RSG Innovation Award – Final Report

Burning for Biodiversity in Southern Africa: Faunal Responses to Fire

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

South African NATIONAL PARKS

EXECUTIVE SUMMARY

Fire is critical for healthy ecosystem functioning in savannas and is widely used as a tool in conservation management. Effects of burning on biodiversity, however, remain poorly understood. Through a multi-faceted programme of research and stakeholder involvement the *Burning for Biodiversity in Southern Africa* project brings together biodiversity research with capacity building and external communication to promote effective fire and conservation management in South African savannas. Project research findings highlight that, surprisingly, burning generally had little effect on many faunal groups. This is critical information for more effective fire management for biodiversity conservation and enables a more flexible approach to burning in many conservation areas. Other outputs from the project include significant baseline data on invertebrate distributions, capacity building with conservation organizations, taxonomic training for South African students, and a public outreach program raising awareness about the role of fire in savanna systems.

Background

Fire, a part of the African landscape for hundreds of millennia, is considered a key disturbance that plays an important role in the structure and functioning of many African ecosystems. Fire is especially widespread and frequent in Africa's savannas where it is widely used today as a land management tool both in agriculture and conservation. Savannas are of great significance to human welfare and economies (e.g. subsistence and commercial agricultural), and are home to a great diversity and abundance of Africa's fauna. For the effective management and conservation of biodiversity in these savanna systems it is essential to be able to understand and predict biodiversity responses to fire and management actions. Historically, however, most fire studies have focused on the effects of fire on vegetation, with only a handful of studies concentrating on the faunal response. Virtually nothing is known about how insects and spiders respond to fire, this despite their high diversity and functional importance in savanna ecosystems.

Project Aims

The '*Burning for Biodiversity in southern Africa*' project was established to improve biodiversity conservation in southern Africa's savannas through a multi-faceted programme of research, stakeholder involvement and effective fire management. Through achievement of the programme objectives more successful, sustainable and informed conservation management will be possible.
The project aims, in brief, were to:

(1) improve scientific understanding of fire effects on faunal biodiversity to provide a sound basis for conservation management;
(2) provide baseline inventory information for a range of taxa (invertebrates and birds);
(3) build capacity in southern African conservation organisations; and
(4) to educate and increase public awareness about the role of fire in savanna conservation.

Study Area

The project is based at sites in Kruger National Park and Hluhluwe-iMfolozi Game Reserve in South Africa. These two parks were chosen because it was possible to investigate how the effects of burning vary with rainfall and savanna type, but also because both South African National Parks and KZN Wildlife support scientific research and, importantly, Park management is strongly committed to translating project findings into management actions.

The project makes use of long-term burning experiment in Kruger National Park which has been running since 1954. The experiment, established in a range of savanna vegetation types, involves the application of a number of different fire regimes (e.g. winter annual fires, summer triennial fires). This unique experiment allows us to tackle research questions related to effects of burning on biodiversity. Four savanna sites in Kruger National Park are Mopani (driest), Satara (intermediate) and Pretoriuskop (wet). A fourth savanna site at Hluhluwe-iMfolozi is the wettest site. These sites are detailed on Figure 1 below (1. Mopani, 2. Satara, 3. Pretoriuskop, 4. Hluhluwe).

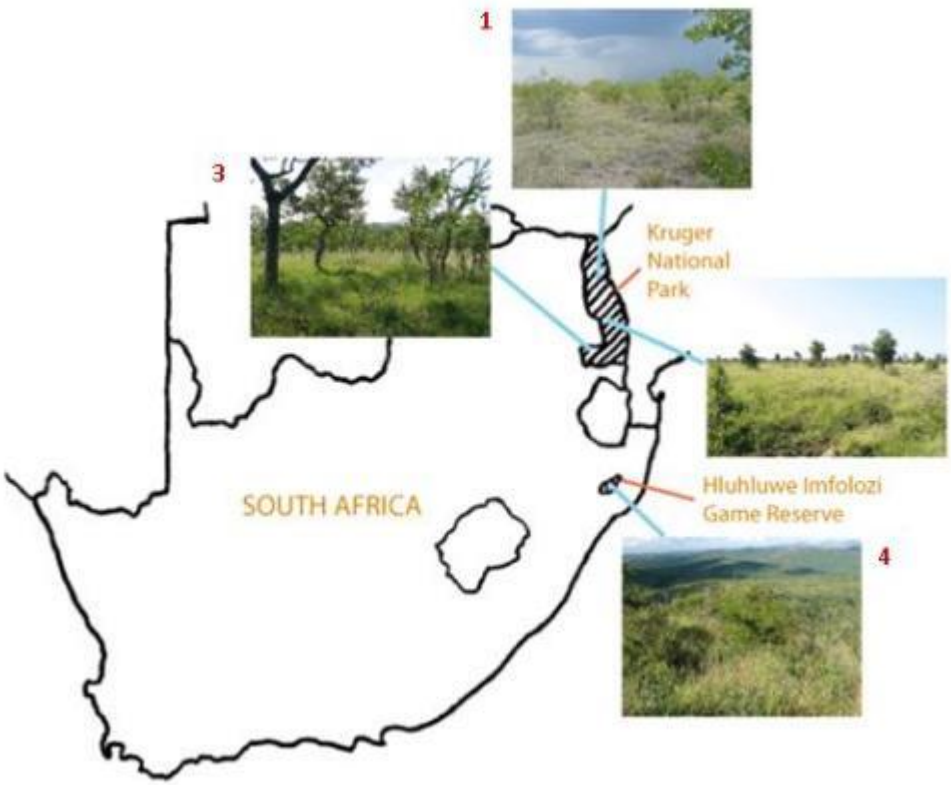

Figure 1. Savanna field sites across South Africa situated along a North-South rainfall gradient. 1: Mopani, 2: Satara, 3: Pretoriuskop, 4: Hluhluwe.

Reporting by Objectives

1. To Improve Scientific Understanding of Fire Effects on Faunal Biodiversity to Provide a Sound Basis for Conservation Management.

Fire is critical for healthy ecosystem functioning in savannas and is widely used as a tool in conservation management. To date however, the effects of burning on biodiversity remain poorly understood; this is concerning because the main objective of many conservation areas is the conservation of biodiversity. Understanding what effect management actions have on progress towards achieving management objectives (such as maintaining bioidversity) is essential for effective conservation. Linking scientific research to management is also important because it can help maximise conservation outputs and reduce costs.

Recent findings suggest that in some savanna habitats the fauna and flora are highly resistant (not affected by burning) and resilient to burning (recovers quickly following fires), while in others they are not. Previous results from studies on a range of taxa hint that variation in the degree of response to fire may be linked to mean annual rainfall. This is because rainfall mediates the relative importance of fire by influencing the degree of habitat change in a system; for example, the greatest change in vegetation structure with burning occurs in higher rainfall areas. It might therefore we expected that the response of fauna to burning will be highest where there is the largest change to vegetation.

If fire has different effects in different savanna types this may mean conservation managers need to vary their management actions accordingly. This project **investigated how faunal responses to repeated fire events varied across savannas along a rainfall gradient**. In doing so, the project findings will inform conservation management in savanna systems throughout Africa where fire is commonly used as a management tool.

Fire management strategies that introduce increased fire variability into the landscape through the use of dynamic spatial and temporal mosaics (patch burning) are increasingly being promoted and implemented in conservation areas. A key assumption is that spatial and temporal fire patterns are surrogates for biodiversity because a range of habitats are created: the greater variation in fires in time and space then the more biodiversity is promoted. However, if savanna biota are resistant to burning, the pyrodiversity idea (diversity of fires in an area) warrants critical investigation. A key issue is **determining the degree of pyrodiversity required for effective biodiversity conservation**. This objective builds on the first part of proposal taking a more management-orientated focus.

Sampling Methods

Sampling was conducted across a range of savanna habitats in South Africa situated along a rainfall gradient. The four sites sampled were

- *Mopane* savanna in Kruger National Park (KNP) (450mm/yr) (Mopani),
- *Acacia* savanna in KNP (550m/yr) (Satara),
- *Terminalia* savanna in KNP (750mm/yr) (Pretoriuskop),
- *Acacia* savanna in Hluhluwe-iUmfolozi Game Reserve (HGR), Kwa-Zulu Natal (900mm/yr).

In KNP, sampling was carried out on experimental burn plots that form part of a long-term savanna burning experiment initiated in 1954. Figure 2 shows some of the burn plots sampled in the Pretoriuskop *Terminalia* savanna; the triennial winter burns (August 3) are the highest intensity fires.

Figure 2. Variation in tree and grass cover with fire regime at Pretoriuskop, Kruger National Park. August triennial fires are the most intense.

A range of fire regimes (combinations of season and frequency of burning, see Table 1) were sampled beginning in autumn 2008. Sampling was repeated in winter 2008 and summer 2008/09. Repeated sampling over a year is important because arthropod species distribution and abundance patterns, especially within spider assemblages, are known to show high levels of temporal turnover, and sampling once may not provide an accurate reflection of how the assemblages are affected by fire in the longer-term.

Table 1. Fire regimes used in Kruger National Park

Fire Regime	Season & Frequency of Burning	Fire Intensity
August 3	Winter, triennial	Highest
August 1	Winter, annual	Intermediate
December 3	Summer, triennial	Lowest
Unburnt	Unburnt for >50 years	-

In HGR where this experimental set-up is not available, fire history (used to calculate fire frequency) was determined using fire mapping records to identify sites of known fire frequencies (high, low, and long unburnt).

Within each savanna type, the response of fauna to different fire frequencies was assessed. A range of taxa were sampled: invertebrates (Formicidae [**ants**], Blattodea: Termitidoidae [**termites**], Araneae [**spiders**], and **birds**. These faunal groups are important drivers of ecosystem processes.

In addition to the originally proposed faunal groups, there was an opportunity to include sampling on two other invertebrate taxa (Lepidoptera [**butterflies & moths**] and Orthoptera [**grasshoppers & crickets**]). The bird, butterfly & grasshopper sampling was, however, restricted to the Pretoriuskop sites due to logistical and financial constraints.

Andrew Davies and Renson Thethe sampling termites from cellulose baits at the Mopani fieldsite, July 2008

A range of standardised sampling methods were employed to sample as much of the targeted invertebrate fauna as possible. Methods included pitfall trapping, vegetation beating, hand collecting, leaf-litter sifting, and baiting. Bird surveys were conducted using point counts in the morning and afternoon (6 sampling periods of 20 minutes/ period on each plot). Birds were recorded if they perch or were actively foraging in the plot. Birds flying overhead but not landing in the plot were not recorded.

Vegetation, soil and temperature data were also collected to characterise each of the sites. This enabled us to assess the degree to which the habitat has been altered by the different fire regimes.
All sampling was completed successfully despite being challenging in extent and intensity. Processing of the collected invertebrate specimens has taken many months and in the case of spiders and grasshoppers is still underway. This is due to the large volumes of material collected and the slow process of sorting and identification.

Andrew Davies and Renson Thethe sampling termites from cellulose baits at the Mopani fieldsite, July 2008

Sampling for butterflies at the Pretoriuskop fieldsite, November 2009

Outputs

Research Impact: Findings

The project had a very successful field component and was able to expand the range of taxa surveyed to include butterflies, day-active moths and grasshoppers. This has provided an unexpected bonus to the biodiversity component.

The project findings strongly indicate that overall the savanna fauna exhibits very high resilience to burning with generally consistent patterns across taxon groups. In other words regular burning had very little effect on the faunal groups studied. The termite and ant faunas appear to be especially resilient to fire with little difference in abundance, species richness or community composition between different burning regimes (see Figure 3). Any differences that were detected were primarily between burnt and unburnt plots rather than between different burning treatments.

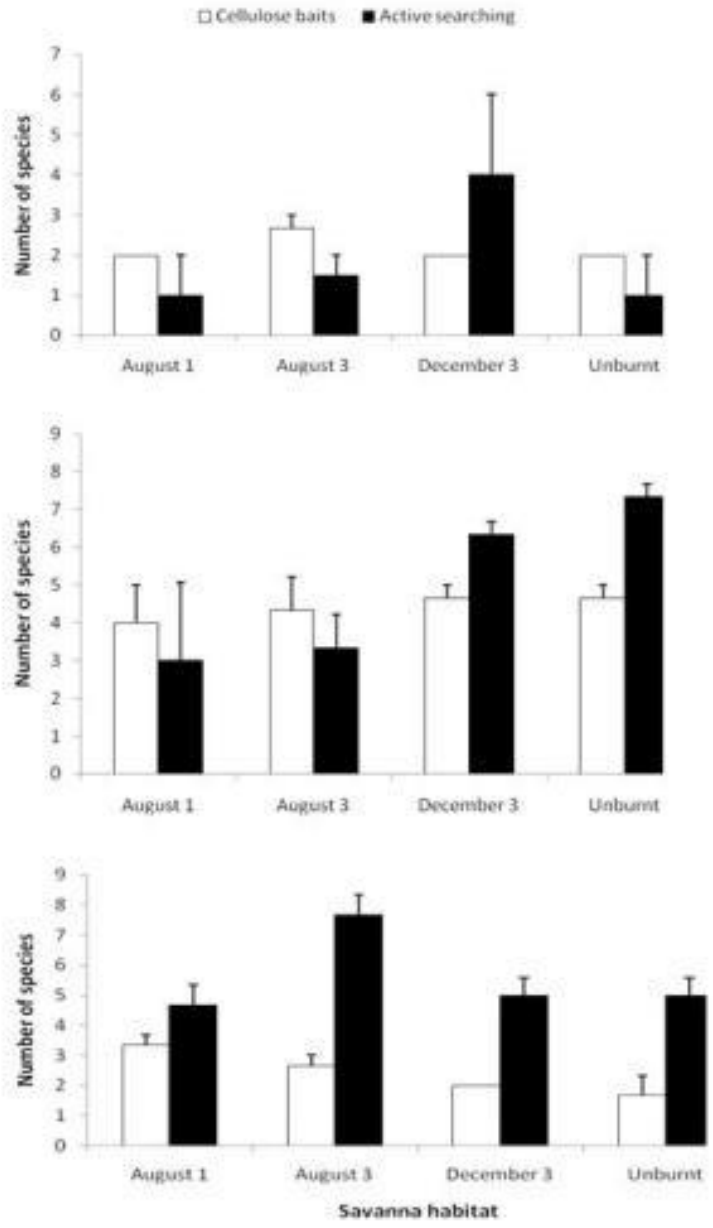

Figure 3: Species density (±SE) across fire regimes for Mopani **(top)**, Satara **(middle)** and Pretoriuskop **(bottom)** for cellulose baits and active searching during the wet season. Note there are no differences at Mopani and only small differences between extreme fire regimes at Pretoriuskop. August 3 = fire burnt every three years in winter, August 1 = fires burnt annually in winter, Variable = ambient fire regime, Unburnt = fire exclusion plot.

With a reduction in frequency of burning, forest-associated species tended to be promoted, although this was only the case in the wetter savannas.

Bird species richness was highest on unburnt plots and there was also a shift in species composition with a reduction in fire intensity and especially with fire suppression. There was also a change in guild structure with the number of insectivorous and frugivorous bird species increasing with a reduction in fire intensity and corresponding increase in habitat complexity and tree cover (Figure 4).

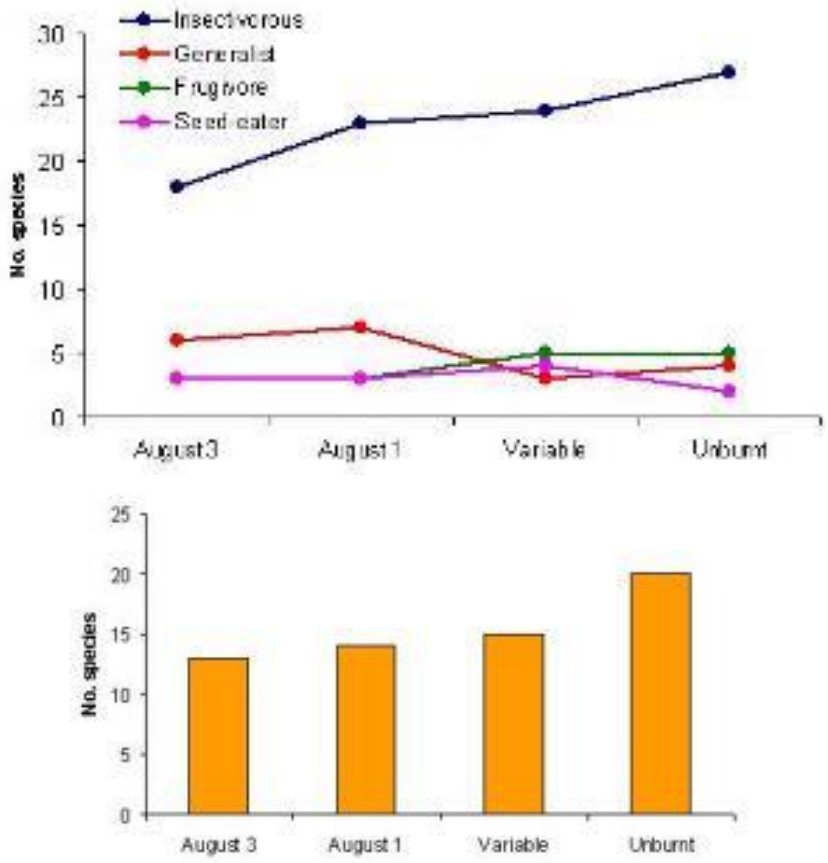

Figure 4. (Top) Change in number of species within each feeding guild, and **(Bottom)** Bird richness per fire treatment at Pretoriuskop (bird richness is average of several estimators). August 3 = fire burnt every three years in winter, August 1 = fires burnt annually in winter, Variable = ambient fire regime, Unburnt = fire exclusion plot.

Due to the very large number of spider specimens collected with the comprehensive sampling and taxonomic difficulties, identification has been time-consuming and is still underway. The project team is working closely with Prof. Ansie Dippenaar-Schoeman (University of Pretoria and curator of the National Collection of Arachnida, Agricultural Research Council, South Africa) and Prof Charles Haddad (University of the Free State, South Africa) to identify all specimens collected. Analyses will be conducted when species-level data are available.

Preliminary results from butterflies and day-active moths indicated similarly high resilience to burning (Figure 5). The diversity of Lepidoptera was high with 71 species of butterfly and moth collected from the Pretoriuskop burn plots in December 2009 and March 2010. There were several species of

butterfly that were unique to the long unburnt plots (e.g. Zulu Shadefly, Common Zebra Blue, Bushveld Ringlet, Forest Sandman). Grasshopper specimens are currently with relevant experts in the United States of America for identification.

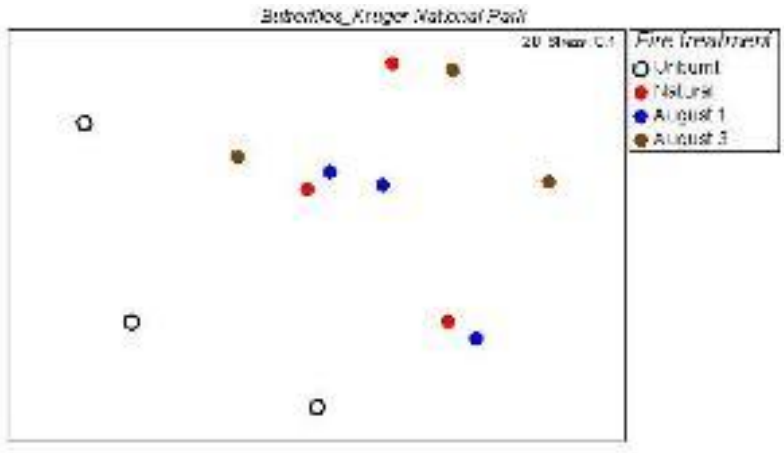

Figure 5: There was a large difference in the composition of butterflies found on unburnt and burnt plots, but not between the different burn treatments. Each dot on the graph represents a burn plot and the closer dots are together in space the more similar the plots are. The unburnt plots are scattered on the left of the figure while burn plots are positioned on the right of the figure indicating a large difference.

The project findings have important implications for conservation management in savanna areas. Because we found that overall the fauna was unaffected by burning, this means generally conservation managers can be relatively flexible in their approach to burning allowing them to apply the most cost-effective and logistically efficient management. In the wetter savannas, however, where fauna showed a greater response to different burning regimes, it would be advisable for managers to use a wider range of fire regimes (e.g. burning throughout the year and at different frequencies). The good news is that in Kruger National Park and Hluhluwe-iMfolozi Game Reserve the current burning policy of patch mosaic burning is already achieving this. In other savanna parks where rainfall is >650mm/ year, conservation management should aim for a variable burning policy.

Research Impact: Scientific Peer-Reviewed Papers

The project has resulted in seven scientific publications either published or nearing submission:

(1) Davies, A.B., Parr, C.L. & van Rensburg, B.J. (2010) Termites and fire: current understanding and future research directions for improved savanna conservation. *Austral Ecology* 35: 482-486.
(2) Bond, W.J. & Parr, C.L. (2010) Beyond the forest edge: ecology, diversity and conservation of grassy biomes. *Biological Conservation* 143: 2395-2404.
(3) Davies, A.B., van Rensburg, B.J., Eggleton, P. & Parr, C.L. (in prep) Factors structuring African savanna termite diversity. Proposed journal: *Ecology*.
(4) Davies, A.B., van Rensburg, B.J., Eggleton, P. & Parr, C.L. (in prep) Assessing the efficiency of termite sampling methods in southern African savannas. Proposed journal: *Insect Conservation & Diversity*.

(5) Reynolds, B., van Rensburg, B.J., Dipenaar-Schoeman, A. & Parr, C.L. (in prep) Spatial patterns in savanna spiders as a function of environmental landscapes: using Kruger National Park as a case study. Proposed journal: *Koedoe*.
(6) Reynolds, B., van Rensburg, B.J., Dipenaar-Schoeman, A. & Parr, C.L. (in prep) Effects of long-term burning regimes on savanna spider assemblages. Proposed journal: *Journal of Applied Ecology*.
(7) Parr, C.L., van Rensburg, B.J., Davies, A.B., Reynolds, B., Sirami, C., Eggleton, P., & Sithole, H. (in prep) Fire and faunal biodiversity in African savannas. Proposed journal: *Diversity & Distributions*.

It is anticipated that further publications will result when all insect and arachnid identifications have been completed.

Research Impact: Conference and Seminar Presentations

Both MSc students presented papers at national and international conferences in 2009. The core 'Burning for Biodiversity' research group presented at the 7th Savanna Network meeting (19-24th April 2009) in Kruger National Park, South Africa. At this meeting MSc student, Andrew Davies won the prize for best student presentation with his talk entitled '*Fire ecology & termites in African savannas*'. In addition both students presented their work at the annual University of Pretoria Zoology Department meeting.

Bradley Reynolds attended the International Congress for Conservation Biology in Beijing, China (11-16th July 2009) and presented his research work (paper entitled '*The effects of long-term burning regimes on savanna spider assemblages*'). Due to logistical arrangements with sample identifications, Andrew Davies and Catherine Parr attended the 10th International Congress of Ecology in Brisbane, Australia (16-21st August 2009). Andrew presented results from his research at a symposium on fire ecology with a talk entitled '*Fire and termite dynamics in a southern African savanna*'. Both student presentations attracted much interest. Finally, in December 2009, Dr Catherine Parr was invited to present research findings from the project at Groningen University in The Netherlands (talk entitled: '*Exploring Savanna Disturbance: Burning for Biodiversity?*').

Fire Managers' Workshop

While on paper a protected area may have the best fire policy for biodiversity conservation and a good understanding of how the ecosystem functions, unless the fire policy is actively being put into practise biodiversity objectives cannot be achieved. In many reserves it is the rangers on the ground that are responsible for implementation of policy (e.g. setting fires at particular times to achieve certain objectives). It is, therefore, critical that the rangers understand the fire policy and the basic research supporting it.

Group brainstorming at the Fire Managers' Workshop.

With this in mind, the project ran a fire managers' workshop which aimed to (1) facilitate direct communication of research to rangers and managers, and to allow for open discussion and questions, and (2) to better understand the challenges to implementing Kruger National Park fire policy. This successful workshop was run in October 2009 in Kruger National Park in collaboration with Navashni Govender (SANParks). Prior to the workshop all attendees were sent a questionnaire. This enabled us to determine how the Kruger Park fire policy is currently interpreted and implemented, and enables us, with a follow-up survey post-workshop, to gauge the success of the meeting.

The workshop was well attended by section rangers, managers, researchers and senior scientific services staff with a total of 36 people taking part. The day involved feedback on research findings from researchers (via short presentations and opportunity for questions), as well as break-out groups and discussion focusing on the challenges and potential solutions to implementing fire policy in KNP. Presentations by researchers direct to Park managers and rangers ensured the most effective communication of research findings. The session on challenges and potential solutions to implementing fire policy raised several important issues and concerns that the rangers had.

A summary document setting out the main points from the workshop was circulated following the meeting to enable any rangers who were unable to attend to comment. We are currently working with SANParks staff to assess change in behaviours and the implications of this for fire policy in practise. A key output will be a shift in the current fire regime from intense late winter fires (viewed as undesirable), to more variable intensities with fires lit throughout the year (in line with Park policy).

Fire Manager in Kruger National Park, Navashni Govender, sorts notes from 'challenges to burning' break-out group brain storming session.

Technical Report

An interim report was submitted to Scientific Services, Kruger National Park in February 2010. The team is awaiting findings from the spider work before submitting final technical reports to the relevant conservation organisations (SANParks and Ezimvelo-KZN Wildlife). Research findings have also been communicated to conservation managers at the Fire Managers Workshop (see above).


2. To Provide Baseline Inventory Information for a Range of Taxa (Invertebrates and Birds)

The project produced substantial baseline information on invertebrate biodiversity across a number of key savanna types. Invertebrates typically receive less attention than vertebrates and plants in biodiversity studies and there are relative few taxonomic experts. This is problematic because invertebrates play pivotal roles in ecosystem functioning including seed dispersal, nutrient cycling and pollination and are highly abundant and highly diverse. For effective conservation it is critical to know just what species occur in an area.

Outputs

Full species lists from all sites are currently in the process of being finalised. Full species lists will be held and voucher specimens will be deposited in natural history museums and insect collections for future reference, including the museum at Skukuza (Kruger National Park), Iziko Museum of Cape Town, the Agricultural Research Council in Pretoria, the National Insect Collection in South Africa and the Natural History Museum, UK. In addition, beetle and cockroach specimens collected as by-catch from pitfall traps have been deposited with the Oxford University Museum collection.

MSc student Bradley Reynolds has worked in close collaboration with the South African National Survey of Arachnida (SANSA) when identifying his spider specimens. Sampling throughout the year and using a wide range of sampling techniques has meant Bradley has been able to make a very valuable contribution to SANSA and to SANParks. A paper currently in preparation will focus on providing the first detailed and comprehensive spatial record of spider distributions across Kruger National Park. Bradley's MSc project on spiders and fire also featured in the July edition of the SANSA newsletter (see Appendix 1).

Termites are notoriously difficult to collect and to identify to species-level because of their subterranean habits and the poor state of taxonomy (many genera in urgent need of revision). Nevertheless, identification of termite specimens was possible through collaboration with Dr Paul Eggleton of the Natural History Museum, London. MSc student, Andrew Davies spent a very productive six weeks working with Dr Eggleton at the Museum. During this time he was able to complete the majority of his specimen identifications to species level and returned to South Africa having considerably improved his taxonomic skills.

An important output for the project is that Andrew is now one of a handful of people with termite taxonomic experience in southern Africa. The project produced a comprehensive list of genera and species for the savanna areas sampled; a total of 18 genera and five subfamilies were collected. This includes a new genus of termite (*Anenteotermes*) for South Africa found in KNP at the Pretoriuskop site. Species from this genus feed on highly decayed wood and organic material in soil.

3. To Build Capacity in Southern African Conservation Organisations

Training of conservation managers and students ensures that knowledge and a range of skills are developed within conservation organisations and research institutes. The development of skills within conservation organisations is vital for ensuring the autonomy and longevity of conservation.

Outputs

Training South African Students

Through involvement in the *Burning for Biodiversity* project, two South African students undertook work towards their MSc degrees at the University of Pretoria. One student has submitted and completed his thesis (title: 'Termite responses to long term burning regimes in southern African savannas: patterns, processes and conservation'), while the second student is part-way through the thesis write-up.

MSc student, Bradley Reynolds, identifying spiders.

Their involvement with the project has equipped them with taxonomic, fieldwork and analytical skills. They have also presented the results of their studies at various meetings including national and international conferences and conservation workshops. This has developed their communication skills considerably.

Building Capacity within Conservation Organizations:

In addition, to skills training the students gained, the close working relationship between project members and SANParks Scientific Services staff has contributed to capacity building within the conservation organisation. Fieldwork at the start of the project involved SANParks Scientific Services staff (the Kruger Arthropod Research Team, KART), and subsequently park staff have accompanied researchers in the field. This provided opportunity to 'learn on the job' and better understand how to sample different invertebrate groups.

The close working relationship and mentoring role of the project leader, Dr Catherine Parr, with SANParks Scientific staff has contributed to building capacity and experience within the organisation. As a result of this mentoring, a manuscript was recently published in the *African Journal of Ecology* with Hendrik Sithole (Invertebrate Research Manager, SANParks) as the lead author.

At the end of the project there is significantly greater understanding of why surveys are needed, of what information can be collected to inform conservation management, and how to undertake ecological sampling. Students and Park staff are able to conduct biodiversity surveys, repeat invertebrate monitoring and basic identifications.

The strong links between South African students and institutions and European scientists is particularly important from the viewpoint of taxonomic expertise. The project has contributed to building valuable invertebrate taxonomic skills within the South African research and conservation community.

Left: Invertebrate Research Manager, Hendrik Sithole, setting pitfall traps in Kruger National Park. **Right**: The Kruger Arthropod Research Team at the end of a day's fieldwork. L - R: Velly Ndluvo, Hendrik Sithole, Renson Tethe.

(4) To Educate and Increase Public Awareness About The Role of Fire in Savanna Conservation.

There is generally a negative public perception about fire in natural ecosystems. Fire is, however, a natural and vital part of savanna systems. Thus, outreach initiatives were integral to the *Burning for Biodiversity* project to increase public awareness and education about the importance of fire and conservation management.

Outputs

Fire & Biodiversity Posters

The project has made contributions in the areas of education and science communication. Posters introducing the *Burning for Biodiversity* project and providing information about why and how savannas should burn, and the effects of fire on biodiversity have been completed. The colourful and eye-catching posters have been produced in both English, and the local language Shangaan, with the aim to provide information for local, national and international visitors to Kruger National Park. Posters have been widely distributed at a range of locations within the Park including the school media centre, environmental education unit, a number of tourist rest camps, picnic sites, the plant nursery, the primary school, and the library. In addition several other external environmental education units (e.g. junior ranger groups) have received copies. See Appendix 2.

Through the development of posters combined with informal discussions and research presentations, there was also improved understanding of the role of fire in savannas by SANParks staff (from game guards to rangers to Scientific Services staff and conservation managers).

Fire and biodiversity poster designed for Park visitors and school learners.

School Talks

Other outreach initiatives include school talks which were organised in conjunction with SANParks' environmental education group. The talks aimed to increase awareness and education about fire and conservation management. In January 2009 as part of the school programme, the *Burning for Biodiversity* project leader, Catherine Parr, and Hendrik Sithole from SANParks spoke to high school learners about fire and insect biodiversity at the Mopani Further Education & Training College in Phalaborwa (Limpopo Province, South Africa).

A total of 36 learners and six teachers came from six local high schools and colleges in the surrounding area (Lepato M. High School, Ntshuxeko High School, Mopani SE FET College, Maphokwane High School, Nkateko High School, Lebeko High School). The project members gave two talks: 'Welcome to the World of Ants' and 'Burning for Biodiversity'. The successful afternoon concluded with a discussion about insect diversity, including many interesting and diverse questions from the students. There was also an opportunity for the students to view a number of different ant species for themselves using microscopes. The outreach activity was organised in collaboration with the South African Environmental Observation Network (SAEON), and was featured in the April edition of the

SAEON newsletter. Refer to - http://www.saeon.ac.za/enewsletter/archives/2009/april-2009/introducing-learners-to-burning-for-biodiversity-in-africa

A school learner takes her first close-up look at an ant.

Students wait their turn to look at ant species under the microscope under the guidance of Dr Catherine Parr.

Television Media

In addition to school learner talks and posters, the ecological and conservation importance of termites was highlighted by MSc student, Andrew Davies, who was filmed by the South African Natural History Unit for an educational television program for children called *Wild Crew.* The episode focused on his research and provided information on termites and their role in savanna ecology. The episode was broadcast nationally by the South African Broadcasting Corporation (SABC) on the 6th of November 2008.

Fire Ecology Network

Plans to develop the fire ecology network are currently under development. It is envisaged that the network will link conservation managers, land managers, fire practitioners and researchers to improve the understanding and role of fire in African savannas. It is anticipated that the fire-ecology network will be linked to the currently existing Southern African Fire Network (SAFNet) which focuses on fire management policy and practice through the use of remote sensing and GIS.

Financial Statement

This statement covers project costs related to the duration of the overall project (January 2008 – September 2010).

	Year 1	Year 2
Expenses	**GB £**	**GB £**
Travel (airfares, vehicle hire and fuel costs)**	11 222.67	7560.71
Field and laboratory equipment	1783.45	1927.85
Fieldwork subsistence	560.00	936.36
Laboratory consumables	5217.57	2238.75
MSc student bursaries (x2)	8571.43	2589.29
Conference costs (x3)	427.28	899.90
Field and laboratory assistance	936.96	1988.36
Transport of samples	82.43	159.64
Project camera	292.46	0
Fire Workshop in Kruger National Park	0	525.14
Poster laminating	11.50	207.26
Exchange rate loss	0	487.95
Expenditure/ year	29 105.75	19 521.21
Total Received		48 585.00
Total Expenditure		**48 626.00**

** Large increase in fuel costs during field work (price increase from R7 to nearly R10/ litre).
Students were also not able to share vehicle costs as anticipated due to differing fieldwork schedules and logistical constraints.

Acknowledgements

The project would not have been possible without the help and active involvement of South African National Parks and Ezimvelo-KZN Wildlife. Assistance with organising school learner talks was gratefully received from Joe Sibiya at SAEON. Smooth running of the project in Hluhluwe-iMfolozi Game Reserve was facilitated by Dave Druce and Sue van Rensburg.

Project Team

Dr Catherine Parr (Project leader), *School of Geography & the Environment, University of Oxford, UK*
Dr Berndt van Rensburg, *Department of Zoology & Entomology, University of Pretoria, South Africa*
Mr Hendrik Sithole, *Invertebrate Research Manager, Kruger National Park, South Africa*
Ms Navashni Govender, *Fire Research Manager, Kruger National Park, South Africa*
Mr Velly Ndluvo, *Kruger National Park, South Africa*
Mr Renson Thethe, *Kruger National Park, South Africa*
Mr Bradley Reynolds, *Department of Zoology & Entomology, University of Pretoria, South Africa*
Mr Andrew Davies, *Department of Zoology & Entomology, University of Pretoria, South Africa*
Dr Clelia Sirami, *Department of Zoology, University of Cape Town*, *South Africa*
Ms Valentina Lupano, *South African National Biodiversity Institute, Cape Town, South Africa*
Mr Ian Sharpe, *South African Butterfly Conservation Assessment, South Africa*
Dr Ansie Dippenaar-Schoeman, *Agricultural Research Council, Pretoria, South Africa*
Dr Paul Eggleton, *Natural History Museum, London, UK*

Appendix 1: SANSA Newsletter

SURVEYS

PREY OF AN ARCHAEODICTYNA SP. (CONT)

This brief study indicates that these small web-building spiders feed on a variety of prey that is captured in their webs. None of the prey species exceeded 4mm in length, suggesting that larger prey cannot be sedated, or that the webs strands are to weak to effectively capture larger prey.

Contact: Charles Haddad at Haddad.sci@ufs.ac.za

Web of *Archaeodictyna* sp. from the central Free State constructed in *Eragrostis* grass. Prey remains are indicated by an arrow.

Inset: The dictynid sp. from the Free State feeding. Photograph: Allen Jones

EFFECTS OF LONG-TERM BURNING REGIMES ON SAVANNA SPIDER ASSEMBLAGES

Fire is a key ecological process that shapes African savannas and, in response to the general lack of information on the role of fire in structuring ecosystems, a long-term experimental burn plot trial was initiated in Kruger National Park (KNP), South Africa in 1954.

The focus of this experiment was to investigate the effects of long-term burning regimes on vegetation and, therefore, to date, this study has focussed mainly on the response of vegetation to long-term burning regimes with minimal work being conducted on animals. There is an enormous lack of studies on the effects of long-term burning regimes on fauna, especially invertebrates, and this is a global problem. This is particularly alarming since fire-driven biomes possess an enormous number and diversity of invertebrates, all of which have pivotal roles to play in ecosystem functioning.

Recently, KNP adjusted its mission statement to include the conservation of biodiversity as a whole, including both fauna and flora, which led to more studies on the effects of long-term burning regimes on fauna. A recent pioneering study by Catherine L. Parr (University of Oxford) and colleagues (published in 2004) looked at the effects of long-term burning regimes on ants, making use of the experimental burn plots in KNP. This provided new insights into the possible effects that these burning regimes may be having on invertebrate fauna.

In order to build on these results, I have embarked on a study investigating the effects of long-term burning regimes on spiders under the supervision of Kate Parr, and Berndt Janse van Rensburg from the University of Pretoria's Zoology and Entomology Department, and in collaboration with Annie Dippenaar-Schoeman. This study will also make use of the experimental burn plots in KNP. Spiders were chosen because they are: a) important predators in ecosystems; b) greatly affected by changes in vegetation structure because they are a very diverse group with many different habitat guilds (e.g. ground-dwelling, leaf litter-dwelling, web-building etc.); and c) affected by changes in prey assemblages that may arise in response to different burning regimes.

We are looking at the possible effects of four different burning regimes across a rainfall gradient within KNP on spider assemblage composition. The burning regimes (each representing a different season and frequency combination) that we are investigating are: August annual burns, August triennial burns, December triennial burns and unburned areas that have remained virtually unburned since 1954. These burning regimes have remained relatively unaltered since 1954 and are, thus, considered suitable for studies on the long-term, cumulative effects of burning regimes. The late winter fires tend to have a high intensity because of a build-up of fuel (dead grass, leaves etc.) over winter, whereas the summer fires tend to be of a low intensity. We expect that spider diversity will be highest in areas that are burned less frequently, or not at all, and that the diversity will be highest in areas that are subjected to "cool" summer fires compared to areas that are subjected to "hot" winter fires. The simplistic rationale behind this is that infrequently burned areas and areas that are subjected to relatively "cool" fires have a more complex vegetation structure, leading to a greater diversity of available niches, which are able to accommodate a wider diversity of different guilds of spiders. More frequently burned areas and areas subjected to relatively "hot" fires tend to have a much simpler, open vegetation structure, which could possibly lead to the exclusion of certain species of spiders because their specific habitat or niche requirements are not available.

Furthermore, we will be examining a wide variety of possible effects of these burning regimes on vegetation structure and, in turn, spider assemblage composition, to understand better the effects that fire, used as a management tool in our conservation areas, may have on our invaluable invertebrate fauna. This will hopefully spark further interest in research on the effects that prolonged fire regimes may have on these generally overlooked assets, and lead to better-informed decision making in conservation circles.

Contact: Bradley Reynolds at bnreynolds@zoology.up.ac.za

Appendix 2: Fire posters (Shangaan & English)