# Medium-term changes in grazing capacity of Rolfontein Nature Reserve

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## Introduction

Vegetation monitoring is a series of observations over time, or repeated surveys of plant diversity using standardized methods (McDougald *et al.* 2003). It involves frequent testing of differences between baseline or initial surveys and follow-up surveys. Vegetation monitoring data must be collected at specific sites and at the specific times, to determine changes in species composition and veld condition over time. The primary objective of monitoring vegetation change is to gain an understanding of what is changing in the ecosystems and why (Roberts-Pichette 1995). Species composition and veld condition changes are monitored in relation to the baseline data, wildlife, rainfall and fire. Vegetation monitoring is used to assess the veld's potential condition as per habitat and soil unit characteristics. It is also used to develop methods necessary to promote effective management plans and to achieve conservation principles.

Grazing capacity is the average number of grazing animals that a particular area will sustain over time (Galt *et al.* 2000, Bothma 2002). Bothma (2002) defines stocking rate as the amount of land allocated to each animal for the grazable period of the year. A thorough understanding and assessment of changes in vegetation form the basis of reserve management decisions like game species composition and stocking rates. Vegetation management is specifically aimed towards improving the veld's condition through maintaining species diversity, improving species composition and maintaining abundance and resilience of species on Rolfontein Nature Reserve (Lloyd & Badenhorst 1995).

In 1995, a network of 29 monitoring sites were identified within the mountainous (koppies) and plains habitats, aimed to reflect veld condition changes, the impact of grazing, rainfall and fire in the two main habitat types. Emphasis was however, placed on the plains and plateau regions that were most degraded at that stage, namely Springbokvlakte (300 ha), Bloeigat (540 ha) and Bitterwater (360 ha) (Lloyd & Badenhorst 1995; Koen, Lloyd & Badenhorst 1997). The main purpose of the baseline data was to have a dataset according to which management actions can be assessed, and to enable analysis of vegetation-soil-game interactions (Lloyd & Badenhorst 1995). The bi-annual vegetation monitoring thus reflects the veld condition and grazing capacity change over the short- and long-term periods, for both dry and wet seasons (Hedges 2007).

**The monitoring sites placements were aimed:**

1. To establish whether the veld condition on the reserve / in regions is improving or not, through a) Detecting herbaceous component changes (species composition and cover), b) Evaluating veld condition change in relation to the baseline data, game, rainfall, fire and the veld's potential condition as per habitat and soil unit characteristics;

2. To guide effective game management with regard to stocking rates, game removals and game species composition,

The main purpose of this report was to assess if the goals of vegetation monitoring have been achieved over time, and to determine and establish long-term patterns and changes in the vegetation, on two habitat types namely the koppies and plains. Rolfontein Nature Reserve (RNR) represents a sweet-veld grass veld type, meaning that it is sensitive to overgrazing and drought (Van Oudtshoorn 1999).

## Methods

### *Study sites*

Rolfontein Nature Reserve was established in 1970. It is adjacent to Petrusville and Vanderkloof, on the southern bank of the Vanderkloof Dam, between 260 59' 00" S and 300 48' 20" S longitude, and 240 40'

20" E and 240 48' 20" E latitude (Lloyd & Badenhorst 1995). The reserve covers about 8 000 hectares (ha) (Birss 2000). The estimated habitat units consist of about two thirds (5 128 ha of the 7 693 ha) of mountainous (koppies) veld habitat, a third (2 565 ha of the 7 693 ha) of plains veld habitat and approximately 307 ha of dam's fluctuation zone habitat (Koen, Lloyd & Badenhorst 1997). RNR lies within a summer rainfall region with a mean annual rainfall of 355 mm, peaking in January, February and March. The RNR has two extreme temperature variations, with summer reaching a maximum daily temperature of 30,40C in January, and winter dropping down to –1,80C in July (Munro 1994).

The reserve is situated on the False Upper Karoo (Acocks 1988). Mucina & Rutherfords (2006) classified the vegetation as Northern Upper Karoo. The altitude varies from 1 000 – 1 500 m (Mucina & Rutherfords 2006). Common shrubs include *Pentzia incana, Salsola calluna, Eriocephalus ericoides, E. spinescens* and *Hermannia spp.,* while grasses, such as *Digitaria eriantha, Sporobolus fimbriatus, Aristida spp., Eragrostis spp.* and *Themeda triandra,* dominate the landscape after good summer rains. *Acacia mellifera, Rhigozum obovatum, R. trichotonum, Rhus burchelli / undulate, R. cilliata and Tarchonanthus camphoratus* are dominant tree species on koppies and slope areas.

Along the dry riverbeds, *Acacia* Karoo is a common element. Acocks considered the area the most degraded of all the vegetation types in South Africa due to potential threats such as desertification, alien species invasion and bush encroachment because of overgrazing, unpredictable rainfall events and drought periods (Bredenkamp *et al.* 1996).

**Vegetation assessment surveys**

Surveys were conducted bi-annually at the end of March/April (wet season, end of summer) and at the end of August/September (dry season, end of winter) at 29 permanently marked monitoring sites (Lloyd & Badenhorst 1995; Lloyd & Badenhorst 1997). Monitoring sites 1 - 9, 15 - 20, 23 - 24, and 26 - 29 were grouped as plains habitat, while monitoring sites 10 - 14, 21 – 22, and 25 were grouped as koppies habitat (Lloyd & Badenhorst 1997). The surveys were conducted by means of the "Strikes-and-Misses" line transect method (Lloyd & Badenhorst 1997) since 1995 (Lloyd & Badenhorst 1995) and specifically concentrates on the herbaceous, in particular grasses, rather than woody components. This method was preferred because most of the game species were grazers on the reserve (Lloyd & Badenhorst 1997), and the plains needed a more active annual management strategy to improve its condition. This method was more appropriate because it showed vulnerable soils prone to erosion (Lloyd & Badenhorst 1995).

Parallel line transects of 25 m in length (25 points per line), were spaced 3 m apart (25 m x 25 m plot size) to record 250 points, reflecting a minimum of a 100 "strikes" (Lloyd & Badenhorst 1997). If less than a 100 "strikes" were recorded from 250 points, the survey points were increased to 300. If more than one species was struck at a point, all were recorded, whether they were available for utilization or not. Thus, you could have more than one strike per survey point, e.g. where grasses grow underneath a shrub. The Grazing Index Values (GIV) was used to calculate the veld condition score (Lloyd & Badenhorst 1995; Lloyd & Badenhorst 1997). If a species does not have a constant GIV assigned to it, a value of 1 was assigned to that species. Plant species compositions were recorded for each monitoring site, together with the percentage canopy cover (Si) for each individual species at the site (Lloyd & Badenhorst 1995; Lloyd & Badenhorst 1997).

$S_i$ = (Number of strikes of species i / Total number of points) x 100

The Veld Condition Score (VCS) was calculated accordingly by summing the Y values for each species (Lloyd & Badenhorst 1995; Lloyd & Badenhorst 1997).

$Y_i = S_i \times GIV_i$

A VCS of 650 was regarded the highest potential score for the vegetation types on the reserve (Nama Karoo), i.e. the highest potential veld condition score possible (Du Toit 2003). This was used due to the absence of benchmarks (Lloyd & Badenhorst 1995; Lloyd & Badenhorst 1997).

The game species composition of RNR was based on four major animal groups, namely non-selective grazers, selective grazers, mixed feeders and browsers. Animal numbers are expressed in large stock units (LSU) and recommendation of species composition ratio of 2:1:1:1 for non-selective grazers: selective grazers: mixed feeders: and browsers are used (Birss 2000). In 1997 (Koen, Lloyd & Badenhorst 1997), 1998, 1999 (Muller, Badenhorst, Birss & Koen 1999) and 2000 (Birss 2000) game numbers were reduced to alleviate the grazing pressure on the plains, allowing the veld to recover and improve its condition (Koen, Lloyd & Badenhorst 1997).

Basic statistical comparison tests were performed using MS Excel, comparing means. I analyzed the medium-term average grazing capacity and seasonal grazing capacity to determine trends and changes in the veld on two habitat types, 1995 vs. 2007. I compared veld condition scores using the seasonal datasets on two habitat types, 1995 vs. 2007. Dominant grass species were recorded in 1995 and 2004 (both reported in Powell 2005) and 2007, to determine if there were any changes in dominant grass species, 1995 vs. 2004 vs. 2007, I compared the dominant species and their percentage cover. All statistical analysis were performed using, and all factors were considered significant when $p<0.05$.

**Results**

The grazing capacity improved from 34.5 ha/LSU in 1995 to 18 ha/LSU by 2007. There have been lots of variation in veld condition and grazing capacity between 1995 and 2007, with the poorest being recorded in 1996, 1998 & 1999 at 38.8 ha/LSU, 36.5 ha/LSU and 39.93 ha/LSU respectively, and the best recorded between 2002 to 2007 (Fig. 1a). The long-term grazing capacity in March reflects an average of 22.71 ha/LSU in comparison to 26.37 ha/LSU in September. The grazing capacity of the veld has improved significantly for both wet and dry season, March ($r^2$=0.64) and September ($r^2$=0.60) (Fig. 1b).

Grazing capacity on plains has improved tremendously, (March data set), improving from 38.3 ha/LSU in 1995 to 16.3 ha/LSU in 2007. The September data set also revealed improvement, changing from 43.6 ha/LSU in 1995 to 25.1 ha/LSU in 2007. The average grazing capacity in the plains habitat was 40.9 ha/LSU in 1995 and has improved significantly to 20.7 ha/LSU by 2007. The data shows a difference of 6.9 ha/LSU on koppies, with an average of 10.6 ha/LSU in 2007 and 17.5 ha/LSU in 1995 (Fig. 2a). Grazing capacity in the koppies habitat improved (March data set) from 16.3 ha/LSU in 1995 to 9.4 ha/LSU in 2007.

The September data set, the grazing capacity improved from 18.7 ha/LSU in 1995 to 11.9 ha/LSU in 2007. The average grazing capacity on the plains was 17.5 ha/LSU in 1995 and has improved to 10.6 ha/LSU in 2007 (Fig. 2b). The veld condition scores showed significant changes in the March dataset, the VCS recorded in 2007 was double that recorded in 1995 on the plains. The March VCS on koppies habitat also improved (Fig. 3a). The VCS in September on the plains improved from 145 to 281, and 372 to 501.5 on koppies. Both these VCS influence the grazing capacity of these habitat types (Fig. 3b).

In 1995, ten dominant grasses were recorded according to their percentage cover. *Digitaria eriantha* had the lowest cover of 4%, followed by *Sporobolus fimbriatus* (5%) and *Eragrostis lehmanniana* and *Eragrostis obtusa* (6% both). In 2004, eleven dominant grass species were recorded these include *Aristida diffusa* having 4% cover. *Sporobolus fimbriatus* had the lowest percentage cover (2%), followed by *Digitaria eriantha* and *Eragrostis bicolor* (3%) and *Aristida adscensionis* (4%).

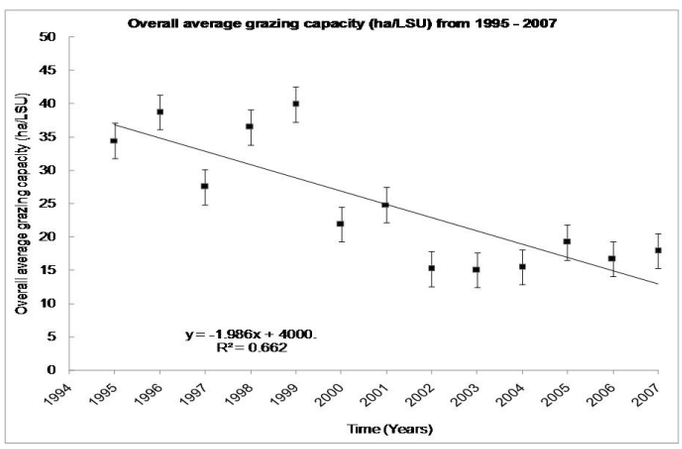
In 2007, twelve dominant grass species were recorded, adding up *Stipagrostis ciliata* with 2% cover. *Aristida congesta subsp. barbicollis, Aristida diffusa subsp. diffusa, Eragrostis curvula* and *Sporobolus fimbriatus* recorded only 3% cover each (Fig. 4). Two new grass species recorded in 2004 were not

recorded in 1995, are *Aristida diffusa subsp. diffusa* and *Eragrostis bicolor* (Powell 2005). However, *Enneapogon desvauxii* was reported in 1995 to have 19% cover was not encountered in 2004. Two more new grass species recorded in 2007 were not recorded in 1995 and 2004, are *Eragrostis curvula* and *Cynodon dactylon. Digitaria eriantha* and *Eragrostis bicolor* were not recorded in 2007. The grass absence in 2007 raises questions of local extinction vs. total extinction of which both terms are of concern in conservation biodiversity.

## Discussion

The medium-term assessment shows that there was an improvement in grazing capacity and veld conditions from 1995 to 2007. Improvement in the grazing capacity and veld condition scores could be attributed primarily to active veld management practices in the reserve and other factors such as rainfall and reduced game numbers. The grazing capacity improved considerably since 1995, especially that of the plains habitat.

Most of the game species on RNR spent more time on the plains habitat, and this is the reason why the plains had low grazing capacity. The management's decision to reduce game numbers reduced the pressure from the veld and that played an influential factor by contributing to veld condition improvement. It is clear from the results that the veld



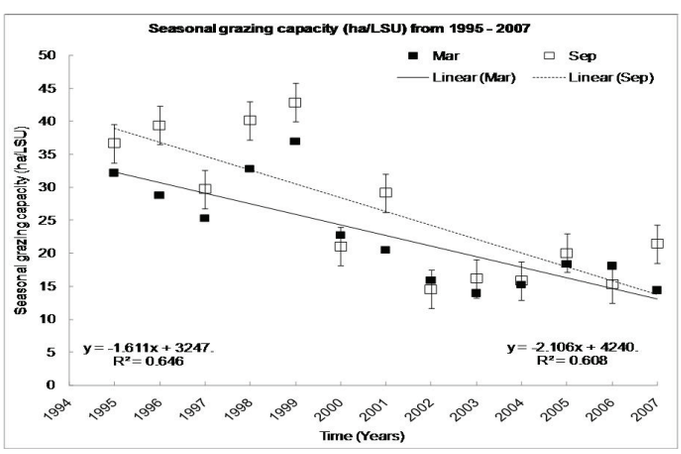




Figure 1. (a) Average grazing capacity since 1995 – 2007 and
(b) the seasonal grazing capacity since 1995 – 2007 of the Rolfontein Nature Reserve.

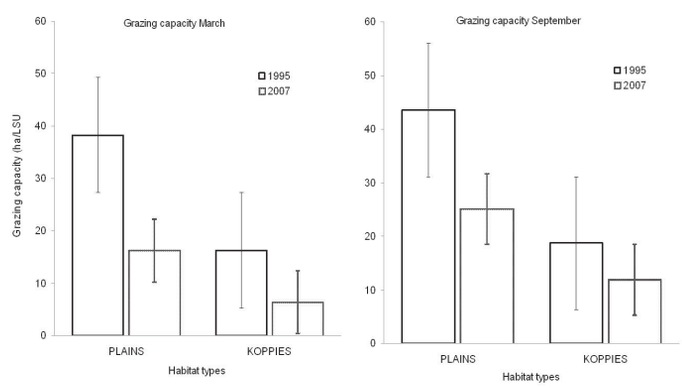



Figure 2. Comparison of seasonal grazing capacity, 1995 vs. 2007,
(a) March and
(b) September on two habitat types (plains and koppies) on RNR.

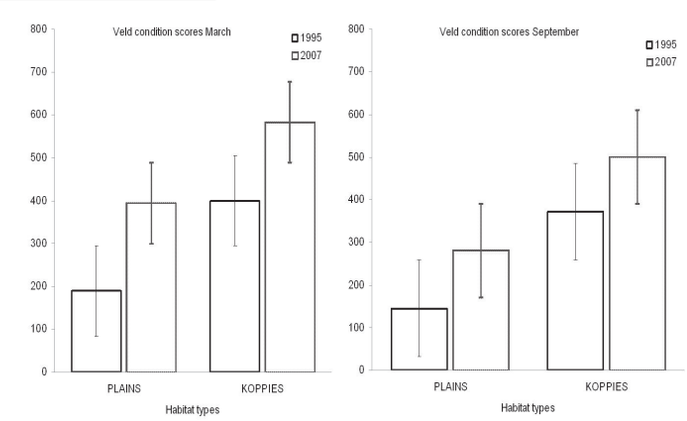



Figure 3. Comparison of seasonal veld condition scores, 1995 vs. 2007,
(a) March and
(b) September on two habitat types (plains and koppies) on RNR.

conditions grazing capacity will probably continue to improve, if active game management is maintained well to suit the needs of the reserve. The September monitoring shows that the veld was in poor condition because of low rainfall and long dry season spell from May to August. The April veld condition was good due to rains received during the growth season, which is from November-March.

These preliminary findings may be used as guidance in preparation for other ecological research projects focusing on species response to grazing and drought. Vegetation monitoring is an effective tool to monitor veld condition in rangelands. This report also encourage further analysis on how rainfall (seasonal) and game numbers (specific species) affect veld conditions in arid areas similar to RNR.

Powell (2005) argued that the veld condition and grazing capacity improvements are mainly due to the improved grass species cover and to a lesser extent species composition and species ratios. In addition, most of the species that increased in percentage cover have higher grazing index values (GIV), like *Themeda triandra* and *Eragrostis lehmanniana,* consequently improving grazing capacity of the veld. This concurs

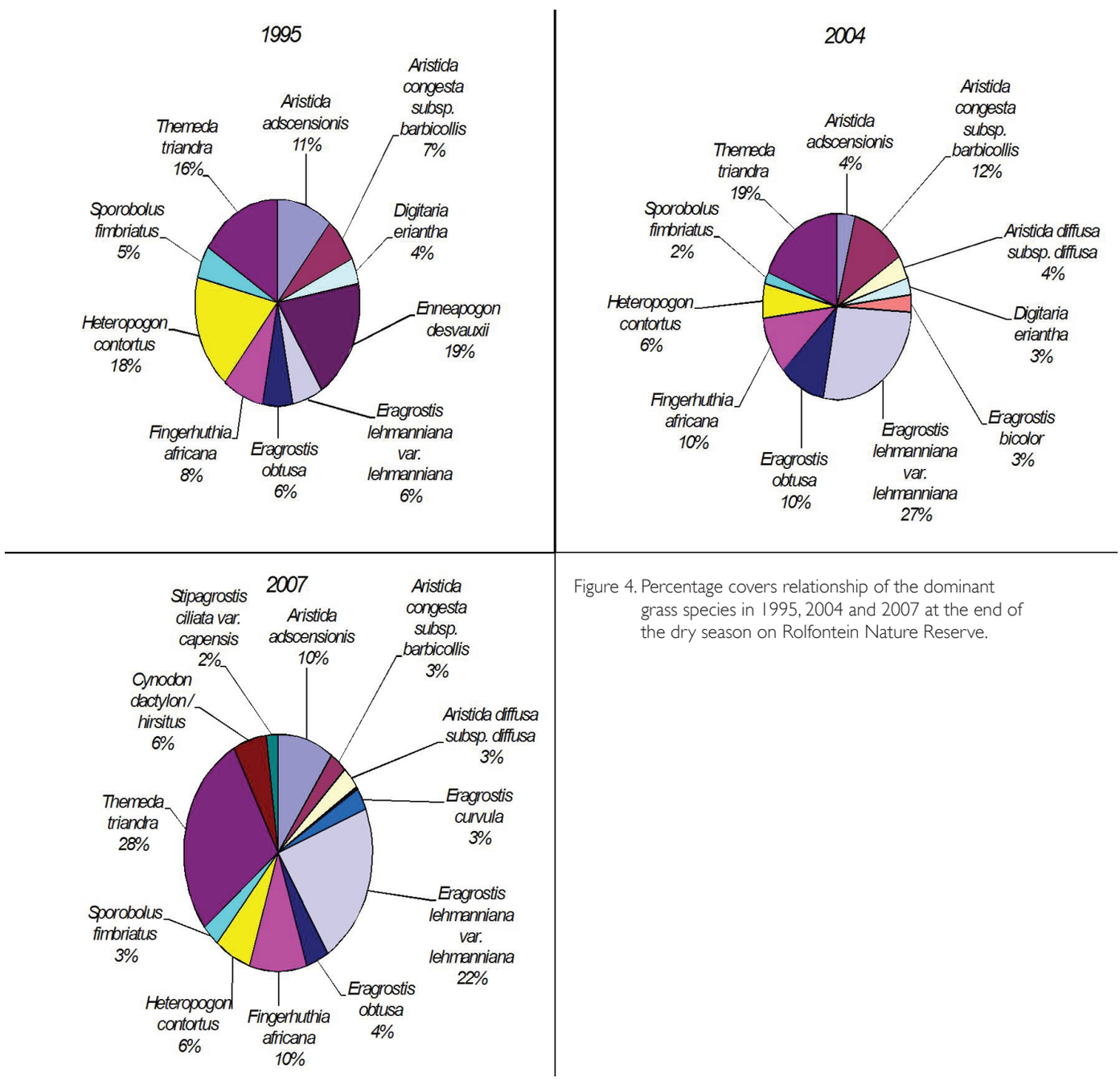



Figure 4. Percentage covers relationship of the dominant grass species in 1995, 2004 and 2007 at the end of the dry season on Rolfontein Nature Reserve.

with my results because *T. triandra* and *E. lehmanniana* had the highest percentage cover in 2007.

The plains habitat, on the other hand, reflects a different picture, as it consisted primarily of pioneer species like *Aristida adscensionis* and *Enneapogon desvauxi* in 1995. High moribund accumulation will suffocate and reduce chances of other grasses to establish, and result in high intense fires after lightning strikes, which is a serious biodiversity threat in this region (Khavhagali 2008).

Conclusively, the management objective of establishing the monitoring plots resulted in improved conditions on the veld. An increase of grass species on the plains will improve the veld. Constant reduction of game species should yield results that are more positive by reducing grazing pressures. However, koppies are not well utilized, therefore it will be important reduce grazers on the plains, considerably so, and bring game species that will utilize the koppies.

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