

# Abstracts – SAWMA conference 2018

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## One health and wildlife conservation

### Keynote 1

#### Closing the One Health circle on the benefits to conservation

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One Health is an integrated approach which acknowledges that the health of humans, animals and the environment are all inextricably interlinked. Despite “One Medicine” transitioning into “One Health”, more than one decade ago, this field still retains a strong anthropocentric focus in which wildlife surveillance programmes prioritise pathogens of public and domestic animal health concern over more holistic assessments of microbial diversity. With recent Ebola and Zika outbreaks fresh in mind and with the oft-quoted concern that “75% of emerging infectious diseases are zoonotic” - “the majority of which originate in wildlife”, this bias is understandable. However, one key realisation to emerge from One Health initiatives is that with declines in host biodiversity, there is a greater potential for negative knock-on effects, including increased pathogen prevalence and spill-over risk. This “dilution effect” and the health benefits that are derived from conserving biodiversity are thus clear. Conversely, the increasingly recognised link between individual health and gut microbiome diversity has resulted in expanded studies across a range of species, including wildlife. Despite the proliferation in baseline microbial diversity data, the full spectrum of applications is yet to be realised. In particular the forensic potential for generating high-resolution, locality-specific microbial signatures, to complement other typing approaches, represents a largely untapped benefit of wildlife disease surveillance programmes. By maximising sampling opportunities to simultaneously address host and microbial diversity, we can ensure that where the One Health circle starts with wildlife surveillance, it ultimately closes with maximum benefit to conservation, and illegally traded species, in particular.

(Full 1)

**Scaly bacteria: the quest to identify pangolin pathogens**

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Increased contact between multi-host populations due to climate change, habitat alteration and trade in animals is recognised as a catalyst for pathogen transmission events. Multidirectional pathogen transmission events across a multidimensional transmission interface have led to major disease epidemics in wildlife, human and domestic animal populations across the world. With the recent spate in illegal trade of the already vulnerable Temminck's ground pangolin (*Smutsia temminckii*), we set out to evaluate; the potential threat that the illicit trade may pose to traffickers, the domestic and wild animal populations around said trade, and pangolin populations themselves. Initial attempts focussed on generating baseline data of *S. temminckii*'s bacterial prevalence and diversity, for the first time using single gene and metagenomics approaches.. Amongst the plethora of pathogens identified from five phyla, presence of the highly pathogenic group of *Clostridium novyi* sensu lato, was indicated. Subsequent species-specific studies indicated that all three pathogenic species were found which all have been implicated as major health risks to wildlife, human and/or domestic animal populations alike. The baseline data generated by our study may be used to determine the disease risks that handling and trafficking of *S. temminckii* may pose. In addition, our study provides valuable population health measures and a reference database for future multidirectional transmission events involving pangolins.

(Full 2)

**Novel haemoplasma in indigenous South African rodent communities – molecular detection and characterisation**

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The importance of *Mycoplasma* infections to animal and human health is increasingly recognised, with disease emergence increasing when wild animals are placed under stress, either due to translocation or confinement. Difficulties in diagnosis and treatment of these bacteria pose a substantial risk to conservation programmes. We set out to resolve current difficulties with diagnosis by developing a rapid PCR-based method for *Mycoplasma* detection in clinical specimens. The assay was used to evaluate haemotropic *Mycoplasma* (haemoplasma) prevalence in four bathyergid species sampled from the Western Cape

province of South Africa, using one published and two novel 16S rRNA PCR assays. The assays confirmed an overall haemoplasma prevalence of 24.1% with *Bathyergus suillus* sampled from a peri-urban site having significantly higher prevalence (41.9%) and diversity (six novel strains identified) compared to the species sampled from natural sites. Phylogenetic analyses revealed that the six novel strains identified here grouped within a discrete clade closely related to *Mycoplasma coccoides*, a species associated with invasive commensal rodents. This suggests spillover to indigenous bathyergids from commensal rodents, most likely facilitated by cosmopolitan arthropod vectors. Newly developed PCR assays have higher levels of sensitivity and specificity than the published assay and will facilitate diagnosis of haemoplasma presence, allowing for broader evaluation of haemoplasma strain distribution and diversity in other indigenous species. This study represents the first report of a haemoplasma species in indigenous South African rodents, since the disease agent was first reported from South Africa in 1942.

(Full 3)

### **Male monkeys get kicked when they're down: increased injury rates during fevers**

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Fevers during infection, and the associated sickness behaviours, often are considered an adaptive response by the host. Yet, within a social context, it may be advantageous to suppress sickness behaviours such as lethargy and anorexia to improve reproductive success or social status. We implanted data loggers to obtain continuous, remote measures of core body temperature of free-living vervet monkeys (*Chlorocebus pygerythrus*) and conducted concurrent behavioural observations. We detected 88 spontaneous febrile episodes (defined as a 0.5°C elevation in mean 24h body temperature) in 39 individuals (21 males) over a 7-year period. Fevers lasted between 2 and 17 days and were characterized by an upward displacement of the nycthemeral rhythm of body temperature. Mean 24h body temperature increased significantly from 37.9±0.3°C when monkeys were afebrile to 38.8±0.3°C when they were febrile. Mean 24h minimum body temperature increased by 0.9±0.4°C and 24h maximum body temperature increased by 0.8±0.3°C during the fever. Average maximum body temperature reached during the fevers was 40.6±0.5°C. The injury rate was an order of magnitude higher when the monkeys were febrile than when they were afebrile, and occurred when the monkeys had established fevers. Male monkeys during the breeding period sustained an injury an average of every 12 febrile days. Male monkeys appear to be able to detect when other males are sick and act to reduce the competitiveness of those males.

Knowledge of how social factors modulate the welfare of infected animals is an important aspect to consider in understanding ecological implications of disease.

(Speed 1)

### **Foraging behaviour and health status of the Red-billed Oxpecker in the Kruger National Park, South Africa**

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Red-billed oxpeckers (*Buphagus erythrorhynchus*) are tick feeding birds that reduce ectoparasite loads in African ungulates. However, little is known about their feeding ecology, seasonal abundance and health wellbeing. All these attributes contribute towards their conservation. We studied the Red-billed oxpecker feeding ecology and health status in the southern regions of Kruger National Park by documenting their seasonal abundance, infection prevalence, body condition and foraging behaviour (host preference and foraging location on host). Oxpecker abundance was highest during the winter and lowest just before the summer rain season. Ectoparasite prevalence on birds was highest in summer and we did not detect any avian hemoparasites. Nine potential ungulate host species were recorded and birds were observed feeding on eight of the present species. White rhinoceros, Cape buffalo and giraffe were the most preferred hosts whereas waterbuck were the least preferred host. Birds preferred sitting and foraging from the back, head and neck of the host ungulate – where they appeared more tolerated by the host. We did not record any wound feeding activity.

(Speed 2)

### **The epidemiology of gastrointestinal parasites in painted dogs of Hwange National Park**

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An epidemiological survey was conducted on the prevalence and risk factors associated with intestinal parasites of African painted dog (*Lycaon pictus*) in Hwange National Park, Zimbabwe between June 2016 and July 2017. Centrifugal flotation and McMaster techniques were employed to obtain data on the prevalence and diversity of gastrointestinal parasites observed. A total of 58 painted dogs were surveyed. Out of these, all were infected with at least one intestinal parasite and 10 parasite genera of gastrointestinal i.e. *Alaria*, *Physolaptera*, *Isospora*, *Spirocerca*, *Dipylidium*, *Uncinaria*, *Toxoscaris*, *Toxocara*, *Taenia*, *Ancylostoma* and *Sarcocystis* spp were recorded. Two parasites (*Physolaptera* and *Spirocerca*) have been detected for the first time in painted dogs. *Sarcocystis* had the highest prevalence (28.2%) and intensity (629.18±113.01), while the lowest prevalence was for *Physolaptera* and *Alaria* spp (0.6% prevalence and 50± 0 intensity). Level of parasitism was

statistically significant across all parasites species ( $F=0.036$ ;  $p<0.05$ ). Coinfection was dominant with 82.8% of the dogs having multiple infections ( $>2$ parasites). Intensity of parasitism was affected by coinfections with 27.1% of multiple infected dogs having a heavy infection ( $>1000$  e.p.g.). The findings also revealed a significant difference in intensity between packs ( $F= 0.037$ ;  $p <0.05$ ), but no significant difference in level of parasitism between seasons ( $F=0.275$ ;  $p > 0.05$ ). Based on geographical location there was no statistical difference in intensity ( $P=0.132$ ), however the results were comparable between Hwange main cam area and Sinamatella. The identification of two new parasite genera shows the scarcity of information on the subject hence the poor management of the wild populations of painted dogs as managers don't know the specific effects of parasites on the species and how they can be mitigated.

(Speed 3)

### **Mancozeb in natural water sources in the Vhembe District and possible endocrine disruption**

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Many chemicals released into the environment are believed to disrupt normal endocrine functions in humans and animals. These endocrine disrupting chemicals (EDCs) affect reproductive health and development of human beings and fishes. A major group of EDCs that could be responsible for reproductive effects are those that mimic natural oestrogens, known as xeno-oestrogens. A number of *in vivo* and *in vitro* screening strategies are being developed to identify and classify xeno-oestrogens, to determine whether they pose a health risk to humans and other animals. Oestrogens and androgens mediate their activity via intracellular receptors – directly in muscular tissue as well as indirectly via stimulation of growth hormones. Mancozeb is a metal ethylenebisdithiocarbamate (EBDC) fungicide used to protect many fruits and vegetables and field crops against pathogenic fungal. It causes a variety of defects on the female reproductive system. The mechanisms of EDCs involve divergent pathways including (but not limited to) oestrogenic, anti-androgenic, thyroid receptors; that are highly conserved in wildlife and humans, and which can be modelled in laboratory *in vitro* and *in vivo* models. The endocrine disrupting properties of Mancozeb are not yet known. Therefore, the T47D-KBluc reporter gene assay, GH3.TRE-Luc and MDA-kb2 reporter gene assay were used determine the possible endocrine disrupting activity/potential of mancozeb. Four Dams were sampled (Albasini Dam, Nandoni Dam, Tate Vondo and Xikundu weir) and no activity was detected in any of the assays, no mancozeb was detected either. Oestrogenic activity was detected in Albasini Dam, Nandoni Dam and Xikundu weir but all values were below the 0.7 ng/l trigger value for oestrogenic activity in drinking water.

(Speed 4)

## **Ixodid ticks parasitising wildlife at Leopard Rock Game Reserve, Zimbabwe**

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Ticks are external parasites of mammals, birds and reptiles throughout the world, which survive and feed on blood of its host. Ticks are vectors of several major diseases that occur in wildlife and livestock. At Leopard Rock Game Reserve (LRGR), in Zimbabwe, animals were dying in the rainy season and seen with heavy tick loads. However, little is known about ticks and tick-borne diseases in the area. Therefore, our study aimed to provide information about tick species parasitising wildlife at LRGR. It also aimed to determine tick abundance on wildlife during different months and amongst different wildlife species. The study was carried out between November 2016 and February 2017. Five plots were demarcated in LRGR, each plot having a Duncan applicator. Each plot had a different mix of wildlife species. Ticks were collected from the Duncan applicators as well as from vegetation and opportunistically from dead animals after which they were counted and identified to species level. The results showed that there were no significant differences ( $p > 0.05$ ) in abundance among the different tick species found. Six tick species were recorded: *Amblyomma hebraeum*, *Rhipicephalus appendiculatus*, *R. Boophilus decoloratus*, *R.evertsi evertsi*, *Hyalomma truncatum* and *H.Rufipes*. The most numerous were the *Rhipicephalus* species followed by the *Amblyomma* species and lastly the *Hyalomma* species. However, there were significant differences ( $p < 0.05$ ) in tick counts for all species combined across months and plots; with the month of December having the highest tick count, followed by January, November and lastly February. The results of this study suggest that the highest tick loads are found on wildlife when there is high rainfall in the area. *Rhipicephalus* species are more dominant on wildlife at LRGR.

(Extended 1)

### **One Health approach to tuberculosis – role of domestic animals, wildlife, and humans**

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Although the scientific and medical communities have recently recognized the threat of zoonotic TB, there is still a lack of awareness of the threats that human TB presents to animals and transmission of *Mycobacterium bovis* within and between wild and domestic

animal species. Recent outbreaks of human TB in African elephants (*Loxodonta africana*) demonstrate the threat of reverse zoonotic diseases. For example, a bull elephant that died of *Mycobacterium tuberculosis* infection in Kruger National Park had the same strain as that in human TB patients in Mpumalunga and Limpopo provinces. Also, bovine tuberculosis has been found in new wildlife species, including African wild dogs (*Lycaon pictus*), and black (*Diceros bicornis*) and white rhinoceros (*Ceratotherium simum*). The discovery of *M. bovis* infection in both rhinoceros species in Kruger National Park has led to quarantine and movement restrictions, until validated diagnostic screening tests are developed. Novel immunological and molecular techniques are currently being evaluated in a number of wildlife species. The complexity of interactions in multi-host species creates a management dilemma. Moreover, the discovery of a controlled disease results in movement restrictions, with potentially significant impacts on conservation programs and population management schemes. Understanding the epidemiology of tuberculosis across species and developing accurate techniques for detection are key in preventing introduction to new populations, and for informing management strategies. A multidisciplinary approach is required to address the various factors that influence disease and risks of spread at interfaces, which will impact the future of wildlife and conservation.

## Emerging wildlife management technologies and techniques

### (Keynote 2)

#### Flying high: the emerging technology of drones in conservation

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Unmanned Aerial Vehicles (UAVs) or drones are a rapidly evolving technology and have the potential to revolutionize conservation and spatial ecology. Biological monitoring of species populations and their management, is an essential component of conservation, requiring accurate population estimates of species and information on their habitats, movements and behaviour. Traditional approaches to collecting this data may be resource intensive, potentially inaccurate, difficult to validate and may pose a significant risk to human safety due to the presence of dangerous animals or environments. The use of UAVs can contribute towards more effective and efficient monitoring and management of biodiversity. They provide the opportunity to collect data at high spatial and temporal resolutions in a better, cheaper, faster and safer manner, although they do have their limitations. New methods need to be developed to use UAVs in conservation monitoring and to compare historical results obtained from traditional monitoring approaches. Machine learning algorithms and artificial intelligence will allow for a big data approach to wildlife conservation and offer new strategies for how to better protect ecosystems and keep species alive as the world changes around them. I explore the history and future of this emerging technology, potential uses and

results in the conservation sector and the issues surrounding their use in South Africa. The application of drones for conservation remains to be explored in depth with room for innovation.

(Full 4)

### **Protecting the protected through assessing driver behaviour in protected areas**

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Social media discussions highlight public concern for wildlife-vehicle collisions inside protected areas. We investigated factors affecting the likelihood of wildlife-vehicle collisions within Pilanesberg National Park, and assessed the comparative effectiveness of wildlife-warning signage for altering driver behaviour. We laid a dummy snake on roads across four combinations of habitat and road shape and recorded 10 driver-related variables for 1454 vehicles that passed or collided with the dummy snake. An interaction between speeding and driver occupation (staff/visitor) was the best indicator for wildlife-vehicle collisions. When driving below the speed limit, visitors were almost three times more likely than staff to hit the dummy snake. Collision probabilities increased when speeding and became more similar between visitors and staff, although still significantly higher for visitors. We investigated the effectiveness of signage in modifying driver behaviour by erecting four variations of wildlife-warning signage, depicting either a snake or a cheetah. We positioned the dummy snake either 100 m or 1 km after the signage and recorded our 10 variables (n = 6400 vehicles). Sixty-one percent of drivers who passed a wildlife-warning signage changed their behaviour when they saw the dummy snake, compared to 37% with no sign present. Further, this behaviour change significantly reduced collisions, with 98% of drivers positively altering their behaviour. Finally, a wildlife-warning signage depicting a snake, and placed 100 m before the dummy snake, was most effective at reducing collisions. Our results suggest that drivers adapt their behaviour to signage that portrays smaller animals and awareness retention is low.

(Full 5)

## **Stable isotope analysis of leopard whiskers reveals intra-population dietary differences**

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Evidence suggests that individual-level dietary differences are widespread in wildlife populations. A better comprehension of these differences is important for the management of large felids, whose numbers are dwindling in increasingly fragmented habitats. Such behaviour is, however, seldom investigated, due to difficulties in obtaining longitudinal diet records for individuals. Stable isotope profiling of whiskers provides a way to assess individual dietary preferences. We exploit this approach to test for individualized diets of leopards from Phinda Private Game Reserve, Northern KwaZulu Natal. A whisker from each of six leopards, for which spatial data are also available, were removed during a de-collaring operation in 2011. Six centimetres of each whisker ( $\approx 92$  days of growth) were sectioned at 2 mm intervals, and each segment was analysed for  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values. These data were compared with isotopic compositions of available prey, categorised into three feeding groups (grazers, browsers and mixed-feeders). Prey availability for each individual leopard was inferred from road transect count data in the respective vegetation types making up each leopard's home range. Prey availability was similar amongst individuals, but  $\delta^{13}\text{C}$  values of whiskers showed high between-individual niche variation (67% of total  $\delta^{13}\text{C}$  variance). Three leopards' preferred grazers despite their low availability (< 15 %). Similarity in niche breaths suggested that none of the leopards were particularly stressed, since marginally foraging individuals are expected to have wider or narrower niche breadths. Our approach emphasizes both the existence of, and a means to characterise inter-individual dietary variation in elusive species such as leopards.

(Full 6)

**Analysing temporal elements of ranger patrols and poacher activities: a case study at  
Balule Nature Reserve**

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Law enforcement rangers are responsible for patrolling large, remote areas with limited resources. Ranger teams need to know not only where patrols should go, but also when to patrol to maximize their effectiveness. The reality of most protected areas is that rangers cannot maintain a presence at all times, and this creates windows of opportunities for poachers. The temporal elements of patrols are often neglected as other studies mostly use spatial units such as area covered. Smaller time frames like hours or days have rarely been used to study patrol activity and how it influences the behaviour of poachers. This study aims to understand how the window of opportunities created by ranger patrols influence the temporal behaviour of poachers. The “Cmore” database contains data on ranger patrols, poacher-related activities, and wildlife-related observations from 2016 onwards. Because the exact timing of most poacher-related activities is unknown, we applied an ‘aoristic analysis’. The aoristic analysis uses time windows to assign a temporal weight to each time unit to estimate the probability that an event occurred in that window. We found that poachers operate mainly at night and seem to avoid peaks of ranger activity. While patrols are often able to cover most of the reserve’s border, the temporal overlap between patrols and poachers was low. We found no evidence that poachers time their activities with activity peaks of high-value species like rhinos inside the reserve. The results help us to evaluate the patrols’ effectiveness and how they influence poacher activity.

(Full 7)

**Factors affecting the success of artificial pack formation in an endangered, social carnivore: the African wild dog**

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Animal reintroductions are an effective conservation tool if implemented correctly. However, examples of the formation of social groups prior to reintroduction are lacking. African wild dogs (*Lycaon pictus*) are endangered, social carnivores and reintroductions have become a routine part of range expansion in South Africa. Artificial pack formation is sometimes required prior to a reintroduction to mimic natural group formation. We examined the proximate (social integration) and ultimate (reproduction) success of 45 artificial pack formations in the wild dog metapopulation in South Africa from 1995 – 2018. The interaction between the number of days spent together pre-release and pre-release aggression affected proximate success. Pack formation was delayed if there was pre-release aggression but was more likely with more time spent together in a pre-release enclosure. The interaction between the proportion of males and pre-release aggression, and the proportion of males alone, affected ultimate success. Reproductive success increased with increasing proportion of males in packs, and pre-release aggression facilitated successful reproduction. We suggest that inter-sexual familiarity increases the success of pack formation, but aggression is an important factor for the creation of the dominance hierarchy. In general, proximate success of artificial pack formations was high (87%), and we use our data to provide important guidelines for

optimising and refining future approaches for artificial pack formation and subsequent reproductive success. With wild dogs listed as endangered, optimising conservation efforts, such as artificial pack formation, is imperative. Ultimately, our results can also be used to guide group formation in other social species.

(Full 8)

**Assessment of the deterioration, acrosome integrity and fertilizing ability of black wildebeest spermatozoa harvested up to 96h post-mortem**

**Helet Lambrechts<sup>1</sup> & Louwrens C. Hoffman<sup>1</sup>**

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Assisted reproductive techniques (ARTs) play an important role in the establishment and maintenance of genome resource banks, especially when the conservation of wildlife species is considered. The temperature at which spermatozoa is maintained and the time that elapses from when the animal is culled until the spermatozoa are harvested, are two important factors influencing the viability and fertilizing ability of spermatozoa in ARTs. The objective of this study was to determine the influence of prolonged storage of black wildebeest (*Connochaetus gnou*) testes on the deterioration and acrosome integrity of epididymal spermatozoa, up to 96 h post-mortem. The testes and cauda epididymii of seven black wildebeest bulls were collected immediately after culling, transported on ice to the laboratory, and stored at 4 °C for up to 96h before being processed. Epididymal spermatozoa were harvested using aspiration and subjected to macroscopic motility assessment before smears were prepared for assessment of sperm deterioration, acrosome integrity, and fertilizing ability. Macroscopic motility ranged between 60-80%, with motility decreasing rapidly to 10% in some samples following storage for 5 min at 20 °C. The average percentage normal sperm was  $71.53 \pm 6.86\%$  (maximum=81.77%, minimum=61.72%), and the average acrosome intact sperm was  $68.53 \pm 7.69\%$  (maximum=81.20%, minimum=61.91%). A perivitelline membrane binding assay indicated that sperm harvested up to 72h post-mortem could successfully bind to the perivitelline membrane, thus indicating their ability to be capable of fertilizing an ovum. Findings can contribute to the formulation of the most optimal harvesting and processing protocols for spermatozoa harvested from culled wildlife species, or top genetic wildlife that are lost due to accidents. The banking of the harvested genetic material will contribute to the establishment and maintenance of genome resource banks, which play an important role in the application of assisted reproductive techniques in the conservation of wildlife species.

(Speed 5)

**Genetic tracking of the *Oreochromis* invasion in the upper Luvuvhu River, Limpopo province South Africa**

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The genus *Oreochromis* represents a radiation of mouth-breeding Tilapiine inhabiting lakes and rivers throughout Africa. Due to incomplete reproductive isolation, most of the 31 species within this radiation can interbreed, producing fertile hybrids. *O. mossambicus* is endemic to southern Africa, but is now coming under threat throughout much of the subregion because of the introduction of the invasive *O. niloticus* and potentially other congeneric species. These congeneric species exhibit higher growth rates that are attractive to the South African aquaculture industry. It is feared that hybrids may replace *O. mossambicus* throughout the subregion if these congeneric species escape from aquaculture facilities. The upper Luvuvhu River in northern South Africa, was free of non-endemic *Oreochromis*, but a recent introduction resulting from the flooding of an aquaculture facility, has seen an increase in the frequency of *O. niloticus* in the Nandoni Dam, downstream of Levubu town, however it was not found in the Albasini dam upstream of Levubu town. The aim of this study was to determine, using genetics, the extent of invasion of non-endemic *Oreochromis* into the upper Luvuvhu. We sequenced the control region of 165 fish samples from both dams. We then reconstructed networks and phylogenies and determine the magnitude of non-endemic *Oreochromis* invasion. We found that at least three non-endemic *Oreochromis* species were introduced into the Luvuvhu system. However, these were only found in Nandoni, and only one in Albasini Dam, 40 km upstream. This suggests that aquaculture facilities in Levubu, which are between the two dams, may be responsible for this recent invasion.

(Speed 6)

**Large mammals of the Palaeo-Agulhas Plain: Conceptual reconstruction of assemblages and habitats**

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Recent evidence indicates that the now submerged continental shelf, the Palaeo-Agulhas Plain, formed a novel ecosystem during periods when sea levels were low. This terrestrial landscape potentially provided nutrient-rich forage and habitats to a variety of large

herbivores and associated predators. This landscape is in stark contrast to the faunal assemblage found in the present-day Cape Floristic Region, which is dominated by landscapes with nutrient-poor soils and unpalatable plants. The archaeological record for the region provides some clues on species occurrence of the region. Here we reconstruct large mammalian species assemblages for the Palaeo-Agulhas Plain and investigate potential gaps in the record using Hutchinson's weight ratio theory. We then compare the results to modern occurrences of mammals on the Cape South Coast. From our results we investigate habitat requirements based on our species assemblage reconstruction and compare these to palaeoenvironmental records.

(Speed 7)

**Development of a classified vegetation land cover model for Balule Nature Reserve,  
South Africa**

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Remotely sensed data based on reflective properties of the earth's surface can facilitate continuous classification of vegetation and surface features over large areas and reduce labour and equipment costs in the field. Detailed vegetation community composition data has assisted in the prioritisation of the expansion of Balule (52000 ha semi-arid nature reserve, Limpopo province, South Africa), with the aim to increase vegetation heterogeneity and support management of ungulate species. We developed a classified vegetation land cover model via unsupervised classification of Landsat 8 imagery surrounding Balule and visited a stratified random subset of Landsat pixel centroids to validate our model. We used 6 Landsat 8 scenes to create Normalized Difference Vegetation Index (NDVI) layers, then used ArcGIS to identify 15 unique classes within the NDVI composite. Each of the classes was subsequently assessed *in situ*, via stratified random sampling, in proportion to the availability of each class within Balule. We identified structural characteristics and species composition within each plot; species, height class, stem class, phenological class, and damage class. Traditional community ordination techniques to identify woody vegetation community differences among classes was not successful due to a very high degree of overlap in species composition across classes. We therefore calculated the mean dominant species per height class based on the species frequency and stem density, and named the communities based on the dominant species in the upper and middle story. The resulting ecologically relevant vegetation classes found on the BNR landscape were then mapped in GIS for use in further research.

(Full 9)

**African wild dog habitat use modelling using telemetry data and citizen scientist sightings: are the results comparable?**

**Tafadzwa Shumba**,<sup>1,4</sup>, **Robert A. Montgomery**<sup>1,2</sup>, **Gregory S. A. Rasmussen**<sup>1,3</sup> & **David W. Macdonald**<sup>1</sup>

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Quantifying landscape characteristics that wildlife select is essential for conservation and management action. Models that map wildlife resource selection tend to be informed by telemetry technology which is costly to acquire/maintain and potentially risky to deploy. Therefore, there is value in pursuing alternative data collection protocols, such as citizen scientist approaches to ascertain whether they can reveal results comparable to those derived from telemetry studies. African wild dogs (*Lycaon pictus*) are a species in which citizen science might be particularly useful, because they are group-living, with conspicuous coat markings. The species is rare and wide-ranging, hence data collection is both challenging and costly. Here, we fitted resource selection functions (RSFs) built from Global Position System (GPS) telemetry data, and from citizen scientist data, collected in and around Hwange National Park, Zimbabwe. We compared RSFs by evaluating the relative importance of parameters, parameter coefficients (direction and magnitude of effect), and the spatial predictions of relative probability of use by African wild dogs. The most important predictors in both models were proportion of woodland and bush land, the number of habitat types, and distance to waterhole. Furthermore, spatial predictions displayed a high degree of overlap ( $r = 0.74$ ), indicating similarities in selected and avoided habitat patches. This shows that citizen science data can be a valuable alternative to telemetry data, particularly when funding is limited. Our work also highlights areas in and around Hwange National Park with the highest probability of being used by African wild dogs, which is where conservation efforts should be intensified.

(Full 10)

**An evaluation of the drivers of herbivore community composition in the Satara section of Kruger National Park**

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Herbivore community composition is dictated by several drivers throughout the system in which they occur. These drivers can be extrinsic – distance to water, forage availability and quality, risk of predation; or intrinsic – body size, metabolic requirements, digestive type and mouth morphology. Herbivore community composition interacts with the extrinsic environment through changing nutrient cycling rates, biomass offtake, facilitation and prey availability for predation, amongst others. Determining this composition is therefore beneficial to improving the understanding of feedbacks between herbivore presence and the environmental variables which drive this composition. This study aimed to determine the composition of herbivore communities and to model the primary drivers of this composition in the Satara section of Kruger National Park. Data were collected using a total of 36 camera traps, across 6 sites, at 3 distances to water (0.5 km, 2.5 km and 5 km). Environmental attributes were assigned to sites and count data retrieved from the cameras were used to obtain average biomass at the sites across the wet and dry seasons. A generalised linear model was used to determine which combination of environmental variables have the strongest effect on herbivore biomass at the sites. Preliminary results indicate that distance to water and time since the sites had burnt had a stronger effect on herbivore biomass at a site than risk of predation or the forage parameters which we had measured.

(Full 11)

**How unique is unique? Quantifying geometric differences in Cape mountain zebra stripe patterns**

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Knowledge of pattern uniqueness and likeness in animals of relatives and non-relatives is limited. Stripe pattern variation in Cape mountain zebra (CMZ; *Equus zebra zebra*) in the Mountain Zebra National Park (MZNP) represents phenotypic variation in a genetically constrained subspecies. We determined: (1) Feasibility in quantifying uniqueness of CMZ stripe patterns using a geometric morphometric approach. (2) Whether expected relatives have

more similar stripe patterns. (3) Variable stripe components that are useful for identification. We photogrammetrically created dense surface models of CMZ ( $n = 56$ ). Stripe edges were landmarked (five times for replication), superimposed and compared for shape variation across replicates and relationships (proxies for relatedness). Re-landmarked replicates showed lower dissimilarity ( $D_i$ ) than non-replicates ( $p < 0.001$ ;  $D_p$ ), representing minimal landmarking error. Quantifying geometric uniqueness ( $U = 1 - \frac{D_i}{D_p} \times 100\%$ ;  $78.07 \pm 1.79\%$ ) of individuals relative to the MZNP population was feasible. However, significant overlap in stripe pattern between groups of expected relatives made only 57 out of 225 group distinctions possible. Branching of the first and second torso stripes and curvature of the rump stripes showed the most pattern variation between individuals (18.81%; 42.87% with 2 additional axes of shape variation), thus useful for identification. This study represents the first known use of geometric morphometrics to quantify uniqueness of coat patterns, providing a baseline of CMZ morphological variation from MZNP and a novel approach to visualizing axes of shape variation using heat maps. However, historic inbreeding or larger embryological effects may be masking a trend between expected relatedness and stripe pattern similarity.

(Full 12)

### **Semi-Automated aerial surveying of elephants using deep neural networks**

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Animal population monitoring is crucial to wildlife conservation in that it helps determine population health and species distribution. The advent of inexpensive DSLR cameras and affordable aerial vehicles have made it possible to produce high resolution imagery of extensive areas at low cost. The Elephant Survey System processes such images using a deep neural network to automatically detect wildlife to provide a time- and cost-effective solution to population monitoring. The system consists of a custom-built rig (housing multiple consumer grade cameras) mounted inside a light sports aircraft. Images are collected at between 2000 and 4000 ft above ground level. Elephants (*Loxodonta africana*) can be detected in images of savanna with an 8-10 cm ground sample distance at a 75% true positive rate for a single false detection per image processed. The neural network required approximately 1 250 images of elephants to train. The network has been found to perform well, even for images of woodlands. However, false positives are still produced due to the extreme class imbalance inherent in the detection of relatively scarce and small objects in large quantities of high resolution images. Therefore, the system also includes human-in-the-loop verification, where the network detections are presented to an operator through a web interface. The user can then accept or correct the detections. Through partial automation, the system reduces the time and cost of aerial surveys, which should enable more regular and larger surveys. This could lead to a more complete understanding of the health of elephant populations over time.

(Full 13)

**Now you see me, now you don't: imperfect camera trap detection probabilities and their effects on density modelling**

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Data from camera traps are increasingly used to model occupancy, estimate densities and record behaviours of animals that are difficult to observe directly. Density estimate models (e.g. distance sampling and random encounter models) mostly assume perfect detection of study animals when they pass within the detection range of individual camera traps. Here we report on trials that aimed to quantify the influences of camera height, distance from the camera, animal speed and ambient temperature on camera detection probabilities. To do this we used a medium-sized terrestrial mammal model (heated soft toy mounted on a remote-controlled car). While a decrease in detection probabilities at higher animal speeds was expected, the rate of decreasing detection probabilities was rapid, with substantially lower detection probabilities estimated (<50%) for animals exceeding 2 m/s - the approximate speed at which humans switch from walking to running. Detection probabilities also decreased with increasing distance from the camera; were highest at an intermediate camera height; and increased at low ambient temperatures. By applying random encounter models to simulated animal movement datasets we demonstrate how imperfect detection probabilities within the detection ranges of camera traps lead to underestimation of densities. We present a modelling approach to correct for imperfect detection probabilities, which we test using preliminary density estimates for three riparian zone predators (African clawless otters *Aonyx capensis*, marsh mongoose *Atilax paludinosus* and Nile monitor lizards *Varanus niloticus*).

(Speed 8)

**Are there two African elephant species?**

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Africa is a major stronghold for the mega-herbivores that evolved during the climatic fluctuations of the Tertiary period. The most prominent of these is the African elephant (*Loxodonta africana*). However, despite compelling genetic evidence for the existence of two African elephant species: the savanna elephant (*L. africana*) and the forest elephant (*L. cyclotis*), the academic community remains divided on the issue. This is concerning as it directly impacts the way in which African elephants will be managed in the future. To shed more light on this, I will reconstruct a time calibrated genealogy of available elephant genomes (seven extant and three extinct) representing all extant and two extinct Elephantidae

species. Further to this, I will perform an assessment of gene flow using D-statistics to determine the level of introgression between savanna and forest elephants. Lastly, I will estimate genetic diversity of all extant elephant species and link this to conservation management. Preliminary results show that African elephant genomes contain a higher proportion of heterozygous sites than Asian elephants, with forest elephants more diverse than savanna elephants. It is hoped that the information resulting from these analyses will help inform conservators about the long term management of genetic diversity.

*(Speed 9)*

**Snapshot Safari – South Africa: Contemporary applications of camera traps to monitor mammal communities in South African protected areas**

**Mika M. Vermeulen<sup>1</sup>, Jan A. Venter<sup>1</sup>, Craig Packer<sup>2</sup>, Rob Slotow<sup>3</sup>, Colleen Downs<sup>3</sup>, Michael J. Somers<sup>4</sup>, Mike Peel<sup>5</sup>, Lourens Swanepoel<sup>6</sup>, Nokubonga Mqgatsa<sup>7</sup>, Hervé Fritz<sup>8</sup>, Sandi Willows-Munro<sup>3</sup>, Mark Keith<sup>9</sup>, Dan Parker<sup>10</sup>, Aliza Le Roux<sup>11</sup>, W. Maartin Strauss<sup>12</sup>, Robyn S. Hetem<sup>13</sup> & Craig J. Tambling<sup>14</sup>**

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The use of camera traps, especially since the mid 1990's, has helped improve our understanding of the ecological relationships and population dynamics of animals in the wild. Improved technology has increased the popularity of camera traps and allowed for their widespread application in wildlife research. The role of camera traps in wildlife ecology has evolved over time, originally camera trap data were used to investigate simple measures of presence and absence. Today, researchers are using camera trap data in far more complex studies, to solve questions relating to animal spatial, behavioural and temporal patterns. The advantages of using camera traps in understanding animal ecology is that the researcher does not need to handle, be present or directly observe interactions for ecological data to be recorded. Here we introduce Snapshot Safari – South Africa, which will include an unprecedented network of camera trap grids in dozens of protected areas and expansion areas in South Africa. Eventually hundreds of cameras will provide continuous monitoring of population sizes and trends of mammal species at each site. Some of the participating focus

areas are managed as conservancies and stewardship areas, some are privately owned, some are state-run, and others under communal tenure. With the help of camera trap censuses, and innovative mapping approaches we aim to develop a methodology that will be able to identify which sites are being managed successfully - and hence which successful management strategies should be incorporated into a toolbox for effective wildlife management.

*(Speed 10)*

**Assessing the extent of and changes in the wildlife production sector in Limpopo province, South Africa**

**Cecilia Prinsloo<sup>1</sup>, Mark Keith<sup>1</sup> and Rheinhardt Scholtz<sup>2</sup>**

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The wildlife production sector plays a pivotal role in ecological and conservation processes in addition to contributing to the economy of South Africa. Despite wildlife production properties covering 16.8% of South Africa, there has been a growing concern around the conservation efficacy of this land use, primarily due to rapid growth in intensive wildlife production and increased fencing which have adverse consequences to ecological processes. The physical change, e.g. in fragmentation of properties, was examined between 2007 and 2017 through remote sensing and image classification methods (support vector machine and random forest) in the south-west corner of the Limpopo province, South Africa. The remote sensing method presented evidence that length of fence-lines increased by 15.9% from 2007 to 2017 (total length: 19637.1 km). The total number of fenced-off areas (camps) increased by 37.8% from 2007 to 2017 (total number of camps: 7976). Over this time period, the number of smaller camps (<200ha) increased whereas the number of larger camps (>200ha) decreased. The image classification method yielded broad overall accuracies (OA) and kappa indices (KI) (OA: 0.30-0.96, KI: -0.06-0.55). These resulting low accuracies can likely be attributed to specific land characteristics, such as elevation and water bodies. The extensive decrease in camp size due to increased fencing can have negative impacts on both wildlife and the broader landscape ecology. Image classification has the potential to provide a feasible method to quantify changes in fencing, however, further research will be required to improve model accuracy.

(Speed 11)

**Using scents makes sense: A novel technique for artificial pack formation in African wild dogs using body rubbing**

**Antoine F.J. Marchal<sup>1,2</sup>, Courtney Marneweck<sup>2</sup>, David G. Marneweck<sup>1,3</sup>, Grant Beverley<sup>1</sup>, Harriet T. Davies-Mostert<sup>1,3</sup> & Daniel M. Parker<sup>2,4</sup>**

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In the increasingly fragmented landscape of Africa, reintroductions and translocations remain a crucial conservation tool for one of Africa's most endangered carnivores, the African wild dog (*Lycaon pictus*). The success of these operations strongly depends on artificial formation of stable packs prior to release into new protected areas. Traditional artificial bonding of two unrelated, opposite-sex groups usually involves using a double-compartment enclosure where the two groups are first physically separated before they are 'bonded' together by opening a common gate. This costly and time-consuming process can lead to death or injuries due to subjective interpretation of social integration. In this study, we describe the use of a novel technique for artificial pack formation that involves rubbing sedated wild dogs to each other before keeping them together in a single-compartment enclosure. We applied the technique to two groups of unrelated wild dogs in an enclosure located in northern Kruger National Park, South Africa. We recorded behavioural data during the 46-day period spent in the enclosure. An alpha pair started forming within the first five days, hoo-calling was limited, negative behaviour decreased overtime, but spatial relationships increased (males resting closer to females over time). Monitoring indicated that individuals remained altogether at least three months after their release, thus confirming successful bonding. These results demonstrate the promise of this technique that does not require physical separation. As this technique is more affordable and more efficient for bonding groups of wild dogs together, we suggest its widespread use but in combination with a strict monitoring protocol to evaluate success.

(Speed 12)

**Primate crop raiding deterrent methods on commercial farms in South Africa**

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Conflict between crop farmers and primates is a world-wide conservation issue of increasing concern. Despite its increasing severity there are very few accounts of systematic evaluations

of techniques to deter primates from crop fields, especially within a commercial setting. Working in partnership with local commercial farmers in South Africa we have previously gained a baseline of primate crop raiding behaviour. Applying this data, and in consultation with the farmers, we use behavioural observational sampling to evaluate a number of different deterrent methods. Here I will present the results from three of those deterrents: model predators, predator vs. human sounds as a deterrent and application of chili oil to crops. Deterrent efficacy was assessed by comparing raiding behaviour and consequential crop damage with and without deterrents in place. While no method was entirely effective we suggest possible adaptations to improve the success of these deterrents and make recommendations for intervention strategies to address primate crop raiding issues on commercial farms.

*(Speed 13)*

**Elephants, big trees and boundaries- what mitigation strategies are available and do they work?**

**Robin Cook<sup>1</sup>, Tamara Eggeling<sup>1</sup>, Riaan van Zyl<sup>2</sup>, Leslie Brown<sup>3</sup>, Mark Griffiths<sup>4</sup>, & Michelle D. Henley<sup>1,3</sup>**

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The management of African elephants (*Loxodonta africana*) often results in concern about the impact they may have on the large tree species in the area being managed. This has driven the need for mitigation methods that will assist in protecting large, charismatic or rare tree species of interest. However, to do this, management strategies have largely shifted from controlling elephant numbers to more of a resource management approach. Therefore, when one is unable to alter elephant distribution on the large scale, one can on a smaller scale, specifically protect the resource of concern itself. We discuss the various mitigation strategies currently under investigation by Elephants Alive. These range from wire-net protection around the base of the tree to the use of beehives and bee pheromones as potential behavioural modification agents. The packing of rocks or concrete triangles around the base of trees has also been applied by various private landowners within the Associated Private Nature Reserves, on the western border of the Kruger National Park. Although some have extensively used the method, it is yet to be quantified as being effective. Various, so-called elephant repelling fluids have also become available for application on large trees. Their efficacy needs to be investigated within the context of their effect on the environment in general and not on elephants alone. We discuss the options that are available and make recommendations with regards to which fluids will have the least effect on the surrounding habitat.

(Speed 14)

**Rating the rats: update on using African giant pouched rats to detect wildlife contraband**

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Shipping containers are frequently used for the international smuggling of wildlife contraband. This environment is challenging for law enforcement officials as effective screening of containers is expensive, time consuming, and even disruptive to port operations. Here we report on training African giant pouched rats (*Cricetomys ansorgei*) to detect wildlife contraband. As proof-of-principle, we trained 11 rats to detect Temminck's Pangolin *Smutsia temminckii* scales (the most widely trafficked endangered mammal in the world) and the African hardwood *Dalbergia* spp. (slow growing trees that are targets of illegal logging). Rats were required to identify these targets from an array of items commonly used to mask the odor of wildlife products. Training was conducted using operant conditioning and all rats learned to indicate the presence of the two target scents whilst ignoring common masking materials found in trafficking containers, such as coffee beans and washing powder. All rats have successfully completed early stages of this training and are currently evaluating 100 samples per training session with only 12 targets present (six each of pangolin and hardwood samples). Target substances are presented in volumes ranging from 0.5-1.5 grams. The rats are currently detecting both targets with an acceptable mean sensitivity of 75%. Future steps include training the rats to detect targets hidden within non-targets and address the challenges associated with potential operational use of trained animals in port environments.

**(Extended 2)**

**Poisons and their responsible use against predators of livestock**

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Predation of livestock is a common cause of human-wildlife conflict around the world, and the lethal control of predators is commonly used to manage such conflict. Of all the lethal control techniques used, poison-baiting of predators is often the most controversial. Regardless of how it may be perceived, however, predator poisoning can be ethically justified and demonstrably safe, humane, target-specific, and effective at reducing or eliminating livestock predation in some contexts. Animal welfare impacts and target specificity are the two most common concerns about poison use. However, animal welfare impacts of poisoning can be addressed through improvements or changes to the toxin used (and its corresponding mode of action), and consideration of all the welfare impacts managers are responsible for.

Target specificity is not only a function of the toxin used, but also the dose, presentation and strategy used. Following a simple and logical 8-step framework can assist managers with determining the risks and benefits of predator poisoning to non-target animals.

Poisoning predators can be justified on ethical and welfare grounds where:

- There is a demonstrable impact of predators on livestock,
- The predator/s responsible for livestock predation can be identified,
- The poison of choice is relatively safe, humane, and target-specific, and
- Poisoning practices can be demonstrably effective at mitigating predation losses.

Poison should not be considered unacceptable or taboo simply because of the stigma associated with 'poison'. Poisons can be the most safe, humane, target-specific, and effective predation management option in some contexts, provided a series of judicious principles are followed.

## Sustainable resource management

### (Keynote 3)

#### Misconceptions of capture-induced hyperthermia

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Wild animals typically develop an acute hyperthermia when captured. It has been proposed that this hyperthermia may play a role in capture myopathy and acute death during capture, so measures usually are taken to decrease the incidence and severity of capture-induced hyperthermia. In the absence of a proper understanding of the mechanisms of capture-induced hyperthermia, these measures are based on anecdotal evidence, and on some unproven assumptions that hot ambient temperatures and exercise during capture are the main causes of this hyperthermia. Most records of capture-induced hyperthermia are based on single measurements of rectal temperature. To better understand the causes of capture-induced hyperthermia, it is essential to measure body temperatures continuously before, during and after capture procedures. Using surgically implanted miniature thermometric data loggers, which measured body temperatures continuously, we studied body temperatures, in a number of antelope species, during capture events to better understand the cause, consequences and treatment of capture-induced hyperthermia. We found that capture-induced hyperthermia is caused predominantly by a "fright" stress rather than by hot ambient temperatures, exercise or capture drugs. We determined the most effective field ready cooling methods to treat this hyperthermia. Surprisingly, we found that this hyperthermia is an indicator of the pathophysiological damage caused during capture, rather than been its cause. Thermal insights related to the best time of day and year to capture animals will also be discussed, and a new cut-off temperature for when capture operations should be stopped will be proposed.

(Full 14)

## **Understanding the genetic effects of captive breeding on lion populations in South Africa**

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Across Africa, wild lion (*Panthera leo*) numbers have declined, with the exception of populations in South Africa, Namibia, Botswana, and Zimbabwe. This population decline is partly due to habitat loss, human-wildlife conflict, and trophy hunting. To meet the high demand of lions for the trophy hunting industry, and to potentially mitigate the decline in wild populations, lions are commercially bred in captivity for hunting purposes. This captive population provides the opportunity to investigate how captivity and commercial breeding influence the genetic diversity of wild animals. A negative effect that has commonly been documented in captive animals is genetic drift (due to small population sizes), subsequently leading to inbreeding and loss of genetic variation. Our work conducted on four captive breeding facilities in South Africa showed low levels of inbreeding. This result was unexpected and we are currently assessing the link between genetic diversity and phenotypes. DNA profiles (developed from forty microsatellite markers) for all sexually mature individuals at the facilities were compared against phenotypic characteristics (i.e. body length and shoulder length amongst others). Both morphometric measures varied across the four facilities, however, this variation was not attributed to inbreeding. The results of this study should be important when linking genotypic and phenotypic data to ultimately understand these possible changes to individuals in captivity.

(Full 15)

**Elephant diet from the Kalahari to the Lowveld: A multi-nutrient objective approach**

**Henry M. van Lelyveld<sup>1</sup>, Yolanda Pretorius<sup>2</sup>, Rob Slotow<sup>3</sup>, Mike J. S. Peel<sup>4</sup>, Jonathan Swart<sup>5</sup> & Michael J. Somers<sup>1,6</sup>**

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Diet selection is influenced by multiple factors. However, many studies have focussed on only one selection currency (most notably energy) that drives diet selection and the ultimate composition and quality of a diet. In this study, we employ a multi-nutrient objective approach to identify foraging strategies that African elephants (*Loxodonta africana* Blumenbach, 1797) adopt along a rainfall gradient in South Africa. We assume nutrients are selected for based on their availability in the environment and in relation to the animal's nutrient requirements. By using linear programming, our model not only specifies dietary constraints to satisfy the minimum requirements for multiple nutrients but also includes goal functions that define a foraging strategy, enabling us to explore the possibility of maximization of particular nutrients. With differences in local plant availability, composition and nutrient availability between our seven study sites, we test several hypotheses and determine the foraging strategy that best fit the observed diets (determined through microhistological faecal analysis). These strategies include random foraging (null hypothesis), energy maximization, nutrient satisficing, nitrogen maximization and phosphorus maximization. The deviation of these predicted diets from those observed is used as a relative measurement to test the hypotheses on the strategy adopted. Although not all data have been analysed, analysis of monocot-dicot frequencies in the observed diets indicates differences in diet selection among all study sites. This study elucidates the spatial differences in resource utilisation by elephants and contributes to the growing theory of foraging for multiple resources.

(Full 16)

### **Criteria for the captive breeding of white rhinoceros in South Africa**

**S.A. Jeanetta Selier<sup>1,4</sup>, R. Emslie<sup>2</sup>, K. Adcock<sup>2</sup>, M. Otto<sup>3</sup> & Michele Pfab<sup>1</sup>**

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South Africa currently holds more than 90% of Africa's wild southern white rhinoceros population (*Ceratotherium simum simum*). Prior to 2007, an average of 15 rhinoceroses were poached every year in South Africa. However, in 2016, the number of rhinoceroses poached had escalated to 1054. This increase in poaching during the last decade has led to discussions around the value and role that Captive Breeding Operations (CBOs) can play in the conservation of white rhinoceroses in South Africa. While larger "wild" populations remain the priority focus of the national conservation effort, the Biodiversity Management Plan for the white rhinoceros in South Africa, recognizes that CBOs may perform the function of helping grow rhinoceros numbers and providing a potential source of founder rhinoceroses to restock wild rhinoceros areas if the poaching crisis has abated. It further stipulates that CBOs should only be conducted under certain conditions for example semi-intensive systems rather than captive conditions. As a result the Scientific Authority of South Africa developed national criteria for the captive breeding of white rhinoceros in South Africa. The guiding principles that underpin these criteria includes: 1. minimizing the long term conservation risks to the species as well as to ecosystems or biodiversity in the landscape and at the CBO site, 2. maximizing the conservation potential of the specimens kept in captivity so that they still contribute to the national meta-population and 3. minimizing the keeping of rhinoceroses under captive conditions for extended periods.

(Full 17)

### **Spatial and temporal variation in ungulate landscape use in relation to resources and constraints at Telperion and Ezemvelo Nature Reserves**

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Telperion and Ezemvelo Nature Reserves host a rich variety of ungulate species. Among them, plains zebra (*Equus quagga*) and blue and black wildebeest (*Connochaetes taurinus*, *Connochaetes gnou*) are increasing in numbers, while red hartebeest (*Alcelaphus buselaphus*) are facing a decline. The reserves are divided longitudinally by the Wilge River, which acts as

a crossable boundary between the more heterogeneous eastern side and the more homogeneous western side. To understand potential reasons for the observed population trends, this study aims to identify the main factors driving ungulate selection at landscape and feeding patch level, and to analyse their relative importance across seasons and landscapes of different heterogeneity. We collected data at used and random locations for each species, at both scales. At landscape level, we measured factors such as distances from other species, NDVI, landscape heterogeneity, elevation, burnt status and proximity to water. At patch level we measured grass greenness, height, biomass and noted the patch status as wetland, burnt or un-burnt. We used linear models to analyse the effect and relative importance of the mentioned variables. Preliminary results show that at landscape level distances from other species, elevation and the presence of recently burnt areas are important drivers for all the species. At patch level, zebra and blue wildebeest preferred to feed in wetlands, while red hartebeest and black wildebeest foraging were influenced by grass height, biomass and greenness. There was no evidence of an effect of season or landscape heterogeneity on animals' landscape use in these reserves.

(Full 18)

### **Changes in waterhole distribution and density: does it change herbivore distribution in arid areas?**

**Petrus J. (Hanno) Kilian**<sup>1</sup>

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A previous study on Khamab Kalahari Reserve indicated that a change in waterhole density and distribution caused a change in the preferred distances of certain ungulate species from water. Whether the observed changes were due to actual changes in herbivore distribution was not investigated though. I used animal distribution data, recorded during annual aerial game counts to calculate ungulate population densities around waterholes before (2010-2011) and after (2015-2017) changes to the waterhole distribution was made. Chi-square test of independence was used to compare changes in herbivore densities to changes in waterhole distribution. These density changes were then compared to the density changes observed in the total reserve area to account for changes resulting from natural population growth or decline. No change in the density of any species was observed within 3km buffers around waterholes after they were closed, while only blue wildebeest (*Connochaetes taurinus*) and warthog (*Phacochoerus africanus*) increased in density within 3km of new waterholes. In areas of overlap of 3km buffers between old and new waterholes, blue wildebeest, gemsbok (*Oryx gazella*), warthog and zebra (*Equus quagga*) increased in density. Only blue wildebeest and red hartebeest (*Alcelaphus buselaphus*) densities decreased in areas that were further than 3 km from water both before and after waterhole changes. These results indicate that the change in the observed distances from water for these species were as a result of distribution changes in response to changes in waterhole distribution, and not because the waterholes were moved into already preferred areas.

(Extended 3)

**“It’s not about the worm” – the impact of resource use within the Kruger National Park**

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The Kruger National Park Resource use programme facilitates the sustainable use of natural and cultural resources derived from ecosystem services flowing from the Kruger Social Ecological System (SES). The programme is underpinned by three main principles including the maintenance of ecological integrity, economic viability and social relevance. Similarly, it is built on a framework that describes natural and cultural resources as products that are derived from final ecosystem services, and that give rise to costs and benefits through impacting either positively or negatively on human well-being. Several examples of natural resource use exist within the KNP including the harvesting of mopane worms, thatching grass, medicinal plants and products derived from lethal animal off-takes. Resource use from within protected areas has always been controversial due to differing stakeholder value systems as well as the challenges associated with defining sustainable off-take rates. These projects are often criticised due to their short time frames, low numbers of participants and perceived low impact. However, our monitoring of small scale resource harvesting projects inside KNP demonstrates that these projects have the potential to enhance local stakeholders perceptions of the park, at a low financial and economic cost (operate for a short time frame and only require guarding). In most cases the benefits from the resource itself was just one of multiple positive outcomes such as (1) enhancing access to the park, (2) contributing positively to basic livelihoods in a tangible way (3) enhancing human well-being and (4) building conservation constituency provided effective governance mechanisms are in place and in most cases the benefits outweighed the costs. At the same time, these projects have an impact on tourists, with some visitors perceiving resource extraction to undermine the role of protected areas, while others support the projects knowing that they contribute to sustainability, through facilitating social relevance. This paper summarises the outcomes from resource use projects implemented in the Kruger National Park through a variety of stakeholder lenses and discusses the trade-offs that are made when managing resources for a wide range of stakeholders with different value systems and world views.

(Full 19)

## **Leopard ecology on a multi-use landscape in Zimbabwe**

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Leopard (*Panthera pardus*) populations across Africa face several threats, including habitat fragmentation, human-wildlife conflict and over-utilization from trophy hunting. However, much of the leopard research within southern Africa has been conducted within recognised protected areas such as national parks and private game reserves. As such, there is a knowledge gap concerning leopard populations outside of protected areas. We determined the population structure and density of leopards on Debshan Ranch in Shangani, Zimbabwe, a 450 km<sup>2</sup> commercial cattle farm that also supports wildlife and where leopards are hunted as trophies. Biannual camera trapping surveys between 2016 and 2018 yielded a total of more than 30 individual leopards (6 adult males, 15 adult females, 6 adults of unknown sex and 6 juveniles) on the ranch (6-9 leopards/100km<sup>2</sup>). This population density is higher than leopard densities recorded in other areas of Zimbabwe. However, annual leopard offtake on the ranch ranges between 0 and 2 (but with an allocated annual quota of 5) mature adult males and this may adversely affect the population structure of leopards on the ranch and the immediately surrounding areas. Our study provides robust baseline population data for an important, mixed-land-use area in Zimbabwe and has significant implications for the sustainability of leopard trophy hunting.

(Full 20)

## **Use of artificial waterholes by animals in the southern region of Kruger National Park, South Africa**

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Artificial waterholes are a widely used, yet a contested wildlife management practice in semi-arid environments. Wildlife water provisioning at four artificial waterholes in the southern region of Kruger National Park was evaluated. The daily waterhole visitation patterns of mammals were documented during the wet and dry seasons using camera-traps. A total of 26 mammal species were recorded at the waterholes, with African elephant (*Loxodonta africana*) and impala (*Aepyceros melampus*) being the most abundant. Generalised linear mixed models

(GLMM) were used to determine what variables (season, time of day, water quality, and the presence of carnivores or elephants) would affect animal visitation. Waterhole visitation patterns differed according to time of day, but this effect remained relatively constant between seasons. More animals visited waterholes in the dry season compared to the wet season. Carnivore presence negatively affected impala abundance. Elephant presence did not affect impala and white rhino (*Ceratotherium simum*) visits to waterholes. Water quality also appeared to play a role in determining animal abundance. Based on these results, some management practices are suggested for consideration when deciding which waterholes should be closed or left open.

(Full 21)

### **Incipient speciation, adaptation and convergence within the bushbuck complex**

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Bushbuck *Tragelaphus scriptus* is the most widespread and ecologically diverse species complex within the spiral-horned antelope and consists of two genetically divergent mtDNA lineages inhabiting the north-western (*Scriptus*) and south-eastern (*Sylvaticus*) halves of the African continent. Within these lineages, several mtDNA haplogroups were previously identified and these may have evolved through ecological heterogeneity across the continent. Therefore, given the fluctuating Plio-Pleistocene paleoclimate, we predicted histories of demographic expansion for both lineages. Furthermore, we test whether the ecologically linked mtDNA haplogroups are similarly structured at four nuclear DNA loci. Nuclear DNA confirmed two distinct evolutionarily divergent, geographically restricted lineages for *Sylvaticus* and *Scriptus* that shared a common ancestor ~2.5 million years ago. Surprisingly, diverse analyses, including Bayesian skyline plots, showed that the effective population sizes of both lineages remained relatively stable during the last 225-450 thousand years. We also observed that ecology was most significantly correlated with nuclear genetic heterogeneity. However, the nuclear data offered lower phylogenetic resolution at the more derived parts of the specie genealogy, possibly due to incomplete lineage sorting of the slower evolving nuclear genome. A prominent exception to this was the dark, long haired montane ecotype *T. s. meneliki* of the Ethiopian highlands, which formed a monophyletic group, branching basally within *Sylvaticus*. The independent evolution of *T. s. meneliki*, relative to highly phenotypically similar montane ecotypes along the East African rift highlight the occurrence of convergence within the bushbuck complex.

(Full 22)

## **Temporal changes in food resource availability of bat assemblages in two karst landscapes**

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Resource availability plays an important role in maintaining predator populations. To better understand the interaction between temporal patterns of food source availability and predator activity, we collected night flying insects and measured bat activity using malaise intercept traps and bat detectors, respectively. Two karst landscapes were studied, Meletse area (Savanna) which hosts a large migratory bat population during the maternity season (Oct-Feb/Mar), and the Cradle of Humankind World Heritage Site (Grassland) where caves provide hibernacula roosts (Apr-Sep) for the same migratory population. For each study area, insect biomass and bat activity peaks coincided, although at different times. In addition, the proportion of larger insects was higher during each peak of insect and bat activity. Insect order variation was greatest during these activity peaks. The insect abundance peak at the Savanna site was not higher than the Grassland site ( $P=0.23$ ) but biomass was considerably greater. In contrast, peak insect abundance at the Grassland site was greater ( $P<0.001$ ) than at the Savanna site, with higher biomass. Bat activity was greater at the Savanna site during all peak occasions ( $P<0.001$ ). Energy demands during maternity season is timed to coincide with periods of adequate food resources (biomass), which corresponds to the emergence of larger sized prey (increase in biomass). Furthermore, greater bat activity during the maternity period places Meletse as an important food resource reservoir supporting resident and migratory species. Monitoring the effect of changes in food availability on predator populations will help better understand predator/prey activity dynamics within key habitats.

(Speed 15)

## **Difference in night and day: Patterns of nest predation in savanna and forest habitats**

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Effective management of avian populations requires an understanding of the factors affecting nesting success and productivity. Predation is one of the main causes of nest failure in birds, but the identity of the predators is seldom known. Since different habitats may support different predator communities, it is essential to correctly identify the predator community. In this study, we compared the predator community in two different habitat types that presumably support a different suite of predators, namely forest and savanna. Nest searching was conducted in the breeding season and trail cameras were placed at a sample of active nests until an outcome (success or failure) was established. The trail cameras were used to

identify the nest predators and daily distribution of predation events. The timing of a predation event was placed in one of four categories: midnight to sunrise, sunrise to noon, noon to sunset and sunset to midnight. The results revealed that the nest predator community differs between the two habitat types. A total of eight different nest predators were recorded in the forest habitat with two species of galagos (*Galagidae*) being the dominant predators and 15 in the savanna habitat with snakes as the main nest predators. There were also interesting temporal differences in predation patterns between the two habitat types. The results of this study show that management of avian populations require an adaptive approach as factors affecting productivity in different habitat types may be substantially different.

(*Speed 16*)

**Bird species diversity and ecological functions in the Wild Coast nature reserves,  
Eastern Cape province**

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Birds provide important services for maintenance of the ecosystems especially in the protected areas. However, there is limited research on the roles of bird species in the ecological maintenance of habitats. This knowledge gap undermines the importance of other ecological processes and thus may retard whole-habitat conservation efforts. Therefore, the study aimed to document different bird species occurring in the Wild Coast nature reserves managed by the Eastern Cape Parks and Tourism Agency, and to determine the possible role of each bird species in habitat maintenance. We conducted bird surveys during warm and cold periods of the year in Mkhambathi, Hluleka, Dwesa and Silaka Nature Reserves. Species diversity and activities were documented in the field using the scan sampling method coupled with drive-by-surveys to maximize spatial coverage during observations. There were 31, 23, 39 and 28 bird species in Mkhambathi, Silaka, Hluleka and Dwesa Nature Reserves respectively during warm periods. Hluleka had significantly greater number ( $t = 22.2$ ;  $df 6$ ;  $p < 0.001$ ) of bird species than Silaka but not Dwesa and Mkhambathi. The latter nature reserves were not significantly different in numbers of bird species. However, there were no differences in numbers of bird species between the nature reserves during the cold period. The Grey heron (*Ardea cinerea*) and the Fork-tailed drongo (*Dicrurus adsimilis*) were common in all nature reserves. The majority of birds were generalist species serving as both seed dispersal vectors and pollinators while other bird species (e.g. birds of prey) displayed complex interactions of which their impacts on each habitat remain unknown.

(Speed 17)

**The relationship between mammalian burrow abundance and *Seriphium plumosum* encroachment**

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Much of the grassland biome in South Africa is prone to shrub encroachment that leads to loss of ecosystem services and habitat for grassland specialists, which include burrowing mammals. These mammals' burrows create microhabitats for other taxa such as birds, reptiles and invertebrates. Here we test if there is a difference in the density of burrows between areas encroached by *Seriphium plumosum* (bankrupt bush) and those not encroached. We predict that mammalian burrow abundance and associated microhabitats decrease with increasing shrub density. We tested our prediction in Telperion Nature Reserve where we calculated shrub density, cover and abundance, as well as medium and large mammal burrow abundance and density in 24 encroached and 24 non-encroached areas. The plots were randomly chosen from areas pre-classified as encroached and non-encroached. The average shrub density in encroached areas was  $0.531 \pm 0.390$  per m<sup>2</sup>, and in non-encroached areas, it was  $0.004 \pm 0.011$  per m<sup>2</sup>. Overall, the average burrow density in encroached areas ( $0.0002 \pm 0.0007$  per m<sup>2</sup>) was lower than in non-encroached areas ( $0.004 \pm 0.005$  per m<sup>2</sup>). There was a significant difference (Kruskal-Wallis rank sum test:  $p < 0.01$ ) between the density of large burrows and medium burrows (Kruskal-Wallis rank sum test:  $p = 0.011$ ) in the two treatment areas. Our initial data suggests that shrub encroachment negatively affects large burrowing mammals. Medium burrowing mammals appear to be unaffected by shrub encroachment.

(Speed 18)

**The diet of serval in a heavily industrialised petroleum plant, Secunda, Mpumalanga, South Africa**

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The commodity industry is a strong player in global and African economies, and especially in South Africa. The most important commodity industries in South Africa, petroleum and

mining, also often require large tracts of land. Such surrounding areas of land tend to be well protected, and can house significant biodiversity, highlighting their potential conservation value. In this study we used the Sasol Secunda Synfuels Operations as a model industrial ecosystem to investigate the diet of a specialist carnivore, the serval (*Leptailurus serval*). We aimed to quantify serval diet in an industrial landscape to assess how this modified habitat could influence the diet of this specialist carnivore. We collected 206 serval scats over a period of 3 years in which scats were collected when encountered and were analysed using the scats analysis methods which are Frequency of Occurrence (FO), Percentage of Occurrence (PO) and percentage biomass consumed. Serval consumed a variety of prey, but their diet was dominated by three rodent species; *Otomys* spp., *Mastomys* spp., and *Rhabdomys* spp. *Otomys* spp. had the highest frequency of occurrence (67%) and relative biomass (46%). Season had no effect on serval diet. Serval diet at Secunda was similar to at other sites in South Africa. This suggests that industrial sites can fulfil the dietary requirements of specialist carnivores such as serval, and that modified environments could be important yet overlooked areas for biodiversity conservation

(Speed 19)

### **Evaluation of land-use and land cover changes using satellite images: A case study of the Limpopo National Park - Mozambique**

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We evaluated changes in land-use and land cover in the Limpopo National Park (LNP) over a period of 20 years using temporal analysis of multispectral Landsat TM 4-5 images. We mapped 8 land-use and land cover classes focusing on areas of dense vegetation cover, bare soil and waterways. Geometric corrections and classifications were made using SPRING software and the thematic classes were estimated using ArcGIS 9.3. Our results indicate significant changes in almost all examined classes over the 20 year period. We detected a 7.8% increase in dense vegetation, which is correlated to a 13.4 % decrease of bare soil areas. Water courses increased by 8.0% with this mainly linked to the expansion of dams. However, considerable conversion of riparian vegetation was found in agricultural areas, which also contributed to the reduction of areas of bare soil by 5.6%, predominantly in the buffer zone, which are resettlement points. These results serve as a warning that measures need to be taken to find the balance between use and exploitation of natural resources. The use of remote sensing combined with GIS is a valuable tool for conducting environmental studies to generate data that supports the decision-making process by LNP managers and local authorities.

(Speed 20)

**Feeding ecology of kudu, with emphasis on diet preferences, feeding height and bite size**

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Kudu (*Tragelaphus strepsiceros*) are predominantly browsers, but how they adapt to the Grassland Biome is less known. To assess this, we investigated kudu foraging ecology through visual observation in association with post-browsing measurements in the central Free State. Foraging ratios, derived from dividing percent feeding time by plant species availability, were used as an index of food preference. Each plant species' preference ratings was ranked from highest to lowest per season. Kudu feeding followed a seasonal cycle where percentage time spent feeding varied between deciduous woody species (46% of total feeding time), evergreen species (19%), herbaceous material (17%), or supplied dry feed (16%) based on seasonal availability. After the first summer rains, kudus spend 49% of their feeding time on grazing newly sprouted *Digitaria eriantha* (Smuts finger grass). Annually, the diets of cows and bulls were similar ( $p > 0.05$ ). However, bulls consistently utilised proportionally more evergreen, and less deciduous species during the dry season. The feeding height range and bite diameter of shoots utilized differed between bulls and cows, with the maximum feeding height 2.36m and maximum shoot diameter 4.44mm. It is difficult to study diet composition of wild herbivores. Percentage time spent feeding can contribute to knowledge of plant species or parts consumed, even though it may not be an exact measurement of the quantity consumed. Kudu have the ability to overbrowse smaller fenced areas where they are confined. Thus, this method can aid in establishing the kudu's preferred species in order to manage these areas towards sustainable use.

(Speed 21)

**Illicit wildlife trade**

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South Africa (SA) boasts a diverse range of landscapes. Associated with these landscapes is a rich biodiversity of both plants and animals. This biodiversity needs to be protected from the threats posed by different factors that are usual as a result of human interference. To safeguard SA's rich biodiversity and human livelihoods, the Department of Environmental Affairs has put regulatory measures in place to protect our biodiversity through the implementation of the National Environmental management Biodiversity Act, 2004 (ACT No. 10 of 2004).

Some of the biodiversity challenges are as a result of wildlife crime as it pushes many of our animals towards extinction. Wildlife crime ranges from the illegal hunting or harvesting, processing, exporting and importing of plant and animal products, and the supply of these illegal products to the black market. To combat wildlife crime effectively, it is important to identify and define all possible offences and to enforce appropriate penalties for offences in a manner that is lawful, procedurally fair and reasonable. The department calls upon all relevant stakeholders in relation to wildlife to come together in protecting our biodiversity and in fighting wildlife crime. This can only be achieved through partnerships and collaborative efforts.

(Keynote 4)

### **Wildlife and the project of de-bordering**

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One of the enduring themes in the study of Africa is the question of colonial borders and how they should be changed in light of their devastating social, economic and political impacts in the African continent. Attempts by regional groupings such as the East African Community and the Southern African Development Community, and the more recent agreement on the African Continental Free Trade Area have yet to realize a borderless Africa. The creation of the new African landscape through the re-establishment of cross-border migratory routes for wildlife as well as by new wildlife management regimes ignites debates on decolonizing African borders but also, more importantly, challenges traditional approaches to some of Africa's big questions about society. Is de-bordering under the impulse of ecological regionalism a useful starting point for experimenting with micro regionalism in Africa? This paper grapples with the question with the aim of bringing wildlife management and cross-border nature conservation projects into conversation with debates on Africa's borders. The paper argues that creating cross-border conservation areas for wildlife is in itself a border-drawing exercise with huge implications for the relations between people and protected areas.

(Full 23)

**Perspectives on rhino conservation among rural communities neighbouring large protected areas in South Africa**

**Andrew Taylor<sup>1</sup>, Kirsty Brebner<sup>2</sup>, Harriet Davies-Mostert<sup>1,3</sup>, Rest Kanju<sup>4</sup>, Jiba Magwaza<sup>1</sup>, Norman Mathebula<sup>5</sup>, Samantha Page-Nicholson<sup>1</sup>, Samson Phakathi<sup>1</sup>, Unjinee Poonan<sup>6</sup> & Conrad Steenkamp<sup>6</sup>**

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During the last decade, South Africa has experienced a major upsurge in rhino poaching to supply the illegal international trade in horn. Transnational criminal syndicates are largely responsible for the organised nature of wildlife trafficking, and have been linked to rural communities located near protected areas (PAs) where they recruit community members to participate in poaching. Rural communities are targeted because they are poor and have few incentives to protect rhinos. Such communities have historically extracted natural resources from the wild to supplement their livelihoods, but their ability to do so has been restricted by environmental laws. To reduce the involvement of communities in illegal wildlife trade it is first necessary to understand their socio-economic needs and their perceptions towards formal conservation. We attempted to do this by conducting surveys in two rural communities bordering PAs with important rhino populations. In Bushbuckridge (bordering Kruger National Park), and Hlabisa (bordering Hluhluwe-iMfolozi Park), the priority needs identified were access to water, improved roads, job creation, more clinics, schools and housing. About 50% of respondents from both communities (n=118) associated no benefits from living close to the parks, while the majority indicated that the parks caused problems. Most respondents thought that rhino poaching was detrimental because it led to reduced tourism benefits, while >90% believed that communities did not benefit from rhino poaching because the only beneficiaries were poachers. Many believed it was dangerous to report poachers to the police. To be successful in combatting rhino poaching, conservation policies will need to address community issues.

(Full 24)

**A broad-scale assessment of the biological and anthropogenic factors affecting brown hyaena occupancy**

**Kathryn S. Williams**<sup>1,2,3</sup>, **Ross T. Pitman**<sup>4</sup>, **Gareth K.H. Mann**<sup>4</sup>, **Gareth Whittington-Jones**<sup>4</sup>, **Jessica Comley**<sup>5</sup>, **Samual T. Williams**<sup>2,3,7,8</sup>, **Russell A. Hill**<sup>2,3,7</sup>, **Guy A. Balme**<sup>4,5</sup>  
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With human influences driving populations of apex predators into decline, more information is required on how biological and anthropogenic factors affect species at national and global scales. This is especially pertinent for species that are reliant on unprotected land such as the brown hyaena (*Parahyaena brunnea*). We collated camera trap data from protected and unprotected sites across South Africa into the largest detection/non-detection dataset collected on brown hyaenas, and investigated the influence of biological and anthropogenic factors on brown hyaena occupancy. Spatial autocorrelation had a significant effect on the data, and was corrected using a Bayesian Gibbs sampler. We show that brown hyaena occupancy is driven by specific co-occurring apex predator species and human disturbance. The relative abundance of spotted hyaenas (*Crocuta crocuta*) and the relative abundance of humans on foot had a negative effect on brown hyaena occupancy, while the relative abundance of leopards (*Panthera pardus*) and the relative abundance of vehicles had a positive influence. Brown hyaenas are estimated to occur across 66% of the surveyed sites. Occupancy varied geographically, with lower estimates in eastern South Africa. Our findings, which can be applied across the species' range, suggest that brown hyaena conservation is dependent upon a multi-species approach focussed on implementing conservation policies that better enable human-brown hyaena coexistence. Finally, we demonstrate the conservation value of pooling fine-scale datasets and utilizing 'bycatch' data to examine species trends at broader spatial scales.

(Speed 22)

## **The efficacy of two snake-repelling agents when applied outdoors**

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About 11% of southern African snake species are highly venomous, posing a threat to human health when encountered and persecution of snakes negatively impacts biodiversity. Chemical substances that can potentially repel snakes represent a promising avenue to reduce snake encounters and the incidence of snakebite. However, a lack of empirical evidence that commonly used chemical repellents are effective, cast doubt on their snake-repelling efficacy. We assessed the efficacy of two chemical agents, Jeyes Fluid and Snake Repel, using a passive trapping protocol in Northern Limpopo. Over a two-week period, we recorded 41 reptile captures consisting of five snake species, as well as eight other reptile species. Preliminary analysis shows that Jeyes Fluid had limited efficacy at repelling reptiles, whereas the Snake Repel treatment did not appear to repel reptiles more than untreated water (the control). There were six captures from Jeyes Fluid, 18 from Snake Repel and 17 from the control treatment. While it is clear that Jeyes Fluid reduced the number of captures, it did not prevent them entirely. Two of the six captures from this treatment were snakes. The application and maintenance of a Jeyes Fluid boundary shows some promise in the reduction of encounters and consequently the incidence of snakebite when compared to Snake Repel and the control. This warrants further study into the efficacy of Jeyes Fluid and other commonly used household products for the repelling of snakes.

(Speed 23)

## **Sustainable management techniques for human-elephant conflicts in a Mozambique conservation area: case of the Tchuma Tchato Program - Chinthopo, Tete**

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Conflicts between humans and elephants (*Loxodonta africana*) are a major concern in the management of conservation areas in Mozambique. Most conflict is linked to the destruction of agricultural crops and infrastructure along with the threat of injury and death to humans. A major concern is that despite the implementation of various mitigation measures, there is a growing trend in the number of human-elephant interactions. The present study was developed to investigate the sustainability of techniques used to manage human-elephant conflict in the community management area of Chinthopo, Mozambique. We used structured

interviews, systematic observations of human-elephant conflict and Global Positioning System (GPS) logged human-elephant interactions to investigate the perceptions of game scouts and local community members to the factors that may influence human-elephant conflict and which methods management uses to mitigate these conflicts. Our results show that conflict occurs in settlements situated along the river and is most likely driven by a lack of water in elephant habitats and the disorderly occupation by communities in elephant corridors. A broad range of management techniques are used to deter elephants from human settlements; including the use of drums, alarms, burning chili seed and burning elephant feces. Furthermore, various preventative methods are also used which includes; guarding crops, creating barriers by tree trunks, use of scarecrows and the cultivation of agricultural crops on the islands of the Zambezi River. Finally, problem elephants are shot to reduce the levels of conflict. However, to ensure the effectiveness of these mitigation measures, it is necessary to ensure appropriate levels of communication and develop capacity in the community in relation to conflict management.

(Full 25)

**The feeding ecology of black-backed jackals: A comparative study between farms and reserves**

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Black-backed jackals (*Canis mesomelas*) are generalist omnivores, consuming resources in accordance with abundance. As such, their diets likely differ between human-modified and natural habitats, owing to prey provisioning and alteration of prey base. We compared the diet of black-backed jackals (consumed biomass) between reserves, with co-occurring apex predators, and livestock / game farms in the Karoo using stomach content analysis. We hypothesized that differences in diet between land-uses would be driven by variation in the consumption of the mammal components owing to anthropogenic provisioning of livestock on farms and the provisioning of carrion by apex predators on reserves. We predicted that jackal diets would differ between land-uses, incorporating predominantly scavenged large ungulates on reserves and actively hunted mammals (e.g. small mammals and livestock) on farms. Small ungulate consumption was similar between land-uses suggesting that active hunting of small ungulates may be ubiquitous across landscapes. Black-backed jackals displayed dietary flexibility in the consumption of other mammalian prey, consuming more small mammals and livestock on farms and more large ungulates on reserves, supporting our prediction. This variation in diet in response to prey availability highlights the trophic adaptability and context dependent nature of black-backed jackal foraging behaviour, which suggests that black-backed jackals may exhibit a mixed foraging strategy comprised of prey selectivity and prey switching in response to changes in resource base.

(Full 26)

**Breeding success and nest-site characteristics of chestnut-backed sparrow-larks in natural and agricultural fields**

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Nest site selection is of central importance to the reproductive success of most birds. Adults must consider a range of biotic and abiotic variables when selecting a nest-site and any of these may negatively affect the reproductive investment and even the survival of the parents. Nest placement will often influence the risk of nest predation and the micro-climate experienced during incubation, and this may, in turn, determine the outcome of nesting attempt. The aim of this study was to compare the breeding success of the chestnut-backed sparrow larks in two different habitat types, namely fallow agricultural fields and natural areas with limited or no disturbance. Nest site characteristics were described with regard to entrance direction and the percentage cover within a 1m<sup>2</sup> quadrant at the nest. The cover parameters scored included the presence or absence of an apron, percentage cover of grass, bare ground, forbs and debris. We also compared habitat features between successful and unsuccessful nest to determine how those characteristics influenced nest success. The nest outcome was recorded as either success or failure, the nest was considered successful if at least one nestling fledged. RMark was used to calculate the breeding success and the effect each one of the models had on breeding. We found a total of 126 nests in both fallow lands and natural vegetation. The results suggest that the birds breeding in the fallow lands have greater nesting success than those in the grazing camp at the study site and possible reasons for this will be presented. Thus, although agricultural activities are often regarded as destructive, this study has shown that some species may benefit from such activities.

(Speed 24)

**Diet assessment of brown hyaenas using scat analysis in Zingela Game Reserve, Limpopo Province, South Africa**

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The brown hyaena (*Parahyaena brunnea*) is classified as 'near threatened'. Although predominantly scavengers, they are frequently blamed for livestock depredations leading to persecution. This and other anthropogenic threats are causing a global population decline.

Limited literature exists detailing localised diets, an important requirement for understanding hyaena diet variation across their range, particularly in response to land use change. Here we build on studies in the Waterberg and North West Province, alongside the body of work from the Kalahari and coastal Namib Desert, to explore the diet of brown hyaena in the Limpopo Province. We collected scats in 2013 (n=41) and 2018 (n=42) from Zingela Game Reserve in the Limpopo province. Mammalian prey species were identified based on their cuticular scale imprints and cross-sectional appearance. Prey species most frequently consumed were Artiodactyls, with a relative frequency of occurrence (RF) 52% (2013) and 75% (2018), dominated by common duiker (*Sylvicapra grimmia*) (2013: 16%; 2018: 22% RF). There was a higher occurrence of larger prey in 2013, particularly greater kudu (*Tragelaphus strepsiceros*) with 11% compared to 2% RF in 2018, still smaller prey were more common (Order Rodentia: 2013: 19% RF; 2018: 5% RF; Aves: 2013: 21% RF; 2018: 0% RF) highlighting a more diverse diet in 2013. We found no remains of domestic animals in our 2018 samples, and one scat from 2013 contained donkey hair. Given the reliance on natural prey species, we advocate the need for increased community engagement work to create awareness regarding the valuable roles scavengers play within ecosystems to increase tolerance for brown hyaenas.

(Speed 25)

### **Rocking the landscape: Chacma baboons as zoogeomorphic agents**

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Animals impact the earth's surface and near-surface environment significantly through their metabolic and behavioural activities. Many digging (e.g. grizzly bears, *Ursus arctos horribilis*) and burrowing (e.g. marmots, genus *Marmota*) animals are considered zoogeomorphic agents through their contribution to soil and rock transport. While the geomorphic significance of soil transporting species has been well established, geomorphic impacts are rarely quantified for rock transporting species. The chacma baboon (*Papio ursinus*), a widespread and abundant primate species, has the potential to be a zoogeomorphic agent through their role in rock transport while searching for hypolithic fauna. We quantified baboon rock movement across a semi-arid Karoo environment in South Africa, and related the abundance and distance of this movement to rock and landscape features to assess the likely drivers of rock transport. Baboon rock movement was found to be extensive, with roughly 3.77 t of rock material displaced over 6.37 ha in one-year. The distance of rock movement was influenced by rock size (large rocks were displaced further) and rock shape (flat rocks were moved further, followed by angular and rounded rocks). Furthermore, slope influenced rock movement, with rocks displaced greater distances on steep slopes. The extent of this rock movement indicates that baboons play an important geomorphic role, with the potential to be a keystone species in a biogeomorphic context. As baboons are considered pests and are being persecuted in many African countries, we run the risk of losing an important geomorphic process without knowing the full implications thereof.

(Speed 26)

**Retrospective analysis of trends of demands for NEMBA regulated A&IS species in South Africa, 2014-2018**

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Understanding the demand of invasive species is paramount to effective management of biological invasions. Here we describe the trends in permit issuing for regulated invasive alien species in South Africa. We examined the Department of Environmental Affairs (DEA) species permitting application database records from October 2015- February 2018. The DEA processed 1390 applications and issued 1376 permits (permits are issued as per restricted activity). Our results illustrate that there is increasing demand for regulated species, with high demand for mammal and freshwater species, and this demand varies according to province. The highest demand was for *Kobus leche leche* and *Dama dama* (mammal), *Ctenopharyngodon idella* and *Oreochromis niloticus* (freshwater fish), *Psittacula krameri* (bird), and *Acacia mearnsii* (plant). Permit requests were mainly for conveyance, passion, breeding and selling. Most of the species with high demand are important for the game hunting, pet trade and game fishing industries. It is important to assess the risk of these species when issuing permits in the different provinces, especially when the environment may be suitable for the species in the case of escape. We suggest that compliance should be reinforced especially for bird and fresh water species that could potentially escape.

(Speed 27)

**The prevalence of, and common factors associated with elephant attacks on humans in South Africa**

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Various types of conflict may occur between humans and elephants (*Loxodonta africana* Blumenbach, 1797) where they share spaces or interact. Elephants may exhibit inappropriate responses to stressors due to past trauma or heightened aggression due to musth. It is concerning when aggression leads to attacks on humans, since this may lead to injury, damage to property or loss of life. It is, therefore, beneficial to ensure that as few as possible attacks occur. This can be done by informed management and mitigation practices. To inform this process, we collected data on the prevalence of attacks in South African reserves, as well as the causal factors that they may share. Data were collected through interviews with reserve owners, managers or ecologists at 47 protected areas. Interview questions covered a broad range of topics, including management techniques, physical aspects of the reserve, details of the current, as well as historical elephant populations, and details of attacks that may have occurred. An attack was defined as a display of aggression, which led to injury, death, or damage to a vehicle. All incidents were assessed to establish common causal factors among them. Preliminary results show that adult bulls and cows were equally likely to kill people, but bulls are more likely to attack vehicles. All fatalities reported occurred while people were on foot. This talk will expand on the causal factors which were identified, as well as make recommendations for mitigation efforts.

(Speed 28)

**High carnivore population density highlights the conservation value of industrialised sites**

**Daan J. E. Loock<sup>1</sup>, Samuel T. Williams<sup>2</sup>, Kevin W. Emslie<sup>2</sup>, Wayne S. Matthews<sup>3</sup> & Lourens H. Swanepoel<sup>2</sup>**

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As the environment becomes increasingly altered by human development, the importance of understanding how wildlife interacts with modified landscapes is becoming clear. Areas such as industrial sites are presumed to have little conservation value, but many of these sites have areas of less disturbed habitats around their core infrastructure, which could provide ideal conditions to support some species, such as mesocarnivores. We conducted the first assessments of the density of serval (*Leptailurus serval*) at the Secunda Synfuels Operations plant, South Africa, using camera trap surveys analysed within a spatially explicit capture recapture framework. Servals occurred at densities of 76.20-101.21 animals per 100 km<sup>2</sup>, which are the highest recorded densities for this species, presumably due to high abundance of prey and the absence of persecution and/or competitor species. Our findings highlight the significant conservation potential of industrialised sites, and we suggest that such sites could help contribute towards meeting conservation goals.

(Speed 29)

**Anthropogenic impacts on carnivores in Limpopo Province, South Africa**

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Increasing human populations and land-use changes are often associated with carnivore declines. Carnivores sharing a landscape with people may need to trade off activities such as foraging close to human activity against risk of persecution. In this study we used camera trap surveys to investigate the impacts of anthropogenic factors (human and vehicle presence) on the occupancy of four carnivore species (the spotted hyena *Crocuta crocuta*, brown hyena *Parahyaena brunnea*, black backed jackal *Canis mesomelas*, and African civet *Civettictis civetta*) commonly found in non-protected areas. The camera trapping grid covered 236 km<sup>2</sup> in the Platjan area of Limpopo Province. Our sampling was underpinned by an occupancy

modelling framework while accounting for non-detections. During a 30-day sampling period, we captured spotted hyenas, brown hyenas, black backed jackals, and African civets on 13, 49, 34, 69 occasions, respectively. We used AICc weights ( $\omega$ ) to assess relative strength of support for models and found strong support that human activity negatively affected detections in jackal and civet ( $\omega = 1.00$ ), some support for BH ( $\omega = 0.64$ ) and little support for SH ( $\omega = 0.36$ ). For all carnivores, human presence had little effect on the occupancy probabilities (all species  $\omega < 0.30$ ). Our results suggest that while human presence can affect the detection probability of the selected study species, their occupancy seems unaffected.

(Speed 30)

**Can conservation amendment of erstwhile Closed Areas contribute to biodiversity conservation? A case study from unprotected arid regions of western India**

**Subhadeep Bhattacharjee<sup>1</sup> & Goddilla Viswanatha Reddy<sup>2</sup>**

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Conventional Protected Areas (PAs) - National Parks and Wildlife Sanctuaries, are the cornerstones for biodiversity conservation in India. However, a large proportion of endangered wildlife persists beyond these PAs. In the 1980's, State Government of Rajasthan, pioneered an attempt to protect the endangered wildlife surviving outside of PAs by notifying 14,689.71 km<sup>2</sup> of wildlife rich areas as 33 Closed Areas (CAs) under section 37 of Indian Wildlife Protection Act of 1972. These CAs prohibit hunting of all species. In 2002-03, an amendment to section 37 declared hunting of wildlife prohibited across the entire country. Thus, all erstwhile, CAs lost their protection priorities and management regime. Simultaneously, rapid developments of road networks and urbanization projects proliferated in and around these CAs. Wild ungulates (blackbuck *Antelope cervicapra*, chinkara *Gazella bennettii*) and canids (Indian grey wolf *Canis lupus*, white footed fox *Vulpes vulpes pusilla*) became susceptible to local extinctions through such anthropogenic interventions. Distance sampling based line transect surveys conducted across seven erstwhile CAs in arid regions of western Rajasthan revealed that the population densities of these species were comparable to the other PAs in India. However, the human induced mortality rates of the wild ungulates in these CAs were appalling as per State Government records. Questionnaire surveys conducted among 3357 adults from 2470 households showed 31% of the population in the region are still positive towards wildlife conservation. Amendment of the status of these erstwhile CAs as 'Community Conservation Areas' or 'Conservation Reserves' with community support could be the strategy for conserving the threatened wildlife population in this region.

(Speed 31)

**“The whole story”: Inter-specific competition for nestbox cavities in a savannah environment**

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Tree cavities are keystone resources in the environment as they are generally relatively scarce but their impact on the ecosystem may be disproportionately large. Comparatively few studies have considered the community ecology of cavity nesters and the mechanisms that create and sustain these complex communities. In this study we monitored nestbox occupancy and competition by various invertebrate and vertebrate taxa at 3-weekly intervals from September 2015 to April 2018 at 80 nestboxes at the Mogalakwena Research Centre in Limpopo. During three avian breeding seasons, several bird species competed with bees, bushbabies, squirrels, wasps, rock monitors, and pythons for roosting and nesting space. Complex dynamics in temporal domination of nestboxes between species revealed an intricate nest web where at least 80% of the nestboxes were occupied at some point during the study. After an initial influx of bushbabies in the first two seasons, their nestbox occupancy declined, possibly because the study area couldn't sustain such an influx in numbers of these species. Although only six bird species utilized the nestboxes for breeding, many species visited the nest boxes at least once during the study. Competition for cavities was highest during the breeding season, when more than 50% of the nestboxes could be occupied at the same time. Bees occupied up to 20% of the nestboxes during the 2016/17 breeding season, displacing breeding birds and making cavities inaccessible for other species. Our study revealed some remarkable interspecific interactions and sheds some light on interspecific competition for a resource most of us take for granted.

(Speed 32)

**Modelling avian collision risk on power lines in South Africa**

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Avian mortalities caused by collisions with overhead power lines has emerged as a significant conservation issue, threatening many species globally. With the continuous demand for energy anticipated to increase it is expected that this unnatural, additive cause of mortality for birds will increase pressure on already stressed populations. Therefore, it is vital that the negative effects of power lines are mitigated. To prevent avian collision, bird flight diverters

are fitted to the conductor cables to make the line more visible to birds in flight – thus preventing mortalities. However, with more than 32 000 kilometers of transmission power lines (132-765kV) in South Africa, it is almost impossible to determine where to start pro-actively marking these power lines. Eskom’s Research Testing and Development partnered with the Endangered Wildlife Trust’s Wildlife and Energy Programme to conduct a modelling exercise to determine which areas in South Africa had higher avian-power line collision risk. This was determined by assessing and analysing historical collision incidents and potential variables (e.g. topography, distance to breeding/roosting sites, water availability) which would increase the likelihood of collisions. Our approach to determining priority transmission power line sections for pro-active mitigation was to predict potential areas of avian power line collisions using ecological niche modelling to predict potential areas of avian power line collisions. This was done for Red-listed species selected for the analysis according to a selection protocol previously developed. The results provided us with a map which displays areas of zero, low, medium and high collision risk that are now used in proactive mitigation plans for Eskom.

(Speed 33)

### Density estimates of spotted hyaenas on arid farmlands of Namibia

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Spotted hyaenas *Crocuta crocuta* populations are stable within protected areas but are declining outside of such areas. This decline is partly due to habitat loss and human-carnivore conflict as it is often assumed that these species are responsible for livestock losses. New technologies such as camera traps and software packages can be used to determine population densities and clan structures for wildlife managers. Here spotted hyaenas densities on the south-western arid farmlands of Namibia were determined by means of camera traps and the software package SPACECAP. The data shows that at least 14 individuals are present in the study area, resulting in the minimum density of 0.85/100 km<sup>2</sup> (SD=0.14;  $p=0.65$ ). This study is the first of its kind in this area and can serve as a benchmark for future research. Our data can assist managers to develop human-carnivore conflict mitigation strategies. Our work also shows that accurate data on the density of individually recognized species, such as spotted hyaenas, cheetahs *Acinonyx jubatus* or leopards *Panthera pardus*, can be collected in a non-invasive manner, eliminating stressful and sometimes life-threatening methodologies such as capturing and fitting GPS collars.

## **(Keynote 5)**

### **Too many, too few and never enough**

**Rudi A.J. van Aarde<sup>1</sup>**

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Our protected areas are remnants of former continuously stretches of heterogeneous landscapes that conceivably catered for ecological and evolutionary processes. This is no longer the case and once continuous populations are now trapped in fragments of protected land where most species are protected, a few are persecuted and others are exposed to artificial living conditions. This is not ideal and certainly not a viable conservation scenario. Species abundances and richness are consequently artefacts of opinion that are not always informed by ecological principles and paradigms. Based on experience gained over a span of 40 years my presentation argues in favour of reinstating or where not possible, mimicking ecological processes to enhance conservation outcomes.

## Conservation management of small populations

(Full 27)

### The use of contraceptive techniques in managed wild African lion populations to mimic open system cub recruitment

Orla K. McEvoy<sup>1</sup>, Susan M. Miller<sup>2\*</sup>, Natalia Borrego<sup>3,4</sup>, André Burger<sup>5</sup>, Sam Ferreira<sup>6</sup>, Brian Courtenay<sup>7</sup>, Cathariné Hanekom<sup>8</sup>, Craig Packer<sup>3,4</sup>, Dave Robertson<sup>9</sup>, Ken Stratford<sup>10</sup>, Markus Hofmeyr<sup>11</sup>, Rob Slotow<sup>3</sup>, Tarik Bodasing<sup>12</sup>, Warren Beets<sup>13</sup> & **Dan M. Parker**<sup>1,14</sup>

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Managed wild lions (*Panthera leo*) are lions found in smaller (<1,000 km<sup>2</sup>), fenced protected areas and comprise a substantial portion of South Africa's wild lions. However, because of an absence of natural population control measures, managers of these enclosed areas face constantly increasing lion populations requiring active management of some vital rates. Fecundity control is used by wildlife managers, but long-term, empirical data on the efficacy and consequences of such interventions in lions are lacking. We assess the efficacy of two methods of contraception (deslorelin implant and unilateral hysterectomy) in reducing the cub recruitment of managed wild lions (n = 94 across 19 protected areas). Deslorelin implants were effective in increasing the age of first reproduction and lengthening inter-birth intervals. There was also an unexpected decrease in litter size. However, behavioural side-effects were recorded in some of treated individuals, and the more successive deslorelin implants a lioness had, the more likely it was that weight gain was reported. Unilateral hysterectomy resulted in a non-significant decrease in litter size post-surgery. No behavioural or physiological side-effects were noted after unilateral hysterectomy. While more side-effects were associated with deslorelin implants than unilateral hysterectomies, a single deslorelin treatment is currently a good option for fecundity reduction. Nevertheless, wildlife fecundity control programmes

should be implemented in a humane manner within each reserve's management objectives and budgets. Any interventions require careful, regular monitoring for any potential side-effects and further scientific evaluation.

(Full 28)

**Between a rock and hard place: medium and large mammal species richness in urban nature reserves**

**Andrea K. Schnetler<sup>1</sup>, Frans G. T. Radloff<sup>1</sup> & M. Justin O'Riain<sup>2</sup>**

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Urban nature reserves are typically small in size with hard edges and limited connectivity. These attributes impact adversely on critical ecosystem processes such as immigration and together with increased risk of stochastic anthropogenic events, increase the risk of local extinction of species. The City of Cape Town (CoCT) manages seventeen such nature reserves that vary in size (4 – 8500 ha), connectivity and edge attributes. We combine this variation in reserve attributes with a camera trapping study to better understand the presence and distribution of medium (>2 kg) and large (>15 kg) mammal species across 13 of these reserves (>30 ha). Understanding the drivers of species richness is essential for conservation planners to decide on critical attributes of reserves and allows reserve managers to respond to both chronic and novel threats to extant species. Sampling commenced in June 2017, will be completed by August 2018 and includes a minimum of 1000 camera days/reserve. To date 8 reserves have been surveyed with a total of 2051 independent photographs of wildlife and 705 of domestic species recorded. A total of 18 species of wildlife has been recorded ranging from 1 – 11 per reserve. Preliminary analyses suggest that species richness increases with reserve size and reserves connected to large protected areas have higher species richness than similar sized isolated reserves with hard edges. Most species recorded in the smaller, isolated reserves are cosmopolitan mammal species of mostly low conservation concern, but they may play important roles in ecosystem functioning that require further investigation.

(Full 29)

**The social behaviour of lions in small, fenced protected areas**

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The population of managed wild lions (*Panthera leo*) in small (<1,000km<sup>2</sup>) fenced reserves across South Africa has increased in recent decades. Successfully re-introduced for tourism and ecological incentives, these isolated lion populations are managed to limit inbreeding and high population growth. The primary ecological driver behind natural lion sociality and population control is competition with other lions in the form of territory and cub defence. The matrix of small reserves in South Africa with varying lion population structure (number of resident prides and adult males) provided an opportunity to investigate lion social behaviour in these reserves. We predicted that lions in small reserves with few prides and few nomadic males will group less with other known lions due to lower levels of intraspecific competition. A total of 6,642 lion sighting records were collected from 33 lion prides across 16 reserves in South Africa between 2010 and 2017. The percentage of adult lionesses from a pride sighted together was lowest in reserves with a single resident pride and male/coalition. Across all reserves, the percentage of adult lionesses sighted together decreased significantly as pride size increased and adult lionesses did not spend more time with other pride members when the pride had resident cubs (3 to 12 months old). However, solitary lionesses with young cubs spent significantly more time with known adult male lions than solitary lionesses without young cubs. These data provide a fuller understanding of lion behaviour in small reserves, which information we believe will support management decisions for managed wild lions.

(Full 30)

### Roost site selection of the endangered Cape Vulture

**Francis R. Martens<sup>1</sup>, Morgan B. Pfeiffer<sup>1,2,3</sup>, Colleen T. Downs<sup>3</sup> & Jan A. Venter<sup>1</sup>**

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Preferred roost sites may be a driving factor of where species are geographically distributed. Roost sites host dense concentrations of birds from vast areas within an individual's distribution range and are selected based on favourable roosting conditions. Large soaring birds often roost on cliffs and large pylons, and thus are restricted to areas where safe take-off and landing can occur. The natural roosting preferences of a cliff nesting, southern African endemic, the Cape Vulture (*Gyps coprotheres*) was explored for five juveniles and three adults. The physical and environmental conditions that influence roost site selection was investigated. Generalised linear mixed models (GLMM) were used to identify which features were considered favourable for roosting sites. To determine the vulnerability of breeding colonies to potential development (i.e. wind energy infrastructure) the density of roost sites around the natal/breeding colony was determined. Roost density around the natal/breeding colony was calculated in predetermined buffer sizes and a GLMM run to determine highest density of roost sites per buffer. Both age classes of Cape Vulture showed a roost preference for areas that were located closer to colonies, had low accessibility to predators and displayed high wind speeds. Cliff aspect and the direction of the prevailing wind direction also influenced roost site selection. The highest density of roosts for juveniles was located within 20 km's from the breeding colony. The protection of roosting sites is an important consideration for conservation management, as these areas often contain high concentrations of vulnerable birds and are often located outside of protected areas.

(Full 31)

### Is predator naivety a determinant of relocation success in metapopulation cheetahs?

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Large predators have been reintroduced into more than 50 fenced reserves across South Africa since 1965. Through the managed metapopulation project for cheetahs (*Acinonyx jubatus*), we have relocated 154 cheetahs between suitable reserves since 2011. Reserves that now support

a diverse large predator guild tend to place a strong emphasis on lion (*Panthera leo*) savviness when obtaining new cheetah for reintroduction or genetic and demographic supplementation purposes. However, although lions are responsible for 32% of cheetah mortalities on fenced reserves in South Africa, there is no hard evidence that previous lion exposure influences relocation success, defined here as survival for at least two years following release onto a new reserve. We conducted a comparative analysis to ascertain differences in survival and reproductive success between lion-savvy and lion-naïve cheetahs released onto reserves containing lions. We accounted for differences in age, sex and reproductive fitness when determining the extent to which previous exposure to lions plays a role in cheetah relocation success. We found that 77% of lion-savvy cheetahs survived for at least 2 years following release onto lion reserves (n=48), whilst 72% of lion-naïve cheetahs survived for 2 years post release (n=11). Irrespective of the presence of lion, 80% of male cheetahs (n=45) and 70% of female cheetahs (n=27) relocated to new reserves survived for 2 years post release. The relocation success of lion-naïve and lion-savvy cheetahs onto lion reserves is not significantly different. We discuss our results in light of management implications when relocating cheetahs between metapopulation reserves.

(Full 32)

**Stable isotope niche structure of herbivore communities provides insights about inter- and intra-specific resource partitioning**

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Large mammal herbivores in African rangelands occupy distinct dietary niches along a browser-grazer continuum. Although interspecific variation in dietary niches has been studied previously, these studies have been limited geographically because of the difficulty of collecting dietary information over broad space and time scales. Isolated studies differ with respect to the degree of species-specificity in dietary niches and hence whether herbivore communities are structured by trophic behaviours. In this study, we examine general trends in large herbivore community structure along a broad-scale environmental gradient to resolve the relative importance of inter- and intra-specific resource partitioning. We evaluated isotopic niche variation across nine protected areas in central South Africa using faecal samples from 12 large herbivore species. Faecal carbon isotope compositions reflected an expected browser-grazer continuum, where grazing species showed consistently higher <sup>13</sup>C compared to browsing species. Species in either guild had variable <sup>13</sup>C isotopic niche breadths, but this did not differ between populations. Across all assemblages, species-level differences accounted for most (75%) of the variation in  $\delta^{13}\text{C}$  data, with within-species differences accounting for (25%) and isotopic niche overlap amongst species was generally low. Although our results imply that species' isotopic niches vary depending on assemblage structure and geographic location, the overall trend confirms the importance of inter-specific resource partitioning for structuring herbivore communities. Our work demonstrates the power of stable isotope approaches for reconstructing spatio-temporal dietary variations in a

way not possible previously.

(Full 33)

### **Habitat structure and reptile occurrence in a fragmented tropical landscape**

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The relationship between species distribution and habitat structure is fundamental to ecology, biogeography and conservation. Squamates (lizards, including snakes and amphisbaenids) are of particular interest in this regard as there has not been sufficient research into the relationship between their distribution patterns and habitat-use, especially in the southern hemisphere. Our study investigates the associations between habitat structure and occurrence of squamates in a Madagascan dry forest, where fine-scale endemism and deforestation put many species at risk of extinction. Presence data for 37 species, collected over four years, and satellite imagery of north-western Madagascar were used in community-level hierarchical occupancy models (that account for imperfect detection of reptiles during surveys) to define species responses to vegetation structure and anthropogenic proximity. Sites with high values of vegetation greenness and low brightness (open soil), that are away from roads and forest edges, promote the greatest levels of species richness. Threatened species are more likely to occur in such sheltered areas. Some snakes show contrasting occupancy patterns, possibly due to the hunting and basking opportunities which roads, villages and forest fringes offer. Responses to site covariates within taxonomic families were highly variable, indicating that habitat selection is more complex than can be explained by phylogenetic groupings. Future research, that includes the effects of foraging strategy and vegetation species composition on species occurrence, may further shed light on the determinants of squamate community structure and habitat selection.

(Full 34)

**Aerial census data, observation error and statistical power: Some modelling considerations for low abundance and cryptic species**

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Imperfect detection associated with aerial surveys of wildlife populations complicates attempts at estimating population size and temporal trends. This is interdependent, most notably, on the size of the population under study. Statistical theory dictates that the smaller the population size, everything else being equal, the higher the coefficient of variation for estimates of population size. Additional to population size, co-variables that might affect detection probability includes for example species size and coloration, and vegetation cover. The implication is a decline in statistical power, and thus an increased likelihood of incorrectly accepting the null hypothesis of no temporal trend in population size. The extensive aerial survey data from North West Parks suggests detection probability, to varying degrees, is dependent on site, species, and time of survey. Within this context, we demonstrate that accuracy of annual census data across North West Parks dictates the need for statistical power if the aim is to detect annual trends. We use fifteen percent annual growth as an arbitrarily chosen expected annual increase in population size of wildlife populations and use arbitrarily chosen single and triplicate surveys to compare power estimates for correctly inferring growth. We do comparisons for short (1 year), and medium (5 year) time periods. We furthermore estimate statistical power, based on a case study, through data simulation under varying scenarios of observation error. This, we hope, demonstrates that studies related to numerically rare species requires sufficient knowledge about the observation process in order to make correct inferences about population trends.

(Full 35)

**Impacts of harvest on the kin-related spatial structure of leopards**

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Natal dispersal enables population connectivity, gene flow and metapopulation dynamics. In polygynous mammals, dispersal is typically male-biased. Classically, the ‘mate competition’, ‘resource competition’ and ‘resident fitness’ hypotheses predict density-dependent dispersal patterns, while the ‘inbreeding avoidance’ hypothesis posits density-independent dispersal.

In two leopard (*Panthera pardus*) populations, one well protected (Sabi Sands Game Reserve) and the other recovering from over-harvest (the Phinda-Mkuze Complex), we investigated the long-term effects of unsustainable harvest on natal dispersal patterns and the resulting population genetic structure. We used 12-years of telemetry and observational data with microsatellite-based parentage and relatedness analyses on 140 leopards across these two populations. We found higher levels of relatedness between neighbouring male and female leopards in the harvested population, providing evidence of opportunistic natal philopatry among males. We did not however find evidence of lower levels of relatedness among neighbouring females in the protected population at capacity, as expected under density-dependent dispersal. While on average mating pairs were significantly more related in the harvested population, there was no discernible difference in their inbreeding coefficients. We conclude that though conservation interventions in the harvested population have facilitated local demographic recovery, they have not restored natal dispersal patterns disrupted by unsustainable harvest. Despite this, leopard populations in this area appear resilient to inbreeding effects, which suggests connectivity among leopard populations over a larger landscape. This study presents novel insights into the natal dispersal behaviour of a wide-ranging, nocturnal and particularly cryptic solitary species.

(Speed 34)

### **The Importance of point data in the conservation management of small plant populations**

**Tommie M. Steyn<sup>1</sup>**

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Geographical points linked to data and photographic images modelled through GIS software provide powerful point data that can be applied in a number of ways, including citizen science projects. In small plant populations point data becomes very relevant as plants are static and point data overtime can provide insight into population dynamics, habitat requirements, reaction to climate change and area of occurrence and occupancy. Point data of small populations can provide a baseline that can later be used as guidelines for recovery or re-establish programs for threatened species. In such instances point data may resolve questions about minimal viable populations, distribution patterns at individual level, population structure, sex ratios and longevity of individuals. The importance of point data on two species, *Encephalartos laevifolius* Stapf & Burt Davy and *Brownleea graminicola* McMurtry are compared with the advantages provided for both species. *Encephalartos laevifolius* point data proved to be important during recovery of stolen plants and assisting in law enforcement efforts as a microchip linked each plant to a geographical point with associated ecological data. With *Brownleea graminicola* point data it is possible to determine the conservation value of a subpopulation in a NR to the survival of the species.

(Speed 35)

**Phylogenomic relationships, demographic history and conservation of polar bears**

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The polar bear (*Ursus maritimus*) is a predatory marine mammal that is adapted to survive harsh Arctic weather conditions. Polar bears diverged from brown bears (*U. arctos*) during the Pleistocene, and although they are separate species with adaptive differences, mitochondrial DNA nests *U. maritimus* within the diversity of *U. arctos* due to ongoing interspecific hybridization. Although genome data have been generated for both polar and brown bears, each analysis focused on limited geographic areas with no study as yet including information from all data sets. Given the high conservation concern for polar bears, especially in light of a potentially warmer climate in the future, we have merged genomic data from previous studies and undertook a more comprehensive geographic analysis of both species. By estimating genome wide heterozygosity, we show that polar bears are much less genetically diverse than brown bears. We are presently testing hypotheses of intraspecific admixture: among polar bears from West and East Greenland with those of Svalbard in Norway; and between brown bears from North America and Europe. We will also present estimates of effective population size through time since the onset of the Pleistocene to determine the influence of past climatic fluctuations on polar bear genomes. These results will be informative for conservation managers, who urgently need to find ways of maintaining genetic diversity in a declining polar bear population.

(Speed 36)

**Conservation efforts and movement patterns of the Pacific Fisher**

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The fisher (*Pekania pennanti*) is an arboreal member of the weasel family that occurs only in North America. Fisher populations in the western United States are of conservation concern due to a combination of historic trapping and loss of suitable habitat. The fisher population in the southern Sierra Nevada is currently of particularly high concern due to their isolation from populations to the north. The Kings River Fisher Project (KRFP) has been monitoring a subpopulation of fishers in the Southern Sierra since 2007, studying fisher ecology,

demography and habitat selection. The KRFP is currently focusing on the fishers' response to an extensive tree mortality event that began in 2015 due to drought and bark beetle outbreaks. To improve our understanding of how fishers are responding to these extensive changes to the forested landscape the KRFP has switched from VHF to GPS collars to gain information on fine-scale movements across areas with variation in tree mortality. GPS collars for a small mesocarnivore such as the fisher are still a relatively new development with both pros and cons for research projects. We observed fishers using areas with less tree mortality and relate our initial experience with GPS collars suitable for mesocarnivores.

(Speed 37)

### **Buffalo reproduction in a non-seasonal environment**

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Reproductive patterns of ungulates are often driven by seasonal rainfall, where the abundance of predictable resources after rains influence the timing of birth and / or conception. Across most of southern Africa, buffalo (*Syncerus caffer*) births peak during wet seasons when nutritious grass is abundant. In the Eastern Cape, however, rainfall occurs throughout the year, raising the question of whether buffalo in this non-seasonal environment have prominent births peaks, or whether births occur year-round. We monitored buffalo breeding herds (n = 2 accounting for ~80% of the buffalo population) in the Addo Elephant National Park over a four year period, assessing the proportion of neonate (0-3 month old) and juvenile (3-6 month old) buffaloes. The annual birth peak was wide and shallow, with neonates present throughout the year. This shallow peak in buffalo births coincided with a marginal peak in April rainfall. However, we detected no relationship between neonate proportions and 1) rainfall during the month of observation (birth) or 2) lagged rainfall 9-11 months prior to the month of observation (conception). These results suggest that long-term rainfall cycles may play a weak role in driving buffalo reproductive patterns in non-seasonal environments. This year round reproduction strategy may have evolved through a combination of year-round rainfall and the historic lack of large predators driving the need for synchronized reproduction. With the reintroduction of large predators to many reserves in the Eastern Cape, it remains to be seen whether buffalo reproductive strategies evolve and if adult buffalo are able to protect juvenile buffalo year-round.

(Full 36)

**Selection of seeds and seedlings of four tree species by South African bushveld savanna rodents**

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There is a decline in the abundance of large, old trees across many ecosystems. One ecosystem suffering high mortality of adult trees and decline in recruitment is the South African bushveld savanna. We set out to investigate the feeding ecology of bushveld savanna rodents, including red veld rat (*Aethomys chrysophilus*), Namaqua rock mouse (*Micaelamys namaquensis*), bushveld gerbil (*Tatera leucogaster*), Smith's Bush squirrel (*Paraxerus cepapi*), multimammate mouse (*Mastomys natalensis*), and chestnut climbing mouse (*Dendromus mystacalis*). We specifically investigated if they would facultatively feed on the seeds and seedlings of bushveld savanna tree species including marula (*Sclerocarya birrea*), jackalberry (*Diospyros mespiliformis*), false marula (*Lannea schweinfurthii*), and knobthorn acacia (*Acacia nigrescens*). Rodents were trapped in Balule Nature Reserve, Limpopo Province, South Africa, and put through feeding trials with the seeds and seedlings of these native tree species. Results showed significant differences in rodents' feeding preferences for seeds. Rodents of every species attacked seedlings, excising cotyledons and inflicting other damage, though there was no evidence of preferences among tree species. These results suggest that rodents may be influencing the recruitment of these tree species.

(Extended 4)

**The potential of privately protected areas to promote the persistence of a regional assemblage of large- and medium-sized mammals**

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There is increasing recognition that the private sector can and should play a role in conserving the world's biodiversity. Despite the increase in privately protected areas (PPAs) around the world, there is a lack of understanding regarding their contribution to the persistence of biodiversity. We assessed the capacity of PPAs to contribute to the persistence of 38 large- and medium-sized mammals in the Cape Floristic Region, South Africa. The trend for PPAs to be small translated into low potential species' richness and alpha diversity on individual PPAs, with two-thirds of the region's PPAs lacking the capacity to support viable populations of more than 50% of the mammal functional guilds. Given the large number of PPAs and their disproportionate occurrence in important areas for mammal conservation, however, potential species turnover and regional (gamma) diversity was higher across PPAs than state-owned protected areas. Furthermore, PPAs could make the greatest absolute contribution towards species conservation targets when adjoining and thus expanding state-owned protected areas. PPAs can therefore serve two mammal-conservation functions: (a) increasing the number of viable populations and regional-scale diversity of protected species, through their high number and non-random distribution across the landscape; and (b) increasing the size of populations and diversity of species and functional groups within individual protected areas, when situated so they are expanding and/or connecting state-owned protected areas. These findings illustrate the substantial role that PPAs could play in contributing to the long-term conservation of terrestrial megafauna within a multi-tenure, regional protected area estate.

(Full 37)

**Implications of opportunistic hunting and sex-specific diets for estimating lion resource use**

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Predator resource use and carrying capacity models are derived from density of preferred prey. However, model utility declines when predator diets deviate from predicted diets through opportunistic hunting and/or sex-specific differences in diets. Lions (*Panthera leo*) prefer large prey providing the greatest benefit for the cost of hunting. This is in accordance with optimal foraging theory, which further predicts less diverse predator diets when there is a greater availability of preferred prey. Therefore, where preferred prey are abundant, lions are predicted to have a narrower dietary niche, dominated by preferred prey. We tested this by investigating lion diets (composition and breadth) in the productive (high prey biomass) Hluhluwe-iMfolozi Park (HiP). We also estimated male and female lion diets. Lions in HiP preferred larger prey, but despite a high abundance of preferred prey, lion diets still included 35% of non-preferred prey. This suggests that lions maintain a degree of opportunism even when preferred prey are abundant. This opportunism in HiP is reflected by the significant consumption of nyala (*Tragelaphus angasii*), typically avoided elsewhere. Therefore, abundant, non-preferred prey can be important in sustaining lion populations. Furthermore, sex-specific differences in lion diets were evident, with males consuming fewer medium- and small-sized prey than females. Understanding the relative impact of different sexes will be important in predicting the impact of lions on prey populations, especially where management actions alter sex ratios in small prey populations. Estimations of lion resource use and carrying capacity should consider opportunistic hunting and sex-specific differences in lion diets.

(Speed 38)

**The spatiotemporal aspects of predation on the Cape Gannet population at Bird Island, Lambert's Bay, Western Cape, South Africa**

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Worldwide, the six remaining Cape gannet *Morus capensis* breeding populations experience predation that limits both their breeding density and breeding success. In 2006 the entire breeding colony deserted Bird Island Nature Reserve due to predation by Cape fur seals *Arctocephalus pusillus pusillus*. The Cape gannet population has subsequently recovered, however, current predators of concern are still Cape fur seals, but also Kelp gulls *Larus dominicanus*. The latter predate on the eggs and young chicks, and the former predate on fledglings at sea. To better understand the effect of predation rate on breeding success we use data from 2006 to 2019 to determine the temporal and spatial aspects of predation. These data were collected in the breeding seasons by monitoring the colony and the water surrounding the island for 12 hours per day to determine predation rate. The Kelp gulls were responsible for 62% of Cape gannet mortalities which took place at the colony and the Cape fur seal predation was much less at 38% at sea. The daily average predation rate for Kelp gulls was  $8 \pm 0.12$  (mean  $\pm$  SE) and the Cape fur seal daily average predation rate was  $8 \pm 0.10$  (mean  $\pm$  SE). 54% of Kelp gull predation took place between 7am and 6pm, and 54% of Cape fur seal predation took place between 12pm and 15pm. This study serves as a scientifically informed guideline for the future management of Bird Island's Cape gannet population.

(Speed 39)

**Environmental determinants of ungulate population dynamics across North West province of South Africa**

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Many ungulate species are now restricted to distribution ranges much smaller than previously occupied. Environmental drivers responsible for the dynamics of ungulate populations and spatial distributions are not easy to identify, as they often act interdependently, thus requiring large data sets for statistical analysis. In addition, reasons for ungulate population fluctuations are still largely unknown especially with regard to inter-specific competition, among other

contributing factors. Some species are affected more than others by fluctuations in rainfall, soil nutrients and other resource availability. Fluctuations in population sizes of many ungulates were observed between 1999 and 2016 across the North West (NW) province. We investigated the cause of such variations by considering survey data and rainfall records across the study sites. It was explored if there was any significant difference in rainfall patterns across the NW province and if there was a positive correlation between ungulate population dynamics and rainfall patterns in those areas. Competition for food resources was also investigated to determine whether the presence of a certain type of foraging species affected the distribution of other species across the study area. The study area was divided according to rainfall gradients as areas with low (<470mm), medium (470-540 mm) and high rainfall (>540 mm). Preliminary results suggested that the bulk grazers and mixed feeders negatively affected populations of selective feeders in the areas of low rainfall (400-470 mm) indicating competition for resources. In the areas with medium and high rainfall, there was no significant competition observed.

(Speed 40)

### **A genetic view on the metapopulation management plan for African wild dogs**

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The Endangered Wildlife Trust's metapopulation project has successfully recovered population numbers of African wild dogs *Lycaon pictus* in South Africa. Although the increase of African wild dogs seems promising, a question remains as to whether the population is genetically viable, considering the small founding population and the isolation of reserves in South Africa. To compensate for the lack of natural dispersal, translocations of packs between reserves have been ongoing since the start of the metapopulation project in 1997. In this study, we aim to assess if the metapopulation approach for African wild dogs has successfully maintained healthy levels of genetic diversity by avoiding inbreeding during the recent population expansion in South Africa. Furthermore, by cataloguing individual genetic diversity and relatedness, the project can make informed decisions about which individuals are viable for translocation and which areas are vulnerable to genetic erosion. To facilitate this, blood samples of African wild dogs have been collected for DNA analysis from reserves that take part in the metapopulation project. Furthermore, we also aim to compare the genetic diversity of the metapopulation to (1) the Kruger National Park, where African wild dogs have always occurred, though at low population densities and (2) the free-roaming population in the Waterberg region of northern South Africa, where African wild dogs have occurred at extremely low population densities. We hope that our results will benefit future conservation practices and to ultimately ensure a future for African wild dogs in South Africa.

(Speed 41)

**Successful brown hyaena translocation in South Africa**

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Increasing human encroachment on natural areas is causing wildlife habitat deterioration. Brown hyaenas *Hyaena brunnea* experience conflict in agricultural areas where increased encounters with people leads to hyaenas being blamed and persecuted for livestock deaths. We investigated translocation as a conflict mitigation tool by removing five hyaenas from farms where landowners had obtained permits to destroy them. Individuals were moved 250 km to a small, fenced conservation reserve within their natural range, free from a resident population of brown hyaenas. We deployed five GPS collars onto the hyaenas prior to a soft release. All hyaenas established home ranges within the designated release site and formed two separate social groups, which both reproduced and successfully reared cubs. These data represent the first spatial analysis and general ecology knowledge for brown hyaena in the bushveld habitat of South Africa's Lowveld region. We provide the first protocol for the translocation and soft release of brown hyaenas. It is also the first GPS-monitored translocation of multiple brown hyaenas simultaneously. We conclude that brown hyaenas, of varying age and sex, respond well to translocation and that animals moved and released together are capable of establishing new, breeding populations with the absence of conflict. We suggest that the soft release technique was a key component for success but are unable to comment on the potential importance of relatedness between translocated individuals.

(Speed 42)

**Survival and distribution of Temminck's ground pangolins retrieved from the illegal wildlife trade in South Africa**

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Today there are eight species of pangolin left in the world, all of them currently considered vulnerable to extinction, with their numbers rapidly declining due to the excessive demand for pangolin scales from the illegal trade. This industry is often highly organised and lucrative, making it extremely problematic to counteract. These factors contribute to pangolins now being regarded as the most poached mammals on Earth. In cases where pangolins have been recovered from the illegal trade, they are typically released shortly after being rescued. Releases are generally done with the assumption that the pangolins will be able to recover and survive once back in their natural environment, with only a few cases where sufficient

monitoring has taken place post-release. In this study, with a focus on the Temminck's ground pangolin (*Smutsia temminckii*), the objective is to determine the success of the release of pangolins recovered from the illegal trade in South Africa. Field data will be gathered from at least ten pangolin that has been released on several approved sites. Data will be collected using VHF- and UHF radio-telemetry systems, as well as GPS equipment as to determine distribution, behaviour, home ranges and the use of habitat. Taking into account the several stress factors from captivity, we hypothesize that appropriate hospitalisation and rehabilitation pre-release will make a significant difference in survival rates. This proposed study is the first of its kind globally for any of the eight species of pangolin.

**(Extended 5)**

**Contrasting evolutionary history, anthropogenic declines and genetic contact in the northern and southern white rhinoceros**

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The white rhinoceros (*Ceratotherium simum*) has a discontinuous African distribution, which is limited by the extent of sub-Saharan grasslands. Northern and southern populations have undergone differing population histories, with the southern population (SWR) declining to its lowest number around the turn of the 19<sup>th</sup> century, but recovering to become the world's most numerous rhinoceros. In contrast, the northern population (NWR) was common during much of the 20<sup>th</sup> Century, declining rapidly since the 1970s, and now only two post-reproductive individuals remain. Until recently, this species has lacked a genetic assessment of its demographic history. We sampled 232 individuals from extant and museum sources and analysed ten microsatellite loci and the mtDNA control region. Both marker types reliably partitioned the species into SWR and NWR, with moderate nuclear genetic diversity. mtDNA diversity was limited to just three haplotypes across the entire species, including all historic samples. We detected prehistoric interglacial demographic declines in both populations. Both populations were also significantly negatively affected by anthropogenic pressure coinciding, as expected, with the colonial expansion for the SWR, but surprisingly, with the much earlier Bantu migrations for the NWR. Finally, we detected secondary contact between NWR and SWR, possibly occurring as recently as the last glacial maximum. These results suggest the species was subjected to regular periods of fragmentation and low genetic diversity, which may have been replenished upon secondary contact during glacial periods. Importantly, secondary contact suggests a potentially positive outcome for a hybrid rescue strategy, although further genome wide data are still required.

(Speed 43)

## Conservation genomic analyses of East Asian leopards in captivity and in the wild

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The genome contains all genetic information of an organism. It is also a faithful record of demographic and selective mutational events that occurred during an organism's evolutionary history. Therefore, studying the genomes of fragmented, declining populations provides crucial information about evolutionary history and fitness, which is becoming increasingly important for conservation. East Asian leopards comprise two small and critically endangered populations: Amur leopards (*Panthera pardus orientalis*) of the Russian Far East and North China leopards (*P. p. japonensis*), now inhabiting Central China. We analysed genomic diversity among East Asian leopards to identify potential differences between captive and wild individuals. Genome-wide heterozygosity was estimated using the site frequency spectrum across the genomes of four East Asian leopards. A captive Amur leopard was more diverse than two wild Amur leopards, and North China leopard was the least diverse. It is possible that high diversity of captive Amur leopards may have arisen through admixture with the North China leopard. We will test this hypothesis by reconstructing the genealogy linking these leopard genomes. In addition, we will present results from a reconstruction of the demographic history of both subspecies and provide an assessment of gene flow among East Asian leopards and other big cats. These results will help determine the impact of generations in captivity, and the consequences of mixing different leopard subspecies. As leopard populations are declining across the Old World, including South Africa, our study will provide essential genetic information that could inform re-introduction programs to boost the diversity of wild populations.

(Speed 44)

## Scat use to determine habitat preferences of leopard

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The elusive nature of leopards *Panthera pardus* in savannas makes it difficult to study their habitat preferences. The aim of this study is to determine if scats and tracks can be used to indicate their habitat use. Two areas were used where little information about leopards exist, namely Buffalo Creek Game Ranch in Limpopo Province (S1) and selected provincial nature reserves around Lydenburg, Mpumalanga Province (S2). These two areas are generally similar in terms of vegetation and topography and are characterised by mountainous terrain

with mixed bushveld. S1 has tall grass (1-2m), dense tree cover and abundant shrubs. S2 has shorter grass (0.5-1m), a canopy cover of 40% or less with little to no shrubs and it is very rocky. Vehicle roads were used as transects. Animal paths were also traversed but with little success. For each scat or spoor found, the GPS position and general habitat description was recorded. Over a year, 81 scat samples were collected. At both study areas, scats were found on flat patches with little to no incline and an open canopy cover. On S2, scats were mostly found on mountain slopes and on S1 in valleys and on mountain slopes. These leopards form a small population that is restricted by boundary fences of the reserves and by smaller camps used for intensive breeding of game. The method has limitations and no specific habitat could be described, but the general habitat of leopard in the two study areas could be compared and described successfully.

(Speed 45)

### **Resurrection of the cheetah population in the Pilanesberg National Park, North West**

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A female cheetah *Acinonyx jubatus* (Von Schreber, 1775) captured on ranchland, was 'hard released' after ~3 months of *ex situ* boma-confinement onto Pilanesberg National Park. The park was simultaneously colonized by two males. She was monitored via satellite telemetry for a period of ~10 months, and interventions took place during this period to maximize survival (i.e. integrated burning, lion management). Post-release movements were not unlike movements elsewhere, and there was no clear indication that she would home back to her origin. This female bred successfully within the first two years of release, and has averaged out to having moderate success (~58.3±29 % survival, range 25-75%,  $n = 3$ ), given the last litter, where only one survived. Her first two litters, showed 75 % survival even into independence, i.e. ~16 months. The population increased to 13, after 3.5 years and although all related, this illustrates the need to fast track removals on small fenced reserves to prevent inbreeding/intra-specific mortality. Given the proximity of the capture site, and period of confinement, this 'hard release' has been a success, and it should be a cost-effective practice for any releases that are contemplated in a similar geographical area (< 100 km, or intra-cluster).