*

tercia.strydom@sanparks.org; eddie.riddell@sanparks.org; tony@saeon.ac.za; jacon@gcs-sa.biz; raubie23@gmail.com

The Letaba River is a model river where Strategic Adaptive Management (SAM) is currently being implemented to ensure adaptive and sustainable water resource management. This unique approach is facilitated by the institutional interaction between dam operators (from the upstream Tzaneen Dam) and stakeholders including Kruger National Park. However, there are huge uncertainties surrounding natural water losses (e.g. evapotranspiration) or gains (e.g. groundwater discharge) in the real-time model currently being used by dam operators. Currently, a multi-organizational project is aiming to narrow down the uncertainty by understanding and quantifying the natural hydrological processes between the two dominant land-uses along this river, i.e. agriculture and protected areas.

In order to understand groundwater gains and losses to the Letaba River, a network a boreholes were drilled. Borehole localities were chosen based on a geophysical surveying method known as Electrical Resistivity Tomography (ERT). These ERT surveys allowed for initial scoping of ideal borehole localities and were subsequently updated after drilling completion. The information gathered from geophysics and borehole characteristics (such as borehole logs and yields) provided detailed insights into groundwater dynamics relating to flow direction and aquifer properties along the Letaba River. This project will contribute significantly to management strategies by using a precise hydrological approach which will aid in improving estimates of water supply in the Letaba River.

POSTER

Long-term groundwater monitoring in Kruger National Park

Petersen, R.[1], Strydom, T.[1], Verster, H.[2], du Toit, W.[2] & Riddell, E.[3]

[1]South African National Parks, Scientific Services, Skukuza, South Africa
[2]Department of Water and Sanitation, Polokwane, South Africa
[3]South African National Parks, Conservation Management, Skukuza, South Africa

robin.petersen@sanparks.org; tercia.strydom@sanparks.org; versterh@dws.gov.za; dutoitw2@dws.gov.za; eddie.riddell@sanparks.org

Groundwater forms a critical component of the hydrological cycle and plays an important role in the environment. During the dry season, groundwater sustains river flows ("base flows") and supports refuge pools. Refuge pools are critical in seasonal rivers, as they support water-dependent ecosystems (wetlands and springs) that would otherwise not survive when the rivers dry up. Additionally, they provide drinking for game in dry areas far from perennial rivers and support a variety of fish and amphibians.

In South Africa's flagship conservation area, the Kruger National Park (KNP), groundwater systems are relatively un-impacted and providing an excellent opportunity to study the natural behaviour of aquifers to rainfall, drought, river flow and other related influences. Currently, more than 40 boreholes have been actively monitored across the KNP for nearly a decade. These loggers have been programmed to measure groundwater levels at hourly intervals, providing high resolution data in order to detect subtle changes in groundwater levels through diurnal cycles and to accurately determine when aquifer systems react to rainfall events. We aim to present insights gained during the last decade into groundwater dynamics through various seasons and across various geologies in a bid to understand natural fluxes in groundwater levels in savanna systems.

Hydrological dynamics in Mapungubwe National Park

Petersen, R.[1], Strydom, T.[1], Verster, H.[2] & du Toit, W.[2]

[1]*South African National Parks, Scientific Services, Skukuza, South Africa*
[2]*Department of Water and Sanitation, Polokwane, South Africa*

robin.petersen@sanparks.org; tercia.strydom@sanparks.org; versterh@dws.gov.za; dutoitw2@dws.gov.za

Mapungubwe National Park (MNP) is typically described as an arid environment where ecosystem functioning is largely driven by water in the landscape especially aquifer dependent ecosystems (i.e. Kalopi wetland and the gallery forest). The key groundwater issues in the park are related to the abstraction of water from the underlying aquifers in particular the Greefswald and Shroda alluvial aquifers along the Limpopo River for mining activities nearby, and the abstraction of groundwater for agricultural purposes. Abstraction from these aquifers not only affects the base flow contribution to the Limpopo River during the dry season, but also applies great stress on aquifer dependent ecosystems.

By gaining an understanding of the processes and mechanisms associated with water in the landscape, groundwater management will be strengthened to allow the natural interaction/movement/exchange between groundwater and surface water, including baseflow of rivers in dry periods and recharge of aquifers during wet periods (bidirectional movement/recharge), conserve and protect aquifer dependent ecosystems (e.g. Greefswald /gallery forest and the Kalopi wetland), and allow sustainable use of groundwater resources without damage to the natural functions and processes associated with the aquifers. Since MNP forms part of the Greater Mapungubwe TFCA, which encompasses areas in our neighbouring countries of Botswana and Zimbabwe, long-term monitoring of this trans-boundary system is of utmost importance as developments in the catchment in either country may impact hydrological dynamics in the park.

This presentation aims to present an initial understanding of the hydrogeological dynamics in MNP in light of anthropogenic pressures relating to mining and agricultural activities adjacent to the park.

Fire season and size influences pyric-herbivory pressure with repercussions for grass community responses in the Kruger National Park

Donaldson, J.[1], Pollard. D.[1], Luhdo, Z.[1], Govender, N.[2], Archibald, S.[1], Parr, C.[3]

[1]*University of the Witwatersrand*
[2]*South African National Parks*
[3]*University of Liverpool*

jedonaldson6@gmail.com;drewpollard@yahoo.com;zoezoo@netactive.co.za;navashni.govender@sanparks.org;sally.archibald@wits.ac.za;Kate.Parr@liverpool.ac.za

The importance of lawn and bunch grass states as resources for grazing herbivores is being increasingly recognized in African savannas. We know fire is an important driver of herbivore movements and grazing patterns, but little is known about the role fire plays in the balance of lawn-bunch grass mosaics over broad scales. In a 3-year experimental manipulation of fire patterns we investigated two fundamental and linked aspects of fire ecology in savanna systems: (1) the effect of pyrodiversity on grazing pressure; and (2) the effect of pyric-herbivory on savanna vegetation. In particular we were interested in the impacts of repeated small fires on grazing pressure and consequent changes in grass composition and the species traits driving community changes.

In a replicated landscape experiment we applied burns in different seasons (Early and Late) and of varying sizes (0.25ha, 5ha and 25ha) in natural tall grass savannas of Kruger National Park. Grazing pressure increased on burnt plots immediately after initial burning and became consistently higher on repeatedly burnt plots compared to un-burnt plots regardless of size. Three years of repeated late-dry season burning and increased grazing pressure resulted in notable shifts in grass community composition toward species with a distinct suite of traits – the same trends were not observable in early-dry season burns or when fire was completely removed. Thus, repeated small-scale fires lit at specific times of the year can shift tall-grass communities into more grazer-tolerant grass communities and are potentially tools for increasing short-grass communities in the KNP.

Community, functional, and ecosystem responses to combined high fire and grazing pressure in a Highveld Grassland

Skhosana, F.[1] & Archibald, S.[2]

[1, 2]*School of Animal, Plant and Environmental Sciences, The University of Witwatersrand, Johannesburg, 2050, South Africa*

felix.mvsan@gmail.com; sally.archibald@wits.ac.za

Since herbivores are attracted to the post-burn green flush, frequent small fires in grasslands can concentrate grazing in small patches in the landscape. A fire-break is an extreme example of this where the same small area is burned every year. We expect changes in grass community and functioning under these conditions: palatable grasses often disappear from heavily grazed areas, but if palatability is associated with grazing tolerance, these sites do not always become degraded. I studied the impacts of a decade of annual burns and continuous grazing on the firebreaks at the Kromdraai Valley Farm on the Highveld.

I compared herbaceous species composition, animal presence, and various indicators of ecosystem health on the firebreaks and in the unburnt matrix. Functional characteristics of the grasses were assessed using grass leaf anatomy data collected from SANBI. I interpret these data to assess whether the firebreaks are 'degraded' in terms of i) whether grazers prefer or avoid the fire-breaks, ii) water infiltration and ANPP, and iii) compositional and functional differences in grass species composition.

Herbivore culling fuels veld fires: Evidence for direct impacts of herbivore densities on fire patterns in a large protected savanna

Smit, I.P.J. [1, 2] & Archibald, S.[2]

[1]*Scientific Services, South African National Parks, Skukuza, 1350*
[2]*Centre for African Ecology, School of Animal, Plant and Environmental Sciences, Wits, 2050*

izak.smit@sanparks.org; sally.archibald@wits.ac.za

Fire and mammalian herbivory are important components of savanna ecosystems across much of their rainfall range in Africa. Interest in the interactions between these consumers is increasing – with much discussion on how fires impact herbivore movements and forage availability. Theory suggests that heavy herbivory should reduce fire by consuming available fuel, but the degree to which this can impact landscape-level fire patterns is not well demonstrated – particularly in conservation areas. Long-term spatially explicit fire scar mapping and herbivore distribution data from the Kruger National Park (KNP) provide a unique opportunity to test whether and how herbivory can influence fire patterns over a time period (1969 – 2015) when there were large changes in herbivore communities due to management interventions such as culling and water point closure.

We looked for changes in annual proportion area burned at various distances from perennial rivers in response to rainfall and changes in biomass of key herbivore species. Areas close to rivers burn significantly less during years when herbivore biomass was high than in years with lower herbivore biomass – with presumably important consequences for the vegetation dynamics of these riverine areas. This pattern was especially evident during drier years and in drier landscapes when grazers could "keep up" with grass growth. Our results show that in a key transitional rainfall range (400-600mm MAR), increased herbivore densities can have direct consequences on fire patterns, essentially switching fire-driven systems ("black-world") to herbivore-driven systems ("brown-world"). This opens up various management opportunities and considerations – we, inter alia, indicate how past culling operations of KNP have increased fire frequency along the perennial rivers of the park.

Assessment of management impact on fire occurrence: Comparison of fire regime of tropical savannas in protected areas

Alvarado, S.T.[1,2], Silva, T.S.F.[1] & Archibald, S.[2]

[1]*Instituto de Geociências e Ciências Exatas, UNESP – Univ Estadual Paulista, Departamento de Geografia, Ecosystem Dynamics Observatory. Caixa postal 178, Rio Claro, SP, Brazil. 13506-900*
[2]*Centre for African Ecology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, Private Bag X3, WITS, 2050, South Africa*

swanni_ta@yahoo.es, tsfsilva@rc.unesp.br, sally.archibald@wits.ac.za

Humans can alter fire dynamics in grassy systems. These changes have effects on vegetation structure and recovery, species composition, and ecosystem function. Understanding how human management can affect fire regimes is vital to detect potential changes in the resilience of plant communities, and to predict future vegetation responses to human management. We evaluated the fire regimes of two new protected areas in Madagascar (Ibity and Itremo NPA) and one in Brazil (Serra do Cipó NP) before and after management intervention. The reserves all had similar rainfall and environments. We compared the pre- and post-management fire history in these areas and analyzed the differences in terms of total annual burned area, number of ignitions, burn scar size distributions, fire return period and the seasonal fire distribution.

More than 90% of the total park area was burned at least once during the studied period, for all parks. We observed a significant reduction in the number of ignitions for Ibity NPA and Serra do Cipó NP after management intervention, but no significant change in total burned area for each protected area. We observed shorter fire intervals for the protected areas in Madagascar (3.23 and 1.82 years) in contrast with the studied areas in Brazil (ME7.91 years). We also observed a seasonal shift with burning happening later in the fire season (October-November) after management intervention. Our results can help managers to formulate or adapt policies of fire management in these regions, and improve the conservation efforts in these protected areas.

POSTER

The risk of passivity: what may happen with the fire regime in protected areas of Brazilian savanna in light of the current fire suppression policies? An example of Canastra National Park, Southeast Brazil

Batista, E.K.L.[1], Russell-Smith, J.[2], Figueira, J.E.C.[1], Yates, C.[2] & França, H.[3]

[1]*Federal University of Minas Gerais, Belo Horizonte, Brazil*
[2]*Charles Darwin University, Darwin, Australia*
[3]*Federal University of ABC, São Paulo, Brazil*

biogenia.k@gmail.com; Jeremy.Russell-Smith@cdu.edu.au; cortesfigueira@gmail.com; Cameron.Yates@cdu.edu.au; helena.franca@ufabc.edu.br

The Brazilian savanna has been threatened by the absence of a consistent fire policy. While many countries with fire-prone ecosystems, such as South Africa and Australia, already prescribe the use of fires to maintaining biological diversity, most protected areas in Brazil have applied total fire suppression policies. These policies reflect a cultural heritage, which considers that fire regimes have a negative impact on biodiversity. Aiming to exemplify what has happened to protected areas of savanna in Brazil and demonstrate the impacts of fire suppression policies on fire-regime descriptors, we analyzed the social context and the spatio-temporal configuration of wildfires (2000-2015) in Canastra National Park (CNP), Southeast Brazil. The Canastra section of CNP is managed by the government, who has applied fire suppression policies, while the other sector (Babilonia) has retained private landowners who manage the landscape on their respective properties.

The annual burned area mapping revealed different fire regimes in both regions of the Park. In the Babilonia region, fires are more frequent, less extensive and concentrated in the early dry season. On the other hand, in the Canastra region, fires are less frequent, very large and concentrated in the late dry season. Our findings provide evidence that the fire suppression policies are leading to undesired social and ecological (frequent extensive wildfires) consequences which are incurring deleterious effects on biodiversity (fire sensitive flora and fauna). It is therefore critical to evaluate if current fire management policies and management strategies are delivering effective biodiversity conservation outcomes in Brazilian savanna protected areas.

Fire Intensity: exploring FRP estimates between human fires and the savanna – woodlands in north-east Namibia

Humphrey, G.J.[1] & Gillson, L.[1]

[1]*Plant Conservation Unit (PCU), University of Cape Town (UCT)*

humphrey.glynis@gmail.com; lindsey.gillson@uct.ac.za

Fire radiative power (FRP) measurements from satellites play an important role in quantifying the energy released by fires, and enable the distinction between fires of different intensities. FRP has a linear relationship with the total amount of vegetation biomass consumed, and biomass availability varies in response to people's use of fire in different seasons. Bwabwata National Park (BNP) is situated within the savanna-woodland biome of the miombo eco-region. We investigated fire regimes in strictly protected areas (Buffalo, Mahango and Kwando) compared with the Multiple Use Area (MUA: where people reside), in order to explore the impact of people on fire intensity and burned area. We analyzed multiyear (2000 – 2015) FRP MODIS derived detections and burned area data to explore relationships between rainfall, seasonality, and fire size for different vegetation and land use types.

We tested the hypothesis that FRP and fire size will differ between the early and late season fires in the MUA where people reside, and in the core wildlife management areas for all vegetation types. Our results reveal higher fire intensity and larger fire sizes in Buffalo and Mahango (where people are not actively burning) versus the MUA and Kwando area, where bi-annual burning is prevalent. Shrublands show higher fire intensities and fire sizes when compared to the savanna-woodland and grassland vegetation types in the core areas where there is less fire activity. Our data suggest that fire intensity influences fire size in different vegetation types, and that human bi-annual burning practices decrease fire size and intensity. Results are of interest to African conservation managers since fire intensity can be manipulated by choosing the season of burn, and by burning in vegetation types in years which yield high fuel loads.

Meta-analysis reveals large long-term effects of fire on soil carbon and nutrients in savanna ecosystems

Pellegrini, A., Pacala,S., Staver, A.C., Hobbie, S., Hoffmann, W., Anderegg, W., Reich,P. & Jackson R.

Changing fire frequencies across the globe have the potential to fundamentally alter carbon and nutrient cycling in ecosystems. However, we have a limited understanding of the long-term effect of fire on soils, which dominate ecosystem carbon pools and regulate nutrient availability, and their implications for plant community function. Here, we present data from a meta-analysis on 39 long-term experimental fire manipulation studies spanning grasslands, savannas, and forests, with an average manipulation time of ~30 years totaling 1,139 site-years. Fire had large effects on soil carbon and nutrients; however the effect of fire differed across ecosystems: savanna-grasslands and angiosperm dominated forests showed strong depletions in carbon and nitrogen with increased burning frequency, while carbon and nitrogen concentrations in coniferous forests were not affected.

The effect of fire on total carbon and nitrogen increased with the length of fire treatment, while inorganic nitrogen stayed consistently depleted; phosphorus was first enriched followed by continuous depletion. The frequency of fire had a significant effect on observed responses: lower fire frequencies reduced soil carbon and nutrients to a lesser extent. Statistically estimated changes in topsoil carbon stocks illustrated that fire exclusion vs. frequent burning results in the loss of 33.5-44.6 MgC/ha from the topsoil in savanna-grasslands and angiosperm forests over the course of 50 years. These results present both quantitative predictions of how fire will change ecosystem carbon and nitrogen pools as well as a mechanistic understanding of how these changes can occur.

Investigating the effect of fire dynamics on aboveground carbon storage in the Bateke landscape, Congo

Nieto Quintano, P.[1] Mitchard, E.[1], Ryan, C.[1] & Rayden, T.[2]

[1]*University of Edinburgh*
[2]*Wildlife Conservation Society Congo*

paula.nieto@ed.ac.uk; edward.mitchard@ed.ac.uk; casey.ryan@ed.ac.uk; trayden@wcs.org

It is estimated that 68% of Africa's surface area burns every year (Roy et al. 2008), being the savanna biome the most continuously affected by burning with strong environmental and social impacts (Romero-Ruiz et al., 2010). Most fires in Africa are anthropogenic and occur during the Late Dry Season, but their dynamics and effects remain understudied. The main objective of this research is to understand the woody cover, productivity, carbon storage and fire regime of the complex forest/savanna system of the Bateke Plateau. The Bateke Plateau is a landscape composed of frequently burned grassland savanna surrounded by tropical forest, situated in the centre of the Republic of Congo.

This study combines two approaches: firstly experimental, with long term field experiments where the fire regime is manipulated, and then observational, using remote sensing to study the past history of fire regime in the region. We found that most savanna areas burnt at least once every 4 years, with more frequent fires occurring in the late dry season and around roads and settlements. These two approaches will be then combined to create a model of vegetation-fire-climate interactions in order to predict the vegetation response to different future scenarios. The results will be used to promote better management of this area to enhance carbon storage, as well as increase our understanding of vegetation dynamics in this understudied ecosystem and help orient policy and conservation.

Social and ecological challenges in understanding fire dynamics and woodland expansion in the Great Plains, USA

Scholtz, R.[1], Fuhlendorf, S.D.[1] & Archer, S.R.[2]

[1]*Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK, 74078, USA*
[2]*School of Natural Resources & The Environment, The University of Arizona, Tucson, AZ 85721, USA*

r.scholtz@okstate.edu, sam.fuhlendorf@okstate.edu, sarcher@email.arizona.edu

Woody encroachment is a global phenomenon on numerous continents (e.g. Africa, Australia, N. America). In North American grasslands, managing tree/shrub proliferation has been challenging, as its causes are varied and actively debated. Social factors (e.g. culturally-ingrained differences in the use of prescribed fire) have contributed to woodland expansion but are seldom factored in to ecological models. Great Plains grasslands are largely comprised of private lands. This, coupled with a lack of consistent fire policy within and across state boundaries, has led to high spatial variability of fire. We used fire occurrence data (1984 – 2012) from N. Dakota to Texas to identify areas with relatively low (<0.65) and high (>0.65) fire probabilities.

We aimed to predict how potential woody cover and stature (key surrogates for biomass and C-mass) vary as a function of fire x climate interactions in these contrasting areas. Results suggest that woody plant height is largely dictated by mean annual precipitation (MAP). However, under low and high fire regimes, their height was restrained to ~3m and ~5 m in areas receiving ≤800mm and ≤1050mm MAP, respectively. In contrast to height, % cover was mainly predicted by mean annual temperature (MAT). Here, warmer areas (e.g. Texas) had greater woody cover than cooler areas (e.g. Kansas) with no consistent relationship with fire and MAP. Overall, MAP, MAT and social constructs (e.g. landowner, burn associations) were the main predictors of fire dynamics. Understanding the interactions between these variables will allow us to better predict areas of future woodland expansion.

Flowering after fire in the Cerrado: an example of *Bulbustylis paradoxa*

Fidelis, A.[1], Zanzarini, V.[1], Camargos, L. [2], Silva, N.[2], Rosalem, P.F.[2] & Martins, A.R.[2]

[1]*Departamento de Biologia e Zootecnia, UNESP – FEIS, Ilha Solteira, Brazil*
[2]*Departamento de Botânica, UNESP, Rio Claro, Brazil*

afidelis@rc.unesp.br

Cerrado is the richest savanna in plant species in the world and is a fire-prone ecosystem. Fires are frequent, low in intensity and severity and plants have traits related to fire, such as resprouting capacity. After fire, one of the first responses of vegetation is flowering: most of graminoids resprout very fast after fire, flowering abundantly and dispersing their seeds within few weeks. The extreme example of rapid response is a sedge, *Bulbostylis paradoxa*, which can be observed flowering within few hours after fire. Therefore, we marked individuals of different sizes of *Bulbosytilis paradoxa* before fire (10 individuals/plot, 4 plots/treatment) and burned plots in July. We also sampled individuals for anatomical and physiolocal studies. After fire, we monitored the individuals, by counting and measuring the size of inflorescences.

The first inflorescences could be observed 30 hours after fire. Some individuals in burned plots had up to 20 inflorescences, whilst the ones in control plots did not have any inflorescence. One week after fire, inflorescences were fully developed and 45 days after fire, we could already observe seeds being dispersed. Grasses after fire in the Cerrado showed the same pattern in these plots: 45 days after fire almost all grass species in the plots were flowering and dispersing their seeds, showing that graminoids can reproduce very fast after fire. In control plots, graminoids are rarely found flowering and when they are found, only few individuals can be observed with inflorescences. Flowering after fire can also be observed in several species in Cerrado (forbs and shrubs), but none of them flower as fast as *Bulbostylis paradoxa.*

Fear-triggered trophic cascades in a megaherbivore dominated system

Le Roux, E.[1], Kerley, G.I.H.[1] & Cromsigt, J.P.G.M.[1, 2]

[1]*Centre for African Conservation Ecology, Department of Zoology, Nelson Mandela Metropolitan University, P.O. Box 77000, Port Elizabeth, 6031, Eastern Cape, South Africa*
[2]*Department of Wildlife, Fish and Environmental Sciences, Swedish University of Agricultural Sciences, 901 83, Umeå, Sweden*

leezaleroux@gmail.com; joris.cromsigt@slu.se; graham.kerley@nmmu.ac.za

Large mammalian predators impact ecosystem processes indirectly through their control over prey distribution and abundance. However, in terrestrial systems dominated by large mammalian species, studies of such trophic cascades reveal effects that vary widely in direction and magnitude and the evidence is seldom empirically demonstrated. Hence, our understanding of the drivers behind the variation in trophic control remains poor. In speciose systems, prey are not uniformly vulnerable to predator consumers. Variation in vulnerability modifies the strength of consumer-prey interactions and with it the consequences to ecosystem properties.

Africa is one of the last remaining places to still support megaherbivores, species that have grown large enough to be practically impervious to non-human predation. Thus predator-triggered cascades may be greatly altered in a megaherbivore dominated system. Here we present the first evidence of community-level trophic cascades explicitly exploring the modulating impact of megaherbivores. We show that megaherbivores' disregard for the landscape of fear, masks predator-triggered trophic cascades and weakens the impact of trophic cascades on the ecosystem. We combine fine-scale experimental manipulations with broad spatiotemporal scale observations to illustrate the mechanistic link between predators and ecosystem processes and to place it within a broader ecosystem perspective.

POSTER

Fear by Moonlight: Ungulate Responses to Periodically Fluctuating Predation Risk

Palmer, M.S.[1] & Packer, C.[1]

[1]*University of Minnesota, Dept. Ecology, Evolution, & Behavior, Minneapolis, USA*

palme516@umn.edu; packer@umn.edu

Prey can act to reduce their risk of predation by selecting safer habitats, modifying their temporal activity patterns, increasing levels of vigilance, or engaging in defensive actions. Behavioral responses to spatially structured predation risk have inspired the development of predictive frameworks for predator-mediated impacts on prey populations, whereas responses to temporally-structured risk remain poorly understood. The lunar cycle dramatically alters night time visibility with concomitant effects on predation risk. Lions hunt primarily at night and are known to capture more prey when nighttime luminosity is low. As hunting success in lions correlates inversely with nightly luminosity, there are predictable monthly patterns of nocturnal risk that their prey could respond to in order to minimize their risk of predation. In this study, we use camera traps to examine the incidence of nocturnal antipredator behaviors throughout the lunar cycle in six species of ungulates in Serengeti National Park, Tanzania. Given that predation risk from lions should be highest around the new moon, we hypothesized that when nocturnal luminosity is low, ungulates (1) suppress overall activity levels, (2) relocate to “safer” areas, and (3) increase incidences of grouping behavior.

Did researcher intervention really drive the extinction of African wild dogs on the Serengeti plains?

Jackson, C.R.[1], Masenga, E.[2], Davies, A.B.[3], May, R.[1], Lyamuya, R.[2], Robertson, M.P.[4], Fossøy, F.[1], Mjingo, E.E.[2], Fyumagwa, R.[2], Belant, J.[5] & Røskaft, E.[6]

[1]*Department of Terrestrial Ecology, Norwegian Institute of Nature Research, Trondheim, Norway*
[2]*Tanzania Wildlife Research Institute, Arusha, Tanzania*
[3]*Carnegie Institution for Science, Stanford, USA*
[4]*Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa*
[5]*Department of Wildlife, Fisheries and Aquaculture, Mississippi State University, USA*
[6]*Norwegian University of Science and Technology, Trondheim, Norway*

craig.jackson@nina.no

The local extinction of a population of African wild dogs in Serengeti National Park (SNP) resulted in huge scientific debate. Their final demise in 1991 was seemingly due to rabies, yet prior to extinction, tests revealed significant rabies antibody titers. Given that many packs disappeared following handling, Burrows (1992) postulated that the stress associated with immobilization caused immune suppression, reactivating the virus, and causing the extinction. Despite extensive criticism, the hypothesis is still defended and the long-standing debate remains unresolved. Part of the wild dog population, however, persisted to the east of the Serengeti plains and has been studied since 2005. Burrows' hypothesis is based on a mechanistic process and should result in predictable effects: handling of these remaining wild dogs should result in high mortality rates.

However, between 2006-2016, 89.6% of 106 handled wild dogs survived >12 months post-handling and 95.5% of 67 relocated animals (6 packs) survived >12 months post-capture. Furthermore, the population failed to recolonize the adjoining Serengeti plains, suggesting other factors might be responsible for the extinction. Lion and hyena populations increased significantly before 1991, with a concomitant decline in the wild dog population. Moreover, an ecological niche model identified competition refuges in SNP, which reintroduced packs actively selected while avoiding the plains. Rather than researcher-induced mortality, we suggest that interspecific competition better explains wild dog decline and subsequent absence from the plains. These findings are broadly relevant given the recent disease-related deaths of study packs in South Africa and the on-going management of remaining packs.

Landscape scale occupancy of lions in the Greater Limpopo Lion Conservation Unit: What limits lions in human-disturbed systems?

Everatt, K.

Apex predators have important ecological roles such that the consequences of their disappearance can reverberate through entire ecosystems and are naturally extinction prone due to their rarity imposed on them by the energetic constraints of their trophic position. However, in spite of their relative rarity, apex predators are often in direct competition with humans and as a consequence many species of apex predators are increasingly becoming spatially and numerically limited by human pressure. For instance, African lions are naturally limited by their trophic position, exert influence on lower trophic levels, are in competition with humans and are now also limited by human pressures. Furthermore, many lion populations are already fragmented and becoming increasingly isolated. Opportunities for conservation are rapidly diminishing with increasing human pressures both inside and outside of protected areas. Such pressures can result in edge effects and threaten the viability of protected source populations. The Greater Limpopo Lion Conservation Unit (GLLCU) covers approximately 73,000 km^2; including South Africa's Kruger National Park, Zimbabwe's Gonarezhou National Park and Mozambique's Limpopo, Banhine and Zinave National Parks.

While KNP supports a stable and protected population, GNP and LNP each support small populations and the majority of the remaining GLLCU are high-conflict landscapes. Here we sampled across gradients of human disturbance and wildlife densities across the GLLCU using the proportion of area occupied (PAO) and the probability of site use (PSU) as measurable metrics and a multi-state occupancy modelling approach that distinguishes between different group demographics such as prides with cubs *vs.* single animals. We employed replicated detection/non-detection surveys to estimate a probability of detection (p) to derive unbiased estimates of occupancy (Ψ) and hierarchical modelling of covariates was used to make inferences on the ecological factors limiting species occurrence and/or detectability. Data were gathered from an average of 40 x 1km long spatially replicated sign surveys of 150 sites (200km^2 grid cells) conducted on foot across gradients of anthropogenic disturbances, management regimes and prey densities in the GLLCU. In addition a spatial lion mortality model was constructed from mortality events recorded across the study area.We tested the following hypotheses related to the landscape ecology of lions in the GLLCU:

1. Lions are limited by exploitive competition with bushmeat hunters.
2. Lions are limited by interference competition with humans.
3. Lions suffer exploitive competition with agro-pastoralists for preferred habitats.

Understanding the interacting effects of these processes will contribute to our understanding of the disturbance thresholds and minimum prey and space requirements of apex predators in human disturbed systems.

Population density and habitat preference of Javan leopard in savanna ecosystem in Baluran National Park, Indonesia

Wahyudi, H.A.[1], Iqbal, M.[2] & Arinal, I.[1]

[1]*Copenhagen Zoo Indonesia Programme, Baluran National Park, Jl. Raya Situbondo KM 35 Situbondo, East Java, Indonesia*
[2]*Baluran National Park, Jl. Raya Situbondo KM 35 Situbondo, East Java, Indonesia*

ha.wahyudi@gmail.com

Javan leopard (*Panthera pardus melas*) is a genetically distinct leopard subspecies and the largest predator on Java. Poaching, habitat loss and retaliation killing has reduced the population to less than 250 individuals remaining in the wild, and it is listed as Critically Endangered by IUCN Red list. With its unique savannah ecosystem, Baluran National Park is one of the most important remaining habitats for the Javan leopard and many prey-species, such as sambar deer, banteng, water buffalo and muntjak. Approx. 7000 hectares of the total park area (~25%) have become overgrown by the invasive African acacia, *Acacia nilotica* resulting in loss of important grazing areas of the park, a reduction in prey density and, finally, risking a collapse of the leopard population.

Copenhagen Zoo and Ministry of Environment and Forestry, Indonesia conducted an extensive camera trapping survey for Javan leopard. The study took place over a 2-year period from 2015-2017 in which 90 cameras were deployed in a 1x1km grid system. A total of 2175 trapnights produced 35827 pictures, of which 75 were leopards. From these 17 individuals were identified from their spots. The results suggest that Javan leopards prefer areas of mixed open woodland, close to savanna areas. This is likely due to a higher prey density on and around savanna areas. This is the first comprehensive ecological study of Javan leopards in a savanna ecosystem in Baluran National Park and the results will contribute to developing an effective species conservation action plan.

POSTER

Carnivore population dynamics on two reserves, comparable or not?

Wentzel, J.M.[1, 2], Fosgate, G.T.[2], Camacho, G.C.[3] & Bourn, M.[4]

[1]University of Pretoria, Hans Hoheisen research station
[2]University of Pretoria, Department of Production animals
[3]Mpumalanga Tourism and Parks Agency (MTPA)
[4]MTPA, Manyeleti Nature Reserve

Jeanette.wentzel@up.ac.za; Geoff.fosgate@up.ac.za; gcamacho@telkomsa.net; mbmanyaleti@gmail.com

The objective of this study was to determine the role of small carnivores in disease transmission and ties in to the carnivore management programs of all reserves. Carnivore presence was determined on reserves managed by Mpumalanga Tourist and Parks Agency. Manyeleti is contiguous with Kruger National park, 23 000 hectares, and has villages on one side. Andover is isolated, 7000 hectares, and has villages on three sides of the reserve. The presence of carnivores and determination of inter-species interactions were measured over a year using randomly placed clusters of cameratraps. These cameratraps were placed for a period of 4 to 6 weeks before being moved to the next location.

Permanent cameratraps were also placed on the interface between the reserves and the villages. Data was entered into Excel and then mapped in ArcGIS 10.4.1 and analysed with ordinary Kriging. The presence of each species was determined for each location and the Mackenzie model was used to determine the daily detection probability. Hyenas *(Crocuta crocuta)* are the most abundant specie present on both reserves. The most abundant species present in Manyeleti were Hyena and Lion *(Panthera leo)*. In Andover the only apex predator present was leopard, while serval, caracal *(Felis caracal)*, mongoose are also present. Some locations where shared among carnivore species, while other areas had no carnivore species detected at all. Areas with prey species, water and access routes to water had the highest probability of carnivore detection.

Institutions, Governance, and the Economic Performance of Protected Areas in Southern Africa

Chidakel, A.

School of Natural Resources and Environment, University of Florida

Though wildlife has been demonstrated to hold an economic comparative advantage in dryland areas of southern Africa, public and private investment in this land use varies significantly. This variation exists both between countries with different institutional regimes for wildlife, and between land ownership categories within countries. From an institutional economic perspective, allocation of resources to wildlife-based land uses, and value generated in consequence, is hypothesized to be in relation to the degree to which rights to own wildlife and responsibility for management are devolved to the scale at which wildlife is produced. Within and between country variation in tenurial and resource governance arrangements therefore presents an opportunity to test predicted relationships with economic efficiency and to explore the implications of institutions on the equity of value distribution.

Economic impact analyses, which measure local value in terms of income, jobs, and value added, are becoming increasingly common of national parks, though they are not often aligned in scale with local areas, and their application to non-statutory protected areas (PAs), where the stakes for rural communities are arguably higher, is rare. In this study, local impact analysis forms the basis of a cross-sectional comparison of the economic value of public, private, and communal PAs of the Greater Kruger Area of South Africa, and of the southern Luangwa Valley in Zambia. The focus of this presentation is on a detailed unpacking of the economic impacts and implications of ecotourism at South Luangwa NP vis-à-vis the impacts of consumptive wildlife utilization in the communal buffer zone surrounding the park and the underlying institutional factors accounting for discrepancies between the two PA types.

Understanding sustainable tourism development and responsible tourism practices in the Kruger National Park: measuring visitor perceptions and experiences against sustainability assessment outcomes

Douglas, A.[1], Wessels, J.A.[2], Retief, F.[2], Fairer-Wessels, F.[1], Morrisson-Saunders, A.[3], Pope, J.[2] & Hughes, M.[3]

[1]*Division: Tourism Management, Department of Marketing Management, University of Pretoria*
[2]*School of Geo and Spatial Sciences, Department of Geography, North West University*
[3]*School of Environmental Science, Murdoch University*

anneli.douglas@up.ac.za; janalbert.wessels@nwu.ac.za; francois.retief@nwu.ac.za; felicite.fairer-wessels@up.ac.za; a.Morrison-Saunders@murdoch.edu.au; jenny@integral-sustainability.net; M.Hughes@murdoch.edu.au

Sustainable tourism development and responsible tourism practices in SANParks are supported by decision making tools such as Environmental Impact Assessments (EIAs) and results from visitor perception and experience surveys. It is thus important to combine these instruments in order to enhance their quality, effectiveness and purpose in the context of sustainability within protected areas. The study has two phases. In the first phase a sustainability assessment and follow-up framework is conceptualised, after which EIA reports from the Kruger National Park are appraised against the framework to determine the extent to which the assessment of SANParks' tourism related infrastructure projects are aligned with sustainability principles and requirements. This paper presents the results of the first phase. While sustainability is critically important, tourist revenue is equally important for funding SANParks' conservation mandate.

In their strategic plan, SANParks further states that "…the continued improvement of the tourism plant with additional infrastructure funding will help increase our market-share as visitors become more attracted to our competitive product offerings…" Tourists will only become attracted to SANParks' product offering if they perceive and experience these products as being able to satisfy their needs whilst remaining within the parameters of sustainable tourism development and responsible tourism practices. This leads to the second phase of the study which is to test visitor perceptions and experiences on the outcomes from the EIA appraisals in the first phase (to commence June 2017). Based on the findings from these two phases, recommendations could be made to align these decision making tools to assist in the quest of achieving the principles of sustainable tourism development and responsible tourism practices.

Biological invasions in South African National Parks

Foxcroft, L.[1, 2], van Wilgen, N.[3, 2], Baard, J.[4] & Cole, N.[5]

[1]*Scientific Services, South African National Parks*
[2]*Centre for Invasion Biology, Stellenbosch University*
[3]*Cape Research Centre, South African National*
[4]*Garden Route Scientific Services, South African National Parks*
[5]*Biodiversity Social Projects, South African National Parks*

Llewellyn.foxcroft@sanparks.org; Nicola.Bredenkamp@sanparks.org; johan.baard@sanparks.org; nicholas.cole@sanparks.org

South African National Parks' (SANParks) mandate emphasises biodiversity conservation and the maintenance of functional ecosystems. The ability to prevent and mitigate alien species' impacts will have long-term effects on achieving these objectives. As protected areas are increasingly recognised as core components of moderating global environmental change, SANParks has a national and international obligation to contribute to these aims. The pervasive effects of invasive alien species are recognised as one of the leading drivers of global environmental change and protected areas are not immune. SANParks has listed 869 alien and extra-limital species across its 39,000 km2 estate, including 752 plants and 117 animals. Since 2000/2001 most work has focused on the control of 101 priority invasive alien plants, with about R590 million spent by the Working for Water/Biodiversity Social Programmes.

At least 39 biocontrol agents have been released as part of a long-term management response. The 2016 Alien and Invasive Species Regulations of the National Environmental Biodiversity Act (Act No. 10 of 2003, hereafter NEMBA) require landowners to develop management plans for alien and invasive species. Of the total species in SANParks, 263 are listed by NEMBA, including 12 category 1(a), 184 category 1(b), 28 category 2 and 39 category 3 species. The large number of listed species and associated control costs necessitates that SANParks prioritise parks and species to maximise outcomes. We provide a short synopsis of i) what alien species are present in SANParks, ii) the species and parks that management has focused on, iii) the implications of the NEMBA Invasive Alien Species Regulations, and iv) future developments.

Form infers processes: patterns of alien plant invasion within geomorphic features of the Sabie River, Kruger National Park

Sibiya, T.E.[1, 2], Esler, K.J.[2] & Foxcroft, L.C.[1, 3]

[1]*Scientific Services, South African National Parks, Skukuza 1350, South Africa*
[2]*Centre for Invasion Biology, Department of Conservation Ecology and Entomology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa*
[3]*Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa*

thabang.sibiya@sanparks.org, kje@sun.ac.za, llewellyn.foxcroft@sanparks.org

Assessing patterns of abundance and density of alien plants is an important question in invasion ecology as it can be indicative of the processes underlying successful invasion. For an alien plant to invade successfully, it must be deposited into suitable habitat. Riparian zones consist a mosaic of plant communities that vary according to the habitat types, formed by the geomorphic units and channel types that have unique physical environments. The aim of this study was to associate abundance and density patterns of alien riparian plant communities with the geomorphic units and channel types of the riparian zones of Sabie River in Kruger National Park. We collected data in February 2015, recording all species and their abundance (number of individuals), their functional traits (shrubs, trees, climbers, annual, perennial, biennial) and the geomorphic units (e.g. lateral bar) and channel types (e.g. braided). The count data (abundance) and density (individuals per area) were also analysed using a Generalised linear model. There was a significant relationship between changes in geomorphic units or channel type, with abundance or density of alien plants. Density of herbaceous alien plants was greatest in the alluvial dominant geomorphic features, similarly the density of alien shrubs was greatest in the alluvial dominant habitat types.

Alien plant were denser in the lateral bar, braided bar and levee and significantly denser in vegetated side bar. Density of herbaceous alien plants was highest in the alluvial dominant channel types, namely: braided and mixed anastomosing channel types. Where herbaceous alien and native plants shared functional traits, alien plants were significantly more abundant than native plants. Woody alien plants did not vary with geomorphic units or channel types. This most likely is due to the efficacy of management actions in the control woody alien plant or hence, the low counts of woody alien species (1% of total woody counts and 6% species richness). The preference for alluvial dominated geomorphology by herbaceous alien plants suggests that the regular disturbance in these areas allows for frequent reintroduction thus allowing alien plants to dominate the native plants. The association with the vegetated bar by herbaceous alien plants may suggest that these sites provide enhanced nutrients and moisture conditions, allowing alien plants to grow quicker and out compete the native plants. These results suggest that the physical environments of riparian habitats is an important factor in the establishment of alien plants.

When should we burn to control invasive species? An example from Cerrado

Damasceno, G.F.[1] & Fidelis, A.[1]

[1]*Dep. de Botânica, UNESP – Univ. Estadual Paulista, Av. 24A, 1515, 13506-900, Rio Claro, Brazil*

fariadamasceno@hotmail.com

The African grasses *Melinis minutiflora* and *Urochloa decumbens* are one of the major threats to the biodiversity and restoration of Cerrado, the Brazilian Neotropical Savanna. Their removal from natural systems is urgent and fire could be an option for their management at large scale. We aimed to evaluate the use of prescribed burns at different fire seasons to control these species. Our major hypothesis was that fire would be more successful in reducing the dominance of the invasive species and favoring native species when the invaders were reproducing. Thus, we have tested three fire seasons: early- (May), mid- (July) and late-fires (October), all performed in 2014. We established 4 plots (15X15m) per treatment (and 4 control plots) for each species (total of 32 plots).

Our study area was an open savanna under natural regeneration since 2000 after the removal of a pine trees plantation. We sampled biomass and vegetation cover over two years after the treatments, grouping the species by functional groups (graminoids, forbs, shrubs and invasive species). The best time to control *M. minutiflora* is at the mid-dry season (July), since fires reduced significantly the cover of this invader and the native vegetation was favored. Late-fires were also efficient to control *M. minutiflora*, but this treatment led to a new invasion by *U. decumbens*. This specie, on the other hand, did not have its cover and biomass reduced by fires at any season, and thus, fire should not be recommended to control *Urochloa decumbens.*

Population dynamics and ecological impacts of *Tarebia granifera* in the Sabie River, Kruger National Park

Tye, D.[1], Govender, D.[2], Foxcroft, L.[2], Bouchard, E.[3], Black, B.[4], Boyer, J.[5] & Seto, I.[6]

[1]*Organisation for Tropical Studies*
[2]*Scientific Services, Kruger National Park*

donovan.tye@tropicalstudies.org; danny.govender@sanparks.org; llewellyn.foxcroft@sanparks.org

An invasive gastropod native to south-east Asia, *Tarebia granifera* (Lamarck, 1822), has invaded a variety of freshwater habitats in sub-tropical regions of South Africa. *Tarebia granifera* was first reported in Kruger National Park (KNP) in 2006, and is the most aggressive invasive gastropod in the park due to the species' ability to spread rapidly and dominate benthic communities. Over the past decade, *T. granifera* has established in all major river systems in KNP, as well as a variety of natural and artificial standing water bodies. However, the population dynamics and ecological impacts of this species in freshwater habitats in semi-arid environments is unclear. Here, we assess the population dynamics and benthic community impacts of *T. granifera* in the Sabie River in KNP. *Tarebia granifera* density and size structure were measured at 12 sites in the Sabie River during four sampling periods between 2014 and 2016.

No consistent seasonal trend in *T. granifera* densities was observed, however, increased mean densities (from 36 ind.m^{-2} in 2014 to 75 ind.m^{-2} in 2016) suggest continued spread and population growth during a period of below average rainfall and prolonged low flows. We also demonstrate that *T. granifera* dominates benthic invertebrate communities in the Sabie River. However, despite a broad range in *T. granifera* densities across sites (0 to 905 ind.m^{-2}), *T. granifera* does not appear to markedly affect the diversity of native benthic invertebrate communities. High density sites (over 500 ind.m^{-2}) were dominated by juvenile individuals which are the most susceptible to displacement and dispersal during high flows. The current drought might therefore facilitate the establishment of high density populations in KNP. This study serves as baseline for future work aimed at quantitatively assessing how population density, size structure and ecological impacts of *T. granifera* interact with environmental stressors across three rivers in the KNP.

Leaf display strategies across savannas

Archibald, S.[1], Lehmann, C.[2] & Mitchard, E.[2]

[1]*Centre for African Ecology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, Private Bag X3,WITS, 2050, South Africa*
[2]*School of GeoSciences, University of Edinburgh, Edinburgh, EH9 3JN, UK*

Sally.archibald@wits.ac.za; clehmann@staffmail.ed.ac.uk; edward.mitchard@ed.ac.uk

One of the key characteristics of most savanna systems is that the dormant season is driven not by low temperatures but by water limitation. While most angiosperms are similarly constrained by low temperatures, solutions to the constraint of low soil moisture are more varied - both within and between different plant growth forms. This makes savanna ecosystems difficult to model: as yet we have no predictive framework for determining the conditions which with result in different "phenological functional types".

Here we discuss how important it really is to accurately depict savanna leaf dynamics – in relation to carbon and nutrient cycling in these ecosystems, and also explore how the patterns of leaf display across savannas can give insights into differences in the functioning of these structurally-similar, but functionally very diverse ecosystems.

Early-greening linked to herbivory avoidance, not to longer growing seasons for two savanna trees

Whitecross, M.A.[1], Twala, T.C.[1], Springer, Tamlyn [1], Archibald, Sally [1] & Witkowski, Ed T.F. [1]

[1]*School of Animal, Plant and Environmental Science, University of the Witwatersrand, Johannesburg, 2050, South Africa*

mwhitecross@gmail.com; Thando.Twala2@students.wits.ac.za; tamlynspringer@gmail.com; Sally.Archibald@wits.ac.za; Ed.Witkowski@wits.ac.za

Early-greening is a phenological phenomenon which refers to the flushing of new leaves by deciduous trees prior to the onset of seasonal rainfall. Savannas are the only terrestrial ecosystems in which early-greening has been observed. Numerous hypotheses have been proposed regarding the benefits that early-greening trees gain by utilizing this seemingly risky strategy. We aimed to test two of these hypotheses which suggest that (1) early-greening trees extend their growing season beyond that of grasses and late-greening trees whose growth are limited by the onset of seasonal rainfall and (2) that early-greening trees avoid invertebrate herbivore damage to vulnerable new leaves at the start of the growing season.

We monitored the leaf phenology of two broad-leaved savanna trees (*Burkea africana* and *Terminalia sericea*) in relation to their chlorophyll content; leaf functionality and invertebrate herbivore damage over two growing seasons at the Nylsvley Nature Reserve. We also monitored environmental conditions including rainfall and soil moisture. New leaves early in the growing season had a negative carbon balance; and only showed positive photosynthetic rates after soil moisture increased. Our data suggest that an extended growing season may be less obvious than initially hypothesised. However; the phenological and physiological strategies employed by each tree species had a significant effect on the levels of herbivory experienced by new leaves at the start of the growing season confirming the potential for early-greening tree species to benefit from reduced invertebrate herbivory.

Linking tree growth rates and functional traits in savannas

Teegalapalli, K.[1]; Wigley, B.[1]; Augustine, D.J.[2], Ratnam, J.[1] & Sankaran, M.[1]

[1]National Centre for Biological Sciences; Tata Institute for Fundamental Research; GKVK campus; Bellary road; Bangalore 560 065; India
[2]Rangeland Resources Research Unit; USDA; Agricultural Research Service; 1701 Center Avenue; Fort Collins; CO 80526; USA

karthikt@ncbs.res.in; jratnam@ncbs.res.in; mahesh@ncbs.res.in

Asian savannas find their closest analogues in Africa. However; unlike African savannas; Asian savannas have been largely ignored; and little long-term information exists on savanna dynamics across most of Asia; including India. To fill this gap; we established multiple 1-ha long-term monitoring plots in savanna ecosystems in India where we are quantifying temporal patterns of tree growth and changes in carbon stocks. All trees in plots have been tagged (girth ≥ 10 cm) and tree growth rates monitored quarterly. Additionally; we have also collected data on the functional traits of the dominant tree species in the sites.

Here; we analyse linkages between tree growth rates and plant functional traits such as specific leaf area (SLA) and wood density (WD) in savanna ecosystems. Although SLA and WD have often been used as proxies for plant growth rates and resource acquisition strategies; few studies have evaluated how well these traits predict tree growth rates; particularly in savanna ecosystems. We argue that in savannas; where light is not likely a limiting factor and majority of the species are deciduous; SLA may not be as well correlated with tree growth rates as wood density. We use data from our long-term plots in Indian savannas; and additionally couple them with similar long-term initiatives from East and Southern Africa; where plant functional traits and growth rates have been likewise quantified; to investigate how commonly measured plant functional traits such as SLA and WD reflect observed patterns of tree growth across diverse savannas in the Old-world.

An investigation of seed size variation across southern Africa: patterns and drivers

Greve, M.[1], Fisher-Botha, C.[1], Jamison, S.L.[1], van Wyk, A.E.[1] & Daru, B.H.[1, 2]

[1]*Department of Plant and Soil Sciences, University of Pretoria, Pretoria, 0002, South Africa*
[2]*Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, MA 02138, USA*

u13034881@tuks.co.za; samjam@live.co.za; braamvanwyk@gmail.com; darunabas@gmail.com; michelle_greve@yahoo.com

Seed mass is an important ecological trait that influences species' regeneration strategies and can be strongly influenced by environmental conditions. However; relatively little is known about patterns of seed size at large spatial scales. Here we investigated patterns of seed size of woody species across southern Africa; and tested which environmental drivers might be influential determinants of seed size. Seed mass was collected for 950 species of southern African woody species from 408 genera across 134 families. Using distribution maps of southern African trees; the mean and median seed mass per quarter degree cell was plotted for the region.

The relationship between seed mass and a number of potential environmental drivers (mean annual temperature; mean annual precipitation; temperature seasonality; precipitation seasonality; fire frequency and biome identity) was tested using simultaneous autocorrelation regression models. Because seed size metrics are constrained by local species richness; we also used a resampling technique to test the effect of richness on seed size. Generally; there was an increasing trend in seed size from the east to the west coast. Seed size was larger in warmer; wetter and more seasonal environments. We conclude that the seed size of trees is significantly influenced by environmental factors across southern Africa.

Natural history of *Zamia boliviana* (CYCADALES, ZAMIACEAE) from Brazilian cerrado savanna

Segalla, R.[1, 2], Morellato, L.P.C.[2] & Pinheiro, F.[3]

[1]*Instituto Federal de Educação, Ciência e Tecnologia de Mato Grosso – Campus Cáceres, Avenida dos Ramires, s/n, 78200-000, Mato Grosso, Brazil*
[2]*Universidade Estadual Paulista UNESP, IB, Departamento de Botânica, Laboratório de Fenologia, CEP 13506-900, Rio Claro, SP, Brazil*
[3]*Departamento de Biologia Vegetal, Instituto de Biologia, IB, Universidade Estadual de Campinas, Campinas, SP, Brazil*

rosane.segalla@cas.ifmt.edu.br; pmorella@rc.unesp.br; biopinheiro@yahoo.com.br

Zamiaceae is a family of gymnosperms with about 10 genera and 200 species, most in Zamia and Encephalartos. The unique species, most at risk of extinction, are represented by small populationdistributed across Oceania, Africa and the Neotropics. *Zamia boliviana* (BRONGN.) A. DC (Cycadales, Zamiaceae) is an endangered species with a restrict distribution, actually known only from Brazilian cerrado savanna and Pantanal (Mato Grosso State) and Bolívia (La Paz and Santa Cruz Province), and poorly known regarding its ecology and natural history. We aim to characterize the habitat of occurrence, population structure and sexuality of two populations of Z*. boliviana* from the Brazilian cerrado savanna at Tarumã, (16º 15' 51.7 S and 058º 11' 15.9" W, 244 m) and Vale Bonito (15º 52'18.9S and 058º 08'09.0" W; 301 m).

We sampled the Zamia individuals in 21 plots of 400 m^2 per site. For each plot we sampled the soil type and measured canopy openness using hemispheric photography. Zamia was observed in several vegetation types in the study areas: cerrado *strictu sensu*, cerradão, riverine forest, seasonal forest and "capões" a typical vegetation from Brazilian Pantanal. *Zamia boliviana* occurred on different types of sandy, well drained Oxisols. Canopy openness averaged 63%, and the density of individuals per hectare was 42 and 53 at Vale Bonito and Tarumã, respectively. We confirmed the dioecy of *Z. boliviana* and the preference for cerrado vegetation, but more studies of *Zamia boliviana* reproductive biology, phenology and genetic diversity are urgent to ensure the local conservation and management.

POSTER

Studies to detect the potential distribution of *Sclerocarya birrea* in the southern part of the Kruger National Park

Lenfers, U.[1], Wigley, B.[2, 3], Ndlovu, V.[4], Brüggemann, R.[5] & Clemen, T.[1]

[1]*Dept. of Computer Science, Hamburg University of Applied Sciences, Germany*
[2]*National Centre for Biological Sciences, Tata Institute of Fundamental Research, GKVK, Bellary Road, Bangalore, 560 065, India*
[3]*School of Natural Resource Management, Nelson Mandela Metropolitan University, Saasveld Campus, South Africa*
[4]*SANParks, Skukuza*
[5]*Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department Ecohydrology*

ulfia.lenfers@haw-hamburg.de; benwigley@gmail.com; brg_home@web.de; thomas.thiel-clemen@haw-hamburg.de

A comparison of the current and potential distributions of selected tree species; e.g. *Sclerocarya birrea* (Marula) could potentially be used to detect shifting species distributions; which will become increasingly important in the light of global climate change. A thorough understanding of the main factors affecting the potential distributions of indicator tree species is therefore necessary. The mathematical concept of partial orders; in combination with Hasse diagrams may help to improve our understanding of the potential distribution of Marula in the southern part of the Kruger National Park (KNP).

Correlations between soil properties and the functional traits of Marula will be presented. Two locations within the KNP were sampled in March 2016 to validate these results. For all Marulas within these sections the GPS-coordinates; stem circumference; height; damage class; age class; and stem–stem-distance between Marula trees were measured and analysed. We found differences in age class distributions between the two sites. Surprisingly; despite the fact that young Marulas are generally rare in the KNP almost 50% of the population at one site are not in an adult state.

DELEGATE LIST

Surname	Name	Title	Organisation	Email	Abstract (pg.#)
Alvarado	Swanni	Dr	Universidade Estadual Paulista/ University of the Witwatersrand	swanni_ta@yahoo.es	122
Ampeng	Ahmad	Dr	Forest Department Sarawak, Malaysia	ahmada@sarawak.gov.my	
Andersen	Alan	Prof	Charles Darwin University	alan.andersen@csiro.au	35
Annecke	Wendy	Dr	SANParks	wendy.annecke@sanparks.org	14
Archibald	Sally	Prof	University of the Witwatersrand	sally.archibald@wits.ac.za	19,47,77, 90,94,103 ,119,120, 121,141 & 142
Armstrong	Doug	Dr	Omaha's Zoo	douga@omahazoo.com	
Attorre	Fabio	Prof	Sapienza University of Rome	fabio.attorre@uniroma1.it	74
Baade	Jussi	Dr	Department of Geography, FSU Jena, Germany	cub@uni-jena.de	33,34,67 & 68
Bailey	Karen	Ms	University of Florida	karen.bailey@ufl.edu	12
Balme	Guy	Dr	Panthera	gbalme@panthera.org	
Bam	Sipokazi	Ms	SANParks	sipokazi.bam@sanparks.org	
Barber-James	Helen	Dr	Albany Museum	h.james@ru.ac.za	113 & 114
Batista	Eugenia	Miss	Federal University of Minas Gerais	biogenia.k@gmail.com	123
Beckett	Heath	Mr	University of Cape Town	heath.beckett@uct.ac.za	
Beechler	Brianna	Ms	Oregon State University	breebeechler@gmail.com	55,56,57, 58,60,61, &63
Bond	William	Prof	SEAON	William.bond@uct.ac.za	43,44,45, 46,90 & 92
Borrego	Natalie	Miss	University of Kwazulu-Natal	nborrego@bio.miami.edu	
Bosch	Almero	Mr	Timbavati Private Nature Reserve	almero@timbavati.co.za	
Boshoff	Willem	Mr	North West Department of READ	wboshoff@nwpg.gov.za	
Botha	Judith	Mrs	SANParks	judith.botha@sanparks.org	79 &104
Botha	Monique	Miss	North West University	moniquebotha210@gmail.com	

Brade	Thomas	Mr	University of Edinburgh	thom.brade@ed.ac.uk	23
Buijs	Daan	Mr	North West Department of READ	buijsdaan@gmail.com	
Buisson	Elise	Dr	Universite d'Avignon	elise.buisson@univ-avgnon.fr	
Bunney	Katherine	Ms	University of Pretoria	katherine.bunney@gmail.com	
Cardoso	Anabelle	Ms	University of Oxford	anabellecardoso@gmail.com	46
Case	Madelon	Miss	Yale Univesity	madelon.case@yale.edu	70
Chamaille-Jammes	Simon	Dr	CNRS	simon.chamaille@cefe.cnrs.fr	
Charles-Dominique	Tristan	Dr	University of Cape Town	tristan@xtbg.ac.cn	
Chidakel	Alex	Mr	University of Florida	achidakel@ufl.edu	135
Clemen	Thomas	Prof	Hamburg University of Applied Sciences	thomas.thiel-clemen@haw-hamburg.de	87,100 & 146
Combrink-Cilliers	Anica	Mrs	North West University	anicacombrink@gmail.com	104
Conradie	Chris	Mr	Human Wildlife Solutions	chris@hwsolutions.co.za	53
Cook	Robin	Mr	University of the Witwatersrand	robinmichaelcook@gmail.com	102
Couch	Claire	Ms	Oregon State University	clairecouch.harpist@gmail.com	53
Coulson	Tim	Prof	University of Oxford	tim.coulson@zoo.ox.ac.uk	50
Cromsigt	Joris	Dr	Swedish University of Agricultural Science	jcromsigt@hotmail.com	78,&129
Carruthers	Jane	Prof	University of South Africa	j.carruthers@mweb.co.za	89
Dabengwa	Abraham	Mr	University of Cape Town	abrahamdabengwa@gmail.com	92
Damasceno	Gabriella	Miss	Universidade Estadual Paulista (UNESP)	fariadamasceno@hotmail.com	139
Davies	Andrew	Dr	Carnegie Institution	adavies@carnegiescience.edu	30, 105 & 131
De Bie	Steven	Prof	Wageningen University	steven.debie@gemeynt.nl	
De Bruyn	Nico	Dr	University of Pretoria	pjndebruyn@zoology.up.ac.za	84 & 85
Dlamini	Thobile	Ms	SEAON	dave@saeon.ac.za	
Donaldson	Jason	Mr	University of the Witwatersrand	jedonaldson6@gmail.com	47,94 & 119
Douglas	Anneli	Dr	University of Pretoria	anneli.douglas@up.ac.za	136
Druce	Dave	Dr	Ezemvelo KZN Wildlife	dave.druce@kznwildlife.com	
Everatt	Kristoffer	Mr	Nelson Mandela Metropolitan University	kteveratt@gmail.com	132
Fairer-Wessels	Felicite	Prof	University of Pretoria	ffairerwessels@gmail.com	136
February	Ed	Prof	University of Cape Town	Edmund.February@uct.ac.za	21, 33
Ferreira	Sam	Dr	SANParks	sam.ferreira@sanparks.org	42
Fidelis	Alessandra	Dr	Universidade Estadual Paulista (UNESP)	afidelis@rc.unesp.br	128 &139

Forssman	Kath	Ms	University of Pretoria, Onderstepoort	banie.penzhorn@up.ac	59
Foxcroft	Llewellyn	Dr	SANParks	llewellyn.foxcroft@sanparks.org	137, 138 & 140
Fritz	Herve	Dr	CNRS & NMMU	herve.fritz@univ-lyon1.fr	10,11 & 99
Gaillard	Jean-Michel	Dr	CNRS	jean-michel.gillard@univ-lyon1.fr	
Gaylard	Angela	Mrs	SANParks	angela.gaylard@sanparks.org	83 & 105
Gelin	Uriel	Dr	Xishuangbanna, Tropical Botanical Garden	uriel@xtbg.ac.cn	
Glidden	Caroline	Ms	Oregon State University	gliddeca@science.oregonstate.edu	60
Govender	Danny	Dr	SANParks	danny.govender@sanparks.org	27,28,32, 62,74,112 ,119 &140
Greve	Michelle	Dr	University of Pretoria	michelle_greve@yahoo.com	94 &144
Grundy	Isla	Prof	University of Zimbabwe	isla.grundy@gmail.com	
Guerbois	Chloe	Dr	Nelson Mandela Metropolitan University	chloe.guerbois@nmmu.ac.za	10 &11
Guillet	Alfredo	Prof	Sapienza University of Rome	alfredo.guillet@gmail.com	
Hannweg	Karin	Ms	Agricultural Research Council	Karin@arc.agric.za	15 & 16
Hedin	Lars	Prof	Princeton University	lhedin@princeton.edu	44 & 45
Hempson	Gareth	Mr	SEAON	ghempson@gmail.com	47 & 90
Henley	Michelle	Dr	Save the Elephants - South Africa	michelephant@savetheelephants.org	101, 102 &106
Herbst	Marna	Dr	SANParks	marnah@sanparks.org	24
Hlongwane	Zabentungwa	Miss	University of Kwazulu-Natal	nolwazihlongwane20@gmail.com	37
Hofmeyr	Michele	Mrs	SANParks	michele.hofmeyr@sanparks.org	15,16,83 &85
Holland	Alexandra	Dr	Albany Museum	a.holland@am.org.za	113
Hughes	Michael	Dr	Murdoch University	m.hughes@murdoch.edu.au	136
Humphrey	Glynis	Miss	University of Cape Town	humphrey.glynis@gmail.com	124
Isden	Jess	Dr	Elephants for Africa	jess@elephantsforafrica.org	51
Jackson	Craig	Mr	Norwegian University of Science & Technology	craigj@bio.ntnu.no	31 & 125
Jacobs	Steve	Mr	NSW Environmental Protection Agency	tally.palmer@ru.ac.za	
Jakins	Cath	Miss	University of Kwazulu-Natal	cathjakins@hotmail.com	
Janecke	Bea-nelri	Dr	University of the Free State	janeckbb@ufs.ac.za	31
Kansky	Ruth	Dr	University of Stellenbosch	kanskyruth@gmail.com	49
Khosa	Steven	Mr	SANParks	Steven.Khoza@sanparks.org	

Kiker	Greg	Prof	University of Florida	gkiker@ufl.edu	100
Kreuter	Urs	Prof	Texas A&M University	urs@tamu.edu	
Kruger	Fred	Dr	Organization for Tropical Studies	fkruger.za@gmail.com	
Lagendijk	Georgette	Dr	University of Kwazulu-Natal	georgette.lagendijk@gmail.com	
Le Roex	Nikki	Dr	University of Cape Town	nikki.leroex@uct.ac.za	83
Le Roux	Elizabeth	Dr	Nelson Mandela Metropolitan University	elizabeth.loza.le.roux@gmail.com	
Lehmann	Caroline	Dr	University of Edinburgh	caroline.lehmann@ed.ac.uk	9 & 141
Lenfers	Ulfia	Mr	Hamburg University of Applied Sciences	thomas.thiel-clemen@haw-hamburg.de	87 &146
Lerm	Rion	Mr	SEAON	rion@saeon.ac.za	111
Linden	Ellie	Miss	University of Connecticut	helanie.linden@uconn.edu	107
Loggins	Annie	Miss	University of Florida	aloggins@ufl.edu	75
Louw	Cornelius	Dr	Unisa	louwcj@gmail.com	
Lu	Mingzhen	Mr	Princeton University	mingzhen@princeton.edu	44
Mabika	Cheryl	Ms	RP-PCP	tcmabika@gmail.com	54
Mabila	Kenneth	Mr	eThekwini Municipality	kennethmabila@durban.gov.za	
Mabuza	Samantha	Miss	SANParks	samantha.mabuza@sanparks.org	
Malatesta	Luca	Dr	University of Rome - Sapienza	luca.malatesta@unifromal1.it	
Malhi Malhi	Yadvinder	Prof	University of Oxford	yadvinder.malhi@ouce.ox.ac.uk	
Manganyi	Adolf	Mr	SANParks	adolf.mangnayi@sanparks.org	
Marchal	Antoine	Mr	University of Pretoria	marchal.ant@gmail.com	84
Marshall	Amy	Ms	SEAON	dave@saeon.ac.za	13
Mathieu	Renaud	Dr	CSIR	tmntungwa@csir.co.za	66
McCleery	Bob	Dr	University of Florida	ramccleery@ufl.edu	12,75 &76
Messina	Mario	Dr	Sapienza University of Rome	mario.messina@uniroma1.it	74
Midlane	Neil	Dr	Singita	neil.m@singita.com	
Mills	David	Mr	University of KwaZulu Natal and Panthera	africanleopard@gmail.com	
Mitchard	Edward	Dr	Universityof Edinburgh	edward.mitchard@ed.ac.uk	126 &141
Mokobela	Masego	Miss	Elephants Alive	masego@elephantsforafrica.org	
Mpanza	Nokukhanya	Miss	SANParks	Nokukhanya@sanparks.org	32
Mudzengi	Clarice	Ms	CIRAD/UZ	clarice.mudzengi@gmail.com	79
Mumby	Hannah	Dr	University of Cambridge	hsm29@cam.ac.uk	106
Munyai	Caswell	Dr	University of Kwazulu-Natal	munyaic2@ukzn.ac.za	36,38,40 & 43
Munyai	Lufuno	Mr	SANParks	lufuno.munyai@sanparks.org	36

Mwabvu	Taro	Dr	University of Mpumalanga	tarombera.mwabvu@ump.ac.za	37 & 39
Myburgh	Albert	Mr	University of Pretoria	u12034542@tuks.co.za	
Ngobeni	Miyelani	Mr	Department of Agriculture, Forestry and Fisheries	miyelanin@daff.gov.za	
Ngwenya	Reuben	Mr	SANParks	reuben.ngwenya@sanparks.org	
Nippert	Jesse	Prof	Kansas State University	nippert@kisu.edu	71
Ntshane	Claire	Miss	SANParks	claire.ntsane@sanparks.org	
Nzima	Noel	Mr	SANParks	noel.nzima@sanparks.org	
Owen-Smith	Norman	Prof	University of the Witwatersrand	Norman.Owen-Smith@wits.ac.za	77 & 93
Palmer	Tally	Prof	Rhodes University	tally.palmer@ru.ac.za	108
Palmer	Tony	Dr	Agricultural Research Council	palmert@arc.agric.za	26
Parr	Kate	Dr	University of Liverpool	Kate.Parr@liverpool.ac.uk	9,30,47,119
Peel	Mike	Dr	ARC	mikep@arc.agric.za	29
Pellegrini	Adam	Dr	Standford University	afapellegrini@gmail.com	125
Petersen	Robin	Mr	SANParks	robin.petersen@sanparks.org	27,28,117 &118
Pienaar	Danie	Mr	SANParks	Dpienaar@sanparks.org	112
Pienaar	Kobus	Prof	North West University	kobus.pienaar@nwu.ac.za	88
Pocock	David	Mr	Private	davidwpocock@gmail.com	109
Postma	Martin	Dr	University of Pretoria	mpostma@zoology.up.ac.za	85
Power	John	Mr	North West Provincial Government	jpower@nwpg.gov.za	
Pysek	Petr	Prof	Charles University, Prague, Czech Republic	pysek@ibot.cas.cz	
Pyskova	Klara	Miss	Charles University, Prague, Czech Republic	klarapyskova@hotmail.com	
Quintano	Paula Nieto	Ms	University of Edinburgh	paula.nieto@ed.ac.uk	126
Ramoelo	Abel	Dr	CSIR	abel.ramoelo@gmail.com	80
Ransom	Caitlin	Miss	University of the Witwatersrand	caitlin.ransom@gmail.com	103
Ratnam	Jayashree	Dr	National Centre for Biological Sciences	jratnam@ncb.res.in	48,81,96 &143
Retief	Francois	Prof	North West University	francois.retief@nwu.ac.za	136
Richardson	Philip	Dr	Human Wildlife Solutions	phil@hwsolutions.co.za	53
Riddel	Eddie	Dr	SANParks	Eddie.Riddell@sanparks.org	27,109,116 &117
Ryan	Casey	Dr	University of Edinburgh	casey.ryan@ed.ac.uk	17,60,65& 126
Sankaran	Mahesh	Dr	National Centre for Biological Sciences	mahesh@ncbs.res.in	48,81,98,

					143
Schaller	Ray	Mr	North West Provincial Government	rschaller@nwpg.gov.za	
Schmitt	Melissa	Dr	SEAON	dave@saeon.ac.za	
Schmullius	Christiane	Prof	Friedrich-Schiller-University	c.schmullius@uni-jena.de	67,68 &69
Scholes	Bob	Prof	University of the Witwatersrand	Bob.Scholes@wits.ac.za	19,22,25, & 78
Scholtz	Rheinhardt	Dr	Oklahoma State University	r.scholtz@okstate.edu	127
Schrama	Maarten	Dr	University of Leiden, The Netherlands	maartenschrama@gmail.com	63
Scogings	Peter	Prof	University of Kwazulu-Natal	scogingsp@ukzn.ac.za	95 & 98
Shikwambana	Purvance	Miss	SANParks	purvance.shikwambana@sanparks.org	27 & 28
Shrader	Adrian	Dr	University of Kwazulu-Natal	shrader@ukzn.ac.za	93
Sibiya	Thabang	Miss	SANParks	thabang.sibiya@sanparks.org	138
Siebert	Frances	Mrs	North West University	frances.siebert@nwu.ac.za	95 & 104
Sikhwivhilu	Thomas	Mr	National Zoological Gardens/SAEON	dave@saeon.ac.za	22
Simms	Chenay	Miss	SANParks	chenay.simms@sanparks.org	
Singh	Jenia	Ms	Max Planck Institute for Biogeochemistry	jsingh@bgcjena.mpg.de	69
Sisson	Danielle	Ms	University of Melbourne	dsisson@student.unimelb.edu.au	57
Sithole	Hendrik	Mr	SANParks	hendrik.sithole@sanparks.org	27, 28 & 36
Skhosana	Felix	Mr	University of the Witwatersrand	felix.mvusan@gmail.com	120
Slotow	Rob	Prof	University of KwaZulu Natal	Slotow@ukzn.ac.za	
Smit	Izak	Dr	SANParks	izak.smit@sanparks.org	64,66,74, 80,107,11 4,121 & 123
Snyman	Andrei	Dr	Mashatu Research	andrei.snyman@gmail.com	
Songhurst	Anna	Dr	Ecoexist	anna.songhurst@hotmail.com	50,52
Staver	Carla	Dr	Yale Univesity	carla.staver@yale.edu	64,70 & 125
Stevens	Nicola	Dr	University of Stellenbosch	nicolastvns@gmail.com	19
Stirzaker	Richard	Dr	CSIRO	richard.stirzaker@csiro.au	109
Strydom	Tercia	Miss	SANParks	tercia.strydom@sanparks.org	27,32,116 117 & 118
Swemmer	Tony	Dr	SEAON	tony@saeon.ac.za	71, 72, 111 & 116

Swemmer	Louise	Mrs	SANParks	louise.swemmer@sanparks.org	13,15,16, 71 & 72
Taylor	Robert	Mr	Ground Truth/SEAON	dave@saeon.ac.za	28 & 73
Te Beest	Mariska	Dr	Wageningen University	mariskatebeest@hotmail.com	21
Teegalapalli	Karthik	Dr	National Centre for Biological Sciences	karthikt@ncbs.res.in	143
Traeholt	Carl	Dr	Copenhagen Zoo, Southeast Asia Programme	ctraeholt@gmail.com	86
Traill	Lochran	Dr	Liverpool John Moores University	lochran.traill@gmail.com	
Trisos	Matthew	Mr	University of Cape Town	trisosm@hotmail.com	30
Trotter	Felix	Mr	University of Edinburgh	felix.trotter@ed.ac.uk	
Twine	Wayne	Prof	University of the Witwatersrand	wayne.twine@wits.ac.za	
Tye	Donovan	Mr	Organisation for Tropical Studies	donovan.tye@tropicalstudies.org	140
Van Coller	Helga	Miss	North West University	21119465@nwu.ac.za	95
Van der Merwe	Izak	Mr	Department of Agriculture, Forestry and Fisheries	izakvdm@daff.gov.za	
Van der Weyde	Leanne	Ms	Cheetah Conservation Botswana	leannevdw@gmail.com	
Venter	Freek	Dr	SANParks	freek.venter@sanparks.org	10
Venter	Jan	Dr	Nelson Mandela Metropolitan University	Jan.Venter@nmmu.ac.za	27
Vogel	Susanne	Miss	University of Oxford	susanne.vogel@zoo.ox.ac.uk	50
Voysey	Michael	Mr	University of Pretoria	mick.voysey@gmail.com	94
Wentzel	Jeanette	Ms	University of Pretoria	jeanette.wentzel@up.ac.za	134
Wessels	Jan-Albert	Dr	North West University	janalbert.wessels@nwu.ac.za	136
Whitecross	Melissa	Miss	University of the Witwatersrand	mwhitecross@gmail.com	142
Wigley	Ben	Dr	National Centre for Biological Sciences	benwigley@gmail.com	96,143 &146
Wigley-Coetsee	Corli	Dr	SANParks	Corli.Coetsee@sanparks.org	72
Wilken	Ria	Mrs	UmSinsi Enviornmental Specialists	Ria.wilken@telkomsa.net	
Williams	Matthew	Prof	University of Edinburgh	mat.williams@ed.ac.uk	18
Wilson	Sally	Ms	University of the Witwatersrand	12wilsonsa@gmail.com	
Woodborne	Stephen	Prof	iThemba LABS	swoodborne@tlabs.ac.za	20 &112
Zambatis	Guin	Mrs	SANParks	guin.zambatis@sanparks.org	82 & 114

The 2017 Science Networking Bags were made by the crafters from the Hlanganani Arts and Crafts Outlet in Phalaborwa.

The money generated through sales from Hlanganani is the only source of income for each of the 30 members of the group.

For several decades, local crafters have been selling a variety of curios next to the roads leading into the Park. Although providing a useful service to tourists and in so doing, contributing to their own economic development, the process was ad hoc, unstructured and there was no quality control or service delivery criterion leading to ineffective business development. In response to these challenges, the park began establishing formal Arts and Crafts retail outlets at major gates where local crafters could sell their products more effectively. Currently there are 6 such facilities (Crocodile Bridge, Numbi Gate, Phabeni Gate, Paul Kruger Gate, Phalaborwa Gate and Punda Maria Gate).

The objective of the Arts and Crafts outlets are to:

- Provide an opportunity for local crafters to gain formal access to the KNP tourism market
- To provide a structured environment for craft capacity development and engagement
- To provide a consolidated approach to craft selling on the borders of the park.

The outlets create opportunities for the crafters to sell crafts at both the local and international markets, and also provide a platform for engagement regarding sustainability in terms of resource harvesting and use. The outlets are owned and managed by crafters living in the various communities neighbouring the park, employing 15 permanent staff to run the 6 shops and collectively supporting over 400 crafters from the surrounding areas. Business seems to be growing annually for the craft shops, with 2015 making an all-time peak turnover of over R3.1 million rand. Monthly sales at the shops vary depending on tourist seasons – with over 580 items being sold from all shops during March 2015.

The Hlanganani Art and Craft Community project was initiated in 1998, as a joint venture by the Kruger Park and Foskor Development trust (FDT). Although FDT is no longer involved, the project has a standing agreement with Kruger to operate from within the park premises. The shop has come a long way since the early days of operating out of a small, temporary wooden hut now having a large, spacious, permanent building next to the Phalaborwa Gate reception from where they sell arts and crafts as well as operate a small but lucrative coffee shop. There are 30 project members who are unemployed arts and crafts entrepreneurs from the local Phalaborwa community (Phalaborwa, Lulekani, Benfarm and Namakgale). Each member produces items on a monthly basis, which are sold in the shop, and they are reimbursed accordingly at monthly accounting meetings. The prices of items are determined by the producer and a 10% mark-up is added which covers the running costs of the shop. Best selling products include leatherwork, beadwork, hand painted t-shirts and fabrics, books, bookmarks, feather paintings and refreshments.

Sponsors and Thanks for this year include:

SANParks

South African Environmental Observations Network

Mpumalanga Promotions

Global Supplies