



Session 10: General poster viewing

The effect of high density livestock grazing on a mesic grassland in South Africa

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Short duration high density stocking is currently gaining popularity amongst farmers in the South African mesic grasslands, but little is known about its potential impact on these grasslands. The aim of this study was to assess the effect of short duration, high density stocking of cattle on the plant species composition and soil physical and chemical properties of a mesic grassland near Kokstad, KwaZulu-Natal. This study was conducted on a fence line contrast between two properties. One that has been stocked with cattle in a short duration rotational system at a high density (HDG) and the other rotational grazing system at a much lower density (LDG) for >17 years. Veld condition assessment was conducted by means of 100 paired points along the fence to determine plant species composition. Basal cover was calculated using the distance to the nearest tuft and tuft diameter measures. Ten 10 x 10 m paired plots were located along the fence. Soil compaction was measured inside each plot using a dynamic cone. Soil samples were collected from the plots and analysed for chemical properties. The veld condition of HDG (61.6%) was lower than that of LDG (87.8%) because of fewer palatable, grazing sensitive grasses (e.g. *Themeda trianda*, 24% vs 47%) and more increaser II species (e.g. *Eragrostis curvula*, 9% vs 0%) in the former. Basal cover was also markedly lower under HDG (22%) than LDG (33%). Soils were 44.4% more compacted ($p=0.014$) under HDG than LDG, but did not differ in any of their chemical properties (total nitrogen, total carbon, total phosphorus and pH). These results indicate that short duration high density stocking has a negative impact on mesic grassland swards, and an examination of their forb populations will reveal whether HDG is also inimical to plant species diversity.

Keywords: mesic grassland, grazing systems, veld condition assessment



Vegetation cover is critical for faunal diversity in moist highland grasslands

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The South African highland grassland system is second only to Fynbos in species diversity. In these grasslands fire and grazing interplay at the landscape level, directly influencing biodiversity. Fire and grazing can be managed to influence ecosystem health. Moist highland grassland (MHG) systems in South Africa are naturally maintained by winter and spring fires (naturally every four years or more) and by summer grazing by small migratory herds of small to medium-sized antelope. Currently, the majority of the system is managed by livestock farmers who burn annually at the onset of the rainy season, coinciding with the beginning of the breeding season for grassland-nesting birds and the emergence of arthropods. In order to assess faunal and floral responses we selected eight management treatments for comparison. We collected data describing ten vegetation structural indices; plant species richness and abundance were quantified (for 114 species); >32 000 arthropods were collected and sorted to order level; 160 km of transects were walked to assess bird species abundance (for 127 species); and 404 grassland bird nests of 12 species were located and monitored to completion. Both nest success and nest-site selection are driven by vegetation structure, which itself is driven by habitat management. Nesting success and abundance of Yellow-breasted Pipits *Anthus chloris* suggest that unconserved areas may house sink populations of this regionally and globally Vulnerable species. Overall Field Metabolic Rate and Biodiversity Intactness Index values both confirm the importance of conserved areas (and specifically the availability of vegetation cover) for plants, insects and birds in MHG systems and support the need for further conservation efforts in grassland systems as a whole by both private landowners and reserve managers.

Keywords: grasslands, birds, fire, grazing, arthropods, vegetation cover.



Degraded communal rangelands compromised by alien infestation: Is restoration possible?

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Land degradation in communal landscapes in the grassland biome is notorious, and often attributed to overstocking, lack of knowledge and poor management. Excessive pressure on the herbaceous component leads to the uncontrolled spread of opportunistic invasive alien woody species in these degraded areas, resulting in enormous loss of ecosystem service capacity, along with soil and land productivity. The erosion of landscapes leads to the erosion of livelihood opportunities. Interventions in the upper Umzimvubu catchment near Matatiele, Eastern Cape Province are showing a different understanding of the attributes and opportunities for effective restoration of grassland to improve ecosystem services. The focus is on enabling land users to restore basal cover for effective rainfall infiltration, erosion protection and stock productivity. Livestock production is viewed as an incentive for participation and buy-in by land users, especially in areas cleared of wattle infestation. The experience of a group of NGOs is showing encouraging results for community-based natural resource management initiatives which are set to work beyond the project stage. Community mobilization and packages of appropriate incentives for stock owners are showing tangible results for both landscapes and livelihoods. Cattle and small stock, which were formerly viewed as grassland destroyers through overgrazing, are now being tested as a tool for rangeland restoration through agreed grazing management systems. Managed use of stock for trampling coupled with exclusion and other techniques to catalyse the rejuvenation of natural plant succession in degraded post-alien cleared areas, is suggesting that inputs don't have to be expensive or high-tech. Livestock management may become a viable and essential part of the follow up strategy for management of alien infestation where restored basal cover in the first season provides a niche for local grassland species to recolonize. Managed grazing across the entire landscape may allow for succession and species composition improvement, which can eventually lead to productive natural grassland. This poster presentation provides a practical explanation of the observations from several sites, as well as recommendations for potential replication on a wider scale.

Keywords: communal grazing, rotational resting



Big trees and elephant in protected areas adjacent to the Kruger National Park

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This presentation serves as an update to a presentation made in 2009. In the reserves adjacent to the KNP, woody density and structure varies both spatially and temporally in response to among others 'wet' and 'dry' periods. With the removal of the fence between the KNP around 1993 the protected areas to the west there was a dramatic increase in the number of elephant in the area. There is ongoing concern that utilisation of tall trees sometimes in conjunction with bush thinning operations will have negative effects on various system components. To investigate the impact of elephant on >5m size class, we have marked in excess of 1 000 trees taller than 5 m in a number of protected areas with differing elephant densities. We report on 9 years of data and compare impacts with the elephant impact data collected during routine monitoring as well as focusing on tree species of concern. In addition to elephant density, it appears that elephant impact is related to rainfall and resulting veld conditions, e.g. wet 1999/00 low impact and visa versa during the 2002/03 drought. The challenge is to determine the rate at which impact occurs so that necessary management interventions can be implemented before a state is reached that compromises long term land use options.

Economic analysis of chemical bush control in Miombo woodlands

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Bush encroachment is a global issue that entails reduction in rangeland production. Bush control measures of the defoliation and stump treatment or foliar chemical application are recommended. However, these methods are capital intensive and their economic viability needs to be practically explored. An economic model was developed as a tool to evaluate the economic efficiency of chemical bush control. The model was based on gross margin analysis of bush control costs and livestock returns based on biomass produced in successive epochs over a period of 10 years in an experiment that was conducted in the miombo woodlands of Zimbabwe. This experiment included the integration of the cut-stump and follow-up foliar treatments where stumps were treated with picloram at various rates (0.0005, 0.000126, 0.00032, 0.0081 and 0.02049 gae.cm)⁻¹. The foliar treatment was applied on coppice at various rates (0.0119, 0.0356, 0.0356, 0.1067, 0.32 and 0.96 gae.plant⁻¹) 7 months after cut-stump treatment. Changes in biomass production were followed over 10 years. Biomass production reached peak production in the 5th year after which it declined to the original state as woody density reverted to the original state by 10th year. This model assumed that reduction in tree density results in increases in biomass production which would translate to increased grazing capacity. The production system used in the model was extensive rearing of cattle weaners that are weaned directly to the rangeland in September (at weight 250 kg) and sold at an age of 15 months (at weight 420 kg). The results of the study indicated that it is economic risky and highly expensive to use chemicals for bush control. It is therefore suggested that browsers should be used as a replacement for foliar treatments to achieve efficient utilisation of coppice while controlling encroachment.

Keywords: bush encroachment, stump treatment, biomass production, picloram, cattle weaners



Fire history and frost in an arid savanna woodland: Understanding its impacts on vegetation structure and diversity at the Waterberg Plateau Park, Central Namibia

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Fire is one of the major factors responsible for shaping vegetation structure and species composition in savanna and grassland biomes. Thus, fire cannot be disregarded when considering the management of rangelands for both domestic livestock and wildlife. The occurrence of fire in any area is dependent on many factors, including annual rainfall and grass biomass. Frost occurs during winter in the study area mainly in low-lying “interdunes”. Frost like fire causes the top-kill of woody vegetation and may limit or prevent the establishment/growth of frost intolerant vegetation species. However, its effects on vegetation dynamics and especially as a synergistic effect with fire are not well known in the study area and in such an ecosystem. Therefore, the study aimed to provide insight and a better understanding of fire effects with frost. The research is focused on understanding how fire history [mean fire return interval (MFRI) and time since last burn (TSLB)] and frost affect vegetation structure and diversity in a savanna woodland at the arid end of the scale. The key research question being addressed was: How do different fire history and frost impact vegetation structure and diversity at the Waterberg Plateau Park? A total of four sites with different fire histories (site 1= MFRI is 18.5 years and TSLB is 26 years, site 2= MFRI is 9.3 years and TSLB is 16 years, site 3= MFRI is 9.3 years and TSLB is 3 and site 4= MFRI is 6.2 years and TSLB is 2 years) were surveyed in the study area. This was to test how fire history changes the vegetation structure and diversity. In addition, to test what frost does to vegetation structure and diversity a site with the same fire history (last burnt 25 years ago) that has some areas in low-lying areas (interdunes) and others on “dunes” was surveyed. The point-center quarter method was used to obtain vegetation structure, species composition and diversity data. The Bitterlich gauge was used to estimate woody cover and also provide additional height structural data and the visual obstruction reading (Robel pole) method and grass clipping was used to estimate grass biomass and grass species composition. The collected data has been captured and summarized, however statistical tests are yet to be done. Multivariate statistics such as ordination will also be used to explain if vegetation data conform to a pattern that could be explained by different fire history and occurrence of frost. The observed results show that fire history plays a role on vegetation structure in that site 4 has a higher mean density of <1 m woody plants and grass density. In contrast, site 1 and 2 have higher mean densities of >4 m woody plants and lower mean grass densities. Site 3 and 4 are more open as they have lower woody cover compared to less frequently burned sites (1 and 2). The most recently burned site 4 has the lowest grass biomass, followed by site 1, whilst site 3 has the highest grass biomass. Frost similarly affects vegetation structure in that the interdune sites have a higher mean density of <1 m woody plants and grass density. In contrast, the sites on the dune have higher mean densities of >4 m woody plants and lower mean grass densities. The interdune sites have higher grass biomass compared to the dune sites. The interdune sites have a higher woody cover of <2 m plants whilst the dune sites have a higher woody cover of >3 m plants.

Keywords: fire history, frost, arid savanna woodland, fire interval, time since last burn, Waterberg Plateau Park



Comparison of herbaceous plant species composition, diversity and rangeland condition between camps utilised by large and small stock at Neudamm Farm, central Namibia

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The study was conducted at Neudamm farm situated 30 km east of Windhoek in central Namibia. Neudamm is a University farm largely utilised for research purposes and it supports small and large stock, as well as small numbers of wild large mammalian herbivores, such as kudu, oryx and red hartebeest. Large stock and small stock utilize the rangeland in different ways, given the allometric considerations of energy requirements. This differential rangeland utilization is hypothesised to result in differences in rangeland condition, and over time would lead to changes in plant species composition and diversity. The overall aim of this study was therefore to assess and compare rangeland condition and plant species diversity between large stock and small stock camps on Neudamm farm. Sampling was done in two camps, one utilized by large stock (cattle) and another utilized by small stock (sheep and goats). A systematic sampling procedure was used where a total of 100 plots measuring 1 m² were sampled along transects in each camp. In each plot grasses and forbs were identified and the percentage cover of each species was visually estimated. A two-sample t-test was used to compare species diversity and richness between the camps while a Chi-Square test was used to compare proportions of increaser and decreaser species between the camps. Hierarchical Cluster analysis was used to compare species composition. Species diversity ($t=1.984$, $p<.01$) and species richness ($t=1.984$, $p<.05$) were significantly higher in the large stock camp than in the small stock camp, while species composition differed by only 17% between the two camps. However, there was no significant difference ($\chi^2=3.964$, $p>.05$) in the range condition between the two camps, measured by proportions of increaser and decreaser grasses. The proportion of perennials to annuals was also similar between the two camps ($\chi^2=0.320$, $p>.05$). These observations are attributed to the differences in feeding behaviour between cattle, goats and sheep where cattle and sheep tend to graze more while goats tend to browse more. Due to more feeding selectivity by small stock compared to cattle which tolerate rougher material, the small stock camp degenerates into lower diversity over time. However, this alone cannot fully explain the observed variation in the species data. Some of this is attributable to the inherent natural heterogeneity of the landscape. The overall rangeland condition for both the camps was classified as good due to the low occurrence of increaser species.

Keywords: large stock, Neudamm, rangeland condition, species diversity, species composition



Influence of *Acacia mearnsii* (black wattle) on rangeland production in semi-arid South African grasslands: implications for rangeland rehabilitation

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South African grasslands are under threat from woody encroachment by invasive alien plants (IAPs) such as *A. mearnsii*. The study sought to determine the effect of *A. mearnsii* invasion on soil quality and grass canopy cover. Replicated soil samples at two depths (10 and 20 cm) were collected in two treatments at four study sites in the north Eastern Cape and analysed for P, K, N, Mg, Ca, Zn, acid saturation, CEC, bulk density, pH and total cations. The treatments were i) recently cleared areas and ii) un-cleared areas inside the wattle thicket, with a control in the adjacent, un-invaded grassland. In addition, using a land systems approach, the influence of wattle's leaf area index (LAI) and terrain slope on grass cover was investigated. Wattle invaded sites were significantly different from uninvaded areas in terms of P, CEC, total cations, acid saturation and pH ($p < .05$). Nitrogen was 20% higher and Ca was 17% lower in invaded than the un-invaded grassland. Wattle's LAI ($p < .001$) had greater impact on grass cover than terrain slope, and when LAI approached 2.1, grass canopy cover dropped to <10% in heavily infested areas. In conclusion, for the north Eastern Cape, wattle adversely impacts rangeland productivity through influencing soil properties and by high canopy LAI. Rehabilitation of rangelands invaded by *A. mearnsii* should be informed by an understanding of soil properties. In addition, the results from the LAI versus grass cover study suggest that it will be possible to thin wattle stands in order to promote grass production without clear-felling and this may inform policy on current large scale clear-felling of wattle.

Keywords: soil properties, *Acacia mearnsii*, LAI, rangeland rehabilitation, grass cover



Vegetation composition of *Opuntia humifusa* invaded cattle and sheep grazing areas of western South Africa

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Vegetation profiles of the semi-arid rangelands of western South Africa consist of a mosaic of patches with high biomass cover that is inter spaced with patches of forbs, wild cactus pear or bare areas. The pattern seems to be moving toward all cactus and bare patches as *Opuntia humifusa* replaces forbs, palatable and unpalatable grasses and legumes decimated by intense grazing, frequent droughts associated with the El Niño Southern Oscillation, and the resultant asymmetrical distribution of water in the degraded areas. The objective of this study was to define the occurrence of common grass species in semi-arid areas invaded by *O. humifusa* and also grazed by cattle, sheep and goats. Vegetation across a 300 ha semi-arid site 150 km south-west of Bloemfontein was described using plant cover data from line transects. Plant surveys were done systematically at 1m intervals to assess species composition and 5 m intervals using a 1 x 1 m quadrat to assess species abundance, using four transects in 25 x 25 m area plots. Nine plots were sampled per site, with two sites grazed by either sheep and goats or beef cattle. The two sites were subdivided into three areas which were i) no *O. humifusa* (NIGA); ii) some invasion (TA) and iii) severely invaded (HIGA), each with three replications. The proportion of identified grass species revealed that the most abundant species in the NIGA cattle site were *Themeda triandra* (4%), *Heteropogon contortus* (7%), *Aristida stipitata* (30%), *Eragrostis rigidior* 15%, *Stipagrostis ciliata* (40%) and some forbs (10%). The proportion of *H. contortus* and *E. rigidior* in the HIGA was 70%. *Stipagrostis* species declined ($p < .001$) by 50%. *H. contortus* was more abundant in the TA (60%) followed by *Eragrostis* species; *T. triandra* was absent. In TA zones grazed by sheep, *T. triandra* was highly abundant followed by *Eragrostis* species. *T. triandra* was the most abundant grass species (90%) in NIGA zones grazed by sheep, with *Eragrostis* and *Stipagrostis* at 2 and 5% respectively. In the severely degraded sheep grazing area (HIGA), forbs and *Eragrostis curvula* dominated the area and *T. triandra* and *H. contortus* were similar in proportions at 0.68 and 0.8% respectively. The proportion of forbs were not categorized however the area was dominated by *Pentzia lanata* and *Salsola tuberculata*. The preliminary report demonstrates that landscape spread of *O. humifusa* shifts vegetation profiles and that cattle grazed sites are more prone to *Opuntia* invasion. Further research will be done to assess ecological trends of forbs and grass species, soil organic matter and exchangeable nutrients across all sites.

Keywords: *Opuntia humifusa*, invaded areas, *Themeda triandra*, degradation, semi-arid, vegetation composition



Morphology of the encroacher shrub *Seriphium plumosum* in Bankenveld grassland

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Seriphium plumosum is an indigenous pioneer plant invading large portions of natural veld and cultivated land in South Africa. The loss of valuable grazing due to encroachment by this dwarf shrub warrants further investigation. In this study, we investigate the morphology of *S. plumosum* in bankenveld at Telperion Nature Reserve, Mpumalanga. Above and below ground plant structures were examined to gain a thorough understanding of *S. plumosum*. Plant height, ground cover and root depth was estimated for all samples. Wet and dry biomass for roots and stems were determined at preordained depths and heights. Preliminary morphology investigations reveal an extensive tap root system for *S. plumosum*. As plant height increases, wet root weight decreases, indicating that robust roots develop early in *S. plumosum*; as the plants grow bigger/older, root development diminishes. We found a strong positive relationship between circumference and number of branches present, indicating that horizontal spread of *S. plumosum* results from the addition of stems, rather than increased stem girth. This study contributes towards an improved understanding of the management of the *S. plumosum*, as an encroacher species.

Keywords: encroachment, biomass, morphology, *Seriphium plumosum*, Bankenveld, Telperion Nature Reserve

Variation in grass morphological traits and their relation to fire in KwaZulu-Natal

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Grasses like other plant families are classified into groups based on their shared traits. Grasses use two possible photosynthetic pathways; C₃ and C₄ and this characteristic plays a role in determining species distribution. These grasses are found in environments with of varying altitudes and so may differ in physical traits. The differences in traits influence how these grasses will burn in the field. The study aimed to determine the relationship between rate of combustion of different grass species using different photosynthetic pathways and measurements of their physical traits. Grass species were sampled at three sites of increasing elevations, the Coast (159 m), Midlands (850 m) and Drakensberg (1850 m). Four questions were asked: 1) Is there a difference in physical traits of different grass species growing within the same area of the same altitude? 2) How do the physical traits of *Themeda triandra* and *Aristida junciformis* vary along an altitudinal gradient? 3) How do grass physical traits affect rate of combustion (flammability)? 4) Is the rate of combustion of C₃ and C₄ grasses different and what physical traits cause these differences? Results revealed that 1) there is a difference in physical traits of different grass species growing under the same area and same altitude and 2) physical traits for *Aristida junciformis* differed markedly in the Drakensberg relative to the two lower altitude sites and physical traits for *Themeda triandra* differed markedly at the Coast relative to the higher altitude sites. The Principal Components Analysis revealed that at the Coast, rate of combustion was highly correlated to specific leaf area and leaf wet mass, at the Midlands site, leaf dry matter and leaf area were the traits most highly correlated to rate of combustion and that the rate of combustion did not appear to be highly correlated to any physical trait at the Drakensberg. The Multiple Regression Analyses revealed that for all species, specific leaf area alongside other traits influenced rate of combustion. *Themeda triandra*, and *Aristida junciformis* had the slowest mean rate of combustion (seconds per gram for dry mass) at the Coast (lowest altitude) and Drakensberg (highest altitude) respectively. *Festuca costata* (C₃) had the fastest rate of combustion when compared to all grass species. Climate change could cause for a shift in vegetation structure resulting in changes in fire regimes.

Keywords: tuft traits, leaf traits, flammability, CO₂



The effect of fire histories on soil nutrients, soil carbon and soil respiration on the Waterberg Plateau Park, central Namibia

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Fire is a natural disturbance that occurs in grasslands, savannas as well as Mediterranean ecosystems, and has been occurring since time immemorial in African savannas. It is recognised as a key factor that shaped and continues to shape savannas for as long as lightning has existed. The use of fire in the management of vegetation and wildlife has been widely used in woodland savannas throughout the world. This concept has also been applied in the Waterberg Plateau Park, central Namibia as a management tool. The park is divided into fire blocks, and has a well-documented fire history. However, there is a knowledge gap on the effects of these fire histories on the soil resources. The key element in this research project was to investigate the effects of fire histories on soil nutrients, soil carbon and soil respiration. This project is part of a broader project looking at the impacts of fire on biodiversity and ecosystem processes in woodland savannas. Six transects (200 m) were randomly selected in four fire blocks with different fire histories (time since last burn ranging from 2-25 years and fire interval ranging from 6.2 – 18.5 years). Soil nutrients and soil organic carbon in the 0 – 10 cm soil layers were investigated by collecting soil samples at 40 m intervals along the transects and then performing standard lab tests. A LI-6400XT instrument was used to measure soil respiration by investigating the CO₂ efflux at different patch types; namely under grass, under shrub and bare ground patch in the blocks with different fire histories. Preliminary results show visible trends, but statistical analysis will be used to confirm that. Clay content has a positive relation with organic matter. The amount of P is controlled by organic matter and due to the relation between clay and organic matter; P tends to increase with higher clay contents. Bulk density reduces with an increasing amount of organic matter. Mean Na strongly decreases whereas mean C slightly increases as time since last burn increase. Mean CO₂ efflux varies between patch types; with shrub having the highest CO₂ efflux and bare soil with the lowest. CO₂ efflux does not differ in a fire block that burned 25 years ago among different patch types. The block that burned 2 years ago recorded the lowest CO₂ efflux on overall. A better understanding of the role of fire histories on soil nutrients, soil carbon and soil respiration will broaden our knowledge and can greatly improve the use of fire in the management of woodland savannas.

Keywords: woodland savannas, LI-6400XT, CO₂ efflux, fire interval, time since last burn, fire blocks



Large-scale foraging behaviour of free-ranging goats: influence of herd size, season and landscape quality

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For animals living in herds, competition between group members increases as herd size increases. Moreover, the intensity of this competition is likely greater across poor quality landscapes, and during the dry season. In contrast to wild herbivores, herd size in domestic livestock is not determined by the animals themselves, but rather by human owners. This then raises the question, how do domestic livestock, like goats, reduce competition for food within these defined herds? To explore this question, we recorded large-scale foraging behaviour of both small (12 to 28 individuals) and large (42 to 83 individuals) herds of free-ranging goats in the Tugela Valley, KwaZulu-Natal, South Africa. We conducted the study on three different landscapes that varied in both food quality and availability, during the wet and dry seasons of 2013. The goats were housed in kraals overnight and released in the mornings to forage on their own unattended. Thus, foraging decisions were made by the goats and not by herders. The large-scale foraging behaviours we focussed on included, (i) total distance travelled by goats while foraging, (ii) distance travelled before starting to feed, (iii) travel speed, and (iv) feeding duration. Using Garmin Foretrex 401 GPS devices harnessed to two goats per herd for five days per season, we found that irrespective of season, there was no significant difference in the total distance travelled by the different sized herds across the different quality landscapes. However, both small and large herds started feeding farther from the kraal in winter in comparison to summer. Despite this, there was no significant seasonal difference in total amount of time the herds spent feeding across the different landscapes. Finally, both small and large herds increased their travel speed across all the landscapes in winter, but large herds travelled faster than small herds. This increase was likely to maximise the time that large herds could spend feeding in good areas. Ultimately, our results indicate that both small and large herds were affected by declines in food quality and quantity during the dry season. However, as large herds made greater behavioural adjustments compared to smaller herds (i.e. feeding farther away from the kraal and travelling faster), it seems that they were more affected by the seasonal increases in intra-herd competition.

Keywords: food availability, food quality, distance, travel speed, feeding duration



Seasonal regulation of condensed tannin consumption by intermediate feeders in a semi-arid savanna

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Although condensed tannins (CTs) are known to reduce forage intake by mammalian herbivores in controlled experiments, few studies have tested these effects in the field. Thus the role of CTs on foraging ecology of free-ranging herbivores is inadequately understood. To investigate the effects of CTs under natural savanna conditions, we pre-dosed groups of goats with polyethylene glycol (PEG, a CT-neutralising chemical), CT powder or water before observing their foraging behaviour. While accounting for the effects of season and time of the day, we tested the hypothesis that herbivores forage in ways that reduce the intake rate (g DM per minute) of CTs. We expected pre-dosing goats with CTs to reduce CT intake rates by (1) consuming diets low in CTs, (2) reducing bite rates, (3) increasing the number of foraging bouts, or (4) reducing the length of foraging bouts. Lastly, (5) we expected CT to have no influence on the number of dietary forage species. In both wet and dry seasons, pre-dosing goats with CTs resulted in lower CT consumption rates compared to PEG goats which seemed relieved from the stress associated with CT consumption. During the dry season, the number of dietary forage species was similar across treatments, although goats that were dosed with PEG significantly increased this number in the wet season. Dosing goats with PEG increased the number and length of browsing bouts compared to goats from the other treatments. Pre-loading goats with PEG also tended to increase bite rates on browse forages, which contributed to increased consumption rates of CTs. Based on the behavioural adjustments made by goats in this study, we concluded that herbivores under natural conditions foraged in ways that reduced CT consumption.

Keywords: bite rate, intake rate, feeding bout, polyethylene glycol, herbivore



Condensed tannins increase the amount of time animals spend grazing

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Tannin concentrations fluctuate spatially and temporally within and among plant species, with consequences for forage quality of herbivores. The extent to which these fluctuations influence foraging activities of goats is not fully understood. While accounting for the effects of the time of day and season, we tested the hypothesis that goats exposed to high levels of condensed tannins (i) spend less of their foraging time browsing, (ii) spend more time grazing, and (iii) reduce their total foraging time, especially during the dry season when grasses dry out and deciduous trees lose leaves. We orally dosed 15 goats with (i) 20 g of condensed tannins extract dissolved in 50 ml of water (high tannin exposure), another 15 goats (ii) with 20 g of polyethylene glycol dissolved in 50 ml of water, which neutralizes the effects of tannins (low tannin exposure), and the last group of 15 goats (iii) with 50 ml of water (control). We recorded the time spent on grazing, browsing and these two activities together (i.e., foraging) for 30 days in the dry and wet season. As expected, dosing goats with condensed tannins reduced their browsing time and increased the time spent grazing. Goats dosed with polyethylene glycol increased their browsing time and lowered their time spent grazing. Animals dosed with polyethylene glycol foraged for longer than other treatment groups in the dry season, whereas the goats dosed with condensed tannins increased their foraging time in the wet season. Overall, all treatment groups spent a similar amount of time foraging, indicating an instinctive drive by goats to maintain high total foraging time while avoiding over ingestion of tannin-rich forages. We concluded that tannins did not suppress total foraging time for free-ranging goats. Instead, they influenced the amount of time animals spent either grazing on herbaceous plants or browsing on woody plants.

Keywords: feeding behaviour, herbivore, polyethylene glycol, foraging



Insect predation on *Dichrostachys cinerea* (Sickle bush) in Limpopo Thornveld

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Sporadic die-out of *Dichrostachys cinerea* populations has been noted throughout the Limpopo Province. While various theories exist why population crashes of this specific species occur, it was never thoroughly investigated. A study was conducted at the Syferkuil Experimental Farm, Polokwane (Pietersburg Plateau False Thornveld), to identify species specific insect predators and determine their effects on *D. cinerea*. One hundred *D. cinerea* trees were randomly selected at a site that appeared infested with stem-boring insects. Each randomly selected tree was inspected for insect infestation. Stems were cut open to determine if predator insects were present and damage to trees quantified. Sixty nine percent of *D. cinerea* plants inspected were infested. Damage occurred to both old (dry wood; 58%) and green stems (42%). In total 13% of the plants inspected were dead, 56% damaged and 31% undamaged. On average, 10.9 holes were counted stem⁻¹ on young growth (green stems and branches), while 11.2 were counted on dry growth (woody stems and branches). The Slender-snouted weevil (*Balaninus valens*) occurred, tunnelling in fresh stems of *D. cinerea* as a primary predatory wood-borer, damaging its vascular system. *Bantua spp.*, as secondary predatory insects, increased holes and tunnels created by *Balaninus valens*, thereby increasing damage to the host plant. It appeared as if the tunnels are used as refuge while these insects feed on *D. cinerea* leaves. Minor infestations by *Phryneta spinator* (fig-stem borer) larvae were also recorded, while other insects that utilize leaves (*Homoeocerus auriculatus*, *Oxyrachis spp* and *Harmonia virgintiduomaculata*) and bark (*Himatismus spp.*) also occurred in the widened tunnels, where they were preyed on by ants (*Gyponyx signifier*). Termites (*Neotermes spp.*) appeared as a tertiary infestation, attacking dead wood that occurred due to stem borer damage. Insect damage to plants varied from a few small holes visible in stems and branches (new infestation) to a top-kill with weak coppice regrowth (old infestation).

Keywords: *Balaninus valens*, *Bantua spp.*, *Phryneta spinator*, stem borers, tree mortality



The effects of associated pod quality on seed recovery and germination of *Dichrostachys cinerea* and *Acacia tortilis* fed ruminants

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Pods of different plant species form an important part of the diet of livestock during the dry season due to their high nutritional value compared to grasses. Therefore, herbivores browsing pods of certain woody plants may disperse intact seeds that can potentially germinate. The quality of associated diet such as pod chemistry (i.e. protein and tannin concentration) is one of the most important determinants of success of livestock faecal seed dispersal. The objective of this study was to determine the effects of associated pods quality (i.e. nutrients and tannins composition of *Dichrostachys cinerea* and *Acacia tortilis* pods) on seed recovery and germination of *D. cinerea* and *A. tortilis* fed to goats and sheep. Both animal species were offered *D. cinerea* and *A. tortilis* pods at 2.5% of their body mass. Seed recovery for *A. tortilis* (38.37±1.79%) was significantly higher than for *D. cinerea* (12.37±1.02%). There was no significant difference found between animal species ($p>.189$). There was no significant difference in germination found between the seeds that passed through the gut of animals ($p>.227$). *A. tortilis* and *D. cinerea* seeds that passed through the gut of goats and sheep had a significantly higher germination percentage than the seeds that had not passed through the gastro-intestinal tract of animals. The results suggest that passage through the gut and associated pod quality may facilitate seed dispersal and thereby germination of woody plant species.

Keywords: associated diet quality, germination percentage, seed dispersal, seed viability, tannins, woody plant encroachment



Impacts of high density of small farm dams on evapotranspiration and catchment water balance

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Small farm dams in semi-arid landscapes are thought to significantly contribute to evaporation particularly if the dam density is high, although research in this area is limited. Water lost through small dams is due to their high surface to volume ratio (which equates to shallow depths and a warmer water body) and seepage losses. Evaporation estimates for small dams in India, Zimbabwe and Australia are in the range of 20-97% with values as high as 4-10 mm per day, which forms part of the total evapotranspiration losses from the landscape. Evapotranspiration (ET) estimates for landscapes in South Africa are about 90% of the Mean Annual Precipitation (MAP). This paper presents comparisons of actual evapotranspiration (ET) derived from MODIS-ET (MOD16) in selected catchments in the Eastern Cape and KwaZulu-Natal regions of South Africa, where grassland is one of the two major biomes. The research presented here is part of a Water Research Commission funded project on rehabilitating grasslands after eradication of alien invasive trees in the Eastern Cape. The project aims to estimate the evapotranspiration rates between different land cover types and evaluate the contribution of different cover types to the catchment water balance. This research explores the effect of land use on ET values for comparable areas with similar mean annual rainfall (one-way ANOVA) in the catchments of the Mzimvubu ($p=.58$) and Mzimkhulu ($p=.71$) rivers. Polygons covering approximately 5 x 5 km areas (or 9 pixels of MAP provided by Schulze 2004 dataset) were chosen in similar quaternaries but with different dominant land covers for two different secondary catchments (T35 and T51). The four different land cover types were areas with a high density of small dams, wetlands, grasslands, and plantations. Results indicate that areas with plantations have highest average annual MODIS ET values irrespective of wet or dry year (2001 versus 2010), while grasslands had the lowest average values, although significance was not consistent in the two catchments (Kruskall-Wallis one-way ANOVA by ranks). Small dams and wetlands do not cover the full area of the nine pixels and they are potentially having an indirect effect on the MODIS ET values through the seepage of water to bordering vegetation. These results have implications for water allocation, for stock watering, production from natural vegetation, water balance, and decisions at a higher level for catchment management and policy.

Keywords: catchment water balance, small farm dams, evapotranspiration, land cover



Reciprocal transplanting demonstrates local adaptation in *Acacia karroo* populations from Zululand, South Africa

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Acacia karroo (alternative name *Vachellia karroo*) is the most widespread tree in southern Africa, and exhibits wide morphological variation. At Richards Bay (RB) and Empangeni (EMP), individual trees grow to ca. 40 m and 5 m, respectively. We sought to determine whether local adaptation was occurring in two neighbouring *A. karroo* populations in South Africa by examining seedling and sapling performance of genotypes grown in reciprocal environments. We collected seeds from the two populations, germinated them in a greenhouse and reciprocally transplanted the seedlings to two field sites that were about 30 km apart, RB and EMP. We measured total height, stem diameter, thorn length, leaf area, leaf weight, plant aboveground dry weight and specific leaf area (SLA) after 4 months and 16 months for greenhouse and field grown plants, respectively. For greenhouse-grown plants, root dry weight was also measured. Greenhouse-grown plants showed lower root allocation for RB than EMP (0.20±0.01 vs 0.60±0.02). Phenotypes of seedlings and saplings from the two populations maintained their differences in the greenhouse and in the field. At RB, plants grew to 330±54 and 176±31 mm for RB and EMP genotypes, respectively. At EMP, plants attained heights of 1 386±62 and 946±72 mm for the RB and EMP populations, respectively. Aboveground biomass of RB plants was also greater than that of EMP plants both at RB (8.1±1.7 vs 0.8±0.2 g) and at EMP (371.2±39.3 vs 78.2±14.8 g). Thorn size showed a similar pattern of greater length for RB than EMP plants while SLA was similar between the populations. We found significant genotype-by-environment interactions for leaf area and leaf weight - two of the seven performance traits measured in *A. karroo* from the two populations for reciprocally-transplanted plants in the field. Consistency of morphological characters measured within populations indicates that differences between populations may have a genetic origin, which suggests local adaptation. We posit that the differentiation that has occurred over such a short distance is due to differences in soil types.

Keywords: Empangeni, local adaptation, morphological differentiation, phenotypes, Richards Bay, reciprocal transplant

Ordination of plant communities in the Nooitgedacht section of Loskop Dam Nature Reserve

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Spatial and temporal interaction analyses that look at plant communities and the environmental variables affecting such communities assist ecologists and reserve managers in understanding and managing the flora on reserves and in protected areas. In this study we investigated the effect of independent environmental variables, altitude, trampling, soil type, erosion and slope on the seven plant communities identified for the Nooitgedacht section of the Loskop Dam Nature Reserve. Using a Constrained Correspondence Analysis based on Chi-squared distances, we performed weighted linear mapping to generate ordination graphs for interrogation. Interpretation of combined ordination results for the various plant communities indicated a strong positive association between erosion and soil type, and weak positive associations between altitude and trampling, trampling and soil type, and trampling and erosion. A strong negative association was observed between altitude and slope. Interestingly, no associations were observed for altitude and soil type, altitude and erosion, soil type and slope, and for erosion and slope. Soil type, slope and altitude were the primary environmental variables influencing the various plant communities.

Keywords: Constrained Correspondence Analysis, ordination, plant communities, environmental variables, Loskop Dam Nature Reserve



Impacts of fire on resource utilization of grazers and browsers in the Waterberg Plateau Park, central Namibia

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Fire is regarded as an important driver shaping savannas, including improving forage quality. The perceived importance of fire to the management and conservation of Waterberg ecosystem has driven this research to focus on the effects of fire on herbivore movements and their forage resources on the Waterberg Plateau Park. This study aimed to determine how important fire history is in influencing resource use by different species of herbivores in arid woodland in Central Namibia. The study was done in 4 fire blocks with different fire histories. A: burnt four months before the study through lightning, B, C and D burnt 2, 14 and 24 years before the study respectively. Data were collected along 6 randomly selected 200 m transects in each fire treatment. Every 20 m, a 4 x 8 m quadrat was laid out. Within each quadrat, the dung of species was identified and counted. At every corner of the quadrat each nearest shrub and grass was identified and its utilization recorded. Roan and sable were combined in the analysis due to difficulties in distinguishing between their dung. A Kruskal-Wallis analysis was conducted, followed by *post hoc* comparisons to determine differences in resource utilisation.

Ten species of mammals were recorded altogether. A significantly higher abundance of mammals occurred in A, than in the other blocks. Five of the mammal species that utilized the four blocks were browsers, mainly giraffe, kudu, eland, duiker and steenbok and five were grazers namely sable, roan, scrub hare, warthog, oryx and buffalo. Of these eland, giraffe, sable/roan, warthog and oryx utilized a significantly more than other blocks. Buffalo utilization in A (slightly higher dung counts) might have been an underestimation, since buffalo dung was observed to be removed by dung beetles overnight. A significantly higher utilization of both grass and woody species occurred in A than in other blocks. Generally, browsers preferred *Acacia ataxacantha*, *Bauhinia petersiana*, *Combretum collinum*, *Grewia flavescens* and *Philenoptera nelsii*, particularly in the recently burnt area. Grazers preferred *Brachiaria nigropedata* and *Digitaria seriata* in A, B and D. In the recently burnt area, typically unpalatable grasses such as *Aristida stipitata* and *Eragrostis jeffreysii* were also utilized. Fire was shown to be important in providing good quality forage to mammal herbivores, particularly in a park which restricts seasonal animal movements. Fire is important in influencing the utilisation of available resources by mammals, and the inclusion of fire-herbivore interactions into ecological and conservation studies practices of fire systems will aid in better understanding and managing of conservation areas.

Keywords: fire, herbivores, forage, plants utilization, dung counts, fire histories



The movements of Cape Buffalo (*Syncerus caffer*) in a confined park,
Waterberg Plateau Park, in relation to fire history

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The Waterberg Plateau Park, Namibia, is a fire-shaped Kalahari woodland at the arid end of the scale, with fires occurring at an interval of five to 20 years, depending upon the fire block, since the 1970s when the park was proclaimed. This pattern has developed mostly unintentionally as a result of lightning fires, accidental fires and a brief period of fire management. Recent policy has been to prevent any unplanned fire (lightning or accidental) to burn beyond the block (around 2000 ha in most cases) from which it initiated, by means of fire breaks and back burns. The park is approximately 40 000 ha in size, and thus represents a confined area for game which normally migrates seasonally in open areas. Fire and the associated regeneration of palatable grasses, herbs and shrubs can have an impact on large ungulate grazing practices. In order to understand the impacts of fire on Cape Buffalo (*Syncerus caffer*), four females were outfitted with GPS collars in September 2013, just prior to three lightning fires on the plateau – these fires occurred within the home range of two herds with GPS collared females. Although both herds utilized to some degree burned areas during the dry season (25 October – 22 November 2013), utilization of the burned area increased dramatically with the onset of the rainy season (23 November 2013 – 30 April 2014). For herd 1 the fire occurred within the core of their home range and served to concentrate their movements during the rainy season. Herd two appears to have nearly doubled their home range to include a distant burned patch, but only after rains began.

Keywords: GPS collars; home ranges; regeneration; palatable

Fate of rhino survivors in South Africa: A critical evaluation of the current literature on
the conservation of the South African rhinoceros

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With an annual loss and a conservation management cost worth \$70-213 billion and \$135 billion respectively, it is clear that wildlife trafficking have thrown off billions of dollars that should have been used to develop economies. South Africa, which has a success record in conserving its two extant rhinoceros species *Ceratotherium simum* and *Diceros bicornis* with current populations of 20 405 and 4 500 respectively, is now faced with poaching where on an average it loses three of its rhino daily. Even though this trend still looks sustainable since the growth rate exceeds the death rate, should these current poaching rates continue to escalate unchecked a point will be reached where the rhino population will start declining down to extinction. Presently a number of governmental, non-governmental and private organisations are putting up strategies to put a halt to the rise in the rhino poaching rate, this work discuss the past and present conservation strategies and make suggestion on how it can improve rhino conservation.

Keywords: Rhinoceros, conservation