Grassland management in Gauteng

Understanding your veld for improved production and conservation

CROCODILE RIVER RESERVE

Grassland Society of Southern Africa

www.grassland.org.za

Advancing Rangeland Ecology and Pasture Management in Southern Africa

Proceedings of a workshop held on 16 March 2014, Hennops, Gauteng

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GRASSLAND MANAGEMENT IN GAUTENG: UNDERSTANDING YOUR VELD FOR IMPROVED PRODUCTION AND CONSERVATION

Edited by Alan Short

BASE 4 CLUB, HENNOPS, GAUTENG

16 MARCH 2014

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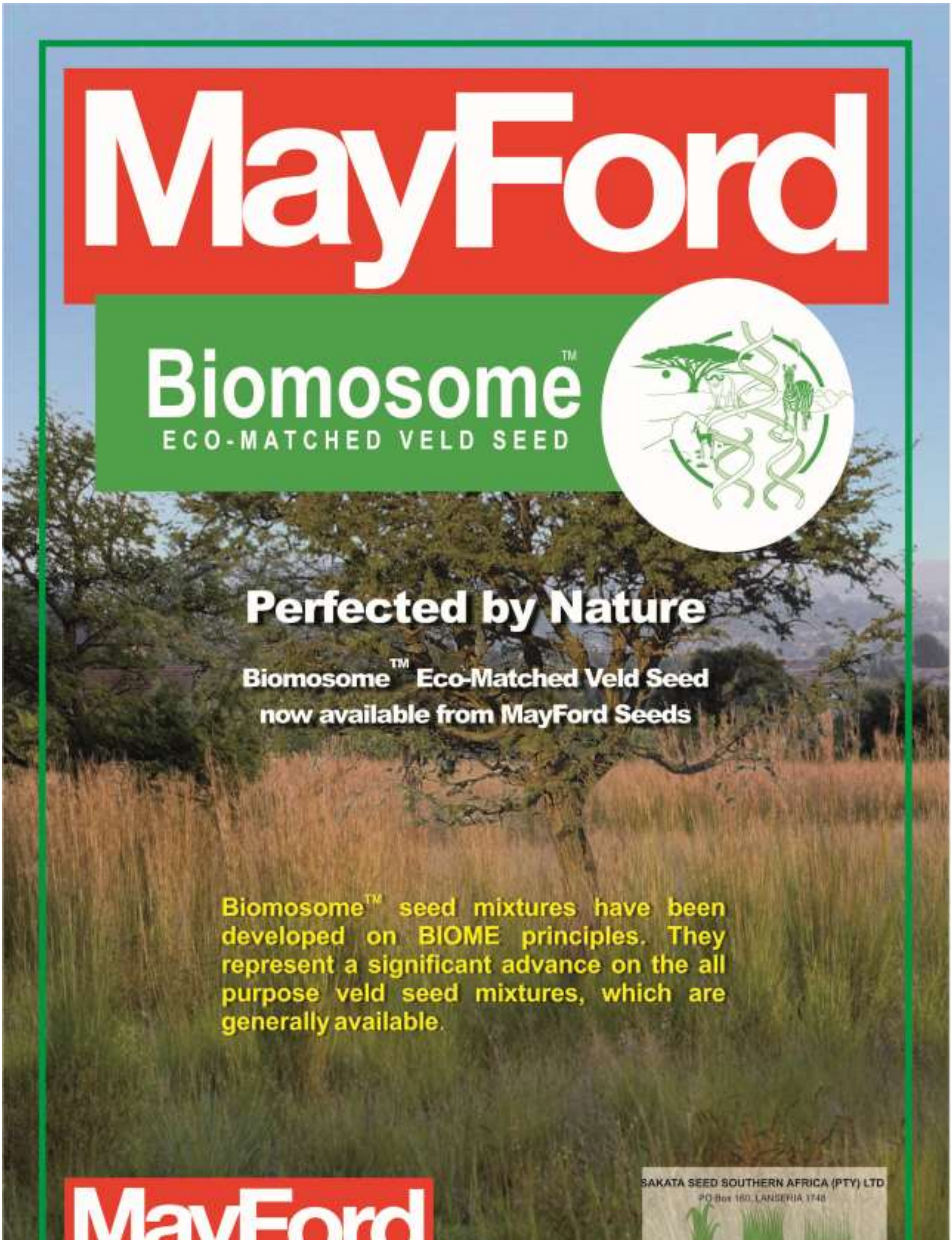
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UPCOMING EVENTS: SAVE THESE DATES!

GRASSLAND SOCIETY OF SOUTHERN AFRICA

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Research Skills Workshop, 20-21 July, Bloemfontein

Fire Management in South Africa – Policy and Practice, 25 July, Bloemfontein

49th Annual Congress of the GSSA, 20-25 July, Bloemfontein

50th Annual Congress of the GSSA, July 2015, KwaZulu-Natal

CROCODILE RIVER RESERVE

Go to www.crocodileriverreserve.co.za for more information

Astri Leroy of the Spider Club of SA: Spider Walk, 6 April, Birdsong

4 May - Jonathan Leeming, author - Scorpion Walk, 4 May, Birdsong

Talk on Acid Mind Drainage with Stephan du Toit (Environmental Management Inspector), 21 June

WORKSHOP PROGRAMME SUMMARY

TIME	PROGRAMME EVENTS
Sunday, 16 March 2014	
08:00-09:00	Registration and Coffee
09:00-09:10	**Introduction and Welcome:** Anthony Duigan, Crocodile River Reserve
09:10-09:40	**The SANBI grassland Ecosystem Guidelines and the Grasslands Programme:** Tsumbedzo Mudalahothe, SANBI
09:40-10:10	**The ecology of fire:** Michael Panagos, Tshwane University of Technology
10:10-10:25	**Introducing the Crocodile River Reserve:** Mercia Komen, Crocodile River Reserve
10:25-10:30	*EcoGuard*
10:30-11:00	TEA
11:00-11:05	**Introducing the Grassland Society of Southern Africa**: Alan Short, Short Ecological Consulting
11:05-11:35	**Biodiversity in grasslands:** Vincent Carruthers
11:35-11:40	*MayFord*
11:40-12:10	**Managing your natural capital: the value of grasslands:** Alan Short, Short Ecological Consulting
12:10-12:40	**Assessing and monitoring rangelands to make better decisions:** Frits van Oudtshoorn, Africa Land-Use Training
12:40-12:45	*4x4 Club*
12:45-13:30	LUNCH
13:30-14:00	**Panel discussion**: Question and answer session with all speakers
14:00-15:00	**Monitoring your veld: practical field demonstration**: Frits van Oudtshoorn

WORKSHOP ORGANISING COMMITTEE

Alan Short	Short Ecological Consulting
Helen Duigan	Crocodile River Reserve
Mercia Komen	Crocodile River Reserve
Freyni du Toit	Grassland Society of Southern Africa
Cathrine Versfeld	Grassland Society of Southern Africa

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MEET THE SPEAKERS

Anthony Duigan

JCP Consulting. Email: Anthony@jcp.co.za

Anthony is a management consultant who focusses on change management and building partnerships. He has dedicated a substantial portion of his time to conservation issues, most notably the Rhenosterspruit Conservancy and the Crocodile River Reserve. He is currently working with an NGO Pan-African programme called Workshop for Africa, providing training in ethical leadership and good governance

Tsumbedzo Mudalahothe

South African National Biodiversity Institute. Email: T.Mudalahothe@sanbi.org.za

Tsumbedzo is Grassland Program Agriculture Coordinator who heads the Agriculture component of the Grasslands Programme. He chairs the Agriculture Task Team of SANBI's Grasslands Programme, working with stakeholders across the agricultural sector like farmers, researchers, government bodies and others to find practical ways to integrate biodiversity conservation into agricultural production. He has more than 20 years' experience in Agricultural Development Management and Project Management, in the private sector, public sector and within NGOs.

Michael Panagos

Tshwane University of Technology. Email: panagosmd@tut.ac.za

Michael is a researcher and lecturer in rangeland science, at Tshwane University of Technology with years of experience in conservation. His focus is on plant ecology, vegetation surveys and methodology, and wildlife management. He has been instrumental in revising and improving the monitoring systems of several nature reserves to bring them up to date with the latest thinking in practical management and ecological understanding.

Mercia Komen

Crocodile River Reserve and Federation for a Sustainable Environment. Email: mkomen@mweb.co.za

Mercia's work experience is in Project Management and Information Technology. She works with volunteers, community organisations, and private land owners. She works to support those who respond as stewards of the environment, especially private land owners who recognise the dire need to protect biodiversity, ecosystem services and natural landscapes. She is a key roleplayer in the Crocodile River Reserve, including running the alien plant control programme.

Alan Short

Short Ecological Consulting. Email: cedara.alan@gmail.com Tel: 072 372 9099

Alan is a consultant with experience in the fields of rangeland monitoring, land planning, resource assessment and livestock and biodiversity management in rangelands. He worked for the KZN Department of Agriculture and Environmental Affairs, Agricultural Research Council, and Gorongosa National Park in Mozambique, focussing predominantly on the interaction of grazing, fire and landscapes on grassland functioning. His main interest is in practical tools for veld managers and understanding where science and management intersect.

Vincent Carruthers

VC Management Services. Email: vcms@mweb.co.za

Vincent is a well-known environmentalist, consultant and author who has shared his lifelong passion for nature through such indispensable books as the *Frogs and Frogging in Southern Africa*, *The Wildlife of Southern Africa*, and *The Magaliesberg*, an account of the history, geology and environment of the mountain range. He's been particularly active in the Magaliesberg, being the founder of the Magaliesberg Biosphere Initiative, and his efforts in conservation have been recognised throughout the country.

Frits van Oudtshoorn

Africa Land-Use Training. www.alut.co.za. Email: info@alut.co.za. Tel: 078 228 0008

Frits van Oudtshoorn is a pasture consultant and agricultural/environmental trainer. He is a well-known grass specialist and the author of *Guide to Grasses of Southern Africa*. For several years he has been using his vast experience to train managers, fieldworkers and farmers around southern Africa in the basics of veld management, rehabilitation, and natural resource management.

SUPPLEMENTARY INFORMATION

There is a whole range of detailed information on the subject of veld management available. We have collected some of the information for you in the workshop CD. Some of the resources listed here are quite technical, while others are guidelines for people with an interest in nature. All of them contain valuable information in natural resource management. Happy browsing!

General

1. DAFF and LandCare. 2013. *CARA Made Easy: The Conservation of Agricultural Resources Act 1983*. Department of Agriculture, Fisheries and Forestry and LandCare, Pretoria
2. SANBI. 2013. *Grasslands Ecosystem Guidelines: landscape Interpretation for Planners and Managers*. Compiled by Cadman, M., de Villiers, C., Lechmere-Oertel, R. and D. McCulloch. South African National Biodiversity Institute, Pretoria. 139 pages.
3. SANBI. 2014. *Grazing and Burning Guidelines: Managing Grasslands for Biodiversity and Livestock Production*. Compiled by Lechmere-Oertel RG. South African National Biodiversity Institute, Pretoria. 42 pages.
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1. Crocodile River Reserve. 2013. *Fire Management Operational Plan*.
2. Crocodile River Reserve. 2013. *Fire Management Plan.*
3. Trollope WSW and Trollope LA. 2007. *Fire Ecology and Management of African Grassland and Savanna Ecosystems*. Working on Fire International
4. DAFF. Undated. Fire legislation web page.

Wetlands

1. Friedel G. 1992. *Hands-On Vlei and Marsh Wetlands: A Field Guide*. Wyatt J (ed). Share-Net, Howick
2. DWAF. 2005. *A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas.* Department of Water Affairs and Forestry, Pretoria.
3. Nel J, Driver A, Strydom WF, Maherry A, Petersen C, Hill L, Roux DJ, Nienaber S, Deventer HV, Swartz E and Smith-Adao LB. 2011. *Atlas of Freshwater Ecosystem Priority Areas in South Africa*. Water Research Commission, Pretoria.

Alien Plant Control

1. DAFF. Undated. *Alien Plant Herbicide Treatments*
2. ARC-PPRI. Fact Sheets on Alien Invasive Plants
3. Nature Conservation Corporation. Undated. *Invasive Alien Vegetation Management Manual.* NCC, Tokai.

Advertorial

AFRICA LAND-USE SERVICES is located in Nylstroom/Modimolle (Limpopo province) and offers the following services to land-users:

Consultation

We offer a consultation service with the aim on improving the carrying capacity on the farm. Frits van Oudtshoorn, author of the book *Guide to Grasses of South Africa*, visits the farm in order to assess the current pasture/veld condition and grazing system on the farm. Thereafter a report is compiled which includes recommendations for improvement and general management. Veld restoration projects can also be managed.

Books and DVDs

Africa Land-Use Services also offers a wide range of agricultural and environmental books as well as DVD's (English and Afrikaans). Some of the titles on offer include;

The Farming Handbook, Cattle Breeds of South Africa, Bushveld – Ecology and Management, Karoo veld - Ecology and Management, Game Ranch management, Dairy Farming at your fingertips, The Pasture Handbook, Guide to Grasses of Southern Africa, Problem Plants and Alien Weeds of South Africa, Vegetation types of South Africa, Lesotho and Swaziland, Soil Classification and Making the most of indigenous trees. See our website for the complete list.

Tree lucerne

Tree Lucerne is a fodder shrub belonging to the legume family. It is a drought resistant evergreen plant that provides high quality fodder, particularly during the winter. It is best suited for well drained soils in temperate and Mediterranean climates. Although Tree Lucerne (or Tagasate) is relatively new in South Africa, it shows promise in these latter parts. We sell plants from our nursery outside Nylstroom. Contact us for prices. Viewing is welcome.

Contact details

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Web: www.alut.co.za

TOWARDS SUSTAINABLE LAND-USE

WORKSHOP PAPERS

THE GRASSLAND PROGRAMME AND THE GRASSLAND ECOSYSTEM GUIDELINES

Tsumbedzo Mudalahothe

South African National Biodiversity Institute. Email: T.Mudalahothe@sanbi.org.za

Introduction

South Africa's grasslands are a remarkable and irreplaceable biodiversity asset of global significance. In South Africa, grassland plant diversity is second only to that of the Fynbos Biome and grassland ecosystems are home to a large number of the country's rare, endangered and endemic animal species.

South Africa's grasslands are resilient and stable ecosystems, which dominate much of the central and eastern South Africa, and are extremely valuable from three related perspectives: livelihoods, biodiversity, and economics.

The conditions that prevail in grasslands make them highly suitable for human habitation, and many of the land-uses upon which food-production and other vital economic activities depend. For these reasons, some 40% of South Africans live and work in grasslands.

These landscapes are also the location of large coal and gold deposits, agricultural lands and commercial forestry plantations, and include the heavily urbanised and industrialised province of Gauteng, which is considered to be the economic heartland of the country. These important activities form the backbone of the South African economy, but they also have impacts on the ecological infrastructure that underpins most of these economic activities.

The Grasslands Program

Recognising the importance of grasslands towards biodiversity conservation and livelihoods the South African National Biodiversity Institute (SANBI) Grasslands Programme was initiated in 2005.

This 20-year public-private partnership, which aims to sustain and secure the biodiversity and associated ecosystem services of the grasslands biome, involves national and provincial government departments, conservation agencies, non-governmental organisations, municipalities, and the private sector.

The initial 2008-2013 phase, funded through an investment from the Global Environment Facility (GEF) through United Nations Development Program (UNDP), specifically aims to ensure that major production sectors operating in South Africa's grassland biome (agriculture, forestry, urban development and coal mining) directly contribute to biodiversity conservation in the grassland biome by developing, piloting and mainstreaming new models for biodiversity management. It does so by integrating biodiversity objectives into these sectors and by strengthening the enabling environment for mainstreaming biodiversity into these sectors. The Agriculture Component of the Grasslands Programme was meant to achieve the following in its sector of focus.

- Provides strategic input into agricultural laws and policies;
- Secures land for biodiversity conservation through biodiversity stewardship;
- Develops guidelines and tools for agricultural land-use planning and decision making;
- Pilots market-based mechanisms for environmentally friendly red meat production.

Provides strategic input into agricultural laws and policies

Policies and Laws that affects biodiversity mainstreaming were supported and challenged during the course of this project including CARA and SUPAR bill from DAFF.

The Program has also participated in different Natural Resource Management (NRM) working groups including DAFF's Letsema NRM working group.

Secures land for biodiversity conservation through biodiversity stewardship:

A big chunk of land was secured for all level of biodiversity stewardship i.e. Nature reserve, Protected Environment and Biodiversity Agreement throughout the grasslands biome in different locations in South Africa. Mpumalanga and KZN constitutes much of this land.

Develop market-based mechanisms for biodiversity friendly red meat

The results from market based mechanism for biodiversity red meat pilots indicated that South African red meat industry is not ready to accept it as an instrument to regulate the market. Its feasibility can only be associated with the niche market which does not have a considerable amount of impact on the behaviour by the managers who are responsible for these rangelands. South Africa lacks regulation which will support and regulate the introduction of certification of environmentally friendly red meat for the sector. The program has developed a market based mechanism which supports the production of biodiversity friendly red meat.

Develop Tools and Guidelines (T&G) for agricultural land-use planning and decision making.

Individuals and institutions who work in grassland landscapes need to be equipped with reliable information that can help them take decisions to ensure that biodiversity is sufficiently considered – and safeguarded – in their decisions, plans and activities.

Grasslands Ecosystems Guidelines (GEG) and Grazing and Burning Guidelines for Biodiversity (GBGB) are some of the T&G which were developed and used by Grasslands Program.

These tools focus on the principles of ecosystem management from a development perspective, aiming to provide development planners and managers the tools needed to make sensible decisions within the grassland biome.

The Grasslands Ecosystem Guidelines(GEG)

The GEG is a practical guide that provides a consistent benchmark and framework for addressing the biodiversity-related aspects of land-use planning, landscape management and environmental regulation in South Africa’s grasslands.

The guidelines address key questions about grassland biodiversity that should be asked when planning or embarking on an activity in grassland. They bring together a consensus of scientifically reliable knowledge from a wide variety of sources and experts, and present it in a nontechnical format that is accessible and relevant to non-specialists.

The Guidelines are intended to enable users to contextualize and interpret spatial biodiversity priority areas, such as those shown in systematic biodiversity plans. They should make it possible for the user to ‘walk off the map’, stand in a grasslands landscape and

- Correctly identify the broad ecosystem type they find themselves in;
- Understand broadly what drives this ecosystem in terms of ecological functioning;
- Understand what the limits of acceptable change are within that landscape, from a land-use and environmental perspective;
- Interpret how impacts need to be managed in that landscape, and how to monitor whether management is effective in securing biodiversity and ecosystem processes.

Grazing and Burning Guidelines (GBG)

Grazing and Burning Guidelines: Managing grasslands for biodiversity and livestock production. The guidelines are designed to encourage grassland managers to think about and observe the dynamics of their particular management scenario, and to apply biodiversity-friendly principles.

The grazing and burning guidelines have been collated from many grassland ecologists, farmers, academics and biodiversity and grazing specialists.

They represent the current best understanding of how to achieve the parallel and mutually-beneficial management objectives of:

a) Economically-viable and sustainable livestock production founded on improved, or at least stable, veld and soil condition; and

b) Conservation of the indigenous grassland ecosystems, including their component plant and animal species.

These guidelines had long been recognised as a sector need that would develop consensus on how best to manage grazing and burning for the benefit of healthy grassland biodiversity and economical viable livestock production.

This grazing and burning guidelines is intended to provide farm managers, conservation and agricultural extension officers and various decision-makers with the best practice principles needed to graze and burn different grassland ecosystems of South Africa in a way that doesn't compromise their production potential or inherent biodiversity value.

The hope is that as these principles are applied over increasing areas, there is greater likelihood for the persistence of biodiversity across the large portions of the grassland biome that are used for extensive animal production.

These guidelines should be used as a resource during the development of farm management plans that consider biodiversity conservation as one of their objectives.

Cattle and sheep in communal grasslands at nThambamhlope, KwaZulu-Natal.

THE ECOLOGY OF FIRE

Michael Panagos

Tshwane University of Technology. Email: PanagosMD@tut.ac.za

Introduction

Fire is a natural and important component of African ecosystems, especially grasslands and savannas. The early Portuguese explorers who rounded the Cape called South Africa “terra dos fumos” – land of smoke and fire. But there is a lot of misunderstanding about fire amongst the general public. Fire is seen as a destructive force, as something to be prevented, or perhaps as a “necessary evil” to be tolerated

Much of this attitude comes from historically from foresters, for whom fire is indeed a destructive force - although even there attitudes are changing, as foresters realise that fire is a crucial component of many natural forests. Fire is also associated with damage and death, when injudicious use of fire results in a powerful force getting out of control.

But the fact is that there is a separation between the general public and those who must manage our natural systems. Fire is the single most important management tool in most of South Africa’s biomes, especially in conservation areas where other forms of management are limited.

So why do we burn?

Controlled use of fire can be used to:

1. Remove moribund grass. This is basic sound veld management as a thick layer of moribund (dead) grass smothers new growth and causes a shift in species composition towards less desirable grass species. Important grazing species like redgrass (*Themeda triandra*) thrive in fire-prone areas.
2. To control woody encroachment – this can be questionable, as very hot fires are required for bush control
3. To make firebreaks – required by law
4. To encourage game movement, especially on large reserves or game farms
5. To control ticks – also a questionable practice
6. To stimulate an out-of-season “green bite”. This is considered unacceptable as it can have a severe effect on the vigour of palatable grasses, reducing veld condition

Overstocking by commercial farmers has led to bush thickening on this farm in North West province

Deciding when to burn

Whether to burn or not should be based on sound veld management knowledge, and the decision should be taken on basic ecological principles rather than on a repeated "calendar".

The condition of the veld measured against the objectives of the manager, determines whether or the area is ready for burning or not. A basic veld condition survey is conducted to determine the ecological status of the veld, and an estimate of the grass fuel load should also be taken. The fuel load is the amount of material available to carry a fire, and is measured in kg/ha. There are various veld condition assessment techniques available – see the paper by Frits van Oudtshoorn on page 26 for more information.

The ecological status of the veld is decided by which categories of grasses dominate the veld. Grasses are divided into four ecological categories, called decreasers and increasers, based on the way they respond to grazing.

- Decreasers: these are generally the most desirable grasses, like redgrass, which will decrease when undergrazed or overgrazed
- Increaser 1: These are grasses which thrive when there is very light or no grazing, such as hairy trident grass (*Tristachya leucothrix*). Increaser 1 grasses can have a good grazing value like trident grass, or they may of little value to livestock, like black-seed grass (*Alloteropsis semialata*)
- Increaser 2: These are grasses that thrive under overgrazed conditions, like Eragrostis species. Often these grasses have moderate or low grazing value.
- Increaser 3: These are grasses that thrive when the veld is selectively grazed, especially by small game or sheep, like 'ngongoni (*Aristida junciformis*). Usually these grasses have little or no grazing value.

Together the ecological condition of the veld and the fuel load are used to determine a forage and fuel factor.

Veld dominated by Increaser 2 grasses should not be burnt. The veld is in a "pioneer" stage. Rangeland dominated by increaser 1 species should be burnt to maintain the state of the veld – resting for too long will result in accumulation of moribund material which will both smother desirable species and result in a fire hazard.

Rangeland that is both moribund and exceeding 4000kg/ha should be burnt.

Types of fires

There are several different types of fires, which are chosen depending on the objective of the burn.

- Surface head fires (head burn) burn the grass in the direction of the wind. These are recommended for controlled burns as they cause least damage to grasses
- Crown fires burn in the canopy (crown) of trees and bushes. These are used for bush control
- Back burn – this is a fire set to burn backwards against the wind. It is usually set deliberately to fight an oncoming fire. Backburns are slow and very hot at ground level and can cause damage to the grass. Backburns are also a natural phenomenon of patch or mosaic burning (see below), where fires spread in different directions to cause a range of fire types.

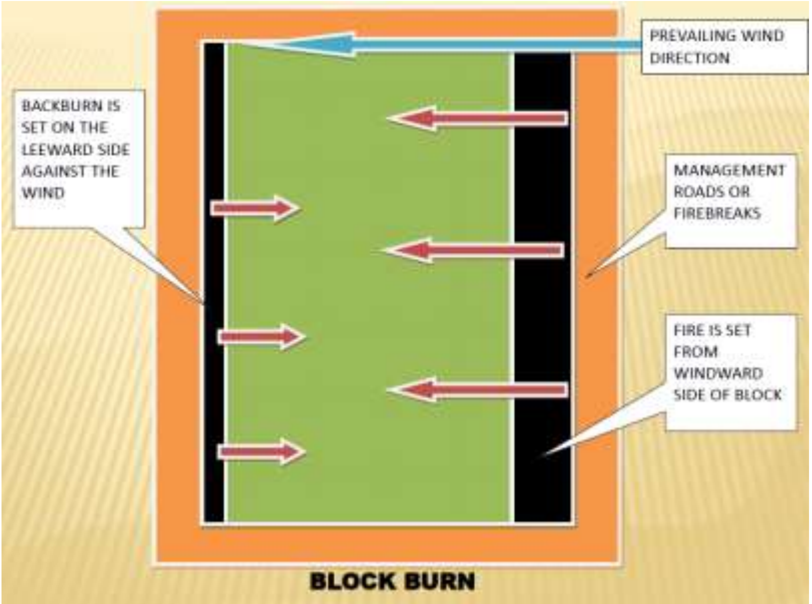
Fires can be burned in several different patterns for different purposes.

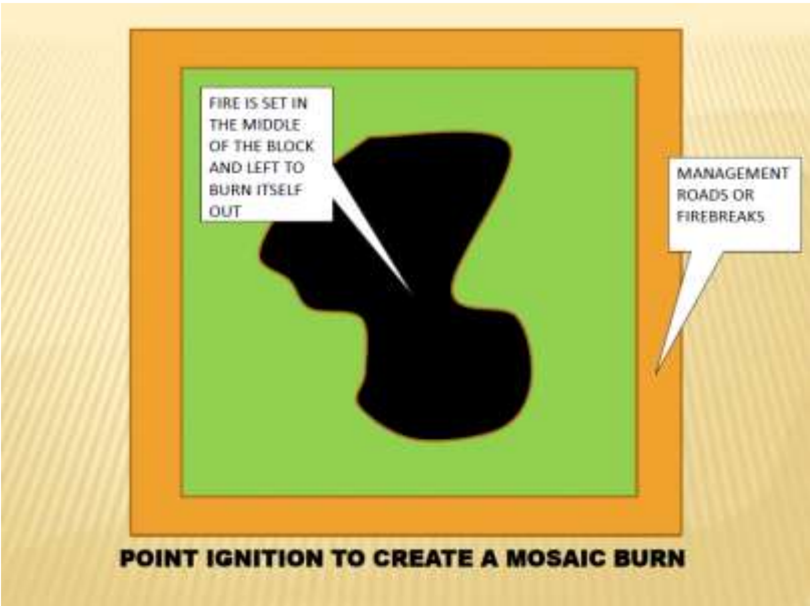
- Mosaic burning. When fires are lit in different places, at different times, in order to result in a semi-random patchwork or "mosaic" of veld with different shapes, ages and frequencies of burning. In large conservation areas, this is the strategy most commonly used, as it allows for heterogeneity in the landscape – that is, a variety of habitats suiting different species.
- Block burning. This is the more traditional approach of setting aside carefully designated blocks and burning them periodically according to a timetable (for example, blocks A, B and C every third September, Block D every year, and Block E no burn). This is often more practical in small management areas as blocks are easier to manage than mosaics. They

are more frequently used on farms where the objective is animal production. Where arson fires are a frequent occurrence, block burns are generally more useful to pre-empt the arson fires and form large, block-sized "firebreaks".

1: Initiation of a block burn on the windward side (headburn) of the block using a drip torch

2: This blockburn will now run with the wind towards the leeward side of the block where a backburn has been set





Fire intensity

Fire intensity is the amount of energy released per unit time per unit of distance, measured in kJ/s/m. Fires are classed as cool fires and hot fires depending on their intensity.

A cool fire (less than 1000 kJ/s/m) is recommended for removing moribund grass. A cool burn can be achieved with a fuel load of less than 4000 kg/ha, air temperature below 20°C, and relative humidity more than 50%. These are the safest conditions to burn, when the fire has less chance of getting out of control.

A hot fire (more than 2000 kJ/s/m) is recommended to control bush thickening, and should be ignited when fuel load is greater than 4000 kg/ha, temperature is greater than 25°C and relative humidity is less than 30%. These types of fires can be dangerous if they get out of control.

Fire season

The best time to burn is when the grass is dormant, usually just before or just after the first spring rains. In the higher-rainfall areas of the country, like KwaZulu-Natal and the Mpumalanga escarpment, it is often best to burn before the spring rains, as there can be sufficient moisture in the soil to stimulate growth after winter before the rains occur.

Burning the veld when the grass is green can cause a great deal of damage to the grass.

Fires for controlling bush encroachment should be burnt when the grass is very dry, in the middle to late dry season.

The frequency of burning is influenced by a range of factors, including climate, vegetation type, and objective. For high-rainfall (above 700mm) grasslands, the frequency of burning is usually between 2-4 years. In arid savannas (less than 500mm) burning intervals should be greater than 7 years. Fynbos areas can be burnt every 12-15 years, ranging up to 30 years in some types of Fynbos.

After the fire

For livestock grazing, the veld should generally be grazed as soon as possible after the burn to take advantage of the nutritious regrowth. This is particularly true of sheep which require short, nutritious grass. The rule of thumb for cattle is to wait until the grass is 10-15cm high. The veld should then be rested to allow it to recover.

For nature reserves, communal areas and other opens systems fire can be used to attract animals towards certain areas and away from others. But the area burnt needs to be large enough to prevent overgrazing on the burnt portion. Usually such systems are fairly extensive (e.g. greater than 20,000 ha) but there is no reason why they cannot be practiced on a smaller scale.

Firebreaks

By law, firebreaks need to be prepared. They can be prepared by burning, mowing, or mechanically clearing. Mechanical firebreaks require flat ground and can be expensive. They also result in bare soil which is subject to soil erosion.

The burnt firebreak requires minimal equipment and preparation, but can be labour demanding and potentially dangerous.

The width of the firebreak varies with local conditions and fire danger. They can be as little as a few metres wide in most areas to greater 100m wide in the Drakensberg, where a combination of berg winds, arson fires and difficult terrain make fire-fighting difficult.

The main role of the firebreak is not to stop the fire – fires can easily be carried for tens or hundreds of metres in windy conditions. Rather, it is to provide access to the fire and provide a safe line from which to start a backburn.

Burning equipment

Burning equipment can range from cheap home-made appliances to sophisticated specialist equipment. The equipment includes both equipment to initiate the burn (drip torch, fire box, rake and match, Mielie cob saturated with diesel and fixed to a length of wire) and equipment to contain it (fire beaters, water pumps).

Conclusion

Fire is a natural part of the grassland and savanna ecosystems of Africa and a great deal of the ecological processes that make the environment function are directly related to fire.

The first rule of fire is to understand it – know how and when fires are likely to occur, and know how to respond. Know when to place controlled burns and when not to, and for what reason. Know how to see the moribund grass in the veld and recognise that it is time to burn. Know how to see the larger patterns in the landscape to decide where to burn, and how much.

And the second rule is to never take it for granted. Fire can be a powerful ally and a dangerous enemy.

INTRODUCING THE CROCODILE RIVER RESERVE

Mercia Komen

Email: mkomen@mweb.co.za

The origins of the Crocodile River Reserve (www.crocodileriverreserve.co.za) can be dated to the early 1990s with a dream that brought landowners together to protect and preserve a pristine landscape. The dream was scuppered, but the Rhenosterspruit Nature Conservancy, including Oori Game Farm and the Roodekrans Game Reserve survived to pay tribute to that dream.

More than two decades later, landowners are applying once again. But this time, others have noticed the ecological value too. The South African National Biodiversity Institute (SANBI) has identified this area for inclusion in Protected Areas. The National Strategy for Expansion of Protected Areas flagged the region east of the Cradle of Humankind as sufficiently intact and ecologically important to be protected (2008).

Later, SANBI identified threatened ecosystems nationwide, three of which occur right here. These findings confirm what landowners have known all along: this is a special place worthy of conservation. Biodiversity Agreements are being concluded with Gauteng Department of Agriculture and Rural Development. These agreements will provide firm and clear indications of willingness to move toward Nature Reserve and/or Protected Environment status.

Progress

More than 200 landowners made formal commitments by signing the Biodiversity Stewardship Agreements. This was a sufficient response to persuade the authority we could "capture" a wide enough area to make Nature Reserve a viable option. There is an earnest and sincere desire in the region to protect the ecosystem in perpetuity

The Biodiversity Agreements were between State and Landowner. That is not our dream. So the Agreements were shelved, and we started a new phase in which Landowners sign a commitment to each other, and elect a management structure empowered to apply for Nature Reserve status and enter into an agreement on the management of the Nature Reserve.

The Reserve has made great strides in establishing an alien plant control programme which employs several people to monitor and control pom pom and other problem plants, and drawing up fire management plans for the reserve as a whole.

INTRODUCING THE GRASSLAND SOCIETY OF SOUTHERN AFRICA

Alan Short

Short Ecological Consulting

The Grassland Society of Southern Africa (www.grassland.org.za) was founded in the 1960s by a small group of researchers, leading farmers and practitioners who felt that veld management and pasture science needed a dedicated voice.

The GSSA has provided that voice for over 40 years. Members include internationally renowned ecologists and fresh students, farmers and policymakers, conservationists and consultants. GSSA members have been at the forefront of shaping global understanding on how ecosystems function, on efficient pasture production, of how society interacts with its natural resources.

The organisation is a dynamic and inclusive forum which champions the sustainable use of rangelands and pastures for the benefit of people and the environment. Members and associates of the GSSA are active in a range of applied fields such as livestock production, wildlife management, nature conservation, water catchment management, rangeland rehabilitation and socio-economic aspects of rangeland management under different land tenure regimes.

The Society enjoys strong support from universities as well as government departments, both agriculture and conservation. The GSSA has a multi-disciplinary base and promotes interaction between environmental practitioners, scientists and students who are affiliated with a wide range of institutions including government, universities, development, agricultural, wildlife and related agencies.

While the Society has historically had a strong agricultural focus, social and environmental sciences are increasingly represented among its members and outputs. The GSSA is a professional association with over 450 members of whom 90% are based in South Africa and 10% in other countries, mainly in the SADC. Recently the GSSA, through its independent Trust, has initiated a mentorship programme to encourage support for qualified but inexperienced young professionals.

The Society publishes the internationally-recognised *African Journal of Range and Forage Science* and *Grassroots*, a quarterly bulletin. An annual Congress is held in July and supported by over 200 South African and international delegates. Each year an award is made to recognise the best conservation farmer in the province where the congress is held. Other awards recognise student and lifetime research achievements in rangeland science. The GSSA hosts various training courses and workshops like the annual research skills workshop, fire workshops, or farmers' days. The GSSA also hands out an award for best young scientist at all of the regional and national ESKOM science expos, an event sponsored by Eskom for over twenty years to encourage learners of all ages to participate in science. The quality of some of the projects presented by these youngsters is often astonishing.

The Society stays relevant by its long unwritten tradition of balancing youth and experience in the council and all its structures. Council members have ranged in age from twenty-something post-graduates to retired professors, a balance which perfectly matches the needs of an evolving scientific landscape in Africa.

GRASSLAND BIODIVERSITY

Vincent Carruthers

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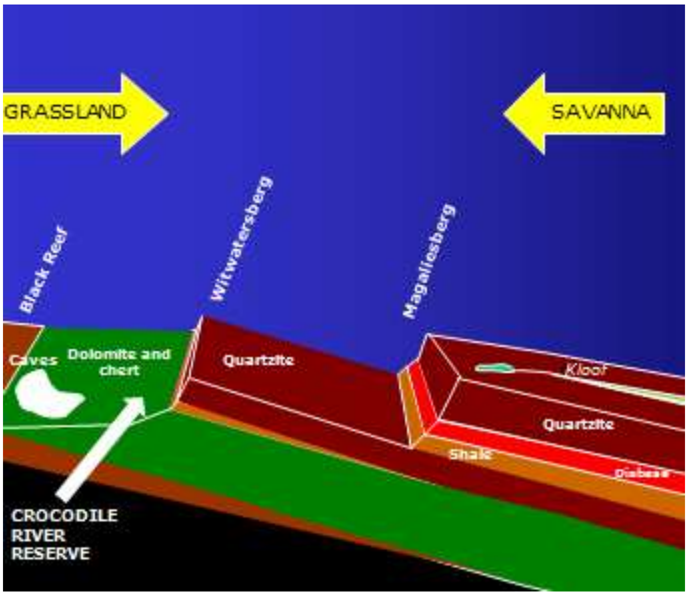
Introduction

This short commentary focuses on the variety of life forms and adaptations that make up the complex ecosystem in the grassland biome. The entire biome covers between 25% and 30% of southern Africa. The area considered in this discussion is centred on the Crocodile River Reserve and beyond to the cover region generally referred to as the Bankenveld, which includes the Magaliesberg and Cradle of Humankind, soon to be formally proclaimed the Magaliesberg Biosphere under the UNESCO Man and the Biosphere Programme (MAB).

Grassland is not, as is sometimes portrayed, a sterile sward of homogeneous pasture. The Bankenveld landscape is the consequence of billions of years of extraordinary geological developments that have created a series of parallel ridges and valleys. Within this structure an intricate mosaic of topography, geomorphology, soil types, climate and drainage all combine to create a wealth of habitat variation and a consequently rich biodiversity. Early Dutch-speaking settlers likened the parallel ridges to pews in church, *banke*, and named the region the *Bankenveld*. The sequence of geological events that produced this diverse landscape is summarised in the table at the end of this paper.



A north-south cross section of the Bankenveld

The following broad habitat types are briefly discussed below together with some examples of the species that have adapted to them:

- Open grasslands
- Subterranean habitats
- Rocky outcrops
- Wetlands
- Disturbed habitats

The evolution of grassland

Graminoids (grasses and related families of plants) evolved before the break up of Gondwana (palynogical evidence suggests that grass was consumed by dinosaurs in the late Cretaceous) however, grass only became widespread in southern Africa from about 20 million years ago as the subcontinent became more arid and rainfall became more seasonal.[1] The botanical structure of

[1] Mucina and Rutherford, p 352

grass with rhizomes or stolons at or below ground level enabled it to withstand long dry seasons and to tolerate frost and fire better than competitive flora. The earliest grasses emerged among the scrubland in the arid west. With further global cooling during the early Neogene, new species of grass adapted to the cold, dry winters of the central plateaux[1]. Eventually grass displaced the woodland that dominated the plateaux at that time and it continues to encroach into the savanna biome wherever grass has an ecological or botanical advantage.

Grassland, like other biomes, is permanently at war, fighting battles for supremacy or displacement along an ecological frontier. The Bankenveld (and Crocodile River Reserve) lies right at the front line of the battlefield, the ecotone between grassland and savanna. It is this dynamism that makes it such an interesting and diverse ecological region.

Open grassland habitats

Concurrent with the rise of the grassland biome was the parallel evolution and adaptation of animal life, notably mammals. Grassland has the highest primary productivity per unit area of all terrestrial biomes[2] and is capable of supporting large herds of grazing ungulates. Often termed "plains game," these large herbivores developed fleet-footed, hoofed mobility for open country and their young are born with the capability of running almost immediately after birth. They also evolved elongated skulls with eyes situated well behind the mouth so that they retain visibility over the grass stems as they graze.

The elevated eye level of red hartebeest allows it to retain long distant visibility while feeding.[3]

The difference between savanna and grassland biodiversity can be demonstrated by paging through the distribution maps in different field guides and seeing how many species have distribution patterns that terminate at the Bankenveld. The distribution patterns of blue and black wildebeest are typical examples.

[1] McCarthy and Rubidge, p 261

[2] Van As *et al*, p 117

[3] By Laura (http://www.flickr.com/photos/twonickels/90893870/) [CC-BY-2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons

The abundance of game on grassland is further increased by the tendency to be selective in the types of grass they utilise, thereby dividing the resources of the habitat. Waterbuck select coarse riverine vegetation, mountain reedbuck graze on slopes with poor quality soils, zebra and wildebeest graze on shorter grass and red hartebeest on a wide selection of taller grasses.[1]

The nutritional value of different grass species varies and most of the ungulates are ruminants which enables them to extract the maximum nutrition from fibrous grass. Grassland hares and rabbits achieve the same result by re-ingesting their faecal pellets.

It is well known that grassland supports many species of forbs, bulbs and small shrubs as well as grass species. Grey rhebok are distributed exclusively in the grassland biome but they specifically browse on the dicotyledonous forbs in grassland, rarely feeding on the grass itself[2].

The two grassland vegetation units in the Crocodile River Reserve, Egoli Granite Grassland and Carltonville Dolomite Grassland demonstrate this and some of the wild flowers are spectacularly beautiful, especially in early summer. Poison bulb *Boophone disticha* uses a wind-driven 'tumbleweed' technique to distribute its seeds over open ground. The method is particularly successful after fire has cleared obstructions. Orchids such as the slipper orchid *Eulophia bainesii* and the crested orchid *Eulophia zyheri* thrive in the grasslands of Rhenosterspruit Conservancy. The equally specular and more abundant bobbejaanstert Xerophyta *retinervens* is also found in grassland especially on stony slopes.

Crested orchid

Eulophia zyheri

Poison bulb

Boophone disticha

Bobbejaanstert

Xerophyta retinervens

The rise of large herds of herbivores introduced another factor, grazing, to which the grasslands were better adapted than woodland. Young tree growth is vulnerable to being browsed off before the plant can become established. With grass, on the other hand, the growth points and nutrition are kept below the surface of the ground, well out of reach of grazers. As a result, woodland can seldom expand in the presence of large numbers of herbivores which inadvertently sustain and expand their own grassland resource.

In the absence of woodland perches a number of ground birds such as the blue cranes, secretary birds, lapwings and black korhaans have evolved characteristic long legs to elevate them above the grass. Seed-eaters replace the frugivores of the woodland and the colourful courtship plumage, necessary in the forest gloom gives way to cryptic colouring and elaborate aerial courtship as in the whydahs and some larks. Ground nest scrapes and well camouflaged eggs are highly developed in many grassland birds.

Trees are generally absent from grassland except where they are protected by rocky outcrops or river banks. However there are a few species that are specifically adapted to withstand fire. Cabbage trees *Cussonia paniculata* have a thick, corky protective bark that seldom burns away to the sapwood. There are also several suffrutices – trees with underground trunks and rootstock – in the dolomitic grassland. By exposing only short aerial leaf shoots to possible fire and frost the

[1] Smithers and Skinner pp 642-688

[2] Smithers and Skinner, p 689

bulk of the plant remains protected underground. Two examples are the mabola plum *Parinari capensis* and the elephant root *Elephantorrhiza elephantina.*

Pintailed whydah[1]

Leaves and fruit of mabola plum *Parinari capensis.* The main part of the tree is underground.

Subterranean habitats

Grassland exists because it is adapted to survive fire, frost and extended dry seasons. Numerous invertebrates have also adapted to these conditions by burrowing underground. Termites are particularly highly developed in that regard. They construct huge subterranean nests where they are insulated from fire and frost and tests conducted at Nylsvley showed that no mortalities occurred during a veld fire. By comparison mortality was almost 100% among arboreal insects in small trees during the same fire, even where the trees were not entirely destroyed.[2] Termites are important components of the grassland trophic web because of their ability to digest the cellulose material in grass thereby giving their predators access to that energy source.

[1] Photo: Erik Stockenstroom

[2] Gander

Many small mammals such as the Bushveld Gerbils *Tatera leucogaster* also use underground burrows and are thus able to survive grass fires as are other arthropods such as scorpions and trapdoor spiders.

Rocky outcrops

The ecological frontier between the advancing grassland and retreating savanna woodland is never a clear-cut line. Pockets of resistance occur wherever the grassland fails to have the advantages and rocky outcrops provide such pockets. Here boulders protect young trees from fire, retain daytime heat to moderate nocturnal frosts and retain small amounts of moisture in dry seasons. Outcrops in grassland are therefore frequently characterised by copses of trees. In dolomite landscapes sinkholes provide similar shelters.

White stinkwood *Celtis africana*, Wild Medlar *Vangueria infausta,* Olives *Olea europaea africana* and Rock Figs *Ficus ingens* are all common species in these situations but a variety of other trees may appear. Most are fruit-bearing and are distributed by birds. Their presence in the rocky outcrops means that small populations of woodland birds are sustained in the grassland such as Go-away Birds, barbets and woodpeckers.

Rocks are also the preferred habitat for reptiles, especially lizards and snakes. The handsome but clumsily named Yellow Throated Plated Lizard *Gerrhosaurus flavigularis* and Ground Agama *Agama aculeata* are among the lizards that frequent this habitat. Relatively few South African snakes are poisonous but ones to look out for in rocky situations are Puff Adders *Bitis arietans,* and Rinkhals *Hemachatus hemachatus.*

Wetland habitats

Wetlands are as much a part of the grassland biome as the grass itself. The Bankenveld is characterised by two main water resources: the major rivers that rise in what are now largely urban areas to the south, and springs rising from dolomitic aquifers within the Bankenveld. The former are currently posing problems of contamination. The dolomitic water remains unpolluted although it may be threatened by acid mine drainage in the future. It provides an abundance of water which is generally absent from other regions with similar rainfall.

The entire Bankenveld is part of the Limpopo catchment and all water courses flow northwards through the region. The dip-slope created by the tilting of the Magaliesberg quartzite ridges also drains precipitation and groundwater northwards and streams on the northern slopes are much more common than on the south.

Amphibians are important indicators of wetland health. About twelve species of frog occur in various wetland niches in the grasslands of the Bankenveld. The distinctive calls of each species allows for easy monitoring of their diversity and population size. Calls that typify healthy wetlands are the Bubbling Kassina *Kassina senegalensis* and the Giant Bullfrog *Pyxicephalus adspersus*.

Riparian bush along a stretch of the Magalies River flowing through cultivated grassland upstream from Hartbeespoort Dam

Wetland vegetation is another, more conventional method of assessing wetland habitats. The banks of rivers flowing through grassland are often not wooded although thickets of riverine bush do occur along some reaches. The most conspicuous riparian tree in the Bankenveld is the river bushwillow *Combretum erythrophyllum* but several other species may occur including many opportunistic invasive species.

Disturbed habitats

One of the more interesting species to have adapted to the grassland was our own. As the woodland retreated over the past five million years most of the arboreal primates remained restricted to arboreal life and similar species to ours such as gorillas and chimpanzees are now confined to the forests of central Africa. Some hominid apes, however, evolved adaptations that enabled them to move away from the trees. They developed bipedal locomotion and hands were free to manipulate tools rather than grasp branches. *Homo sapiens* became a distinctly grassland species.

Human evolutionary dependence on grassland has remained with us throughout history. Almost all successful human societies on all continents have been based in grassland. Graminoids such as wheat, mealies and other cereals are staple diets. Grass-eating cattle are the most common domesticated animals and in Africa thatch is historically the dominant traditional building material.

However, as we enter the Anthropocene epoch after a million years of grassland existence, human activity appears to be reversing the grassland expansion. Huge areas of grassland are now given over to monoculture, sometimes of grains but more and more for timber.

Another significant impact on grasslands in South Africa has been the rapid expansion of open cast mining in Mpumalanga and North West Province. Rehabilitation programmes are simulating grassland cover but the re-establishment of functional ecosystems and any depth of biodiversity is proving difficult to reproduce.

Some palaeo-ecologists believe that the original expansion of grasslands contributed to the cooling of the earth during the late Tertiary period.[1] Grasslands store less carbon than forests in actual plant material but grassland soils are richer in carbon than forest soils. Effectively grasslands are more efficient at removing carbon from the atmosphere. This is further aided by grass fires that generate large amounts of charcoal that is reintroduced into the soil.

The Magaliesberg Biosphere

The notion of a biosphere reserve in the greater Magaliesberg area was first proposed in 2006 and official registration is expected in June 2014. The original meaning of the term refers to the layer of air, land and water that envelops the planet and in which all known life exists. In 1970 the UNESCO used the phrase “biosphere reserves” to describe special areas and ecosystems where sustainable land use by humans could be reconciled with the conservation of biodiversity. These places are nominated by national governments and internationally recognised while remaining under the jurisdiction of the states in which they are located.

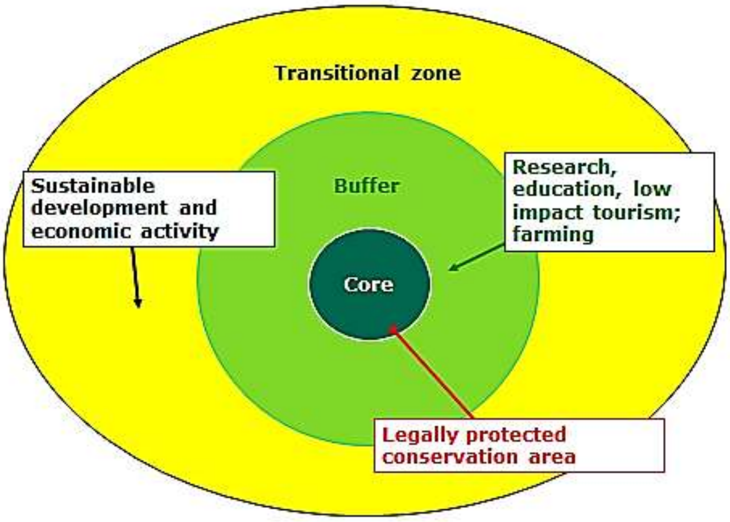
Biosphere reserves have three functions:

- The conservation of natural ecosystems
- Economic development that is sustainable, and
- A support function for research, monitoring and education.

Every biosphere reserve comprises three zones:

1. A central core area where the environment and biodiversity is protected by law.
2. Around these cores are buffer zones for various land uses such as tourism, agriculture, education, research as well as certain types of residence.
3. Beyond the buffer is a transition zone where any economic activity can take place provided it does not impact negatively on the biosphere.

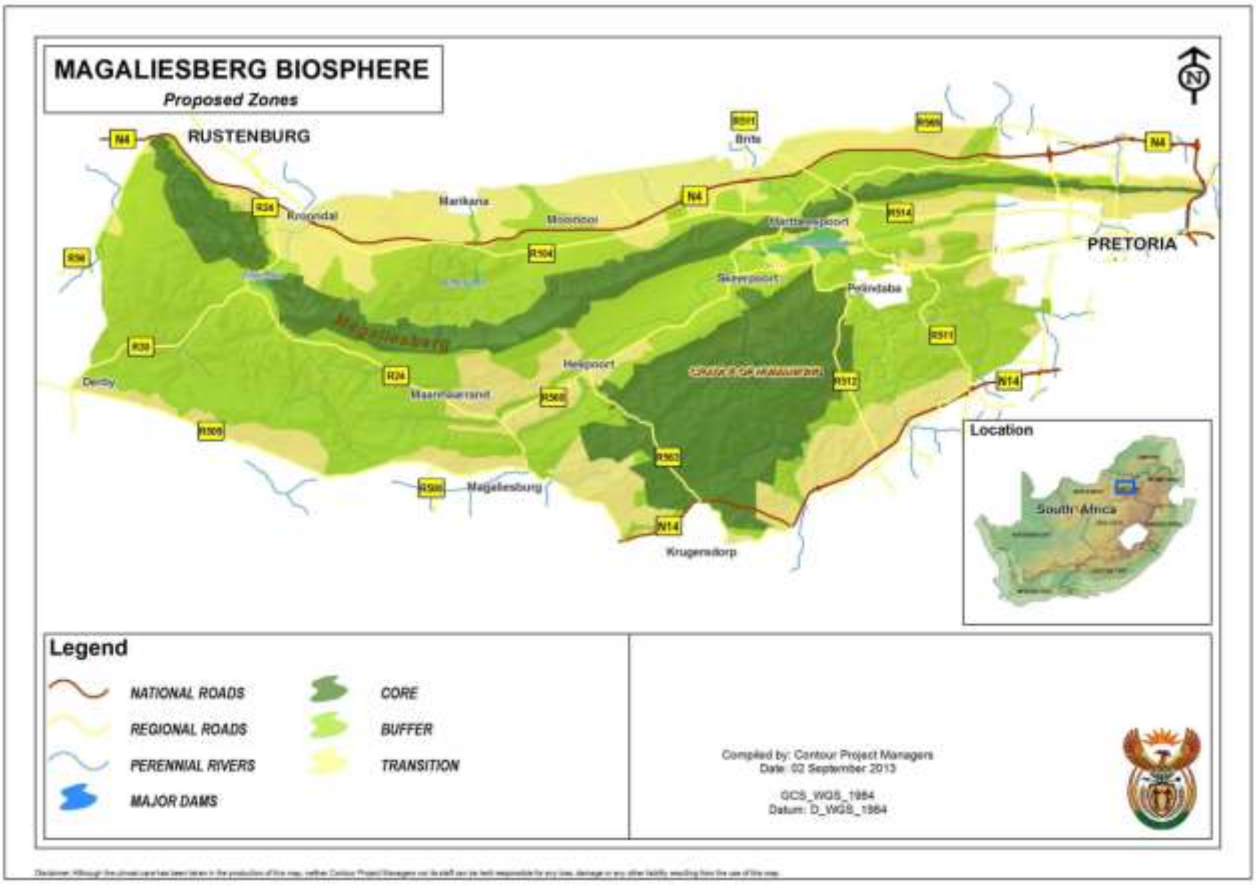
[1] Retallack cited in McCarthy and Rubidge p 261



Simplified diagram of the biosphere concept.

The core areas of the Magaliesberg Biosphere will be the Magaliesberg Protected Area under the National Environmental Management Protected Areas Act (No. 57 of 2003) and the Cradle of Humankind World Heritage Site under the World Heritage Convention Act (No. 49 of 1999).

The buffer zones will be the existing conservancies where landowners are voluntarily implementing sound environmental practices. The Rhenosterspruit Conservancy is one of the largest and most important of these and members of this conservancy played major roles in developing the biosphere application.



Summary of geological events that created the topography of the region[1]

Topographical feature	Geological event
BLACK REEF: Auriferous quartzite conglomerates exposed on the south of the Rhenosterspruit Conservancy.	2650 MILLION YEARS AGO tectonic movements caused parts of the ancient Kaapvaal Craton, the earliest continental mass, to subside below sea level. River estuaries were drowned and filled with the silt, some of which bore traces of gold and other minerals. The silt deposits consolidated into the Black Reef quartzite conglomerate.
DOLOMITE: The calciferous rock landscape and cave formations that characterise the Cradle of Humankind and much of the Rhenosterspruit Conservancy	2650–2350 MILLION YEARS AGO a shallow sea developed in the Kaapvaal hinterland. Bacterial life in the form of cyanobacteria evolved the capacity to photosynthesise and proliferate in vast quantities in the shallow waters. Photosynthesis precipitated calcium carbonate which later combined with magnesium to form dolomite rock which characterises much of the Rhenosterspruit Conservancy. Cyanobacteria formed domed structures of various sizes called stromatolites. The calcified fossils of stromatolites are abundant throughout the dolomitic areas of Rhenosterspruit.
OXYGEN: The oxygenated atmosphere we breathe and the development of almost all animal life as we know it today.	Photosynthesis released oxygen as a by-product. For the next 500 million years the oxygen combined with soluble iron to create the iron ore deposits of Thabazimbi and elsewhere. Only after the iron and other minerals had been oxidised did free oxygen begin to be released into the atmosphere.
The Skurweberg and the conspicuous Rhenosterkop.	Dolomite is often interspersed with siliceous chert which is very resilient and accounts for the elevated koppies on the north of the Rhenosterspruit Conservancy.
QUARTZITE: The base material of the Magaliesberg range.	2350–2060 MILLION YEARS AGO the cyanobacteria beds were swamped by silt deposits of sub-tidal sand and mud. The silt accumulated to a depth of several kilometres on the seabed in interspersed layers of quartzite and mudstone shale sediments known as the Pretoria Group.
GRANITE OUTCROPS: Sills and outcrops of igneous boulders in the Rhenosterspruit Conservancy and throughout the Magaliesberg.	2061 MILLION YEARS AGO rhyolite magma erupted over the ancient seabed, followed by intrusions of basalt and diabase collectively known as the Bushveld Complex. The magma intruded between the older layers of sedimentary quartzite and shale forming sills of igneous rock.
BANKENVELD RIDGES. The Magaliesberg and Witwatersberg mountains	The sheer weight of the igneous material depressed the centre of the sedimentary rock beds of the Pretoria Group so that they lifted around the perimeter like the rim of a saucer. Rich deposits of platinum, chrome, manganese and vanadium were precipitated at the edges of the Bushveld Complex. The elevated rim of the sedimentary rocks forms a series of ridges. The valleys in-between were weathered from the softer mudstone shales sandwiched between the more resistant quartzite.
KLOOFS: The steep-walled canyons on the north side of the Bankenveld ridges	1200 MILLION YEARS AGO the Pilanesberg volcano erupted, sending rivers of molten syenite through the Magaliesberg, widening rock faults into kloofs, poorts and riverbeds.
MAGALIESBERG ALTITUDE	500-350 MILLION YEARS AGO the supercontinent of Gondwana moved under the South Pole and the peaks of the Magaliesberg ridges were shaved off to a more or less constant altitude by the polar ice.
RIVER BEDS: The Crocodile, Jukskei, Hennops and other rivers flowing from the south are deflected along east-west riverbeds when they enter the Rhenosterspruit Conservancy.	65 MILLION YEARS AGO the modern Bankenveld landscape began to be re-exposed after millions years of burial under Karoo sediments and lava from the eruptions that split Gondwana into the modern continents. As the crests of the old Bankenveld ridges emerged above ground level, north-flowing rivers of the Limpopo system were defected east or west, often merging before finding passages through the mountain barrier.
KARST CAVES AND DOLOMITIC	4 MILLION YEARS AGO subterranean caverns that had been formed

[1] Based on McCarthy and Rubidge 2005.

SPRINGS	by dissolution of semi-soluble dolomite were exposed to the surface in what is now the Cradle of Humankind. Bones, including those of early hominids, accumulated on the cave floor and were fossilised. The enormous water resources from the karst caves augment the north-flowing tributaries of the Limpopo system.

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MANAGING YOUR NATURAL CAPITAL: THE REAL VALUE OF GRASSLANDS

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> *The grass is rich and matted, you cannot see the soil. It holds the rain and the mist, and they seep into the ground, feeding the streams in every kloof. It is well-tended, and not too many cattle feed upon it; not too many fires burn it, laying bare the soil. Stand unshod upon it, for the ground is holy, being even as it came from the Creator. Keep it, guard it, care for it, for it keeps men, guards men, cares for men. Destroy it and man is destroyed.*
>
> Alan Paton, *Cry The Beloved Country*

Introduction

When Alan Paton wrote those lines in 1948, he could not have known how they would resonate sixty years later. They have been quoted over and over again, and yet, despite the power of the message in those 90 words, society hurries heedless on its course.

There is a relatively new field of study concerned with the understanding the value of the goods and services produced by nature. Many of these goods and services we know quite well, but often take for granted – soil to produce crops, clean water to drink, wood to build or burn, thatch for our roofs. And there is a whole suite of other, less obvious ecosystem goods and services.

The study of the economic value of ecosystems tries to put a real value to all of the things that we take for granted in order to understand the true costs society of degrading ecosystems. And one of the most important factors included in any economic analysis is capital. In nature, we refer to "natural capital".

The International Institute for Sustainable Development defines natural capital as[1]:

> *Natural capital is the land, air, water, living organisms and all formations of the Earth's biosphere that provide us with ecosystem goods and services imperative for survival and well-being. Furthermore, it is the basis for all human economic activity.*

So what is the capital value of nature?

The economic value of a functioning ecosystem is phenomenal, but more importantly, it is not inexhaustible. There are many studies from around the world that demonstrate just how valuable nature really is to humanity, in dollar terms.

One of the major issues with natural capital is that it is usually externalised in economic or financial analyses. In other words, any depletion of the capital is not factored into the accounting of an operation that impacts on that system.

The most obvious example that Gautengers will recognise is acid-mine drainage[2]. When the geologists and the economist calculated the value and the cost of extracting valuable metals from the Witwatersrand geology decades ago, the cost to future generations of cleaning up afterwards was not considered. We are now likely to spend billions of rands over decades, possibly centuries, to come, to monitor and contain the acidic water that resulted from the mining practices that built this country's economy.

Rangelands (the global term for veld) provide a major source of income to millions of people. For poor people in the former homelands of South Africa, the value of ecosystem goods and services from rangelands was estimated at nearly R3 Billion for livestock-related production and another R6.7 Billion for other resources in 1999[3]. These patterns are backed up by numerous detailed studies in different regions.

[1] http://www.iisd.org/natres/agriculture/capital.asp

[2] Expert Team of the Inter-Ministerial Committee on Acid Mine Drainage 2010

[3] Twine 2013

For commercial farmers, the most obvious economic value of rangelands is in forage production for livestock and game.

Forage production

One of the simplest ways to calculate the cost of degraded rangelands on forage production is to use the rain-use-efficiency rule of thumb. In veld that is in good condition, for every mm of summer rain that falls, approximately 5kg/ha of grass is produced. As the veld degrades, so the amount of grass produced per mm of rain declines proportionally. So veld that is at 50% condition will only provide 2.5kg of grass per hectare for every mm – even though the same amount of rain has fallen.

Gauteng receives an average of 670mm of rain every year. So grazing capacities will range between 5 or 6 ha/animal unit for good condition veld, to more than 20 ha/AU for poor condition veld[1].

3: Degraded veld. There are large bare areas between the grass tufts, and the soil is "capped" (i.e. has a hard surface which reducing the rate of rain infiltration drastically). The grass is 'ngongoni (*Aristida junciformis*), which is tough and unpalatable.

Forage production is also severely reduced by bush encroachment, alien plant encroachment and soil erosion. So the cost of degradation in forage terms can be calculated several ways, for example:

[1] One animal unit is the equivalent of a 450 kg steer. To convert ruminants (cattle, sheep, goats, antelope or buffalo) to AU, apply the following simple formula: take the average body weight of that type of animal, double it, add 100, and divide by 1000. One animal unit requires 10kg of forage per day. Multiply by 1.5 for lactating females. (Smith 2006). The requirement for horses is much higher per day.

1. The number of bales of hay that would be required to feed the same number of animals for the same number of days;
2. The number of animals that would have to be removed in order to maintain production for the remaining animals;
3. The cost of bush control to maintain forage production for the same number of animals;
4. The cost of rehabilitation to restore degraded veld to a productive state.

In other words, veld condition has a direct effect on profitability.

Water resources

The main catchment areas for the rivers that power South Africa's economy, fuel its agriculture, provide for its people and form the lifeblood of its ecosystems fall in the grassland biome.

The value of a healthy, functioning grassland for water production cannot be understated, and is recognised by government. For example, water-use licences, including plantation forestry, are based on the proportion of water from each catchment that the licensee will use.

A study in the Thukela catchment indicated that good management practices could result in an *additional* 12.8 million cubic metres of winter base flow, with a direct sales value of R3.8 million per year and adding R18 - R80 million in value to the economy. This catchment only has about 4 million cubic metres of surplus water, so the additional base flow would triple the water available from the catchment.[1]

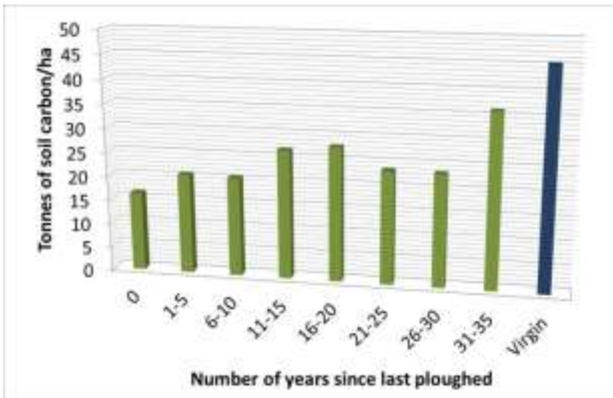
However, the same report also calculated the hundreds of millions of rands it would cost to rehabilitate the catchment. Once again, the cost of depletion of the catchments natural capital was externalised, so that the cost of degradation was not taken into account until it was too late.

Carbon sequestration

Carbon accounting is becoming increasingly important in many "triple-bottom-line" audits. There are numerous market-based mechanisms around the world to incentivise carbon offsets or sequestration. But almost all of them are based around forestry.

Tonnes/ha of soil Carbon in virgin (unploughed) veld in different grassland systems

Amount (tonnes/ha)	Place	Soil depth
38-57[2]	Highveld Plateau (around the Free State)	Top 20cm
55-174[3]	KZN Drakensberg from Mpumalanga border to Underberg	Top 20cm
122[4]	Brotherton Ridge, Cathedral Peak, Drakensberg	Top 20cm
164[5]	Underberg	Top 50cm. Total carbon stocks, not just soil



The recovery of soil carbon after ceasing cultivation in the Highveld, compared to veld that has never been ploughed ("virgin"). After more than 30 years of resting, the soil carbon has recovered to about 80% of the amount of carbon in virgin veld[2]

[1] Maloti Drakensberg Transfrontier Project 2007.

[2] Preger et al. 2010

[3] Knowles et al 2010

[4] Manson et al. 2007

[5] Mills et al. 2005

The grasslands of South Africa are the country's most important carbon storage reservoir. Natural forests are insignificant in our semi-arid environment, covering less than 1% of the country. Other biomes, especially the thicket of the Eastern Cape, are also very important but the sheer size of grasslands largely outweighs the other ecosystems.

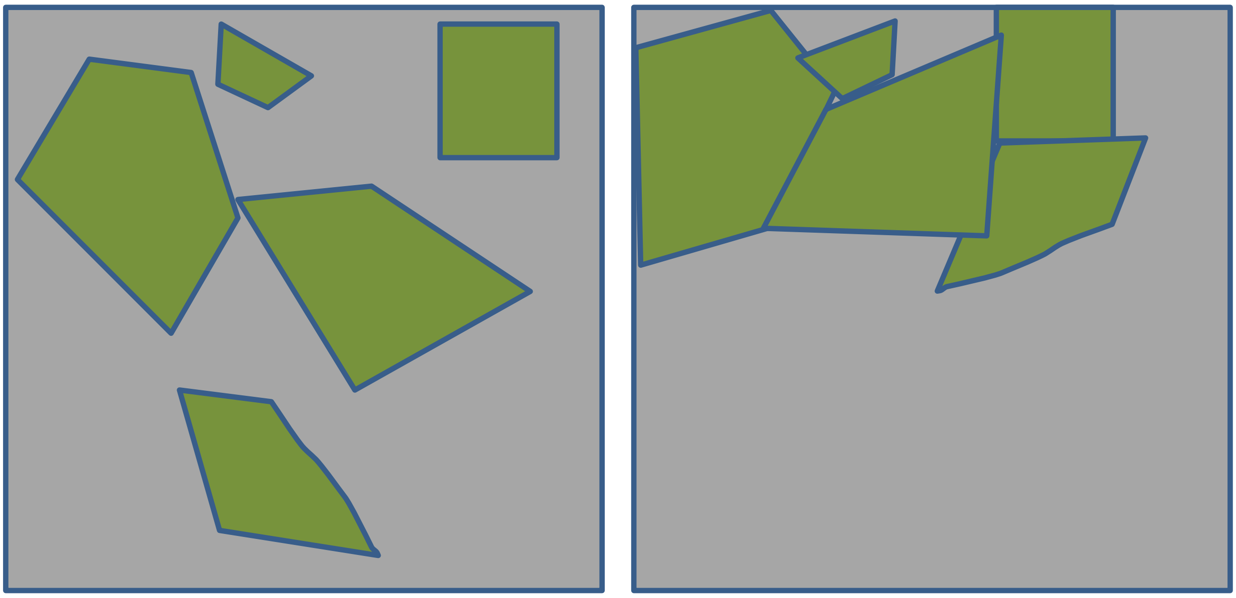
The carbon reservoir of grasslands is not above ground, but below the surface of the soil. In KwaZulu-Natal, healthy grasslands can store between 55 and 170 tonnes/ha of Carbon in the top 50cm of soil alone. In the Highveld, the figures for virgin grasslands are around 40-60 tonnes/ha of Carbon. Cultivation has a massive effect on the amount of soil carbon: Cultivated soils on the Highveld contain about 36% of the soil carbon of virgin veld, and even after nearly 4 decades of resting from cultivation, the soil carbon does not recover to its full capacity.

Connectedness, contiguity and economies of scale

One of the most important concepts in conservation of natural resources is the concept of fragmentation, and its converse, contiguity.

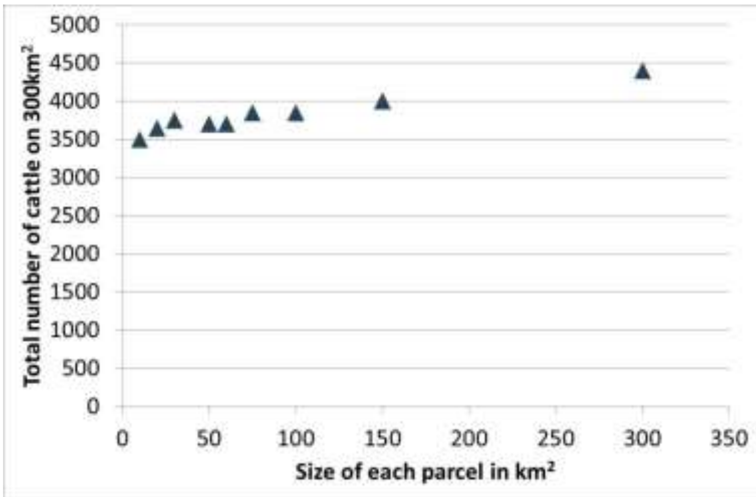
In grasslands, economies of scale are critically important. While the ecosystem goods and services from 300 ha may be little, the ecosystem goods and services from 3,000 ha are substantial, and from 30,000 ha are enormous. These ecosystem goods and services increase disproportionately to the increase in area.

Fragmentation of landscapes into smaller, disconnected parcels is one the greatest conservation concerns. The function of an area of, say, 30,000 ha divided into small parcels separated by transformed land is greatly reduced compared to 30,000 ha of contiguous grassland.



4: Area on the left is fragmented into 5 grassland areas with little connection between them, separated by transformed land. The grasslands on the right are the same total area in hectares, but arranged as one connected ecosystem. The ecosystem functionality on the right is likely to be far greater than on the left, even though the total area is the same.

Even where there are large areas of land adjoining one another, the effect of subdividing the land by fencing and different management objectives can be substantial. One simulation study, using data from South Africa, demonstrated the likely effect on cattle numbers of taking a 300km^2 of land and dividing into smaller and smaller parcels under different managers. Thirty parcels of 10km^2 carry far fewer cattle than one parcel of 300km^2, even though the total area is the same in both cases. The reason for this is heterogeneity – the concept of variation in the landscape. For example, one parcel may have wetlands that can be used for winter grazing, but are too wet for summer grazing, while the neighbour has none.



5: An example of the effect on total numbers of cattle of subdividing one large, contiguous area of 300km² with fences into separate parcels. [1] One large parcel of 300km² can carry nearly 1000 more cattle than 10 small parcels of 30km².

So what next?

The concept of natural capital is still relatively new, but the concept of sustainable management of natural resources is as old as humanity.

The first step in managing capital is to account for it. Conduct an audit of natural resources on your property and estimate (even if only roughly) the quantities of each. If you carry game, livestock or horses, the first question that needs to be asked is: What is the carrying capacity of the veld and do I have enough for all my animals? But also consider the assets that I have listed here and many that I have not: soil and water value, biodiversity, natural landscapes for tourism, and others. What is the state of your streams, dams and rivers? Are your roads in good condition so as not to cause erosion? What is the state of alien plant or bush encroachment?

And the second step is to decide where you would like to see those assets in a generation's time. Capital can accumulate value over time, it can remain stable – or it can deplete until the account is empty.

Conclusion

Economic analysis of natural capital is a new, powerful tool that can help us fully understand and account for the true cost of environmental degradation on society. It is a tool that is shaping government policies globally, and shaping the way conservation organisations address their concerns.

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**VELD CONDITION ASSESSMENT AND MONITORING:
IS MY VELD IN GOOD CONDITION?**

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Introduction

As the human population increases, our demand for residential, industrial and cropping land increases. This demand for more land results in the shrinking of natural veld as well as the over-utilisation of existing veld. As the extent of natural veld decreases, the need and accountability of good veld management practices increases. Without good veld management practices the production potential and general biodiversity of our remaining natural veld is undermined. This is especially true in Gauteng, the most developed province in South Africa.

How do I know my veld is in a good condition?

Many land users might not know how to determine their veld condition. There might even be land users who are not aware of the concept of veld condition. Veld condition **assessment** refers to the evaluation of certain aspects which indicate the "state of health" of the veld for production and/or other ecological aspects (such as biodiversity).

Veld condition **monitoring** on the other hand refers to the repeated assessment of veld condition over time. The purpose of veld condition assessment and monitoring is to determine whether the veld condition is improving or deteriorating. The results from veld condition assessments allow land users to adjust their management strategies in order to ensure long-term sustainable (economic and ecologic) land-use. Veld condition assessment and monitoring is therefore record keeping of natural resources and is just as important as keeping record of one's finances.

Veld condition assessment and monitoring is usually done by land users, appointed veld managers (and their monitoring teams) or ecological consultants. To do objective veld condition assessments a good knowledge and experience of the local plants as well as basic ecological processes are important.

Various criteria are used to determine veld condition. To determine veld condition the following criteria are usually assessed:

- Plant (grass) species composition
    - Good grasses vs. poor grasses (increasers vs. decreasers)
    - Diversity
- Biomass
    - Vitality
    - Moribund
- Landscape function (water infiltration, nutrient recycling)
    - Open patches
    - Soil condition (crust, litter, etc)

Where do we assess?

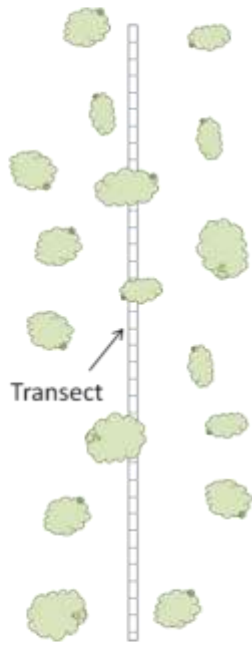
When selecting assessment and monitoring sites it is important to have sites represented in all vegetation units, camps or landtypes on the property. The larger the unit the more sites it should have and vice versa. The sites should be spread out through each vegetation unit/camp. This is best done when a farm planning resource map is available. The map can then be used to identify and plot monitoring sites.

Each site should be well marked with metal stakes and by recording the GPS coordinates. In order to have comparable data it is important to use the exact same spot as the previous assessment. Veld condition assessment is best done towards the end of the growing season, when plants are fully grown but still identifiable before the dry season. In the summer rain regions this is towards March and April.

An example of a farm map, showing 17 monitoring sites (red dots) representing 7 camps and 3 Landtypes occurring on the farm.

How do we assess (various methods)?

There are various methods that can be used to collect data for a veld condition assessment or a long-term monitoring programme. The two basic methods are collecting data along a transect (a long, straight line) or in a quadrat (a small square or rectangle). The former method is mainly used on a farm scale. During this method data is usually collected at 1 m intervals along a 100 m transect. This data can include a species survey (quality of grazing), grass biomass (quantity of grazing) survey or a landscape function survey.

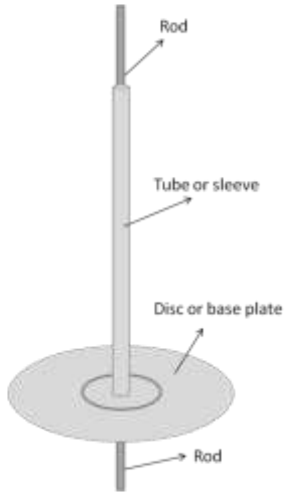


Below is an example of a grass species survey data sheet, where the nearest plant to each meter point was recorded. Where the meter mark is directly on the plant it is recorded as a "hit". The percentage of hits equals the basal cover. This data is then further used to determine the veld condition and even the grazing capacity.

Plant name	Nearest plant	Nearest sub-total	Hit	Hit sub-total	Total
Themeda triandra	卌 卌	10%	卌	5%	15%
Cymbopogon pospichilii	卌 卌	10%	|||	3%	13%
Elionuris muticus	卌 卌 ||||	14%			14%
Brachiaria serrata	卌 ||	7%			7%
Eragrostis racemosa	卌 |	6%	|	1%	7%
Eragrostis chloromelas	卌 卌 ||||	14%			14%
Eragrostis curvula	卌 ||	7%			7%
Aristida congesta subsp *congesta*	卌 |||	8%			8%
Hyparrhenia hirta	卌 卌	10%	||	2%	12%
Setaria sphacelata var. *torta*	|||	3%			3%
	Totals	89%		11%	100%

How to determine grass biomass

Biomass (kg dry grass/ha) determination can be done by cutting, drying and weighing of grass samples collected in 1 m square quadrats. Alternatively biomass estimation can be done by using a Disc Pasture Meter (DPM). The height of the standing crop is measured by placing the rod (see illustration to the right) vertically onto the ground, with the tube and base plate in the upper position. The tube with base plate is then dropped to the ground in order to settle onto the grass sward. The standing crop height is then taken from the ruler where the rod exits the upper part of the tube. This reading is then recorded on a sheet. A minimum of 100 readings at each assessment site needs to be recorded. The average of this 100 readings, in centimetres, is then used to estimate the herbaceous biomass or standing crop in kilograms per hectare (kg/ha). This is done by looking up the average disc height in the table below and looking up the grass biomass for your region.



Converting the average disc pasture metre height to kg of grass per hectare for different pasture and biomes of the country

Average disc height (cm)	Bushveld[1]	Grassveld[2]	Kikuyu[3]	Ryegrass[6]	Eragrostis[4]
1			992	1257	
2	177		1235	1413	
3	895	85	1478	1569	93
4	1501	362	1721	1725	392
5	2035	638	1963	1881	691
6	2517	915	2206	2037	990
7	2960	1192	2449	2193	1289
8	3373	1468	2692	2349	1588
9	3761	1745	2935	2506	1887
10	4128	2022	3177	2662	2186
11	4477	2298	3420	2818	2485
12	4810	2575	3663	2974	2784
13	5130	2852	3906	3130	3083
14	5437	3129	4149	3286	3382
15	5734	3405	4391	3442	3681
…					
20	7088	4789	5605	4222	5176

Once the species composition and biomass production is known the veld condition and grazing capacity can be determined. The most common methods used for this is the benchmark method[1]

[1] Trollope and Potgieter 1986

[2] Kreuter 1985

[3] Bartholomew 1985

[4] Bransby and Tainton 1977

and the biomass method[2]. These methods are generally time-consuming and used for long-term monitoring.

For quicker assessments multi-criteria methods, relying on visual ratings, are becoming more popular. These methods are much quicker but more subjective as they do not rely on actual data but on the perception of individuals.

Such methods were developed by Roberts for the Karoo[3] and Van Zyl for the Highveld[4]. The method we are going to use today during our practical session was developed by Van Oudtshoorn for the Limpopo department of Agriculture[5] and is suitable for bushveld and grassland regions.

Adaptive management

As mentioned earlier, the purpose of a veld condition assessment is to fine-tune veld management. These might include decisions on the following;

- To burn or not to burn
- To slash
- To change a grazing strategy/system
- To reduce or even increase animal numbers
- To change the ratios between types according to their feeding behaviour

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[1] Danckwerts and Teague 1989

[2] Moore and Odendaal 1987

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