A VEGETATION CLASSIFICATION AND MANAGEMENT PLAN FOR THE HONDEKRAAL SECTION OF THE LOSKOPDAM NATURE RESERVE

By

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Submitted in accordance with the requirements
for the degree of

MAGISTER TECHNOLOGIAE

in the subject

NATURE CONSERVATION

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF LR BROWN

FEBRUARY 2010

'Where wast thou when I laid the foundations of the earth? Declare, if thou hast understanding. **Job 38:4**

'For the wisdom of this world is foolishness with God.' **1Cor 3:19**

'The fear of the Lord is the beginning of wisdom.'
'For the Lord giveth wisdom: out of his mouth cometh knowledge and understanding.' **Prov 2:6 & 9:10**

I dedicate this dissertation to:

My Lord Jesus Christ, whom enables me in everything I do

'All things were made by him; and without Him was not anything made that was made.'

John 1:3

My husband Corrie, My Children Danielle and Liam,

And last but not least, my mom and my dad

A vegetation classification and management plan for the Hondekraal Section of the Loskopdam Nature Reserve.

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Abstract

As part of a vegetation survey program for the newly acquired farms incorporated into the Loskop Dam Nature Reserve, the vegetation of the Hondekraal Section was investigated. The study provides an ecological basis for establishing an efficient wildlife management plan for the Reserve. From a TWINSPAN classification, refined by Braun-Blanquet procedures, 12 plant communities, which can be grouped into eight major plant communities, were identified. A classification and description of the major plant communities are presented as well as a management plan. Descriptions of the plant communities include characteristic species as well as prominent and less conspicuous species of the tree, shrub, herb and grass strata. This study proves that the extended land incorporated into the Reserve contributes to the biological diversity of the Reserve.

Keywords

Loskopdam, Braun-Blanquet , floristic composition, phytosociology, plant communities, TWINSPAN, JUICE

Student number: 3805-249-0

I, Nicolene Filmalter, declare that '**A VEGETATION CLASSIFICATION AND MANAGEMENT PLAN FOR THE HONDEKRAAL SECTION OF THE LOSKOPDAM NATURE RESERVE**' is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

SIGNATURE
(Ms N Filmalter)

DATE

SUMMARY

Title of dissertation:

A vegetation classification and management plan for the Hondekraal section of the Loskopdam Nature Reserve.

By:

Nicolene Filmalter

Degree:

Magister Technologiae

Subject:

Nature Conservation

Supervisor:

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Summary:

The purpose of this study was to firstly to classify the vegetation of the Hondekraal section of the Loskopdam Nature Reserve and secondly, to compile a management plan for this section to be incorporated into the current management plan of the Reserve.

The Honderkaal section (including portions of Groenvallei) has a size of approximately 3 729 ha and is situated in the South Western section of the Loskop Dam Nature Reserve. The Reserve is located approximately 52km's north of Middelburg on the N11 National Road. It is situated in the Olifants River valley, Mpumalanga province at latitude 25º34' to 25º56' South and 29º15 to 29º40' East.

According to Muccina & Rutherford (2006), the vegetation is classified as Loskop Thornveld (SVcb 14) and Loskop Mountain Bushveld (SVcb 13). The elevation of the Reserve varies from 990 m to1450 m above sea level, giving rise to a diverse topography that ranges from incised plateaus on the higher lying areas through steep cliffs and a variety of slope types, to deep valleys and relatively flat valley bottoms (Van Biljon 1960). The geology of the greater part of the reserve consists of the Waterberg System, the Loskop System and Rooiberg felsite.

The reserve lies in the summer rainfall area with typical mild to very hot summers and mild winters with frost occurring on the high-lying hill top areas as well as in the low-lying valleys. Rainfall is in the form of high intensity thunderstorms and showers.

Though the vegetation in the study area has been previously disturbed over large areas due to agriculture, it is now in a stage of recovery with the exception of localised overgrazing and out of season burning, especially in the western sections of the area. A total of 76 plots were placed out on a randomly stratified basis (Barbour *et al*. 1987, Bezuidenhout 1996, Brown & Bredenkamp 1994, Brown 1997) within representative stands of vegetation so as to exclude as much heterogenity in terms of floristic composition, structure and habitat as possible. The Braun-blanquet approach to vegetation ecology as described by Westhoff and Van der Maarel (1978), Werger (1974a) and Mueller Dombois & Ellenberg (1974) was applied in this study. The analysis resulted in the following 13 plant communities which may be grouped into 8 major vegetation types and are discussed floristically and quantitatively:

1. *Sporobolus africanus – Cyperus esculentus* drainage channel

    1.1 *Schoenoplectus corymbosus – Juncus* species sub-community

    1.2 *Pennisetum macrourum – Hypoxis rigidula* sub-community

    1.3 *Eragrostis plana – Cyperus rupestris* sub-community

2. *Hyperthelia dissoluta – Indigofera daleoides* grassland

2.1 *Hyperthelia dissoluta – Elephantorrhiza elephantina* grassland

2.2 *Hyperthelia dissoluta – Digitaria eriantha* grassland

3. Faurea saligna – Setaria sphacelata open woodland

4. *Faurea saligna – Burkea africana* woodland

5. *Burkea africana – Digitaria eriantha* open woodland

6. *Combretum molle – Xerophyta retinervis* open to closed woodland

7. *Tristachya biseriata – Loudetia simplex* grassland

8. *Combretum apiculatum – Panicum ecklonii* open woodland

A floristic analysis, species list as well as tables to supplement the discussion of the plant communities are given as appendices.

Key terms:
Loskopdam, Braun-Blanquet procedures, JUICE vegetation analysis, TWINSPAN, conservation area, floristic composition, habitat types, phytosociology, plant communities, vegetation classification, vegetation management plan

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to the following, without whose assistance this study would not have been possible:

My Heavenly Father, who enables me in everything I do.

My husband and children as well as my mother, for their support and encouragement and for believing in me, even when I couldn't. A special thanks to Corrie for his assistance during surveys.

Professor Leslie Brown for his faith in me, his advice and constant encouragement – his commitment and support through many years has been unequivocal.

Ms Leslie Adriaanse for her kindness as well as her professional and efficient supply of information.

Mr David Hedding for the compilation of the GIS maps for the area.

Daniel Koen for the compilation of the GIS vegetation map.

Mpumalanga Tourism and Parks Agency (MTPA), Mr J Eksteen for conducting the recognisance visit with us as well as the supply of maps and information for the area. Mr J Coetzee and staff of the Loskopdam Nature Reserve for allowing the research in the Reserve and Mr Coetzee is also thanked for the data that he supplied.

Louis and Roelien for their kindness and support and Louis and Corrie for climbing 'the' mountain with me.

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CHAPTER 1

INTRODUCTION

Diversity and significance of vegetation in southern Africa

The physiographic diversity that is characteristic of southern Africa culminates in an exceptional concentration of phyto-geopraphic units and high floristic diversity with endemism at all taxonomic levels (Cowling & Hilton-Taylor 1994). Southern Africa forms a discrete phytogeographic entity comprising of a southern temperate flora with endemic components that are not uniformly distributed, but rather form an almost continuous arc below and including sectors of the Great Escarpment across the subcontinent. With 21 137 indigenous species (Arnold & De Wet 1993) in 1 930 genera and 226 families, the flora of southern Africa is among the richest in the world compared to other areas of similar size and including those in the tropical areas of Africa and elsewhere as concurred by various authors (Goldblatt 1978; Gibbs Russell 1985; Cowling & Hilton-Taylor (1994). Ten families are endemic to southern Africa of which seven are endemic to the Cape Region, whilst 560 or 29% of native genera are endemic to southern Africa. Goldblatt (1978) considers this to be an exceptionally high value for a sub-continental landmass and in addition states that approximately 80% of the southern African flora species are endemic to the region, adding to its extraordinary uniqueness. It is thus important that this rich and unique flora is protected in order to ensure its continued existence for present and future generations. Overexploitation of natural resources has resulted in these natural areas diminishing at an alarming rate worldwide.

In addition, when considering the importance of the primary production function of vegetation as well as its role in protecting soil and hydrological processes, it is important to implement conservation strategies to mitigate the negative effects of fragmentation, transformation, utilization, and degradation. However, inventories of the different plant species and ecosystems present in an area are needed if quantitative measures of biodiversity are to be used in developing ecologically defendable conservation strategies and management plans. The basis for sound vegetation management is the plant community that is defined by Whittaker (1978) as vegetation units characterised by their floristic composition. According to Gabriel & Talbot (1984) plant communities reflect a recurring assemblage of plant species of characteristic composition and structure, growing in an area of essentially similar environmental conditions and land use history. The necessity to identify and describe plant communities as the basis of a management plan was further researched and documented by Mentis & Huntley (1982), Brown & Bredenkamp (1994, 1996) as well as Scheepers (1983).

Vegetation management in Nature Reserves

For the successful as well as ecological and scientifically defendable management of both statutory and private conservation areas, the formulation and implementation of spatial management plans are required (Mucina & Rutherford 2006). Bredenkamp & Theron (1978) also stated that it is necessary to investigate the renewable natural resources of Nature Reserves to compile scientifically sound management plans and conservation policies. These plans are based on the results of vegetation surveys that stratify land into various management units. According to Mucina & Rutherford (2006) the differences between vegetation patches in terms of structure, texture, floristic composition as well as variety in habitat composition culminate in the identification and classification of different vegetation types. This classification is an effective way of simplifying the complexity of vegetation, where floristic composition, as determined by environmental conditions, is used as the primary entity for the conceptualization of mapping units, presented as a vegetation map. The vegetation unit is further explained as "*the basic element of the vegetation map, defined as a complex of plant communities ecologically and historically (both in spatial and temporal terms) occupying habitat complexes at the landscape scale*".

A vegetation map is very useful in biological management of nature reserves and wildlife conservation areas in South Africa. Vegetation and ecological surveys of conservation areas were and still are considered to have high priority by the National Committee for Nature Conservation (NACOR 1979). According to Demers (1991), the role that vegetation maps play in the real-world is significant as they not only form a baseline for studies relating to vegetational succession, but they also provide important indicators of ecological responses to disturbance. He states that the principal purpose of these maps is to produce a visual thematic pattern that corresponds to the vegetation classification method that has been used. The theory and method of vegetation mapping has been dominated by the floristic-sociological approach to vegetation classification as used in the Braun-Blanquet approach (Mueller Dombois & Ellenberg 1974, Werger 1974a & Westhoff & Van der Maarel 1978). Current vegetation mapping operates on a much broader theoretical and methodological platform by incorporating new approaches of remote sensing and spatial environmental correlation through GIS as stated by Muccina (2006). According to Westhoff and Van der Maarel (1978) however, floristic classification still forms the framework for any plant ecological study, and also forms the basis of sound land-use planning, management and further research (Brown *et al.* 1995, Brown & Bredenkamp 1994 & 1996, Brown 1997). Hence, vegetation mapping attempts to firstly produce a map featuring vegetation units to create a graphical spatial model of the vegetation of an area; and secondly, to describe the vegetation units using various floristic, vegetation, bio-geographical, physio-geographical and environmental descriptors such as distribution, vegetation and landscape features, geology and soils, important species and endemic species (Mucina & Rutherford 2006).

A short history of vegetation classification

The production of the very first vegetation map for South Africa was done by Pole Evans in 1936 (Pole Evans 1936), heralding a new era of field work and synthesis that culminated in the production of Acocks' 1953 veldtype map (Mucina & Rutherford 2006). Acocks' work was updated and reprinted in 1975 and again in 1988. According to Cowling *et al.* (2003) a global upsurge in environmental awareness culminated in the International Biological Program (IBP), during 1967-1972. Although South Africa played a minor role in the IBP, the philosophy and approach of these large, multi-organisational research programs captured the imagination of amongst others, South African ecologists. Research on the structure and function of South African ecosystems received a significant stimulus during the 1970's and 1980's through a network of interdisciplinary studies in mainly the Savanna (1973), Fynbos (1977) and Karoo (1986) biomes (Mucina & Rutherford 2006). This lead to several comprehensive syntheses by researchers such as Cowling (1992), Scholes & Walker (1993) as well as Muccina (2006). Cowling *et al.*

(2003) accedes that Southern African vegetation science has made great advancement, largely as a result of the positive impact of National Programs for Ecosystem research initiated by the Council for Scientific and Industrial Research since the mid 1970's.

Since the introduction of the Braun-Blanquet method to South Africa and the decision to standardise on this method for the analysis and description of South African vegetation, numerous Braun-Blanquet type surveys have been completed within the country's various biomes, including work done by Coetzee (1974a & b); Bredenkamp & Theron (1978); Van Wyk & Bredenkamp (1986); Behr & Bredenkamp (1988); Bredenkamp *et al.* (1989), Bezuidenhoudt (1993, 1996) as well as Brown & Bredenkamp (1994, 1996).

Various 'African Century' goals have been set for South Africa and the continent as a whole which included various growth initiatives, infrastructure needs as well as wise land use demands. These initiatives culminated in the establishment of the South African National Biodiversity Institute (SANBI), the successor to the former National Botanical Institute (NBI), in itself having its roots in the Botanical Research Institute and the National Botanical gardens of South Africa, established in 1903 and 1913 respectively (Mucina & Rutherford 2006). With the realization of the Biodiversity Act of 2004 (South Africa 2004), parliamentary mandate was given to SANBI to monitor and report on the status of the Republic's biodiversity as well as the conservation status of species and ecosystems and their various impacts. However, it was clear that, in addition to an understanding of the constituent ecosystem dynamics, such reporting required detailed vegetation baseline studies.

Notwithstanding biome-level syntheses of research already done on the different biomes, a definite need for an updated subcontinent-wide synthesis of vegetation research was needed. The southern African sub-region (including Botswana, Lesotho, Namibia and Swaziland) forms a cohesive ecological and phytogeographical unit with exceptionally high endemism at the taxic, vegetation type and phytochorion levels (Goldblatt 1978; Gibbs Russell 1985; Rutherford & Westfall 1986; Cowling & Hilton-Taylor 1994). Even though vegetation surveys that were conducted through the latter part of the previous century had been widely scattered and uncoordinated, they were still considered crucial in establishing an integrated regional synthesis.

It was felt that the Acocks' vegetation maps were becoming outdated and a decision was taken by the South African Association of Botanists (SAAB) to produce a more recent map during the early nineteen nineties. This resulted in the map of Low & Rebelo (1996) that was reprinted as a second edition in 1998. It was basically a simplification of Acocks' map and consisted of a mixture of less detailed and more detailed parts as well as being made at a smaller scale than that of Acocks. However, even before Low & Rebelo's map was published in 1996, it was clear that a much more detailed approach than either previous authors would have to be implemented for planning at regional and local levels (Mucina & Rutherford 2006). As a result, the VEGMAP Project was initiated in 1996 to prepare a successor to the "Veld types of South Africa" by Acocks. The VEGMAP project eventually culminated in the publication of the most recent classification, "The vegetation of South Africa, Lesotho and Swaziland" edited by Mucina and Rutherford in 2006. Many of the local maps used in this compilation, were published in local journals. These maps, including numerous maps in unpublished reports and management planning documentation of the provincial nature conservation bodies, as well as postgraduate master's and doctoral theses were used in the compilation of VEGMAP (Mucina & Rutherford 2006), reiterating the importance of these independent studies in further research and synthesis of information. This latest map and vegetation descriptions has made an invaluable contribution to conservation and management initiatives in South Africa.

Conservation in southern Africa

Conservation refers to the sustainable utilization of natural resources and is only possible if it is based on sound veld management that could be described as the utilization and conservation of natural veld without adversely affecting the vegetation (Brown 1997). To be able to utilize and conserve, one must be familiar with what is available and how it would react to different management applications.

Conservation in South Africa has been marked by a gradual succession from the preservation of large mammal species with little regard for the floristic and ecosystem aspect (Pringle 1982), through to predator elimination, total fire protection, provision of artificial water supplies, veld improvement and maintaining the ‘balance of nature’ (Huntley 1978; Rebelo 1992 a,b).

During the first half of the 20th century, conservation actions were increasingly guided by ecosystem-level considerations. By the mid 1940’s, Wicht (1945) reviewed the effects of fire regime, pasturing, erosion, invasive alien organisms and other aspects, culminating in his advocating the establishment of a minimum of five reserves of national status. They were all located in the mountains with the emphasis on preserving the flora rather than the fauna. This was around the same time that a survey was initiated to describe and map the vegetation types of South Africa (Cowling *et al.* 2003) that resulted in the publication of Acocks’ Veld types of South Africa (Acocks 1953).

In 1968 a survey was initiated with the aim of outlining the conservation status of the 70 Acocks’ veld types and was taken up by NACOR, which instituted a national plan (Scheepers 1983). The international focus shifted during the 1970’s to rare species and representative ecosystems, whilst a shift towards game utilization, mainly in the form of recreational hunting, resulted in large areas of the savanna biome being managed in a manner compatible with ecosystem conservation (Huntley 1978). Unfortunately, conservation of large game species in some regions resulted in the deterioration of vegetation largely due to so called ‘veld-improvement’ and the provision of artificial water sources (Rebelo 1992b).

The 1980’s was characterised by a huge increase in literature pertaining to conservation. This period was also marked by an international call for each country to strive towards conserving 10% of each vegetation type. The trend today is towards the conservation of biodiversity of the region that should be represented optimally by a network of reserves (Huntley 1994). The Biodiversity Treaty, signed by most southern African states, requires the formulation of national plans for the conservation of representative systems (World Resources Institute 1994). Perceptions have changed towards sustainable utilization rather than the setting aside of land without benefit to local people (Anderson & Grove 1987; Stuart & Adams 1990). Unfortunately in South Africa, conservation areas today, have to be defended and justified as beneficial to local communities, mainly as a result of apartheid doctrines (Huntley 1978; Stuart & Adams 1990). Emery *et al.* (2002) states that the goal of conservation is not only to ensure minimum landscape, habitat and species protection, but also to represent geographic gradients and to enable longer-term ecological processes to persist.

Of the five countries in southern Africa, two have achieved the goal of protecting 10% of their vegetation, with South Africa only halfway to achieving this goal at the current 5.1%. Already in 2003, Cowling *et al.* (2003) stated that three of the then seven (now nine) southern African biomes have more than 10% of their area conserved (Desert, Fynbos and Savanna) whilst the Forest biome is approaching 9%. However, the Nama-karoo, Grassland and Succulent Karoo biomes have less than 3% of their area conserved. The greater part of these biomes falls largely within South Africa (Cowling *et al.* 2003). Each of the nine biomes comprises smaller distinguishable vegetation types located within the different provinces of South Africa.

One of these provinces, Mpumalanga is characterised by an extraordinary floral diversity with an estimated 1946 plant taxa occurring within the province, largely due to its varied topography that ranges from the lower-lying valley bottomland to the high-lying crest grasslands. Although it only comprises 3% of southern Africa's surface, it supports 21% of its species diversity. Emery *et al.* (2002) explains that this diversity is not evenly distributed, but is mainly confined to four Centres and two Regions of Endemism. A total of six phytochoria were mapped and described in terms of diversity, protection status and transformation. As expected, a high number of endemic plant taxa are confined to these phytochoria, many of which are narrow endemics and subsequently on the Mpumalanga Tourism and Parks Agency's (MTPA) threatened plant list. It is clear from the report that more land needs to be incorporated within nature reserves to protect the province's biodiversity.

Conservation in Mpumalanga and the Loskopdam Nature Reserve

In their report on the conservation value of land in Mpumalanga, Emery *et al.* (2002) identified amongst other organisms, 81 threatened plants and 26 economically important medicinal plants occurring naturally in the Province. Of the 81 threatened plant taxa, one was assessed as Extinct, 9 as Critically Endangered, 16 as Endangered, 37 as Vulnerable and 18 as Near Threatened. The Highveld and montane grasslands in the Province are important habitats for these plants. In addition, the trade in medicinal plants presents its own set of challenges, but it is highly unlikely that the sustainable supply of these plants will ever meet the demand, especially considering the current levels of exploitation. However, these species do not adequately represent the geographical range of all of the estimated 350 threatened plant taxa occurring on the Mpumalanga Parks Board threatened plant list.

It was also found that 13 (62%) of a total of 21 landscapes were under protected (<10% under formal protection) (Emery *et al.* 2002). The recommended IUCN standard is set at 10% conservation for a vegetation type. In addition, five landscapes (23%) have been transformed by more than 40% which is the threshold beyond which ecological processes are significantly disrupted. The major cause of transformation in the dry type landscapes was cultivation, whilst the forest plantations were the major cause of all wet type landscape transformations. Five (24%) of the 21 under-protected landscapes are regarded as critically important for conservation action and are distributed along the foothills and high lying areas of the escarpment.

Of the 20 vegetation communities within Mpumalanga, it was found that two were endemic and three were near-endemic to the province, all of which were grasslands (Emery *et al.* 2002). In addition, 17 of these vegetation communities were under conserved at <10% with all the grasslands having less than 5% of their area conserved. The Bankenveld to Sour Sandveld Transition and *Themeda* Veld were identified as the most important vegetation communities within the province (Emery *et al.* 2002). This reiterates the importance of grasslands within Mpumalanga and their need for conservation.

The protected areas map of Mpumalanga represents all areas that are formally protected under the National Biodiversity Act (Act 10 of 2004), which includes the Mpumalanga Nature conservation Act of 1988 as well as Act 57 the National Parks Act 0f 1976 (South Africa 1976). These areas are managed by the Mpumalanga

Parks Board, Department of Agriculture, Conservation and Environment (DACE) or South African National Parks. The analysis done by Emery *et al.* (2002) highlights the need to conserve the foothills of the escarpment and explains that the current network of reserves on the escarpment plays an important role in conserving parts of landscapes. According to Emery *et al.* (2003), vegetation communities have been described and/or mapped at various scales for different parts of Mpumalanga by researchers such as Deal *et al.* (1989), Matthews *et al.* (1994) and Eckhardt *et al.* (1996). Other plant ecological work on the vegetation types of the Province include those of Smit *et al.* (1997) who described the vegetation of the Witbank Nature Reserve as well as Barrett *et al.* (2006) who described the vegetation of the Blydeberg Conservancy.

There are 13 proclaimed Nature Reserves (including National Parks) in the Mpumalanga Province, conserving a total of 14.5% of the Province. However, if the Kruger National Park is excluded from this calculation, the results change dramatically with only 3% of the province under conservation. Once again, this highlights not only the importance of Kruger National Park, but also the inadequately conserved remainder of the province. In addition, a total of eight conservancies exist within the province as listed Emery *et al.* (2003).

One of the largest and oldest reserves in the Province, the Loskop Dam Nature Reserve (LNR) is currently under the management of the Mpumalanga Tourism and Parks Agency (MTPA). Section 24 of the Constitution of the Republic of South Africa 108 of 1996 (South Africa 1996) stipulates that the MTPA is assigned to ensure the protection of the environment for present and future generations through the use of reasonable legislation. Subsequently, measures are implemented to prevent environmental degradation, whilst promoting conservation and sustainable use of natural resources, as well as ecologically sustainable development.

Emery *et al.* (2003) state that areas with heterogeneous landscapes, diverse geology and a variety of environmental conditions (such as the Loskopdam Nature Reserve), provide a diverse number of habitats for plant species. Therefore, some parts of the province are critically important for the conservation of threatened plants at the species level and the identification of these sites serve towards short and medium term conservation of these taxa. The greater Loskopdam area was identified as one of these critically important sites.

The first detailed vegetation analysis, classification and description of the Reserve was done by Theron (1973), whilst the Parys and Rietfontein areas were classified and described by Götze *et al.* (1998). Mucina & Rutherford (2006) classify these areas as Loskop Thornveld (SVcb 14) and Loskop Mountain Bushveld (SVcb 13).

The Hondekraal section (including portions of Groenvallei) was incorporated into the Reserve in 1996. According to Eksteen (2003), there is a strong trend amongst surrounding and nearby land owners towards ecotourism development, where land use is changing from livestock grazing to game-based land concurrent with the findings of Anderson & Grove (1987) as well as Stuart & Adams (1990) as outlined earlier that perceptions have changed towards sustainable utilization.

However, optimal grazing and browsing can only be applied once the vegetation of the area has been classified, described and mapped as relatively homogeneous plant communities. This will form the basis for the compilation of a wildlife management plan. Veld in South Africa has been subjected to especially grazing by game species for thousands of years and is well adapted for these conditions. Information in this regard is however limited and often one has to rely on speculation and logical conclusions. Since the combination of plant species that can be utilised by animals differ from one area to the next, it is necessary to establish the carrying capacity of each area by determining the veld condition in every homogenous plant community. Veld management practices can then be adapted to the grazing/browsing behaviour of the various game species.

A plant species list is one of the core elements of the description of a vegetation unit according to Mucina & Rutherford (2006) and is primarily aimed at providing information on floristic composition of the plant communities forming the vegetation units. The species are categorized under the appropriate families.

Aims of the study

With these considerations in mind as well as the fact that no previous vegetation classification nor descriptions have been done for this area, the management of the LNR outlined the need for a vegetation classification and management plan for the Hondekraal section of the reserve.

Consequently, the aims of the study were to:

1) Identify, classify and describe the vegetation of the study area.
2) Compile a vegetation map for the area.
3) Determine the grazing capacity and stocking rate for the area.
4) Propose broad management recommendations.

It is hypothesised that the vegetation of the Hondekraal section of the reserve has little affinity to that of the current reserve.

According to Mr J Coetzee[1] (*pers. comm*. 2008), Regional Ecologist of the MTPA, the proclamation of the new areas is awaited, but the process has been delayed due to land-claims that have not yet been Gazetted. Should the claim be awarded, it is envisaged that a cooperation-agreement between the owners and SanParks (SANP) as the conservation body, will be compiled. This entails the relocation of the local farmer and his cattle to an area outside of the reserve. This area will be allocated in cognisance with the purpose of supplying adequate grazing for the cattle. There are no specific plans in place with regards to the buildings in the area, but they will most probably be demolished.

[1] COETZEE, J. Regional Ecologist - Mpumalanga Tourism and Parks Agency (MTPA).

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CHAPTER 2

STUDY AREA

Location and size

The Loskopdam Nature Reserve (LNR) is situated approximately 52km's north of Middelburg on the N11 National Road. It is situated in the Olifants River valley, Mpumalanga province at latitude 25º34' to 25º56' South and 29º15 to 29º40' East (Figure 2.1).

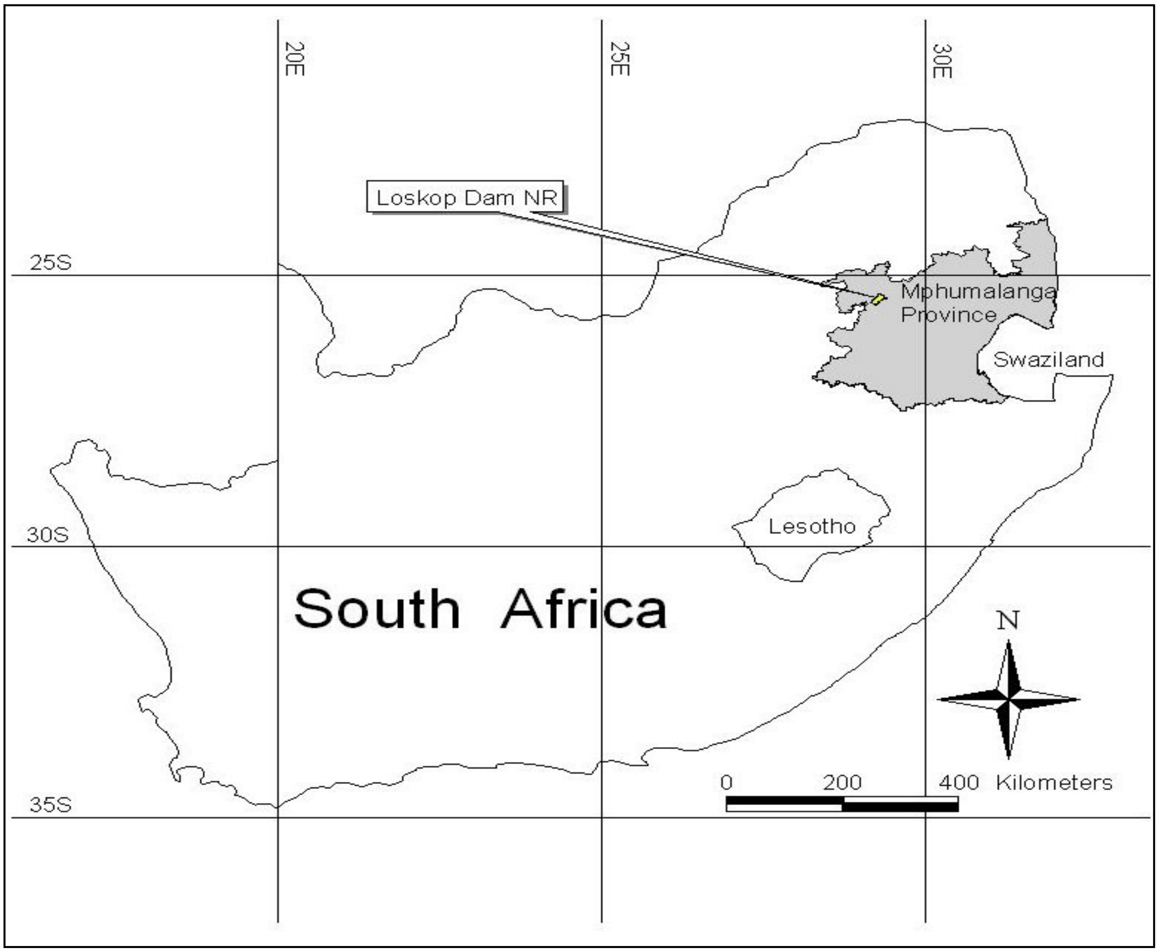

Figure 2.1 The location of the study area in South Africa

The Loskop Dam was completed in 1938 and the raising of the dam wall in the 1970's resulted in more of the valley being flooded. The dam that is approximately 30 km long, supplies water to a vast irrigation scheme in the areas of Loskop, Marble Hall and Groblersdal. The elevation of the Reserve varies from 1 990 – 1 450 meters above sea level. Five perennial streams occur on the Reserve, namely the Olifants River, Fontein Zonder End, Scheepersloop, Kerkplaasloop and Krantzspruit, whilst a multitude of smaller streams drain the reserve (Eksteen 2003).

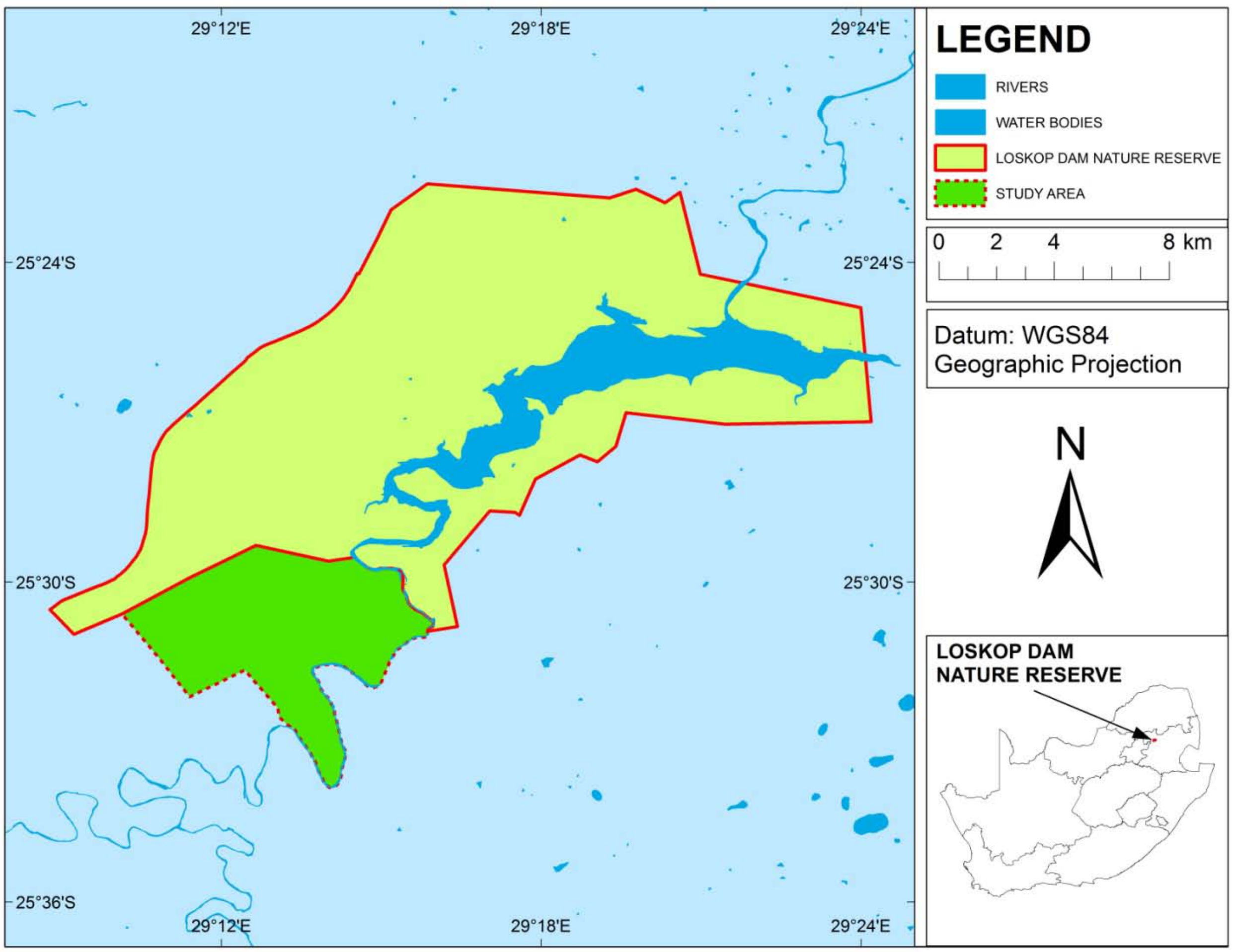

Figure 2.2 Location of the Hondekraal study area in the Loskopdam Nature Reserve (Map compiled by Mr D,W. Hedding, Department of Geography, University of South Africa)

In order to supply good quality water to the downstream users, it is important that the land surrounding the dam is properly managed. Originally, a small reserve was proclaimed around the existing dam in 1954 (Administrators Notice 223 of 1954), but the size of the reserve has since been increased with the acquisition of neighbouring farms and today covers 23 175 ha of which approximately 2 350 ha is covered by the dam (Emery *et al.* 2002).

The study area comprises the Hondekraal section (including portions of Groenvallei) and has a size of approximately 3 347 ha (Chapter 4 – Figure 4.1). It is located in the South Western section of the Loskop Dam Nature Reserve (Figures 2.2 and 2.3).

Figure 2.3 Western boundary of the LNR linking the study area to the reserve.

Topography and Geology

The elevation of the Reserve varies from 990 m to1 450 m above sea level, giving rise to a diverse topography that ranges from incised plateaus on the higher lying areas through steep cliffs and a variety of slope types, to deep valleys and relatively flat valley bottoms (Van Biljon 1960). The reserve is bordered on the southern and south-eastern side by the Waterberg Plato, breaking to form an almost continuous band of steep cliffs that constitutes a clear border towards the north (Figure 2.2). This sharp break in the Waterberg Plato along the steep cliffs continues along steep to very steep slopes, down to the Olifantsriver valley. Seasonal streams are found in the narrow ravines located between adjoining mountains, with their associated hygrophytic tree- and shrub communities (Theron 1973).

The extremely mountainous terrain with its deeply carved drainage lines is the result of four geological systems/groups that underlie the area (Figure 2.4). These groups are the Group Rooiberg, Granophyre intrusions, Formation Loskop Sediments, and the Group Waterberg, whilst some dolerite intrusions are also found. (Van Biljon 1960).

- *Group Rooiberg* (previously known as Rooiberg felsites) (Vs) – The lithology of the Rooiberg Group and the Formation Selonsriver, is described as volcanic rocks, quartzite zenolith, sandstone and quartzite (Geological Survey 1981). Rhyolite underlies the mountains to the north of the dam, reaching a height of 1 420.3 m above sea level (Theron 1973). The rocks are of a dense reddish-brown colour with a characteristic stripyness representing the flow-structure of the original lava. The felsite layers are interspersed by tuff, sandstone, quartz and shale. These sediments according to Van Biljon (1960) has numerous seams, and are softer and more porous than the felsite, resulting in a higher moisture content and denser vegetation than that of the surrounding felsites. According to Van Biljon (1960), the north-facing quartzite and sandstone reefs are characterised by the presence of *Diplorhynchus condylocarpon* in the otherwise *Combretum apiculatum* dominated plant-community. Seasonal streams are found in the narrow ravines found between adjoining mountains, with their associated hygrophytic tree- and shrub communities. Rhyolite weathers to form a sandy-loam soil (Theron 1973).

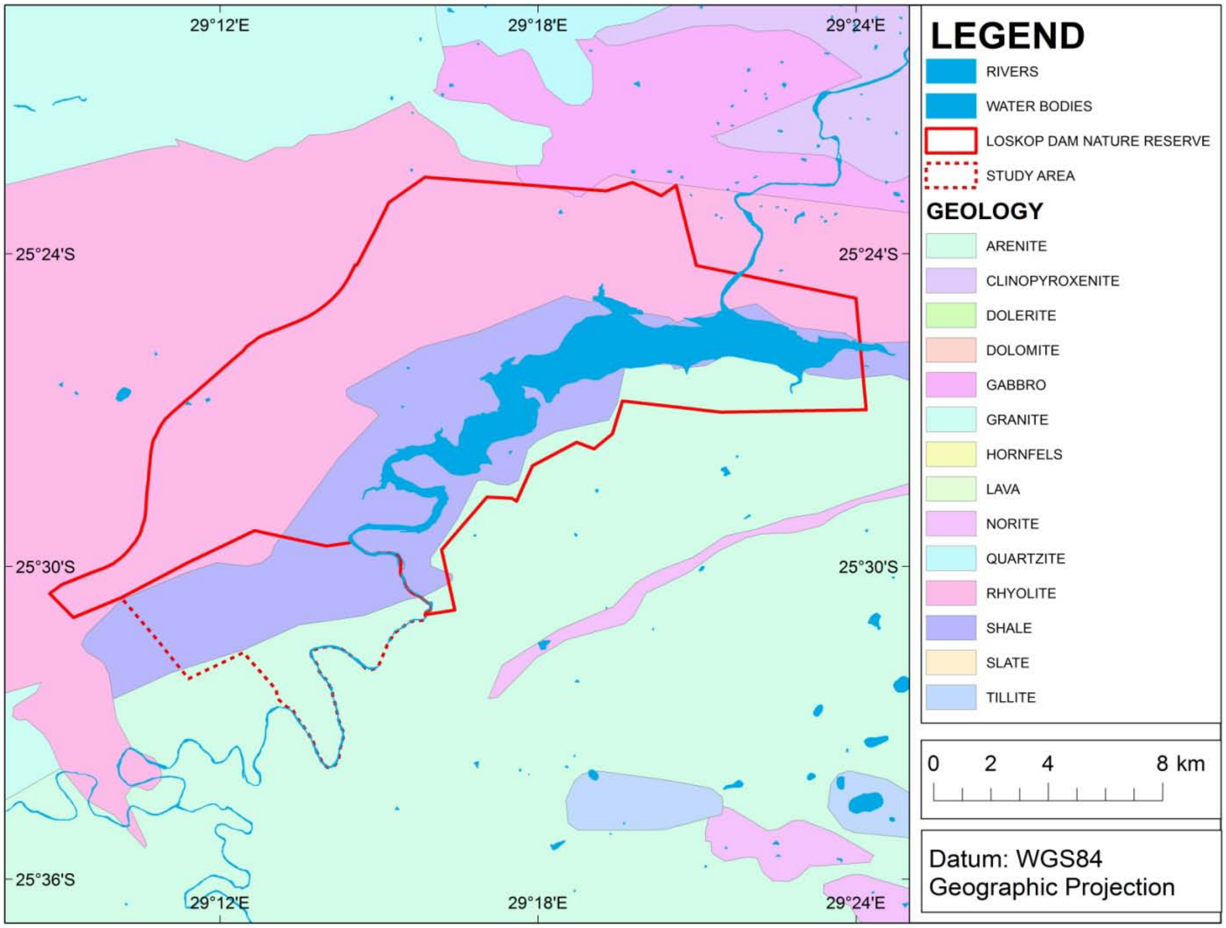

Figure 2.4 Geological map (Map compiled by Mr D.W. Hedding, Department of Geography, University of South Africa)

- *Granophyre intrusions* - This is an intrusive rock that under lays the koppies forming Lombardsbay. The rocks are also brownish-red in colour and weathers to form a sandy-clay soil.

- Formation Loskop (Vls) - Classified under the Valian Quartenare (Geological Survey 1981), the Formation Loskop consists of soft, felspatic sandstone interlaid with shale and conglomerates. Sediments of this system are mainly found on valley bottoms and it weathers to form a sandy to sandy-loam, shallow soil. According to Theron (1973), the sediments of this system are pleated and overturned to such an extent in the Hondekraal area that they stand vertically.

- *Group Waterberg (Mw-brown)* Classified in the Mongolian Quartenare, the Group Waterberg consists of rough-reddish to purple sandstone and patches of quartzite Conglomerates and is also found in the eastern and south-eastern parts of the reserve (Figure 2.7). Shale often occurs interlaid with the other layers. These weather to form a rough sandy to sandy-loam soil. The shale weathers into a more sandy-clay soil.

- *Diabase/Dolerite* - These intrusive rocks are dense and dark coloured, weathering to form clayey soils.

Soil

According to Eksteen (2003), the topography and weathering of the different geological substrate types resulted in complex soil patterns with soil types varying significantly over short distances. The underlying Sandstone and Rhyolite rock types give rise to commonly observed acid soils. Soil types vary from talus like soils just below the ridges, very shallow soils on steeper slopes and ridges to deeper soils closer to the valley bottoms. Plateau areas are characterised by relatively shallow, sandy to sandy-loam soils with a high acidity (pH 3.5 – 4.5), whilst foothills and valley floors have deeper soils, classed as sandy-loam to sandy-clay soils with pH values ranging from 4.5-5.5. Soil depth has been identified as a major influence on the vegetation types that may occur.

Vegetation

The LNR lies in the transitional zone between the Grassland and Savanna Biomes (Rutherford & Westfall 1986). The vegetation on the higher lying regions is typical of the Grassland Biome whilst the lower lying areas represent vegetation typical of the Savanna Biome (Eksteen 2003) (Figure 2.5). A total of one thousand and fifteen plant taxa are listed for the Loskop Dam Nature Reserve of which sixty five are currently on the list of protected plants for Mpumalanga (Emery *et al*. 2002). Of these species, the most important are *Encephalartos middelburgensis*, the only viable population in the province occurring in this reserve. Also found on the reserve, is a few colonies of the threatened succulent *Haworthia koelmaniorum*. Woody vegetation occurring on the reserve includes *Combretum apiculatum* on shallow soils, *Burkea africana*, *Faurea saligna*, *Englerophytum magalismontanum* and *Acacia caffra*.

The most recent classification of the area by Mucina & Rutherford (2006) is Loskop Thornveld (SVcb 14) and Loskop Mountain Bushveld (SVcb 13). These areas were previously classified by Van Rooyen & Bredenkamp (1998) as Mixed Bushveld (Vegetation type 19) in the low lying areas and Rocky Highveld Grassland (Vegetation type 34) in the high lying areas, whilst the original classification by Acocks (1988) was Mixed Bushveld (Veldtype 18) and Sourish Mixed Bushveld (Veldtype 19) in the lower-lying areas, with Bankenveld (Veldtype 61) represented on the high lying areas. Already in 2003, Eksteen (2003) commented that what is now classified as Loskop Thornveld (SVcb 14) and Loskop Mountain Bushveld (then Mixed Bushveld) and which covers the largest portions of LNR, is very heterogenic. It is also characterised by a range of variations and transitions due to the heterogeneous topography and environmental factors, specifically aspect, soil depth and altitude. Within these vegetation types, a number of plant communities can be distinguished. Theron (1973) identified a total of twenty three different communities on the reserve of which thirteen are tree-savanna, four tree/shrub savanna, three tree/shrub thicket, and two hygrophilous communities of which one is classified as an old field.

Loskop Thornveld (SVcb14)

Proportionally, the classification of Loskop Thornveld (Mucina *&* Rutherford 2006) is composed of 71% Mixed Bushveld (Vegetation type 18) as classified by Van Rooyen & Bredenkamp (1998) or 91% Mixed Bushveld (Veld type 18) as classified by Acocks (1988) within the Savanna biome (Rutherford & Westfall 1986).

This vegetation type mainly occurs in die low lying valleys and plains areas that form part of the upper Olifants River catchment. The altitude ranges between 950-1 330m and it is generally described as open, deciduous to semi-deciduous, tall, thorny woodland, usually dominated by *Acacia* species. The woody layer is characterized by trees such as *Acacia gerrardii, Acacia tortillis* subsp. *heteracantha*, *Combretum zeyheri*, *Peltophorum africanum* and *Searsia leptodictya*, whilst the shrub layer consists of species such as *Euclea cripsa*, *Searsia pyroides* var *pyroides*, *Dichrostachys cinerea*, *Grewia flava* and *Asparagus suaveolens* amongst others. The herbaceous layer is characterized by species such as the forb *Rhynchosia minima* and the grasses *Themeda triandra*, *Aristida congesta*, *Cenchrus ciliaris* and *Enneapogon scoparius* amongst others (Mucina & Rutherford 2006).

Loskop Mountain Bushveld (SVcb13)

The proportional composition of this vegetation type is 61% Mixed Bushveld (Vegetation type 18) as classified by Low & Rebelo (1998) or 49% Mixed Bushveld (Veld Type 18) plus 47% Sourish Mixed Bushveld (Veld Type 19) as classified by Acocks (1988), both within the Savanna biome (Rutherford & Westfall 1986) respectively.

This Vegetation type is mainly found on low mountains and ridges with open tree savanna on lower-lying areas and are dominated by the trees *Burkea africana.* The altitude varies from 1 050 – 1 500m. A denser broad-leaved tree savannah is found on the lower slopes and mid-slopes with prominent species such as *Diplorhynchus condylocarpon, Combretum apiculatum* and *Acacia caffra*. The herbaceous layer is dominated by grasses such as *Setaria sphacelata, Loudetia simplex, Trachypogon spicatus, Digitaria eriantha* subsp. *eriantha, Heteropogon contortus* and *Themeda triandra* amongst others (Mucina & Rutherford 2006).

Land types

A land type displays a marked degree of uniformity with respect to climate, soil pattern and terrain form. It denotes an area that can be shown on a map with a scale of 1:250 000. It, Therefore different land type display different soil and climate patterns (Land Type Survey Staff 1988). Different land types are separated using characters such as A, B and C etc. Each land type can be further subdivided by using small cap characters such as a, b and c etc. With the inclusion of a number e.g. Ab20, it is indicated that it was the twentieth land type to be included within that specific broad soil pattern.

Land type information which includes a generalised description of the soil of each type was obtained and is included as Annexure A1 – A4. The following land types (Bc, Fa & Ib) were identified in the Hondekraal area and a short description of the dominant soil forms are given.

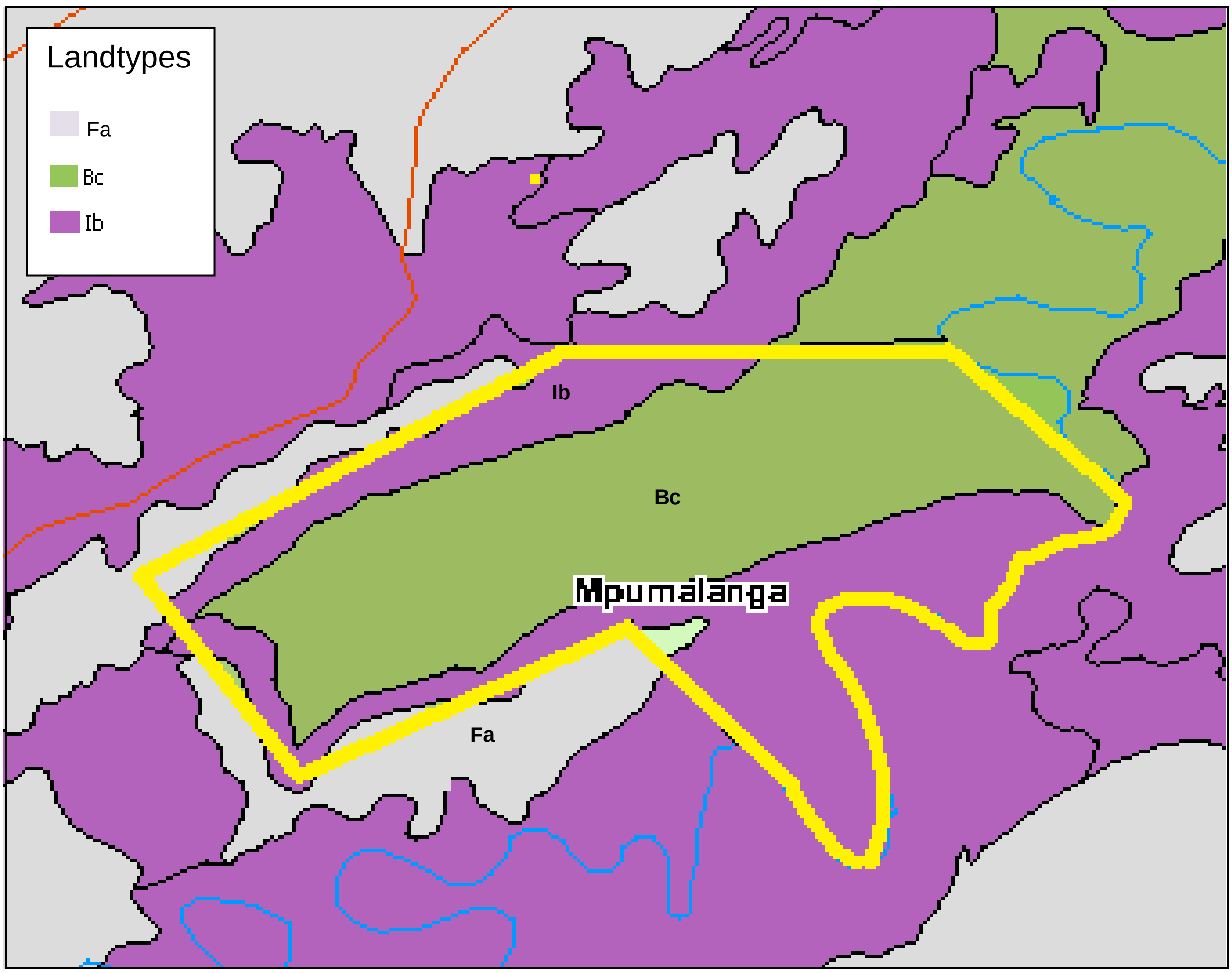

Figure 2.5 Landtype Map – Hondekraal (AGIS 2009)

B Land type (Bc1)

This land type is located centrally in the study area and mainly comprises foot slopes and relatively flat valley bottomlands with some koppies located towards the central and north-eastern parts of the area (Figure 2.5). The geology for this land type can mainly be described as shale, sandstone and conglomerates of the Loskop Formation. Some ferro-gabbro and ferro-diorite of the Upper zone and gabbro and norite of the Main zone of the Rustenburg Layered Suite, Bushveld Complex as well as rhyolite of the Dam wall Formation of the Rooiberg Group and diabase are also present (Land Type Survey Staff 1988). The broad soil pattern of this type is described as plinthic soils (with sub-surface accumulation of iron and manganese oxides over a fluctuating water table) with high base status. Red soils are widespread. Upland duplex and black clay soils are rare. The deep Hutton soil form is dominant and is described as a red-brown to brown topsoil overlying freely drained, red apedal to weakly structured soil material. The dominant Hutton soil form is followed by the moderately shallow Mispah and Glenrosa soils being a grey to dark brown topsoil over hard rock. The moderately deep Avalon soil form is described as a dark brown to grey brown topsoil over well drained, yellow-brown apedal to weakly structured sub-soil over imperfectly drained grey material with red, yellow and black iron. Other soil forms present include Bainsvlei, Longlands, Kroonstad, Oakleaf, Swartland and Sterkspruit (Land Type Survey Staff 1988).

F Land type (Fa7)

Situated on the south-western boundary of the study area, this land type comprises of mountain crest grasslands and consists of two terrain units. Mid slopes comprise 95% of the land type whilst valley bottoms constitute the remaining 5%. Soils in this unit are commonly shallow (shallower than 400mm) on hard rock, fractured rock or weathering rock materials. Lime is rare or completely absent in this landscape. The dominant geological groups/formations are Rhyolite of the Selonsriver Formation, Rooiberg Group, some Rashoop granophyre and Ecca sandstone. The soil forms that are present are the moderately shallow Clovelly, Hutton and Glencoe soils that are described as dark brown to grey brown topsoil over freely drained, apedal yellow-brown soil material.

The moderately shallow Mispah and Glenrosa soil forms are described as grey to dark brown topsoil over hard rock (Land Type Survey Staff 1988).

I Land type (Ib10, Ib16)

These soils constitute the northern (Ib10) as well as southern and western (Ib16) mountain ranges that form the boundary of the study area (Figure 2.5). It consists of crests, steep scarps, and steep mid-slopes, indicating land types with exposed rock that covers 60-80% of the area. This land type consists of three terrain units, crests comprising 20% of the land type, mid slopes comprising 75% of the land type and valley bottoms constituting the remaining 5% of the land type. The Ib10 land type geology is described as predominantly Rhyolite of the Selonsriver and Dam wall Formations of the Rooiberg Group as well as some Quartzite of the Selonsriver Formation, whilst the broad soil pattern can be described as rocky areas (> 60% rock) with miscellaneous, usually shallow soils. The dominant soil form is Mispah and is described as a grey to dark brown topsoil over hard rock. The Hutton soil form has already been described, whilst Clovelly is a dark brown to grey brown topsoil over freely drained, apedal yellow-brown soil material. Glenrosa also occurs and is described as a grey to dark brown topsoil over soil materials mixed with partly weathered rock-derived materials to hard rock fragments and stones. Swartland also occur (Land Type Survey Staff 1988).

The Ib16 land type geology is described as Sandstone of the Wilgeriver Formation, Waterberg Group, whilst the broad soil pattern can be described as rocky (>60% rock) with miscellaneous, usually shallow soils. The moderately shallow Clovelly soil form is described above as well as the shallow Mispah, moderately shallow Hutton and shallow Glenrosa soils. Dundee also occurs as well as Streambeds (Land Type Survey Staff 1988).

Land use history

According to Theron (1973), the areas that now constitute the LNR was previously cultivated with *Zea mays, Sorghum caffrorum* as well as *Gossipium* spp. These cultivated areas were primarily located on the low-lying plains where the soil is often sandy and naturally poor in nutrients. This lead to the further leaching of already poor soils. It can therefore be expected that reclamation of these areas by climax species would take a very long time. It was also found that some of these areas have not been cultivated for a period of 20 years, but was still in a pioneer stage. The natural progression towards secondary succession was strained due to overgrazing and burning.

Fauna

A total of 70 mammal species have been recorded on the reserve, including 15 predator species. Game of significant importance that occurs on the reserve includes White Rhino, Buffalo, Oribi and Sable. Several threatened mammal species also occur including the African Wild Cat, Antbear, African Civet, Aardwolf, Brown Hyena, Serval and Leopard, whilst important bird species include the Red-billed Oxpecker, Blue Crane, Bald Ibis, African Finfoot, Cape Vulture, Martial Eagle, Stanley's bustard and Caspian tern. A total of 367 bird species, 42 reptile, 19 amphibian and 42 fish species have been recorded on the reserve (Eksteen 2003). In addition, cattle belonging to the local farmer are still present in this area, mainly occurring in the western sections where the farmhouse is located.

Climate

Climate is described as the physical state of the atmosphere and is considered the result of the radiation influence of the sun on the atmosphere which enfolds the surface of the earth. Isaacs *et al.* (2005) defines climate as the characteristic pattern of weather elements in an area over a period. These elements include temperature, rainfall, humidity, solar insulation, wind etc.

The regional distribution of vegetation is influenced by abiotic factors of which climate is a primary factor (Bond *et al.* 2003). Temperature can however contribute to floristic variations on a meso- and macro scale, however, rainfall is the single most important component of climate that can have an influence on the vegetation. Bredenkamp & Brown (2006) also identified rainfall as the main determining factor for savanna dynamics.

Situated within the summer rainfall area, the reserve is characterised by moderate to very hot summers and mild to cold winters, often accompanied by frost on mountain tops and in low-lying valley bottoms (Theron 1973).

Temperature

There is a significant difference in the temperatures of the higher lying areas and that of the lower lying areas. These differences are especially evident when comparing the average daily minimum temperatures during winter. The lower lying areas are generally frost free, but temperatures sporadically drop below 3º C. In higher lying areas, the frost period extends from May to September with some days of severe frost (Eksteen 2003).

The average maximum and minimum temperatures for each month as well as the absolute maximum and minimum temperatures for the period 2003-2007 as recorded on the reserve are given in Table 2.1 and Table 2.2 (LNR Weather Station). The average maximum and minimum temperatures recorded for the summer months (November-April) of the 3 years preceding the study was 29.6º C and 18.03º C. This is approximately 2 degrees higher than the temperatures recorded during the study period (2007-2008) namely 27.5º C and 16.31º C respectively. The average maximum and minimum temperatures recorded for the winter months (May to October) of the 3 years preceding the study was 26.01º C and 11.23º C and is very similar to those recorded during the study period of 10.7º C and 25.9º C.

The absolute minimum and maximum temperatures vary from 0º C recorded in June 2003 to 42.7º C recorded in January 2005. During the study period, the absolute minimum temperature was 0.1º C recorded in June 2007 and the absolute maximum temperature was 38.5º C recorded in February 2007 (Table 2.2).

Temperatures usually differ significantly between the higher and lower lying areas, however, weather data obtained from the Weather Bureau (2008) for the Middelburg station depicted temperatures that were similar to figures obtained from the reserve (Tables 2.3 & 2.4). The Middelburg weather station gives a clearer indication of the lower temperatures that is to be expected at the higher altitudes compared to the expected warmer temperatures at the lower altitudes such as those of Loskopdam. However, there was little difference in the minimum temperatures as measured at LNR and those measured at Middelburg. These similarities could probably be ascribed to the huge body of water in the Loskopdam, lowering minimum temperatures in the low lying areas further than would be expected.

Table 2.1 TEMPERATURE STATISTICS (Average Minimum and Maximum) FOR THE PERIOD 2003-2007

Recorded at Loskopdam Nature Reserve Office Weather Station

AVERAGE MINIMUM AND MAXIMUM TEMPERATURES Loskopdam (ºC) (Time 08h00)

MONTHS	2003		2004		2005		2006		2007		2008		Ave Max 2003-'07	Ave Min 2003-'07
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
Jan	n/a	n/a	19.2	29.7	18.8	31.1	20	28.6	19.3	31.6	18.5	27.3	29.7	19.2
Feb	n/a	n/a	18.4	29.3	18.3	33.1	19.5	27.7	19.7	32.3	17.7	30.0	30.5	18.9
Mch	n/a	n/a	17.6	27.9	16.4	31.1	18.3	25.6	18	27	16.4	27.1	27.8	73.6
Apr	n/a	n/a	15.8	27.1	13.2	26.9	15.2	28.4	14.9	27.6	11.6	25.31	27.5	14.1
May	9.5	27	10.2	25.7	11.4	25.5	9.4	25.6	12	26.4	n/a	n/a	26.0	10.5
Jun	9.2	20.6	6.6	21.6	9.5	23.6	9.2	21.8	7.3	23	n/a	n/a	22.1	8.36
Jul	n/a	n/a	6.5	19.9	8.7	23.7	8.6	22.1	6.5	22.4	n/a	n/a	22.0	7.6
Aug	n/a	n/a	11.1	26.6	11.4	26.9	8.8	22.5	8.8	25.2	n/a	n/a	25.3	10.0
Sept	n/a	n/a	10.6	27	15.4	32.1	14.3	28.3	14.4	31.8	n/a	n/a	29.8	13.7
Oct	16.4	31.2	16.6	32.4	14.8	31.9	18.7	31.1	15.2	26.5	n/a	n/a	30.6	16.3
Nov	18.6	31.4	18.2	32.4	18.3	30.6	18.1	21.7	16.6	27.86	n/a	n/a	28.8	18.0
Dec	20.3	33.2	19.9	30.3	18.5	29.1	20.2	30.7	17.1	27.5	n/a	n/a	30.2	19.2
Ave Wet*	n/a	n/a	18.3	29.77	17.5	30.82	18.3	28.33	18.37	28.48	16.31	27.5	29.0	17.8
Ave Dry*	5.85	13.13	10.3	25.53	11.9	27.28	11.5	25.23	10.7	25.88	0	0	23.4	10.0

*Average Wet indicates average temperatures measured from November of the previous year to April of the current year
*Average Dry indicates average temperatures measured from May to October of the current year

Table 2.2 (.) TEMPERATURE STATISTICS (Absolute Minimum and Maximum) FOR THE PERIOD 2003-2007

Recorded at Loskopdam Nature Reserve Office Weather Station

ABSOLUTE MINIMUM AND MAXIMUM TEMPERATURES PER MONTH (ºC)

MONTHS	2003		2004		2005		2006		2007	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Jan	17.9	35	16.7	37.5	16	40.7	15.5	34	13.8	35.1
Feb	17.8	37	15.7	36.6	18.5	42.1*	14	36	15.2	38.5
Mch	14.5	36.8	14.4	32.4	14.5	40.8	10.5	27.5	13.5	36.9
Apr	13.5	35	12.4	30	10.2	36.2	8	32.2	7.4	32.5
May	7.4	35.5	9.1	29.5	5.4	29.8	0.4	28.5	2	30.8
Jun	0*	n/a	7.2	24	4	25.5	2	24.8	0.1	27
Jul	6.5	30	5.1	27.5	3	28	4	23.4	4	27.4
Aug	4.5	30.5	6.5	31.5	5	37.9	2	28.5	5	31.4
Sept	13	33.4	10	34.8	10.5	37.5	6.9	33.6	5	36.5
Oct	12.5	37.3	12.4	34.5	10	38.2	13.2	37.8	9	32.5
Nov	17.3	37.5	14.5	35.9	12.9	42	13	36.5	5.1	34.1
Dec	16	38.3	14.7	39.5	13.5	33.5	15	37	15	n/a

Blue figures indicate the monthly absolute minimum temperatures from 1998-2007
*Blue indicates the absolute minimum temperature recorded for the last 10 years
Red indicates the monthly absolute maximum temperatures from 1998-2007
*Red indicates the absolute maximum temperature recorded for the last 10 years

Table 2.3 TEMPERATURE STATISTICS FOR THE PERIOD 2003-2007
Recorded at Middelburg Weather Station

AVERAGE MINIMUM AND MAXIMUM AND ABSOLUTE TEMPERATURES Middelburg (ºC) (Time 08h00)

MONTHS	2003		2004		2005		2006		2007		2008		Ave max	Ave Min
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	03-'07	03-07
Jan	19.1	31.5	19.5	30.7	24.1	35.2	18.5	29.3	18.3	32.5	17.6	28.9	31.4	19.5
Feb	19.8	32.9	18.6	30.2	23.9	36.7	16.9	26.7	19.3	34.1	16.9	30.4	31.8	19.35
Mch	18	32.6	17.9	28.7	16.9	31.7	13.4	23	18.6	33.2	15.8	28.4	29.6	17.1
Apr	16.5	30.7	15.5	27.4	14.5	31.2	11.7	27.6	15.2	29.2	12.3	26.9	28.8	15.2
May	11	26.2	11.4	25.9	9.2	22.5	6.1	19.3	10.1	26.1	10.3	23.9	24.0	10.9
Jun			8.3	21.7	6.6	20.7	5.3	18.4	6.8	22.4	7.7	22.9	21.2	6.9
Jul	7.4	23.9	6.3	22.2	6	21	7.1	18.4	5.7	22.6	n/a	n/a	21.6	6.5
Aug	7.6	24.5	13.3	26.8	10	26.8	8.4	24.4	8.1	25.8	n/a	n/a	25.7	9.5
Sept	13.7	29	14.1	27.8	14.6	32.8	12.3	28.9	8.6	31.2	n/a	n/a	29.9	12.7
Oct	17.3	31.4	19.9	32.5	16.7	33.2	17.5	32.2	13.8	26.7	n/a	n/a	31.2	17.0
Nov	18.9	31.1	18	32.6	17	30.9	18.1	30.4	15.2	27	n/a	n/a	30.4	17.4
Dec	18.9	33.5	17.6	30.3	16.4	28.2	19.4	32.4	n/a	n/a	n/a	n/a	31.1	18.1
Average W	n/a	n/a	18.2	30.3	19.2	33.0	15.7	27.6	18.2	32.0	15.6	28.3	30.2	17.3
Average D	9.5	22.5	12.2	26.2	10.5	26.2	9.5	23.6	8.9	25.8	n/a	n/a	24.8	10.1

*Average Wet indicates average temperatures measured from November of the previous year to April of the current year
*Average Dry indicates average temperatures measured from May to October of the current year

Table 2.4 TEMPERATURE STATISTICS FOR THE PERIOD 2003-2007
Recorded at Middelburg Weather Station

ABSOLUTE MINIMUM AND MAXIMUM TEMPERATURES PER MONTH (ºC)

MONTHS	2003		2004		2005		2006		2007		2008	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Jan	17.9	35	16.7	37.5	16	40.7	15.5	34.2	13.8	35.1	14.5	34.8
Feb	17.8	37	15.7	36.6	18.5	42.1*	14	36	15.2	38.5	14	34.5
Mch	14.5	36.8	14.4	32.4	14.5	40.8	10.5	27.5	13.5	36.9	12.3	33.5
Apr	13.5	35	12.4	30	10.2	36.2	8	32.2	7.4	32.5	8	30
May	7.4	35.5	9.1	29.5	5.4	29.8	0.4	28.5	2	30.8	n/a	n/a
Jun	0*	n/a	7.2	24	4	25.5	2	24.8	0.1	27	n/a	n/a
Jul	6.5	30	5.1	27.5	3	28	4	23.4	4	27.4	n/a	n/a
Aug	4.5	30.5	6.5	31.5	5	37.9	2	28.5	5	31.4	n/a	n/a
Sept	13	33.4	10	34.8	10.5	37.5	6.9	33.6	5	36.5	n/a	n/a
Oct	12.5	37.3	12.4	34.5	10	38.2	13.2	37.8	9	32.5	n/a	n/a
Nov	17.3	37.5	14.5	35.9	12.9	42	13	36.5	5.1	34.1	n/a	n/a
Dec	16	38.3	14.7	39.5	13.5	33.5	15	37	15	n/a	n/a	n/a

Blue figures indicate the monthly absolute minimum temperatures from 2003-2007
*Blue indicates the absolute minimum temperature recorded for the last 5 years
Red indicates the monthly absolute maximum temperatures from 2003-2007
*Red indicates the absolute maximim temperature recorded for the last 5 years

Rainfall

Bredenkamp & Brown (2003) states that rainfall is the main determining factor in savanna dynamics with the moister savannah tending towards the equilibrium side of the gradient and arid savanna towards the arid side. According to Eksteen (2003), the mean long-term rainfall for the reserve is approximately 650 mm per year and occurs mainly in the form of showers and high intensity thunderstorms from October to March. These thunderstorms are often accompanied by severe lightning and strong, gusty, south-westerly winds. Rainfall is usually associated with strong south westerly winds and mainly occurs in the form of short-lived, high intensity thunderstorms.

The average monthly rainfall figures for the years 2002-2007 are indicated in Table 2.7 for the Loskopdam Nature Reserve (LNR Weather Station) and Table 2.8 for the Middelburg area (Weather Bureau 2008). The average annual rainfall (YTOT) for the study area for the period (2003-2007) was 493.7 mm with a high of 784.1 mm and a low of 306.6 mm recorded for 2006 and 2003 respectively. A more accurate presentation is that of average rainfall for the wet season (AVE W) that is recorded from November-April in the reserve. The average monthly rainfall recorded over the last five years during the wet season (summer) was 496.7 mm, whilst the average monthly rainfall recorded for the wet season during the study period was 594.8 mm. The highest average wet season rainfall was recorded in 2006 at 671.5 mm and the lowest average recorded was 285.1 mm in 2003. The years 2003 through to 2004 is characterised by lower than average annual and wet season rainfall figures. Climate diagrams (Walther & Lieth 1960) for the LNR and Middelburg areas are presented in Figures 2.6 and 2.7 respectively. The dry period extends through the months where the rainfall curve is lower than the temperature curve (May – September) and the wet period, when the rainfall curve is higher than the temperature curve (October – April). With the exception of the dry period recorded for the Middelburg area from November – March, the climate diagrams for both stations (LNR & Middelburg) followed the same general trend. Low rainfall figures were recorded during 2003-2004 and high figures during 2006 (Tables 2.5 & 2.6).

In general, the rainfall figures recorded for the Middelburg Station was lower than that recorded on the reserve (Table 2.8). The average annual rainfall (YTOT) recorded for the Middelburg Station for the period 2003 – 2007 was 380.98 mm with a high of 729.3 mm and a low of 218.6 mm recorded for 2006 and 2003 respectively. The average monthly rainfall recorded over the last five years during the wet season (AVE W) was 302.98 mm. The highest average wet season rainfall was recorded in 2006 with 712 mm and the lowest average was recorded in 2004 with 102.5 mm.

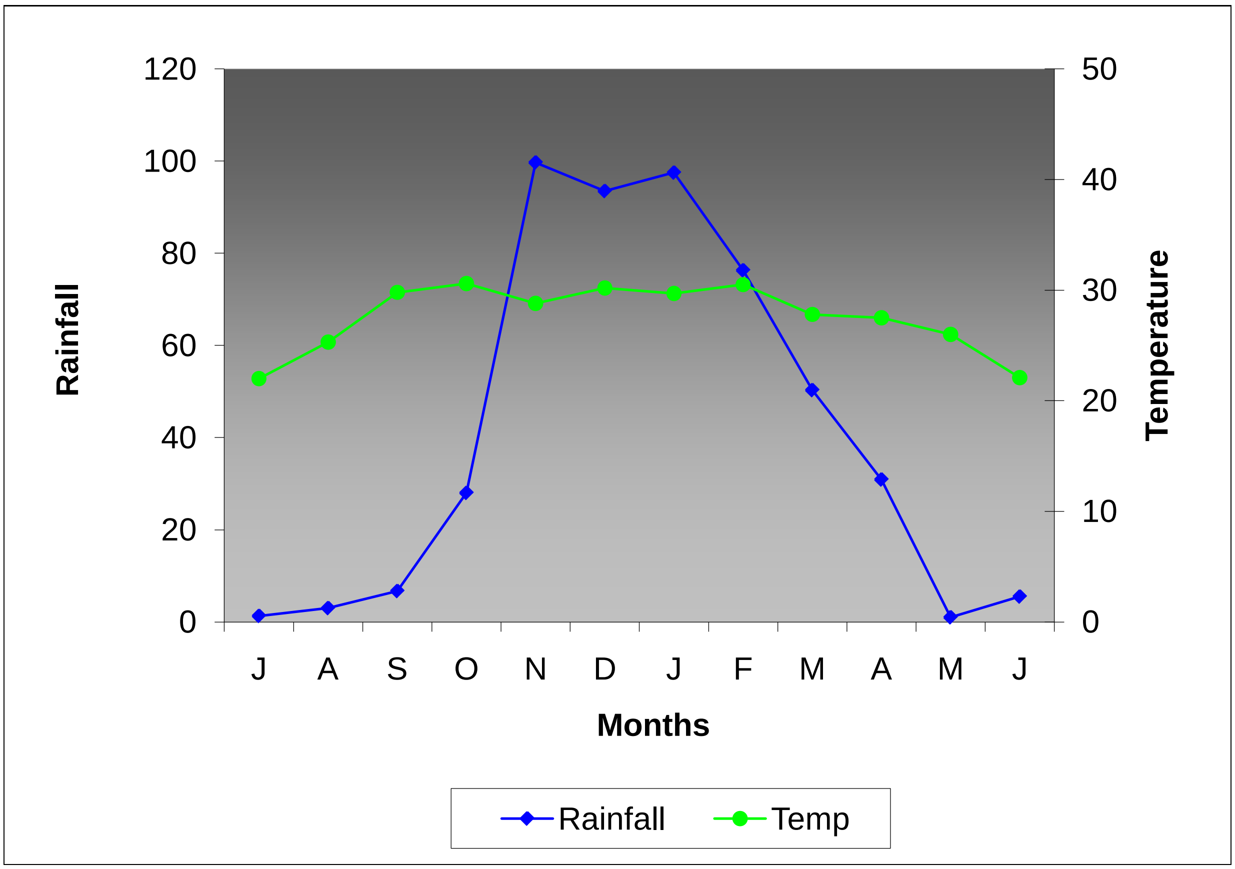

Figure 2.6 Climate diagram for the Loskopdam Nature Reserve (diagram according to Walter & Lieth (1960))

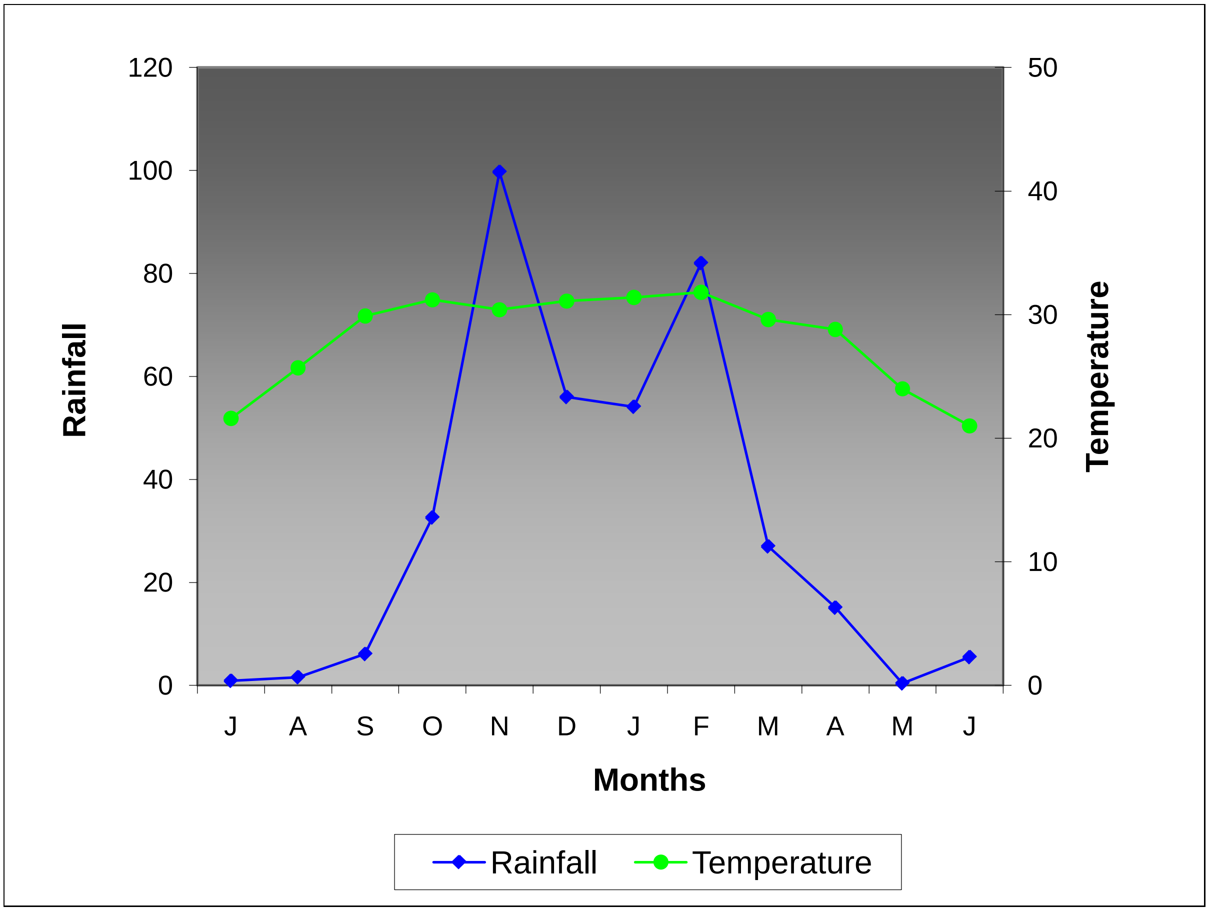

Figure 2.7 Climate diagram for Middelburg (diagram according to Walter & Lieth (1960))

Table 2.5 MONTHLY RAINFALL FIGURES (mm) FOR THE YEARS 2003-2007
Recorded at Loskopdam Nature Reserve (2008)
Weather Stations 90; 10; 911; 912 & 913

MONTHLY RAINFALL (mm)

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YTOT	STOT	AVE W	AVE D
2002	73.4	54.2	35	31.3	5	3	0	14.6	1	106.5	39.5	60.8	424.3	n/a	n/a	130.1
2003	87.7	71.7	4	21.4	0	3.5	0	0	0	15.5	35.3	67.5	306.6	410.7	285.1	19
2004	62.7	76.7	99.8	50	3	1.1	6.5	0	0	24.2	119	116.7	559.7	411.6	392	34.8
2005	113.9	29	65.8	53.4	1.2	0	0	0	0	12	137	54	466.3	529.7	497.8	13.2
2006	223	176.5	74.3	6.7	1	0	0	15.1	0	18.5	123.5	145.5	784.1	684.5	671.5	34.6
2007	0	27.5	7.8	23	0	23	0	0	33.5	69.65	83.6	84	352	383.9	327.3	126.15
2008	277.5	30.5	80	39.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	594.75	n/a
Ave Monthly	97.5	76.3	50.3	30.9	1.0	5.5	1.3	3.0	6.7	28.0	99.7	93.5	493.7	484.1	496.7	45.6

YTOT = Total for the year
STOT = Total for the season (July of previous year to June of present year)
AVE W = Average monthly rainfall for wet season (Nov-Apr)
AVE D = Average monthly rainfall for dry season (May-Oct)

Weather stations:

90	Office
910	Doornfontein
911	Nooitgedacht
912	Rietfontein
913	Parys

Table 2.6 MONTHLY RAINFALL FIGURES (mm) FOR THE YEARS 2003-2007 Recorded at Middelburg Weather Station (2008)

MONTHLY RAINFALL (mm)

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YTOT	STOT	AVE W	AVE D
2002	95	30	29	29	0	3	0	9.5	0	0	18.5	0	214	n/a	n/a	12.5
2003	0	89.1	3.5	12.5	0	0	0	0	0	11	42.5	60	218.6	133.1	123.6	11
2004	0	0	0	0	0	0	4.5	0	0	25	64.5	137.5	231.5	113.5	102.5	29.5
2005	47.5	51	52	9	0	0	0	0	0	5.5	101.5	52.5	319	391	361.5	5.5
2006	190	253.5	67	48	2	0	0	8	0	14.5	116.8	30	729.3	719.5	712	24.5
2007	33.5	16.5	12.5	6	0	27.5	0	0	30.5	107	173	0	406.5	265.3	215.3	165
Ave/month	54.1	82.0	27	15.1	0.4	5.5	0.9	1.6	6.1	32.6	99.7	56	380.98	324.48	302.98	47.1

YTOT = Total for the year
STOT = Total for the season (July of previous year to June of present year)
AVE W = Average monthly rainfall for wet season (Nov-Apr)
AVE D = Average monthly rainfall for dry season (May-Oct)

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CHAPTER 3

METHODS

Introduction and motivation

This study was conducted over a one year period to include at least one winter and two summer seasons. The Braun-Blanquet approach to vegetation ecology as described by Westhoff & Van der Maarel (1978), Werger (1974a) and Mueller Dombois & Ellenberg (1974) was applied in this study. This approach to the study of vegetation is commonly used in South Africa (Behr & Bredenkamp 1988; Bezuidenhout 1996; Bredenkamp & Bezuidenhout 1995; Bredenkamp & Theron 1978; Brown & Bredenkamp 1994, 1996).

The basic principles of the Zürich-Montpellier approach can be summarised as follows according to Westhoff & Van der Maarel (1978):

- Plant communities are recognized as vegetation units on the basis of their floristic composition – this being the most important characteristic.
- The floristic composition of a plant community consists of species that have certain mutual relationships and are known as diagnostic or differential species.
- These diagnostic species are used to organize plant communities in a hierarchical classification where the association forms the basic unit. A plant association is a "plant community of definite floristic composition, presenting a uniform physiognomy and growing in uniform habitat conditions" (Gertenbach 1987; Werger 1974).

The practical execution of the Zürich-Montpellier approach consists of the following (Westhoff & Van der Maarel 1978):

- Sampling of subjectively selected representative, homogeneous plots/units of a certain minimum size.
- Recording and rating of all species on a cover-abundance scale.
- Recording of other qualitative and quantitative characteristics of the vegetation such as density, production etc.
- Samples are entered into a table from which the vegetation units are extracted.
- The composition, differentiation and characterisation of associations.

Survey methods

Observations

The Reserve was visited in spring 2006 with the purpose of getting acquainted with the study area. It also had to be determined whether the remote location of the study area would be a hindrance in the completion of this study.

Aerial photograph interpretation and delineation

A 1:50 000 stereo aerial photograph was used to stratify the entire area into relative homogeneous physiographic-physiognomic vegetation units (Barbour *et al.* 1987, Kent & Coker 1997). In the article compiled by Trollope *et al.* (1990), Gabriel & Talbot (1984) defines physiognomy as the general outward appearance of a plant community that is determined by the life form of the dominant species.

Plot size, distribution and number

The plot size was fixed at 100 m² (Bezuidenhout & Bredenkamp 1991; Bredenkamp & Theron 1978; Behr & Bredenkamp 1988). The number of sample plots is determined by the scale of the survey, the variation in the vegetation composition and the accuracy required (Werger 1974, Gertenbach 1987). A total of 76 plots were placed out on a randomly stratified basis (Barbour *et al*. 1987, Bezuidenhout 1996, Brown & Bredenkamp 1994, Brown 1997) within representative stands of vegetation so as to exclude as much heterogeneity in terms of floristic composition, structure and habitat as possible.

The general position of the sample plots was thus determined beforehand but each section within the identified stand had the same chance of being selected. If it was found that a position was not representative of the general vegetation, the sample plot was moved to be more representative of the immediate vegetation and environment in accordance with requirements for the traditional Braun Blanquet-type surveys (Werger 1974, Coetzee 1975 and Gertenbach 1987). The location of each plot was recorded using a GPS. The position format used was hdddºmm'ss.s" and the Map Datum was WGS 84.

Habitat data

The main habitat variables that are correlated with differences in floristically defined plant communities according to Bredenkamp & Brown (2003) are geology, topography (landform, aspect, slope) and altitude. In addition, soil texture and depth are also important factors (Coetzee 1975; Bredenkamp 1975; Coetzee 1993) although only texture was recorded for this study. Other habitat factors recorded include the rockiness, degree of erosion, accessibility as well as signs of fire and wildlife. Aspect was measured by using a compass and slope was measured with the aid of a clinometer. A modified classification of slope units as described by Westfall (1981) was used (Table 3.1). The following classification of slope units was used based on Westfall (1981).

Table 3.1 Modified classification of slope units used for this study (adapted from Westfall 1981)

Symbol	Description	Class
L	Level	0º – 3º
G	Gentle	4º – 9º
M	Moderate	10º – 15º
S	Steep	16º-25º
VS	Very steep	26º-55º

Sampling

A detailed floristic analysis that commenced in January 2007 and completed in April 2008, was undertaken. Within each sample plot, all plant species present were identified and recorded and the percentage of the plot covered by each species (cover abundance) was estimated using a modified Braun-Blanquet cover abundance scale (Mueller-Dombois & Ellenberg 1974) (Table 3.2). Cover is defined as the vertical projection of the crown per height class (Mueller-Dombois & Ellenberg 1974, Gertenbach 1987). The evaluation of plant species in each sample plot was done according to an 8-point scale and not according to the traditional 7 point scale of Braun-Blanquet (Werger 1974; Gertenbach 1987; Van Staden 2002).

Table 3.2 Modified Braun-Blanquet cover abundance scale (Mueller-Dombois & Ellenberg, 1974.)

Scale	Description
r	One or a few individuals with less than 1% cover of the plot area
+	Species occur occasionally with less than 1% cover of the total area of the plot
1	Abundant, but with low cover or less abundant but with greater cover, but less than 5% of the total plot area (single individuals)
2a	Abundant, but with 5-12% cover of the total plot area
2b	Abundant, but with 13-25% cover of the total plot area
3	25-50% cover of the total plot area irrelevant of amount of individuals (small clumps)
4	50-75% cover of the total area of the plot, irrespective of amount of individuals (extensive matts/clumps)
5	75-100% cover of the total area, irrespective of amount of individuals (continuous populations)

Sampling of each releve also included a general structural analysis where the total tree density as well as the density of each tree species was determined by counting the trees in each height class respectively. Structural terminology is according to Edwards (1983). The woody stratum was divided into three height classes namely lower (0-1m), middle (>1-3m) and upper classes (>3m) (Emslie 1991; Rogers 1993; Brown & Bredenkamp 1994). The percentage grass, forb, tree and shrub cover were also estimated for each sample plot.

Veld condition & grazing capacity

The Ecological Index method (Foran *et al.* 1978; Smit 1988; Vorster 1982), which was proven successful in formulating management practices (Orban 1995) was used to determine the veld condition and grazing capacity of the Hondekraal Section of the Reserve. The step-point method (Mentis 1981; Dankwerts 1989) was used to conduct grass surveys in each sample unit, whilst the percentage tree, shrub and grass cover for each sample site was also noted.

For each sample site, the frequency of the grass and forb species was calculated and the species classified according to their reaction to utilisation into one of the following ecological classes; Decreasers, Increasers I, II, and III (Van Oudtshoorn 2004). Forbs were classified as Increaser III species. A minimum of 200 step points were done for each plot.

Data analysis

Analysis of Floristic data

All vegetation data was captured in the TURBOVEG database that placed the plant species data in a matrix of columns for each plot and rows for each of the plant species (Hennekens & Schaminee 2001). This system, developed originally in the Netherlands, was accepted as the standard computer package for the European Vegetation Survey in 1994 and as such is well tested and deemed suitable for purposes of this study.

The data was then exported into the JUICE program (Lubomír 2002), a multifunctional editor of phytosociological tables from where the numerical classification program, Weighted Two-Way Indicator Species Analysis, TWINSPAN (Tichý *et al*. 2007), was used to derive a first approximation of the floristic data. Further refinement of the classification was achieved by affecting Braun-Blanquet procedures (Barbour *et al*. 1987; Kent & Coker 1997; Bezuidenhout 1996). Using the phytosociological table and the habitat information gathered during the sampling period, the different plant communities were identified and described. Although no attempt was made to fix formal syntaxonomic names for the plant communities, the plant community names conform to the basic rules of syntaxonomic nomenclature

(Barkman *et al.* 1986). Plant communities were recognized by using diagnostic/character species as defined by Westhoff & Van der Maarel (1978). These species are those that are largely restricted to a community and do not necessarily have a high importance value. The different plant communities are described according to their dominant species and habitat data. Dominant species are those that are most conspicuous in the community and are high in one or more of the importance values (Whittaker 1978), in this case canopy cover and frequency.

Determination of veld condition and grazing capacity

The Veld Condition Index was determined for each of the plant communities that were identified in the study area. Relative index values were assigned to each group namely 10 to Decreaser species, 7 to Increaser I species, 4 to Increaser II species and 1 to Increaser III, forbs, and invader species. The sum of the products of the proportion contributed by the different ecological classes and the relative index values assigned to each group is the condition score for a particular sample site (Hardy & Hurt 1989). The maximum theoretical index value that could be obtained is 1000. An ecological index value of 0 – 399 indicates veld in poor condition, 400 – 600 indicates veld in average condition and 601-1000 indicates veld in good condition (Bothma 1995). Veld in good condition with a high grazing capacity will have a high percentage Decreaser and Increaser 1 grass species composition.

This data was incorporated into the Graze model (developed by Bredenkamp, Ecotrust cc[1]) ((Brown 1997) to calculate the grazing capacity for game for each plant community both for an average rainfall year as well as for a below-average period (average rainfall: 494 mm/year; below average rainfall: 306 mm/year - see Chapter 2).

Together with the Veld Condition Index, the Graze model incorporates various attributes pertaining to the specific plant community to determine the grazing capacity for each plant community. These attributes include the following: 1) the size (ha) of each plant community, 2) the percentage canopy cover of the tree, shrub and

[1] P.O. Box 25533, Monument Park, 0105

grass layers, 3) the accessibility of the terrain to game, and 4) rainfall, and 5) fire regime for the area.

Relatively flat and easily accessible to antelope areas were given a factor of one (1) in contrast to the more mountainous areas, which are not as easily accessible and assigned a factor of 0.8 (Brown 1997). These two factors were applied to the plant communities found in the study area where accessibility is hindered by the extremely rugged and steep topography. These areas are normally under-utilised notwithstanding the presence of highly palatable Decreaser grass species (Brown, 1997).

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CHAPTER 4

VEGETATION CLASSIFICATION AND DESCRIPTION

Plant community description

The results of the classification procedure are presented in a phytosociological table (Table 4.1) and the identified plant communities are mapped on a scale of 1:50 000 The analysis resulted in 12 plant communities which can be grouped into 8 major vegetation types being identified (Figure 4.1). In the descriptions all references to different species groups refer to Table 4.1.

1. *Sporobolus africanus–Cyperus esculentus* drainage channel

    1.1 *Schoenoplectus corymbosus–Juncus* species sub-community

    1.2 *Pennisetum macrourum–Hypoxis rigidula* sub-community

    1.3 *Eragrostis plana–Cyperus rupestris* sub-community

2. *Hyperthelia dissoluta–Indigofera daleoides* grassland

    2.1 *Hyperthelia dissoluta–Elephantorrhiza elephantina* grassland

    2.2 *Hyperthelia dissoluta–Digitaria eriantha* grassland

3. Faurea saligna–Setaria sphacelata open woodland

4. *Faurea saligna–Burkea africana* woodland

5. *Burkea africana–Digitaria eriantha* open woodland

6. *Combretum molle–Xerophyta retinervis* open to closed woodland

6.1 *Lannea discolor-Diplorhynchus condylocarpon* woodland

6.2 *Setaria sphacelata-Mundulea sericea* woodland

7. *Tristachya biseriata–Loudetia simplex* grassland

8. *Combretum apiculatum–Panicum ecklonii* open woodland

The general vegetation of the study area is characterised by the presence of species from species group T in all plant communities. These species can therefore be considered as common species for the area. The indigenous encroacher shrub *Dichrostachys cinerea* is present in most communities except in the *Tristachya biseriata-Loudetia simplex* grassland community (community 7) while the tree *Burkea africana* is prominent in all communities except in the open grassland and drainage channel communities (communities 1, 2 & 8). The most prominent grass species with 69% constancy for the study area is *Setaria sphacelata*, while the grasses *Heteropogon contortus* and *Trachypogon spicatus* are present at low frequencies in almost all the communities.

Table 4.1 Phytosociological table for the Hondekraal Section of the Loskopdam Nature Reserve

Communities 1–2:

Community number	1									2												
	1.1			1.2		1.3				2.1					2.2							
Releve number	69	68	70	72	71	64	65	40	38	32	33	6	31	34	10	1	3	12	44	5	2	19
Species group A																						
Juncus species	2	2	+					+														
Terminalia brachystemma	+	+	+					r									+					
Rorippa nasturtium-aquaticum	+	r	+					+														
Oenothera rosea	+		+																			
Ranunculus multifidus	+		+																			
Gomphocarpus fruticosus			2																			
Lobelia erinus			+																			
Searsia leptodictya		+						+														
Species group B																						
Hypoxis rigidula				+	+																	
Verbena brasiliensis			+		+				+													
Pennisetum villosum				+																		
Gymnostephium fruticosum				+																		
Cyperus species					+																	
Mariscus congestus				+															+			
Species group C																						
Eragrostis plana						2	2	2	2													
Cyperus rupestris				+	+	2	2	3						1								
Eragrostis capensis						2	1	+														
Raphanus species						+	+	+														
Nidorella anomala						+	+	+														
Hyparrhenia hirta						3	4										1					
Sporobolus fimbriatus						r		1														
Helichrysum rugulosum					+	1	+							+								
Fuirena pubescens						+	+															
Chironia purpurascens						+	+															
Lobelia species						+	+															
Miscanthus junceus		+					+	+														
Persicaria lapathifolia							+		r													
Persicaria serrulata		+				+		+														
Bothriochloa radicans						+																
Potamogeton species							+															

Communities 3–5:

Community number	3		4												5										
Releve number	39	37	66	53	52	17	16	15	59	30	18	58	43	22	20	21	27	9	29	23	28	11	24	8	7
Species group A																									
Juncus species																									
Terminalia brachystemma			2								3														
Rorippa nasturtium-aquaticum																									
Oenothera rosea																									
Ranunculus multifidus																									
Gomphocarpus fruticosus																									
Lobelia erinus																									
Searsia leptodictya								r						r				r							
Species group B																									
Hypoxis rigidula																									
Verbena brasiliensis																									
Pennisetum villosum																									
Gymnostephium fruticosum																									
Cyperus species																									
Mariscus congestus			+																						
Species group C																									
Eragrostis plana																									
Cyperus rupestris																									
Eragrostis capensis																									
Raphanus species																									
Nidorella anomala																									
Hyparrhenia hirta																									
Sporobolus fimbriatus									r																
Helichrysum rugulosum																									
Fuirena pubescens																									
Chironia purpurascens	r																								
Lobelia species																									
Miscanthus junceus																									
Persicaria lapathifolia																									
Persicaria serrulata																									
Bothriochloa radicans																									
Potamogeton species																									

Communities 6–8:

Community number	6																	7										8	
	6.1										6.2																		
Releve number	67	42	63	60	61	36	35	76	62	41	55	57	56	51	14	54	13	75	4	74	73	47	48	45	46	49	50	26	25
Species group A																													
Juncus species																													
Terminalia brachystemma																													
Rorippa nasturtium-aquaticum																													
Oenothera rosea																													
Ranunculus multifidus																													
Gomphocarpus fruticosus																													
Lobelia erinus																													
Searsia leptodictya																													
Species group B																													
Hypoxis rigidula																													
Verbena brasiliensis																													
Pennisetum villosum																													
Gymnostephium fruticosum																													
Cyperus species																													
Mariscus congestus																													
Species group C																													
Eragrostis plana																													
Cyperus rupestris																													
Eragrostis capensis																													
Raphanus species																													
Nidorella anomala																													
Hyparrhenia hirta																													
Sporobolus fimbriatus																													
Helichrysum rugulosum																													
Fuirena pubescens																													
Chironia purpurascens																													
Lobelia species																													
Miscanthus junceus																													
Persicaria lapathifolia																													
Persicaria serrulata																													
Bothriochloa radicans																													
Potamogeton species																													

Species group D											
Sporobolus africanus	1 + 1 + 2	+ +		+ r		+ +					
Cyperus esculentus	+ + + +	+ 3 +		+		r				r r	
Verbena bonariensis	+ + + +	1 + +	+	+ r							
Phragmites australis	3 + 3 2 1	+									
Panicum maximum	1 + + +	r 2				r + + r + +	r	1 r	3	r	
Paspalum dilatatum	+ + + 1	+ +									
Schoenoplectus corymbosus	3 3 2 2	+									
Pennisetum macrourum	2 1 1	+ 3									
Imperata cylindrica	1 1 +	+ +									
Cynodon dactylon	1 +	1 1		+ + +		1 4					
Species group E											
Cyperus obtusiflorus	+ +	2 2 2	r r + 2			+ r +		+ r r r +		r r	
Wahlenbergia undulata		+ r +	r r + r		r +	+ +		r +	r		
Species group F											
Limeum viscosum			1 1 1 +			+	r	r 1			
Elephantorrhiza elephantina			1 1 2	r	1	r		r			
Tephrosia longipes			1 2					+ + r	r 1 +		
Kohautia amatymbica			+ r	+		+					
Solanum incanum			+ +			r	r r			+	
Pollichia campestris			+ + +			r r +					
Kyllinga alba		+	+ +					r			
Hibiscus pusillus			+ +			r					
Species group G											
Indigofera daleoides			+ 1 +	1 + +		+ 1 + +					
Senecio species	+ +		+ +	r r +		r					
Helichrysum miconiifolium				2							
Hermannia boraginiflora			+ +	r +							
Tephrosia lupinifolia			+	r + +	r	r		+		r +	
Chamaecrista mimosoides			+	+		+ r r				+	
Richardia brasiliensis			r	r							
Species group H											
Bulbostylis burchellii		+ +	+ + + +		1 1			+ +			
Pelargonium luridum	+	r	r		r 1						
Triumfetta sonderi		r			2	r r	r r r	+ r	r		
Seriphium plumosum		r			r	r					

Species group I												
Faurea saligna			r	+		2 2	+ r 1 2 2 1 1 2 1 +	1		+ +		
Vernonia natalensis						r	+ r 1 1 r + 1 + 1	1 1 2 r		+ +		
Eragrostis gummiflua					+		r r r 1 + + +	1 + +		r		
Dichapetalum cymosum			r	r 1 r		+ r	+ r r r r					
Helichrysum species	+ + +		1				r r 1 2	r				
Nidorella hottentotica							r 2 r r 1			r r	r r	
Agathisanthemum bojeri				+ + +	+	+ 1	+ + r		1 r			
Species group J												
Hyperthelia dissoluta			1	4 4 4 2	3 3 5 4 4 4 r 1	+ +	3 r 2 3 + 1 2 3 r 2 + 1	2 2 r + + 1 +	+ r r 2 +			
Pogonarthria squarrosa			r	r + + +	1 1 + r + +		r r 2 r + + 1 1 2	r 1 r + 1 r 1 1 r r +			+	
Digitaria eriantha			r	+	2 2 + r + 3	r	r r r + r r r +	2 2 1 r r r 1 + r r r	1 +			r 1
Eragrostis curvula		+	2	1 r + + 2	+ + + + + +	+	+ + + r r r +	r r r r				r
Vernonia oligocephala			+	1	r 1	1 3	+ r r + r r + 1	r 1 + r r +	r			
Waltheria indica				r r +	r +		r + +	+ r r 1 r r +				
Lippia javanica	+ + +	+	+		r + +	+	2 + 1 r 1 1 3	+ + +	r	+ 1 r r r r		
Terminalia sericea	+ + +				+ r r + r	2	2	+ 1 r r r				r
Perotis patens				r	1 r 1		r r r r 1	+ r r			r	
Eragrostis chloromelas				+	+		+ r			+ + r		
Oldenlandia herbacea				+	r + r			r r	r	+	r r +	
Felicia muricata				r		r	r r +	+ 1 r				
Species group K												
Eragrostis rigidior			+		1 +		+	3 1 3 r r r				
Acrotome hispida								r r + r r	+	r	r	
Panicum coloratum			r				r	r + r r r			r	
Acacia caffra	+	1		r			+ r r +	2 2 2 +	+	1		
Justicia betonica				+ + + +		+ +		2 1 r +	+			r
Strychnos spinosa							2 3	2 r 2 r				
Stylosanthes fruticosa								1 1 r 1				
Elionurus muticus			+	r				r + r	r		r	
Acacia karroo		+					3	2 2				2
Lippia rehmannii						r	r +	2 +				r
Sida cordifolia			+		+		+ r +	1 +	+ +		r	
Acacia burkei					r			2				
Dovyalis caffra				r				2				
Strychnos cocculoides								2		r		
Tristachya leucothrix								1				
Species group L												
Aristida diffusa							r	r r r + r r	+ 1 r + +	+ r	r	
Aloe marlothii								r 1 r	1 r r 1 1 +	1 + r		r
Ozoroa paniculosa					+			r + r r	1 + r r	r	r	
Berkheya species			+					+ r r	r + + r r	r	r	
Eragrostis superba				+	1	r	+	r + + +	r r 2			
Kyphocarpa angustifolia								r r r	r + r +	r r		

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Species group M											
Combretum molle						r		+ 2 + r 2 1 r + 1 r	2 1 + 3 2	1 r +	
Tagetes minuta						r		+ 1 + 2 2 r + 1	3 + r		
Pentanisia angustifolia								+ + +		r +	
Gerbera species								+ +	+		
Species group N											
Schmidtia pappophoroides								+ 1 2 r + + r			
Lannea discolor					1	+ r 2 +	r	1 r 1 r 2 2 2 1			r
Brachiaria serrata			2	r	1 +		r 1 +	+ 1 1 r + 2		r	
Maytenus tenuispina						r	2	1 1 1 1		+	r r
Ipomoea crassipes								+ r + + r			
Selaginella dregei								+ + r + r		r	
Solanum panduriforme			+	r		+ r +		+ + + +	r	+	
Ochna pulchra				r		r	+	+ + + +			
Evolvulus alsinoides				+		+	r	+ + 1			
Jatropha zeyheri								+ + +			
Thesium utile		r		r	r		+ r	+ r +			
Ehretia rigida							r	+ 1			
Diospyros lycioides						+		3			
Species group O											
Mundulea sericea							+	r r r	+ 1 r r 1 3	+ r	
Athrixia elata									+ r + + 2	r	
Andropogon schirensis								1	r r + +	1	
Asparagus laricinus							r r		r r r r 1		r
Lantana rugosa		r					r		r r + +		
Heteropyxis natalensis									2 r		
Cymbopogon excavatus									+ r r		
Sphedamnocarpus galphimiifolius									2		
Strychnos madagascariensis							r	+ r	2 r		
Species group P											
Diheteropogon amplectens		r	+		+	r r r	+ r r	1 1 + r 1 1 2	r +	2 3 2 2 + 1 r r r	
Melinis nerviglumis		2	r +	r	r	r	r r +	+ + 1 2 2 1 1 + + r	+ r + r r	r +	r
Xerophyta retinervis							r r	r r r + 2 r + +	1 2 2 1	r + + + 1 2 +	
Commelina erecta			+ + + +			+ r r		1 1 r r + 1	+	+ + + r r	
Protea caffra								r	r 2 1	1 1 1 2 r r 1	r
Englerophytum magalismontanum			r					r r 1		r r + r 1 + 1	
Rhynchosia nitens								1 1 r	r	+ + 2 r	
Commelina africana	+		r			+	r	r r	1	r r r r +	
Asparagus suaveolens								+ r r +		r + r r	
Schkuhria pinnata						+ + +		+ + r	1	+ +	
Ischaemum afrum						r			r 1 2	+ + +	
Asparagus aethiopicus									+	r r	
Ledebouria revoluta								r		r	r

Species group Q												
Tristachya biseriata		+						r		+	2 + 1 1 2 2 3 2	
Eragrostis racemosa							+ + r r	r			r r r r r r r r	
Bulbostylis hispidula		+			+ + + +		r + + +		+ +		1 1 1 + 1 + +	
Parinari capensis						r	1	r 1 r +			+ + + + r r +	
Urelytrum agropyroides								+			1 r + + r 1	
Panicum natalense									r	+ r	r + r r r	
Rhynchosia minima				+ +							1 1 1 r	1
Cleome maculata						r					+ + + +	
Elephantorrhiza burkei							r		r		3 1 1	
Bewsia biflora							r r				+ + +	
Monocymbium ceresiiforme											+ + +	
Chaetacanthus costatus								r			r r r	
Searsia magalismontana											+ +	
Species group R												
Loudetia simplex							+	2 2 r r r r r r	2 2 2 r 1 + 2 2 1	+ + r	3 r 2 3 3 3 2 2 1 2	1 r
Themeda triandra					r		r r	2 + r r	+ + r r + +	+ + + r + r	r + + r	2 r
Pellaea calomelanos							+	r r r r	+ r r + 1 r r r	r 1 + r	r + r + r	r
Diplorhynchus condylocarpon								1 r	2 3 3 3 3 + 2 2 r		1 2 r	1 2
Combretum apiculatum							r	1 2	+	3	2	3 3
Artemisia afra							+	1	r	+ r r	+ + + + r	
Clerodendrum triphyllum								r		+	r	
Species group S												
Panicum ecklonii												r 2
Hypoxis hemerocallidea												r +
Grewia flava				r								r +
Acacia permixta												2
Brachiaria brizantha												r
Species group T												
Setaria sphacelata	2	+ +	+ + 2 2	2 2	r + +	2 2	2 2 2 2 + 2 3 1 r	1 1 + 2 2 + 1 3 + 2 1	+ + 2 r + 1	2 2 + 3 2 3	+ + + r 1 +	r
Burkea africana					+	1	2 3 r 1 1 1 2 2 r	2 2 1 + 1 2 2 2	+ + + + 1 2		r + 1 r + r + 3	
Dichrostachys cinerea	+ +	1	+	r 1 r	+ + 1 + +		3 r r + 2 r + 1	1 1 + 2 1 r 1 1	r r r + 1			
Heteropogon contortus			+	+	r	+ +	r r r r	+ + r + 1	r			r 3
Trachypogon spicatus			+	+			+	r +	r	r	1	

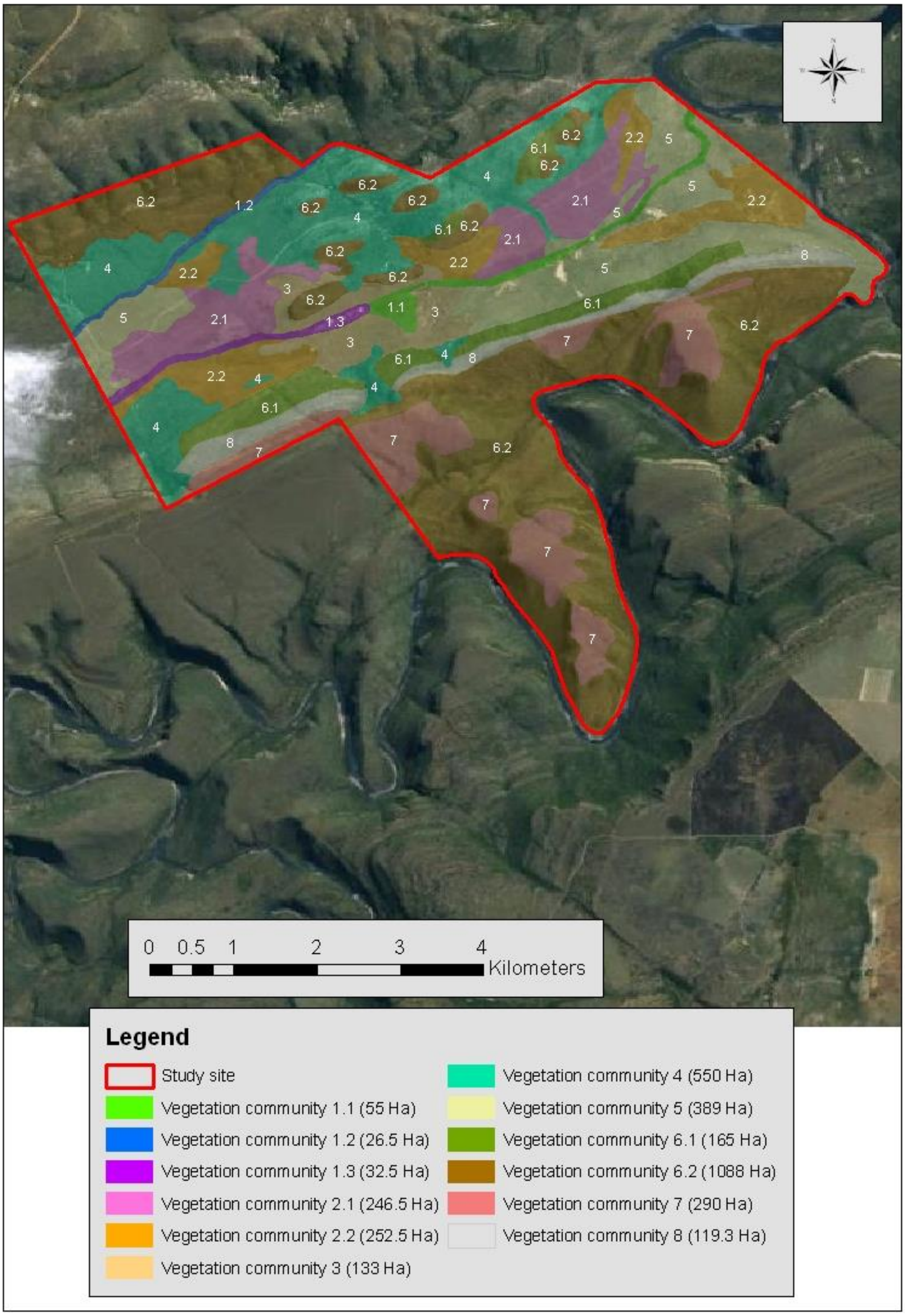

Figure 4.1 Vegetation Map for Hondekraal

1. *Sporobolus africanus–Cyperus esculentus* drainage channel

Figure 4.2 Broad, open channels observed in the *Eragrostis plana–Cyperus rupestris* sub-community

This seasonally wet drainage channel community has an altitude that ranges from 1 034 m – 1 151 m above sea level, covering approximately 3% (114 ha) of the study area. It comprises two feeder streams that flow in an easterly direction into the Olifantsriver and is located centrally within the study area (Figure 4.1). The drainage channel community is wide in places (Figure 4.2) and narrower in others (Figure 4.3). Although the channel is mainly open, consisting of herbaceous vegetation with a well-developed woody layer absent in the largest section of the channel, the woody *Acacia caffra* (species group K) and *Dichrostachys cinerea* (species group T) are prominent in some areas surrounding the drainage channels with the shrub *Lippia javanica* also present (species group J).

These areas represent the Bc1 land type (Land Type Survey Staff 1988). The alluvial soils are deep and sandy with a high degree of trampling and overgrazing in some areas.

Species from species group D are characteristic for this community and include the grasses *Sporobolus africanus, Phragmites australis, Panicum maximum, Paspalum dilatatum, Pennisetum macrourum, Imperata cylindrica, Cynodon dactylon,* and the forbs *Cyperus esculentus*, *Verbena bonariensis,* and *Schoenoplectus corymbosus.*

The grass layer is dominated by *Sporobolus africanus, Phragmites australis,* and *Pennisetum macrourum* (species group D).

The woody layer cover ranges from 3% - 60% in some of the areas surrounding these channels.

The grass cover in this community range from 20% - 80% with *Setaria sphacelata* (species group T) prominent locally whilst *Panicum maximum* and *Paspalum dilatatum* (species group D) are also prominent.

The herbaceous cover range from 30% - 40% with *Schoenoplectus corymbosus* (species group D) and *Cyperus obtusiflorus* (species group E) locally dominant, whilst C*yperus esculentus* and *Verbena bonariensis* (species group D) are constantly present.

Plant communities that are similar to the marshy areas in Hondekraal have been described by Theron (1973) under the Moist Soil/hygrophyllic Communities (22c), which includes Poaceae and Cyperaceae species that prefer moist soil conditions. Grasses that are prominent in both communities include the grasses *Imperata cylindrica,* and *Paspalum dilatatum,* as well as the forb *Cyperus esculentus*. Other communities with some, but limited floristic affinity include the Swampy Plants Communities (22b) (Theron 1973) with only the grasses *Phragmites australis, Pennisetum macrourum* and *Imperata cylindrical* in common with this community.

The average number of different plant species recorded for this community is 25 per 100m². Due to floristic variation, this community can be divided into 3 sub-communities (Figure 4.1).

1.1 ***Schoenoplectus corymbosus–Juncus* species sub-community**.

Figure 4.3 Dense vegetation in *Schoenoplectus corymbosus-Juncus* spp sub-community.

This drainage channel sub-community covers approximately 48.3% of the *Sporobolus africanus-Cyperus esculentus* drainage channel and is situated centrally and towards the eastern section of the drainage channel. It consists of a densely vegetated seasonal drainage channel, narrow in places and widening in others with sometimes moribund vegetation observed (Figure 4.3). This unit has deep, sandy soil with no rock cover present.

Species from species group A are characteristic for the sub-community and include the trees *Terminalia brachystemma, Searsia leptodictya* as well as the forbs *Juncus* species, *Commicarpus fruticosus*, *Oenothera rosea*, *Ranunculus multifidus, Lobelia erinus* and *Rorippa nasturtium-aquaticum.*

The vegetation is dominated by the forbs *Schoenoplectus corymbosus* (species group D), its cover ranging from 25% - 50%, *Juncus* species (species group A), its cover ranging from 5% - 25%, as well as the grass *Phragmites australis* (species group D) with a cover ranging from 5% - 50%.

The woody layer varies from fairly open conditions (20% cover) to more dense conditions (40% cover) in the areas adjacent to the channel, with a total density of 533 ind/ha with 100 ind/ha are in the lower class (<1m), 200 ind/ha in the middle class (1-3m) and 233 ind/ha in the upper class. Single individuals of *Terminalia brachystemma, Searsia leptodictya* (species group A), *Terminalia sericea, Lippia javanica* (species group J) as well as *Dichrostachys cinerea* (species group T) are present in the areas adjacent to the channel.

Grass cover ranges from 40% - 90% with *Sporobolus africanus, Imperata cylindrica* and *Panicum maximum* (species group D) prominent whilst *Pennisetum macrourum* (species group D) and *Setaria sphacelata* (species group T) are locally prominent. The grasses in this sub-community are mostly palatable sub-climax and climax grasses utilized by animals (Van Oudtshoorn 2004).

Herbaceous cover is high and ranges from 50%-80%. The forbs *Commicarpus fruticosus, Rorippa nasturtium-acquaticum* (species group A) as well as *Helichrysum* species (species group I) are common throughout this sub-community.

An average number of 23 species per 100m² were recorded in this sub-community.

1.2 ***Pennisetum macrourum–Hypoxis rigidula* sub-community**

Figure 4.4 *Pennisetum macrourum–Hypoxis rigidula sub-community*

This sub-community represents approximately 23.3% of the *Sporobolus africanus–Cyperus esculentus* drainage channel community and it is characterised by deep, sandy soils with rock cover of 40% in the form of medium sized rocks. It is located on the "Kerkplaas se Loop" towards the northern side of the study area and comprises of a densely vegetated, broad seasonal drainage channel (Figure 4.4).

Species from species group B are characteristic for this sub-community and include the grass, *Pennisetum villosum*, and the forbs *Verbena brasiliensis, Hypoxis rigidula, Gomphocarpus fruticosus*, *Cyperus* species and *Mariscus congestus*.

The vegetation of this sub-community is dominated by the grasses *Phragmites australis* and *Pennisetum macrourum* (species group D), both with a cover of approximately 5% - 25%.

The woody layer cover ranges from 15% in the open sections within in the immediate vicinity of the channel to 60% in the more dense areas, which are located adjacent to this channel. The total woody density for this community is 400 ind/ha with 100 ind/ha in the lower class and 150 ind/ha for both the middle and the upper class. It consists of a few single individuals of *Acacia caffra* (species group K) and *Dichrostachys cinerea* (species group S) that are locally prominent.

The grass cover ranges from 70% - 90% with *Sporobolus africanus* and *Paspalum dilatatum*, (species group D) prominent. The dominant and prominent grasses in this unit are either sub-climax or climax grasses (Van Oudtshoorn 2004).

Herbaceous cover range between 5% - 20% with *Cyperus rupestris* (species group C)*, Cyperus esculentus, Verbena bonariensis, Schoenoplectus corymbosus* (species group D) and *Senecio* species (species group G) present throughout this community.

An average number of 23 species per 100m² were recorded in this sub-community.

1.3 ***Eragrostis plana–Cyperus rupestris* sub-community**

Located in the western and central section of the drainage channel, this sub-community comprises a broad, open drainage channel or seasonal vlei (Figure 4.5) and covers approximately 28.5% of the *Sporobolus africanus–Cyperus esculentus* drainage channel community. The soil is moderately deep and sandy with a depth of not more than 1m and an approximate 2cm organic layer on top and no rock cover. Some mottling has been observed indicating seasonally wet conditions (Figure 4.6).

Species from species group C are characteristic for this sub-community and include the grasses *Eragrostis plana, Eragrostis capensis, Hyparrhenia hirta, Sporobolus fimbriatus, Bothriochloa radicans,* and the forbs *Cyperus rupestris, Raphanus* species, *Nidorella anomala, Helichrysum rugulosum, Fuirena pubescens, Chironia purpurascens, Lobelia* species, *Miscanthus junceus, Persicaria lapathifolia* and *Persicaria serrulata.*

Figure 4.5 *Eragrostis plana–Cyperus rupestris* sub-community

The vegetation is dominated by the grass *Eragrostis plana* with a cover ranging from 5% - 25% and the forb *Cyperus rupestris* (species group C), its cover ranging from 25% - 50%.

This sub-community does not have a well-developed woody layer and the shrub cover is only 2% consisting of a few scattered woody seedlings. The total density of 225 ind/ha with 50 ind/ha both in the lower and upper class and 125 ind/ha in the middle class mostly comprises of young individuals of the trees *Faurea saligna* (species group I), *Lannea discolor* (species group N) and *Burkea africana* (species group T), whilst a few individuals of the shrub *Seriphium plumosum* is also present.

The grass cover ranges from 20% - 80% and include prominent species such as *Eragrostis capensis, Hyparrhenia hirta* (species group C), *Cynodon dactylon* (species group D) and *Setaria sphacelata* (species group T).

Figure 4.6 Mottling in soil of sub-community 1.3.

Herbaceous cover varies from 20% - 40% with the forb *Cyperus obtusiflorus* (species group E) prominent and *Raphanus species, Nidorella anomala* (species group C), *Cyperus esculentus* and *Verbena bonariensis* (species group D) present.

An average number of 28 species per 100m² were recorded in this sub-community.

The dominance and prominence of the increaser II grasses (Van Oudtshoorn 2004) *Eragrostis plana,* and *Cynodon dactylon* in sections of this sub-community indicates the overgrazed and trampled state of the regularly burnt (twice per year during study period) vegetation. In addition, the dominance of the anthropogenic grass *Hyparrhenia hirta* in certain parts also indicate previous human disturbance.

***2. Hyperthelia dissoluta–Indigofera daleoides* grassland**

Located in the central low-lying areas (Figure 4.1 & 4.7) with an altitude that ranges between 1 039 m – 1 139 m above sea level and a gradual 2° – 7° slope, these grasslands cover approximately 15% (499 ha) of the study area. The grasslands are mostly located on old lands that were previously ploughed as is evident from the ploughing contours observed throughout this unit.

These areas mostly represent the Bc1 land type (Land Type Survey Staff 1988). The soil ranges from loamy-clayey to deep, sandy loam moist soil.

Figure 4.7 Central location of *Hyperthelia dissoluta–Indigofera daleoides* grassland

Species from species group G are characteristic for this community and are mostly perennial forbs including *Indigofera daleoides, Senecio species, Hermannia boraginiflora, Tephrosia lupinifolia, Chamaecrista mimosoides* and *Richardia brasiliensis*.

The vegetation of this community is completely dominated by the grass *Hyperthelia dissoluta* (Species group J) with a high cover value (50% - 100%) throughout this community.

The woody layer is not well-developed and has a cover ranging from 1% - 7%. *Dichrostachys cinerea* (species group T) is present throughout the area. Scattered, individuals of *Terminalia sericea* (species group J) also occur, while the dwarf suffrutex (Schmidt *et al.* 2002) *Elephantorrhiza elephantina* (species group F) is locally prominent in certain parts.

The grass layer covers the largest proportion of this community, with the cover ranging from 60% - 95%. Other grasses that are present in this community include *Pogonarthria squarrosa and Eragrostis curvula* (species group J).

The herbaceous cover is fairly low and ranges from 1% - 5%, and include *Indigofera daleoides* and *Senecio* species (species group G).

Even though it has a low frequency in this community, the constant presence of the woody *Dichrostachys cinerea*, is indicative of possible encroachment into this unit. This is probably due to overgrazing and previous mismanagement (Bothma 1995). The disturbed condition of this community is also substantiated by the dominance of the grass *Hyperthelia dissoluta.* Although this grass normally grows in these sandy moist soil conditions (Van Oudtshoorn 2004) it would not be totally dominant as is the case in this community.

A similar community was identified by Theron (1973) in the larger LNR and is described under the Grass Communities of Abandoned Cultivations/Old Lands (24). Prominent species identified in this unit include the grass *Hyperthelia dissoluta* as well as the woody *Acacia karroo, Lippia javanica, Dichrostachys cinerea, Burkea africana* and *Terminalia sericea*. At the time of the study done by Theron in 1973, the assumption was made that this community would probably progress towards either *Burkea africana–Loudetia simplex* tree savanna, or *Faurea saligna–Setaria sphacelata* tree savanna or *Acacia karroo–Setaria sphacelata* tree savanna areas. These types of communities were identified in other areas of Hondekraal and will be described under plant communities 3, 4 and 5.

The average number of plant species recorded for this community per 100m² is 20 species. Due to floristic variation, this community can be divided into two sub-communities.

2.1 ***Hyperthelia dissoluta–Elephantorrhiza elephantina* grassland**.

This open and fairly dry grassland sub-community is situated centrally on very gradual slopes (Figure 4.8) and covers approximately 49.4% of the *Hyperthelia dissoluta–Indigofera daleoides* grassland community. Some units are located close to drainage channels with loamy and sandy soils and no rock cover present.

Figure 4.8 High crown cover in *Hyperthelia dissoluta–Elephantorrhiza elephantina* grassland.

Species from species group F are characteristic for this sub-community and include the perennial forbs *Limeum viscosum, Elephantorrhiza elephantina, Tephrosia longipes, Kohautia amatymbica, Solanum incanum, Pollichia campestris, Kyllinga alba* as well as *Hibiscus pusillus.*

The vegetation is dominated by the grass *Hyperthelia dissoluta* (species group J) with a high cover value that ranges from 25% - 75% and the dwarf suffrutex *Elephantorrhiza elephantina* (species group F), its cover ranging from 5% - 25%.

Woody cover is low and ranges from 1% - 5% with a total density of 360 ind/ha of which 280 ind/ha occur in the lower class (<1 m), and 40 ind/ha for both the middle (1–3 m) and upper (>3 m) class, respectively. *Dichrostachys cinerea* (species group T) is prominent with seedlings (<1 m) occurring at a density of 260 ind/ha.

Figure 4.9 Low basal cover as observed after burning in *Hyperthelia dissoluta–Elephantorrhiza elephantina* grassland

The grass layer has a high canopy cover (60% - 80%) but a low observed basal cover, as large open spaces are found in between the grass clumps (Figures 4.9). The average height of the grass layer varies between 1.5 m – 2 m. The grass *Eragrostis curvula* is prominent throughout this sub-community whilst the grasses *Pogonarthria squarrosa* (species group J), and *Setaria sphacelata* (species group T) are also present.

The herbaceous cover is low, ranging from 1% - 5% with *Limeum viscosum* (species group F), *Bulbostylis burchellii* (species group H), *Justicea betonica* (species group K) and *Commelina erecta* (species group P) constantly present.

This sub-community shares the forbs *Cyperus obtusiflorus* and *Wahlenbergia undulata* (species group E) with the *Eragrostis plana*-*Cyperus rupestris* sub-community (1.3) but differs from the latter in that the forb *Cyperus obtusiflorus* is not as dominant.

Some grazing by cattle and buffalo has been observed in this sub-community, mainly early in the growing season, after the area was burnt. From field observations, it seems as if the perimeter of these grasslands is gradually being encroached by the woody encroacher *Dichrostachys cinerea*. The high number of woody seedlings supports these observations.

The average number of plant species recorded for this community per 100m² is 25 species.

2.2 ***Hyperthelia dissoluta–Digitaria eriantha*** **grassland**

Representing approximately 50.6% of the *Hyperthelia dissoluta–Indigofera daleoides* grassland community (Figure 4.10), this tall grassland sub-community has sandy to loamy moist soil and no rock cover present. This sub-community is located adjacent to the drainage channel communities in certain places. Similar conditions exist in this unit with regards to the crown and basal cover of the plants as discussed in unit 2.1.

This sub-community has no characteristic species and is charactarised by the absence of species from species groups E & F.

The vegetation is dominated by the grasses *Hyperthelia dissoluta* (50% - 100% cover) and *Digitaria eriantha* (4% - 50%) whilst the grass *Pogonarthria squarrosa* is also prominent (species group J).

Figure 4.10 *Hyperthelia dissoluta – Digitaria eriantha* grassland

Woody cover is low and ranges from 1% - 5% with a total density of 450 ind/ha. Most of the woody species, 363 ind/ha, are seedlings representing the lower class (<1 m) with only 88 ind/ha occurring in the middle class (1-3 m). *Dichrostachys cinerea* seedlings occur at a density of 163 ind/ha, whilst *Terminalia sericea* seedlings occur at a density of 100 ind/ha, also in the lower height class.

The grass layer is approximately 2m tall and has a cover of between 60% - 95%. The grass *Eragrostis curvula* is constantly present whilst *Perotis patens* is locally prominent (species group J).

The herbaceous cover is low (1% - 5%) except for *Helichrysum miconiifolium* (species group G) that is locally prominent whilst *Indigofera daleoides* (species group G) and *Bulbostylis hispidula* (species group Q) are also prominent. The dominance of grasses such as *Digitaria eriantha* are a clear indication of more moist conditions in this sub-community such as those found close to drainage channels, whilst *Pogonarthria squarrosa* and *Eragrostis curvula* is associated with overgrazed and trampled veld. All of the dominant grasses are also indicative of sandy soil conditions (Van Oudtshoorn 2004).

The large proportion of woody seedlings of the encroacher species *Dichrostachys cinerea* and *Terminalia sericea* is in accordance with field observations indicating the encroachment of woody species on the perimeter of this grassland sub-community.

The average number of plant species recorded for this community per 100m² is 15 species.

3. *Faurea saligna–Setaria sphacelata* open woodland

This woodland is located on gentle slopes of rocky outcrops flanking the central drainage channel of the study area (Figure 4.1 & 4.11). This low-lying community comprises 133 ha and has an altitude of approximately 1 067 m – 1 139 m above sea level.

Figure 4.11 *Faurea saligna–Setaria sphacelata* open woodland

These areas are mostly representative of the Bc1 land type (Land Type Survey Staff 1988). The soil is sandy and leached with no rock cover present.

This community is characterised by the presence of species from species group H which includes the forbs *Bulbostylis burchellii, Pelargonium luridum, Triumfetta sonderi* and *Stoebe vulgaris*.

The vegetation is dominated by the tree *Faurea saligna* (species group I) with a density of 200 ind/ha in the upper height class (>3m) and 400 ind/ha in the lower height class (>1m) as well as the grass *Setaria sphacelata* (species group T) and the forb *Vernonia oligocephala* (species group J). Crown cover for these species ranges from 5% - 50%.

The woody layer covers 25% - 35% of this unit with a total density of 1900 ind/ha. The largest proportion (1350 ind/ha) occur in the lower height class (<1 m) with the remaining 550 ind/ha in the upper height class (>3 m). *Terminalia sericea* (species group J) is locally prominent due to the presence of a fairly high number of seedlings (600 ind/ha) whilst *Lannea discolor* (species group N) and *Burkea africana* (species group T) is also present. The perennial shrublet *Triumfetta sonderi* (species group H) is locally prominent and the dwarf suffrutex *Elephantorrhiza elephantina* (species group F) is also present.

The grass layer covers approximately 40% of this community with *Brachiaria serrata* (species group L), *Hyperthelia dissoluta* (species group J) and *Heteropogon contortus* (species group T) also present.

Herbaceous cover ranges from 10% - 20% with the forbs *Bulbostylis burchellii, Pelargonium luridum* (species group H) *Agathisanthemum bojeri* (species group I), and *Justicia betonica* (species group K) also present.

The presence of the dominant tree *Faurea saligna* as well as *Terminalia sericea* and *Burkea africana* indicate sandy soil conditions (Palgrave 1983). According to Theron (1973) and Van der Meulen (1979), a high cover of *Terminalia sericea* and *Burkea* *africana* is also characteristic for deeper, sandy, infertile soils. These soils usually have a low fertility as a result of leaching (Van der Meulen 1979).

This woodland was most probably cleared for grazing purposes in the past hence the presence of high numbers of *Faurea saligna, Terminalia sericea* and *Burkea africana* seedlings. If left unattended this open woodland would most probably become a dense woodland. The woody *Terminalia sericea* is a declared invader plant in the province previously known as the Transvaal (Henderson *et al.* 1987) and should be managed to prevent it from becoming dominant and replacing other species. The grass layer is dominated by palatable climax grass species that are well utilised by animals, and is indicative of good veld condition (Van Oudtshoorn 2004).

A similar plant community namely *Burkea africana–Loudetia simplex* tree savanna (15) was described by Theron (1973). This community was described as variable open savanna to a more dense savanna where trees are smaller. Prominent species include the trees *Burkea africana* and *Faurea saligna* while the grass layer differs from this community with the grasses *Loudetia simplex* and *Setaria perennis* dominant.

A species diversity of approximately 21 species per 100m² was recorded for this community.

4. ***Faurea saligna–Burkea africana* woodland**

The *Faurea saligna–Burkea africana* woodland (Figure 4.12) is located centrally in the western sections of the study area and adjacent to the grasslands as discussed under plant community 2. It has a size of approximately 550 ha (Figure 4.1). These woodlands mainly encompass the foot slopes of mountains where they gradually merge into the adjacent grassland communities (communities 2.1 and 2.2). Some areas in this plant community are level whilst others are located on gradual (2° - 7°) north to north-west facing slopes at an altitude that ranges from 1 046 m – 1 171 m above sea level.

Figure 4.12 *Faurea saligna–Burkea africana* woodland

This community occurs on the Bc1 land type and the soil is mainly sandy and erodible, but varies from a deep, sandy (north-facing gradual slopes and south-facing gradual slopes), to deep sandy – loam (gradual north-facing slopes and level areas), to red, sandy (gradual south-facing slopes) and dark loamy soil (level areas). Most of this area has no rock cover with only 5% recorded in certain sections.

The vegetation of this community is characterised by the presence of species from species group I and include the tree *Faurea saligna*, the shrub *Vernonia natalensis*, the grass *Eragrostis gummiflua* and the forbs *Dichapetalum cymosum, Nidorella hottentotica,* as well as *Agathisanthemum bojeri*.

The vegetation is dominated by the trees *Faurea saligna* (species group I), *Burkea africana* (species group T) together with the grasses *Hyperthelia dissoluta* (species group J) and *Setaria sphacelata* (species group T). The tree *Faurea saligna* has 375 ind/ha in the lower class, 33 ind/ha in the middle class and 150 ind/ha in the upper class, and *Burkea africana* has 217 ind/ha in the lower class, 13 ind/ha in the middle class and 188 ind/ha in the upper class. The canopy cover for both these trees vary from 5% - 50%.

Crown cover for the woody layer varies from 2% - 70% and it is represented by all three height classes (>1m, 1-3m and >3m) with 1 367 ind/ha in the lower height class, 221 ind/ha in the middle height class and 638 ind/ha in the upper height class with a total density of 2 225 ind/ha. Woody species that are locally prominent are *Lannea discolor* (species group N) and *Lippia javanica* (species group J) with *Dichrostachys cinerea* (species group T) almost constantly present throughout this community. Variable woody species prominence occurs in places with widely scattered large individuals of *Strychnos spinosa* (species group K) (Figure 4.13) as well as *Lannea discolor* (species group N) seedlings.

Figure 4.13 Denser vegetation & large individuals of *Strychnos spinosa*

Even though it has a low frequency, the dense growing *Acacia karroo* (species group K) is locally prominent in certain places (western sections) with a high cover estimated at 25% - 50%.

The grass cover ranges from 15% - 70% and include the prominent grasses *Eragrostis gummiflua* (species group I) and *Pogonarthria squarrosa* (species group J). Patches of *Cynodon dactylon* (species group D) with a cover estimated at 50% - 75% were observed in sections (Figure 4.14). Species that are constantly present in this community include *Panicum maximum* (species group D) as well *as Digitaria eriantha* and *Perotis patens* (species group J). In some areas, the observed basal cover is fairly low with large open spaces between grasses.

The herbaceous layer has a low cover that varies between 2% - 15%. Prominent forbs include *Vernonia natalensis* (species group I) that occur in extensive patches locally, whilst *Vernonia oligocephala* (species group J) is constantly present.

The dominant woody species occurring in this community (*Faurea saligna* and *Burkea africana),* are indicators of sandy soil conditions. The constant presence of *Dichrostachys cinerea* as well as extensive carpets of *Cynodon dactylon* in certain parts (Figure 4.14) indicates overutilization of this unit (Van Oudtshoorn 2004).

In other parts, moribund conditions have been observed where the grass *Hyperthelia dissoluta* occurs with a high cover. Evidence of ploughing contours and farming implements are present in this unit (Figure 4.14), whilst out of season burning by the local farmer is a regular occurrence. Various footpaths transect the area as well, adding to the disturbed state of this unit.

A similar community was described by Theron (1973) namely the *Faurea saligna–Setaria perennis* tree savannah (16) in the greater LNR. This area is described as an open tree savanna with dominant trees *Faurea saligna* and *Acacia caffra* as well as the grass *Setaria perennis*.

Figure 4.14 Extensive patches of *Cynodon dactylon* and farming implements in *Faurea saligna* – *Burkea africana* woodland

An average number of 24 species per 100m² have been recorded for this community.

5. ***Burkea africana–Digitaria eriantha* open woodland**

The *Burkea africana–Digitaria eriantha* open woodland (Figure 4.15) is located centrally and also in the eastern and north-eastern parts as well as in the western half of the study area (Figure 4.1) It is found adjacent to grasslands as discussed under plant community 2 and edges on mountain foot slopes towards the south (Figure 4.16). It has a size of approximately 389 ha, representing 11.6% of the study area. The slope varies between level to gradual (2° - 7°) north-west, southern and west-facing slopes to slightly steeper (10° - 20°) east to north-eastern slopes with an altitude that ranges from 1 027 m – 1 155 m above sea level.

Figure 4.15 *Burkea africana–Digitaria eriantha open* woodland

These areas occur on the Ib16 land type (Land Type Survey Staff 1988). The soil is mainly fine, sandy to sandy-loam whilst rock cover ranges from zero in places to almost 50% in others.

The vegetation of this community is characterised by the presence of species in group K which are the trees *Acacia caffra, Strychnos spinosa, Acacia karroo, Acacia burkei, Dovyalis caffra* and *Strychnos cocculoides*, the shrub *Lippia rehmannii,* the grasses *Eragrostis rigidior, Panicum coloratum, Elionurus muticus* and *Tristachya leucothrix*, as well as the forbs, *Acrotome hispida, Justicia betonica*, *Stylosanthes fruticosa* and *Sida cordifolia* (Table 4.1).

Figure 4.16 *Burkea africana–Digitaria eriantha open* woodland bordering on mountain foot slopes.

The vegetation is dominated by the tree *Burkea africana* (species group T), its canopy cover ranging from 5% - 25% and the grasses *Digitaria eriantha* (species group J) and *Setaria sphacelata* (species group T), its cover ranging from 5% - 50%. *Burkea africana* has a density of 282 individuals per hectare in the lower class, 36 individuals per hectare in the middle class and 146 individuals per hectare in the upper class.

The woody layer cover varies from 5% - 25% and is represented by all three height classes (>1m, 1-3m and >3m). The total density of 1 618 ind/ha consists of 818 ind/ha in the lower class, 264 ind/ha in the middle class (1 m – 3 m) and 536 ind/ha in the upper class (>3m). The shrub *Dichrostachys cinerea* (species group T) is prominent with 118 ind/ha in the lower class, 100 in the middle class, and 9 in the upper class. Other important trees that are locally prominent but with a low frequency include *Acacia caffra* and *Strychnos spinosa* (species group K) whilst *Terminalia sericea* (species group J) and *Aloe marlothii* (species group L) is also present.

The overall grass cover ranges from 10% - 60%. The grasses *Pogonarthria squarrosa* (species group J) is constantly present whilst *Hyperthelia dissoluta* (species group J), *Eragrostis rigidior* (species group K), and *Loudetia simplex* (species group R) are locally prominent. Other grasses present include *Panicum coloratum* (species group K), *Aristida diffusa* and *Eragrostis superba* (species group L).

The herbaceous layer covers 2% - 10% of this community. Prominent species vary between *Vernonia natalensis* (species group I), *Vernonia oligocephala, Waltheria indica* (species group J), *Justicea betonica* and *Stylosanthes fruticosa* (species group K). Other species that are present include *Acrotome hispida* (species group K) and *Pellaea calomelanos* (species group R).

The woody species occurring in this community indicate well-drained sandy soil conditions. Some areas are being encroached by *Dichrostachys cinerea* as is evident from the fairly high number of seedlings in this community. *Acacia caffra* often occur in the transitional zone between grasslands and bushveld (Schmidt *et al.* 2002), whilst *Acacia karroo* is main*l*y associated with climax grasses such as *Themeda triandra*, indicating sweetveld and good grazing (Van Oudtshoorn 2004). Sweetveld areas are often overgrazed (Bothma 1995) and this has probably resulted in the encroachment of *Dichrostachys cinerea* into this community.

The *Acacia karroo–Setaria perennis* tree savanna (8) as described by Theron (1973) as a ‘very heterogenic community that is a generally open tree savanna but dense next to drainage lines, is similar to this plant community. Important species shared with this community include *Acacia karroo* and *Dichrostachys cinerea*.

An average number of 25 species per 100 m² have been recorded for this community.

6. ***Combretum molle–Xerophyta retinervis* open to closed woodland**

Figure 4.17 *Combretum molle–Xerophyta retinervis* open to closed woodland

The *Combretum molle–Xerophyta retinervis* open to closed woodland (Figure 4.17) is located on steep north and south facing slopes (15° - 30°) of the mountains located in the north-western section, as well as the moderate to steep east-facing slopes (10° - 65°) of the southern mountains and koppies located in the central and north-eastern sections of the study area (Figure 4.1). The areas located on the northern mountains are commonly known as Groenvallei and the altitude ranges from 1 083 m – 1 334 m above sea level. This is the largest community with a size of approximately 1 372 ha, representing 41% of the study area.

These areas represent the Ib10 (northern mountains) as well as Ib16 (southern mountains) land types, whilst the koppies located in the central and north-eastern sections (Figure 4.21) represent the Bc1 land type (Land Type Survey Staff 1988). The soil varies from a light sandy to sandy-loam that is often leached on the (north-facing slopes of mountains and koppies) to a dark sandy-loam (south-facing slopes of mountains and koppies) with a rock cover in the form of small to medium sized rocks as well as granite boulders, its cover ranging from 5% - 50%.

The vegetation of this community is characterised by the presence of species from species group M namely the tree *Combretum molle* and the forbs *Tagetes minuta, Pentanisia angustifolia* and *Gerbera* species (Table 4.1).

The vegetation is dominated by the tree *Combretum molle* (species group M), with a canopy cover of up to 50%, with the grass *Melinis nerviglumis* and the forb *Xerophyta retinervis* (species group P) co-dominant, their canopy cover ranging from 4% - 25%.

The woody layer cover varies from 5% - 40% and is represented by all three height classes. Other woody species present in this community are *Aloe marlothii* and *Ozoroa paniculosa* (species group L).

The grass cover range from 15% - 60% with *Themeda triandra* (species group R) and *Setaria sphacelata* (species group T) also present. The herbaceous cover range from 5% - 20% with *Tagetes minuta* prominent and *Pellaea calomelanos* (species group R) present.

An average of number of 25 species per 100 m² was recorded for this unit. Due to floristic variation, this community can be subdivided into two sub-communities.

6.1 ***Lannea discolor-Diplorhynchus condylocarpon* sub-community**

The *Lannea discolor-Diplorhynchus condylocarpon* woodland sub-community (Figure 4.18) is predominantly located on the steep north-facing slopes (30° – 50°) of the southern mountain range as well as on the north and south facing slopes (30° – 40°) of the koppies located in the central and north-eastern sections of the study area. The altitude ranges from 1 083 m – 1 316 m above sea level and it represents approximately 20.7% of the *Combretum molle–Xerophyta retinervis* open to closed woodland.

Figure 4.18 The *Lannea discolor-Diplorhynchus condylocarpon* sub-community

This north-facing slope sub-community of the southern mountains are mostly located in the Ib16 land type, whilst the koppies are located in the Bc1 land type.

Species from species group N characterise this woodland and include the woody *Lannea discolor, Ehretia rigida, Ochna pulchra, Gymnosporia tenuispina,* the grasses *Schmidtia pappophoroides, Brachiaria serrata,* and the forbs *Diospyros lycioides Ipomoea crassipes, Selaginella dregei, Solanum panduriforme, Evolvulus alsinoides, Jatropha zeyheri,* and *Thesium utile*.

The vegetation is dominated by the tree *Diplorhynchus condylocarpon* (Figure 4.19), with a cover of up to 50%, and the grass *Loudetia simplex*, its cover ranging from 4% - 25% (species group R). *Diplorhynchus condylocarpon* has a total density of 540 ind/ha with 180 ind/ha recorded in the lower class, 100 ind/ha in the middle class and 260 ind/ha in the upper class.

Figure 4.19 North-facing slopes on koppies with local dominance of *Diplorhynchus condylocarpon*

The woody layer covers between 15% and 50% of the area and has a density of 2 030 ind/ha with 990 ind/ha in the lower class, 370 ind/ha in the middle class and 670 ind/ha in the upper class. The trees *Combretum molle* (species group M) and *Lannea discolor* (species group N) are prominent in this sub-community. *Aloe marlothii* (species group L) and *Burkea africana* (species group T) as well as the shrub *Gymnosporia tenuispina* (species group N) are also present.

The grass cover range from 15% - 60% with *Diheteropogon amplectens* and *Melinis nerviglumis* (species group P) prominent in this sub-community. *Brachiaria serrata* and *Schmidtia pappophoroides* (species group N) are also present.

The herbaceous layer is not well-developed and canopy cover is fairly low ranging between 2% - 5% with *Tagetes minuta* (species group M) prominent and *Xerophyta retinervis, Commelina erecta* (species group P) as well as *Pellaea calomelanos* (species group R) also present.

6.2 *Setaria sphacelata-Mundulea sericea* sub-community

Figure 4.20 Prominent trees *Protea caffra* and *Mundulea sericea* as well as common shrubs *Lippia javanica* on steep south-facing slopes

This sub-community (Figure 4.20) is located on the steep south-facing slopes of the northern mountains (15° - 35°) as well as on the steep south and east-facing slopes (65°) of the southern mountains (Figure 4.21) of the study area at an altitude that ranges from 1 083 m – 1 334 m above sea level. It represents approximately 79.3% of the *Combretum molle–Xerophyta retinervis* open to closed woodland.

These areas are mostly representative of the Ib10 land type, however, the east-facing slopes located in the south-eastern mountain section of the study area is representative of the Ib16 land type. The soil is a dark, sandy to sandy-loam with a rock cover that ranges between 5% - 30%.

Figure 4.21 Steep east-facing slopes of *Setaria sphacelata-Mundulea sericea* woodland

This community is characterised by the presence of the trees *Strychnos madagascariensis, Heteropyxis natalensis,* the shrubs *Mundulea sericea, Asparagus laricinus,* the grasses *Andropogon schirensis, Cymbopogon excavatus,* and the forbs *Athrixia elata, Lantana rugosa* and *Sphedamnocarpus galphimiifolius* (species group O).

This sub-community is dominated by the trees *Combretum molle* (species group M) and *Mundulea sericea* (species group O), as well as the grass *Setaria sphacelata* (species group T) the cover for all three species ranging between 15 - 50%. A total density of 443 ind/ha were recorded for *Combretum molle* with 86 ind/ha in the lower class, 186 ind/ha in the middle class and 171 ind/ha in the upper class. *Mundulea sericea* has a total density of 457 ind/ha with 71 ind/ha in the lower class, 329 ind/ha in the middle class and 57 ind/ha in the upper class.

Woody cover ranges between 5 – 50% with a total density of 2 029 ind/ha of which 771 ind/ha were recorded in the lower class, 786 ind/ha in the middle class and 471 ind/ha in the upper class. The trees *Protea caffra* (species group P) and *Heteropyxis* *natalensis* (species group O) are locally prominent the latter present only within this sub-community. The shrub *Lippia javanica* (species group J) is constantly present. The total density recorded in this sub-community is 200 ind/ha of which 157 ind/ha are in the lower class, and 43 ind/ha are in the middle class.

The grass cover varies from 30% - 60% with *Themeda triandra* (species group R), *Andropogon schirensis* (species group O) and *Ischaemum afrum* (species group P) present throughout this sub-community. Herbaceous cover range from 1% - 20% in this sub-community. The forbs *Xerophyta retinervis* (species group P) and *Tagetes minuta* (species group M) are locally prominent. Other species present include *Tephrosia longipes* (species group F) and *Athrixia elata* (species group O).

This sub-community is also distinguished from the *Lannea discolor-Diplorhynchus condylocarpon* sub-community (sub-community 6.1) by the total absence of the woody species *Diplorhynchus condylocarpon* (species group R) *Burkea africana* (species group T) *Lannea discolor, Gymnosporia tenuispina* (species group N) *Englerophytum magalismontanum* and *Rhynchosia nitens* (species group P), the grasses *Schmidtia pappophoroides* and *Brachiaria serrata* (species group N) and the forbs *Ipomoea crassipes* and *Selaginella dregei* (species group N) from this sub-community.

An average number of 21 species per 100 m² was recorded for this sub-community.

7. ***Tristachya biseriata–Protea caffra*** **open woodland**

The *Tristachya biseriata–Protea caffra* open woodland is located on the high-lying southern mountains including “Voster se Berg” (Figure 4.22), Skurwekop & Uithoek at an altitude that ranges from 1 244 m – 1 373 m above sea level. Some areas are located on steep south to south-east facing and west-facing slopes of between 15° - 30° (Figure 4.22), whilst other areas are level (Figure 4.23). With a size of 250.5 ha, this community represents 7.5% of the study area.

Figure 4.22 South to south-east facing slopes of the *Tristachya biseriata–Protea caffra* open woodland

These areas mostly represent the Ib 16 land type, whilst a small portion of the Fa7 land type which consists of steep slopes and mountain crests is located in the south-western corner of the study area (Land Type Survey Staff 1988). The soil is leached and varies from a light and red sandy to loam with a high rock cover that varies from 10% to 40% in places

The vegetation of this community is characterised by species from group Q and include the shrublets *Elephantorrhiza burkei, Searsia magalismontanum*, *Parinari capensis*, the grasses *Tristachya biseriata*, *Eragrostis racemosa*, *Urelytrum agropyroides, Panicum natalense*, *Bewsia biflora* and *Monocymbium ceresiiforme* as well as the forbs *Bulbostylis hispidula, Rhynchosia minima, Cleome maculata* and *Chaetacanthus costatus*.

The vegetation is dominated by the tree *Protea caffra* (species group P), and the grasses *Tristachya biseriata* (species group Q) and *Loudetia simplex* (species group R) with a canopy cover ranging from 15% - 50%. *Protea caffra* has a density of 60 ind/ha in the lower class, 100 ind/ha in the middle class and 20 ind/ha recorded in the upper class.

Figure 4.23 *Tristachya biseriata–Protea caffra* open woodland

The woody layer covers 2% - 30% of this community with individuals represented in all three height classes. The total woody density recorded for this community is 1 560 ind/ha, with 1 070 ind/ha in the lower class (<1m), 230 ind/ha in the middle class and 260 ind/ha in the upper class. The tree *Burkea africana* (species group T) is locally prominent in this community with 390 ind/ha in the lower class in the western sections of the plato area of this community (Figure 4.24). *Elephantorrhiza burkei* (species group Q) is locally prominent whilst *Englerophytum magalismontanum* (species group P) as well as the dwarf shrub *Parinari capensis* (species group Q) are also present.

The grass cover is high and ranges from 50% - 80%. *Diheteropogon amplectens* (species group P) is prominent in this community whilst *Setaria sphacelata* (species group T) and *Eragrostis racemosa* (species group Q) are also present.

The herbaceous cover range from 2% - 8% with *Xerophyta retinervis* (species group P) the most prominent species (Figure 4.28) and *Bulbostylis hispidula* (species group Q) present throughout this community.

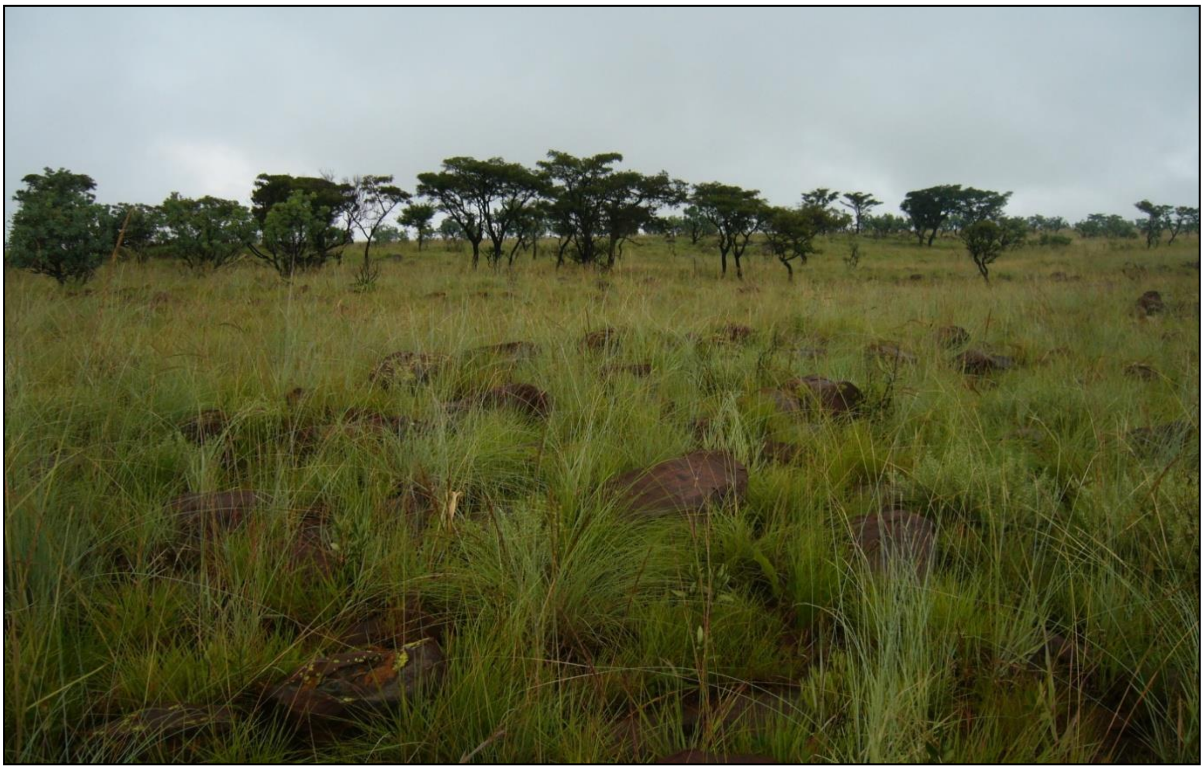

Figure 4.24 Local prominence of *Burkea africana* on mountain plato

The tree *Protea caffra* is common on medium to high altitudes as well as sheltered places according to Palgrave (1983). The prominent woody species are all common in grasslands as well as on rocky ridges, whilst *Elephantorrhiza burkei* is more prominent in sheltered rocky ridges (Van Wyk & Malan 1998). The dominance of the climax grasses *Loudetia simplex* and *Tristachya biseriata*, as well as *Diheteropogon amplectens* are characteristic of these areas, but have not been burnt regularly, probably because of the remote location of this community. These grasses are commonly found in open grasslands and against ridges where the soil is poor and sandy according to Van Oudtshoorn (2004).

Plant communities that are similar to this one, were described by Theron (1973) as the *Protea caffra–Tristachya biseriata–Loudetia simplex* tree savanna (20) as well as *Tristachya biseriata* grassland (21). Prominent species include *Protea caffra, Faurea* *saligna, Mundulea sericea, Xerophyta retinervis, Tristachya biseriata* and *Loudetia simplex.* Gőtze, *et al.* (1998) also described the *Protea caffra - Tristachya leucothrix* community (1) in the classification of the Parys and Rietfontein areas that were added into the reserve. Diagnostic species include *Protea caffra* and the dominant *Tristachya leucothrix*.

This community has an affinity with the *Tristachya biseriata-Protea caffra* Cool Temperate Mountain Bushveld of the Bankenveld as described by Bredenkamp & Brown (2003) that is dominated by the tree *Protea caffra* and the grasses *Tristachya biseriata, Loudetia simplex* and *Diheteropogon amplectens* . On a larger scale this area falls within the Rand Highveld Grassland (Gm11) (Mucina & Rutherford 2006).

An average number of 25 species per 100 m² occur in this community.

8. ***Combretum apiculatum–Panicum ecklonii* open woodland**

The *Combretum apiculatum–Panicum ecklonii* open woodland is located on the steep (35°) north-facing slopes of the mountains in the eastern half of the study area, at an altitude of approximately 1 097 m above sea level (Figure 4.25). This plant community has a size of approximately 39.5 ha, representing 1.2% of the study area.

These areas occur on theIb15 land type (Land Type Survey Staff 1988) and the soil is sandy with a high rock cover estimated at 30%.

Species from species group S are diagnostic for this community and include the tree *Acacia permixta*, the shrub *Grewia flava*, the grasses *Panicum ecklonii* and *Brachiaria brizantha* as well as the forb *Hypoxis hemerocallidea* (Table 4.1).

The vegetation is dominated by the tree *Combretum apiculatum* (species group R) with a crown cover of 25 – 50% as well as *Diplorhynchus condylocarpon* (species group R) with a crown cover of 10%. *Combretum apiculatum* has a density of 650 ind/ha in the lower class, 300 ind/ha in the middle class and 350 ind/ha in the upper class whilst *Diplorhynchus condylocarpon* has a density of with 100 ind/ha recorded in the middle class and 50 ind/ha in the upper class.

The woody cover ranges from 20% - 35% with individuals represented in all three height classes. A total density of 3 050 ind/ha were recorded for this community with 2 050 ind/ha in the lower class, 550 ind/ha in the middle class and 450 ind/ha in the upper class. *Acacia karroo* (species group K) and *Acacia permixta* (species group S) are locally prominent with high numbers of *Acacia karroo* seedlings in places (1 000 ind/ha in). The shrub *Gymnosporia tenuispina* (species group N) is constantly present.

Figure 4.25 *Combretum apiculatum–Panicum ecklonii* open woodland

The grass cover is low (30%) due to the combination of high rock and woody cover in this community. The most prominent species are *Panicum ecklonii* (species group

S) with a crown cover of 4% - 25% as well as *Heteropogon contortus* (species group T) with a crown cover of 4% - 50%. *Themeda triandra* (species group R) is locally prominent whilst *Digitaria eriantha* (species group J), and *Loudetia simplex* (species group R) is also present.

Herbaceous cover is low at 2% with *Hypoxis hemerocallidea* (Species Group S) present.

The *Combretum apiculatum–Heteropogon contortus* tree savanna (7) as described by Theron (1973) as an 'open to closed tree savanna', is similar to this plant community. Prominent species identified are *Combretum apiculatum* and *Xerophyta retinervis*. Gőtze *et al*. (1998) described the *Diplorhynchus condylocarpon – Loudetia simplex* community with important species being *Diplorhynchus condylocarpon* and *Combretum apiculatum*.

An average number of 16 species per 100 m² have been identified in this community.

Discussion & Conclusion

Vegetation communities reflect a recurring assemblage of plant species of characteristic composition and structure, growing in an area of essentially similar environmental conditions and land use history (Gabriel & Talbot 1984). Various authors (Bredenkamp 1975, Bezuidenhout 1993, Coetzee 1974, Coetzee 1993; Bredenkamp & Brown 2003) concur that the differences in floristically defined plant communities are mainly correlated with habitat variables such as geology, land type, topography (landform, aspect, slope) and altitude, although rockiness, soil texture and depth are also important factors. Clear distinctions were found between the eight main plant communities identified in the Hondekraal section of the Nature Reserve.

Some of the species that are common in the study area indicate past mismanagement. Previous agricultural practices and present overgrazing in parts as well as out of season burning for grazing by cattle, contributed to the degraded state of certain sections. An example of these indicator species is the abundance of the potential bush encroacher *Dichrostachys cinerea* (Bredenkamp 1986; Bothma 1995) and also the dominance of grasses such as *Pogonarthria squarrosa* and *Cynodon dactylon* (Van Oudtshoorn 2004). Evidence of ploughing contours and farming implements are present in many places of the study area whilst various footpaths transect the area as well, adding to the disturbed state of these sections.

There is an association between the different plant communities identified and the land types. Plant communities 1 to 4 represent the Bc1 land type; plant community 5 represent the Ib16 land type (Land Type Survey Staff 1988); plant community 6 represent the Ib10 (Land Type Survey Staff 1988) (northern mountains – sub-community 6.2) and Ib16 (Land Type Survey Staff 1988) (southern mountains – sub-community 6.1) land types as well as the Bc1 land type (Land Type Survey Staff 1988) (koppies); plant community 7 represent the Fa7 land type (Land Type Survey Staff 1988) and plant community 8 represent the Ib15 land type (Land Type Survey Staff 1988). These land types are discussed in more detail in Chapter 2.

Affinities between plant communities

Floristic affinities exist between different plant communities as indicated in Table 4.1. Species from species group E (*Cyperus obtusiflorus, Wahlenbergia undulata*) are found in both sub-communities 1.3 and 2.1. These sub-communities are often located adjacent to one another (Figure 4.1) at altitudes ranging from 1 034 m – 1 151 m above sea level. Representing the Bc1 land type (Land Type Survey Staff 1988), the soil is sandy and moist with no rock cover. According to Van Wyk & Malan (1998), the forbs *Wahlenbergia undulata* is often found in seasonally moist places as described in both these sub-communities.

Plant communities 2, 3, 4 and 5 have affinities due to the presence of species from species group J. Plant communities 2 to 4 occur on the Bc1 land type (Land Type Survey Staff 1988) and community 5 on the Ib16 land type. These communities are located on low-lying level areas as well as gently sloping mountain foot areas at altitudes that ranges from 1 027 m – 1 171 m above sea level. The soils of these communities are deep and range from sandy to loam as indicated by the prominence of the grass *Hyperthelia dissoluta* and the tree *Terminalia sericea.* These areas have previously been heavily grazed and are subjected to regular fires. With the exception of plant community 5, rock cover is absent in these communities.

Plant communities 5 and 6 have species from species group L in common (Table 4.1). Community 5 is located mostly on level areas that borders onto mountain foot slopes, whilst sub-community 6.1 is located on the steep north facing slopes (15° - 30°) as well as the koppies located in the central and north-eastern section of the study area. Plant community 6.2 comprises steep south and east-facing slopes (15° - 30°). The altitude ranges from 1 027 m – 1 334 m above sea level. Plant community 5 as well as the north-facing slope communities of plant community 6.1 are representative of the Ib16 landtype (Land Type Survey Staff 1988) with light sandy to sandy-loam soil conditions. The predominantly south-facing slopes of sub-community 6.2 are mostly representative of the Ib10 landtype (Land Type Survey Staff 1988) with dark, loamy soils. The rock cover is high in both communities and range between 5% - 50%. The presence of the grass *Aristida diffusa* in these communities is characteristic of shallow soils and overutilised veld, whilst the Increaser II grass *Eragrostis superba* also indicates these disturbances (Van Oudtshoorn 2004). The grass *Brachiaria serrata* present in low numbers is indicative of the natural rocky vegetation of the area (Theron 1973; Bredenkamp & Brown 2003).

Species from species group P are found in communities 6 and 7 (Table 4.1). These communities are located at an altitude that ranges from 1 083 m to 1 373 m above sea level. Opposed to the steep slopes of community 6, community 7 is located on the southern mountain crests. Some areas in this community comprises of steep south to south-east facing and west-facing slopes of between 15° - 40°, whilst other areas are level. This plant community represents the Fa7 land type (Land Type Survey Staff 1988) where the leached soil is light and red sandy to loam with a high rock cover that varies from 10% - 40%. The decreaser grass *Diheteropogon amplectens* is characteristic of rocky sour grassland in open areas and slopes (Van Oudtshoorn 2004) with the woody *Englerophytum magalismontanum* as well as the perennial forbs *Xerophyta retinervis* and *Commelina erecta* also prominent within these two communities. The woody *Protea caffra* present within these areas shows an affinity for medium to high altitudes, and are also on prominent on dry rocky ridges on hills and mountain slopes as well as mountain grasslands (Van Wyk & Malan 1998).

Woody layer

By assessing the woody strata to evaluate possible bush encroachment and browsing potential, an overall contribution can be made to the management of the reserve (Brown & Bredenkamp 1996). According to Smit *et al.* (1999) the increase in woody plant density is commonly referred to as 'bush encroachment' and have resulted in a decline in grazing capacity of large areas of the South African savannas (bushveld). Removal of some or all of the woody plants will normally result in an increase in grass production and therefore also in grazing capacity. Reasons for the increase in woody vegetation are diverse and complex, with determinants of savanna systems having been modified by man, either directly or indirectly. According to Teague & Smit (1992), these may be primary determinants such as climate and soil or secondary determinants, such as fire and herbivore impact. Although secondary determinants acts within the constraints imposed by the primary determinants, they can often be directly modified by management, for example through the exclusion of occasional hot fires, high stocking rates, poor grazing management and so forth.

The drainage channels and the grasslands (communities 1 and 2 have the lowest density of woody species (367 ind/ha – 415 ind/ha), whilst the woodland communities (communities 3 – 8) have the highest densities (1 560 ind/ha – 3 050 ind/ha). From a potential bush encroachment/densification point of view, communities 2.1, 2.2, 3, 4, 5, 6, 7 and 8 have more woody ind/ha in the lower class than the middle and upper classes combined.

Sub-communities 2.1 and 2.2 have a total density of 280 ind/ha and 363 ind/ha respectively in the lower class, which predominantly comprises of *Dichrostachys cinerea, Terminalia sericea* and *Lippia javanica* seedlings. The most prominent woody species recorded for both sub-communities is *Dichrostachys cinerea* with 260 ind/ha in sub-community 2.1 and 163 ind/ha in sub-community 2.2.

The highest density recorded in the lower class was in plant communities 3 and 4 with 1 350 ind/ha and 1 367 ind/ha respectively. Prominent woody seedlings in the lower class of plant community 3 include *Terminalia sericea* (600 ind/ha), *Faurea saligna* (400 ind/ha) and *Lannea edulis* (300 ind/ha). In plant community 4, the lower class mainly comprised of *Faurea saligna* (375 ind/ha), *Burkea africana* (217 ind/ha), and *Dichrostachys cinerea* (133 ind/ha).

Sub-community 6.1 had a total of 990 ind/ha in the lower class comprising mainly of *Diplorhynchus condylocarpon* (180 ind/ha), *Burkea africana* (170 ind/ha) and *Diospyros lycioides* (110 ind/ha) seedlings. Plant community 7 had 1 070 ind/ha recorded in the lower class where *Burkea africana* had the highest density (390 ind/ha) followed by *Elephantorrhiza burkei* (190 ind/ha), *Parinari capensis* as well as *Rhynchosia nitens* (both with 90 ind/ha) and *Protea caffra* (60 ind/ha). In plant community 8, a total of 1 050 ind/ha were recorded in the lower class with *Acacia karroo* being very prominent (1 000 ind/ha), followed by *Combretum apiculatum* (650 ind/ha) and *Acacia permixta* (300 ind/ha).

In plant community 5, a total of 818 ind/ha were recorded for the lower class with highest densities recorded for *Burkea africana* (282 ind/ha), *Dichrostachys cinerea* (118 ind/ha), *Acacia caffra* (109 ind/ha) and *Acacia karroo* (91 ind/ha). Plant community 6.2 had a total of 771 ind/ha in the lower class of which *Strychnos madagascariensis* had the highest density (300 ind/ha), followed by *Lippia javanica* (157 ind/ha).

The presence of a high number of *Terminalia sericea* seedlings together with the high density of *Dichrostachys cinerea* seedlings in communities 2 and 3 indicates the commencement of bush encroachment into these predominantly grassland areas. Although *Terminalia sericea* normally occurs on sandy soils, it is together with *Dichrostachys cinerea* a declared invader plant in the Transvaal according to Henderson *et al.* (1987) and monitoring measures should be taken so as to ensure early detection of possible undesirable increases.

The high number of woody species (total density) in communities 4 (2 225 ind/ha), 5 (1 618 ind/ha), 6 (2 029 ind/ha) and 8 (2 050 ind/ha) indicate that possible bush densification is taking place. None of these woody species are invasive, but have high densities in especially the lower classes indicating disturbance in the grass layer in the form of overgrazing and trampling.

Acacia karroo seedlings are present at low densities in communities 4 (42 ind/ha) and 5 (91 ind/ha), but at very high densities in plant community 8 (1 000 ind/ha). This tree is mainly associated with climax grasses such as *Themeda triandra*, indicating sweetveld and good grazing (Van Oudtshoorn 2004), however, the high number of seedlings in community 8 indicate possible bush densification by this species.

The presence of *Acacia caffra* seedlings (67 ind/ha in community 4; 109 ind/ha in community 5; 18 ind/ha in sub-community 6.1 does not indicate bush densification, but rather that the community is in a dynamic equilibrium with the environment (Theron 1973). Where overgrazing does take place, an increase in *Lippia javanica* was observed.

Brown (1997) found the total tree density of up to 1 800 ind/ha to be the threshold value for mixed bushveld where after veld condition will decrease rapidly and removal of woody species should be considered in communities 4, 6 and 8.

Herbaceous layer

Increaser I and II grass species are relatively abundant compared to the decreaser grass species (Figure 4.26). This can also be attributed to previous mismanagement (Increaser II) as well as the remote location and difficulty of access to browsers in some areas (Increaser I). The prominence of *Cynodon dactylon* in plant communities 1.2 and 1.3 indicates an overgrazed and trampled state, augmented by the presence of strong perennial grasses such as *Eragrostis plana* and *Eragrostis capensis* which are also indicative of possible overgrazing and excessive burning practices.

Out of season burning by the local farmer is probably a regular occurrence and was observed during the study period, resulting in the prominence of the climax Increaser grasses. In other parts, moribund conditions have been observed where *Hyperthelia dissoluta* occur with a high cover. This grass is dominant in communities 2, 3 and 4. Although this Increaser I grass normally grows in sandy, moist soil conditions (Van

Oudtshoorn 2004) it would not be totally dominant as was observed in these communities, unless the area have been previously disturbed. The sub-climax grass *Pogonarthria squarrosa* and the climax grass *Digitaria eriantha* is commonly found in moist, sandy soil conditions with *Pogonarthria squarrosa* also indicating disturbance whilst the constant presence of *Eragrostis curvula* as well as *Perotis patens* indicates overgrazed, trampled and compacted soil conditions in certain sections (Van Oudtshoorn 2004). These grasses are however not as prevalent in the gently sloping plant community 3 where the sandy, leached soil is drier than that of the other communities, indicating the affinity of these species to moist soil conditions.

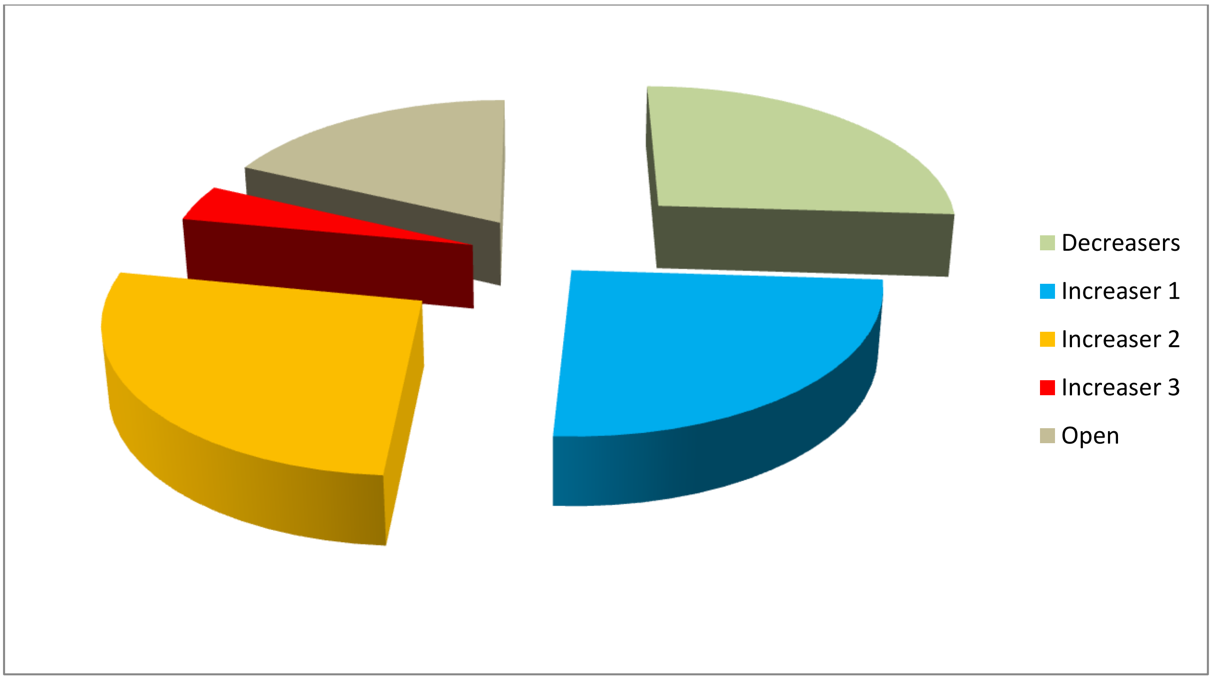

Figure 4.26 Relative proportions of the ecological classes of the grasses

Melinis nerviglumis is locally prominent in community 6 and is a very important pioneer grass as it stabilises disturbed soil (Van Oudtshoorn 2004). The high percentage cover of the annual weed *Tagetes minuta* further amplifies the disturbed nature of certain sections (Van Wyk & Malan1998) such as was found in community 6, probably due to overgrazing by cattle in the immediate vicinity. *Pogonarthria squarrosa* is a sub-climax Increaser II grass that usually occurs in disturbed areas as observed in certain parts of the study area.

Although the grass layer of the total study area is generally dominated by Increaser species (Figure 4.26), highly palatable and nutritious decreaser species such as *Setaria sphacelata, Digitaria eriantha, Panicum maximum, Panicum ecklonii, Brachiaria serrata,* and *Diheteropogon amplectens* also occur frequently throughout the area.

The dominant, climax grasses *Loudetia simplex*, and *Diheteropogon amplectens* as well as the Increaser I grass *Tristachya biseriata* are commonly found in open grasslands and against ridges where the soil is poor and sandy. The dominance of *Diheteropogon amplectens* and the prominence of *Setaria sphacelata* in these high lying areas also indicate that these areas are in a good condition, although the prominence of *Tristachya biseriata* on the high-lying mountain crest areas indicates that the veld is underutilised and has not been burnt regularly, probably because of the remote location of this community.

General discussion

An average of 23 species per $100m^2$ (0.1ha) were identified in the study area with the highest number of species being 28 species/$100m^2$ in sub-community 1.3. This indicates that the species diversity for Hondekraal is quite low when compared to the 40-100 species per 0.1 ha for the Southern African savanna areas (Whitaker *et al*. 1984; Cowling *et al*. 1989).

Concurrent with Theron's (1973) findings, *Burkea africana* is widespread throughout the plains areas and against north facing slopes in the *Faurea saligna-Burkea africana* woodland (4) as well as *Burkea africana-Digitaria eriantha* open woodland (5). It is also present in a dwarf form on top of the mountains and on high altitudes as found in the *Tristachya biseriata-Loudetia simplex* grassland community.

Furthermore, Theron (1973) found that *Terminalia brachystemma* only occurred in one stand in the larger Loskopdam Nature Reserve within the *Acacia caffra–Combretum apiculatum–Themeda triandra* tree savanna. However, this species is also present in plant community 1, 2 and 3 of the study area. *Faurea saligna* usually occur together with *Acacia caffra*, however, it does not occur on dolerite soil against south-facing slopes. *Acacia caffra, Lippia javanica* and *Mundulea sericea* are essentially ‘highveld’ species but also occur on the south-facing slopes, down to the valley and plains areas of the study area concurrent with Theron’s (1973) findings.

Protea caffra is common on medium to high altitudes as well as sheltered places (Palgrave 1983), whilst *Elephantorrhiza burkei* is more prominent in sheltered rocky ridges (Schmidt *et al*. 2002). The *Protea caffra-Tristachya leucothrix* community described by Gőtze *et al.* (1998) is similar to the *Tristachya biseriata-Protea caffra* open woodland described in the study area. *Diplorhynchus condylocarpon* is commonly found on steep to very steep slopes and more often on north to north-west facing slopes as described in the *Lannea discolor-Diplorhynchus condylocarpon* woodland sub-community (6.1) of the *Combretum molle-Xerophyta retinervis*-open-closed-woodland (6) and also in the *Combretum apiculatum-Panicum ecklonii*-open woodland (8). According to Theron (1973), this species can also be found on the south and south-east facing slopes; however, this species was not recorded on the south-facing slopes of the Hondekraal study area. It is also very resistant to fire and its leaves are readily eaten by game and stock. A similar community was described by Gőtze *et al.* (1998) under the *Combretum apiculatum-Themeda triandra* community with its predominantly northern aspect. Dominant species are *Combretum apiculatum* and *Dichrostachys cinerea* whilst other important woody species included *Lannea discolor* and *Acacia karroo.*

The *Tristachya biseriata-Protea caffra* open woodland (community 7 – Figure 4.27 and 4.28) has affinities with the Rand Highveld Grassland (Gm11) (Mucina *et al.* 2006) [also referred to as Rocky Highveld Grassland & Moist Sandy Highveld Grasslands – Vegetation types 34 & 38 by Low & Rebelo (1998) as well as Bankenveld – Veld Type 61 by Acocks (1988)]. Gőtze *et al*. (1998) described a similar community (*Protea caffra-Tristachya leucothrix)* community in the Parys and Rietfontein area of the reserve with the tree, *Protea caffra* being diagnostic and the grass *Tristachya leucothrix* dominant. Other important species identified in this plant community include the grasses *Loudetia simplex, Themeda triandra, Diheteropogon amplectens* as well as *Eragrostis curvula*.

Species that are characteristic in this vegetation type are *Acacia caffra* and *Protea caffra* according to Bredenkamp & Brown (2003). The proportionate composition as described in previous classifications is 45% Rocky Highveld Grasslands plus 21% Moist Sandy Highveld Grassland as described by Low & Rebelo (1998) or 64% Bankenveld as described by Acocks (1988).

Figure 4.27 *Tristachya biseriata-Protea caffra* open woodland affinities with Rand Highveld Grassland (Gm11).

Mucina & Rutherford (2006) describes this as a highly variable landscape with extensive sloping plains and a series of ridges that are slightly elevated over undulated surrounding plains (Figure 4.27). The altitude ranges from 1 300 – 1 635m, but reaches 1 760m in places. The species-rich vegetation can be described as wiry, sour grassland with most common species belonging to the genera *Themeda, Eragrostis, Heteropogon and Elionurus*. A high diversity of forbs, especially from the family Asteraceae is also a typical feature whilst woody species are represented by *Protea caffra* subsp. *caffra, Acacia caffra* as well as *Rhus magalismontanum*.

Geology is characterized by quartzite ridges of the Witwatersrand Supergroup and the Pretoria Group as well as the Selons River Formation for the Rooiberg Groups (last two are the Transvaal Supergroup).

Figure 4.28 Rand Highveld Grassland (Gm11) with *Protea caffra*

Rockiness of the soil surface is a further common characteristic shared by most Bankenveld areas (Bredenkamp & Brown 2003). Soils vary in quality and are shallow Glenrosa and Misphah forms (especially on rocky ridges). Land types identified for this vegetation type in Hondekraal are mainly Ib16 (on the southern and south-western mountains) and a small portion of Fa7 (located on the south-western mountain crests, just outside the study area). This is discussed in more detail under 'Landscapes'.

In this study the very steep cliffs and inaccessible location of Uithoek, Skurwekop and Dolf se Kloof in the east of the study area have led to these areas most probably been under sampled. Further studies could result in more detailed descriptions of these areas.

Clear distinctions between the eight main communities were identified. It is therefore recommended that each community be managed as a separate ecological unit. This implies the assessment of the grazing potential of each of the management communities to evaluate the possible stocking rate of this area. In addition, an assessment of the vegetation in terms of its variability and reaction to various practices such as burning, grazing & browsing should be done annually. A close association between the major plant communities and the different land types has been observed in this study.

Conservation value

According to Mucina & Rutherford (2006) the conservation status of the Loskop Thornveld (SVcb 140) is vulnerable with a target of 19% set as minimum area required for optimal conservation of this vegetation type (Table 4.2). Approximately 11% is statutorily conserved in the LNR. About one quarter of the vegetation type has already been transformed in the Mpumalanga Province mainly for agricultural crops that also require irrigation.

TABLE 4.2 Proportional Vegetation types and the relative conservation status (adapted from Mucina & Rutherford 2006).

Vegetation Type			Target Conservation Area (%)	Current Conservation Area (%)
Mucina et al. (2006)	**Low & Rebelo (1998)**	**Acocks (1953/88)**		
Loskop Thornveld (SVcb 14)	Mixed Bushveld (VT18) [71%]	Mixed Bushveld (VT18) [91%]	19%	Vulnerable 11% in LKNR
Loskop Mountain Bushveld (SVcb13)	Mixed Bushveld (VT18) [61%]	Mixed Bushveld (VT18) [49%] + Sourish Mixed Bushveld (VT19) [47%]	24%	Least Threatened 15% mainly in LKNR
Rand Highveld Grassland (Gm11)	Rocky Highveld Grassland (VT34) [45%] + Moist Sandy Highveld Grassland (VT38) [21%]	Bankenveld (64%)	24%	Endangered 1%

In addition to the most common crops, there has also been a dramatic increase in the establishment of vineyards. Old lands are invaded by *Acacia tortilis* and *Hyparrhenia hirta* as well as *Dichrostachys cinerea* and *Terminalia* species.

In contrast, the Loskop Mountain bushveld (SVcb13) is the least threatened vegetation type in the Savanna Biome with about 15% statutorily conserved in the province (target 24%), mostly in the Loskop Dam Nature Reserve, but also in the Mabusa Nature Reserve, emphasizing the important role that Nature Reserves fulfill in protecting vegetation and as outlined by Emery *et al.* (2002). Less than 3% has been transformed by cultivation and urban and built-up areas (Mucina & Rutherford 2006).

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CHAPTER 5

FLORISTIC ANALYSIS

Introduction

The continued human population increase worldwide results in greater pressures than before on the natural environment (Huntley 1991). Natural areas act as reservoirs for plant and animal populations (Brand *et al.* 2008). Vegetation surveys provide information on the different plant communities and plant species present and form the basis of any management plan for a specific area (Brown *et al.* 1996).

Little is known about the different taxa of the Hondekraal section of the Loskopdam Nature Reserve and a detailed floristic and ecological survey was undertaken as part of a vegetation classification of this area. Plant species lists not only provide important information on the floristic composition of an area but also on its natural status as well as affinities with other areas. This chapter therefore aims at providing an overview of the different plant taxa present in the study area. Taxonomic names conform to Germishuizen *et al*. (2006).

Results

The Hondekraal vascular plant species list comprises a total of 302 species represented by 204 genera and 71 families. An alphabetical list of flowering plants are shown in Table 5.1 and are represented by the Pteridophyta with 3 species in 2 families (3% of the total number of families), Monocotyledoneae with 99 species in 12 families (17%) and Dicotyledoneae with 200 species from 57 families (80%) (Figure 5.1). The complete species list separated into the different divisions and sorted by family is attached as Annexure B.

Table 5.1 Plant families identified in the study area indicating the number of genera and species in each family

PTERIDOPHYTA 2 Families 3 Genera 3 Species		
Families	**Genera**	**Species**
Pteridaceae	2	2
Selaginellaceae	1	1

SPERMATOPHYTES MONOCOTYLEDONEAE 12 Families 62 Genera 99 Species		
Families	**Genera**	**Species**
Amaryllidaceae	1	1
Asparagaceae	1	3
Asphodelaceae	1	1
Commelinaceae	1	2
Cyperaceae	6	10
Hyacinthaceae	2	2
Hypoxidaceae	1	3
Iridaceae	2	2
Juncaceae	1	1
Poaceae	44	72
Potamogetonaceae	1	1
Velloziaceae	1	1

SPERMATOHYTES DICOTYLEDONEAE 57 Families 139 Genera 200 Species		
Families	**Genera**	**Species**
Acanthaceae	7	8
Amaranthaceae	2	2
Anacardiaceae	4	11
Apocynaceae	2	2
Asteraceae	19	27
Boraginaceae	1	1
Brassicaceae	2	2
Buddlejaceae	1	1
Campanulaceae	1	1
Capparaceae	1	3
Caryophyllaceae	1	1
Celastraceae	1	1
Combretaceae	2	5
Chrysobalanaceae	1	1
Convolvulaceae	3	6
Crassulaceae	2	2
Cuscutaceae	1	1
Dichapetalaceae	1	1
Dipsacaceae	1	1
Ebenaceae	2	3
Elatinaceae	1	1
Euphorbiaceae	4	4

Fabaceae	17	34
Flacourtiaceae	2	2
Gentianaceae	1	1
Geraniaceae	1	2
Heteropyxidaceae	1	1
Illecebraceae	1	1
Lamiaceae	7	8
Lobeliaceae	1	2
Malvaceae	4	7
Malpighiaceae	1	1
Molluginaceae	1	1
Nyctaginaceae	1	1
Ochnaceae	1	1
Olacaceae	1	1
Onagraceae	1	1
Papilionoideae	2	2
Pedaliaceae	1	1
Plantaginaceae	1	1
Polygalaceae	2	4
Proteaceae	2	2
Ranunculaceae	1	1
Rubiaceae	7	7
Rutaceae	1	1
Santalaceae	1	1
Sapindaceae	2	2
Sapotaceae	1	1
Scrophlariaceae	1	1
Solanaceae	1	4
Sterculiaceae	3	5
Strychnaceae	1	4
Thymelaeaceae	1	1
Tiliaceae	3	4
Urticaceae	2	2
Vahliaceae	1	1
Verbenaceae	4	6

	Families	**Genera**
PTERIDOPHYTA	2	3
MONOCOTYLEDONEAE	12	62
DICOTYLEDONEAE	57	139
Total	**71**	**204**

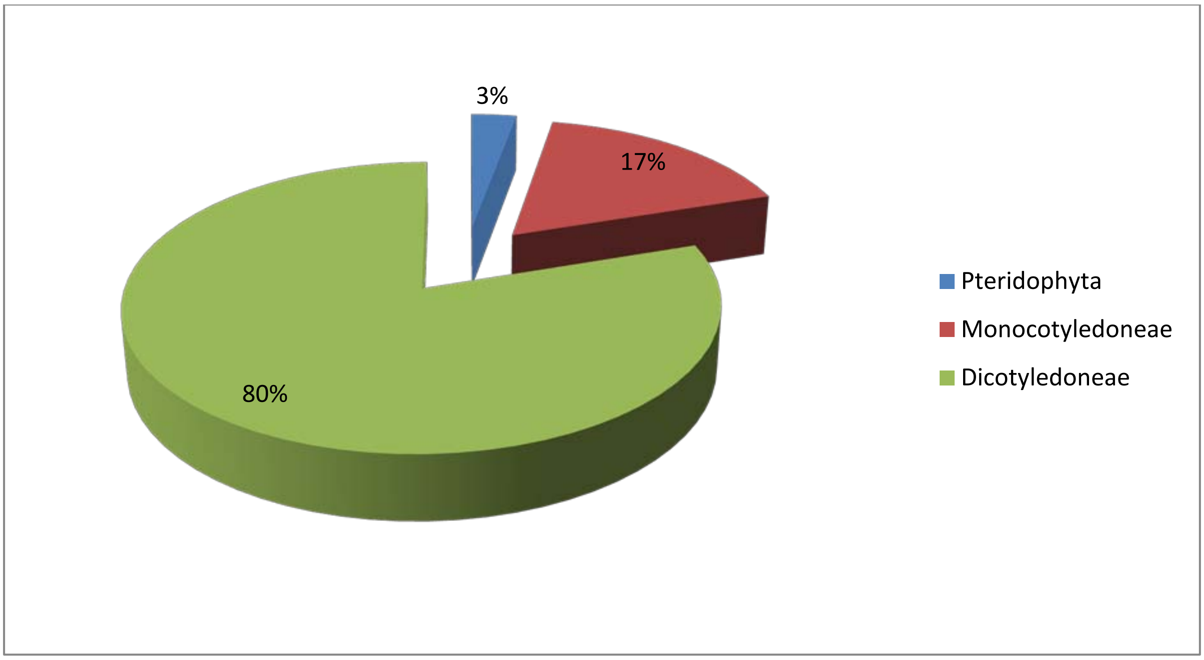

Figure 5.1 Plant divisions reflected as a percentage of the total number of plant families

The largest families in the study area are indicated in Figure 5.2 and are represented by 8 species or more. These seven families comprise 171 species from 105 genera which represents 57% of the total flora recorded for Hondekraal with the remaining 63 families reflecting 41% (Figure 5.2).

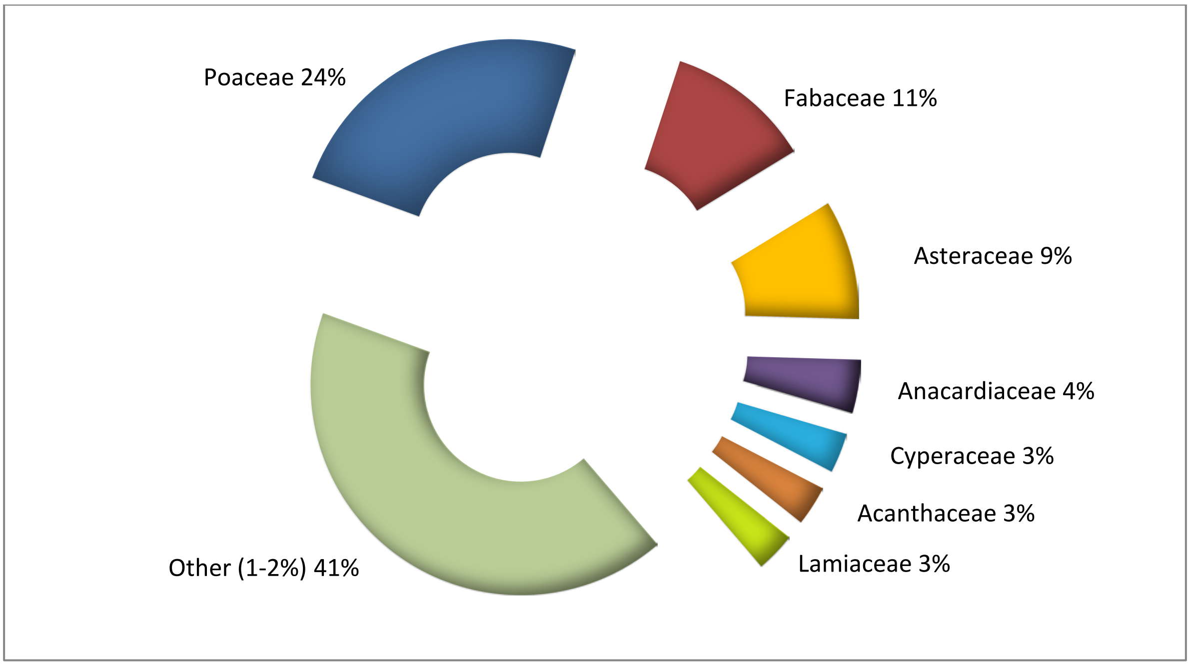

Figure 5.2 Dominant plant families reflected as a percentage of the total flora

The different genera for the Poaceae in the study are indicated in Table 5.2.

Table 5.2 Genera for Poaceae in descending order

Genus	Species	Percentage
Eragrostis	13	18%
Aristida	5	7%
Panicum	4	5%
Brachiaria	3	4%
Andropogon	2	3%
Digitaria	2	3%
Melinis	2	3%
Pennisetum	2	3%
Schizachyrium	2	3%
Sporobolus	2	3%
Tristachya	2	3%
Paspalum	1	1.4%
Setaria	1	1.4%
Alloteropsis	1	1.4%
Bewsia	1	1.4%
Bothriochloa	1	1.4%
Chloris	1	1.4%
Chrysopogon	1	1.4%
Cymbopogon	1	1.4%
Cynodon	1	1.4%
Diheteropogon	1	1.4%
Elionurus	1	1.4%
Enneapogon	1	1.4%
Eustachys	1	1.4%
Heteropogon	1	1.4%
Hyparrhenia	1	1.4%
Hyperthelia	1	1.4%
Imperata	1	1.4%
Ischaemum	1	1.4%
Loudetia	1	1.4%
Miscanthus	1	1.4%
Monocymbium	1	1.4%
Perotis	1	1.4%
Phragmites	1	1.4%
Pogonarthria	1	1.4%
Schmidtia	1	1.4%
Themeda	1	1.4%
Trachyandra	1	1.4%
Trachypogon	1	1.4%
Tragus	1	1.4%
Trichoneura	1	1.4%
Triraphis	1	1.4%
Urelytrum	1	1.4%
Urochloa	1	1.4%
Total	72	101%

Discussion

An analysis of the flora for Hondekraal (Figure 5.2) shows that the Poaceae is the largest family with 72 species from 44 genera representing 24% of the total flora, followed by the Fabaceae with 17 genera represented by 34 species (11%) and the Asteraceae with 27 species from 19 genera reflecting 9% of the total flora. The remaining four largest families reflect a significantly lower number of species and are followed in descending order by Anacardiaceae with 11 species from 4 genera (4%), Cyperaceae with 10 species from 6 genera (3%) and Acanthaceae as well as Lamiaceae being represented by 8 species from 7 genera (3%) each.

Further analysis of the Poaceae reflects the genus *Eragrostis* as being the most representative with 13 species (18%) followed in descending order by *Aristida* with 5 species (7%), *Panicum* with 4 species (5%) and *Brachiaria* with 3 species (4%). The genera *Andropogon*, *Digitaria*, *Melinis*, *Pennisetum*, *Schizachyrium*, *Sporobolus* and *Tristachya* consist of 2 species each (3% respectively), whilst the remaining genera consist of 1 species per genera collectively representing 45% of the Poaceae family. The complete list of genera for Poaceae is reflected in Table 5.2 in descending order.

An analysis of Fabaceae indicates that the largest component (59%) comprises woody plants with 41% annual and perennial forbs, whilst the Anacardiaceae consists only of woody plants. As expected, the Asteraceae represents most of the annual and perennial forbs of the herbaceous layer (Annexure B).

Conclusion

The prominence of the Poaceae is not unusual for the Savanna Biome as the herbaceous layer in most savannas' are usually dominated by grass species with a discontinuous to very open tree layer in parts (Mucina & Rutherford 2006). The herbaceous layer comprises of perennial as well as annual grasses and forbs that survive the dry seasons by dying back to the ground or as seeds respectively. The prominence of the genus *Eragrostis* is to be expected with Scholes (1997) confirming the dominance of tall, tuft-forming species in the broad-leaved savanna areas.

A small proportion of the herbaceous layer comprises dicotyledonous plants (annuals or facultative perennials) (Scholes 1997). According to Scholes (1997), the proportion of forbs in the herbaceous layer of the Savanna Biome is normally less than 5% on a biomass basis, but will increase and dominate in areas following prolonged drought, heavy grazing or soil disturbance. This floristic composition is also reflected in the study area with the Poaceae the most dominant family followed by the Fabaceae, Asteraceae and Anacardiaceae, the latter three comprising mostly trees and a smaller component forbs. (Annexure B).

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CHAPTER 6

VELD CONDITION AND GRAZING CAPACITY

Introduction

One of the aims of this study was to obtain a basis for the establishment of procedural guidelines to be used in the compilation of a management plan for the Hondekraal section by means of veld condition assessments, annual game counts as well as rainfall data.

A Nature Reserve can be described as an area of land removed from the development stream in order to conserve and protect wildlife and vegetation and its natural processes (Visser *et al*. 1996). Thus to ensure effective functioning of the ecosystem it is important that the vegetation or veld is managed effectively to ensure that the natural resources are used in a sustainable manner. Veld management refers to the management of natural vegetation for specific objectives that are related to different forms of land use (Trollope *et al*. 1990). A thorough knowledge of the vegetation of an area is a prerequisite for the planning of veld management, the stocking of game as well as various other management applications. For the effective management of vegetation, relatively homogeneous vegetation units should be identified, described and mapped (Schmidt *et al*. 1993; Visser *et al*. 1996) and the veld condition and tree density determined for each of these different units.

According to Trollope *et al.* (1990), veld condition refers to the condition of the vegetation in relation to certain functional characteristics such as forage production and resistance of the veld to soil. Some of the first authors to recognise the need for veld condition assessments as input for management decisions according to Foran (1976) were Smith (1895), Griffith (1903) and Wooten (1908). Since soil loss may be regarded as an absolute measure of the health of grazing lands, the ideal approach to veld condition assessments is the ecological approach wherein the primary objective is the long-term stability of the community and its ability to protect the soil from unacceptable soil losses (Wilson *et al.* 1984). Veld condition has been proven very valuable in the formulation of veld management practices such as stocking rate, rotational grazing/resting and veld burning. The botanical composition of the grass sward is a good indicator of the inherent ability of the veld to produce forage for grazing ungulates.

Distinct preferences are shown by specific herbivores for certain plant communities within a specific region, spending most of their time and energy utilising these areas (Dankwerts 1989). The utilisation of specific areas result in some areas becoming overutilised, whilst the less preferred areas become under-utilised. Utilisation preferences of the ungulate species are used to manipulate the stocking rates according to the type of plant communities that are present in the area, the associated veld condition as well as the resultant carrying capacity of the veld under a specific rainfall regime (Dankwerts 1989). Consequently, the application of this knowledge in a game management plan will result in the efficient management of wildlife by producing optimal numbers of game without deterioration of the specific vegetation in the area.

According to Galt *et al.* (2000), there has been an increase in the use of grazing capacity surveys for range management decisions over the 5 years preceding the year 2000 in developed as well as developing countries. In addition, it is widely being recognised by managers that successful veld management is dependent on correct stocking rates to ensure adequate protection of the area and prevent possible degradation. Grazing capacity as defined by Galt *et al.* (2000) is considered to be the average number of animals that a particular range or area will sustain over time and it is based on stocking rate.

The vegetation of the study area is representative of Mucina & Rutherford's (2006) Loskop Thornveld (SVcb 14) and Loskop Mountain Bushveld (SVcb 13). The grazing thus varies from sweet (mainly in the eastern sections) to sourveld. This area was utilised for agricultural practices in the past as well as cattle farming which is still being practiced in some parts. Overgrazing due to out of season burning led to bush encroachment in certain areas and the resultant weakening of the veld. Twelve different plant communities were identified in the phytosociological classification for the study area. The following is a description of the veld condition and grazing capacity, for each of the different plant communities identified.

Results & discussion

The grazing capacity and stocking rate for each of the different plant communities are presented in Table 6.1. The total grazing capacity for the study area is 9.5 ha/LSU for game (Table 6.1).

Schoenoplectus corymbosus–Juncus **species sub-community** (1.1)

This size of this sub-community is 55 ha and it covers 1.6 % of the study area. The present grazing capacity is 7.6 ha/LSU (Table 6.1). The ecological index (veld condition index %) of the veld is currently 51.6% indicating that this sub-community is in average condition, with a higher proportion Increaser I (35%) and Increaser II (34%) species, than Decreaser species (10%) (Figure 6.1). The average percentage grass cover is 65%, the remainder mainly comprised of forbs. During a year with below average rainfall, the grazing capacity will decrease from 7.6 ha/LSU to 15.4 ha/LSU. This can mainly be attributed to the proportionately low percentage Decreaser species (10%) and the high percentage Increaser 3 species (grasses and forbs) that are not readily utilised by animals.

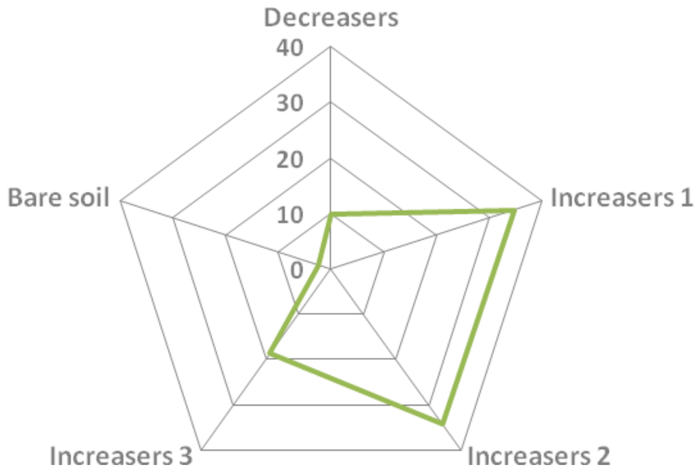

Figure 6.1 Percentage compositions of the different ecological status classes of the grass layer for sub-community 1.1

Table 6.1 Veld condition and Grazing Capacity for the Hondekraal Section of the Loskopdam Nature Reserve.

Plant community	**1.1**	**1.2**	**1.3**	**2.1**	**2.2**	**3.0**	**4.0**	**5.0**	**6.1**	**6.2**	**7.0**	**8.0**	**Total**
Size (ha)	55	27	33	247	253	133	550	389	284	1088	251	40	3347
Trees % cover	15	15	1	1	0	23	21	15	21	14	10	33	
Shrubs % cover	1	1	2	4	3	10	11	12	17	16	10	23	
Bush factor	0.90	0.90	0.99	0.98	0.99	0.81	0.82	0.86	0.80	0.85	0.90	0.70	
Decreasers	30	43	47	80	81	95	291	353	244	379	247	78	
Increasers 1	104	59	142	220	354	19	329	90	160	131	274	2	
Increasers 2	103	76	135	119	211	33	311	359	286	33	334	74	
Increasers 3	56	13	66	1	58	0	41	45	18	17	13	2	
Encroachers	0	0	0	0	0	0	0	0	0	0	0	0	
Bare soil	7	9	10	80	96	53	228	253	292	140	132	44	
Total	300	200	400	500	800	200	1200	1100	1000	700	1000	200	
Veld Condition Index %	**51.6**	**59.9**	**53.4**	**57.5**	**53.7**	**61.6**	**55.4**	**52.9**	**48.7**	**69.6**	**59.0**	**56.5**	
Grass cover %	65	80	50	73	79	40	53	41	42	51	64	30	
Rainfall (mm/yr)	494	494	494	494	494	494	494	494	494	494	494	494	
Accessibility	1	1	1	1	1	1	1	1	1	1	1	1	
Fire (0.8\1)	1	1	1	1	1	1	1	1	1	1	1	1	
Grazing Capacity													
Average year													
ha/LSU Cattle	4.7	4.0	8.2	7.0	7.4	5.5	6.3	6.3	6.5	5.9	6.1	5.9	
ha/LSU Game	7.6	6.5	14.4	12.2	13.2	8.3	9.7	9.8	9.7	9.3	9.9	8.2	
Number Cattle	**11.7**	**6.6**	**4.0**	**35.3**	**33.9**	**24.2**	**86.6**	**62.2**	**43.8**	**183.2**	**41.1**	**6.7**	**539.3**
Number LSU Game	**7.2**	**4.1**	**2.3**	**20.2**	**19.2**	**16.0**	**56.8**	**39.6**	**29.2**	**117.2**	**25.3**	**4.8**	**341.5**
Grazing Capacity	11.7	9.4	17.1	14.3	15.2	13.7	16.2	16.1	17.6	13.8	14.3	15.1	
Below average year													
ha/LSU Cattle	9.5	7.6	16.5	13.5	14.8	10.6	12.6	12.8	13.7	10.9	11.7	11.9	
ha/LSU Game	15.4	12.4	29.0	23.6	26.1	16.1	19.2	20.1	20.5	17.0	19.1	16.7	
Number Cattle	**5.8**	**3.5**	**2.0**	**18.3**	**17.1**	**12.5**	**43.7**	**30.5**	**20.8**	**99.8**	**21.4**	**3.3**	**278.6**
Number LSU Game	**3.6**	**2.1**	**1.1**	**10.4**	**9.7**	**8.3**	**28.7**	**19.4**	**13.8**	**63.9**	**13.1**	**2.4**	**176.4**
Total Grazing Capacity (ha/LSU)				**Cattle**	**6.2**	**Game**	**9.8**						

The grasses with the highest percentage frequency are as follows:

Species	**% Frequency**
Phragmites australis	29%
Pennisetum macrourum	18%
Sporobolus africanus	15%
Paspalum dilatatum	12%
Setaria sphacelata	11%
Imperata cylindrica	7%
Panicum maximum	7%

Phragmites australis which is the dominant grass species in this sub-community are only grazed by animals during the growing season where after it becomes too hard and fibrous. According to Ausden *et al.* (2005), light grazing throughout the year will lead to a decrease in biomass of *Phragmites australis*. Jutila *et al*. (2001) concurs in recording that *Phragmites australis* was much more common in un-grazed than in grazed plots and was found to be one of the species which were most consistently and negatively influenced by grazing. This is a very competitive species which according to Jutila *et al.* (2001) effectively uses resources and as a tall plant, shades other species. Except for the grasses *Panicum maximum, Setaria sphacelata* and *Paspalum dilatatum*, the other grasses are not palatable and seldom grazed (Van Oudtshoorn 2004). From the ecological status as depicted in Figure 6.1 it seems as though this sub-community is overgrazed. However these species occur naturally in and along water courses and therefore, this sub-community mostly represents natural vegetation.

***Pennisetum macrourum–Hypoxis rigidula* sub-community** (1.2)

With a size of 27 ha, this sub-community covers 0.8% of this study area. Table 6.1 indicates that the present grazing capacity is 6.5 ha/LSU and the veld condition index of 59.9% indicate that this sub-community is also in average condition. A higher percentage Decreaser species (22%) were recorded than in sub-community 1.1 whilst the proportion Increasers are similar at 30% and 38% for Increaser I and Increaser II species respectively (Figure 6.2). The average percentage grass cover is high at 80% resulting in 'n fairly high grazing capacity of 6.5 for an average rainfall year, that will decrease to 12.4 ha/LSU during a below average rainfall year.

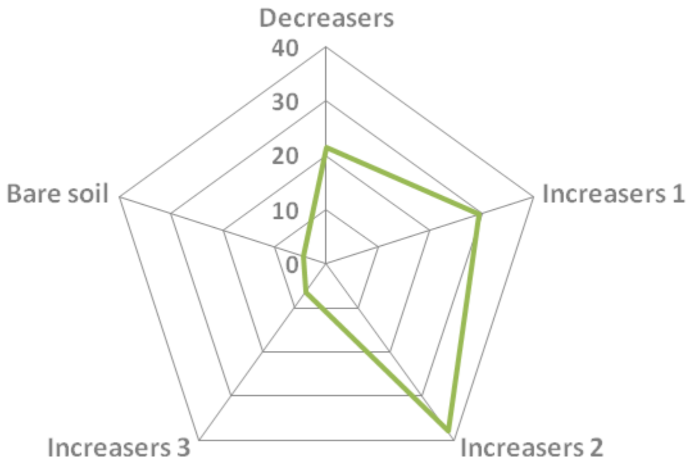

Figure 6.2 Percentage compositions of the different ecological status classes of the grass layer for sub-community 1.2

The grasses with the highest percentage frequency are as follows:

Species	**% Frequency**
Phragmites australis	31%
Sporobolus africanus	13%
Pennisetum macrourum	12%
Panicum maximum	9%
Imperata cylindrica	8%
Cynodon dactylon	8%
Setaria sphacelata	6%
Paspalum dilatatum	4%
Pennisetum villosum	4%
Tristachya biseriata	3%

The high proportion of the dominant grass *Phragmites australis* have been discussed under sub-community 1.2. as well as its natural occurrence in and along water courses together with *Sporobolus africanus, Pennisetum macrourum* and *Imperata* *cylindrica*. Most of these species are not readily utilised by animals due to the hardness of their leaves, but they do however, play an important ecological role, especially as soil stabilisers (Van Oudtshoorn 2004). The ecological status (Figure 6.2) indicate that this sub-community is probably overgrazed and trampled due to the presence of species such as *Sporobolus africanus* and *Cynodon dactylon* which is often found on overgrazed and trampled banks of rivers and dams (Van Oudtshoorn 2004).

***Eragrostis plana–Cyperus rupestris* sub-community** (1.3)

This drainage channel sub-community has a size of 33 ha and covers 0.9% of the study area. At present, the grazing capacity is 14.4 ha/LSU whilst the veld condition index is 53.4%, indicating that this sub-community is in an average condition (Table 6.1). The percentage Decreasers recorded was low (12%), whilst the percentage Increaser I and II species are once again similar to that of the previously described drainage channel sub-communities (Figure 6.3). Grazing capacity will decrease even further to 29.3 ha/LSU during a below average rainfall year.

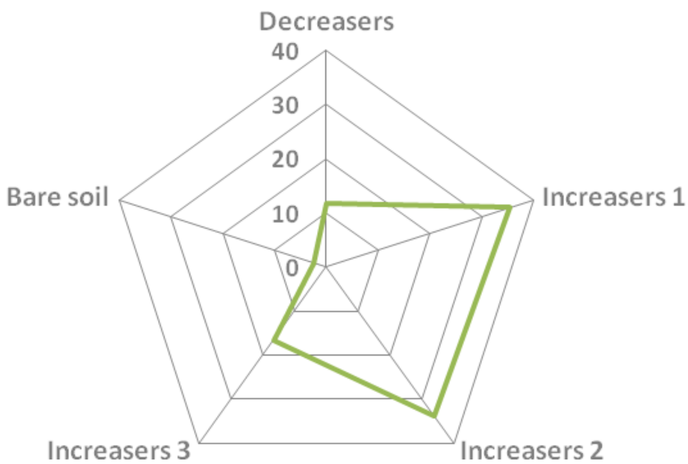

Figure 6.3 Percentage compositions of the different ecological status classes of the grass layer for sub-community 1.3

The grasses with the highest percentage frequency are as follows:

Species	**% Frequency**
Hyparrhenia hirta	23%
Eragrostis plana	20%
Pennisetum macrourum	16%
Setaria sphacelata	9%
Eragrostis curvula	8%
Cynodon dactylon	5%
Panicum maximum	5%
Eragrostis capensis	3%

This sub-community has the lowest average grass cover (50%) of all the drainage channel sub-communities, with forbs such as *Cyperus rupestris* comprising up to 50% of the cover (average herbaceous cover is 30%). From Figure 6.3, it could be deduced that this sub-community is under-utilised in some areas and over-utilised in others. However, both the unpalatable, Increaser II species *Eragrostis plana* as well as the Increaser I species *Hyparrhenia hirta* and *Pennisetum macrourum* are not well utilised by animals except for early in the growing season, thereby eliminating the option of possible overgrazing. The dominance of *Eragrostis plana* and the high percentage forbs most probably indicate over burning as was observed during the study period and confirmed by Van Oudtshoorn (2004). In addition, all of these species also occur naturally in and around moist areas and are mostly representative of the natural vegetation found in and around water courses.

***Hyperthelia dissoluta–Elephantorrhiza burkei* grassland** (2.1)

Covering 7.4% of the study area, the size of this grassland sub-community is 247 ha. The present grazing capacity is 12.2 ha/LSU (Table 6.1). The ecological index (veld condition index %) of the veld is currently 57.5% indicating that this sub-community is in an average condition, with a high proportion Increaser I (44%) species (Figure 6.4). The average grass cover is 73%. During a year with below average rainfall, the grazing capacity will decrease from 12.2 ha/LSU to 23.6 ha/LSU.

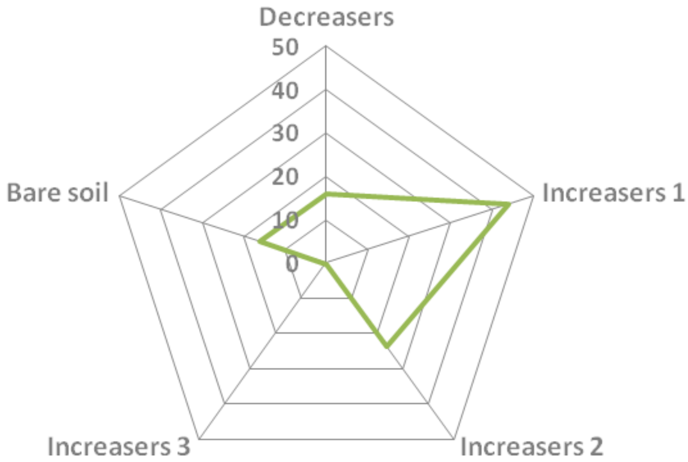

Figure 6.4 Percentage compositions of the different ecological status classes of the grass layer for sub-community 2.1

The grasses with the highest percentage frequency are as follows:

Species	**% Frequency**
Hyperthelia dissoluta	50%
Eragrostis curvula	16%
Setaria sphacelata	15%
Pogonarthria squarrosa	4%
Eragrostis lehmanniana	3%
Brachiaria serrata	3%

The dominance of the Increaser I species *Hyperthelia dissoluta,* indicate that these areas are probably under-utilised (Figure 6.4). This species is mainly utilised early in the season, or after being burnt, where after it becomes tough and unpalatable to grazers. It is also very competitive and under conditions of under-utilisation, it forms very dense stands that are difficult to eliminate. According to Van Oudtshoorn (2004), the only viable way of controlling this grass is through light grazing with for example cattle which, through their movement in effect opens up these grasslands thereby stimulating the growth of more palatable grasses. With the exception of *Pogonarthria squarrosa* and *Hyperthelia dissoluta* later in the season, all these grasses are palatable and well utilised by animals and with the appropriate stocking rate, would probably become more prominent in this community.

***Hyperthelia dissoluta–Digitaria eriantha* grassland** (2.2)

With a size of 253 ha, this grassland sub-community covers 7.6% of this study area. Table 6.1 indicates that the present grazing capacity is 13.2 ha/LSU and the veld condition index of 53.7% indicate that this sub-community is also in an average condition. A high percentage Increaser I species (44%) were also recorded in this grassland sub-community, as well as 26% Increaser II species (Figure 6.5). The average grass cover is high at 79%, however, the presence of the Increaser I species *Hyperthelia dissoluta* at the high frequency of 46%, resulted in the low grazing capacity of 13.2 ha/LSU. The grazing capacity will decrease even further during a year of below average rainfall to 26.1 ha/LSU.

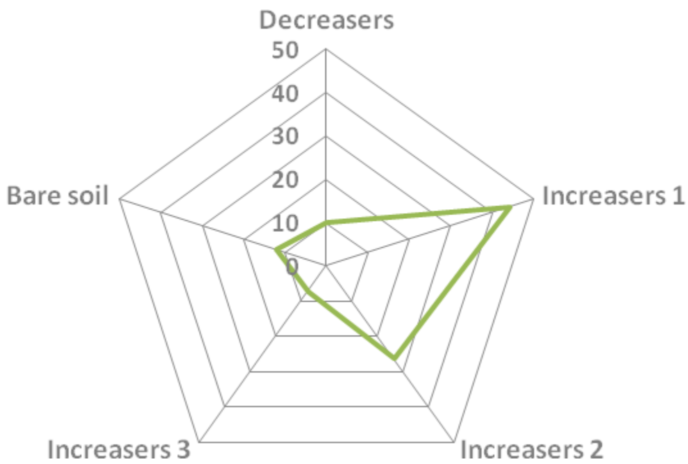

Figure 6.5 Percentage compositions of the different ecological status classes of the grass layer for sub-community 2.2

The grasses with the highest percentage frequency recorded are:

Species	**% Frequency**
Hyperthelia dissoluta	46%
Digitaria eriantha	14%
Pogonarthria squarrosa	8%

Eragrostis curvula	8%
Perotis patens	6%
Setaria sphacelata	4%
Aristida adscensionis	3%
Cynodon dactylon	3%

The properties of *Hyperthelia dissoluta* have been discussed under sub-community 2.1 and are also relevant here where under-utilisation and the strong competitive ability of this grass lead to its domination.

***Faurea saligna–Setaria sphacelata* open woodland** (3)

This open woodland community has a size of 133 ha and covers 4% of the study area. At present, the grazing capacity is 8.3 ha/LSU whilst the veld condition index is 61.6%, indicating that this plant community is in a good condition (Table 6.1). Even though this community has a low average grass cover of only 40%, it is mostly comprised of the palatable Decreaser (50%), *Setaria sphacelata* which has a frequency of 53% (Figure 6.6). The grazing capacity will decrease to 16.1 ha/LSU during a below average rainfall year.

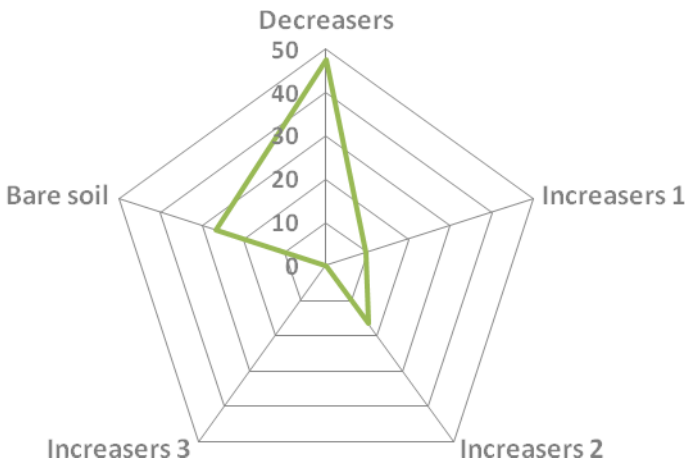

Figure 6.6 Percentage compositions of the different ecological status classes of the grass layer for community 3

The grasses with the highest percentage frequency recorded are as follows:

Species	**% Frequency**
Setaria sphacelata	53%
Eragrostis curvula	13%
Hyperthelia dissoluta	12%
Brachiaria serrata	9%
Heteropogon contortus	7%
Diheteropogon amplectens	3%
Eragrostis superba	3%

Even though this community has a fairly low grass cover of 40% (Chapter 4), it is in a good condition with a high proportion Decreasers present (Figure 6.6). The palatable climax species in this community are well utilised by animals and are indicative of a good veld condition (Van Oudtshoorn 2004). The prominence of the Increaser II grass *Eragrostis curvula* that is also well utilised by animals, indicate that this community is probably subject to period overgrazing and trampling. Together with the presence of a 25% - 30% woody layer (Chapter 4), this contributes to an increase in proportion of bare soil.

***Faurea saligna–Burkea africana* woodland** (4)

This woodland community has a size of 550 ha and covers 16.4% of the study area. At present, the grazing capacity is 9.7 ha/LSU whilst the veld condition index is 55.4%, indicating an average condition (Table 6.1). The percentage Decreasers, Increaser I and Increaser II is very similar at 24%, 27% and 26% respectively (Figure 6.7) and the average grass cover is 53%. During a below average rainfall year, the grazing capacity will decrease to 19.7ha/LSU.

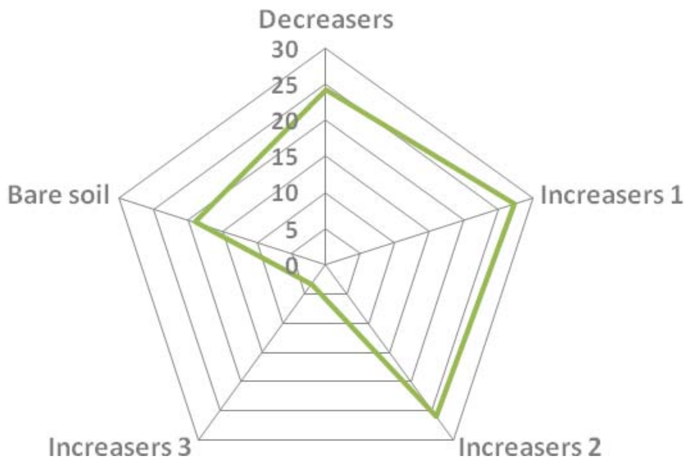

Figure 6.7 Percentage compositions of the different ecological status classes of the grass layer for community 4.

The grasses with the highest percentage frequency recorded are as follows:

Species	**% Frequency**
Hyperthelia dissoluta	35%
Setaria sphacelata	25%
Pogonarthria squarrosa	12%
Eragrostis gummiflua	5%
Eragrostis curvula	4%
Panicum maximum	3%

The practice of burning out of season was observed during the study period and the associated overgrazing has probably resulted in an increase of Increaser II species such as *Pogonarthria squarrosa*, *Eragrostis curvula* and *Cynodon dactylon* in certain sections. In addition, the Increaser I grass, *Hyperthelia dissoluta* is able to withstand fires and actually increases slightly in density (Van Oudtshoorn 2004), as is evident in this community. As mentioned before, this grass is mainly utilised early in the growing season. With the exception of *Pogonarthria squarrosa* and *Eragrostis gummiflua*, all the other grasses are palatable and well utilised by animals. The average condition of this community could be improved through the implementation of a proper burning programme whilst the presence of a higher proportion *Hyperthelia dissoluta* could be controlled through an adequate stocking rate with the appropriate game species.

***Burkea africana–Digitaria eriantha* open woodland** (5)

With a size of 389 ha, this open woodland community covers 11.6% of the study area. Table 6.1 indicates that the present grazing capacity is 9.8 ha/LSU and the veld condition index of 52.9% indicate that this sub-community is in average condition. The average grass cover is moderate at 49% and this in combination with the relatively high percentage of open spaces (23%), will result in a decreased carrying capacity of 20 ha/LSU during a year with below average rainfall.

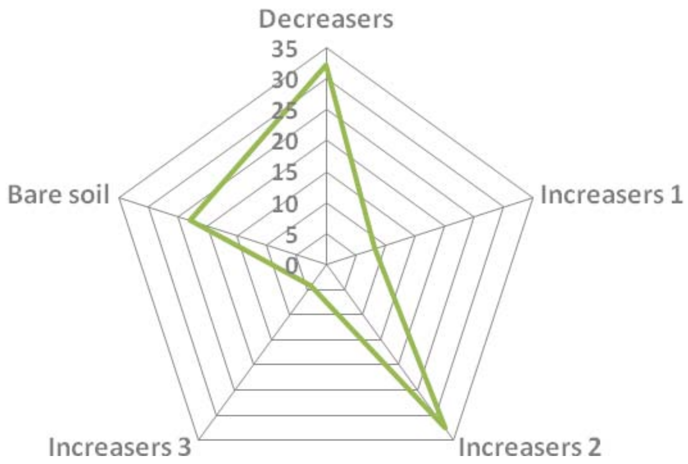

Table 6.8 Percentage compositions of the different ecological status classes of the grass layer for community 5.

The grass species with the highest percentage frequency recorded are:

Species	**% Frequency**
Setaria sphacelata	23%
Eragrostis rigidior	12%
Pogonarthria squarrosa	11%
Digitaria eriantha	10%

Loudetia simplex	7%
Hyperthelia dissoluta	6%
Heteropogon contortus	4%
Themeda triandra	3%

A high percentage Decreasers (32%) as well as Increaser II species (33%) were recorded in this community (Figure 6.8), indicating that the palatable Decreaser species are probably being overgrazed to some extent resulting in an increase in less palatable Increaser II species. With the exception of the palatable Decreaser *Setaria sphacelata* and *Digitaria eriantha*, all of the remaining prominent grasses are either unpalatable or has a low palatability and is therefore not well utilised by grazers (Van Oudtshoorn 2004). The palatable species in this community should be monitored and together with the correct stocking rate, a further increase and possible domination by Increaser II species should be prevented.

Lannea discolor-Diplorhynchus condylocarpon **woodland** (6.1)

The size of this woodland sub-community is 284 ha and it covers 8.5% of the study area. The present grazing capacity is 9.7 ha/LSU (Table 6.1). The veld condition index of the veld is currently 48.7% indicating that this sub-community is in an average to poor condition, with a higher proportion Increaser II (32%) species than Decreasers (22%) (Figure 6.9). The average grass cover for this sub-community is 42% and it has a high percentage (29%) of bare soil resulting in a grazing capacity that will decrease to 20.5 ha/LSU during a year with below average rainfall.

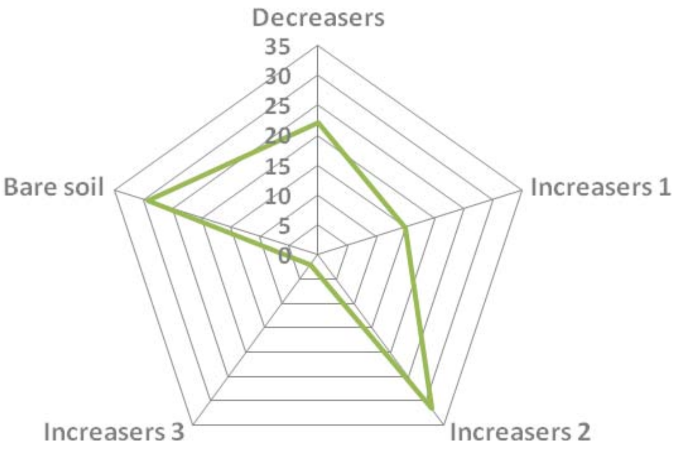

Table 6.9 Percentage compositions of the different ecological status classes of the grass layer for sub-community 6.1.

The grasses with the highest percentage frequency are as follows:

Species	**% Frequency**
Loudetia simplex	26%
Melinis nerviglumis	16%
Diheteropogon amplectens	12%
Setaria sphacelata	8%
Schmidtia pappophoroides	8%
Brachiaria serrata	6%
Themeda triandra	5%
Eragrostis superba	4%
Aristida diffusa	3%
Hyperthelia dissoluta	3%

The dominant Increaser II grass *Loudetia simplex* is a tough grass that is seldomly grazed and also indicates poor soil and/or possible overgrazing (Van Oudtshoorn 2004). With the exception of this grass as well as *Melinis nerviglumis*, and the early-season utilisation of *Eragrostis superba* and *Hyperthelia dissoluta*, all the other grasses as palatable and well utilised by animals. Even though parts of this sub-community are not easily accessible, the presence of a higher proportion Increaser II species indicate that the palatable species in this area need to be monitored to prevent overutilization and dominance by Increaser II and III species.

***Setaria sphacelata-Mundulea sericea* woodland** (6.2)

The size of this woodland sub-community is 1 088? ha and it covers 32.5% of the study area. The present grazing capacity is 9.9 ha/LSU (Table 6.1). The ecological index (veld condition index of the veld is currently 69.6% indicating that this sub-community is in a good condition, with a high proportion Decreaser (55%) species (Figure 6.10). The average grass cover is 51% and the percentage open spaces (rock cover) comprise 21%. The Increaser I species percentage frequency of 18% is probably due to the difficulty in accessing parts of this sub-community. During a year with below average rainfall, the grazing capacity will decrease to 17 ha/LSU.

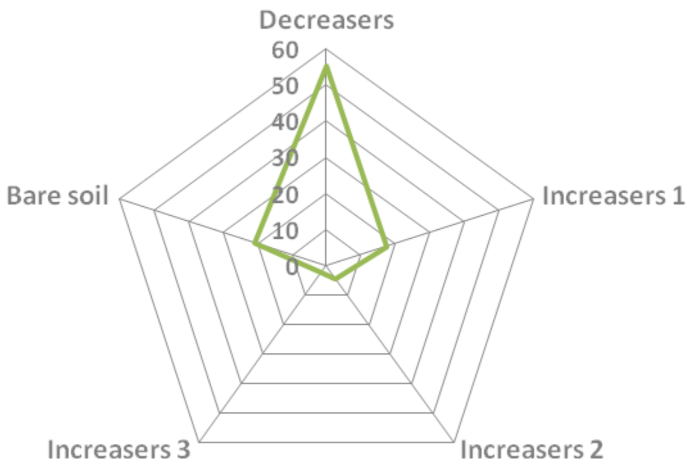

Figure 6.10 Percentage compositions of the different ecological status classes of the grass layer for sub-community 6.2.

The grasses with the highest frequency are as follows:

Species	**% Frequency**
Setaria sphacelata	48%
Ischaemum afrum	12%
Panicum maximum	11%

Themeda triandra	7%
Tristachya biseriata	4%
Melinis nerviglumis	4%
Andropogon schirensis	3%
Loudetia simplex	3%

From the ecological status classes (Figure 6.10) it can be derived that this sub-community is in a good condition with a high proportion Decreasers mainly *Setaria sphacelata* which is also dominant. With the exception of *Ischaemum afrum*, *Loudetia simplex* and the early-season utilised *Tristachya biseriata* and *Andropogon schirensis*, all the other grasses are palatable and well utilised.

***Tristachya biseriata–Loudetia simplex* grassland** (7)

With a size of 251 ha, this grassland community covers 7.5% of this study area. Table 6.1 indicates that the present grazing capacity is 9.9 ha/LSU and the veld condition index of 59% indicate that this community is in average condition. Grazing capacity would be higher if the area was not as difficult to access. Proportionately, the Decreasers, Increaser I and II species have a similar percentage cover of 25%, 27% and 33% respectively (Figure 6.11). The average grass cover is 64%. During a year with below average rainfall, the grazing capacity will decrease to 19.1 ha/LSU.

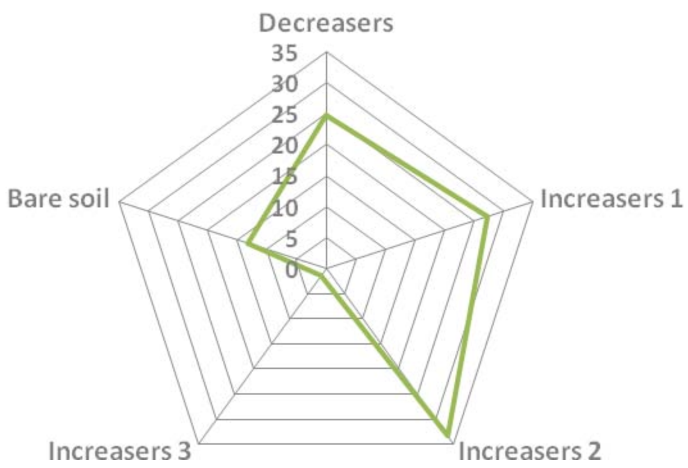

Figure 6.11 Percentage compositions of the different ecological status classes of the grass layer for community 7.

The grass species with the highest percentage frequency recorded are:

Species	**Frequency**
Loudetia simplex	36%
Tristachya biseriata	20%
Diheteropogon amplectens	14%
Setaria sphacelata	7%
Chrysopogon serrulata	4%
Bewsia biflora	3%

As mentioned previously, the dominant Decreaser II grass *Loudetia simplex* has a weak to average grazing value that is not readily grazed by animals whilst *Tristachya biseriata* has a relatively low leaf production and is utilised early in the growing season where after it becomes too tough and unpalatable. This grass indicates under-utilisation in parts of this community, probably, as mentioned, because of the remote location.

***Combretum apiculatum–Panicum ecklonii* open woodland** (8)

Covering 1.2% of the study area, this open woodland community has a size of 40ha. At present, the grazing capacity is 8.2 ha/LSU whilst the veld condition index is 56.5%, indicating that this community is in an average condition (Table 6.1). The percentage Decreasers and Increaser II species are the highest at 39% and 37% respectively (Figure 6.1). The average grass cover is only 30 % due to the high rock cover of 22% in this community. During a below average rainfall year, the grazing capacity will decrease to 16.7ha/LSU.

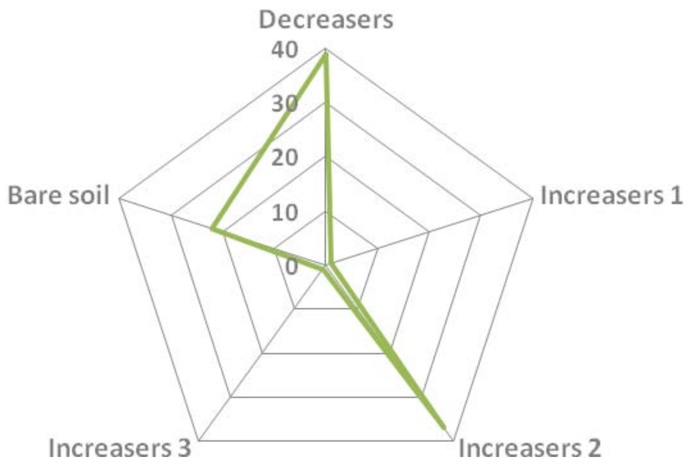

Figure 6.12 Percentage compositions of the different ecological status classes of the grass layer for community 8.

The grasses with the highest frequency recorded are as follows:

Species	**% Frequency**
Heteropogon contortus	34%
Themeda triandra	31%
Loudetia simplex	14%
Panicum ecklonii	11%
Digitaria eriantha	8%

The high percentage Increasers and Decreasers possibly indicate that the palatable Decreaser grasses are being replaced by less palatable Increaser II species. This will however have to be monitored to determine the changes in grass and other species composition.

Conclusion

Condition assessments of plant communities constitutes a convenient means of comparing different communities and also provides a way of quantifying and observing spatial and temporal changes within a particular vegetation type (Tainton *et al.* 1999). Whilst recognising the fact that the manager has little control over the influence of climate and soils on vegetation composition and structure, management through fire and grazing/browsing have a significant influence on plant communities. With clear management objectives as a prerequisite, the management of plant communities are governed by knowledge of the condition of these communities relative to their ‘ideal’ as determined by the objectives.

Each plant community has a species composition that differs from that of other plant communities and therefore also differs with respect to grazing capacity and stocking rate and its suitability as a habitat for certain game species This reiterates the fact that plant communities with their associated habitats form the basis for efficient and scientific veld management.

The grasses of the study area are mostly representative of a sub-climax to climax phase. The drainage channel sub-communities 1.1 (*Schoenoplectus corymbosus-Juncus* spp) and 1.2 (*Pennisetum macrourum–Hypoxis rigidula)* have the highest grazing capacity at 7.6 ha/LSU and 6.5 ha/LSU respectively. The lowest grazing capacity was recorded in the grassland sub-communities 2.1 (*Hyperthelia dissoluta–Elephantorrhiza elephantina)* and 2.2 (*Hyperthelia dissoluta – Digitaria eriantha)* at 12.2 ha/LSU and 13.2 ha/LSU respectively. The highest veld condition index was recorded in the south-facing *Combretum molle–Xerophyta retinervis* sub-community 6.2 at 69.6% whilst the lowest index was recorded at 48.7% in the north-facing *Lannea discolour-Diplorhynchus condylocarpon* sub-community 6.1. Most of the plant communities have an average veld condition index (Figure 6.13).

Due to the moist conditions that are more prevalent in some parts of the drainage channel sub-communities (1.1 – 1.2), they are not subject to the excessive damage of frequent fires as was recorded in the areas surrounding these channels. The buffering effect of the moisture is evident in the moribund conditions that were observed in some parts of these channels, but will be discussed in Chapter 7.

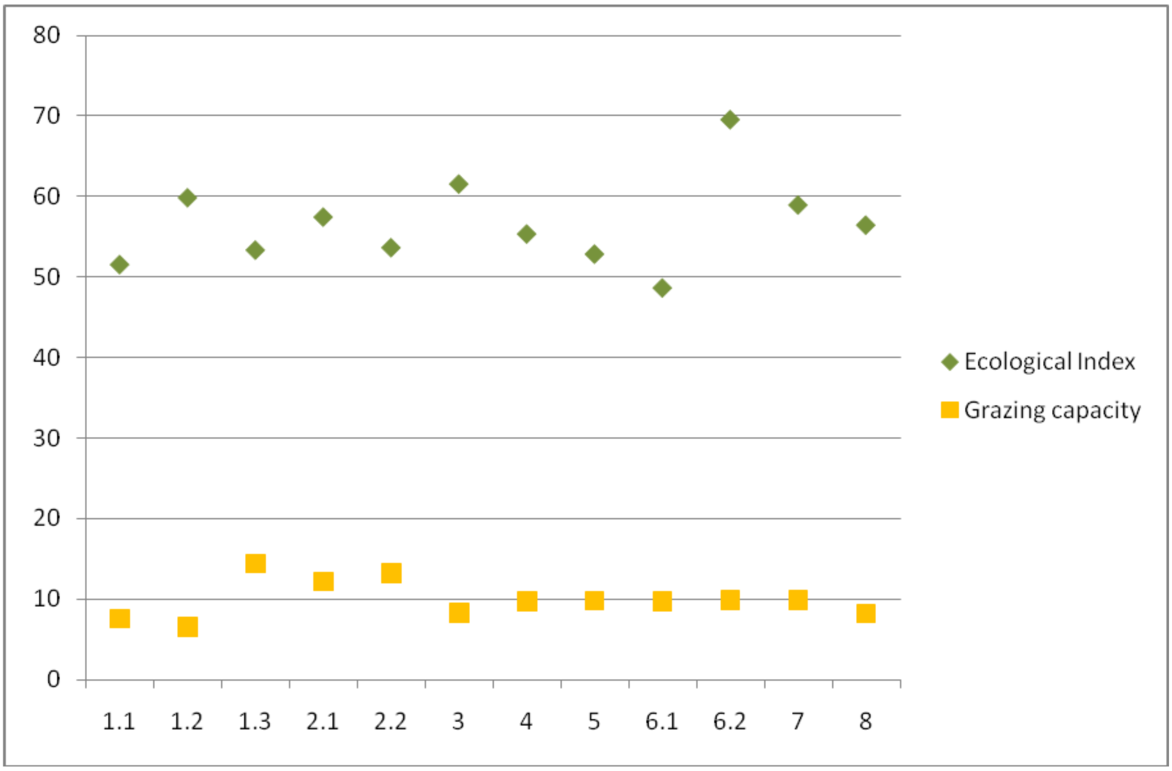

Figure 6.13 Ecological Index and grazing capacity for plant communities of Hondekraal

Even though the percentage composition of the ecological status classes for sub-communities 1.1 – 1.3 (Figures 6.1 – 6.3) indicate possible overgrazing, most of the species that are dominant occur naturally in and around water courses and are therefore the natural vegetation for this area. However, frequent burning in these sub-communities and the resultant overgrazing and trampling has probably led to the prominence and increase of species such as *Sporobolus africanus* and *Cynodon dactylon* as well as the anthropogenic grass *Hyparrhenia hirta*. According to Van Rooyen *et al.* (2004) *Phragmites australis* is a key wetland species that provides many essential ecosystem services. It is a major component of freshwater bodies and often forms the interface between land and water. Due to over-harvesting, most reed beds in communal areas have been degraded, whilst most of the productive reed beds are situated in conservation areas (Van Rooyen *et al*. 2004). To prevent degradation of reed beds, sustainable levels of utilisation should be established and will be discussed in Chapter 7. In addition, the diameter of the reeds are positively correlated to its utility, where reed were recorded to be thicker and taller in unutilised sites, compared to utilised sites. Fire significantly reduces mean read density, but significantly increases read diameter, whilst not having a significant effect on reed height (Van Rooyen et al. 2004). Utilisation of these reeds should be confined to the winter months (dormant season), when damage is minimal. Should burning be necessary, it should only be implemented during winter or early spring to minimise negative effects. The unutilised areas observed in the study area should be burnt to remove moribund material and to yield a larger proportion of tall and thick reeds. Long-term effects of fire have not been investigated by Van Rooyen et al. (2004) and therefore, the annual burning as was observed during the study period, is not recommended.

The low grazing capacity of the grassland sub-communities (2.1 and 2.2) can mainly be ascribed to the dominance of the Increaser I grass, *Hyperthelia dissoluta.* This grass is completely grazed in the early stage or after being burnt, but at later stages the stems are usually left un-grazed whilst only the leaves are eaten. It is also very competitive and under conditions of under-utilisation, it forms very dense stands that are difficult to eliminate. According to Van Oudtshoorn (2004), the only viable way of controlling this grass is through light grazing with for example cattle, however, buffalo or zebra would be preferable in this area. By means of moving through the grasslands, these animals manage to open the veld up and simultaneously stimulate the growth of more palatable grasses. Stocking rates should be kept in line with the grazing capacity of the veld so that the vigour of the preferred grasses can be maintained. This is also recommended for plant community 4.

The presence of a high proportion Increaser II species in communities 1.3, 3, 4, 5, 6.1, 7 and 8 indicate that the palatable species in these areas need to be monitored and together with the correct stocking rate and burning programme, overutilization and dominance by Increaser II and III species could be prevented.

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CHAPTER 7

VELD AND GAME MANAGEMENT PLAN

Introduction

Stocking rate is defined by Dankwerts (1989) as '*the area of land in a system of management that the operator has allotted to each animal unit in the system and is expressed per length of the grazable period of the year*.' A simpler definition is that of Bartholomew (1991) '*as the number of animals of a particular class that are allocated to a unit area of land for a specified period of time*.' It can be expressed either in terms of animal numbers per unit land area (ha) or as land area available for each animal. The latter is usually used when referring to veld (Tainton *et al*. 1999).

According to Tainton *et al.* (1999), stocking rate has an immediate effect on the quantity of forage that is available to the grazers, affecting intake as well as animal performance. In addition, long-term effects of incorrect stocking rates include a reduction in the vigour of forage plants (Van Niekerk *et al.* 1984) as well as a change in botanical composition. In general, these changes constitute a replacement of palatable, productive species by unpalatable and less productive grasses and forbs (Tainton *et al.* 1999) that will inevitably lead to reduced animal performance (Van Niekerk *et al.* 1984).

Present game numbers of the 2007/8 aerial count for the Hondekraal section (Table 7.1) was obtained from the current management of the reserve (Coetzee 2008)[1]. From these numbers, the Graze model (Brown 1997) was used to calculate the Large Stock Unit (LSU) equivalents and the percentage of the grazing capacity of the area that these game numbers occupy.

[1] COETZEE, J. Regional Ecologist - Mpumalanga Tourism and Parks Agency (MTPA).

Results

Table 7.1
Present game numbers for the Hondekraal section of the LNR

Maximum LSU game (minus cattle)			1	
Maximum LSU cattle (minus game)			2	
Game type	**Number**	**LSU Conversion**	**LSU Equivalent**	**% of capacity**
Non-selective grazers				
Buffalo	49	1.00	49.0	14.3
Bushpig	0	4.00	0.0	0.0
Hippopotamus	0	0.55	0.0	0.0
Mountain Zebra	0	1.84	0.0	0.0
Ostrich	0	3.50	0.0	0.0
White Rhinoceros	2	0.41	4.9	1.4
Zebra	4	1.84	2.2	0.6
Total	55		56.1	16.4
Selective grazers				
Black wildebeest	0	2.69	0.0	0.0
Blesbok	0	4.97	0.0	0.0
Blue wildebeest	2	2.65	0.8	0.2
Gemsbok	0	2.30	0.0	0.0
Grey rhebok	0	7.00	0.0	0.0
Red hartebeest	0	2.61	0.0	0.0
Reedbuck	6	6.14	1.0	0.3
Roan antelope	0	2.28	0.0	0.0
Sable antelope	0	1.95	0.0	0.0
Springbok	0	9.00	0.0	0.0
Tsessebe	0	3.32	0.0	0.0
Waterbuck	104	2.17	47.9	14.0
Total	112		49.7	14.5
Mixed grazers				
Eland	1	1.23	0.81	0.2
Impala	144	6.14	23.45	6.9
Mountain Reedbuck	30	7.00	4.29	1.3
Nyala	0	3.91	0.00	0.0
Warthhog	5	5.62	0.89	0.3
Total	180		29.4	8.6
Browsers				
Black rhinoceros	0	0.64	0.00	0
Bushbuck	0	7.62	0.00	0
Duiker	18	12.00	1.50	0
Giraffe	0	0.68	0.00	0
Klipspringer	1	12.00	0.08	0
Kudu	20	2.45	8.16	2
Steenbok	0	15.00	0.00	0
Total	39		9.7	2.9
Grand total	**386**		**144.9**	**42.4**

Discussion

Veld and game management recommendations

The present game numbers for the Hondekraal section of the LNR are presented in table 7.1 and from this table it can be deduced that the study area is under stocked by 57.6% or 144.9 LSU.

The graze spectrum of game for the Hondekraal Section was adapted from Bothma (1995) and is presented in Table 7.2. Based on the graze spectrum presented in this table, the recommended game numbers are presented in Table 7.3 and include the suggested sex ratio, male and female numbers as well as minimum herd size. The four categories as described by Bothma (1995) were used namely: Non-selective grazers, Selective grazers, Mixed grazers and Browsers.

Mentis (1977) and Van Rooyen *et al.* (1995) recommend a stocking ratio of approximately 40 percent LSU bulk grazers : 40 percent LSU concentrate grazers : 20 percent browsers. However, a stocking ratio of approximately 40 percent non-selective grazers to 40 percent selective grazers to 30 percent mixed grazers and browsers was used successfully by Brown (1997). This results in the recommended stocking rate exceeding the grazing capacity of this section of the reserve by 10 percent, subsequently providing for the browsers feeding differently than the grazers (Bredenkamp & Brown 1995).

The objective of herbivore population management according to Eksteen (2003) is to maintain a variety of game species that historically occurred in an area. Grazing should be applied at optimum stocking rates and maintained to the advantage of priority game species. The game species in the Hondekraal area (study site) (especially the waterbuck, impala and kudu) were observed to be especially skittish when approached by any vehicles. This indicates that there is a strong possibility of uncontrolled and illegal hunting taking place, which is compounded by the remote location of the area. This problem should receive crucial consideration before the relocation of game to this area can be undertaken. In addition, cattle are still present, specifically in the western sections of the study area. Additional animal species should not be introduced to the area until this problem has been eliminated. Furthermore, the game fence that is currently still in place between Hondekraal and the rest of the reserve should be removed to establish the natural exchange of genetic material between game species.

The complications associated with rotating game in natural areas is well known, and even though this can be achieved to some degree by burning, licks or water point manipulation, it is often more viable to limit the number of animals to the availability of preferred habitat and increase the spectrum of species stocked (Tainton *et al.* 1999). In other words, certain species such as impala, wildebeest and warthog concentrate on nutrient-rich areas and are not readily induced to move to nearby broadleaf woodland.

Conversely, long-medium grass feeders such as sable and roan antelope display habitat preference for the less fertile broadleaf woodlands, mainly to avoid competition. A more viable option would thus be to rather stock less wildebeest, warthog and impala than to try and entice them to nutrient-poor areas and instead, stock these areas with long-medium grass grazers. Bothma (1995) however suggests that a game relocation program which is focussed on establishing viable populations of a certain species rather than small populations of many different species, is ecologically and economically a more viable option.

Table 7.2 Graze spectrum of game in the Hondekraal Section of the LNR (adapted from Bothma 1996)

Game type	Year 2007	Year 2008	Average	Graze Spectrum
Non-seclective grazers				
Buffalo	48	49	48.5	Ug; LG; As
White Rhinoceros	0	2	1	Ug; SG; As
Zebra	5	4	4.5	Ug; LG; Sg; Sp
Total	**53**	**55**	**54**	
Selective grazers				
Blue wildebeest	5	2	3.5	SG; Sg; Sp
Red hartebeest	1	0	0.5	SG; G&L; Sg
Reedbuck	11	6	8.5	Sg; LG; As
Tsessebe	0	0	0	Sg; Sp
Waterbuck	162	104	133	SG; G&L; LG; As
Total	**179**	**112**	**145.5**	
Mixed grazers				
Eland	1	1	1	G&L; L&ngf; SG; Sp
Impala	118	144	131	G&B; SG; As;
Mountain Reedbuck	34	30	32	SG; G&L; LG; As
Warthog	25	5	15	Ug; SG; As
Total	**178**	**180**	**179**	
Browsers				
Duiker	18	18	18	L&g; L&ngf; As; Sp
Klipspringer	1	1	1	L&ngf
Kudu	44	20	32	L&ngf; Sp
Giraffe	0	0	0	L&ngf; Sp
Total	**63**	**49**	**56**	
Grand total	**473**	**396**	**434.5**	

Ug	Unselective: grass
LG	Long grassveld
As	Area selective
SG	Short grassveld
Sp	Selective: plant part
G&L	Grass & Leaves
Sg	Selective: grass
L&ngf	Leaves & non-grass forbs
L&g	Leaves, sometimes grass

Table 7.3: Recommended game numbers for the Hondekraal section of the LNR

Maximum LSU game (minus cattle)			1						
Maximum LSU cattle (minus game)			0						
Game type	% of Capacity	LSU Conversion	LSU Equivalent	Number Animals	Sex Ratio	Number Male	Number Female	Minimum Herd Size	% Increase
Non-selective grazers									
Buffalo	17.0	1	0.08	0	1:3	0	0	12	25
Bushpig		4	0.00	0	2:3	0	0	5	25
Hippopotamus		1	0.00	0	2:3	0	0	5	10
Mountain Zebra		2	0.00	0	3:7	0	0	10	20
Ostrich	0.0	4	0.03	0	1:1	0	0	6	50
White Rhinoceros	6.0	0	0.07	0	1:2	0	0	6	10
Zebra	17.0	2	0.22	0	3:7	0	0	10	20
Total	40.0		0.39	1					
Selective grazers									
Black Wildebeest		3	0.00	0	3:5	0	0	8	20
Blesbok	0.0	5	0.00	0	3:7	0	0	10	40
Blue Wildebeest	9.0	3	0.12	0	1:4	0	0	15	20
Gemsbok		2	0.00	0	1:4	0	0	5	40
Grey Rhebok		7	0.00	0	1:3	0	0	4	20
Red hartebeest	6.0	3	0.08	0	3:5	0	0	8	20
Reedbuck	0.5	6	0.01	0	3:7	0	0	10	20
Roan antelope	0.1	2	0.00	0	3:5	0	0	8	20
Sable antelope	1.7	2	0.02	0	3:5	0	0	8	20
Springbok		9	0.00	0	1:4	0	0	25	40
Tsessebe	2.0	3	0.03	0	3:5	0	0	8	20
Waterbuck	20.7	2	0.27	1	3:5	0	0	8	20
Total	40.0		0.52	1					
Mixed grazers									
Eland	8.0	1	0.10	0	1:3	0	0	12	25
Impala	9.0	6	0.12	1	1:4	0	1	25	35
Mountai Reedbuck	1.0	7	0.01	0	1:3	0	0	8	20
Nyala	0.0	4	0.00	0	3:7	0	0	10	20
Warthog	2.0	6	0.03	0	2:3	0	0	10	15
Total	20.0		0.26	1					
Browsers									
Black Rhinoceros		1	0.00	0	2:3	0	0	5	6
Bushbuck		8	0.00	0	1:3	0	0	8	20
Duiker	0.5	12	0.01	0	1:1	0	0	4	20
Giraffe	7.0	1	0.09	0	3:5	0	0	8	15
Klipspringer	1.0	12	0.01	0	1:1	0	0	4	20
Kudu	6.0	2	0.08	0	1:3	0	0	12	20
Steenbok	0.5	15	0.01	0	1:1	0	0	6	20
Total	15.0		0.20	1					
Grand total	**105.0**		**1.38**	**4**					

According to Bothma (1995), the most important habitat requirements of buffalo are an adequate supply of high quality grasses as well as sufficient shade and water. They usually drink twice per day and will utilise the high quality grasses in the vicinity of the water points such as *Themeda triandra, Panicum maximum* and *Heteropogon contortus*. As discussed in Chapter 6, the grassland communities surrounding the drainage channels are mostly dominated by *Hyperthelia dissoluta,* especially in the western sections of the study area. According to Van Oudtshoorn (2004) the only viable way of controlling this grass is through light grazing with for example cattle, however, buffalo or zebra would be preferable in this area. By means of moving through the grasslands, these animals manage to 'open the veld up' whilst simultaneously stimulating the growth of more palatable grasses. Stocking rates should be kept in line with the grazing capacity of the veld so that the vigour of the preferred grasses can be maintained. The diet of buffalo also includes small amounts of woody species such as *Grewia* spp., *Dichrostachys* spp., and *Combretum* spp. They prefer to take refuge in the reed beds of rivers and vlei's, enjoying mud baths at the warmest time of the day. During the dry season, these animals often accumulate in water rich areas where grass supply is adequate. However, during the rainy season, smaller herds are formed that are spread out more uniformly over their habitat. The results of this study indicate that the habitat of the study area is well suited to buffalo, with adequate water, shade and grass. It is therefore recommended that their numbers be increased to 58 individuals (Table 7.3).

White Rhino's have a preference for areas with good grass cover and a low (>2m) shrub layer that is not too dense, but with adequate shade. They are selective grazers preferring palatable broad-leaved grasses such as P*anicum maximum, Panicum coloratum, Digitaria eriantha, Urochloa mosambicensis, Sporobolus nitens* as well as *Themeda triandra* (Pienaar 1994, Pienaar & Du Toit 1995). They also prefer low growing grasses (<400mm) and can graze grasses down to 30mm above ground level (Bothma 1995). Although they are water dependent, they can survive without water for up to four days. They enjoy mud baths and are territorial with territoriums that can range from one to 13km², depending on the size of the reserve, the suitability of the habitat and the population density (Bothma 1995). Most of these habitat requirements are found in the study area and it is therefore recommended that their numbers be increased to eight. Relocation of these animals should be done in the shortest possible time, preferably after the first spring rains have fallen so that adequate food and water is present.

To obtain a more balanced ratio between selective- and non-selective grazers in the study area, it is also recommended that more zebra be introduced by increasing their numbers to 107 animals. Zebra (non-selective grazer) together with blue wildebeest (selective-grazer) are normally predisposed towards migration due to the fact that they feed on a narrow range of vegetation according to Talbot & Talbot (1963). However, since this option is not available in nature reserves due to fencing, they are likely to utilise one or more specific areas throughout the year. It would therefore be necessary to monitor the numbers and impact of especially blue wildebeest to prevent area-specific over-utilisation. Zebra and blue wildebeest often graze together where zebra, through their utilisation of mostly long grasses in effect ‘open up’ these areas for utilisation by blue wildebeest which are predisposed to short grassveld areas (Bothma 1995). It is thefore recommended that the numbers of these species should be increased to 107 and 163 for zebra and blue wildebeest respectively.

According to Eksteen (2003), only species that have a historical distribution within the Loskopdam area will be considered for re-introduction, and only if sufficient habitat is available. Tsessebe and eland have been considered for re-introduction by the management of the LNR. According to Carr (1986), tsessebe is regarded as one of the three most threatened savanna antelope species in southern Africa, their numbers showing a steady decline in areas outside nature reserves. They were initially assigned a conservation status of “endangered”, but since their numbers have increased inside nature reserves, they have been reclassified as “rare” (Carr 1986). These animals prefer open grassland and tall tree savanna ecosystems according to Skinner & Smithers (1990) and Carr (1986). They are dependent on water during the dry season, spend most of their time close to these areas. During the wet season, they will move into neighbouring open woodland areas where they utilise the palatable grasses. Bush encroachment has been identified as one of the factors accounting for reductions in range and numbers (Skinner & Smithers 1990) and should therefore be controlled. Taking cognisance of their conservation status in addition to the suitability of the study area to their habitat requirements, it is recommended that 23 animals be introduced to this area at a ratio of 3 : 5 (Table 7.3).

Red hartebeest are associated predominantly with open grasslands as well as floodplains and extensive areas of vlei's as they are water dependent (Skinner & Smithers 1990). They tend to avoid more closed types of woodlands. Preferred grasses include *Themeda triandra*, *Sporobolus* spp. and *Eragrostis* spp. according to Skinner & Smithers (1990) and Kilian (1993). Based on the suitability of the area and the need to increase ungulate species diversity, it is recommended that 27 red hartebeest be introduced to this area (Table 7.3). Due to the fact that red hartebeest will utilise the same area as blue wildebeest during certain periods of the year (Kilian 1993), their numbers and impact should be controlled and monitored.

Reedbucks are classified as selective grazers (Bothma 1995) and have very specific habitat requirements. According to Skinner & Smithers (1990), they only occur in tall grassland areas with permanent water, such as is found in plant communities 1 and 2 (Chapter 4). They prefer grasses such as *Hyperthelia dissoluta*, *Trachypogon spicatus, Panicum maximum* and *Heteropogon contortus* (Skinner & Smithers 1990). These conditions are perfectly matched within the study area and considering their low present numbers (Table 7.1), it is recommended that their numbers be increased to 63 animals (Table 7.3).

Waterbuck are mainly associated with reedbeds and riverine areas, but also woodland and grasslands (Apps 1996.) Classified as selective grazers (Table 7.2), they prefer grasses such as *Panicum maximum, Cynodon dactylon, Phragmites australis, Heteropogon contortus, Digitaria* spp., and *Themeda triandra*. As indicated by their present numbers (Table 7.1), these animals are thriving in the study area where they are present at 14% of the capacity (Table 7.3). Therefore, no additional increases are recommended at this time.

As mentioned earlier, eland have also been considered for re-introduction by the management of the LNR. Classified as Africa's largest antelope (Skinner & Smithers 1990), their habitat requirements are versatile and include open savanna, woodland, semi-arid and mountain grasslands. They are classified by Bothma (1995) as mixed grazers even though they are predominantly browsers according to Skinner & Smithers (1990). Preferred woody species include *Combretum apiculatum, Grewia* spp., *Strychnos* spp., *Diplorhynchus condylocarpon, Terminalia* and *Euclea* spp. Grasses utilised by eland include *Urochloa mosambicensis, Schmidtia pappophoroides* and *Chloris virgata* whilst forbs eaten by eland include *Tagetes minuta* and *Bidens pilosa*. With the suitability of the Hondekraal area and the versatility of this species, it is recommended that 21 animals be introduced to this area (Table 7.3).

Impala are also classified as mixed grazers even though they are mostly grazers preferring grasses such as *Digitaria eriantha, Urochloa mosambicensis, Cynodon dactylon, Panicum maximum*, *Themeda triandra* and *Eragrostis* spp. (Skinner & Smithers 1990). Impala change their diet from grass in the wet season to browse in the dry season preferring species such as *Acacia tortilis*, *Combretum* spp., *Grewia* spp., *Ziziphus mucronata*, *Dichrostachys cinerea*, *Maytenus* spp. and *Terminalia* spp. (Skinner & Smithers 1990). No further increases are recommended at this time.

Mountain reedbucks are present in the area, preferring low-lying rocky hillsides and terraces and avoiding summits according to Skinner & Smithers (1990). Even though they are classified as mixed grazers, they are almost exclusively grazers (Skinner & Smithers 1990). Their preference for grass species vary seasonally. In a study done by Irby (1976) in the Loskopdam Nature Reserve, grasses such as *Themeda triandra, Hyparrhenia* spp., *Aristida* spp., *Cynodon* spp. and *Eragrostis* spp. was identified as being utilised by these animals. It is recommended that their numbers be increased to 48 individuals due to the suitability of the area (Table 7.3).

There are currently no giraffes within the study area even though they do occur in the remainder of the reserve. Being the tallest animal in the world (Skinner & Smithers 1990), they are browsers with a feeding height of up to five meters, thereby eliminating any competition with other browsers (Skinner & Smithers 1990). They occur in a wide variety of dry savanna communities, provided that these include the particular range of food plants (Skinner & Smithers 1990). Preferred woody species include *Acacia* spp., *Combretum* spp., *Terminalia* spp. and *Ziziphus* spp. These species are mostly found in the eastern half of the study area in communities 5 and

7. It is recommended that 23 individuals be introduced to the study area at a ratio of 3:5 (Table 7.3).

Kudu are present in the study area and it is recommended that their numbers be increased to 42 (Table 7.3). Being a savanna woodland species, they are found in areas that afford them protection and food. These areas include riparian woodland and thickets along drainage lines (Skinner & Smithers 1990), as well as hill base ecotone habitats (Skinner & Smithers 1990). In a study done by Du Toit (1995b), it was found that bulls have a high preference for riverine habitat whilst the cows were relatively widely distributed across savanna habitats. They are found in areas where dense stands of *Acacia* spp., *Terminalia* spp., or *Combretum* spp. occur such as is found in communities 5, 7 and 6.2. Preferred woody species include *Acacia tortilis*, *Combretum apiculatum* and *Dichrostachys cinerea* (Skinner & Smithers 1990). The study area provides a suitable habitat for this species and it is recommended that their numbers should be increased to 42 animals (Table 7.3).

Other smaller antelope such as duiker, klipspringer and steenbok generally have very little influence on the veld condition (Orban 1995). It is however preferable to have their numbers increase as indicated in Table 7.3. Duiker are found in areas with enough bush cover and feed, whilst klipspringer are found in open mountainous areas. They are highly selective feeders of perennial shrub species according to Norton (1984) and are almost entirely restricted to rocky terrain (Apps 1996). In contrast, steenbok prefer more open savanna areas, whilst duiker would probably be found over the whole reserve.

Vegetation monitoring

The aim of a monitoring program is to detect changes in species composition of the grass layer over time. These changes could be the result of climatic influences and/or management. At present, there are ± 50 fixed 200-point monitoring plots spread over the larger Loskopdam Nature Reserve according to Eksteen (2003) and they are monitored on a 3-year cycle at the end of the growing season. It is recommended that fixed monitoring plots be placed out in all the communities of the Hondekraal section to represent each of the identified communities within this area.

Grass surveys for condition assessments should include an estimate of the standing crop of grass by using the disk pasture meter Mentis (1981).

The monitoring of the shrub and tree layer is also aimed at identifying changes in composition as well as woody plant structure over time.. A total of ± 41 Variable Quadrant monitoring plots are spread over the larger reserve and are monitored for grass and woody species composition on a 5-8 year cycle at the end of the growing season. Data from these surveys provide a basis for adjusting the stocking rate of grazers and browsers (Eksteen 2003).

It is recommended that similar variable quadrant monitoring plots be placed out in plant communities 1.3, 3, 4, 5, 6.1, 6.2. 7 and 8 and monitored on the same basis as outlined by Eksteen (2003). In addition, fixed photo-points can be used at key sample sites to monitor trends in the condition of bush. This can be done annually.

Bush encroachment/densification

The woody species densities for communities 2 and 3 indicate bush encroachment into these areas while bush densification is taking place in plant communities 4, 5, 6 and 8 (Chapter 4). Bush control is therefore recommended for these areas.

It is however important to note that not all bush clearing have the desired effect in terms of veld condition. The clearing of woody plants in mixed savannas dominated by *Combretum apiculatum* resulted in only a small improvement in grazing capacity. Differences in soil type and soil fertility are indicated by Dye & Spear (1982) as the reason for differences in the response to clearing of woody species. Trees may also have positive effects on grass growth, the net result of the positive and negative interactions being dependent on the tree density (Stuart-Hill *et al.* 1987). Sub-habitats that are created beneath established trees and which differ from the open habitat exert different influences on the herbaceous layer. Stuart-Hill *et a*l. (1987) recorded high yields beneath and immediately to the south of the tree canopy in the Eastern Cape, with lower yields immediately to the north, attributing the former to the favourable influence of the tree on the micro-environment due to for example leaf litter and shading. Smit & Swart (1994) also recorded higher DM yields under the canopies of leguminous trees than either under non-leguminous trees or between the tree canopies in the mixed Bushveld. In contrast, Grossman *et al.* (1980) measured the biomass in the open veld to be significantly greater than under *Burkea africana* and *Ochna pulcra* trees, although the canopied habitats did yield better quality forage, and specifically higher protein content of forage growing under *Burkea africana* trees.

Thus, the relatively high nutrient status of the soil beneath tree canopies lead to a relatively higher nutrient content of the grass growing under the canopy, compared to the grass growing between the canopies. Information in this regard is further well documented in the description of the association between *Panicum maximum* and the under-canopy sub-habitat of the larger trees (Bosch & Van Wyk 1970; Smit & Rethman 1992; Smit & Swart 1994). In addition, the roots of savanna woody plants extend well beyond their projected crown radii (Wu *et al.* 1985) with some species in *Burkea* savanna reported to have lateral roots extending linearly up to seven times the extent of the canopy (Rutherford 1980a). A large proportion of the roots are also concentrated at a shallow depth (Rutherford 1983) where they actively compete with the shallow rooted herbaceous plants. Thus, the larger the tree, the larger the area of resource depletion and the greater its competitive effect on its neighbours. Tree thinning will result in an immediate change in the competition regime (Smit *et al*. 1999), but will also invariably reduce the amount of available browse at peak biomass. However, the remaining browse may be better distributed with the leaves younger and remaining attached longer into the winter (Smit *et al*. 1999).

It can thus be concluded that high density stands may not only be poorly suited to grazers, but also to browsers. Large trees provide favourable habitats for the growth of the highly favoured *Panicum maximum*. It is therefore recommended that the small trees (0-1 m) and where applicable the middle height class (>1-3 m) should be thinned in communities 4 – 8 where total tree density is more than 1 800 ind/ha (Brown 1997). It is also recommended that all lower class woody species in communities 2 and 3 are removed since these grassland areas are becoming encroached by the woody species. In summary, the control of the woody plants should aim at a compromise between reducing the competitive effect of the trees on the grass whilst still retaining the positive effects which trees can have on the system

(Smit *et al*. 1999). The aim should be an open savanna comprised mainly of large trees, but with at least some small trees.

Fire management and controlled burning

It is well known that fire is a crucial parameter in the management and maintenance of natural areas and according to Tainton *et al.* (1999), fire is regarded as a natural environmental factor in Southern Africa. It follows that fire plays an important role in plant communities as well (Kruger & Bigalke 1984; Tainton & Mentis 1984; Trollope 1984b). Lightning induced fires are a natural phenomenon in Africa and are the major driving force in maintaining the open conditions of grasslands and savanna, whilst the absence thereof would result in the replacement of these areas by scrub or forest. The primary aims of fire within conservation areas are:

- To maintain the ecosystems in their natural state,
- To conserve genetic resources and diversity,
- To counter bush encroachment,
- To create suitable habitats for grazing animals and
- For the promotion of tourist game viewing (Tainton 1981).

According to Eksteen (2003), fire also forms an integral part of the ecological system within the LNR and therefore has to be included in the management of vegetation. The primary aim of fire in the LNR according to Eksteen (2003) is:

- The protection of property through adequate firebreaks
- The creation of a habitat mosaic
- The prevention of moribund conditions and thus dangerous wild-fires
- The control of woody plants

According to the Veld and Forest Fire Act (Act 101 of 1998), it is compulsory for area owners/managers to establish firebreaks at least along the boundaries of the property. Internal firebreaks are necessary to implement management burns and prevent run-away fires.

Slope significantly influences the forward spread rate of surface fires by modifying the extent to which the material ahead of the fire is pre-heated (Tainton & Mentis 1984). It follows that a fire burning up-slope will have the characteristics of a head-fire since the material directly ahead of the fire front, will be pre-heated. Trollope (1978a) measured that head-fires travel at seven and a half times the speed of back-fires. Conversely, since the heat generated by the fire is carried away from the un-burnt down-slope material, a fire burning down-slope will have the characteristics of a backfire. At ground level, back-fires are hotter than head-fires, whilst temperatures in both types of fires are higher at grass canopy level than at ground level. These factors should be taken into consideration in the Hondekraal area especially, since the northern and southern boundary of this area comprises of high and steep slope mountains.

Annual burning in sourveld areas has always been considered too frequent (Tainton & Mentis 1984) as this results and a reduced yield in the summer immediately following the burn. As the primary aims of burning in the LNR are to remove low-quality material and prevent dangerous wild fires (Eksteen 2003), burning should be timed so that the veld is able to recover a leaf canopy in the shortest possible time (Tainton & Mentis 1984). Trollope (1984c) recommends that veld burning be allowed only during the four week period preceding the expected commencement of the growing season and for a two-week period succeeding the actual commencement of the growing season. In this way, controlled burns can be safely carried out on a dormant grass sward.

According to Tainton & Mentis (1984), the bush component of savanna vegetation vary in its sensitivity to different types of fires due to the differences in vertical distribution of heat that is associated with different types of fires. Head-fires cause a greater top kill of stems and branches than back-fires because more of the heat is carried upwards into the canopies, as measured by Trollope & Tainton (1986) in the Eastern Cape where a surface head-fire reduced the phytomass of bush by 75% compared to only 42% by a back-fire. However, bush is extremely resistant to fire alone and the resultant coppice from the collar region changes the vertical structure of the community. Top kill is increased by a high intensity fire (Trollope & Tainton 1986). Even though frequent fires improve the nutritional value of forage produced in savanna areas, the major influence of fire on the bush component is the extent to which coppicing individuals are able to recover and the amount of grass fuel that can accumulate in the inter-fire period. Therefore, with repeated moderately intense fires, savanna communities can be kept relatively open since the fires will prevent coppice growth from gaining stature (Tainton *et al.* 1999). According to Brown (1997), densities exceeding 2 500 ind/ha indicate conditions of bush densification and should be burnt. In plant community 8, the woody density is estimated at 3 050 ind/ha and should therefore be burnt to reduce bush densification. In addition, plant communities 4 and 6.1 should be monitored with densities estimated at 2 225 in/ha and 2 030 ind/ha respectively (Chapter 4).

Management burns in the reserve are carried out on a 3-4 year cycle. In 1999, a patch-mosaic burning programme was introduced to be used in the sourveld portions of the reserve during the second half of summer. This allows for veld to burn randomly throughout the year according to Eksteen (2003). It is recommended that, based on annual grass surveys, every community be burnt on a e-year cycle in accordance with the current regimes outlined in the management plan.

During the study period, out of season burning by the local farmer was observed in the Hondekraal section and is probably a regular occurrence. This practice eventually results in the replacement of palatable Decreaser species by inferior Increaser I species such as *Hyperthelia dissoluta*. Continuous grazing following these burns further encourages the growth of Increaser II species such as *Eragrostis plana* at the expense of Decreasers such as *Themeda triandra*. In addition, the ability of fire climax communities to resist invasion by pioneer species will be reduced and deterioration in species composition is certain to follow (Tainton *et al*. 1999).

Only head-fires should be used in the study area for controlled burning because they cause less damage to the grass layer than do back-fires and because such fires can cause maximum damage to the woody vegetation. Because the least damage is done to the grass sward when it is burnt during dormancy, burns to remove moribund vegetation should be applied immediately after the first spring rains whilst the fire hazard is low. When burning to remove accumulated moribund and unacceptable grass material, cool low intensity fires of less than 1 000 kJ/s/m are recommended by Tainton *et al.* (1999). This can be achieved by burning when the air temperature is below 20°C and when the relative humidity is above 50% to hold the intensity low. These conditions will be prevalent before 11h00 and after 15h30. To control undesirable woody species, high intensity fires in excess of 2 000 kJ/s/m are required and can be achieved when the grass fuel load is in excess of 4 000 kg/ha, air temperature is between 25 °C and 30°C and the relative humidity is less than 30%. These burns should be applied before the first spring rains while the grass is dry and dormant so as to produce an intense fire that will cause significant top kill of trees and shrubs up to 3m tall. In all cases, wind speed should not exceed 20 km/h (Tainton & Mentis 1984).

Treatments should be applied on a rotational basis to attract game to these areas and thus providing rest periods to the vacated areas. The most effective way to do this is to burn the veld as well as place out licks in the sections that need to be utilised. It is essential that the size of the area which will be burnt, exceed the short term forage requirements of the game so that no over-utilisation occurs.

Figure 7.1 Moribund conditions in the drainage channels

Moribund conditions have been observed in some of the drainage channels (sub-community 1.1 and 1.2) and it is therefore recommended that these areas be burnt (Figure 7.1). Burning is necessary for *Phragmites australis* to remove moribund material and to yield a larger proportion of tall and thick reeds (Van Rooyen *et al*. 1995). Finally, all the areas that are burnt should be recorded on a map every year with the date and reason why it was burnt.

Erosion control

Localised erosion have been observed in sections of plant communities 3 and 5 and these areas need to be rehabilitated (Figure 7.2).!

Figure 7.2 Erosion in plant community 3.

Previous rehabilitation work has been done by the Working for Wetlands program as part of the Hondekraal wetland rehabilitation project. These areas should be monitored annually with fixed point photography whilst the recovery should be monitored every second year (Bothma 1995). Precautions should be taken to ensure that the vlei areas are not trampled.

Roads

Figure 7.3 Poorly planned and constructed roads lead to erosion

Ill-constructed and poorly planned roads lead to or enhance erosion as can clearly be seen in Figure 7.3. Some of the roads in Hondekraal are only accessible with a 4x4 vehicle. Due to the high erodibility of the soils in the region, no grading of management roads is allowed according to Eksteen (2003). However, rock beds should be constructed at key areas such as the link area between Hondekraal and the main reserve as well as low lying areas close to the drainage channels. Careful planning and maintenance of roads should be done regularly. Road Planning should involve an Environmental Impact Assessment. In areas that have fewer visitors, gravel roads are recommended.

Due to the fact that most of the roads in Hondekraal are less than 8m wide, the ability to function as fire-breaks or tourist roads are not feasible. The majority of the roads in Hondekraal are two-track roads that are more suitable as hunting roads. To function as tourist roads, roads should be widened to 8m. Regular long stretches should be avoided whilst an attempt should be made to establish winding roads that link the different water points.

Tourism

Figure 7.4 A possible location for a lookout point

The scenic beauty of this area and the excellent visibility with regards to game viewing makes it an ideal destination for tourists. The remoteness of the area further ad to its appeal and the possibility of horse trails should also be considered. Furthermore, the possibility of marketing this area to 4x4 enthusiasts is also a possibility. Various lookouts points (Figure 7.4) are available where basic facilities for tourists could be erected (for example cement chairs and tables, shade and so forth).

A bird hide could be constructed close to this natural drainage channel (Figure 7.5).

Figure 7.5 Possible location for a bird hide

The location of this old camping site near Kanongat (Figure 7.6) is an ideal camping area. It is surrounded by mountains and is scenically beautiful. Very basic facilities for example French drains and a bush-kitchen (Figure 7.7) could ‘put this on the map’ as a unique and remote retreat for busy city dwellers who want to experience camping as it is supposed to be done. Obviously, stricter control measures should be introduced at the access gate to Hondekraal. A camping fee should be considered as well as strict guidelines to campers requiring them to ‘leave nothing behind’. In other words, similar regulations that apply to hikers, should apply to campers in Hondekraal in that they need to remove all their own rubble – ‘what you bring in, you take out’. This location is also ideal for school groups and adventure seekers.

The annual monitoring of the herbaceous layer could be marketed to the Nature Conservation Departments of Tertiary Institutions, enabling their students to gain relevant experience in the practical execution of this procedure. The same applies for erosion and its control.

Figure 7.6 Old camping site near Kanongat

Figure 7.7 An example of basic facilities at Bivane Dam Bushcamp

Community involvement

Balancing resource conservation and utilisation is crucial in the formulation of resource management strategies. According to Sola (2005), sustainable resource use should be based on socially responsible economic development whilst promoting the resource base as well as the status of the ecosystem. Ultimately the objective of a resource management plan should be sustainable utilisation of natural resources. It is well known that the status of the resource is inseparably linked to the way in which it is used, because of the dynamic equilibrium that exists between utilisation and renewal (IUCN 1996). This implies that the formulation of management plans should attempt to establish, monitor and manage this equilibrium with an adaptive management strategy as the basis.

In Zimbabwe, thatch grass was identified as one of the key livelihood resources and most important livelihood activities for the Tombo community of Nyanga (Sola 2005). This community has been harvesting thatching grass for subsistence as well as commercial purposes for centuries. The most preferred species according to Sola (2005) which is also pertinent to the Hondekraal area, are *Hyparrhenia hirta* and *Hyperthelia dissoluta*. Transect cutting with a sickle is mainly used in harvesting the grass whilst processing involves pruning to remove all the dead leaves, shaking to remove excess dirt as well as combing with a brush. It is essential that the grass be hardened by the cold, therefore, grass is mainly harvested between June and October in Zimbabwe by which time the seeds have matured and been dispersed as well (Sola 2005). It is preferable not to have any grazing before cutting to ensure the availability of tall, unbroken grass.

Hyperthelia dissoluta is the dominant grass species in plant communities 2 and 4 where the cover ranges from 50% - 100% in places, whilst *Hyparrhenia hirta* is more prominent in the drainage channel sub-community 1.3 (Chapter 4) with a frequency of 23% recorded. The percentage frequency for *Hyperthelia dissoluta* ranged from 35% to 50% (Chapter 6). Collectively, plant communities 2 and 4 constitute 31% of the Hondekraal area. The early utilisation and competitive edge of this grass under conditions of under-utilisation have been discussed (Chapter 6). In addition to the recommendations made by Van Oudtshoorn (2004) of light grazing to open up these grasslands for palatable grass colonisation, harvesting of this grass in a patch mosaic pattern could assist in the endeavour to re-establish palatable species in these plant communities and simultaneously rectify the moribund conditions that have been observed in parts of these communities.

Phragmites australis is used extensively for hut building, fencing, thatching and craftwork in Maputaland (Van Rooyen *et al.* 2004). Van Wyk & Gericke (2000) concurs that the thick hollow stems are used extensively for building walls, fences and bomas. Stems are woven into traditional sitting mats and baskets and also for tobacco pipe stems, flutes and parts of musical instruments. Over-harvesting have lead to the degradation of most reed beds in communal areas and at present, most productive reed beds are found in conservation areas. To prevent degradation of reed beds in conservation areas, sustainable levels of utilisation for this resource should be established. Sustainable harvesting in ecological terms is defined according to Hall & Bawa (1993) as harvesting that has no long-term detrimental effect on the reproduction and regeneration of the population being harvested, compared with similar non-harvested populations. Natural degeneration of *Phragmites australis* is often associated with the accumulation of its own organic matter (Van der Putten *et al*. 1997; Clevering 1999; Lenssen *et al*. 2000.)

The results of the study done by Van Rooyen *et al*. (2004) indicate that harvested areas contained thinner and shorter reeds than un-harvested areas. However, fire could be used to increase reed diameter in harvested areas even though it does not significantly affect reed height and also reduces the mean reed density. The density of preferred reeds is approximately 15 reeds/m^2. It is preferable that reeds should only be harvested after the active growth period when most of the nutrients have been translocated. Summer harvesting, if done year after year, will deplete rhizome reserves and is probably a major factor in the decline in reed quality according to Van Rooyen *et al*. (2004). Reed quality could be improved with the implementation of a three-year rotational harvesting programme so that the reeds are able to recover sufficiently before being harvested again (Van Rooyen *et al*. 2004).

Should the area not be utilised through harvesting, it is recommended that fire be used to remove moribund material and to yield a larger proportion of tall and thick reeds. The study by van Rooyen et al. (1995) suggests that these reeds will be shorter (although not statistically significant), however, this has been discussed under Fire Management and Controlled Burning.

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CHAPTER 8

CONCLUSIONS

The objectives that were set for this study in Chapter 1 were satisfactorily attained. The successful identification, description, classification and interpretation of the plant communities of the Hondekraal section of the Loskopdam Nature Reserve resulted in the compilation of a detailed vegetation map for the area. No vegetation descriptions have previously been completed on the vegetation of the study area and this research therefore provides valuable data on the present ecosystems. This data should be incorporated into the current management plan of the LNR. The classification of the vegetation and the subsequent vegetation map should also serve as a valuable tool in the planning of future developments, conservation and management of the natural vegetation in this section of the reserve. The impact of management recommendations should be regularly monitored to determine if the aims that were set, were achieved.

The preservation of diversity and the persistence of species should be one of the primary goals of nature conservation (Walker 1989) and for this reason, it is important that nature reserves be upgraded and well managed. Ecosystems react differently to different management practices (Bredenkamp & Theron 1976). It follows that a description and classification of the vegetation of an area is essential in establishing what it is that needs to be conserved and what the present status is.

The Braun-Blanquet approach proved to be an accurate and cost effective way whereby floristically defined plant communities could be classified and identified in the field. The Braun-Blanquet method has been successfully used within the various biomes of South Africa since 1969 (Du Preez 1991). The method has been widely accepted due to the fact that it meets the three most important requirements for a vegetation ecology study namely 1) it fulfils the necessity of classification at an appropriate level, 2) it is scientifically sound and 3) it is the most versatile and efficient approach amongst comparable approaches (Werger 1974).

There are clear distinctions between the eight main communities identified. It is therefore recommended that each community be managed as a separate ecological unit. This implies the assessment of the grazing potential of each of the management communities to evaluate the possible stocking rate of this area. In addition, an assessment of the vegetation in terms of its variability and reaction to various practices such as burning, grazing & browsing should be done annually. A close association between the major plant communities and the different land types has been observed in this study.

Due to the broken topography of the larger reserve as well as the predominance of shallow, infertile soils over most of the reserve, the stocking rate is relatively low when compared to other game areas in the province and is maintained at 11-12 ha/AU (Eksteen 2003). From the data collected in this study the Hondekraal section with more open grassland areas has a higher grazing capacity of 9.8 ha/LSU for game in normal rainfall years (Table 6.1 - chapter 6).

Due to previous management practices large sections of the reserve are degraded and bush encroachment/densification is present in most communities. Various management recommendations are made that should contribute towards the conservation of the area.

Theron (1973) states that *Combretum apiculatum*-veld occupies the largest part of the Loskopdam Nature Reserve and that it is typical of the of the Mixed bushveld veldtype (Rutherford & Westfall 1986). Although similar vegetation is present on the north facing mountain slopes (community 8 - *Combretum apiculatum–Panicum ecklonii* open woodland) the vegetation of the study area comprises largely of different plant communities. Large parts of the study area consist of open grasslands which are not as prevalent in the rest of the reserve. Grassland areas have significant value as outlined by Emery *et al.* (2002), their preservation and conservation adding to the ecosystem diversity of the reserve, the province and the country. It can therefore be concluded that the vegetation of the Hondekraal section adds to the floristic and ecosystem diversity of the current reserve.

Although a land claim is lodged against the study area this study proves that it is important that the Hondekraal section is conserved or at least co-managed as a conservancy by Mpumalanga Parks and Tourism Agency to ensure sustainable utilisation of the area. Not only does this area contributes towards ecosystem diversity, but also provides opportunities for tourism, community involvement and further research.

The following recommendations based on the results of this study can be made:

- It is recommended that the vegetation of the steep slopes and escarpment of community 7 is further researched to determine the presence of micro habitats.

- Experimental trials should be conducted on the reaction of *Hyperthelia dissoluta* to specific stocking rates and specific grazers.

- Further trials on the restoration of these grasslands should be conducted.

- Wetland delineation and functioning studies are proposed.

- Community involvement and integrated management of these areas should be considered as a practical option should the land claim not be awarded to the LNR Management.

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ANNEXURES

The names in bold refer to the soil form whilst the names in italics refer to the name of the soil series according to the 1977 soil classification system (Land Type Survey Staff 1988).

Annexure A

Table A1 Land Type Information: Generalized Description of Soils [Bc1] (Land Type Survey 1988).

ARC • LNR

ARC - Institute for Soil, Climate and Water

Land Type Survey Staff: 1973 – 2004

Land Type Information: Generalized Description of Soils

Mpumalanga

Natural Resource Area: Bc1
District Municipality: Nkangala
Local Municipality: Greater Groblersdal Municipality Groblersdal

Map Number and Map Name:
Land Types: Bc1
Land Type Climate Zones 589S **Total Area (Ha):** 18250

Description of Broad Soil Pattern:
Plinthic soils (with subsurface accumulation of iron and manganese oxides over fluctuating water table) with high base status. Red soils are widespread. Upland duplex and black clay soils are rare.

Summary Description of Climate (Koppen Climate Classification):
Cool (warmest month <22°C) humid subtropical with summer rainfall

Summary Description of Vegetation: Mixed Bushveld

Dominant Geological Groups/Formations: Mainly shale, sandstone and conglomerate of the Loskop Formation; some ferrogabbro and ferrodiorite of the Upper zone, and gabbro and norite of the Main zone of the Rustenburg Layered Suite, Bushveld Complex; rhyolite of the Damwal Formation of the Rooiberg Group; diabase.

Soil Rock Complex

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Rock	**Rock**				12.0
Ms10Hu34 Hu36	**Mispah** *Mispah* **Hutton** *Zwartfontein* *Shorrocks*	Moderately shallow	Grey to dark brown topsoil over hard rock	Topsoil lacks free lime; High base status (lacking free lime), loamy Medium sand to sandy loam subsoil; High base status (lacking free lime), sandy loam to sandy clay loam subsoil	5.0

Soil Description (In order of dominance)

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Hu36Hu26	**Hutton** *Shorrocks* *Msinga*	Deep	Red-brown to brown topsoil overlying freely drained, red apedal to weakly structured soil material	High base status (lacking free lime), sandy loam to sandy clay loam subsoil; Medium base status, sandy loam to sandy clay loam subsoil	20.5
Ms10Ms11 Gs17	**Mispah** *Mispah* *Klipfontein* **Glenrosa** *Trevanian*	Moderately shallow	Grey to dark brown topsoil over hard rock	Topsoil lacks free lime; Topsoil lacks free lime; Medium sandy loam to sandy clay loam topsoil	10.8
Av36Av34 Av24	**Avalon** *Soetmelk* *Heidelberg* *Leksand*	Moderately deep	Dark brown to grey brown topsoil over well drained, yellow-brown apedal to weakly structured subsoil over imperfectly drained grey material with red, yellow and black iron and	High base status (lacking free lime), sandy loam to sandy clay loam subsoil; High base status (lacking free lime), loamy medium sand to sandy loam subsoil; Medium base, status loamy	9.8
Hu34Hu24	**Hutton** *Zwartfontein* *Clansthal*	Deep	Red-brown to brown topsoil overlying freely drained, red apedal to weakly structured soil material	High base status (lacking free lime), loamy Medium sand to sandy loam subsoil; Medium base status, loamy medium sand to sandy loam subsoil	7.5
Bv36Bv26	**Bainsvlei** *Bainsvlei* *Lonetree*	Moderately deep	Red-brown to brown topsoil over well drained, red apedal to weakly structured subsoil over imperfectly drained red and grey material with iron oxide mottling. The mottled subsoil layer commonly has a higher clay	High base status (lacking free lime), sandy loam to sandy clay loam subsoil; Medium base, status sandy loam to sandy clay loam subsoil	6.5

1

Table A2 Land Type Information: Generalized Description of Soils [Fa7] (Land Type Survey 1988).

ARC • LNR

ARC - Institute for Soil, Climate and Water

Land Type Survey Staff: 1973 – 2004

Land Type Information: Generalized Description of Soils

Mpumalanga

Natural Resource Area: Fa7
District Municipality: Nkangala
Local Municipality: Thembisile KwaMhlanga

Map Number and Map Name:
Land Types: Fa7
Land Type Climate Zones 47S **Total Area (Ha):** 37390

Description of Broad Soil Pattern:
Commonly shallow soils on hard rock, fractured rock or weathering rock materials. Other soils may occur. Lime is rare or absent in the landscape.

Summary Description of Climate (Koppen Climate Classification):
Cool (warmest month <22°C) humid subtropical with summer rainfall

Summary Description of Vegetation: Mixed Bushveld

Dominant Geological Groups/Formations: Rhyolite of the Selonsrivier Formation, Rooiberg Group; some Rashoop granophyre and Ecca sandstone.

Soil Rock Complex

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Rock	**Rock**				19.3
Ms10Gs16 Ms11	**Mispah** *Mispah* **Glenrosa** *Williamson* **Mispah** *Klipfontein*	Shallow	Grey to dark brown topsoil over hard rock	Topsoil lacks free lime; Fine sandy loam to sandy clay loam topsoil ; Topsoil lacks free lime	13.0
Cv26Cv16 Hu26Hu16	**Clovelly** *Southwold* *Oatsdale* **Hutton** *Msinga* *Hutton*	Shallow	Dark brown to grey brown topsoil over freely drained, apedal yellow-brown soil material	Medium base status, sandy loam to sandy clay loam subsoil; Low base status, sandy loam to sandy clay loam subsoil; Medium base status, sandy loam to sandy clay loam subsoil; Low base status, sandy loam to sandy clay	10.5
Cf12Wa12	**Cartref** *Arrochar* **Wasbank** *Burford*	Shallow	Grey to grey brown topsoil over bleached grey layer, over partly weathered or fractured rock material	Fine sandy loam to sandy clay loam texture in the grey topsoil; Fine sandy loam to sandy clay loam texture in the grey topsoil	2.0

Soil Description (In order of dominance)

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Cv16Hu16 Hu17Gc16	**Clovelly** *Oatsdale* **Hutton** *Hutton* *Farningham* **Glencoe** *Appam*	Moderately shallow	Dark brown to grey brown topsoil over freely drained, apedal yellow-brown soil material	Low base status, sandy loam to sandy clay loam subsoil; Low base status, sandy loam to sandy clay loam subsoil; Low base status, clay loam to clay subsoil; Low base, status sandy loam to sandy clay loam subsoil	30.3
Ms10Ms11 Gs16	**Mispah** *Mispah* *Klipfontein* **Glenrosa** *Williamson*	Moderately shallow	Grey to dark brown topsoil over hard rock	Topsoil lacks free lime; Topsoil lacks free lime; Fine sandy loam to sandy clay loam topsoil	18.4

Other Soils: Hu26Hu16Hu17 (5.6%), Lo12Cf12Du10 (1%)

1

Table A3 Land Type Information: Generalized Description of Soils [Ib10] (Land Type Survey 1988).

ARC - Institute for Soil, Climate and Water

Land Type Survey Staff: 1973 – 2004

Land Type Information: Generalized Description of Soils

Mpumalanga

Natural Resource Area: Ib10
District Municipality: Nkangala
Local Municipality: Nokeng tsa Taemane Local Municipality Cullinan

Map Number and Map Name:
Land Types: Ib10
Land Type Climate Zones 588S **Total Area (Ha):** 37700

Description of Broad Soil Pattern:
Rock areas (>60% rock) with miscellaneous, usually shallow soils

Summary Description of Climate (Koppen Climate Classification):
Warm (average annual temperature >18°C) semi-arid with summer rainfall

Summary Description of Vegetation: Mixed Bushveld

Dominant Geological Groups/Formations: Predominantly rhyolite of the Selonsrivier and Damwal Formations of the Rooiberg Group; some quartzite of the Selonsrivier Formation.

Soil Rock Complex

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Rock	**Rock**				60.5
Ms10	**Mispah** *Mispah*	Shallow	Grey to dark brown topsoil over hard rock	Topsoil lacks free lime	15.0
Hu26Hu36	**Hutton** *Msinga* *Shorrocks*	Shallow	Red-brown to brown topsoil overlying freely drained, red apedal soil material	Medium base status, sandy loam to sandy clay loam subsoil; High base status (lacking free lime), sandy loam to sandy clay loam subsoil	5.5
Cv26Cv36	**Clovelly** *Southwold* *Blinkklip*	Shallow	Dark brown to grey brown topsoil over freely drained, apedal yellow-brown soil material	Medium base status, sandy loam to sandy clay loam subsoil; High base status (lacking free lime), sandy loam to sandy clay loam subsoil	5.0
Gs16	**Glenrosa** *Williamson*	Shallow	Grey to dark brown topsoil over soil materials mixed with partly weathered rock-derived materials to hard rock fragments and stones	Fine sandy loam to sandy clay loam topsoil	3.3

Other Rock Complex Soils: Wa12 (0.25%)

Soil Description (In order of dominance)

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Sw31	**Swartland** *Swartland*	Shallow	Dark brown to grey brown topsoil, commonly with a clear transition to a moderate to strong blocky structured brown subsoil on weathering or hard, fractured rock. An increase in clay content, or a stronger structure grade, or a harder consistence of the subsoil relative to the topsoil are common	Sandy clay to clay subsoil. Lime absent in subsoil layers	4.3

Other Soils: Oa36Oa16 (2%), S (1.5%), Du10 (1.5%), Hu26Hu36Bv36 (1.25%)

1

Table A4 Land Type Information: Generalized Description of Soils [Ib16] (Land Type Survey 1988).

ARC • LNR

ARC - Institute for Soil, Climate and Water

Land Type Survey Staff: 1973 – 2004

Land Type Information: Generalized Description of Soils

Mpumalanga

Natural Resource Area: Ib16
District Municipality: Nkangala
Local Municipality: Thembisile KwaMhlanga

Map Number and Map Name:
Land Types: Ib16
Land Type Climate Zones 591S **Total Area (Ha):** 23120

Description of Broad Soil Pattern:
Rock areas (>60% rock) with miscellaneous, usually shallow soils

Summary Description of Climate (Koppen Climate Classification):
Cool (warmest month <22°C) humid subtropical with summer rainfall

Summary Description of Vegetation: Rocky Highveld Grassveld

Dominant Geological Groups/Formations: Sandstone of the Wilgerivier Formation, Waterberg Group.

Soil Rock Complex

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Rock	**Rock**				60.0
Cv14Cv15	**Clovelly** *Mossdale* *Soweto*	Moderately shallow	Dark brown to grey brown topsoil over freely drained, apedal yellow-brown soil material	Low base status, loamy medium sand to sandy loam subsoil; Low base status, loamy coarse sand to sandy loam	9.3
Ms10	**Mispah** *Mispah*	Shallow	Grey to dark brown topsoil over hard rock	Topsoil lacks free lime	7.0
Hu14Hu15	**Hutton** *Middelburg* *Kyalami*	Moderately shallow	Red-brown to brown topsoil overlying freely drained, red apedal soil material	Low base status, loamy medium sand to sandy loam subsoil; Low base status, loamy coarse sand to sandy loam	5.8
Gs15Gs14	**Glenrosa** *Glenrosa* *Platt*	Shallow	Grey to dark brown topsoil over soil materials mixed with partly weathered rock-derived materials to hard rock fragments and stones	Loamy coarse sand to sandy loam topsoil ; Loamy medium sand to sandy loam topsoil	5.0

Other Rock Complex Soils: Wa20Wa30 (1.5%), Cf20Cf30Cf21 (1.5%)

Soil Description (In order of dominance)

Soil Code	Soil Name	Depth	Soil Form Description	Soil Series Description	%
Du10	**Dundee** *Dundee*	Deep	Brown to grey topsoil over irregularly stratified and textured alluvium in	Wide texture range possible. Refer to detailed information sources	4.0
Streambeds	**Streambeds**				3.0

Other Soils: Oa33Oa34 (3%)

1

Annexure B

PLANT SPECIES CHECKLIST

PTERIDOPHYTA 2 Families 3 Genera 3 Species	
SELAGINELLACEAE	
Selaginella dregei (C.Presl) Hieron.	35 45 62 63 67 76
PTERIDACEAE	
Pellaea calomelanos (Sw.) Link	4 7 8 9 11 14 26 35 36 41 45 46 47 54 55 56 62 63 66 67 76 42 48 50
Cheilanthes species	50
MONOCOTYLEDONEAE 12 Families 62 Genera 99 Species	
ALOACEAE/ASPHODELACEAE?	
Aloe marlothii A.Berger	9 11 13 25 28 35 42 54 56 62 63 67 76
AMARYLLIDACEAE	
Boophane disticha (L.f.) Herb.	40 46 49 63
ASPARAGACEAE	
Asparagus aethiopicus L.	14 49 50
Asparagus laricinus Burch.	8 13 24 25 54 55 56 57
Asparagus suaveolens Burch.	35 45 62 67 73 74 75 76
COMMELINACEAE	
Commelina africana L.	4 6 11 35 45 46 47 48 54 59 60

	71										
Commelina erecta L.	31	32	33	34	35	36	46	47	52	53	55
	62	63	66	67							
CYPERACEAE											
Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke	31	32	33	34	35	36	37	38	39	40	
Bulbostylis hispidula (Vahl) R.W.Haines	2	5	19	41	43	44	45	46	47	49	53
	58	59	62	73	74	75					
Cyperus esculentus L.	2	40	43	64	65	69	70	71	72	73	75
Cyperus obtusiflorus Vahl	31	32	33	34	40	41	42	43	46	50	59
	62	64	65	66	67	68	71	72	76		
Cyperus rupestris Kunth	34	40	64	65	71	72					
Cyperus species	71										
Fuirena pubescens (Poir.) Kunth	64	65									
Kyllinga alba Nees	31	34	36	38							
Mariscus congestus (Vahl) C.B.Clarke	44	66	72								
Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J.Raynal	40	68	69	70	72						
HYPOXIDACEAE											
Hypoxis hemerocallidea Fisch. & C.A.Mey.	25	26									
Hypoxis rigidula Baker	71	72									
Hypoxis species	11										
IRIDACEAE											
Aristea woodii N.E.Br.	31	43									
Gladiolus woodii Baker	55										
JUNCACEAE											
Juncus species	40	68	69	70							
HYACINTHACEAE											
Eucomis species	15										
Ledebouria revoluta (L.f.) Jessop	25	42	46								
POACEAE											

Alloteropsis semialata (R.Br.) Hitchc.	31	36	37	39							
Andropogon eucomus Nees	3										
Andropogon schirensis A.Rich.	35	45	54	55	56	57					
Aristida adscensionis L.	19	23	24	26	41	43	52	59			
Aristida congesta Roem. & Schult. ssp. barbicollis (Trin. & Rupr.) De Winter	10	23	52	54							
Aristida congesta Roem. & Schult. ssp. congesta	2	6	7	31	59						
Aristida diffusa Trin.	7	9	11	20	21	27	36	41	45	55	56
	58	61	62	67							
Aristida stipitata Hack.	2										
Bewsia biflora (Hack.) Gooss.	49	58	59	73	75						
Bothriochloa radicans (Lehm.) A.Camus	64										
Brachiaria brizantha (A.Rich.) Stapf	25										
Brachiaria nigropedata (Ficalho & Hiern) Stapf	9										
Brachiaria serrata (Thunb.) Stapf	2	4	7	8	11	31	35	36	37	39	41
	42	62	63								
Chloris virgata Sw.	51										
Chrysopogon serrulatus Trin.	4	7	11								
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy	13	14	56								
Cynodon dactylon (L.) Pers.	1	2	3	15	40	43	65	71	72		
Digitaria eriantha Steud.	1	2	5	7	8	9	10	11	12	15	16
	20	21	23	24	25	26	27	28	29	30	31
	37	40	43	44	52	53	59	63	66	76	
Digitaria monodactyla (Nees) Stapf	31										
Diheteropogon amplectens (Nees) Clayton	4	9	11	20	31	36	37	45	46	47	49
	50	53	56	57	58	59	60	61	62	63	64
	67	73	74	75	76						
Elionurus muticus (Spreng.) Kunth	8	9	11	31	36	49	65				
Enneapogon scoparius Stapf	4										
Eragrostis biflora Hack. ex Schinz	63										
Eragrostis capensis (Thunb.) Trin.	40	64	65								
Eragrostis chloromelas Steud.	3	31	54	55	56	58	59				
Eragrostis curvula (Schrad.) Nees	1	2	3	5	6	7	8	9	15	16	17
	18	19	23	25	31	32	33	34	37	38	44
	52	53	66	71							
Eragrostis gummiflua Nees	14	15	17	18	19	21	27	28	52	53	58

	59
Eragrostis lehmanniana Nees	1 11 22 32 33
Eragrostis nindensis Ficalho & Hiern	47
Eragrostis plana Nees	38 40 64 65
Eragrostis racemosa (Thunb.) Steud.	4 7 16 17 18 45 46 48 49 53 73 74 75
Eragrostis rigidior Pilg.	1 7 8 9 10 24 28 29 40 43
Eragrostis species	21 27 31 38
Eragrostis superba Peyr.	9 10 20 21 22 28 31 36 37 41 42
Eragrostis trichophora Coss. & Durieu	2
Eustachys paspaloides (Vahl) Lanza & Mattei	56
Heteropogon contortus (L.) Roem. & Schult.	1 7 8 9 11 17 20 25 26 31 37 39 40 52 53 59 61
Hyparrhenia hirta (L.) Stapf	3 64 65
Hyperthelia dissoluta (Nees ex Steud.) Clayton	1 2 3 5 6 7 8 10 12 15 16 17 18 19 20 21 22 23 24 29 30 31 32 33 36 37 39 40 43 44 52 53 58 59 60 62 66 67 76
Imperata cylindrica (L.) Raeusch.	40 65 68 69 72
Ischaemum afrum (J.F.Gmel.) Dandy	55 56 57 59 73 74 75
Loudetia simplex (Nees) C.E.Hubb.	4 7 8 9 13 20 23 24 25 26 27 29 35 41 42 45 46 47 48 49 50 53 54 57 60 61 62 63 67 73 74 75 76
Melinis nerviglumis (Franch.) Zizka	1 4 7 8 9 14 25 31 32 35 36 37 38 41 42 54 55 56 57 58 60 61 62 63 67 74 76
Melinis repens (Willd.) Zizka	1 2 7 10 20 43
Miscanthus junceus (Stapf) Pilg.	40 65 68
Monocymbium ceresiiforme (Nees) Stapf	73 74 75
Panicum coloratum L.	4 9 11 15 21 23 24 38
Panicum ecklonii Nees	25 26
Panicum maximum Jacq.	15 16 22 28 30 38 40 43 50 51 52 63 68 69 71 72 76
Panicum natalense Hochst.	13 14 35 45 46 73 74 75

Paspalum dilatatum Poir.	64 65 69 70 71 72
Pennisetum macrourum Trin.	40 70 71 72
Pennisetum villosum R.Br. ex Fresen.	72
Perotis patens Gand.	1 2 5 15 20 21 23 31 43 52 53 59 74
Phragmites australis (Cav.) Steud.	64 68 69 70 71 72
Pogonarthria squarrosa (Roem. & Schult.) Pilg.	1 2 5 6 7 8 9 10 11 12 16 17 20 21 22 23 24 27 28 29 30 31 32 33 40 43 44 52 53 59
Schizachyrium jeffreysii (Hack.) Stapf	7 8
Schizachyrium sanguineum (Retz.) Alston	7 20
Schmidtia pappophoroides Steud.	42 60 61 62 63 67 76
Setaria sphacelata (Schumach.) Moss	1 4 7 8 9 10 11 13 14 16 17 18 19 20 21 23 24 25 27 28 29 30 31 35 36 37 38 39 40 41 42 43 45 46 47 48 50 52 53 54 55 56 57 58 59 67 71 72 76 34 64 65 70
Sporobolus africanus (Poir.) Robyns & Tournay	2 3 16 22 64 65 68 69 70 71 72
Sporobolus fimbriatus (Trin.) Nees	40 59 64
Themeda triandra Forssk.	4 7 10 11 13 14 18 25 26 27 29 35 36 41 42 47 48 50 54 55 57 59 62
Trachyandra species	51
Trachypogon spicatus (L.f.) Kuntze	4 7 20 31 35 53 54 65
Tragus berteronianus Schult.	2 7 43
Trichoneura grandiglumis (Nees) Ekman	2 59
Triraphis andropogonoides (Steud.) E.Phillips	4 8
Tristachya biseriata Stapf	4 8 14 46 48 49 50 73 74 75
Tristachya leucothrix Nees	29
Urelytrum agropyroides (Hack.) Hack.	4 7 45 49 73 74 75
Urochloa mosambicensis (Hack.) Dandy	30

POTAMOGETONACEAE

Potamogeton species	65

VELLOZIACEAE

Xerophyta retinervis Baker	4 11 13 29 35 36 41 42 45 46 49 54 55 62 67 73 74 75 76

DICOTYLEDONEAE

57 Families 139 Genera 200 Species

ACANTHACEAE

Barleria species	57
Blepharis species	7
Chaetacanthus costatus Nees	7 45 46 49
Crabbea angustifolia Nees	7
Crossandra greenstockii S.Moore	9 37 74
Justicia anagalloides (Nees) T.Anderson	31
Justicia betonica L.	7 9 21 26 27 31 32 33 34 36 37 39
Ruellia cordata Thunb.	7 8 54 55

AMARANTHACEAE

Gomphrena celosioides Mart.	33 34
Kyphocarpa angustifolia (Moq.) Lopr.	8 11 14 28 42 51 60 61 63

ANACARDIACEAE

Lannea discolor (Sond.) Engl.	8 15 25 35 36 39 41 52 53 60 62 63 66 67 76
Lannea edulis (Sond.) Engl.	11 39 40 52
Lannea gossweileri Exell & Mendonça ssp. tomentella (R.& A.Fern.) J.B.Gillett	15
Ozoroa paniculosa (Sond.) R.& A.Fern.	5 8 9 20 27 36 41 45 56 60 42
Sclerocarya birrea (A.Rich.) Hochst.	4 9 66
Searsia chirindensis Baker f.	43 72
Searsia dentata Thunb.	7
Searsia gracillima Engl.	35 46

Searsia lancea L.f.	29
Searsia leptodictya Diels	9 15 22 40 68
Searsia magalismontana Sond.	47 48
APOCYNACEAE	
Diplorhynchus condylocarpon (Müll.Arg.) Pichon	4 8 25 26 27 35 41 42 48 49 60 61 62 63 67 76
Gymnostephium fruticosum DC.	72
ASTERACEAE	
Artemisia afra Jacq. ex Willd.	4 29 36 49 54 55 57 58 73 74 75
Athrixia elata Sond.	13 47 54 55 56 57
Berkheya species	8 11 29 36 42 46 54 60 61 62 71
Bidens pilosa L.	54
Callilepis leptophylla Harv.	45 46
Conyza bonariensis (L.) Cronquist	20
Dicoma species	54
Dicoma macrocephala D.C.	7
Felicia muricata (Thunb.) Nees	17 20 24 29 32 39 43 53
Geigeria burkei Harv.	4
Gerbera species	57 67 76
Helichrysum aureonitens Sch.Bip.	14
Helichrysum miconiifolium DC.	19
Helichrysum rugulosum Less.	34 64 65 71
Helichrysum species	16 17 18 22 23 40 68 69 70
Lopholaena coriifolia (Sond.) E.Phillips & C.A.Sm.	4
Nidorella anomala Steetz	40 64 65
Nidorella hottentotica DC.	30 52 53 54 56 58 59 73 75
Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt	17 21
Schkuhria pinnata (Lam.) Cabrera	35 52 55 58 59 60 61 73 75
Senecio oxyriifolius DC.	37 46 47
Senecio species	1 2 10 33 34 43 71 72
Stoebe vulgaris Levyns	18 38 39
Tagetes minuta L.	36 42 52 54 55 56 60 61 62 63 67 76

Vernonia natalensis Sch.Bip. ex Walp.	9 15 16 17 20 23 29 30 37 43 52
	53 54 57 58 59
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.	9 12 17 18 19 20 21 22 23 27 28
	30 31 36 37 38 39 53 58 59 66
Vernonia poskeana Vatke & Hildebr.	60
BORAGINACEAE	
Ehretia rigida (Thunb.) Druce	24 60 61
BRASSICACEAE	
Raphanus species	40 64 65
Rorippa nasturtium-aquaticum (L.) Hayek	40 68 69 70
BUDDLEJACEAE	
Buddleja saligna Willd.	52
CAMPANULACEAE	
Wahlenbergia undulata (L.f.) A.DC.	31 32 33 34 37 38 39 40 54 58 59
	60 65 76
CAPPARACEAE	
Cleome maculata (Sond.) Szyszyl.	39 46 73 74 75
Cleome monophylla L.	34 38 46 47 50 55
Cleome rubella Burch.	5 43 44
CARYOPHYLLACEAE	
Dianthus mooiensis F.N.Williams	45 46
CELASTRACEAE	
Gymnosporia tenuispina (Sond.) Szyszyl	25 26 27 49 53 62 63 67 76
COMBRETACEAE	
Combretum apiculatum Sond.	11 25 26 27 50 51 53 76
Combretum molle R.Br. ex G.Don	4 30 35 36 41 42 48 50 51 54 55
	56 57 60 61 62 63 67 76

Combretum zeyheri Sond.	4 23 48 51 52
Terminalia brachystemma Welw. ex Hiern	3 18 40 66 68 69 70
Terminalia sericea Burch. ex DC.	1 2 5 10 11 12 21 26 27 28 29
	39 53 68 69 70
CHRYSOBALANACEAE	
Parinari capensis Harv.	4 7 8 11 24 39 43 45 46 49 73
	74
CONVOLVULACEAE	
Evolvulus alsinoides (L.) L.	2 8 18 41 42 60
Ipomoea crassipes Hook.	35 41 62 67 76
Ipomoea obscura v. fragilis (L.) Ker Gawl.	9
Ipomoea purpurea (L.) Roth	46
Ipomoea species	54 66
Xenostegia tridentata (L.) D.F.Austin & Staples	67 76
CRASSULACEAE	
Crassula swaziensis Schönland	35 56
Kalanchoe paniculata Harv.	54
CUSCUTACEAE	
Cuscuta campestris Yunck.	48
DICHAPETALACEAE	
Dichapetalum cymosum (Hook.) Engl.	15 31 32 34 37 38 39 52 58 59 66
Dichapetalum macrocarpum Engl. ex K.Krause	7
DIPSACACEAE	
Scabiosa columbaria L.	38
EBENACEAE	
Diospyros lycioides Desf.	15 35
Euclea crispa (Thunb.) G□rke	8 9 25
Euclea species	47 48

ELATINACEAE	
Bergia decumbens Planch. ex Harv.	10
EUPHORBIACEAE	
Acalypha angustata Sond.	29
Bridelia mollis Hutch.	9 14 42 66
Jatropha zeyheri Sond.	63 67 76
Phyllanthus parvulus Sond.	4 35 36
FABACEAE	
Acacia burkei Benth.	9 28 12
Acacia caffra (Thunb.) Willd.	7 9 15 21 22 29 34 55 58 59 70
	71 76
Acacia karroo Hayne	22 25 28 29 72
Acacia permixta Burtt Davy	26
Acacia species	42
Burkea africana Hook.	4 7 8 9 11 15 16 17 20 22 23
	24 28 30 39 41 43 44 45 46 47 50
	52 53 60 62 63 66 67 73 74 75 76
Chamaecrista mimosoides (L.) Greene	2 4 31 52 59 66
Crotalaria sphaerocarpa Perr. ex DC.	38
Dalbergia melanoxylon Guill. & Perr.	55
	74 75 76
Dichrostachys cinerea (L.) Wight & Arn.	2 5 7 8 10 11 12 16 22 23 24
	27 28 29 30 32 33 34 35 36 40 41
	43 44 52 53 58 61 63 66 68 70 71
Elephantorrhiza burkei Benth.	47 48 50 52 60
Elephantorrhiza elephantina (Burch.) Skeels	31 32 33 35 39 44 58
Indigofera daleoides Benth. ex Harv.	2 12 31 32 33 43 44 52 59 66
Indigofera hedyantha Eckl. & Zeyh.	61
Indigofera melanadenia Benth. ex Harv.	4 6
Indigofera nebrowniana J.B.Gillett	1 5 8
Lablab purpureus (L.) Sweet	46

Medicago sativa L.	45								
Melolobium wilmsii Harms	44								
Pearsonia sessilifolia (Harv.) Dummer	35								
Pearsonia species	35								
Peltophorum africanum Sond.	15	60							
Rhynchosia minima (L.) DC.	25	33	34	46	74	73	75		
Rhynchosia monophylla Schltr.	4								
Rhynchosia nitens Benth.	4	13	35	45	46	47	60	61	
Rhynchosia totta (Thunb.) DC.	4	35	43						
Stylosanthes fruticosa (Retz.) Alston	8	9	11	29					
Tephrosia capensis (Jacq.) Pers.	2	58	63						
Tephrosia longipes Meisn.	13	32	33	36	42	54	55	61	
Tephrosia lupinifolia DC.	1	5	31	39	44	45	46	58	60
Tephrosia multijuga R.G.N.Young	63								
Tephrosia species	40								
Zornia linearis E.Mey.	31								
Zornia milneana Mohlenbr.	2	44	66						
FLACOURTIACEAE									
Dovyalis caffra (Hook.f. & Harv.) Hook.f.	29	34							
Scolopia zeyheri (Nees) Harv.	7								
GENTIANACEAE									
Chironia purpurascens (E.Mey.) Benth. & Hook.f.	39	64	65						
GERANIACEAE									
Pelargonium luridum (Andrews) Sweet	31	37	38	39					
Pelargonium species	52								
HETEROPYXIDACEAE									
Heteropyxis natalensis Harv.	55	56							
ILLECEBRACEAE									
Pollichia campestris Aiton	15	17	31	33	34	43			

LAMIACEAE	
Acrotome hispida Benth.	8 9 14 20 23 29 41 48
Becium angustifolium (Benth.) N.E.Br.	7
Becium species	7
Hemizygia pretoriae (G□rke) M.Ashby	4
Leonotis leonurus (L.) R.Br.	4
Plectranthus species	42
Salvia species	7
Teucrium trifidum Retz.	11 23
LOBELIACEAE	
Lobelia erinus L.	70
Lobelia species	64 65
MALVACEAE	
Hibiscus microcarpus Garcke	31
Hibiscus pusillus Thunb.	32 34 52
Melhania prostrata DC.	9
Pavonia transvaalensis (Ulbr.) A.Meeuse	60
Sida alba L.	65
Sida cordifolia L.	8 11 40 43 44 47 52 66 67 76
Sida dregei Burtt Davy	9 47
MALPIGHIACEAE	
Sphedamnocarpus pruriens (A.Juss.) Szyszyl.	54
MOLLUGINACEAE	
Limeum viscosum (J.Gay) Fenzl	7 31 32 33 34 35 41 52
NYCTAGINACEAE	
Commicarpus fruticosus Pohnert	70
OLACACEAE	
Ximenia caffra Sond.	47 66

OCHNACEAE	
Ochna pulchra Hook.	7 44 62 63 66 67 76
ONAGRACEAE	
Oenothera rosea L'Hér. ex Aiton	69 70
PAPILIONOIDEAE	
Mundulea sericea (Willd.) A.Chev.	4 13 14 27 35 41 42 46 54 55 56 57
Pterocarpus rotundifolius (Sond.) Druce	60 67
PEDALIACEAE	
Ceratotheca triloba (Bernh.) Hook.f.	14 33
PLANTAGINACEAE	
Erinus species	64
POLYGALACEAE	
Polygala hottentotta C.Presl	3
Polygala uncinata E.Mey. ex Meisn.	35 41
Persicaria lapathifolia (L.) Gray	38 65
Persicaria serrulata (Lag.) Webb & Moq.	40 64 68
PROTEACEAE	
Faurea saligna Harv.	15 16 17 18 20 30 34 37 38 39 52 53 55 57 58 59 66
Protea caffra Meisn.	13 14 25 35 46 47 48 49 56 73 74 75
RANUNCULACEAE	
Ranunculus multifidus Forssk.	69 70
RUBIACEAE	
Agathisanthemum bojeri Klotzsch	2 17 18 31 33 34 36 37 39 41 53

Fadogia homblei De Wild. 4 24 43 50 52 66
Kohautia amatymbica Eckl. & Zeyh. 6 33 44 66
Oldenlandia herbacea (L.) Roxb. 1 2 19 21 23 31 42 45 46 47 55
Pentanisia angustifolia (Hochst.) Hochst. 35 36 41 46 49
Richardia brasiliensis Gomes 3 6
Tapiphyllum parvifolium (Sond.) Robyns 4 7 46 58

RUTACEAE
Zanthoxylum capense (Thunb.) Harv. 13

SANTALACEAE
Thesium utile A.W.Hill 7 19 29 36 37 38 62 63

SAPINDACEAE
Pappea capensis Eckl. & Zeyh. 4
Dodonaea angustifolia L.f. 15

SAPOTACEAE
Englerophytum magalismontanum (Sond.) T.D.Penn. 34 35 36 42 45 46 47 48 50 73 75

SCROPHLARIACEAE
Striga elegans Benth. 6 52 53 74

SOLANACEAE
Solanum incanum L. 7 11 33 34 46 59
Solanum mauritianum Scop. 63
Solanum panduriforme E.Mey. 4 34 43 44 57 59 62 63 66 67 76
Solanum species 67

STERCULIACEAE
Dombeya rotundifolia (Hochst.) Planch. 29 42 53
Hermannia boraginiflora Hook. 2 12 32 33
Hermannia species 7
Hermannia transvaalensis Schinz 7

Waltheria indica L.	1	2	6	7	9	11	15	24	27	28	29
	32	33	52	53							
STRYCHNACEAE											
Strychnos cocculoides Baker	8	51									
Strychnos madagascariensis Poir.	9	13	14	41	60						
Strychnos pungens Soler.	7										
Strychnos spinosa Lam.	8	11	23	24	43	52					
THYMELAEACEAE											
Gnidia capitata L.f.	11	31									
TILIACEAE											
Corchorus asplenifolius Burch.	4										
Grewia flava DC.	25	26	34								
Grewia monticola Sond.	8	9									
Triumfetta sonderi Ficalho & Hiern	9	18	20	23	35	36	38	39	57	58	
URTICACEAE											
Pouzolzia mixta Solms	51										
Obetia tenax (N.E.Br.) Friis	51	53									
VAHLIACEAE											
Vahlia capensis (L.f.) Thunb.	13										
VERBENACEAE											
Clerodendrum triphyllum (Harv.) H.Pearson	8	47	55								
Lantana rugosa Thunb.	9	38	51	54	56	57					
Lippia javanica (Burm.f.) Spreng.	3	7	9	12	13	14	20	22	30	38	39
	42	43	44	52	53	54	55	56	57	59	66
	68	69	70	72							
Lippia rehmannii H.Pearson	8	23	26	15	16	39					
Verbena bonariensis L.	3	19	34	40	64	65	69	70	71	72	
Verbena brasiliensis Vell.	38	70	71								

When I consider the work of thy heavens, the work of thy fingers, the moon and the stars,
which thou hast ordained;
what is man, that thou art mindful of him?
And the son of man, that thou visitest him?
Psalms 8:3-4