

PROJECT REPORTS

2003

TABLE OF CONTENTS

Comparing grass biomass production between sodic sites and crests in the semi-arid granitic savannas of the Lowveld	8
Alard G	8
Vegetation monitoring in Kruger National Park using multiscale remote sensing analysis	9
Aplin P.....	9
Human ecological footprints of protected areas in South Africa 2002-2003.....	10
Barry M	10
Unnaturally eroded sodic soils rehabilitation report	11
Basson S.....	11
Tsetse fly (<i>Glossina morsitans morsitans</i>) surveillance in the Kruger National Park.....	12
Bengis RG	12
Non-lethal control of African elephant (<i>Loxodonta africana</i>) populations by means of immunocontraception	13
Bertschinger HJ	13
Collection and freezing of semen from buffalo in the Kruger National Park for insemination of foot and mouth disease free buffalo elsewhere in South Africa	13
Bertschinger HJ	13
Studies on the stick insects (Phasmida) of the Kruger National Park, including the description of new species	15
Brock PD.....	15
Ejaculate endocrine traits and the establishment of optimal methods for collecting and freeze preserving spermatozoa from selected species of wildlife in the Kruger National Park.	16
Bush M	16
Evaluation of the tuberculin test in African elephants (<i>Loxodonta africana</i>).....	16
Bush M	16
Study of feline immunodeficiency virus (FIV) in lions, leopards, and cheetah in the Kruger National Park.....	17
Bush M	17
Pharmacokinetic study of long acting tetracycline in free-ranging African elephants (<i>Loxodonta africana</i>).....	17
Bush M	17
Structure and function of upland riparian boundaries.....	19
Cadenasso ML	19

Developing a safe, effective anesthetic protocol for rapid, anesthesia of free-ranging giraffes	21
Citino SB.....	21
The sampling method of elephant (<i>Loxodonta africana</i>) tusks.....	22
Codron J	22
A study of the interactions between fire, vegetation and nitrogen dynamics in the Kruger National Park	24
Coetsee C	24
Longitudinal studies of bovine tuberculosis in the buffalo population of the Kruger National Park	25
Cross PC	25
The evaluation of a BCG vaccine against bovine tuberculosis in African buffalo (<i>Syncerus caffer</i>).....	27
de Klerk L	27
An experimental intratonsilar infection model for bovine tuberculosis in African buffalo (<i>Syncerus caffer</i>)	28
de Klerk L	28
The ecology of anthrax in the Kruger National Park	29
De Vos V.....	29
Survey of Arachnida of the Kruger National Park with emphasis on spiders (excluding mites and ticks)	30
Dippenaar-Schoeman AS.....	30
Scramble competition within a guild of browsing herbivores	32
du Toit JT.....	32
Ungulate browsing as an ecosystem process: An investigation into browser-plant-soil interactions in a southern African savanna.....	34
du Toit JT.....	34
Vertical aerial photography and image processing as an aid to monitor woody canopy cover in the Kruger National Park.....	36
Eckhardt HC	36
Fixed point photography and image processing as an aid for long-term vegetation monitoring in the Kruger National Park.....	37
Eckhardt HC	37
Regeneration of riparian vegetation on the Sabie River in the Kruger National Park	38
Eckhardt HC	38
Mechanisms of grass/tree interactions in savannas	39
February E	39
The effect of altered fire regime on the soil microbial community composition and activity in the Savannas of the KNP.....	40
Feig G	40

Using hyperspectral remote sensing of plant chemicals to explain the interaction between secondary plant compounds and herbivores	42
Ferwerda J	42
Factors influencing the distribution and abundance of an invasive plant, <i>Opuntia stricta</i> , and its biological control agent, <i>Cactoblastis cactorum</i> , in Kruger National Park.....	43
Foxcroft L.....	43
Executive summary of three market research survey reports conducted for the Limpopo valley spatial development initiative	44
Gardner M.....	44
Factors governing elephant impacts on the riparian woodlands of certain seasonal rivers in the northern Kruger National Park.....	46
Gaylard A.....	46
Earlier Stone Age Geoarchaeology of the Northern Kruger Park	48
Gibbon R	48
The Spatial and Temporal Scale of Vegetation Change in Kruger National Park	49
Gillson L	49
Bionomics of the malaria vector (Diptera: Culicidae) <i>Anopheles arabiensis</i> in the Kruger National Park, South Africa	50
Govere JM.....	50
Landscape heterogeneity and the use of space by elephants in the Kruger National Park, South Africa	52
Grainger M.....	52
The effect of the closure of artificial waterpoints on the ecology of the far northern basalt plains in the Kruger National Park	54
Grant CC.....	54
Determining the role of large mammalian grazers in the redistribution and concentration of nutrients in soil and vegetation of the Kruger National Park	56
Grant CC.....	56
Biocomplexity in African Savannas Programme.....	58
Hanan NP.....	58
Movements, activity patterns and choice of social environment in male buffalo (<i>Syncerus caffer</i>) in the central region of the Kruger National Park	60
Hay CT	60
The ecological determinants of group size and composition in terrestrial primates	62
Hill R	62
Biological control of <i>Opuntia stricta</i>	64

Hoffmann JH	64
The seasonal abundance of arthropod parasites of impalas, <i>Aepyceros melampus</i> , in the Kruger National Park	65
Horak IG.....	65
The abundance and seasonal abundance of free-living ticks in the Kruger National Park	66
Horak IG.....	66
Scientific evaluation of traditional use of scarce medicinal plants occurring in the Kruger national Park aimed at developing and commercialising new plant-based drugs.....	68
Horak M.....	68
The evolution of echolocation in the insectivorous bat family Rhinolophidae	71
Jacobs D.....	71
The epidemiology of tuberculosis in free-ranging lions in the Kruger National Park	72
Keet DF	72
Hydro-geomorphic and patch mosaic characteristics of an ephemeral wetland on the northern plains of the Kruger National Park, South Africa	74
Rogers KH.....	74
A study to validate and derive fuel biomass prediction models for savanna ecosystems in South Africa.....	76
Landmann T	76
Migration and habitat selection of Luvuvhu river tigerfish (<i>Hydrocynus vittatus</i>) population in the Kruger National Park	77
Leslie B.....	77
Long term effect of fire frequency and season on the <i>Colophospermum mopane</i> shrubveld of the Kruger National Park.....	78
Lombard PJL.....	78
An analysis of the impacts of elephants on woody vegetation in the Kruger National Park research exclosures	80
Mamphweli NS.....	80
Collection and study of insects in the Kruger National Park.....	82
Mansell MW	82
Survey of agricultural important mites and their predators (Arachnida).....	84
Meyer MKP.....	84
Distribution, density and biomass of mound-building termites in the northern Kruger National Park.....	86
Meyer VW	86

The effect of fire on soil properties in the Kruger National Park burn plots	88
Mills AJ	88
Pack dynamics of the wild dog in the Kruger National Park	91
Mills G	91
Hyperspectral remote sensing of tropical grass quality	94
Mutanga O	94
Vegetation dynamics as affected by fire, drought, herbivory and artificial water provision on the Tsende plains of the Kruger National Park	97
Oelofse J.....	97
Structuring of ant communities in African Savannas.....	99
Parr CL	99
Towards a predictive understanding of savanna ecosystem dynamics in the Lowveld of the Mpumalanga and Northern Provinces.....	101
Peel MJS	101
The influence of large woody debris and the interaction with large herbivores and fire on riparian vegetation dynamics on the Sabie River, Kruger National Park, South Africa.....	102
Pettit N.....	102
Veld burning in the Kruger National Park	104
Potgieter ALF.....	104
<i>In situ</i> ultrasonographic reproductive evaluation of the female black rhinoceros (<i>Diceros bicornis</i>) and white rhinoceros (<i>Ceratotherium simum</i>) in South Africa	106
Radcliffe RW	106
Interference potential of the alien invasive plant <i>Parthenium</i> <i>hysterophorus</i> with indigenous plant species in the Kruger National Park	108
Reinhardt CF	108
Medium term geomorphic change in semi-arid rivers with mixed bedrock/alluvial influence	109
Rountree M	109
Inkomati Tigerfish Telemetry Project.....	110
Roux F	110
A GIS Model of Bovine Tuberculosis in the African Buffalo (<i>Syncerus caffer</i>) Population of Kruger National Park, South Africa.....	112
Ryan SJ	112
The demography of a culled sample of African Buffalo, <i>Syncerus</i> <i>caffer</i> , in the Kruger National Park with particular emphasis on correlating age with tooth wear and habitat	114

Sanson GD.....	114
Dung beetle richness, dung preference and assemblage structure in the Kruger National Park, South Africa	116
Scholtz CH	116
Using isotopic evidence of large mammal nutritional ecology to track vegetation change through time	118
Sponheimer M	118
Modelling buffalo - lion interactions and implications for the spread of bovine tuberculosis in Kruger National Park, South Africa	120
Tambling CJ	120
Harvest, hand-rearing and re-introduction of the second-hatched southern ground hornbill (<i>Bucorvus leadbeateri</i>) chicks from Kruger National Park	122
Turner A	122
State in community-based natural resource management: the Makuleke Region of Kruger National Park.....	124
Turner RL.....	124
Cremnophilous Succulent Plants: structure and adaptations	126
van Jaarsveld E.....	126
The effects of translocation on African Elephant.....	127
Viljoen JJ	127
The role of cloven-hoofed animals in the epidemiology of foot-and- mouth disease.....	129
Vosloo W	129
Monitoring the climate in the Kruger National Park.....	131
Zambatis N	131
Field layer dynamics of the Kruger National Park	132
Zambatis N	132
A pilot study for the determination of instream flow requirements of mayflies.....	133
Zituta MN.....	133

Comparing grass biomass production between sodic sites and crests in the semi-arid granitic savannas of the Lowveld

Alard G¹, and Grant CC²

¹ Scientific Services, Kruger National Park

² Northern Plains Program c/o Kruger Park Marathon Club

glynna@sanparks.org

Fieldwork to date has covered the first envisioned sampling season, i.e. the wet season of 2002/2003. All data presented, reflect dry mass of clipped grass from the sampling plots within the study area, which was measured in grams. ANOVA analysis was used to analyse the results. Sodic sites produced significantly more [over double, across multiple temporal scales, across the season and within a month] grass biomass than crest zones ($p < 0.05$; $f = 4.847$; D.F. = 1) within the area of grazing exclusion. Nutrient analysis of the dry tissue samples revealed a significant difference between the nutrients in sodic site and crest grasses; grasses in the sodic site having significantly more nitrogen ($p < 0.005$; $f = 14.434$; d.f. = 1). These results demonstrate the viability of this study and a justification for its continuation.

Furthermore, a very significant difference between samples obtained from inside the Nkuhlu enclosure vs. outside ($p < 0.0005$; $f = 13.284$; d.f. = 1) demonstrate the effectivity of this site in excluding grazing from designated treatments, and, for the purpose of this study the suitability of the site. Therefore, over the period of one wet season, the hypothesis that grass biomass production is higher on sodic sites than on crests has been verified. However, this is deemed to be deficient, as the extent of temporal and spatial scales has to be increased to increase degree of confidence.

Vegetation monitoring in Kruger National Park using multiscale remote sensing analysis

Aplin P

School of Geography, University of Nottingham

paul.aplin@nottingham.ac.uk

The main aim of the project is to identify vegetation change in Kruger National Park (KNP), South Africa over the last thirty years. Initial work has focused on generating vegetation indices and land cover classifications from a series of remotely sensed images. Analysis has been conducted at the local scale using field work in November 2003 and spatially detailed images (QuickBird, IKONOS), and extrapolated over a wider area using coarser spatial resolution images (Landsat Thematic Mapper and successors). The research is being conducted to demonstrate the effect of anthropogenic land management practices on the natural environment. It is believed that the introduction of artificial water resources such as dams and boreholes has led to an increase in vegetation abundance, leading subsequently to an increase in large herbivore populations. However, it is also believed that vegetation diversity has decreased, due partly to over-grazing of certain plant types by large herbivores, but also due to competition from dominant plant species benefiting from favourable growing conditions.

Human ecological footprints of protected areas in South Africa 2002-2003

Barry M¹, Reyers B¹, van Jaarsveld AS¹, and Meickeljohn KI²

¹ Faculty of Science, University of Stellenbosch

² Department of Geography and Geoinformatics, University of Pretoria

Vanjaarsveld@nbict.nbi.ac.za

In March 2002 data on waste, water and electricity utilization, tourists numbers, staff numbers and budget were collected at the Addo Elephant National Park. Satellite imagery of the Kruger National Park was obtained in May 2002. Most of these images were not accurately geo-rectified. Through a contact at SAC, 2 free images were obtained which were accurately geo-rectified. Various classifications have been performed. The biggest challenge has been to distinguish between transformed areas and natural areas. In some cases the spectral value will be the same in these two different classes. These classified images will then be analysed using Fragstats, this will enable calculation of habitat fragmentation. Most of the preliminary analysis was conducted on one of the Kruger scenes, scene 168077 (Nwanetsi).

Unnaturally eroded sodic soils rehabilitation report

Basson S¹, Wentzel K, Venter F, Zambatis N, du Plessis B, Venter J, Ehrlich

¹ South African National Parks

sandraba@sanparks.org

Different applications of CASO_4 , gypsum, were applied to the soil in order to verify its potential to be used in the reclamation and stabilization of sensitive sodic soils in localities where anthropogenic soil erosion occurs. Twenty experimental plots had been demarcated, surveyed, marked out and photographically recorded. Each plot is 1000m² in size, 20m wide and 50m long. The plots are spaced 10m apart and at its closest 15m from the road verge. Completed September 2002. Next photographic recording planned for April/May 2004. Plots were then randomly chosen for the different application methods/placing of soil saver material. Application of gypsum was done as follows, the amount of gypsum to be applied to each plot was changed to a certain number of "rows per bucket" in order to make it easier for the people working with the it. Different treatments of gypsum were applied in different plots. These were done during September 2002, November 2002, February 2003, May 2003, August 2003, and February 2004. Next application is planned for May 2004.

Soil samples of each plot were taken before and after the gypsum was applied and sent to Central Analytical Laboratories in Pelindaba for analysis. No conclusions could be made of the results obtained. Grass surveys, rain measurements and water samples were also done.

Tsetse fly (*Glossina morsitans morsitans*) surveillance in the Kruger National Park

Bengis RG¹, Bagnall RJ¹, and Keet DF¹

¹ State Veterinarian, Kruger National Park

royb@nda.agric.za

Tsetse fly occurred historically in certain areas of the KNP up until the Rinderpest outbreak of 1896, when probably due to the decimation of their blood meal source, this fly disappeared. During the 1960's a tripartite tsetse control programme involving officials from South Africa, Rhodesia and Mozambique succeeded in eradicating tsetse flies south of the Sabie River in Mozambique and Rhodesia. Subsequently, following deterioration of international co-operation between these three countries, and internal instability in Mozambique, little or no tsetse fly control has been practised and no information is available from Mozambique on southward movement of flies since fly control ceased.

Tsetse flies usually recolonise previous habitat at a rate of 5 to 10 km per year and with this scenario, if they should cross the watershed south of the Lundi River, they would then enter the Limpopo drainage system and within a few years could feasibly spread into the northern regions of the Kruger National Park. The movement of Tsetse flies southward could however be retarded due to the paucity of hosts, both wild and domestic in post civil war Mozambique. The main objective was to institute an early warning surveillance system to monitor re- incursion of Tsetse flies into the Limpopo/Levuvhu drainage system of the KNP.

Non-lethal control of African elephant (*Loxodonta africana*) populations by means of immunocontraception

Bertschinger HJ¹, and Kirkpatrick JF²

¹ Faculty of Veterinary Science, University of Pretoria

² The Science and Conservation Center of Zoo Montana

henk.bertschinger@up.ac.za

No work has been done since the last trial, which ended in 2001. A trial was started in Makalali Game Reserve in 2000 and this is ongoing. Previously it has been shown that pig and African elephant have shared zona pellucida epitopes. The concept of using porcine zona pellucida (pZP) proteins as a contraceptive vaccine thus seemed feasible. This research was followed up with two field trials in the Kruger National Park that proved that pZP vaccine is able to contracept elephants. The work has since been continued in two smaller populations of elephants in private game reserves.

Collection and freezing of semen from buffalo in the Kruger National Park for insemination of foot and mouth disease free buffalo elsewhere in South Africa

Bertschinger HJ¹, Bengis R², Keet D², and Vosloo W¹

¹ Faculty of Veterinary Science, University of Pretoria

² State Veterinarian, National Department of Agriculture

henk.bertschinger@up.ac.za

Since the buffalo culling stopped there has been no further research since the last report. We would be pleased to continue this project and would welcome information relating to culls.

Studies on the stick insects (Phasmida) of the Kruger National Park, including the description of new species

Brock PD

Freelance Reseacher, close links with Natural History Museum, London

pbrock@wexhamcourt.slough.sch.uk

In May 2003 a preliminary research visit was made to Skukuza, several specimens in the collection were identified, including designation of paratypes. Material in the Transvaal Museum and the National Collection in Pretoria were also checked. Suitable collecting areas were identified for a visit in 2004; research included `phone discussions with Leo Braack.

Ejaculate endocrine traits and the establishment of optimal methods for collecting and freeze preserving spermatozoa from selected species of wildlife in the Kruger National Park.

Bush M¹, Wildt DE¹, and Howard JG¹

¹ Veterinary Services, Smithsonian Institution

mbush@crc.si.edu

This is a potential ongoing study as we develop improved methods of collecting and preserving spermatozoa, but recent planned studies have been curtailed due to lack of funding.

Evaluation of the tuberculin test in African elephants (*Loxodonta africana*)

Bush M

Veterinary Services, Smithsonian Institution

mbush@crc.si.edu

This was a concurrent study during the Tetracycline study where the elephants required repeated anesthesia at 48 or 72 hr. We did tuberculin tests in the tail folds and found that all the elephants tested (n=13) had positive tuberculin tests. This was prior to the diagnosis of Bovine TB in KNP and showed that the intradermal tuberculin test would be of little value in evaluating the disease status of elephants.

Study of feline immunodeficiency virus (FIV) in lions, leopards, and cheetah in the Kruger National Park

Bush M¹, Obrien S², and Kennedy-Stoskopf S³

¹ Veterinary Services, Smithsonian Institution

² Natinat Cancer Institute, Fort Derrick, Maryland

³ College of Veterinary Medicine, North Carolina State University

mbush@crc.si.edu

Fundascopic examination of lions was done and lesions comparable to ocular lesions in AIDS patients were found in several lions, where previously this virus was thought to cause no lesions in free-living lions. Further studies are indicated when funding becomes available.

Pharmacokinetic study of long acting tetracycline in free-ranging African elephants (*Loxodonta africana*)

Bush M¹, Raath JP², de Vos V², and Stoskopf MK³

¹ Veterinary Services, Smithsonian Institution

² Scientific Services, Kruger National Park

³ College of Veterinary Medicine, North Carolina State University

mbush@crc.si.edu

This is the first work on determining a therapeutic dose of this long acting antibiotic (tetracycline) in both adult and calves. As stated above – when

the antibiotic (tetracycline) is considered for therapy in elephants the results from this study can provide the KNP veterinarian appropriate therapeutic guidelines.

Structure and function of upland riparian boundaries

Cadenasso ML¹, Pickett STA¹, Benning TL², Schwarz K¹, and Sizemore E¹

¹ Institute of Ecosystem Studies, New York

² Department of Environmental Science, University of San Francisco,

cadenassom@ecostudies.org

Our objective is to quantify the three-dimensional structure of vegetation changes across transects from the riparian through to the upland savanna, and secondly to measure atmospheric deposition of nutrients on leaf surfaces, quantify sizes of nutrient pools in woody plant leaf tissue and in the surface soils and assess the turnover rates of key nutrients in soils. In June 2001 ten forested riparian sites were selected along the Shingwedzi River and its tributaries. These sites were selected to represent the ecological contrasts of parent material and position in the hydrological network. Seven of the sites are on mainstem rivers – 4 on granite and 3 on basalt parent material. Three of the sites are along fine scale fault lines or dolerite dykes in granite.

Mapping of the three dimensional structure of the woody vegetation in all 10 sites was completed, these maps are accurate and detailed including the location, species, height, and crown extent of all trees and shrubs. The basal area of all of the trees was also measured. Other features of the sites such as topographical breaks, termite mounds, coarse woody debris piles, and dead stems were also mapped.

Our preliminary analysis of the data show that the sites on the mainstem rivers are more similar, structurally and compositionally, to each other than the sites on the finer scale fault lines. This suggests that location along the

drainage network is more important in determining vegetation structure than parent material. However, we say this with caution as riparian zones along the mainstem rivers may all be located on granite-derived alluvium that has been deposited. If this is the case, the riparian sites selected may be located on the same parent material.

Developing a safe, effective anesthetic protocol for rapid, anesthesia of free-ranging giraffes

Citino SB¹, Bush M², Hofmeyr M³, and Lance W⁴

¹ Department of Veterinary Sciences, White Oak Conservation Center

² Veterinary Services, Smithsonian Institution

³ Veterinary Wildlife Services, Kruger National Park

⁴ Wildlife Pharmaceuticals

scottc@wogilman.com

This study will evaluate the safety, efficacy, and physiological effects of a relatively new drug regimen, A3080/medetomidine/ketamine, for capture and relocation of free-ranging giraffe. Our hypothesis is: Free-ranging giraffe can be rapidly and safely anesthetized using a combination of A3080 (thiafentanil), medetomidine, and ketamine for capture and relocation procedures. The objectives of this study are to: 1) evaluate the safety and effectiveness of A3080, medetomidine, and ketamine for anesthesia of free-ranging giraffe during capture and relocation efforts, 2) evaluate the physiologic effects of A3080, medetomidine, and ketamine in free-ranging giraffe, and 3) to develop field techniques for respiratory support of anesthetized giraffe.

To date, some data has been collected on 8 giraffe using A3080 alone and 3 giraffe with A3080/Medetomidine/Ketamine during a capture and translocation session in Kruger last August. Since so few giraffe were caught with the A3080/Medetomidine/Ketamine combination during this session, it is too early to draw any conclusions. This project is scheduled to continue for two more years.

The sampling method of elephant (*Loxodonta africana*) tusks

Codron J¹, Lee-Thorp J², Bond W¹, Sponheimer M³, and Grant CC⁴

¹ Department of Botany, University of Cape Town

² Department of Archaeology, University of Cape Town

³ Department of Anthropology, University of Colorado at Boulder

⁴ Northern Plains Program c/o Kruger Park Marathon Club

jacqui@age.uct.ac.za

Elephant ivory and tail hair were obtained in January 2003 from the stockpiles of the collection in Skukuza. Elephant faeces were collected from various localities throughout the Kruger Park. Data from faeces were used to assist with interpretations of isotopic data from elephant hair and ivory. This study aimed to trace short- and long-term dietary and ecological shifts in elephants living in the Kruger Park. The outcome of this research would yield information about elephant ecology, but will also offer quantifiable data on environmental changes in the Park throughout the past decades.

Stable carbon and nitrogen isotope data from faeces have shown that elephants in the northern regions of Kruger Park consumed more grass during the dry season than do their southern counterparts. Throughout the Park, elephants increased their grass intake towards the end of the rainy season. No differences were observed in the proportion of grass to browse consumed by elephants living on granitic soils as opposed to basaltic soils. Serial isotopic analysis results show that elephant diets may fluctuate by more than 40% throughout the year, in terms of the proportions of grass to browse consumed.

Carbon isotope ratios indicate that elephants have begun to consume significantly more grass in the northern regions of Kruger Park during the last several decades. In the southern regions, however, their grass/browse intake has remained relatively unchanged. Most importantly, it appears that a dietary shift has occurred in elephants from the northern parts of the Park during the past few decades.

A study of the interactions between fire, vegetation and nitrogen dynamics in the Kruger National Park

Coetsee C¹, Bond W¹, February E¹, and Stock WD

¹ Department of Botany, University of Cape Town

ccoetsee@botzoo.uct.ac.za

Fire is a prevalent ecological process in savannas and may dramatically influence ecosystem structure, composition and nutrient cycling. This study contributes to the Tree Grass Program, which compares the two models for tree/grass interactions in savannas, by investigating the influence of fire on nitrogen dynamics. Experiments have been set up using both the buried core method and resin bags. To evaluate the response of fine root growth to the treatments, root ingrowth cores will be used. A soil corer will be used to establish fine root biomass and sampling will be done mid-summer to a depth of 30 cm. Fine root biomass will be calculated per unit ground area. A fine root subsample will be retained for nitrogen determination.

It seems that nitrogen becomes available to plants in KNP only during short periods of the year, usually after the commencement of the first rains. Strong competition exists between trees and grass for the limited amounts of N becoming available. In order to determine if trees and grasses have different competitive abilities in taking up available nitrogen, a tracer experiment will be conducted. Historical grass compositional data will be compared with a more recent grass composition to establish if any change has taken place in the dominant grass functional types.

Longitudinal studies of bovine tuberculosis in the buffalo population of the Kruger National Park

Cross PC^{1,2}, Getz WM¹, Hofmeyr M³, Michel A⁴, du Toit JT², Bowers J², Hay C², Wolhuter J², Bulunga K³, and Mabunda A³

¹ Department of Environmental Science, Policy and Management, University of California at Berkeley

² Mammal Research Institute, Department of Zoology & Entomology, University of Pretoria

³ Veterinary Wildlife Services, Kruger National Park

⁴ Tuberculosis Laboratory, Onderstepoort Veterinary Institute

pcross@nature.berkeley.edu

This study is about combining field studies and mathematical models to develop a deeper understanding to the spread of bovine tuberculosis, caused by *Mycobacterium bovis*, in the buffalo population of the Kruger National Park. The prevalence of bovine tuberculosis (BTB) increased in the buffalo population of the Kruger National Park (KNP) from 1991 to 1998, and the buffalo population appears to be a reservoir host. Using an age and sex structured mathematical model our first study looked at the potential effectiveness of a vaccination strategy to control or eradicate BTB. Our analysis suggests that a lifelong vaccine would eradicate BTB if 30% of the total population (or 80% of the calf population) were vaccinated every year.

As an important predictor of spatial spread of disease, our second study investigated the association patterns of buffalo. We developed a new metric for assessing association patterns in fission-fusion societies. In contrast to the traditional analysis, our new approach showed no clear clustering pattern. This suggests only weak structure in the African buffalo and a

dynamic fission and fusion process that may lead to faster disease spread than originally anticipated. Our radio-tracking work suggests that the adult females and juveniles have switched herds and moved between Satara and Lower Sabie, while adult bulls have dispersed as far as Shingwedzi from Satara.

The evaluation of a BCG vaccine against bovine tuberculosis in African buffalo (*Syncerus caffer*)

de Klerk L¹, Michel AL², Bengis RG³, Bush M⁴, Kriek NPJ¹, and Griffin JFT⁵

¹ Veterinary Science, University of Pretoria

² Tuberculosis Laboratory

³ State Veterinarian, National Department of Agriculture

⁴ Veterinary Services, Smithsonian Institution

⁵ Department of Immunology, University of Otago

Lin-marid@sanparks.org

Bovine tuberculosis (BTB) in African buffalo (*Syncerus caffer*) in the Kruger National Park has become a subject of great concern over the past ten years. As part of the overall BTB control programme, the development, validation and use of an effective vaccine is proposed.

The BCG vaccine was not effective in protecting the buffalo calves against infection and disease. There might be several reasons for vaccine failure, one of which is that the BCG-Pasteur vaccine was unable to elicit a proper immune response against *M. bovis* in the African buffalo. Another possibility could be the presence of extrinsic factors such as stress and viral disease that caused the vaccine to fail. The challenge dose might have been too high, having an overriding effect of the immune response and thus causing rapid disease progression. The fact that a similar dose of BCG-Pasteur vaccine was able to protect red deer infected with similar live *M. bovis* doses to what was used in this experiment, might also indicate that the *M. bovis* strain from the KNP is more virulent than *M. bovis* strains elsewhere in the world.

An experimental intratonsilar infection model for bovine tuberculosis in African buffalo (*Syncerus caffer*)

de Klerk L¹, Michel AL², Grobler DG³, Bengis RG⁴, Bush M⁵, Kriek NPJ¹, Hofmeyr M³, Griffin JFT⁶, and Mackintosh CG

¹ Veterinary Science, University of Pretoria

² Tuberculosis Laboratory

³ Veterinary Wildlife Services, Kruger National Park

⁴ State Veterinarian, National Department of Agriculture

⁵ Veterinary Services, Smithsonian Institution

⁶ Department of Immunology, University of Otago

Lin-marid@sanparks.org

The infection model served to show that *M. bovis* could be recovered from at least 5 weeks post infection from the regional lymph node associated with port of entry of infection. General macropathology of the experimentally infected animals compared well to the necropsy findings of an adult buffalo with BTB. The laboratory tests were able to differentiate at an early stage between infected and non-infected animals. It was found that the IFN- γ was the superior test to diagnose BTB in buffalo in this study, showing a sensitivity of 88.2 % and a specificity of 100%. The infected buffalo calves had growth rates comparable to the controls throughout the duration of the study. Our results infer that experimental *M. bovis* infection at these doses should not affect the body condition or weight gain in young animals for at least 6 months post infection. Because of the short time frame of the experiment, it was not unexpected that very few animals would have developed disseminated lesions. In this study the majority of tuberculous lesions were restricted to the left medial retropharyngeal lymph nodes.

The ecology of anthrax in the Kruger National Park

De Vos V¹, Bengis R², and Arntzel L³

¹ Wildlife Disease Consultant

² State Veterinarian, National Department of Agriculture

³ National Institute of Communicable Diseases

v.devos@absamail.co.za

Anthrax has emerged as a formidable weapon in bio-warfare and bio-terrorism and remains a nightmare for the international community in the foreseeable future. This has rekindled great interest in the disease from the standpoints of epidemiology, detection, protection and treatment. The Kruger National Park being a possible cradle of anthrax plays a vital role in establishing a baseline for especially the epidemiology (ecology) of anthrax. Hence, it is vital that epidemiological studies should continue. Objectives of this study are, to study the pre-history of anthrax, to understand its role and distribution in the KNP ecosystem and to obtain practical, effective and safe prophylactic and control measures against anthrax in a free-living situation such as the Kruger National Park. Evidence indicate that anthrax is an indigenous disease to southern Africa, and more specifically to the Kruger National Park, where early sttlers and their domestic animals have come into contact with the disease in their downward trek through Africa. Studies on the genotype grouping of *B. anthracis* may be the sub-Sharan African continent with Kruger plaing a central role.

Survey of Arachnida of the Kruger National Park with emphasis on spiders (excluding mites and ticks)

Dippenaar-Schoeman AS¹, and Leroy A

¹ Biosystematics Section, Agricultural Research Council-Plant Protection Research Institute

rietasd@plant2.agric.za

As part of the South African National Survey of Arachnida (SANSA) an inventory of the Arachnida of the Kruger National Park is underway. The arachnids (spiders, scorpions, solifugids, amblypygids and pseudoscorpions) constitute an abundant and highly successful group of invertebrate animals. In the past invertebrates were largely ignored in conservation endeavors. Meaningful conservation cannot take place if species involved are not known. Therefore, surveys of invertebrate fauna became more important, especially in reserved areas where conservation strategies are already in place. The overall aims of this project were, to collect, describe and make an inventory of the Arachnida species of the Kruger National Park, to publish results in the form of checklists and to include data in the SANSA electronic database on arachnid fauna in conserved areas.

A checklist of spiders of the KNP has been published. It is represented by 152 species, 116 genera and 40 families. This represents about 7.6 % of the total known South African spider fauna. Of the 152 species, 103 are new records for the park. The ground dwelling spiders comprise 58 species from 25 families. Of these, 21 % are web dwellers and 62 % free living, while 17 % live in burrows. From the plant layer 94 species have been collected of which 53 % were web builders and 47 % free living wandering spiders. In a checklist of the pseudoscorpions of South Africa (Dippenaar-

Schoeman & Harvey, 2000) seven species from the KNP have been reported. An updated checklist of the Solifugae of conserved areas in South Africa has been completed. This list includes a total of 44 species that have been recorded from the KNP. A checklist of the opilionids of the KNP is currently being prepared.

Scramble competition within a guild of browsing herbivores

du Toit JT¹ , Woolnough AP¹, and Cameron AZ¹

¹ Mammal Research Institute, University of Pretoria

jtdutoit@zoology.up.ac.za

The objectives of this study were to consider (1) differences *between species* within a browsing ungulate guild and (2) differences *between sexes* within a species (giraffe), in terms of nutritional benefits derived by the larger species or sex when feeding above the feeding heights of the smaller species or sex.

From our research to date we contend that our findings are analogous to those from equivalent studies on grazers, suggesting that as a general rule within ungulate guilds the smaller-bodied species will competitively displace the larger-bodied species when shared resources become restricted. Results from the second objective confirmed that males do feed at higher levels than females, and that feeding efficiency is reduced at high feeding heights (due to more interruptions of feeding for scanning and also a lower biting rate). Males thus incur a foraging cost when feeding above the height levels used by females, and we hypothesize that intersexual differences in giraffe feeding height are driven by indirect scramble competition.

The results of this study have enabled a test of the indirect scramble competition hypothesis on ungulate guild structure, which was developed from research on grazers. By conducting parallel studies on browsers, we have been able to cross-test the hypothesis and thereby extract a unified understanding of interactions between ungulate species within guilds, and sexes within size-dimorphic species. The value of this for Kruger is that

peer-reviewed publications are appearing in international journals and books, which attract the attention of ecologists around the world and demonstrate that Kruger is fulfilling its mandate to support scientific research.

Ungulate browsing as an ecosystem process: An investigation into browser-plant-soil interactions in a southern African savanna

du Toit JT¹, Fornara D¹

¹ Mammal Research Institute, University of Pretoria

jtdutoit@zoology.up.ac.za

The only studies of browsing as an ecosystem process have been conducted in boreal forests, where the evidence is that the long-term consequences of intensive browsing include a shift in dominance towards unpalatable woody species. The mechanism appears to be that selective browsing on palatable deciduous woody plants provides a competitive advantage to chemically defended slow-growing evergreens, which produce leaf litter that decomposes slowly. No differences in numbers of palatable and unpalatable species across the three different sites. Palatable species were more abundant overall than unpalatable ones (65% vs. 35%) in each site. In general it seems that all the nutrients are present in good concentration for woody plant requirements. Consequently, with slow nutrient uptake by slow-growing plants, combined with leaching, there is a net loss of nutrients down the soil profile. In African savannas, however, it could be that the positive effects of grazing on nutrient cycling cancel out any negative effects of browsing. Furthermore, a moderate level of browsing might stimulate shoot and leaf production, enhancing turnover and availability of nitrogen to plants and thereby maintaining palatable species despite browsing. It is thus important that the effects of browsing be uncoupled from those of grazing in savanna ecosystems studies. The work being undertaken here is groundbreaking in this regard.

The more spinescent *Acacia tortilis* has shown lower values of browsing intensity (in terms of number of shoots browsed) than *Acacia nigrescens* in the low-browsed areas (15 %) as well in the high-browsed-high-grazed site (~ 40 %). Grazing might also play an important role in influencing seedling establishment (influencing root competition for water and nutrients). The number of total seedlings was higher in the high-browsed-low-grazed site than in the other two sites. Unexpectedly, the number of *Acacia nigrescens* seedlings was high in both the two high-browsed areas, which means browsers do not impede seedlings recruitment.

Vertical aerial photography and image processing as an aid to monitor woody canopy cover in the Kruger National Park

Eckhardt HC

Scientific Services, Kruger National Park

holgere@sanparks.org

Vertical aerial photography is a useful tool for ecological monitoring and is especially applied in the vegetation monitoring field. The existing aerial photographic data set is of such a scale that it can be used for detecting changes in vegetation structure, *i.e.* cover and density. In some cases it is even possible to distinguish between different woody species, especially where these are large specimens. The photographic data set covers a relatively long period, enabling one to compare historic with more recently taken photographs. Changes in vegetation cover particularly, but also to a limited extent in species composition, are easily detectable and could provide important management feedback. Since the aerial photographs are in digital format, image processing can be conducted to analyze the data. Heterogeneity indices can also be derived from the images.

Aerial photographs were taken of a selected number of transects during August 2002 for the reason of having winter photographs which can be compared to historical photographs (derived from Dept Surveys and Mapping) also obtained during winter. It was thought that analyzing winter photographs and comparing them with summer images could result in underestimating the woody canopy cover.

Fixed point photography and image processing as an aid for long-term vegetation monitoring in the Kruger National Park

Eckhardt HC

Scientific Services, Kruger National Park

holgere@sanparks.org

Fixed-point photography is a useful method of recording long-term changes in the vegetation. It shows gross vegetation changes in an objective visual way. Quantitative data are not easily extractable from the images because of the absence of a fixed surface area which is ascribed to the horizontal view into space contrary to vertical views focusing on ground surface. There are, however, semi-subjective means that can be used to derive quantifiable information. One of the easier parameters is the number of individual trees which can be simply counted in order to obtain time series data.

The full set of fixed-points was rephotographed during April 2002 and some of those photos even used for subsequent analysis. An additional 60 sites were selected and photographed on the Lebombo Mountains due to complete under sampling in the past. A new set of fixed-points was also compiled for the area within and around Capricorn camp. Over 900 photographs were analyzed derived from sites all-over the KNP. Current findings revealed that the lower (<2m) and intermediate (2-5m) height classes are highly dynamic, changing within a period of a few years depending on fire and rainfall. Bush encroachment has been observed during more recent years; especially on the granites increase in densities of woody individuals became a scenario. Trends in tall tree (>5m) numbers are negative, showing a sharp decline by over 40% throughout the KNP

Regeneration of riparian vegetation on the Sabie River in the Kruger National Park

Eckhardt HC

Scientific Services, Kruger National Park

holgere@sanparks.org

Two modeling projects have evolved under the above-mentioned title, namely: Rule based modeling for management of riparian systems, and, modeling of terrestrialisation and technology transfer to enable management of Kruger National Park Rivers. These two projects were developed by the Centre for Water in the Environment (CWE, Wits University) with the main objective of engaging research, prediction, technology transfer and monitoring through rule-based modeling, to enable effective management of riparian system response to changes in flow regime. In order to achieve this overall aim, various objectives were pursued. The development and testing phase of the project has been completed and will in future be managed by the above-mentioned scientist. For more information about this project, the two reports WRC Report No 813/1/99 and WRC Report No. 1063/1/03 are available.

Mechanisms of grass/tree interactions in savannas

February E¹, and Bond W¹

¹ Department of Botany, University of Cape Town

efeb@botzoo.uct.ac.za

The primary objective of this project is to develop a predictive understanding of tree/grass interactions in savanna ecosystems. We aim to develop this predictive understanding using site-specific versions of the rooting-niche (NSH) and demographic bottleneck (DBH) models of savanna dynamics to predict the outcome of each burn plot. A predictive model of how fire influences grass-tree ratios across soil and rainfall gradients could be a powerful management tool.

Thus far focus has been on *Terminalia sericea* in the mesic savanna of Pretoriuskop and *Acacia nigrescens* in the arid savanna of Satara. For both savannas the trees increased the most in the no burn treatments and the least in the annual burns. Different fire intensities would result in different probabilities of top kill and differences in the frequency of sapling release. Using both photographic imagery and demography data from disparate methods, it has been shown that there was very little change in tree cover in the first 20 years of the burning treatments (except in no fire plots). However since 1970s there has been large increases in shrub densities in the less intense burning treatments in the mesic savanna.

The effect of altered fire regime on the soil microbial community composition and activity in the Savannas of the KNP

Feig G¹, Scholes MC¹

¹ School of Animal, Plant and Environmental Sciences, University of Witwatersrand

mary@gecko.biol.wits.ac.za

The long term burning experiments in the Kruger National Park provide an ideal opportunity to study the effects of altered fire regime and soil types on below ground biological processes. The composition and activity of various soil microbial communities was studied on sites burnt annually and those that have been protected from fire since 1954. This study was performed on nutrient poor sandy soils derived from granite, and nutrient rich clay soils derived from basalt, in both the summer and winter seasons. Changes in the overall bacterial community structure were measured through community level physiological profiles using the BILOG™ assay and the total below ground metabolic activity was inferred through the measurement of soil respiration. Population size estimates of nitrifying bacteria were obtained through most probable number counts and their activity was measured through the determination of *in situ* nitrogen mineralization rates.

Proportions of roots infected by mycorrhizae were determined microscopically. It was found that there was no significant difference in soil respiration rates between fire treatments, soil types or seasons. The community level physiological profiles revealed that the bacterial communities separated on a seasonal basis. The nitrogen mineralization rates were significantly different between soil types in winter but not in summer due to the exceptionally hot and dry conditions experienced during

the sampling period. Annual burning in the sandy soils resulted in a reduction in the percentage mycorrhizal infection in the roots to 12% from 35% in the protected sites. This reduction was not noted in the clay soils. (This is an abstract taken from a poster that was presented at the International Rangelands Congress in Durban (July/August 2003).

Using hyperspectral remote sensing of plant chemicals to explain the interaction between secondary plant compounds and herbivores

Ferwerda J¹, Skidmore AK¹, Prins HHT, van Wieren S

¹ Department of Natural Sciences, ITS

Ferwerda@itc.nl

The aim of this project is to identify those areas of the electromagnetic spectrum which are useful for predicting nutrient (N, P, K, Ca, Na, Ca, Mg) and deterrent (Polyphenols, Tannins) levels in vegetation. Ultimately this will lead to a spatial model of the chemical composition of vegetation. To this effect Hyperspectral data (HYMAP: Spatial resolution 4.2m, 92 bands) was flown over the Northern Plains region. An area covering approximately 6*30 KM was flown, from east to west, with the roan camp in the center. The weather conditions were not optimal, but at the end of February a successful flight was performed. In the same month the ASTER satellite was reprogrammed to collect data over the same region.

Analysis of spatial patterns of the 2002 samples revealed a potential relation between soil properties and tannin content. This is currently being tested in a greenhouse in Wageningen. For this purpose a number of seeds of Mopane was transported from the Kruger National Park to the Netherlands. These seeds were planted, and successfully grew to plants (After 6 months they now vary from 10 to 60 cm tall). The first samples have been collected from these plants, and will be chemically analyzed in January 2004.

Factors influencing the distribution and abundance of an invasive plant, *Opuntia stricta*, and its biological control agent, *Cactoblastis cactorum*, in Kruger National Park

Foxcroft L¹, Viljoen J², Hoffmann J³

1 Scientific Services, Kruger National Park

2 Department of Nature Conservation, Tshwane University of Technology

3 Department of Zoology, University of Cape Town

llewellynf@sanparks.org

Opuntia stricta, an invasive alien plant, has invaded an area of more than 35 000 hectares in the Skukuza region of the Kruger National Park (KNP). In order to unravel the dynamics of the *O. stricta* invasion, the distribution of the plant together with features of the environment were mapped in an attempt to determine those factors which may affect the distribution and density of the plant. A principal component analysis (PCA) of *O. stricta* density revealed that none of the environmental factors that were monitored influenced the density or abundance of *O. stricta* in KNP. Furthermore, there seemed to be no natural barriers that might limit the extent of invasion within the KNP. Logistic regression also indicated no relationship between *O. stricta* density and *C. cactorum* presence, while a PCA suggests that other factors such as plant size may be important factors in determining the distribution of *C. cactorum*. The study therefore shows there is a high probability that, unless there is appropriate intervention, *O. stricta* will eventually invade the entire KNP.

Executive summary of three market research survey reports conducted for the Limpopo valley spatial development initiative

Gardner M

Tourism Consultant, STRISA

vavasour@mweb.co.za

In an attempt to explore the tourism linkages that could be established between the Mozambique coast, in the vicinity of the Limpopo River mouth, and Macarratane, Massingir, the Great Limpopo Trans Frontier Park and Kruger National Park, three separate market research surveys were undertaken.

A high proportion (86%) of tourists included Kruger National Park in their packaged or tailor-made trips. The most frequently used camps in Kruger for operators were Skukuza, Satara, Pretoriuskop and Lower Sabie. Two night stays for overseas clients was the average, whilst domestic tourists tended to spend only one night on average. The visitor survey showed a different picture, the interviews were conducted in the north of the Park. The camps mentioned most were Letaba, Mopani and Shingwedzi, with Satara being most favoured in the south. The average length of stay by visitors in Kruger was 5,08 nights, differing greatly to the average given by operators. The conclusion here is that operators are sending clients on strict itineraries with limited time, whilst those interviewed in the Park had made their own arrangements, and thus spent a longer time.

The positive feedback was that new and different destinations are always being investigated, and will be used as long as they have a quality standard,

are not overpriced, and conditions and restrictions on getting there were not onerous or threatening. The visitor survey revealed that three quarters would be interested in the extension into Mozambique concept, mainly to see a wider range of game and habitats, and other wildlife pursuits, but there was concern as to the proper management of such a large park, and there was particular concern regarding Zimbabwe's part in the greater region, especially in respect of game poaching.

Market profiles show that locals going to Kruger Park and the greater area are mainly from Gauteng, with low numbers of family groups. Younger more affluent couples were buying packaged tours into Mozambique. Nationals from the major European nations were clearly the predominant foreign markets for both operators and those interviewed in Kruger.

Factors governing elephant impacts on the riparian woodlands of certain seasonal rivers in the northern Kruger National Park

Gaylard A^{1,2}, Owen-Smith RN², Rogers KH²

¹ Scientific Services, Kruger National Park

² School of Animal, Plant and Environmental Sciences, University of Witwatersrand

angelag@sanparks.org

The aim of this study was to investigate how the spatial and temporal heterogeneity of surface water in seasonal riparian zones influenced the distribution of elephant impacts on woody vegetation, and the consequences of this for strategic management of the riparian zone under potential changes in elephant numbers and water supply (brought about by changes in rainfall or agriculture upstream). The study rivers were the Shingwedzi, Phugwane and Mphongolo rivers in the northern region of the Kruger National Park.

Data of aerial photographs from 1942, 1961, 1977 and 1987/9 were collected, digitized and GIS files produced of all natural waterholes in the study area. Time-series analysis using GIS were used to analyze the spatial and temporal variability in this water. Data collection (radiotracking, spoor transects and feeding trails) completed and data analyzed. Learnt Visual Basic programming and started compiling a spatially explicit stage-structured model of riparian plant populations across a landscape. Continued refining the model with the assistance of a VB programmer. The model now also runs in batch mode in order for statistics to be computed. The model is now at the stage where the elephant impact component can be added.

Since elephants are water-dependent, their use of the environment is related to the spatial and temporal distribution of water. In a semi-arid environment such as the Kruger National Park, the spatio-temporal heterogeneity in water distribution therefore leads to spatial and temporal variations in elephant impacts, e.g. during the wet season elephants disperse, and their impacts are thus spread over a wide area, while during the dry season elephants (and, consequently, their impacts) are concentrated around sources of water.

Earlier Stone Age Geoarchaeology of the Northern Kruger Park

Gibbon R¹, Kuman K¹, Moon B¹, Partridge TC, and Verhoef J

¹ School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand

gibbonr@science.pg.wits.ac.za

Fieldwork within the Kruger National Park was conducted between the 13th of January and the end of May 2003. The study area is in the Pafuri region. This area covers about 400 square kilometers and is anked by Mozambique to the east, with Zimbabwe and the Limpopo River to the north. Fieldwork primarily consisted of walking transects across the study area, recording both artefact locations and landscape types (geomorphology). Secondly, surface artefact collection provided artefact assemblage samples from various localities. Thirdly, ten test pits dug within various landscape localities was to obtain *in situ* artefacts and to further the understanding of the geomorphology.

The mapping of the artefact concentrations will allow for a fuller understanding of the exact landscape evolution and will allow for testing of the above models and potentially the formation of a new ones. Further field testing (test pits and survey) of any such models will also need to be conducted. Analysis is also being conducted on the artefact assemblages to achieve a greater understanding of the technology and industries within the context of the preservation history. Artefacts from both surface and test pit assemblages are being processed. Cataloguing and study of the artefacts will hopefully reveal more about the technology in terms of consistency across the landscape, time period, and technological signatures of the hominids.

The Spatial and Temporal Scale of Vegetation Change in Kruger National Park

Gillson L¹, Duffin K¹, and Aplin P²

¹ Environmental Change Institute, University of Oxford

² School of Geography, The University of Nottingham

lindsey.Gillson@eci.ox.ac.uk

Savanna ecosystems are highly dynamic, their vegetation structure can change dramatically due to the influence of fire or changing herbivore populations. This presents dilemmas for habitat managers, who must decide on appropriate management strategies for National Parks and other savanna areas. Often, long-term data on vegetation change is lacking, and managers must interpret current habitat change without the benefit of knowledge about the natural variability and resilience of ecosystems. Palaeoecology has the potential to supply such data, providing a spatial, temporal and quantitative context for the interpretation of ecological change taking place today. The objectives of this study were to determine the variability of the vegetation in the Kruger National Park, to understand the role of fire on vegetation change and to determine the implications for habitat management.

Four sites, Mafayeni, Mapimbi, Malahlapanga and Makwadzi have been selected for pollen analysis. Results to date indicate a high degree of variability in tree cover at local scales. Fire appears to play an important role in vegetation change around Mafayeni. Around Mapimbi (in Pafuri) human disturbance, probably in the form of vegetation clearance for cereal cultivation, may have played a role in vegetation dynamics.

Bionomics of the malaria vector (Diptera: Culicidae) *Anopheles arabiensis* in the Kruger National Park, South Africa

Govere JM¹, Durrheim DN, Braack LEO³, and Gericke A

¹ World Health Organisation, Zimbabwe

goverej@whoafr.org

A good knowledge about vector behaviour is essential for successful vector control. Current knowledge and understanding about *An. arabiensis* behaviour, which is the main malaria vector in South Africa and much of southern Africa is limited. Malahlapanga (22⁰53'S 31⁰02'E) is a fresh water geothermal spring in a pristine wilderness area in the remote north of the Kruger National Park. Polymerase chain reaction investigation has confirmed the existence of a pure colony restricted to *An. arabiensis* mosquitoes, which are free of known human pathogens, including *Plasmodium spp.* Some very useful studies have been conducted at the site and the results of these studies have contributed to malaria control at programme and individual level in South Africa. The objectives of the project are to conduct studies on specific characteristics of *An. arabiensis* mosquitoes that can be successfully manipulated for malaria vector control at individual or community level, and to conduct field based evaluation of the role of commercial and plant repellents in malaria vector control and disease prevention.

A field evaluation of three local plants, fever tea (*Lippia javanica*), rose geranium (*Pelargonium reniforme*) and lemon grass (*Cymbopogon excavatus*), was conducted to assess repellency against *Anopheles arabiensis* mosquitoes. All three plants provided significantly more protection ($p=0.010$) than water and alcohol controls. After 4.5 hours of application, alcohol extracts of *L. javanica*, *C. excavatus* and *P. reniforme*

provided 75%, 60% and 33.3% protection, respectively. *Lippia javanica* still provided 66.7% protection after 5 hours. The results of this field study indicate that *L. javanica*, *P. reniforme* and *C. excavatus* effectively protect against *An. arabiensis* mosquito bites with the repellent effect of *L. javanica* lasting appreciably longer than that of the other two plants.

The results of our study confirm traditional beliefs prevalent in the rural malaria region of Mpumalanga Province, in which the Kruger National Park is located, that plants of the genus *Lippia* act as repellents against mosquitoes. The repellent has a pleasant smell, the plant is abundantly available locally during the wet summer season and the repellent is relatively easy to prepare and apply. Phytochemical analysis of *L. javanica* should be carried out. Our findings suggest that *L. javanica* may prove an effective alternative to expensive DEET-containing synthetic repellents with potential application as a personal protection measure against *An. arabiensis* mosquitoes, the principal malaria vector in Mpumalanga Province.

Landscape heterogeneity and the use of space by elephants in the Kruger National Park, South Africa

Grainger M¹, van Aarde R¹, and Whyte I²

¹Department of Zoology & Entomology, University of Pretoria

² Scientific Services, Kruger National Park

mgrainger@zoology.up.ac.za

Several reasons have been put forward to account for intra-specific home range variation. There are strong links between home range size and resource availability. Landscapes provide the ecological template on which resources are laid out. Resource distribution is rarely homogenous as landscapes are made up of a mosaic of patches. The role that landscape heterogeneity plays in home range size variation has largely been ignored. Large mammals such as the elephant provide good models for studies of this type as their large home ranges encompass large amounts of landscape heterogeneity. Our analyses of data from the Kruger National Park show that the home ranges of elephants are related to some measures of landscape heterogeneity. In general the home range size of bulls is more strongly related to measures of the heterogeneity of landscapes. This suggests that the sexes have different perceptions of heterogeneity. The availability of water sources is a strong determinant of home range size. The provision of water sources for herbivores in the KNP may influence home range size.

Home range size ranged between 72 and 4451km² (mean \pm S.D.= 987.8 \pm 991.4km²). The mean values for bulls and cows were similar (t-value= 0.95; $P>0.05$) and season did not influence the sizes thereof (t= 1.95 & 1.79; $P>0.05$ respectively for bulls and cows). Home range size declined

exponentially with an increase in landscape patch richness density (number of landscape patches per 100km²) for both sexes and during both seasons. These range size also declined exponentially with an increase in natural water source richness but not for bulls during the dry season. Landscape heterogeneity indices such as the largest patch index, percentage contagion, percentage cohesion, mean shape index, edge density, mean edge contrast, natural water source Euclidean nearest neighbour distance and artificial water source and Euclidean nearest neighbour distance metrics during explained some of the variability that we recorded.

Our preliminary interpretation of the findings suggests that landscape heterogeneity and the availability of water explain variability in home range areas. In management terms this suggest that the artificial decrease of distances between water supplies will reduce range size. This may intensify impact on vegetation and the apparent destructive influences that elephants have for natural landscapes.

The effect of the closure of artificial waterpoints on the ecology of the far northern basalt plains in the Kruger National Park

Grant CC¹, de Buys A¹

¹ Northern Plains Program c/a Kruger Park Marathon Club

rinag@sanparks.org

This study examined the effect of the closure of waterpoints on the vegetation and animal distribution. The presence of artificial waterpoints seemed to exacerbate the effect of the long, dry climatic cycle by allowing large numbers of water dependent bulk grazers especially, Burchell's zebra (*Equus burchelli*) to move into the Northern Plains. This was associated with specific changes in the vegetation that were detrimental to the small roan antelope (*Hippotragus equinus*) population, which showed a sudden, severe drop towards the end of the 1980's. This stimulated the re-evaluation of the water provision policy and prompted the decision to close waterpoints in the area with the highest remaining roan antelope population.

The interaction of herbivores and the vegetation is also reflected in the sequence of decline of herbivores in the study sites before closure. With the initial change from a decreaser to an increaser dominated sword the selective Type II herbivores were compromised, they were therefore the first to decline with the decrease in rainfall. The Type III herbivores that prefer slow-growing increaser species were the next to decline as soil moisture declined with the low rainfall. The Type 1 herbivores that can utilize bulk forage of low quality were the last to decline. These species only declined when the biomass was very low as a result of the extended drought period.

Zebra, which is a hindgut digester and responds to a decrease in the quality of grazing by increasing intake were the last to decline. This sequence in the decline of animals indicates that the presence of a high density of waterpoints can support animals such as zebra and buffalo up to a point that very little biomass is left.

We suggest that the poor recovery of the free roan populations might not be entirely due to the effect of the remaining predators, which did not move out of the area as anticipated. The effect of the Type I herbivores that are still present in the area and that still maintain a vegetation dominated by increaser species seems to maintain a vegetation state that is to their advantage, but not to that of the roan antelope. Apart from the fact that the population might be too small to recover, the habitat outside the enclosure is still not optimal for Type II herbivores. It seems necessary to reduce the number of waterpoints even further to overcome the effect of the Type 1 herbivores and to allow the vegetation to recover. This study will be replaced by a more comprehensive ecosystem study that would aim at improving our understanding the effect of increased water supply in an arid system on the biodiversity.

Determining the role of large mammalian grazers in the redistribution and concentration of nutrients in soil and vegetation of the Kruger National Park

Grant CC¹, Scholes MC²

¹ Northern Program c/o Kruger Park Marathon Club

² School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand

rinag@sanparks.org

The purpose of the project was to compare soil-plant-animal interactions on nutrient-poor (granitic) soils to those on relatively nutrient-rich (basaltic) soils of the Kruger National Park (KNP). This information will improve the understanding of the selection of certain areas by herbivores. The area under study is the semi-arid Kruger National Park, which, given its latitudinal extent and diversity, is stratified by rainfall and soil nutrients gradients.

The land types in the western half are located on low nutrient granite-based soils and those in the eastern of high nutrient clay-based soils, while the rainfall decreases from south to north. Within the four sampled similarly stratified land types, preferred foraging patches were identified by determining the percentage tuft utilization at different positions on the catena. More utilized foraging patches could be differentiated from less utilized patches using nitrogen and sodium concentration in the forage.

Even in the high nutrient, high rainfall; southern basalts these high quality patches, in this study associated with sodic sites and termite mounds, were more utilized than the crests. The highest utilization rates and herbivore

biomass was also recorded in this area. However, on the larger conservation area scale, herbivore biomass distribution could not be explained from differences in rainfall even when geology and dietary preferences of herbivores was taken into account when comparing the average herbivore biomass at different scales over 13 years. Subsequently, utilizing simple rainfall models to determine the potential herbivore biomass may over or under-estimate the number of herbivores that could be supported by a specific area. Furthermore, because these nutrient-rich patches will presumably be the first to show degradation, it is suggested that monitoring programmes should focus on these areas. Signs of over utilization and system degradation should thus be detected in time to design appropriate management actions that would avoid irreversible system changes.

Biocomplexity in African Savannas Programme

Hanan NP¹

¹ Natural Resource Ecology Laboratory, Colorado State University

niall@nrel.colostate.edu

Savannas are globally important ecosystems of great significance to human welfare and economies, especially in many less developed countries in Africa and Eurasia. In our research we are investigating how complex interactions manifest themselves in the emergent characteristics of the diverse savanna regions around Africa, we are developing both conceptual and numerical models that will help us explain and analyze savanna dynamics, and new theory to explain how biogeochemistry, climate and disturbance interact and contribute to savanna dynamics across scales of space and time.

A meta-analysis of savanna structure was carried out to investigate how the relative importance of the different factors influencing the tree-grass coexistence varied across broad environmental gradients. This analysis was of data from 176 sites in Africa. The data provide strong evidence for intra-specific competition between trees for water: a mechanism for savanna persistence not frequently invoked. The results further suggest that savannas switch from being water-limited equilibrium systems to disturbance-mediated non-equilibrium systems across a gradient of increasing rainfall. We have also developed analytical and spatial models that explicitly link savanna structure and function to the availability of limiting soil nutrients (N & P) and moisture. Preliminary results indicate that the model is able to predict patterns of aboveground carbon and nitrogen stocks and herbivore consumption levels with reasonable fidelity, suggesting

the model captures most of the essential dynamics of nutrients and herbivory at the continental scale.

A pilot study was carried out using the long term experimental burn plots (EBP) of the Kruger National Park, South Africa. For this study, tree size and density measurements were made on the control plots on which one of the primary disturbance factors (fire) has been suppressed for almost 50 years. These results suggest that in savannas, which are water-limited environments, tree on tree competition for water does occur. Furthermore, it provides a mechanism for maintenance of savannas that does not require either disturbance or tree-grass competition to explain tree and grass coexistence in savanna systems.

This part of our work on complexity in African savannas explores patterns and environmental correlates of variation in seed traits of common African savanna tree species, and aims to interpret these in the context of selective forces that are thought to be important drivers in savanna systems. Candidate tree species were selected that are representative of savanna habitats. These were the five species of the common African savanna genus *Acacia*: *Acacia albida* (now *Faidherbia albida*), *Acacia tortilis*, *Acacia nilotica*, *Acacia senegal* and *Acacia erioloba*. From northern to southern latitudes in Africa, seed mass increases linearly. Mean seed mass decreased in areas with high rainfall and high temperatures, but increased in areas with high tree cover.

Movements, activity patterns and choice of social environment in male buffalo (*Syncerus caffer*) in the central region of the Kruger National Park

Hay CT¹, Funston PJ¹, Cross PC²

¹ Tshwane University of Technology

² Department of Environmental Science, Policy and Management, University of California at Berkeley

CraigH@sanparks.org

Studies on African buffalo (*Syncerus caffer*) have mainly been focused on the biology, ecology and behaviour of buffalo in mixed herds. This study proposes to look into aspects of buffalo bull life in a semi-arid environment in Southern Africa. Buffalo bulls are encountered in two social environments: herds ranging from 50 to over 1000 animals of both sexes, and smaller groups of bulls. The underlying factors driving the switching of bulls from one herd type to another is not yet clearly understood. This project is monitoring the movements, choice of social environment, habitat selection and mortality of buffalo bulls in the existing radio-collared herds in the central region of the KNP. This would enable a clearer understanding of the dynamics of bulls within a buffalo population and could provide important insights into their role in the spread of bovine tuberculosis in the KNP.

A total of 30 radio-collared adult bulls have been monitored. An attempt is made to locate these animals at least once a week. Data from radio-collared animals and from bachelor herd size indicates a movement of bulls into bachelor groups during the dry months and into mixed herds during the wet months to coincide with the breeding season. Certain radio-collared

individuals have however shown fidelity to the group in which they were collared and have demonstrated no or very little switching between herd types. Data was collected on the daily movement of buffalo, and bachelor groups appear to be much more sedentary and on average cover less distance than mixed herds over a 24 hour period. Monthly faecal samples were collected from all mixed herds and bachelor groups encountered in the study area. Faecal sampling data from 2001 indicated that bachelor groups may be obtaining superior quality forage as measured by faecal nitrogen, compared to mixed herds. Data from 2002 showed no differences in forage quality consumed by the two different herd types.

In order to determine an index of predation risk, we measured maximum visibility in areas utilized by buffalo and areas where buffalo mortalities occurred. The data thus far indicate that mixed herds are utilizing more open habitats than bachelor groups, and that buffalo mortalities tend to occur in similar habitat to that which bachelor groups utilize, in terms of visibility. An analysis of the mortality of our radio-collared animals shows clearly that adult bulls are being predated at a higher rate than adult cows.

The ecological determinants of group size and composition in terrestrial primates

Hill R

Department of Anthropology, University of Durham

r.a.hill@durham.ac.uk

The primary objective of the research project is to survey the size, composition and density of baboon and vervet groups throughout the Kruger National Park. The observed variation in group size and composition will be assessed alongside factors such as climatic variables, vegetation types, surface water availability, predator densities and tourist/rest camp locations to determine the key variables underlying sociality in primates. These findings will be fed back into systems models of primate socioecology to develop a highly robust model of the ecological constraints on terrestrial primate sociality.

The entire park was surveyed from the tourist roads to produce a preliminary map of baboon and vervet densities. Following expectations based on climate data and herbivore distribution, primate densities appear greatest in the area of the Sabie Sands river between Skukuza and Lower Sabie. Contrary to expectations, however, baboon and vervet densities also appear to be high along the Luvuvhu and this will be investigated further on future visits. To date, accurate counts have been obtained for 13 baboon and 8 vervet groups. Baboon group sizes range from 11 to 55 individuals (mean 26.2 individuals), with vervet group sizes ranging from 7 to 24 (mean 14.0). However, these are both clearly underestimates. Incomplete counts were frequently obtained for baboon groups containing at least 50 animals

(largest group was 85+), and vervet groups of 10+ animals (largest 32+). On future field visits time will be taken to gain accurate counts on some of these large groups. It was clear, however, that many of the primate (particularly baboon) groups surrounding tourist camps or picnic areas were substantially smaller than groups more distant from human activity as the result of past control. The actual impact of this will be more formally assessed once further data on complete group counts are available.

Biological control of *Opuntia stricta*

Hoffmann JH¹, Zimmermann HG², Foxcroft L³

¹ Department of Zoology, University of Cape Town

² Agricultural Research Council, Plant Protection Research Institute

³ Scientific Research, Kruger National Park

hoff@botzoo.uct.ac.za

Two herbivorous insects, a phycitid moth, *Cactoblastis cactorum*, and a cochineal insect, *Dactylopius opuntiae*, have been introduced into KNP for biological control of one of the park's most troublesome invasive species, *Opuntia stricta*. Both insect species are well established in the park and, particularly the cochineal, these insects are causing widespread damage and mortality of the weed. The density of *O. stricta* has declined by over 85% in some areas and continues to decline. Fruit production and long-range dispersal of the weed has been severely impeded by the insects. This project ranks among the most successful of the many biocontrol programmes that have been undertaken in South Africa during the past 90 years and is realizing massive savings for KNP. A long term monitoring programme is continuing to quantify the eventual levels of control that are achieved and to determine how sustainable these are.

The seasonal abundance of arthropod parasites of impalas, *Aepyceros melampus*, in the Kruger National Park

Horak IG¹, de Vos V², Braack LEO³, Boomker J⁴

¹ Department of Veterinary Tropical Disease, University of Pretoria

² Wildlife Diseases Consultant

ivan.horak@up.ac.za

The objective of this research was to establish a research base-line for arthropod parasite infections of impalas under normal and stressful conditions in the Kruger National Park. Commencing in January 1980 an impala lamb, a sub-adult, an adult male and an adult female were shot at monthly intervals for 15 months near Skukuza as well as near Malelane and a single adult male impala was shot at monthly intervals for 13 months at Crocodile Bridge. Data on the tick burdens of these impalas have been included in a publication on the role of body size and of habitat as determinants of tick infestations of wild ungulates. Four impalas were also shot at Pafuri. A fairly large number of fresh impala carcasses were found around Skukuza during October of the drought of 1982/83 and a number of apparently healthy impalas from the same locality were shot at the same time. Forty-five young impalas from around Skukuza and 20 from Pafuri were processed for ectoparasite recovery during the drought of 1992/93. All these animals were processed for ectoparasite recovery and their parasites identified and counted. Parasite burdens were analyzed in relation to locality, sex, age class, month and drought. A manuscript on the prevalence and on the seasonal intensity of ectoparasites on the impalas has been published.

The abundance and seasonal abundance of free-living ticks in the Kruger National Park

Horak IG¹, Braack LEO², Spickett AM³

¹ Department of Veterinary Tropical Disease, University of Pretoria

ivan.horak@up.ac.za

The distribution of large mammals and also that of the various vegetation types have been determined in the Park. The distribution of free-living ticks on the vegetation in the Park would add to this knowledge. The seasonal abundance of ticks on blue wildebeest, Burchell's zebras, warthogs, impalas, kudus, rodents, scrub hares and guinea fowls in the Park has been determined. A survey of the seasonal abundance of free-living ticks on the vegetation of the Park will complement these results. At the same time the effect of veld-burning on the abundance of free-living ticks will be determined.

During March 1988, 32 of the Park's 36 vegetation zones were each drag-sampled with flannel strips 6 to 27 times for a distance of 250 m each time for the recovery of free-living ticks. The greatest tick densities were recorded in the south of the Park and along the western border in the north. The results have been published. Since August 1988 the seasonal abundance of free-living ticks has been determined at monthly intervals by doing 9 "drags" of 250 m each, at each occasion over the vegetation around Skukuza (Zone 4, Thickets of Sabie and Crocodile Rivers) and between Lower Sabie and Crocodile Bridge (Zone 17, Marula/Knob Thorn savanna). Veld-burning markedly reduced the numbers of free-living ticks in a portion of Zone 17. It took 5 months after burning for the numbers of free-living ticks on the vegetation of this burnt portion of Zone 17 to equal those on an

unburnt portion.

The larvae of *Boophilus decoloratus* reached peak abundance during various months within the period September to December during 10 of the 11 years. In 1998, however, a year with a particularly warm late summer and winter, they peaked during July and again during October. From August 1988 to July 1989 a total of 1 092 *Rhipicephalus appendiculatus*, including all stages of development, were collected from the vegetation. This number increased to more than 9 000 in both 1990/91 and 1991/92 and then decreased to only 76 in 1996/97, 5 years after a severe drought that occurred during 1991/92. The largest numbers of adult *Rhipicephalus simus* and *Rhipicephalus turanicus* were collected from the vegetation during 1995, approximately 8 months after the end of a rodent population explosion. Rodents serve as hosts for the immature stages of the latter two ticks. The results have been published in the Proceedings of the Tick and Tick-borne Pathogen Conference held in Slovakia in 1999.

Scientific evaluation of traditional use of scarce medicinal plants occurring in the Kruger national Park aimed at developing and commercialising new plant-based drugs

Horak M¹, Maharaj V¹, Fouche G, Wadiwala E, and Mtshemla S

¹ Bio/Chemtek Bioprospecting Programme, CSIR

mhorak@csir.co.za

Lippia javanica has been reported to be used medicinally for the treatment of colds, coughs and fever, as well as having insect repellent properties. Research has been ongoing at the CSIR on the essential oil of *Lippia javanica* for its mosquito repellent properties. Essential oils obtained from similar and different locations gave varying bio-assaying results throughout the period 1994-2001. This led to the design of a study aimed at understanding the possibility that different chemo-types are present in *Lippia javanica*, and that the relative abundance of these are affected by human interventions. For this study, plant samples were collected from a specific geographical location in the Kruger National Park and the chemical profiles of the plant extracts compared. The purpose of this study is to determine whether different chemotypes of *Lippia javanica* co-exists in undisturbed ecosystems.

Leaves and stem samples of *Lippia* spp. were harvested from three ecological niches. The samples were filtered and GC and GC-MS analysis were conducted on the pentane extracts. The wilted and fresh plant material samples were analysed by GC and compounds identified using GC-MS. The major compounds found in the extracts of the fresh leaves were 1,8-cineole, camphor, 1-octan-3-ol, α -phellandrene, β -phellandrene, β -

caryophyllene, fenchyl alcohol, borneol, camphene, limonene, E-ocimene and Z-ocimene. Similar major compounds were found in the extracts of the wilted leaves.

The fresh and wilted plant extracts in *population A* had low concentrations of limonene, E-ocimene and Z-ocimene. The three major compounds found in this population were 1,8-cineole, camphor and borneol. Plant extracts of *population B* had E-ocimene and Z-ocimene as major compounds. There was no significant difference in the GC profile of the major compounds between wilted and fresh leaves extracts. The GC profile for the samples in population C and B were similar, except for β -phellandrene that was found present only in the fresh leaf extract of one sample (sample close to the river, with lowest altitude). The chemical compositions of extracts from the various plant populations *i.e.* A, B and C, within the region, are different. These differences may be attributed to changes in environmental and ecological factors across the population sites.

Varying chemical profiles were also observed within each plant population. It thus seems that morphologically similar but not identical plants of the species grow in close proximity, irrespective of the ecological niche. These variations indicate to the possibility of more than one chemo-type of *Lippia javanica* within a single plant population. Prior to this study, the difference in chemical metabolite patterns observed for *Lippia javanica* plants harvested outside the protected area could be ascribed either to seasonal variations or the effect of soil type and related agronomic parameters, or alternatively to the possible existence of different chemotypes. The main implication of the results obtained during this study is that different chemotypes exist and that it is possible to develop a commercial mosquito repellent product based on specific chemotypes of the plant.

It is also interesting to note that *Lippia* spp seems to occur only in broken soil in the Park, as can be expected of a pioneer plant. These areas are near the top of rocky hills where heavy rains cause soil erosion and near streams

and rivers. There is no indication that regular veld fires had the effect of suppressing the diversity of *Lippia* chemotypes in this region.

The evolution of echolocation in the insectivorous bat family Rhinolophidae

Jacobs D¹, Schoeman C¹, De Lemos Ribeiro D¹, Stoffberg S¹, and Shackleton A¹

¹ Department of Zoology, University of Cape Town

djacobs@botzoo.uct.ac.za

Thus far we have collected tissue samples, echolocation calls and morphological data from 8 of the 10 species of South African Rhinolophidae. DNA has been extracted from all of the tissue samples and sequencing of the cytochrome b has begun. Simultaneously the faecal pellets (diet), echolocation calls and wing parameters are being analyzed. We collected tissue samples (3 mm biopsy punches from the wing) from *R. landerii* (2), *R. hildebrandtii* (1), *R. fumigatus* (2).

The epidemiology of tuberculosis in free-ranging lions in the Kruger National Park

Keet DF¹, Kriek NPJ², and Mills MGL³

¹ State Veterinary, Kruger National Park

² Faculty of Veterinary Science, University of Pretoria

³ Scientific Services, Kruger National Park

dewaldk@nda.agric.za

At the start of this comparative study in November 1999, 16 uninfected lions were identified in the north of the Park and clinically evaluated. A comparable group of 16 infected lions were identified in the south of the Park and clinically evaluated. These two groups have been monitored intensively for the past four years. Currently there are still 8 of the original non- infected lions alive in the north of the Park, compared to 4 of the original infected southern group. Five of the southern lions died of advanced tuberculosis. The remaining seven died as a result of apparent social disruption in the prides after prominent members in the social hierarchy died of tuberculosis. Of the three study prides identified in the south only one pride still exists. In the far north all three female prides are still functional.

The loss of mature territorial pride females and stabilizing male coalitions in the south, makes prides vulnerable to "take over" by healthy nomadic groups. The northern population had many more old lions (another female that had been branded in 1989 eventually died this year, and 7 lions that were branded in 1993 are still alive and well). Conversely, no lions older than 10 years could be identified in the south. Regarding haematology and blood chemistry, northern lions had better profiles in all parameters, when compared to southern lions. Northern adult lions are significantly heavier

than their southern counterparts (Females: 118.37 kg versus 143.52 kg, males: 186.55 kg versus 200.01 kg). The sex ratio in the south is distorted: two males for every female. In the north it is one male for every two females. More cubs were born in the south but were killed or evicted during subsequent take-overs. Tenure of territorial male coalitions in the north is much longer than that of southern male coalitions

After three years of monitoring, the continued study of the effects of tuberculosis infection on these two lion populations was unfortunately delayed as a result of defective radio transmitters and poor quality collar strapping. These transmitters were meant to last five years, but did not live up to their advertised functional life. This necessitated the replacement of 19 radio collars. This was achieved during two mass capture operations: one in the south where 36 lions were captured and identified, and one in the north where 40 lions were captured and identified. Twenty-seven radio-tracking sessions were done during the period of report.

Hydro-geomorphic and patch mosaic characteristics of an ephemeral wetland on the northern plains of the Kruger National Park, South Africa

Rogers KH¹, and Kröger R¹

¹ School of Animal, Plant and Environmental Sciences, University of Witwatersrand

cwewits@global.co.za

The purpose of the study was to have an understanding as to how the Northern Plains wetlands contribute to savanna heterogeneity and to conserving KNP biodiversity. Vegetation composition and structure, especially of the boundary patch type, were spatially heterogeneous along the longitudinal and lateral/vertical gradient within the wetland. These results have pronounced implications for furthering the understanding behind the roan decline, the spatial distribution of nutrient rich forage resources and roan grazing on the northern plains of KNP. Previous exploratory studies in an enclosure on the N'washitsumbe wetland suggested that the boundary between wetland and upland was important for roan because they selectively grazed *Sporobolus ioclados*. *Sporobolus ioclados* is a species of grass that only occurs in the boundary and has higher sodium as well as nitrogen grass sward concentrations than adjacent upland and wetland species.

Identification of large areas of boundary along the wetland provides managers with important areas to monitor when assessing the condition of roan habitat within the northern plains landscape. Changes in grass sward nutrient status of *S. ioclados* throughout the year can be compared to levels of grazing by roan and other generalist grazers to provide information to

managers about resource competition between roan and other generalist herbivores on the northern plains. Information about the percentage of boundary habitat present within certain roan herd ranges provides data on availability of this crucial resource to roan.

The association between the roan population decline, past waterhole management and the recent findings of boundary utilisation and heterogeneity needs to be examined more closely. If roan were utilising *S. ioclados* as an essential dietary resource in winter, and abundance of this grass species was severely depleted, roan population would decline. The unwillingness of roan to shift home ranges in times of drought and/or poor forage quality only exacerbates the roan's plight. Furthermore the presence of predators around waterpoints and waterpoints situated in close proximity to the wetland (a patch used by roan for its tall grass swards to shelter calves) could have led to the increase in calf detection by predators and subsequent calf mortality.

A study to validate and derive fuel biomass prediction models for savanna ecosystems in South Africa

Landmann T¹, Rohwer N¹, Scholes R¹

¹ Environmentek, CSIR

tlandmann@csir.co.za

Biomass fuels within the southern Kruger National Park were collected and analyzed in situ. The related field fuel data to corresponding data from biomass fuel prediction models was also analysed. Two biomass fuel models were investigated: a satellite remote sensing high resolution Landsat Enhanced Thematic Mapper (ETM+) index model and a point spread ArcGrid prediction (PS) model. An attempt was made to validate the accuracies of the different prediction models and approaches. We found the point spread (PS) model to be more accurate than the ETM+ model in predicting grass mass [g/m²]. Twig litter [g/m²] was significantly predicted using the ETM+ index model, whilst the PS model showed no significant relationship. Leaf litter [g/m²] can be most significantly predicted using the ETM+ approach. We conclude that an integrative and hybrid fuel biomass model should be derived using both biomass model approaches. The use of daily orbiting and cost effective moderate resolution satellite data to predict litter fuels should be investigated to augment the grass fuel predictions using the PS model. This hybrid model could improve or feed fire danger rating systems. This study shows the importance of validating the available and new fuel models before they are readily implemented.

Migration and habitat selection of Luvuvhu river tigerfish (*Hydrocynus vittatus*) population in the Kruger National Park

Leslie B¹, Deacon A², and Pienaar DJ²

¹ Conservation Services, Kruger National Park

² Scientific Services, Kruger National Park

brucel@sanparks.org

The aim of this project is to establish population size, fish movements, identifying winter refuge habitat, spawning areas and nursery areas in the Luvuvhu River in the Kruger Park. To date 236 tigerfish have been tagged in the Luvuvhu River system in the KNP. Only two recaptures have been recorded. One fish was recaptured in the same pool 10 weeks after the initial capture and the second fish tagged at Magovani was caught by a fisherman 14 kilometer down stream from its original location where it was tagged.

Long term effect of fire frequency and season on the *Colophospermum mopane* shrubveld of the Kruger National Park

Lombard PJL¹, [v.Z Brönn A](#)¹, and Potgieter ALF²

¹ Port Elizabeth Technikon

² Scientific Services, Kruger National Park

abronn@petech.ac.za

A fundamental requirement in the implementation of a management plan, for a savannah ecosystem, is to have a thorough understanding of the reaction of the vegetation to different intensities of herbivory and different fire regimes. One of the recent developments that have occurred in fire ecology is the recognition that the type and intensity of fire are very important components of fire regime and must be considered when interpreting the effects of burning on the vegetation. To date a study has been conducted and reported on in the Kruger National Park on the effects of head fires of different intensities on the mortality and topkill of trees in the major vegetation landscapes, excluding the Mopane veld. This information has proven to be essential in interpreting and predicting the effects of woody vegetation in Southern Africa savannas. It has resulted in the postulation of the hypothesis that fires arising from point ignitions have a greater range of effects on the vegetation and therefore may promote species and structural diversity in savanna landscapes. While excellent progress has been achieved in the KNP in this field of research, the task is not complete and the information is still required on the effects of head and back fires of different intensities in the Mopani veld

This research will serve to answer questions and to confirm or deny assumptions on the historical active fire management approach within the

park. During April/May 1999, complete veld surveys was conducted on all four burning plots – Tsende, Mooiplaas , Nshawu, and Dzombo. The veld surveys were done on the same way as during 1957 to ensure that the data is comparable. Additional surveys concerning the grass production (disc meter surveys) and elephant damage on *Colophospermum mopane*, were also done. All the data from the surveys and previous (original) data were entered into a computer data base. A computer programme was developed in order to analyse the data. Soil samples were also taken of all 56 plots, to determine the effect of fire on the soil. The HYDROPYROMETER was tested as suggested by Prof. Trollope. This experiment was unique due to the fact that it was a first for the Kruger National Park. Leaf samples were also taken to determine the effect of fire on the leaves nutrients.

An analysis of the impacts of elephants on woody vegetation in the Kruger National Park research exclosures

Mamphweli NS¹, Saidi TA¹

¹ Division of Biology, University of Venda

smamphweli@yahoo.com

The aim of this project was to analyse existing data from the Letaba and Sabie exclosures to gain an understanding of the impacts of elephants on woody vegetation in the Kruger National Park. The data was collected in 10mx20m plots along transect lines established in the exclosures. The data collected include; identity of plant species, canopy height, canopy diameter, lowest foliage and basal diameter of the identified species, and any identifiable impact on species. Data was transferred to the Software Program for Social Sciences (spss); this program was then used to calculate the frequency of occurrence for each species in both experimental site and control site collectively. The frequency of plant species showing signs of particular elephant damages were also calculated using spss. The conservation status of the principal forage species for elephants was determined according to the IUCN criteria.

In the Kruger National Park, eleven species were found to be amongst the elephant's diet in the exclosures. *Combretum hereroense* and *Euclea divinorum* were the principal forage species. *Grewia bicolor*, *Acacia exuvialis*, *Acacia grandiconuta*, *Combretum zeyheri*, *Dicrostachys cineria*, *Pappea capensis*, *Rhigozum zambesiicum*, *Spirostachys africana* and *Combretum apiculatum* were also found to be amongst the elephant's diet although their patterns and rate of utilization was low. *Sclerocarya birrea* was found to be one of the preferred tree species in the Kruger National

Park. However, the species density is not high in the exclosures and this might be the reason why it was not recorded amongst the elephant's principal forage species in this study.

Two species were found to be vulnerable to elephant utilization in the partial exclosure, and these are *C. apiculatum* and *C. hereroense*. The conservation status of *C. apiculatum* was found to be in least concern category in both the full exclosure and unfenced area. *C. hereroense*, *C. zeyheri* and *E. divinorum* were found to be nearly threatened in the full exclosure. Both *C. zeyheri* and *E. divinorum* were found to belong to the least concern category in the partial exclosure and in the unfenced area. *C. hereroense* was found to be in the category of least concern in an unfenced area. All other species were also in the least concern category in terms of conservation status.

The statistics suggests that there is an increase in elephant damage with an increase in age. Elephant damage was high on senile trees; this might be due to the fact that senile trees are damaged at their lower stages of development and by the time they reach senility they are already severely damaged. The statistics suggests that the impact magnitude is low in all sections of slope with the sodic zone having a higher impact magnitude followed by riparian and crest zone respectively. There is an inverse relationship between elephant damage and slope section, the higher the slope the lower the impact. Elephant feeding activities are concentrated much on riparian zone and decrease in the sodic and crest zone respectively. This could be due to the fact that riparian zones are adjacent to the active river channel, so elephants frequent these areas in search for water.

The combination of both experimental and a control site generates a perfect linear dependence ($r=0.907$, $df=1$, two-tailed correlations) with a negative slope (-0.145). This means that generally, there is an inverse relationship between elephant damage and slope section. The lower the slope angle, the higher the damage and visa versa.

Collection and study of insects in the Kruger National Park

Mansell MW

Biosystematics Division, Plant Protection Research Institute, Agricultural Research Council

vrehmwm@plant5.agric.za

The Kruger National Park, with its great variety of biotopes and warm subtropical climate, supports a rich and diverse insect fauna. It also forms part of the eastern tropical corridor, along which many species extend their ranges into southern Africa. Although insects comprise the major faunal component in terms of species numbers, diversity and abundance, relatively few comprehensive surveys have been carried out and comparatively little information is available on the insects of the Park. The Kruger National Park also offers excellent opportunity for the study of insects in a savanna ecosystem. Such a study will, in turn, provide the Parks Board with data on this significant component of the Park's fauna, and contribute towards the inventory of South Africa's fauna in terms of the International Convention on Biodiversity. The objective of this project was to establish reference collections and an electronic database of insects from the different biotopes of the Park.

The first collecting trip to the Park, by staff of the National Collection of Insects, was undertaken in January 1984. Several subsequent field trips have taken place, and much of the accumulated material has now been evaluated. Focus of the project has largely shifted to specific groups of insects, especially the order NEUROPTERA, where considerable progress has been made. An electronic database has been designed and implemented,

and includes data on the Neuroptera of KNP. An up-to-date inventory of species of Neuroptera recorded from KNP has been compiled.

Survey of agricultural important mites and their predators (Arachnida)

Meyer MKP¹, and Ueckermann EA¹

¹ Biosystematics Division, Plant Protection Research Institute, Agricultural Research Council

Rieteau@plant2.agric.za

Arachnids constitute an abundant and highly successful group of invertebrate animals. In the past invertebrates were largely ignored in conservation endeavours. Meaningful conservation cannot take place if species involved are not known. Therefore, surveys of invertebrate fauna became more important, especially in reserved areas where conservation strategies are already in place. For the past three decades, mites (Arachnida: Acari) were collected at irregular intervals in the Kruger National Park by members of the ARC-Plant Protection Research Institute, Pretoria. The mites were collected by beating plants over a white tray or by using a sweepnet. Voucher specimens were deposited in the National Collection of Arachnida, ARC-Plant Protection Research Institute, Pretoria.

A total of 121 mite species are presently known from the KNP. This includes representatives from two orders and 21 families. In 1970 a first checklist of mites from the national parks was published by Meyer. Descriptions of species collected and notes on their distribution were published in a number of taxonomic papers. A final checklist of the mites of the Kruger National Park is being prepared by Ueckermann.

Invertebrates include more than 80% of all animals, yet they are severely under-represented in studies of southern African diversity. Site biodiversity

estimates that do not consider invertebrates, not only omit the greatest part of what they are attempting to measure, but also ignore major contributors to essential ecosystem processes. The results showed that the KNP has a rich fauna of mites. However, this check list represents only a portion of the species present as no quantitative collecting was done.

Distribution, density and biomass of mound-building termites in the northern Kruger National Park

Meyer VW¹, and Crewe RM¹

¹ Department of Zoology and Entomology, University of Pretoria

victormeyer@iname.com

This is a final report on the number of individuals in *Macrotermes natalensis* (Hav.) colonies, their biomass and food consumption in the northern Kruger National Park. The ecology of *M. natalensis* is largely undocumented despite the abundance of colonies in southern African savannas. The measurement of food consumption gives further insight as to how much litter is removed, fragmented and redistributed as nutrients in the ecosystem. The study area borders Mozambique on the eastern side, and is located between the Olifants and Limpopo Rivers, the latter being an international border with Zimbabwe. Mounds were completely excavated, termites collected by means of vacuuming, and colony size estimated by sub-sampling. It was estimated that, on average, small mounds contained more than 5 000, medium mounds more than 45 000, and large mounds more than 200 000 individual termites. A highly significant relationship between total number of individuals (N) and mound height (h) was found, given by $\ln N = 7.893 + 1.093h$ ($r = 0.92$). The proportion of soldiers was found to change as colonies grew larger.

In order to derive biomass estimates, a statistical bootstrap procedure was carried out using three databases: body mass, colony population sizes and mound density. Live biomass for small, medium and large mounds was found to be 0.17, 1.40 and 4.16 kg. Dry/wet body mass ratios were established for workers (23.7 %), major soldiers (20.3 %), minor soldiers

(35.3 %), nymphs (17.1 %), king (35.4 %) and queen (20.8 %). Average live and dry biomass was calculated to be 0.51 kg/ha (0.051 g/m²) and 0.11 kg/ha (0.011 g/m²). Geology, geomorphology, elevation, local relief, soil patterns and annual rainfall were the abiotic factors shown to be most influential in determining termite biomass, either directly or indirectly. Termite biomass is high in undulating areas where the elevation is 250–400 m, where granitic and rhyolitic soils occur, and where annual rainfall is high (650–700 mm) in the context of the region.

Major workers fetch woody litter outside the nest through ingestion into the section of the crop and gizzard. Gut contents were dried, weighed, ashed and reweighed. The ash mainly represents soil particles. The ash-free mass of food that is consumed during a single foraging trip by a foraging individual is 0.166 ± 0.009 mg (CI). Frequency of foraging trips between the mound and food source was observed using translucent tubing. The annual food consumption is given by the formula $365mnp/t$, where m = individual mass of ashed crop-gizzard contents, n = number of foraging major workers, p = daily foraging period, and t = individual time spent between nest and food source. Food consumption of this termite in the northern KNP is calculated to be 20.2 kg/ha/yr. It has been shown that termites are primary decomposers and contribute to litter fragmentation and the recycling of nutrients into the soil. This project has given greater insight into aspects such as colony development, biomass investment and resource utilization of *M. natalensis* in the northern KNP.

The effect of fire on soil properties in the Kruger National Park burn plots

Mills AJ¹, and Fey MV

¹ Department of Soil Science, University of Stellenbosch

mills@nbict.nbi.ac.za

Savannas and grasslands in South Africa are adapted to fire, yet long-term effects of fire on soil, water and nutrients remain largely unknown. To determine whether frequent burning increases the tendency of soils to crust and alters soil chemistry, topsoils from the Kruger National Park experimental burn plots were examined. A comparison of soils from burnt and unburnt plots revealed that composite samples taken to a depth of 10 cm from burnt plots had lower laboratory infiltration, electrical conductivity (EC) of 1:5 extracts, water-soluble K, water-soluble NH₄, total C, total N and labile C. Burnt plots had higher pH in KCl, water dispersible clay and modulus of rupture. Rate of soil respiration from composite samples (0-2 cm) from burnt plots was lower than from unburnt plots (means of 21 vs 36 ng C g⁻¹ s⁻¹).

Rainfall simulation on the same samples demonstrated that burnt plots crusted more rapidly than unburnt plots (19 vs 35 mm hr⁻¹), while results from sampling at 1 cm intervals revealed that the greatest differences between burnt and unburnt plots were in the 0-1 cm layer. The top few centimetres of soil are likely to have a disproportionate effect on ecosystem functioning by influencing the rate of infiltration and mineralisation of soil organic matter. This thin surface layer has been named the *pedoderm*. Soil from 0-1 cm in burnt plots had lower total C (means of 0.8 vs 2.7% for burnt and unburnt plots, respectively), total N (0.07 vs 0.23%), (NH₄)OAc-

extractable Ca (7 vs 17 mmol_c kg⁻¹), Mg (2 vs 7 mmol_c kg⁻¹), K (0.8 vs 1.5 mmol_c kg⁻¹) and a greater exchangeable Na percentage (17 vs 8%). The results indicate that burning increases soil crusting. This was ascribed to a decrease in humus content (and associated disaggregating effect) and an increase in the dispersion of clay. Nutrients are lost from burnt plots over time, probably by the removal of ash in surface runoff. Calcium, Mg, and K were lost more readily than Na probably because plants take up these nutrients in greater concentration than Na. The net effect was an increase in the exchangeable sodium percentage. Crusting on burnt plots may be self-perpetuating, because increased runoff is likely to increase the loss of soluble salts. The bottom line to emerge from this investigation is that annual burning is likely to increase the tendency of soil to crust and thereby reduce the infiltration of rainwater.

After forty seven years of annual burning in *Terminalia* woodland and *Acacia/Combretum* savanna on sandy, granite-derived soils in the southern Kruger National Park, a dense cover of trees/shrubs persists on some burnt plots and is largely absent from others. We postulated that intense browsing pressure by antelope and other herbivores prevents recruitment of trees in burnt plots and that herbivores congregate on plots that are richest in nutrients. Herbivore abundance did not show a relationship with soil macronutrients and we consequently investigated micronutrient status. The reduction in tree cover as a result of annual burning was positively correlated with mass of herbivores (> 15 kg and < 1500 kg) ($r^2=0.65$, $n=8$). This index of herbivore abundance was in turn positively correlated with total Zn ($r^2=0.64$, $n=8$). Other indices of herbivore abundance showed significant relationships with total clay content and Mn. The data corroborate the postulates that: (i) herbivores congregate on sites with greater clay content (possibly due to a greater availability of micronutrients); and (ii) that tree cover can remain relatively dense under a regime of annual burning if browsing pressure is not intense. We suggest that it is the interaction between soil properties, herbivory and fire that determines the extent of tree versus grass cover under a regime of annual burning in these savanna

systems. The bottom line to emerge from this investigation is that tree cover on burnt plots in these granitic, nutrient-poor landscapes appears to be a function of the intensity of herbivory which in turn may be related to soil nutrient status.

Pack dynamics of the wild dog in the Kruger National Park

Mills G¹, Bengis R², Raath C, Keet D², de Villiers M, Wilkinson I, Wildi H, Viljoen P, English R, van Niekerk H, Otto P, Jordaan F, Malan J, Prinsloo C, and Davies H

¹ Scientific Services, Kruger National Park

² State Veterinarian, National Department of Agriculture

gusm@sanparks.org

The wild dog *Lycaon pictus* is endangered. Although the KNP harbours a viable population of these animals, little is known about the factors that regulate the population. The objectives of this project were, to obtain a better understanding of the manner in which the wild dog population fluctuates and is regulated by documenting changes in pack composition and reproductive success and following the life histories of the individuals in certain packs and to identify the factors responsible for regulating pack size.

The dynamics of 27 packs have been documented over the 13-year study period. The turn-over of packs was high with the average life of a pack; defined as keeping the same male and/or female blood-line, is approximately 2 years. Survival was found to be very poor for the first two years of a dog's life. Annual survival for pups was 0.35 (exact binomial CI: 0.29 - 0.42), and yearling survival was 0.45 (CI: 0.34 - 0.57). Altogether, only 16% of newborns survived to adulthood at two years of age. After reaching adulthood, annual survival was good, remaining above 0.72 for all ages except five-year-olds, for which the sample size was not large ($N = 16$). There was no evidence for senescence in the survival rates.

Mean litter size was 9.4 ± 0.70 pups, $N = 57$. High fecundity in Kruger is partly due to the fact that litters are large among those females that breed, however poor survival among young age classes means that very few females reach ages older than four. Consequently, most females that are four or older have no older pack mates of the same sex, and they are likely to be dominant. Consequently, fecundity of females of age four or older is high partly because few are non-breeding subordinates. Litter sizes tend to be small for young females producing their first litters, and rise as female age increases this rise continues unabated to the oldest age classes. Reproductive success is related to the number of adults in a pack. The number of pups born increases as the number of adult pack-members increases. The number of pups raised to one year also increases as pack size increases, an association that is even stronger than the previous one. In general, reproductive success is better for older females in larger packs.

Stochastic projections for the Kruger population show a clear tendency to decline, with stochastic $\lambda = 0.986$. This does not mean to imply that the Kruger population will follow such a trajectory. With a change in population density, the demography may shift, and it is not known if growth is density dependent. However, the conclusion is that the *current* demography of wild dogs in Kruger leads to dynamics that are more prone to collapse than is seen in other populations. In Kruger, a large proportion of the wild dog population is young, due to high fecundity and a steep survivorship curve. However, the number of young individuals varies dramatically, jumping up in response to the survival of females into old, highly fecund age classes. The probability of females surviving to these highly fecund age classes is low, but when it happens, the impact is large. Consequently, the age-structure of Kruger is volatile in comparison to other similarly studied wild dog populations in Botswana and Tanzania. The greater this demographic variance, the larger will be the difference between the deterministic and stochastic growth rates, as has been revealed in the three Kruger wild dog

population censuses carried out in 1989 (357 dogs), 1995 (434) and 2000 (177).

Hyperspectral remote sensing of tropical grass quality

Mutanga O

International Institute for Geo-Information Science and Earth Observation

mutanga@itc.nl

The main objective of this study was to develop techniques to predict and map the quality of tropical grasses at canopy level using hyperspectral remote sensing. We collected field spectral measurements of grass in the Northern plains of the KNP using a GER 3700 spectroradiometer as well as collecting samples for laboratory analysis. Building on the observations that we made under controlled laboratory conditions, we developed and improved on a new approach to quantify the biochemical concentration of tropical grasses *in situ*. The new approach, analysis of continuum removed absorption features, is superior to other techniques such as the conventional near infrared reflectance spectrometry (NIRS).

We tested the utility of using four variables derived from continuum-removed absorption features for predicting canopy nitrogen, phosphorus, potassium, calcium and magnesium concentration: (i) continuum-removed derivative reflectance (CRDR), (ii) band depth (BD), (iii) band depth ratio (BDR) and (iv) normalised band depth index (NBDI). It was shown in this study that stepwise regression on normalised bands calculated from continuum-removed reflectance spectra could explain the variation of *in situ* grass quality, with R^2 values ranging between 0.43 and 0.80 – an encouraging result under natural conditions. Low root mean square errors

(RMSE) for an independent test data set were also obtained using the new variable, CRDR as compared to the other variables tested.

In order to better understand the variation of the nutrients that were measured in the field, we established the possible factors influencing that variation at a local scale. Our results indicate that there is a significant relationship between grass quality parameters and site-specific factors such as slope, altitude, percentage grass cover, aspect and soil texture. Plant characteristics such as species type interact significantly with slope, altitude and geology in influencing nutrient distribution. There was generally higher N concentration in the granites as compared to the basalts, however it interacts strongly with the amount of biomass. Therefore, the several environmental variables cannot be used singly in explaining a variation in foliar quality, but multivariate analytical approaches which unearth the interaction of the variables is imperative. The results provide a better insight on foliar nutrient distribution patterns at a landscape scale in savanna rangelands.

Hyperspectral imagery, HYMAP MK1 was flown over the northern KNP on 18 March 2003. Grass samples were collected for N concentration analysis. These laboratory measurements were directly related to the reflectance signatures on the hyperspectral imagery, following transformations. The new integrated approach, involves continuum removed absorption features, the red edge position (REP) and neural networks. The red edge position was shown to be strongly related to quality and has been found to be insensitive to atmospheric and background effects and therefore suitable for measurements under natural conditions. Finally, a neural network algorithm was applied so as to cater for the possible non-linear relationships in a mixed species environment.

We showed that the new integrated approach (continuum-removed absorption features, the REP and a neural network) could explain 60 % of the variation in savanna grass nitrogen concentration on an independent test data set using airborne hyperspectral data, with a RMSE of 0.13 (\pm 8.30% of the mean observed nitrogen concentration). This result was better compared to the conventional multiple linear regression analysis in predicting savanna grass quality. There is high nutrient concentration in the burnt areas, primarily due to rejuvenation of plant material, distribution of similar amounts of nutrients over less above ground biomass and change in plant tissue composition (i.e. higher leaf: stem ratios with leaves having higher nutrient concentration). This example shows the capability of the method developed in this thesis to unearth the spatial distribution of foliar nitrogen concentration in a mixed species environment of southern Africa.

Vegetation dynamics as affected by fire, drought, herbivory and artificial water provision on the Tsende plains of the Kruger National Park

Oelofse J¹, Biggs HC¹, Ebersohn C²

¹ Scientific Services, Kruger National Park

² Department of Nature Conservation, Tshwane University of Technology

johanno@sanparks.org

There was an increase in the density of zebra on the central unit, and also on adjoining zones of the study area between 1988 and the burn in September 1991. During the 1992 drought the density of zebra on the central unit decreased to their lowest numbers, whilst numbers were still high at 2 and 4 km from the central unit. In 1993 and 1994 the densities increased on the central unit, and peaked in 1993. The number of zebra on the central unit declined in 1995 to half their previous numbers. In both 1991 and 1993 the distribution of zebra was not even across all zones up to 10 km from the central unit, and therefore zebra were exercising selection for the central study area.

Between 1990 and 1992 the proportion of perennial grasses in the grass sward was >60%. In 1993 after the drought perennial grasses declined to 14%. This year corresponded with the highest zebra densities recorded during the study, and also corresponded with a shift towards annual grasses (25%), and forbs (57%), reflecting the contribution of zebra grazing impact on this post-fire and drought grass sward. Through 1994 and 1995 perennial grasses failed to re-establish to previous levels, remaining at a low <15%. There was an increase in annual grasses to between 50-and-60% that replaced much of the forbs cover.

Between 1989 and before the fire during 1991 the standing crop over the burnt unit N140 of the study site varied between 3250 kg to 4600 kg / ha with below average rainfall recorded. During 1992 the effects of the fire and drought is clearly manifested in the zero registration of standing crop over the area. From 1993 through 1994 and 1995 the grass sward failed to re-establish to pre-fire and drought levels and standing crop values remained <1000 kg /ha. This again corresponded with the high 1993 and 1994 zebra densities over the study area and saw the eventual departure of zebra from the area during 1995. By comparison the standing crop of the adjacent unburnt unit N139 conformed very closely to that of the burnt unit from 1989 up until the 1992 crash, after which the standing crop recuperated in conjunction with the rainfall trend and very low zebra density in the 2 km zone surrounding the study unit.

Structuring of ant communities in African Savannas

Parr CL¹, Chown SL¹, Robertson HG², and Crewe RM³

¹ Department of Zoology and Entomology, University of Stellenbosch

² Iziko Museum of Cape Town

³ Faculty of Natural & Agricultural Sciences, University of Pretoria

clp@sun.ac.za

The structuring of ant assemblages in a Southern African savanna was investigated using data from the only long-term, large-scale savanna fire experiment in Africa. The ant sampling that was undertaken forms the first quantitative, systematic, repeatable and reasonably complete survey of ground-foraging ants in two savanna habitat types (Mopane and Satara areas) of the KNP. Sampling over two years yielded a total of 169 species from 41 genera. This includes additional species from hand-collecting and baiting (*Agraulomyrmex* sp.1, *Camponotus* sp.15, *Cataulacus* sp.1, *Meranoplus nanus*, *Polyrhachis gagates*, *Leptothorax* sp.1, *Rhoptromyrmex transversinodis*, *Tetramorium* sp. 18), and an *Apomyrma* queen found in a pitfall trap. This is a substantial improvement on previous records.

With the structuring of local assemblages, competition was the most significant local factor tested. A model developed to test mechanisms that could be responsible for the form of this relationship supported the hypothesis that competitive exclusion by dominant ants at least partially reduces species richness. Habitat complexity was not found to play an important role in determining ant assemblage body size in this savanna system. The size-grain hypothesis which predicts that environmental rugosity results in positive allometric scaling of leg length on body length because of changes in locomotion costs, was tested by comparing the body

sizes of ants from areas of contrasting habitat complexity. No support for the hypothesis was found.

This study revealed that burning has little effect on savanna ant assemblages. There was no significant effect of burning on mean ant species richness and abundance between burn plot treatments, although there were clear differences in ant assemblage composition with season and frequency of burn, and plot age. Differences in ant assemblages were only detected between burned (treatment) and unburned (control) plots. Epigaeic ant assemblages in this savanna system are both highly resistant and resilient to burning. Degree of resistance to burning is also likely to be related to the assemblage's history of association with fire. Contrary to the view that fire is a major disturbance in Southern African savannas, fire was not found to be a key factor structuring ant assemblages.

This study explored the potential of ants as bioindicators by testing the responses of ant assemblages to fire. Although the ant assemblages showed high resistance to fire this does not preclude the use of ants as bioindicators in Southern African savanna systems. Within the Mopane and Satara areas of KNP, the few species that could be identified as indicators of burning emphasised the resistance of these ant assemblages to fire. In Pretoriuskop, there was a greater response of ant to burning, and there appears to be a much greater potential for the development of ants as indicators of burning. The most important potential use of ants as bioindicators in this system relates to their sensitivity to environmental disturbance, but also, to how representative ants are of other taxa. In Southern African savannas the degree to which ants reflect the responses of other invertebrate groups still requires further investigation. The EBPs illustrated the important role that savanna heterogeneity can play in influencing ant diversity. Although at the scale of several tens of kilometres vegetation within an area may appear homogenous (particularly in the Mopane area), this study has demonstrated that for organisms such as ants, there is sufficient variability within the landscape to maintain diversity.

Towards a predictive understanding of savanna ecosystem dynamics in the Lowveld of the Mpumalanga and Northern Provinces

Peel MJS¹, Peel JMH¹, and Jacobs AF¹

¹ Range and Forage Institute, Agricultural Research Council

mike@itsc.agric.za

The ARC-RFI ecological monitoring programme assesses vegetation conditions annually at some 500 sites in the wildlife utilization areas of Mpumalanga and Limpopo Provinces. This section is in the unique position of having collected vegetation data, on both sides of the boundary, since the western boundary fence of the Kruger National Park was dropped. The data will be valuable in detecting vegetation trends in the study area and the knowledge thus gained is used to provide guidelines for the efficient management of the savanna areas of the Lowveld.

The influence of large woody debris and the interaction with large herbivores and fire on riparian vegetation dynamics on the Sabie River, Kruger National Park, South Africa

Pettit N¹, and Naiman R¹

¹ School of Aquatic and Fishery Science, University of Washington.

npettit@u.washington.edu

The formation of large woody debris (LWD) piles has a profound impact on channel patterns and riparian succession in temperate rivers. The opportunity to study LWD along the Sabie River, a river in the semi-arid region of Kruger National Park, South Africa, arose in February 2000 after a significant flood (~100 year return interval) removed a large proportion the fully mature riparian forest and other plant communities.

Between January and March 2003 a total of 120 LWD piles were surveyed. Piles were surveyed along 9 transects set up perpendicular to the river and were designed to sample piles situated in different zones of the river macro-channel based on frequency of flooding as well as the adjacent terrestrial zone. Transects were placed at locations that are representative of the different river geomorphological types that have been identified for the Sabie River. Along each transect all piles within a 20 metre wide strip were measured. Measurements taken included volume of pile, pile density, pile type, size and identity of key members of piles as well as light readings and soil temperature. A soil sample was also taken which was later analyzed for moisture content, particle size and soil nutrients.

Much of the uprooted vegetation was deposited as LWD piles (woody vegetation accumulations deposited on the ground $>0.1\text{m}^3$) throughout the

riparian and upland zones. Within the areas surveyed there were 68 LWD piles per hectare, the median size of LWD piles was 4.6 m³ but pile sizes (by volume) varied widely. Distribution, size and pile characteristics of LWD are affected by channel geomorphology and flood frequency. LWD piles were found to create an environment favourable to the germination and growth of plants with high soil moisture and soil nutrients and the accumulation of fine soil particles. This will affect the subsequent development of vegetation communities as debris piles form a mosaic of patches of surviving organisms and propagules that can strongly influence the initial trajectory of succession post-flood.

Veld burning in the Kruger National Park

Potgieter ALF¹, Govender N¹, and Trollope WSW²

¹ Scientific Services, Kruger National Park

² Department of Agriculture, University of Fort Hare

navashnig@sanparks.org

Fire is regarded as a natural phenomenon in the Kruger National Park (KNP) and the total exclusion of fire is regarded as an undesirable and unnatural practice. Hence, correct application of fire as an agent in maintaining the biodiversity of the KNP is essential. The research objectives were to determine long term consequences of fire applied at different frequencies and seasons on the herbaceous and woody vegetation of the park. It was also to determine the long-term influences of herbivory on the herbaceous vegetation of the KNP after the application of fire at different fire frequencies and seasons.

It is of utmost importance to be able to assess the effect of fires and subsequent utilisation by herbivores on the herbaceous vegetation of the KNP, in order to guard against the degradation of the grass sward due to burning in the wrong season or at the wrong frequency. The large EBP plots showed clearly that herbivores concentrating on burned plots had a significant impact on especially the grass layer. For this reason three exclosures were constructed during 1971-72 with the aim of conducting fire experimentation on smaller plots without the impact of herbivores after a burn. This would provide information on the effect of fire only on the herbaceous vegetation. Baseline vegetation surveys of both bush and grass were done before any burn treatments commenced. This first experiment eventually proved too involved and time and labour consuming with the

resources available, especially over three landscapes, and was terminated. The bush and grass surveys done before the commencement of the treatments however provide valuable baseline data.

A second experiment, less intricate, was started in October 1987 only in the Makhohlola enclosure situated in the *Sclerocarya birrea*/*Acacia nigrescens* savanna near Crocodile Bridge. The other two enclosures were dismantled. The second experiment was meant to be a once only application of fire at different seasons, fire frequency not playing a role. After the first fire treatments were applied, plots were allowed to recover completely before a second series of the same fire treatments were applied. This was done three times. The experiment therefore consisted of three cycles where the grass was burned, plots were allowed to recover completely for two or three seasons before the next burn cycle commenced. It appears that grass burned in the late summer to mid winter (February to June) takes longer to recover fully after the burn than grass burned in spring (October) after the first rains.

The below average precipitation experienced during the rainfall season preceding the year under report as well as during the year made it difficult to apply all the scheduled experimental burns on the EBP' especially on the plots due for burning in the *Acacia nigrescens*/*Sclerocarya birrea* Savanna at Satara as well as in the *Colophospermum mopane* Shrubveld at Mooiplaas. Plots in these areas came under severe grazing pressure due to the dry conditions. The standing crop of herbaceous vegetation (providing the fuel for burning) was mostly below 4000 kg/ha and even as low as 2500 kg/ha (as measured with the disc pasture meter) on some of the plots. At least 3000-kg/ha grass fuel biomass is required to sustain relatively hot fire. Most burns were relatively dirty (patchy) and of a low intensity, except for the mid winter burn at Pretoriuskop.

***In situ* ultrasonographic reproductive evaluation of the female black rhinoceros (*Diceros bicornis*) and white rhinoceros (*Ceratotherium simum*) in South Africa**

Radcliffe RW¹, Hofmeyr M², Morkel P³, Emslie R⁴, Mavterson C⁵, and Buss P²

¹ Department of Animal Health, Fossil Rim Wildlife Centre

² Veterinary Wildlife Services, Kruger National Park

³ Frankfurt Zoological Society

⁴ African Rhino Specialist Group

⁵ Specialist Game Services

robinr@fossilrim.org

The black rhinoceros (*Diceros bicornis*) is endangered throughout Africa following decades of poaching for its horn. Just over 2,700 survive in the wild. Today, poaching remains the single greatest threat to this species' long-term survival. The control of poaching in South Africa and other African nations can be attributed, in part, to intensive protection and monitoring of isolated rhino populations.

As black rhino populations expand, this management scheme involving intensive protection and monitoring through translocation, radio-telemetry techniques, etc. will be critical to control of poaching pressure. An important factor that may threaten ongoing management of these mammals in some African range states is the concern, to date unsubstantiated by any scientific data, that intensive management practices may be a source of fetal loss and/or early embryonic death, and thus limit expansion of wild rhino populations. The African Rhino Specialist Group recently evaluated the problem and supports research efforts that would provide insights into the effects (or the lack thereof) of the capture

process on rhino fertility. The information that this project would produce may ultimately affect management decisions for *in situ* rhino populations by answering this question. In addition, this project would provide two additional benefits to black rhino survival. First, the knowledge accumulated would aid management decisions regarding safe movement and overall handling of pregnant animals and would help provide an indication of reproductive health of a population. Second, this project would involve training of local scientists in ultrasonographic techniques in the rhinoceros to facilitate ongoing studies, provided benefits justify purchase of necessary equipment.

The application of this work to the field situation has great potential. As the various rhinoceros species become further isolated into smaller and smaller geographic areas, an opportunistic reproductive monitoring program of females immobilized for radio-collaring studies or translocation purposes could be implemented. An understanding of the reproductive health of wild rhino groups would prove valuable in formulating management plans for these fragmented populations. Opportunistic ultrasonography at the time of capture could provide insights into the effects of the translocation process on embryo/fetal viability during different stages of gestation. For an animal having such a long interbirth interval and producing a single offspring, this information may prove valuable as rhinos are by necessity becoming more painstakingly managed in parks, reserves, conservancies, sanctuaries, and IPZ's throughout Africa and Asia.

Interference potential of the alien invasive plant *Parthenium hysterophorus* with indigenous plant species in the Kruger National Park

Reinhardt CF¹, Robbertse PJ, and Hurle K

¹ Department of Plant Production and Soil Science, University of Pretoria

creinhardt@bioagric.up.ac.za

Original aims of the project were to determine the allelopathic potential of *Parthenium*, to quantify its allelopathic effects on the germination and seedling development of selected indigenous plant species. It was also to assess the interference (competition plus allelopathic) potential of *Parthenium* with certain indigenous species and measure the production and dissemination of *Parthenium* pollen, and to evaluate its effect on pollen germination, fertilisation and fruit set of selected indigenous species.

Evaluating the allelopathic potential of live *parthenium* plants, and extracts from those plants in bioassays under controlled conditions. This aspect of the research was successfully completed at facilities of the University of Pretoria and the University of Hohenheim. The research culminated in a master's degree for Sabrina Kraus who is registered at the latter university. Ms Kraus spent a period of four months (September 2002 to January 2003) as guest of the University of Pretoria, and during that time conducted part of the research on the project. Her work at UP involved mainly bioassays for determining the allelopathic potential of *P. hysterophorus*, and upon her return to Germany she was involved with chemical analysis of the allelochemicals responsible for the biological effects. Prof. Reinhardt used sabbatical leave (June and July 2003) to work together with our German collaborators on the latter aspect.

Medium term geomorphic change in semi-arid rivers with mixed bedrock/alluvial influence

Rountree M¹, and Rogers K¹

¹ School of Animal, Plant and Environmental Sciences, University of Witwatersrand

markr@gecko.biol.wits.ac.za

This project examines the geomorphological changes in the Olifants, Letaba and Sabie Rivers over the last 60 years in order to better understand the medium- to long-term (~100 year) functioning, variability and dynamics of these river systems. Specific reference is paid to the role that large, infrequent floods events (such as those in 2000) have in the longer-term patterns of change. Earlier findings from the Olifants River (following the 1996 floods; refer to publication below) have been reinforced by the results emerging from data on the Sabie River. The alluvial braided and more bedrock-influenced pool-rapid channel types are relatively unstable channel patterns and appear to frequently switch between these two states, dependent on the amount of sediment stored (and consequent exposure of the underlying bedrock geology) in that section of the channel. The mixed anastomosing channel type is a very stable planform, whereas many of the bedrock anastomosing sections have been stripped clear of vegetation and sediment following the 2000 floods, such that some sections of the river are similar to the 1940's condition of the river (the 1940's aerial photographs document the river following large floods in 1925 and the 1930's). Analysis of the Sabie and Letaba River historical aerial photographs is ongoing.

Inkomati Tigerfish Telemetry Project

Roux F¹, and van Buynder D

¹ Mpumalanga Parks Board

hydrocynus@mweb.co.za

Although this project is still in progress, some interesting and valuable results have been obtained thus far. There have been 289 Tigerfish deployed with VI tags, of which there has not been a single re-capture. A total of 28 transmitters have been deployed. Since September 2002, there are 2 transmitters confirmed to be in crocodiles (tagged fish eaten by crocodiles), 1 transmitter tagged fish is assumed to be dead (no movement was recorded in a period of 3 months), and a 4th has been lost to downstream migrations into Mozambique. The remaining 25 are monitored on a daily basis. These have provided valuable information pertaining to **summer movements**. The remaining 8 fish migrated to the confluence of the Crocodile and Komati Rivers where they remained for the whole **winter season**. Little movement was detected during this period. It was noted that during the diurnal and nocturnal surveys that some fish would leave their position to hunt and feed in the mornings and evenings, but would return after these events.

The most frequently used **habitat** of the Tigerfish has been identified as a single channel in extensive areas of slow deep instream habitat, a substrate of bedrock, with a moderate amount of over hanging vegetation, and with sparse to moderate quantities of aquatic macrophytes, in the Crocodile and the Incomati Rivers. The Tigerfish were shown to utilise an average depth of 1.32m. The minimum depth they used was 0.3m and the maximum was

3.4m. The earlier winter season telemetry results indicated that the Komati River was used only in early spring. It has been established which weirs / obstructions are non-obstructive, and which fish ladders are functional and effective in allowing the movement of the Tigerfish (and therefore the other species). The **breeding season** of the Tigerfish has been established as December and January, with water temperatures being above 32°C, directly after increased water levels (due to rainfall), with the associated turbid waters. It appears that the males reach the spawning areas prior to the females, and then wait for ripe and running females to arrive.

From the results it is evident that Tigerfish prefer deep pools with a bedrock substrate creating microhabitats. Due to the regulation of the rivers these deep bedrock pools are limited in availability, because of the increased sediment loads being deposited. The scarcity of available habitat can possibly explain the reason for limited migrations and area specific behaviour taking place. The prime habitat at present is in the confluence area of the Incomati River. The Incomati River is very important to the winter survival strategy of Tigerfish. The downstream area of the confluence is characterised by deep pools with lots of dolerite intrusions and basaltic lavas. The lethal temperature for a Tigerfish is 14.5 °C and below. The average water temperature in the winter months of the river studied is between 16 and 18 °C. It is thought that these rock formations radiate thermal heat to the water, making it more suitable for Tigerfish. The Komati River is 2 °C warmer than the Crocodile River; the multiple weirs could, as a result of the increased water surface area, have created this.

Habitat availability and diversity are major determinants of aquatic community structures, and loss of habitat is regarded as the single most important factor that has contributed towards the extinction of species. With the knowledge gained during this ongoing project, and new techniques used such as telemetry, a better understanding is obtained of the requirements and the ecology of these species.

A GIS Model of Bovine Tuberculosis in the African Buffalo (*Syncerus caffer*) Population of Kruger National Park, South Africa

Ryan SJ¹, Getz W¹, Cross P¹, Lloyd-Smith J, Knechtel C, Kim T, Fang X, and Wondolowski L

¹ Department of Environmental Science, Policy and Management, University of California at Berkeley

sjryan@nature.berkeley.edu

The objectives of this study were, to create a GIS model of buffalo response to climate and habitat, incorporating demographically driven age-structured disease transmission, to assess management strategies (vaccination, culling, exclusion zones) within this GIS modeled environment of Kruger National Park and to provide Kruger National Park with information and data regarding modeled strategies, habitat data and crucial demographic data for African Buffalo. In pursuit of these objectives, extracting and organizing data comprises a large proportion of the work involved.

The data on calving events has been used to examine timing and synchrony of buffalo births in the Klaserie Private Nature Reserve. The rain data from KPNR HQ was transcribed from ledgers in 2001 and used to predict yearly grass biomass accumulation for the period 1994-2001. It seems that buffalo are able to respond to proximate ecological cues and adjust their conception timing to the peak of the biomass distribution. The Mark-Recapture database has been used to estimate survival and fecundity for the Klaserie buffalo herd. Approximately monthly observations over nine years of identified individuals with the covariates of sex and age have been compiled into a Mark-Recapture database and an apparent survival estimate (open population) obtained for preliminary demographic models of this population.

Both the fecundity and the survival estimates fall within the range of values in the literature. The confounding effects of male seasonal emigration mean that both the probability of re-sighting and the apparent survival are decreased in this analysis, and therefore it is more reliable to work with the female estimates. A preliminary model of buffalo demography was constructed in Matlab, using a range of parameters from both ongoing studies and the literature.

Further models within the Mark-Recapture framework will be used to analyze the effects of climate on overall parameters, in addition to models addressing the seasonal composition of herds. My null hypothesis is that there is a female core group which persists in the herd throughout the seasons. This hypothesis will be tested using Program MARK to set up multi-state models including transients (seasonally migrating males, and potentially, females). In addition, I anticipate using the mark-recapture database in association models. An association database for this herd for the repeated encounters has been entered into the software SOCPROG written by Hal Whitehead at the University of Dalhousie, Nova Scotia. Further analyses of association data and appropriate methods to analyze it are currently under investigation by W. Getz and P. Cross.

The demography of a culled sample of African Buffalo, *Syncerus caffer*, in the Kruger National Park with particular emphasis on correlating age with tooth wear and habitat

Sanson GD

Department of Biological Sciences, Monash university

gordon.sanson@sci.monash.edu

The two major aims of this project are, to measure the tooth wear on different parts of the molar teeth of a sample of African buffalo (*Syncerus caffer*), and relate these results to residence on basalt or granite soils, or a mixture of these soils; and; to examine growth rings in the teeth and, if possible, relate the results to age and seasonal condition of the buffalo. All buffalo teeth have now been scanned and digitized in three dimensions. These are now being analyzed for wear. A program is close to completion that analyses dynamically the occlusal interaction of upper and lower teeth and simultaneously measures the mechanical advantage of each contact, and the number of synchronous contacts. The velocity of closure of contacts is also being measured.

Twenty study sites were randomly located, 10 on basalt soils and 10 on granite soils. Dominant grass species from each study site were collected, with sites as replicates. Leaves and stems of each grass from each study site were kept moist and measured on the same day for biomechanical properties including force to fracture, work to fracture and specific work to fracture. The measurement of leaf biomechanical properties in herbivory: opportunities, problems and procedures. *Austral Ecology* 26, 535-546.). This was carried out by a shearing test on custom-built force-testing

equipment. Cross-sectional area of stem and leaf was measured in order to determine specific parameters. Specimens have been kept for fibre and abrasive analysis, which is continuing. Initial results of the analysis of biomechanical properties indicates that while there are large differences between stem and leaf parameters, the high level of variation found among basalt species is hindering determination of significant differences between those and granite species. The analysis of differences between wet and dry season plants is yet to be completed.

Dung beetle richness, dung preference and assemblage structure in the Kruger National Park, South Africa

Scholtz CH¹, Davis ALV, Holter P, Coetzee J, and Sithole H

¹ Department of Zoology and Entomology, University of Pretoria

² Scientific Services, Kruger National Park

chsoltz@zoology.up.ac.za

The dung beetle fauna of Africa is the largest in the world. This wealth of diversity has been attributed to the close association of the dung beetles to the dung producers themselves, which, in Africa, are mainly the large mammalian herbivores. It thus follows that the highest dung beetle diversity is to be found in areas with high mammalian diversity. The Kruger National Park is probably the area that most approximates undisturbed pre-western-civilization in Africa. Furthermore, it cuts across several soil, vegetation and landscape types, characteristics that increase the habitat complexity, and hence, diversity of dung beetles.

There has long been an untested perception amongst scarab researchers that dung beetles display distinct preferences for certain dung types – the so-called coarse-dung-feeders supposedly prefer the coarser fibred dung of monogastric herbivores such as elephant, rhino and zebra while the fine-dung-feeders prefer ruminant dung. The association was thought to be related to the sizes of the dung particles in the respective dung types. Although there is strong evidence to suggest that some species display distinct preferences, the particle size hypothesis has been shown to be a fallacy. The current project has several aspects to it, to test, experimentally, the dung preferences of the dung beetle community at Skukuza. Dung of two non-ruminants (elephant and zebra) and three

ruminants (buffalo, impala, giraffe) were tested. Elephant dung was most attractive to the highest number of species and individuals, followed by buffalo dung. Giraffe dung was least attractive.

To determine the actual particle size preferences of coarse-, and fine-dung-feeders. This has been done for dung beetles classified as tunnellers (bury dung immediately beneath the dung source) and dwellers (live and breed inside the dung source) but remains to be done for rollers (dung beetles that form balls at the food source, then roll them away). To assess dung beetle diversity and abundance across the major regions of the KNP. This has been done around Skukuza but will be expanded to the rest of the Park as time allows. To interpret the major dung beetle groups biogeographically to attempt an understanding of their relationships to extra-limital groups and their biogeographical patterns relative to those of their close relatives. This is ongoing. Since the inception of the project representative species have been added to the reference collection at Skukuza.

Using isotopic evidence of large mammal nutritional ecology to track vegetation change through time

Sponheimer M¹, Grant CC², Lee-Thorp J³, Codron J⁴, and Codron D⁴

¹ Department of Anthropology, University of Colorado at Boulder

² Northern Plains Research Programme c/o Kruger Park Marathon Club

³ Department of Archaeology, University of Cape Town

⁴ Department of Botany, University of Cape Town

matt.sponheimer@colorado.edu

The aim of this project was to study the ecology of large mammals in Kruger National Park, with the ultimate goal of reconstructing its historic environments through stable isotope analysis. Our modern study has demonstrated that the isotopic ecology technique is well suited for determining dietary differences within species in different areas of the park. Stable isotope analysis of both faeces and hair have shown, for instance, that impala browse more in Mopane-dominated northern Kruger (~60%), than in southern Kruger (~30% browse). Furthermore, analyses of hair from known individuals have demonstrated that male impala graze about 14% more than females. Elephants, in contrast, graze more in northern Kruger (~35% grass) than they do in the south (~20% grass), and indeed their diets comprised predominantly of grass during the rains of 2002.

Our research on rare species like roan and sable antelope has also provided interesting results. Faecal data demonstrated that the Northern Plains roan eat grass nearly exclusively, and that their faecal nitrogen concentration (~0.8%) is lower than that of any other herbivore in KNP, including bulk grazers like zebra and white rhino. Similarly, sable appears as nearly an exclusive grazer, though our data indicate a notable increase in browse

during October 2003. Sable also has very low fecal nitrogen concentrations (~1.0%), but not as low as those of their congener the roan.

Modelling buffalo - lion interactions and implications for the spread of bovine tuberculosis in Kruger National Park, South Africa

Tambling CJ¹, Getz WM², and du Toit JT¹

¹ Mammal Research Institute, University of Pretoria

² Department Environmental Science Policy & Management, University of California at Berkeley

cjtambling@zoology.up.ac.za

The objective of the study was to examine the ability of predators to maintain the health of pathogen host populations using an example of bovine tuberculosis (BTB), African buffalo (*Syncerus caffer*) and lion (*Panthera leo*) in Kruger National Park. An age and sex structured SEI (susceptible, exposed, infectious) epidemiological model with frequency dependent transmission incorporating the effects of lion predation biased towards infectious buffalo was developed. Model results were compared to field data for buffalo population trends and the age structures of infected buffalo from culled samples. Two predation scenarios were simulated, (1) compensatory predation and (2) additive predation. Sensitivity analysis suggests that, due to increased mortality levels on bulls, their survival has the greatest impact on the prevalence after 50 years. An increase in predator density causes a decline in prevalence after 50 years but a substantial increase in predator density (not likely under normal field conditions) is required to reduce BTB prevalence by any useful amount. The results (an increase in predator density causes a decline in prevalence within host populations) agree with previous simulations, but also highlights the importance of the mechanism of population regulation within the host population. Finally, the study highlights where more work needs to be done

on how ecological conditions and predators interact to influence buffalo survival with and without BTB.

Harvest, hand-rearing and re-introduction of the second-hatched southern ground hornbill (*Bucorvus leadbeateri*) chicks from Kruger National Park

Turner A¹, Kemp A, Kemp M, and Kemp L

¹ Ground Hornbill Project, Mabula Game Reserve

project@ground-hornbill.org.za

The Southern Ground Hornbills (*Bucorvus leadbeateri*) have disappeared from around 70% of their historical range and the Project aims to continue, expand and perfect the harvesting and rearing of second-hatched Ground Hornbill chicks so as to establish self-sustaining groups back into their historical range. Collection and correlation of up to date real time data on Ground Hornbill populations, trends, risk areas, numbers and conservation needs forms part of the projects objectives. There is now a group of seven free-roaming, self sustaining Ground Hornbills on Mabula Game Reserve. Made up of five Kruger harvested birds of various ages and two older rehabilitated birds from poisoning incidents. Because of the longevity of these birds it may take several years before this group starts breeding.

The Project has entered its' second phase as it is believed that without the additional studies into secondary poisoning, awareness and education of the general public, population status and captive breeding, the suspected decline of the present population in Southern Africa will continue. The Ground Hornbill Action Group has been formed, under the umbrella of the Project, to instigate action on the above important issues, and involves the relevant individuals and groups, both nationally and internationally, to implement this work. A workshop was held at Mabula during August to discuss how to best

improve the handrearing of Ground Hornbill chicks. These findings produced a protocol, and was implemented with some success this harvest season.

A total of 38 nests were visited from 15th December until 31st, of which 3 new nests were discovered. Only three additional groups were encountered during the field work (Mtomene, Houtboschrand, Tshokwane) of which one was singleton and the two others did not appear to be breeding. Of the active nests, 12 were well lined and visited but without contents. Five nests contained eggs of which one clutch hatched and one disappeared before the end of our visit. Eight nests had chicks, ranging in estimated ages from 3-10 weeks (suggesting laying from early September to late October). Second hatched chicks removed to Moholoholo Re-habilitaion Centre and later to Pretroia Zoo. DNA tests are being done on feathers from 34 birds in KNP, Timbavati, Zimbabwe and Botswana to establish whether these species vary.

State in community-based natural resource management: the Makuleke Region of Kruger National Park

Turner RL

University of California at Berkeley

rlturner@uclink.Berkeley.edu

In July and August, 2002 exploratory research on a potential research site, the Makuleke Region of Kruger National Park in South Africa was conducted. During this trip, interviews were conducted with staff of Kruger National Park and South African National Parks, residents of the Makuleke community, members of the Land Restitution Commission, nongovernmental organizations, consultants, and local researchers. Archival research was conducted at Makuleke Communal Property Association (Makuleke), Kruger National Park, South African National Parks headquarters (Pretoria), the Land Restitution Commission (Pretoria), and the South African National Library (Cape Town).

The Makuleke Region has its origins in South Africa's particular history of land dispossession and conservation. The Makuleke Region, named for the people who consider the land their ancestral home, comprises approximately 24,000 hectares located in the northern part of the Kruger National Park, South Africa's premier park and tourist attraction. Kruger Park was created in 1898 and its territory has gradually expanded over the last century. The Makuleke people resided in the Makuleke region, outside the Park, until they were forcibly removed by the apartheid state in the late 1960s. Most of the land was then incorporated into Kruger Park.

With the end of apartheid, the Makuleke sought restitution through formal procedures established by the postapartheid state. The Makuleke filed a collective restitution claim, participated in an extensive negotiation process with several governmental actors, and eventually reached a settlement in which the Makuleke agreed that preserve the area's status as a conservation area. In late 1998, the Makuleke Communal Property Association gained formal title to the Makuleke Region, and they were granted exclusive rights to commercial development of this region. This was the first successful restitution claim against a South African national park. Although the particulars of the Makuleke Region may be unusual, this case provides a rich site for thinking through conservation-based tourism as a catalyst for community development.

Cremnophilous Succulent Plants: structure and adaptations

van Jaarsveld E¹, and Xaba P¹

¹ Kirstenbosch Botanical Gardens, National Botanical Institute

Vanjaarsveld@nbict.nbi.ac.za

No obligate cremnophytes were observed within reserve. Opportunistic cremnophytes collected (live specimens) listed below. One Bulbine species collected in on the Letaba Gorge cliffs represent the first record of a Bulbine for the Kruger National Park. This plant still has to flower and may represent an undescribed species. Once in flower positive identification can be made and a specimen prepared for the herbarium at Skukuza. *Sansevieria hallii* were commonly recorded in the Levhuvu Gorge from Punda to near Pafuri. Cliffs of the Levhuvu and Letaba gorges of the Kruger National Park have no specialized cliff face flora. Plants collected there merely represent opportunistic cliff dwellers (depending on the outcome of the Bulbine sp. If it is not new it would represent the northern most distribution record for *Bulbine frutescens*.)

The effects of translocation on African Elephant

Viljoen JJ¹ Langbauer Jr WR¹ du Toit JT² and Reynecke HC

¹ Department of Nature Conservation, Tshwane University of Technology

² Mammal Research Institute, University of Pretoria

viljoej@TechPTA.ac.za

The African elephant is considered a keystone species due to its ecological importance. The major research aim is to investigate and evaluate the effects of translocation on the behaviour of African Elephants as indicated by vocal communication, feeding behaviour and hormonal indicators of stress reflected in cortisol levels in faecal samples and temporal gland secretions. Records from historical sources were reconstructed which highlights behavioural disorders as a result of removing elephants from existing social structures. The time immediately after translocation will present the translocated elephants with a large number of social and ecological challenges, from maintaining social bonds and relationships with resident elephants, to establishing a new home range.

In December 2000 an elephant cow in the breeding herd was fitted with a VHF radio collar (tracking). The herd was tracked on a daily basis and the general home range was established by taking GPS co-ordinates whenever visual contact was made. July 2001 vocalization collars (first generation) were fitted to two cows in the breeding herd. A method to assess the impact on woody vegetation (feeding behaviour) was developed. Faecal samples both from the experimental- and control groups were collected.

Transmitter design - PC board for the voltage regulator, transmitter, receiver and audio amplifier completed. Busy with software for the timer circuit

(LCD) to switch the elephant transmitters on & off to save battery power and to prolong total recording time. Twenty two hours of hand held recordings were made – wind noise and getting close to elephants were the limiting factors. Pre-translocation data collection completed (480 sample plots with a radius of 5 meters completed, 360 from experimental and 120 from the control group). Started with the transformation of data and the analysis. Feecal samples (n= 259) were collected between May 2001 and April 2003, 38 389 ha for the dry seasons and 33 602 ha for the wet seasons.

There was no significant difference ($F= 0.4525$, $P>0.05$, 258 df) between the glucocorticoid concentrations as measured between the experimental and control groups therefore the data were pooled. No significant differences were found between the three age classes ($F= 0.0402$, $P>0.05$, 257 df). The only significant difference found was between seasons ($F= 33.6708$, $P<0.05$, 258 df). Among the seasons, significant differences exist between all the seasons with the exception to the early wet and late wet seasons.

The role of cloven-hoofed animals in the epidemiology of foot-and-mouth disease

Vosloo W¹, Bengis RG², Keet D², Phiri C, Esterhuysen JJ, Dwarka RM, Botha B, Boshoff CI, Jones H, and Bauman M

¹ Exotic Diseases Division, University of Pretoria

² State Veterinary, Kruger National Park

Wilna@saturn.ovl.ac.za

Foot-and-mouth disease (FMD) virus causes the most economically important viral disease of animals. The outbreaks of FMD during 2000/2001 indicated the devastating effects, it could have on agricultural production and loss of export markets for agricultural products in specific regions as was demonstrated in KwaZulu Natal, Mpumalanga and Northern Province. The Kruger National Park (KNP) is a FMD endemic area and one of the major tasks of the Directorate of Animal Health is to implement measures to prevent the escape of the virus to adjacent domestic animal populations. It is established that buffalo in southern Africa maintain the SAT types of FMD virus but precisely how they are maintained within free-living buffalo populations and the mechanics by which they may be transmitted from buffalo to domestic stock are not clearly understood and are studied in this project. The recent outbreaks in the regions surrounding the KNP were shown to be caused by isolates similar to buffalo viruses isolated in the KNP previously. The role of other species in the epidemiology of FMD in the KNP is also investigated. Furthermore, monitoring the variability and antigenic range of FMD field strains is crucial to ensure that vaccines in current use in the endemic zone that borders the KNP are effective.

Genetic characterization of viruses isolated from buffalo between 2001 and 2003 as well as serological studies, yielded the following results. A total of 7 viruses were isolated during 2002 (2 x SAT-1 and 5 x SAT-3) from buffalo kept in the Skukuza boma for a tuberculosis experiment. These animals were captured from the Shingwedzi and Punda Maria areas. One SAT-1 isolate was characterised in 2001, followed by 2 in 2002 and 4 during 2003. All the isolates clustered as part of the southern topotype of viruses containing viruses from the Kruger National Park and southern parts of Zimbabwe. The 2001 KNP isolate, KNP/01/01, was characterised from a FMD outbreak that occurred in buffalo held in a boma in Skukuza as part of a tuberculosis research project. These buffaloes were moved from the Shipandi Windmill area in the northern region of the KNP to Skukuza. Both isolates from 2002 were from the Elandskuil area. However, they differ by 14 % from each other. The two 2003 isolates, KNP/10/03 and KNP/03/03 from Nshawu and Pafuri respectively, clustered with viruses from the northern region of the KNP, i.e., Shipandi-Windmill. KNP/7/03 from Shangoni clustered with viruses from Shingwedzi and Mondswene, while the isolate from Masorini, KNP11/03 grouped with KNP viruses from Ntshawa and a 2002 outbreak strain from Mauricedale. Although there was a tendency for viruses from the northern region to cluster together, some viruses clustered with viruses that had their origins from the southern parts of the KNP.

The main conclusions were that, the viruses from the KNP clustered as part of the southern topotype of viruses across all three serotypes, the clustering profile of the buffalo isolates from the KNP as well as the outbreak strains from cattle in neighbouring region of the park suggests that buffalo may have played a role in outbreaks occurring in regions adjacent to the KNP, and also viruses from the northern regions of the KNP do not always cluster exclusively with themselves, suggesting that there is migration of buffalo between the north and south of the KNP.

Monitoring the climate in the Kruger National Park

Zambatis N¹, weather observers & section rangers.

Scientific Services, Kruger National Park

nickz@sanparks.org

In conjunction with the SA Weather Service, routine (daily) monitoring of the climate of the KNP at two 1st-order, six 2nd-order and two 3rd-order weather stations, and 17 rainfall stations. As the climate of the KNP plays a major driving role in the KNP ecosystem, monitoring will continue. Together with other monitoring programmes however, the climate monitoring programme is scheduled for revision during the early part of 2004.

Field layer dynamics of the Kruger National Park

Zambatis N¹, and section rangers

Scientific Services, Kruger National Park

nickz@sanparks.org

Annual veld condition assessment surveys were undertaken by the various section rangers on approximately 500 permanent sample sites in the KNP. Only the herbaceous layer was surveyed in 2003, the woody layer being scheduled for survey in 2005.

A pilot study for the determination of instream flow requirements of mayflies

Zituta MN¹, Gerber A¹ and Thirion C

¹ Department of Water Affairs and Forestry, RQS

zitutan@dwaf.gov.za

The project considers determining the instream flow requirements of mayflies (specifically Baetidae sp.) through sampling and identification of macroinvertebrate community from three biotopes (SIC, Vegetation, and Mud and Sand) and linking the stream flow with the water quality on the sampled biotopes. So far, SASS 5 has been used, as a sampling tool but can not give us the precise measurements on flow velocity of Baetidae species.