A vegetation classification and management plan for the Nooitgedacht section of the Loskop Dam Nature Reserve.

by

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DECLARATION

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I, Sellina Ennie Nkosi, declare that “A vegetation classification and management plan for the Nooitgedacht section of the Loskop Dam 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 SE Nkosi)

2014 November 28

DATE

DEDICATION

To God be the Glory!

I dedicate this dissertation to my parents who raised and nurtured me: my mother Thoko J Skosana, and my father Mfelane R Nkosi.

To their next generations,

'Ngiyibekile induku ebandla'

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ABSTRACT

The vegetation of the Nooitgedacht section of the Loskop Dam Nature Reserve resembles Bankenveld vegetation and differs from the other areas of the reserve. This study was undertaken to identify, classify, and describe the plant communities present on this section, and to determine their veld condition. The Braun-Blanquet approach was followed to classify the different plant communities. A total number of 170 sample plots (100m^2) were placed in all homogeneous vegetation units in a randomly stratified basis. The Ecological Index Method (EIM) was used to determine the veld condition. Data were collected using the step-point method and incorporated into the GRAZE model from where the veld condition was calculated. A minimum of 400 step points were surveyed in each community with more points in the larger communities. Plant community data was analysed using the JUICE software program. A total of 11 plant communities were identified. The overall veld condition score indicates the vegetation to be in a good condition, resulting in a high grazing capacity.

KEYWORDS:

Braun-Blanquet, Ecological Index method, step point method, vegetation classification, JUICE, plant communities, TWINSPAN, Loskop dam

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

Chapter 1

1 INTRODUCTION

Vegetation in South Africa has been subjected to varying degrees of utilization ranging from agricultural practices (such as planting of crops and grazing by cattle) to grazing by game species for hundreds of years. Tourism has become an important contributor to the economy of South Africa with a large number of nature reserves, private game farms and National Parks conserving and managing the natural vegetation in these areas to cater for the needs of national and international visitors. The conservation of biological diversity in these protected areas contributes largely towards the tourism industry and therefore adds value to the total tourism package offered to clients.

The tourism industry has grown significantly since the country's first democratic elections in 1994. The number of hotels in key locations, such as Cape Town, Johannesburg, Pretoria and Durban has increased to accommodate the growing number of tourists. A steady growth trend has been recorded since 2002. There has been a growth of 5.6% of tourists' arrivals to South Africa since 2008. A 15.1% growth was recorded in 2010 compared to 5.7% in 2009 (South Africa, 2011). This growth was boosted by the 2010 FIFA World Cup hosted in the country. Research shows that the World Cup did not only boost this increase, but also significantly elevated awareness of South Africa as a leisure destination across the world (South Africa, 2011).

There has been a further 3.3% increase of tourists visiting South Africa on the 2010's recorded increase for 2011, and this was boosted by "INDABA 2011", which is the biggest event on African tourism calendar, attracting 1 813 exhibitors to South Africa (South Africa, 2012). Tourism growth in SA continues to outperform the global tourism growth to more than double the global average of 6.7% recorded in 2010 and 7% in 2012 (South Africa, 2013). Tourism developments at the same time have

potential to negatively impact on the natural ecosystem. These impacts are associated with the infrastructure developments such as roads, railways and airports, tourism facilities like resorts, shopping centres, hotels and others. South Africa's land has been transformed in many ways, at the expense of wildlife ("Tourism growth outperforms global economy in 2012.," 2012).

Publicly owned protected areas, both national and provincial makes up 5.52% of South Africa, and covers most of the major terrestrial and marine biomes or habitat types that makes up the biodiversity heritage of South Africa (Kent, 2012). The Percy Fitzpatrick Institute at the University of Cape Town estimated that '74% of plants, 92% amphibians, 92% of reptiles, 97% of birds and 93% of mammals are represented in the existing protected areas in South Africa' (Chadwick, 1995). South Africa has allowed private ownership of game and this 'has acted as a very important incentive for conservation resulting in many successful wildlife-based tourism enterprises' in the country. Areas previously used for agricultural purposes have been converted into game farms. If these game farms are managed incorrectly it could lead to a loss of biodiversity and grazing lands.

Optimal grazing and browsing can only be achieved if correct veld management practices and stocking rates are applied based on scientific principles. In order to make scientifically based management decisions for the natural vegetation in an area it is important that the plant communities present on the property or area is known. Plant community classification and description forms the basis of any scientific management plan of a nature reserve or natural area (Brown, 1997; Brown *et al.*, 2013).

1.1 Vegetation Classification concepts and its importance

According to Westhoff & Van der Maarel (1978) floristic classification forms the framework for any plant ecological study. The main aim of classification is to group together a set of individuals (vegetation samples) on the basis of their attributes or species composition. A group of plants derived from a set of vegetation samples

through the classification process in terms of their species composition, is considered a plant community of that area (Kent, 2012). According to Mucina & Rutherford (2006) a plant species list is an important element in the classification and description of a plant community as it provides information on the floristic composition of the different plant communities of an area. It is therefore important that all species are recorded, and that plots are geo-referenced to set conservation targets for the different vegetation types.

It is important to investigate the renewable natural resources of a protected area (in this case, a nature reserve) so that scientifically sound management plans and conservation policies can be compiled (Bredenkamp & Theron, 1978). A scientific management plan should be based on the results of the vegetation classification and description of an area. Different plant communities are usually indicated on an accompanying vegetation map.

A vegetation map becomes a useful tool in biological management of protected areas. Such a map supplemented with the descriptions of the different plant communities presents valuable information that assists managers and conservationists in understanding the environments and the abiotic factors affecting them. According to Egbert, Park & Price (2002), it is critical to obtain the current status of vegetation cover and structure in order to be in a position to protect and restore ecosystems where necessary. It is equally important to acquire updated vegetation data on an annual basis to better understand and assess any changes in the environment.

According to Rouget *et al*. (2004), information on the vegetation of an area provides a good representation of biodiversity since most animals, birds, insects and other organisms are associated with particular plant communities. Thus, not only does a vegetation classification and description provide information on the natural resources present, but it can also be used to describe the suitability of an area for a specific species in terms of habitat and dietary requirements (Brown *et al*., 2013). The latest remote sensing technology assists researchers and managers of large areas in their

studies on vegetation composition and structure (Langley, Cheshire, & Humes, 2001).

1.2 History of vegetation classification in South Africa

According to Rutherford, Mucina & Powrie (2012), southern Africa has from an ecological and evolutionary point of view been recognized as one of the most interesting and important areas of the world. The country has one of the richest floras with high levels of local and regional endemism and unprecedented regional beta diversity. It is also home to the renowned Fynbos biome, the smallest floristic kingdom of the world (Cowling, Richardson, & Pierce, 2003). During the 1970's and 1980's, the ecosystems of South Africa have attracted a significant amount of attention from researchers working on their structures and functions through a network of interdisciplinary studies mainly in the Savannah (1973), Fynbos (1977) and Karoo (1986) biomes (Mucina & Rutherford, 2006).

The first colour vegetation map of the Union of South Africa was prepared by Dr Pole-Evans in 1923. According to a map produced in 1935 (Pole-Evans, 1936), only 12 vegetation types were described. A subsequent map published by Adamson described 14 vegetation types (Adamson, 1938). Twenty years later, the publication titled 'Veld Types of South Africa' was first released in 1953 by Acocks. The second edition of 'Veld Types of South Africa, was updated and reprinted in 1975, with the third edition revised and released in 1988 (Pole-Evans, 1936; Low & Rebelo, 1996; Rutherford, 1997). Acocks identified and broadly described a total of 70 different veld types in his publication (Acocks, 1988; Cowling, Richardson, & Pierce, 2003).

A decision was taken during the early 1990's by the South African Association of Botanists (SAAB) to produce a more current map. The results of this decision was the production of the Low & Rebelo (1996) map, with the first edition published in 1996, and the second in 1998. However, after these maps were published, it was clear that a more detailed approach would have to be implemented for planning at regional and local levels (Mucina & Rutherford, 2006). The VEGMAP Project

(Mucina & Rutherford, 2006) was then initiated in 1996 to prepare a successor to the "Veld types of South Africa" publication by Acocks. This project resulted in the publication of the most recent classification, "The vegetation of South Africa, Lesotho and Swaziland" edited by Mucina and Rutherford in 2006. This latest publication became a valuable asset to conservation in South Africa.

1.3 Current classification

According to Brown *et al*. (2013), vegetation studies done on the olden days' national and regional vegetation were mostly of a non-formal descriptive nature (e.g. Bews, 1918; Pole Evans, 1922; Muir, 1929; Dyer, 1937; Louw, 1951; Bayer, 1955; Killick, 1963; Edwards, 1967) with only species lists of a particular area provided. The South African vegetation was classified by Acocks (1988) into 70 veld types and 75 variations based on floristic data collected in survey plots and also recording their abundances.

South African vegetation scientists adopted a more flexible approach using statistical numerical classification methods to derive a first approximation of plant communities in a particular area (Kent, 2012). This included an option to 'refine' the classification by applying the Zurich-Montpellier methods which allows the moving of relevés to other clusters by considering a number of factors than only those used by the particular numerical algorithm (Bredenkamp, 1982). The TWINSPAN classification algorithm (Hill, 1979) contributed to a large extent in obtaining more objectivity and repeatability in the classification whilst retaining the advantages of a phytosociological table at the same time. This provided a valuable overview of species cover and abundance, constancy, fidelity and the general habitat (Brown *et al*., 2013).

It was recommended that conservation policies and environmental management plans should be based on the knowledge that goals of sustainable utilisation linked with effective conservation cannot be achieved without thorough knowledge of the ecology and therefore plant communities of a particular area (Edwards, 1973). As a

result many phytosociological projects were initiated in nature conservation areas on national, provincial and privately owned areas. This resulted in a number of publications on vegetation of these areas in different biomes of South Africa (Brown *et al*., 2013).

Databases of floristic diversity were developed to store information of the occurrence and co-occurrences of different plant species as well as the characteristics of the region. In South Africa, a national vegetation database was developed to serve as source of data for preliminary vegetation classification which was applicable to the Fynbos and later the Karoo biomes (Rutherford, Mucina & Pierce, 2012).

"The classification and mapping of vegetation is one of the most widely used tools for interpreting complex ecosystem" (Brown *et al*., 2013). European researchers have been using the Braun-Blanquet approach in their vegetation classification studies since it was established (Westhoff & Van der Maarel, 1978). This approach was introduced in South Africa since the early 1900s. The Braun-Blanquet technique still remains very important and relevant in vegetation science (Brown *et al*., 2013). The main reason for following this approach is that the vegetation of the world has been and still is surveyed and classified according to a relatively uniform protocol (Chytrý, Schaminee, & Schwabe, 2011).

1.4 Conservation status in Mpumalanga

The Mpumalanga Tourism and Parks Agency (MTPA) and the Department of Agriculture and Land Administration (DALA), jointly developed the Mpumalanga Biodiversity Conservation Plan Handbook (MBCP) (Ferrar & Lötter, 2007). This was the very first plan produced for the province and intended to guide the conservation and land-use decisions in support of sustainable development. This plan takes its mandate from the South African Constitution, the National Environmental Biodiversity Act (South Africa, 2004) and the MTPA Act 10 of 1998 (Mpumalanga Province, 2005).

Two principal maps were produced in the Mpumalanga Biodiversity and Conservation Plan (MBCP), namely Map 1: indicating where the overall biodiversity priorities are located; and Map 2: indicating where the aquatic biodiversity targets should be best met. The localities of the most important sub-catchments areas for water production were included in the second map. The distribution of the province's known biodiversity was indicated in the first map and divided into different categories listed below. These categories were ranked according to their ecological and biodiversity importance (Ferrar & Lötter, 2007):

- Protected areas – areas that are already protected and managed for conservation.
- Irreplaceable areas – no other options available but to crucially protect.
- Highly significant areas – areas in need of protection with limited chances to survive if left unprotected.
- Important and Necessary areas – areas needing protection with high chances to succeed in protecting their ecological and biodiversity significance.
- Ecological Corridors - mixed natural and transformed areas for long term connection with other natural ecosystems to enhance biological connectivity.
- Areas of Least Concern – natural areas that could be developed with low impact on the environment.
- Areas with No Natural Habitat Remaining – areas totally transformed and no natural ecosystem processes remaining.

In terms of the above categories, the Mpumalanga Province has only 14.8 percent of surface land falling under protected areas; 2.4% of irreplaceable areas; 12.3% areas of high significant; 9.5% important and necessary areas; 25.2% areas of least concern, and 35.8% areas of remaining natural habitats with very little value to biodiversity.

Three of the nine biomes of South Africa are represented in the Mpumalanga Province, and covers a total of 86 940 km². These biomes include the Grassland Biome (Highveld and escarpment hills), Savannah Biome (Escarpment foothills and

the Lowveld) and the Forest Biome (south and east facing escarpment valleys). The MBCP document recognizes a total of 53 100 km² of the Province is in a grassland biome, which consist of 56% natural vegetation and 44% already transformed habitats. The savannah biome covers an area of 33 800 km² consisting of 75% natural vegetation and 25% of transformed habitats. The best conserved biome within the province is the forest that covers 40 km² of the province with 99% natural vegetation and 1% transformed.

From the above, it follows that the grasslands and savannah areas are under threat from development and agricultural activities in the province. It is therefore important that more information on the status of vegetation of the natural and protected areas of the province is obtained to assist the MTPA in the conservation planning and decision making on the management of these areas.

1.5 Vegetation classification for Loskop Dam Nature Reserve

A total of 18 nature reserves in the province are managed by the MTPA. The Loskop Dam Nature Reserve (LNR) is one of the largest and oldest reserves in the Mpumalanga province. The reserve was initiated in 1942 and proclaimed as a nature reserve in 1954. More land was incorporated on several occasions since then, and the current size of the reserve is 23 175 ha. The mandate of the MTPA, as stated in the second and most recent Act in 2006 is to 'promote and sustainably manage tourism and nature conservation and provide for the sustainable use of natural resources'. According to the MBCP categories (Ferrar & Lötter 2007) the areas outside the northern and the southern boundaries of the reserve are categorised as "highly significant", "important" and "irreplaceable" habitats.

The areas along the western and the southern borders of the reserve are used for farming activities such as livestock and/or game farming. The area on the north-western boundary comprises urban development where livestock is kept on communal grazing areas. On the north-eastern boundary, a combination of resort/lodge development and game farming activities are evident. According to

Eksteen (2002), there is a strong trend amongst surrounding and nearby landowners towards eco-tourism development. The land use is changing from livestock grazing to game-based farming activities. According to Stuart & Adams (1990), the land owners surrounding the reserve show strong trends towards sustainable utilization .

1.6 Previous vegetation studies

The first detailed vegetation study to classify and describe the different plant communities on the reserve was done by Theron (1973). The size of the reserve has increased through acquisition of neighbouring farms since then. The Parys and Rietfontein farms were added on the north-eastern side of the reserve, and were classified and mapped by Götze *et al*. (1998) using 1:30 000 aerial photographs. This was the second vegetation study on the reserve. Two other areas, the Hondekraal and the Nooitgedacht sections were also added to the reserve in the 1990s. A third vegetation classification study was subsequently done on the Hondekraal section (which includes portions of Groenvallei) by Filmalter (2010). The Hondekraal section covered approximately 3 347 ha of the reserve. A total of 12 plant communities divided into eight major vegetation types were identified and described for this area.

No ecologically based vegetation description study has been undertaken on the Nooitgedacht section of the reserve. The area covers approximately 4 457 ha. This study forms part of a larger project to classify and describe the vegetation of the current Loskop Dam Nature Reserve. The classification and description of the vegetation of the Nooitgedacht section is the last part of the larger project, where after all the different areas of the reserve that have been studied and described will be combined to produce a large vegetation map for the reserve.

Research hypothesis

The vegetation of the Nooitgedacht section of the reserve differs in species composition and grazing capacity from the old sections of the reserve.

Rationale

a) No similar vegetation descriptions have previously been completed on the vegetation of the study area and this research therefore provides valuable data on national and reserve levels for the ecosystems present.

b) This study will have immediate application to the management of the reserve. Data obtained from this study could be incorporated into the management plan for the reserve.

Aims

i. To provide a detailed vegetation classification and description at a local scale of the vegetation for the study area.

ii. To provide an ecological interpretation of the different ecosystems for the study area.

Objectives

(i) Identify, classify and describe the vegetation of the study area.

(ii) Compile a vegetation map for the area.

(iii) Determine the grazing capacity and stocking rate for the area.

(iv) Propose broad management recommendations.

Chapter 2

2 STUDY AREA

The Loskop Dam Nature Reserve (LNR) is situated approximately 55 km North of Middelburg in the Olifants River valley at latitude 25°22' to 25°31' South and 29°10' to 29°24' East (Figure 2.1). Construction of the dam wall was completed in 1938. The dam wall was raised in the 1970's, resulting in a larger area of the valley being flooded. The dam is approximately 30km long and supplies water to a vast irrigation scheme in the areas of Loskop, Marble Hall and Groblersdal. The elevation for the reserve varies from 1 450 to 1 990 meters above sea level (m.a.s.l.). Five perennial streams occur on the reserve namely, the Olifants River, Fontein Zonder End, Scheepersloop, Kerkplaasloop and Krantzspruit (Eksteen, 2003).

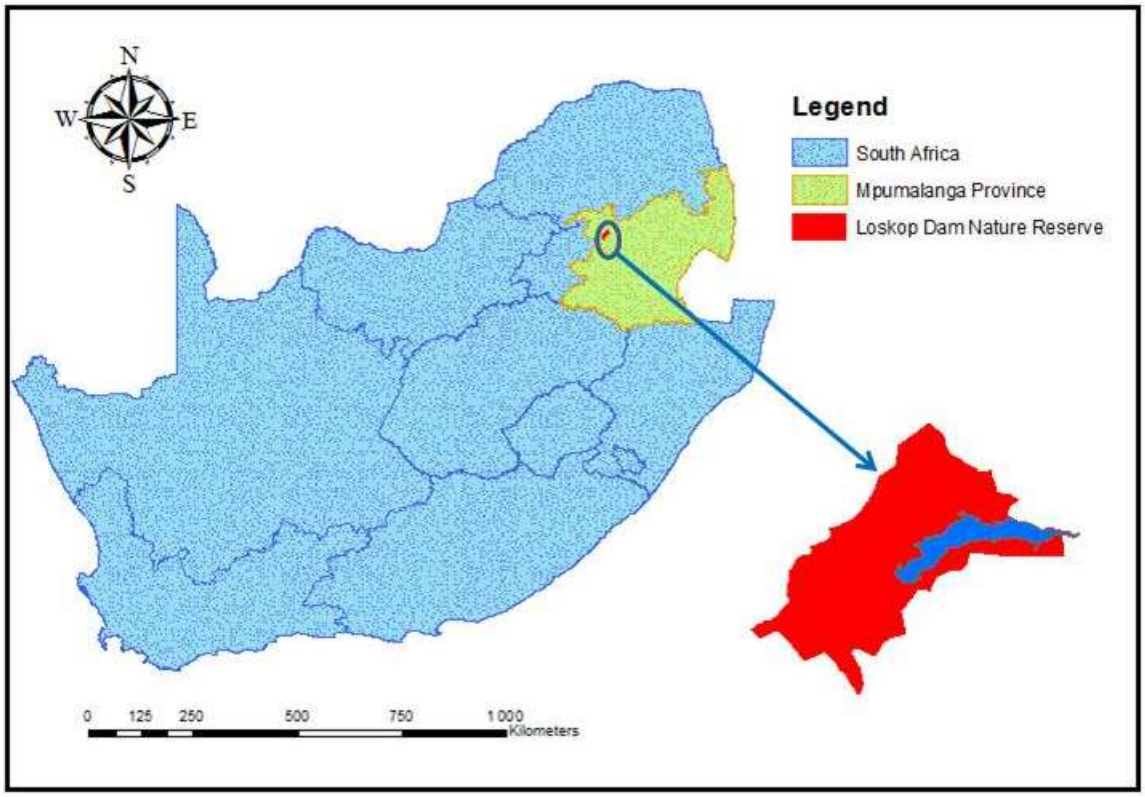


Figure 2.1: Locality map of the Loskop Dam Nature Reserve (LNR) in South Africa

There are currently no land acquisitions foreseen by the Mpumalanga Tourism and Parks Agency (MTPA) for the LNR. However, the MTPA supports the establishment

of a conservancy towards the southern side of the reserve. A successful conservancy on the LNR boundaries will add significantly to the current area conserved. This buffer on the reserve boundary will benefit the reserve's management by enhancing the protection of the reserve's biodiversity and increase conservation efforts (Eksteen, 2002).

2.1 Locality of the study area

The Nooitgedacht section (study area) comprising the Doornnek, Nebo, Stroomwater, Doornfontein and Greenbushes farm portions. This section covers approximately 4 457 ha and is located on the western border of the reserve (Figure 2.2).

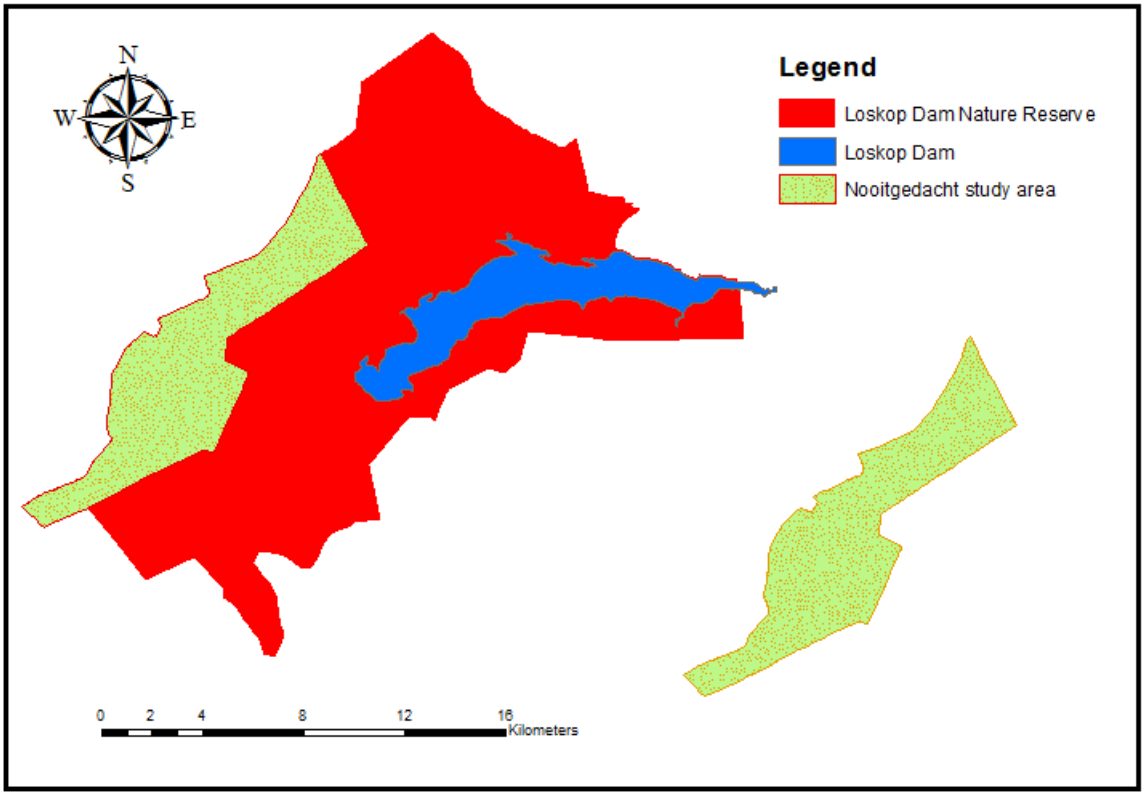


Figure 2.2: Locality map of the Nooitgedacht section in the LNR

This section is located on the higher lying areas with a typical grassland veld type. The soil is mostly shallow and leached with prominent rocky outcrops present throughout the area. Deeper soil within this veld type is limited and veld is classified as relatively acidic. Regular fires occur within the study area, especially during the

summer season when thunderstorms with lightning occur. Rocky outcrops and surface rocks reflect in the name of this veld that is 'Bankenveld' or 'klipveld' (Acocks 1988). According to Brown & Bredenkamp (2003) and Acocks (1988), Bankenveld is described as a "False Grass" veld type. The climax stage of this veld type, should be an open savannah (Acocks, 1988), but it has been modified and is maintained by regular fires as a grassland. Acocks advocated that if fire was excluded from this veld type, it would develop into savannah vegetation. This statement was rejected by Brown & Bredenkamp (2003) who stated "there are no differences between grassland and savannah in terms of the fire regimes, but rather the colder climate during the non-growing season influences the exclusion of woody species".

The woody vegetation found in the study area occurs in warm sheltered valleys and on slopes, while the grasslands occur mainly on exposed plateaus (Brown & Bredenkamp, 2003). Bankenveld vegetation consists of a mosaic of grassland and bushveld communities resulting from the topographically heterogeneous landscape. It has been suggested by Coetzee (1993) and Grobler (2000) that a link exists between certain grassland and savannah vegetation found on the same geological substrate .

The major source of old disturbances on the reserve relates to agricultural activities from the past. These activities include buildings, roads, dams, ditches, cultivated fields and livestock facilities. A limited amount of prospecting was also done on the reserve with some old prospecting shafts still evident in some localities (Eksteen, 2002).

2.2 Fauna

There are several populations of important game species occurring on the reserve. The priority species include the White rhino (*Ceratotherium simum*), Buffalo (*Syncerus caffer*), Oribi (*Ourebia ourebia*) and Sable antelope (*Hippotragus niger*). Several other threatened mammal species such as African wild cat (*Felis silverstris* subsp. *lybica*), antbear (*Orycteropus afer*), African civet (*Civettictis civetta*), aardwolf

(*Proteles cristata*), brown hyena (*Hyaena brunnea*), serval (*Leptailurus serval*) and leopard (*Panthera pardus*) are also found. Important bird species occurring on the reserve includes Cape vulture (*Gyps coprotheres*), martial eagle (*Polemaetus bellicosus*), Stanley's bustard (*Neotis denhami*), Caspian tern (*Hydropogne caspia*), African finfoot (*Podica senegalensis*), bald ibis (*Geronticus eremita*), red-billed oxpecker (*Buphagus erythrorhynchus*) and the blue crane (*Anthropoides paradiseus*).

2.3 Vegetation

2.3.1 Previous classification

The LNR lies on the transition between the Grassland and Savannah biome, with the vegetation on higher lying areas characteristic of a Grassland biome and the lower lying areas characterised by Savannah habitats (Eksteen, 2003). Acocks (1988) classified the vegetation of the study area as belonging to two vegetation types namely, the Mixed Bushveld (Veld type 18) and the Sourish Mixed Bushveld (Veld type 19) - Figure 2.3.. This area also falls within the broader classification of the higher-lying grasslands namely Bankenveld (Veld type 61) (Bredenkamp & Brown 2003).

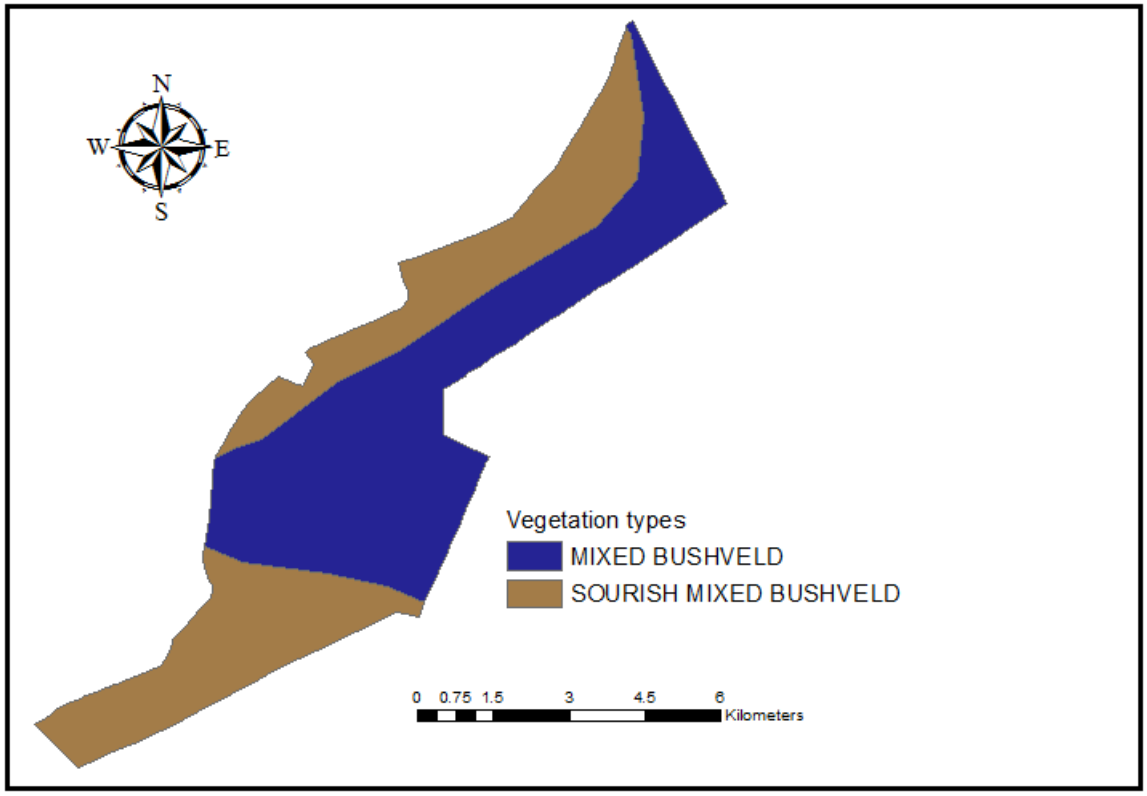


Figure 2.3: Vegetation map according to Acocks (1988)

The Bankenveld veld type as previously classified by Acocks (1988) is prominent on the higher lying areas of the reserve. Van Rooyen & Bredenkamp (1988) have classified these areas as Mixed-bushveld (Veld type 18) within the Savannah biome and Rocky Highveld Grassland (Veld type 34) within the Grassland biome respectively (Rutherford & Westfall, 1994).

According to Eksteen (2003) and as described by Filmalter (2010), the mixed bushveld veld type, which covers the largest portions of the LNR is very heterogenic and characterized by a range of variations and transitions. This is due to the heterogeneous topography of the area and various environmental factors, especially aspect, soil depth and altitude. Within the previously mentioned veld types, a number of plant communities can be distinguished. Theron (1973) identified a total of twenty three different plant communities on the original reserve, of which thirteen were tree-savannah, four were tree/shrub savannah, three were tree/shrub thickets, two were hygrophilous communities and one old land.

2.3.2 Current classification

Mucina & Rutherford (2006) have compiled an updated and comprehensive overview of the vegetation of South Africa, Lesotho and Swaziland. In their recent classification, they identified two vegetation types in the study area namely, the Central Sandy Bushveld (SVcb12) and the Loskop Mountain Bushveld (SVcb13) - Figure 2.4.

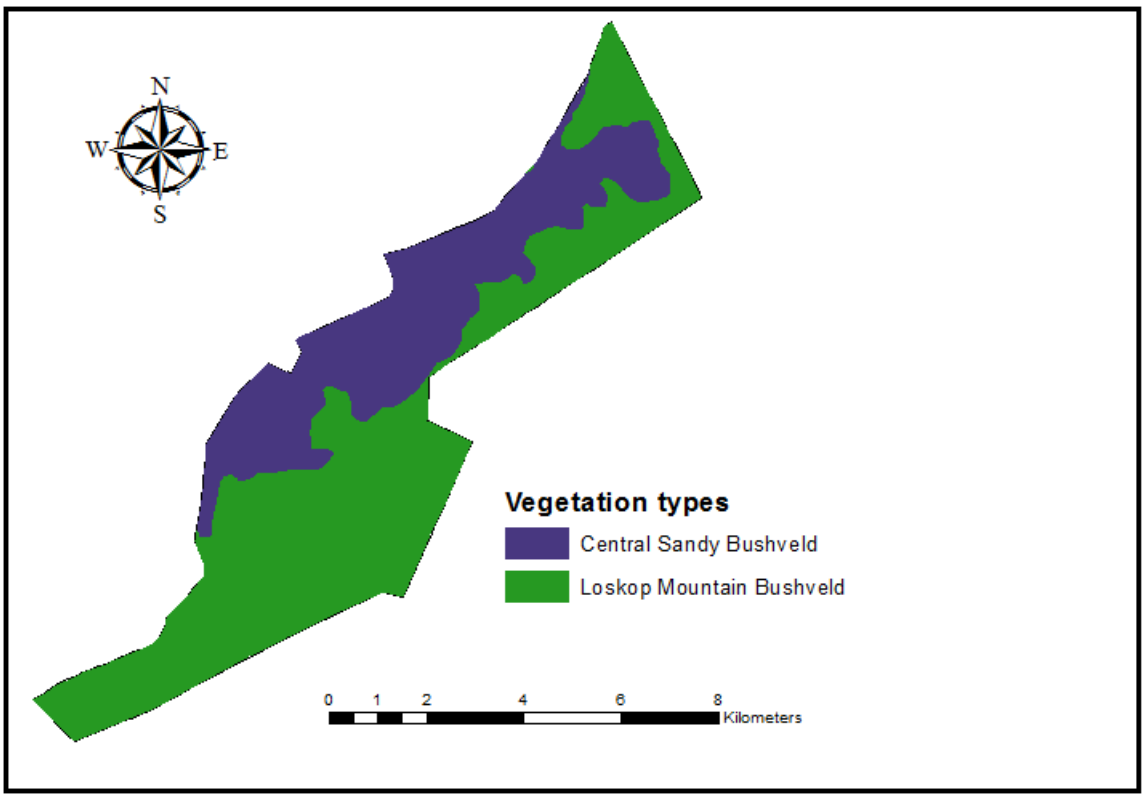


Figure 2.4: Vegetation types according to Mucina & Rutherford (2006)

2.3.2.1 The Central Sandy Bushveld (SVcb12)

This vegetation type occurs on undulating terrain at altitudes ranging between 850 and 1 450 m.a.s.l. in some lower lying areas. Deep sandy soil occurs with the dominant trees *Burkea africana* and *Terminalia sericea* present in such areas. On the shallow rocky soil areas *Combretum* woodland occurs (Mucina & Rutherford, 2006).

Important woody species found on these areas include *Senegalia burkei, Sclerocarya birrea* subsp. *caffra, Burkea africana, Combretum apiculatum, C. zeyheri, Terminalia sericea, Ochna pulchra, Peltophorum africanum* and *Searsia leptodictya*. Important grass species include *Eragrostis rigidior, Hyperthelia dissoluta, Panicum maximum, Perotis patens, Aristida scabriavalvis* subsp. *scabriavalvis, Brachiaria serrata, Elionurus muticus, Loudetia simplex, Schmidtia pappophoroides, Themeda triandra* and *Trachypogopon spicatus* (Mucina & Rutherford, 2006).

2.3.2.2 The Loskop Mountain Bushveld (SVcb13)

This vegetation type occurs on low mountains and ridges with open tree savannah on the lower areas, dominated by *Burkea africana.* A denser broad-leaved tree savannah occurs on the lower and midslopes with prominent woody species such as *Diplorhynchus condylocarpon, Combretum apiculatum* and *Senegalia caffra* (Mucina & Rutherford, 2006).

This veld type comprises of the following important woody species *Senegalia burkei, A. caffra, Burkea africana, Combretum apiculatum, C. zeyheri, Croton gratissimus, Faurea saligna, Heteropyxis natalensis, Ochna pulchra, Protea caffra, C. molle, Englerophytum magalismontanum, Ozoroa sphaerocarpa, Searsia leptodictya, Strychnos cocculoides, Diplorhynchus condylocarpon, Elephantorrhiza burkei, Mundulea sericea, S. zeyheri* and grass species *Aristida transvaalensis, Loudetia simplex, Trachypogon spicatus, Digitaria eriantha, Heteropogon contortus, Setaria sphacelata, Themeda triandra and Tristachya biseriata,* with the most prominent herb being *Xerophyta retinervis* (Mucina & Rutherford, 2006).

2.4 The land types on the study area

Land types are map units indicating land which can be mapped at a 1:250 000 scale, for which there is a marked uniformity of climate, terrain form and soil pattern (Mucina & Rutherford, 2006). Different land types display different soil and climate patterns (Fitzpatrick *et al.*, 1986).

Four different land types (Fa7, Ib10, Ib13 and Ib17) were identified in the Nooitgedacht study area and are briefly described below (Figure 2.5). The land type information giving the generalized descriptions of the different soils was taken from the Land type Survey staff (1988).

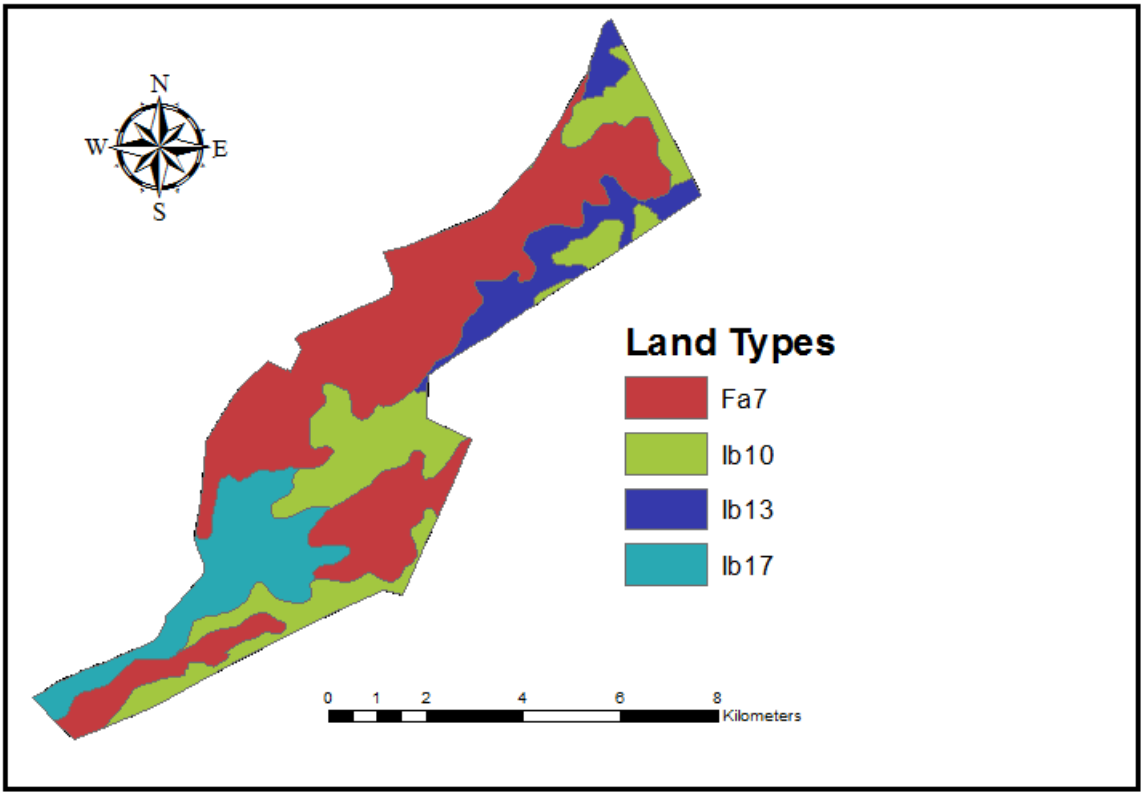


Figure 2.5: Land types of the study area (Land Type Survey Staff, 1988)

2.4.1 F Land type (Fa7)

This is the most dominant land type in the study area and is located on the northern and southern side. This land type occurs in both the Central Sandy Bushveld (SVcb12) and the Loskop Mountain Bushveld (SVcb13) areas of the study site. The soil depths are mostly shallow. The terrain units associated with this land type include crest, midslope, footslope and valley bottoms.

Soils types associated with the shallow depths of grey to dark brown topsoil occur over hard rock were Mispah and Glenrosa. The dark brown to grey-brown topsoil on freely drained, apedal yellow-brown topsoil material include: Clovelly and Hutton,

while the Cartref and Wasbank soil forms of grey to grey brown topsoil over a bleached grey layer and/or over partly weathered or fractured rock material. The broad soil patterns in this land type are described as shallow soils on hard, fractured rock or weathering rock materials. Other soils may occur, however, lime is rare or absent in this landscape. The dominant geological groups/formations include Rhyolite of the Selonsrivier Formation, Rooiberg Group, some Rashoop granophyre and Ecca sandstone (Land Type Survey Staff, 1988).

2.4.2 I Land type (Ib10)

The broad soil pattern of this land type can be described as shallow soil with >60% rocky areas. The geological groups/formations are predominately Rhyolite of the Selonsrivier and Damwal Formations of the Rooiberg Group; and some Quartzite of the Selonsrivier Formation. All five terrain units are represented on this land type namely crests, scarps, midslopes, footslopes and valley bottoms. Mispah, Hutton, Clovelly, Glenrosa and Swartland soil occurs at shallow depths in this land type (Land Type Survey Staff, 1988).

2.4.3 I Land type (Ib13)

This land type comprises shallow soil mostly with more than 60% rock cover. The geological groups/formations include the Rhyolite of the Selonsrivier and Damwal Formations (Rooiberg Group) and some Rashoop granophyre. Terrain units associated with this land type include crests, midslopes, footslopes and valley bottoms. Soils include those of the Ib10 land type: Wasbank and Glencoe but excluding Swartland (Land Type Survey Staff, 1988).

2.4.4 I Land type (Ib17)

This land type also has >60% of rocky areas with miscellaneous, usually shallow soil. It occurs within the Loskop Mountain Bushveld (SVcb13) vegetation type with a cool humid subtropical climate and summer rainfall. Soils associated with this land type include Mispah, Glenrosa, Clovelly, Hutton and Longlands. These soils occur at moderately shallow depths. The dominant geological groups/formations were Rhyolite of the Schrokkloof Formation and the Rooiberg Group. This land type was associated with footslopes and valley bottoms (Land Type Survey Staff, 1988).

2.5 Climate

Figure 2.6 below, represents the rainfall and temperature data received from the reserve's main office during study period 2010 - 2012 (Annexure A).

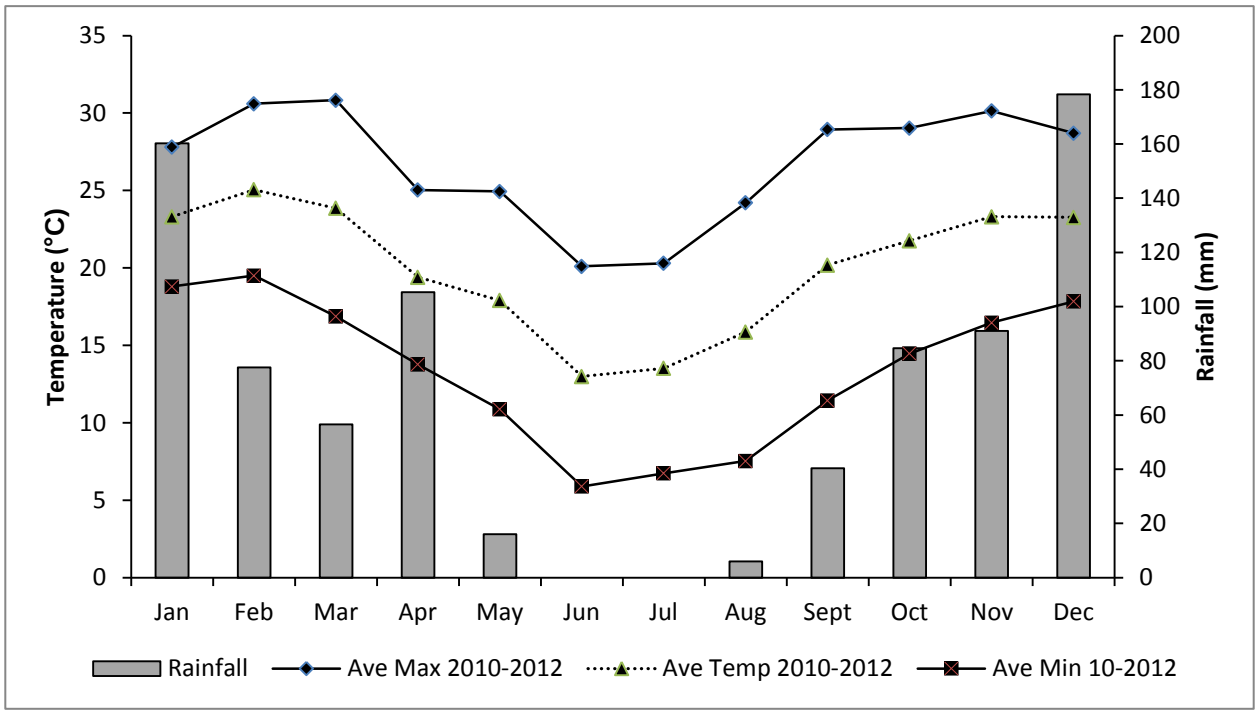


Figure 2.6: Rainfall & temperature data collected from the LNR's main office

Rainfall is the main determining factor in savannah dynamics with the moist savannah tending towards the equilibrium side of the gradient and arid savannah tending towards the arid side (Brown & Bredenkamp, 2003). The Loskop Dam nature

reserve is situated in the summer rainfall region of South Africa and has warm to very hot summers with moderate winters. Rainfall occurs as showers and high intensity thunderstorms, often with severe lightning and strong, gusty south-westerly winds. The rain mainly falls during the summer months (November - April). Mean long-term rainfall for the LNR is 650 mm per annum and occurs mainly between October and March. The lower lying areas are generally frost free, except for the valley bottoms with temperatures sporadically dropping to below 3°C. In the higher lying areas, the frost period extends from May to September with some days of severe frost (Eksteen, 2003).

2.5.1 Rainfall

Average rainfall data collected from the main office of the reserve during 2010-2012 was 816 mm. This data was supplemented with readings from the Nooitgedacht picket, which was 615 mm for the same period. Rainfall for Nooitgedacht was 5.4% less than the reserve's average annual rainfall of 650 mm. This was calculated by working out the difference between the annual rainfall figures of Nooitgedacht picket from the annual rainfall figure for the reserve. Rainfall received from the main office was 25% more than the average rainfall for the reserve, and 33% more than the rainfall received from the Nooitgedacht picket.

The majority of the Nooitgedacht section is located on the Fa7 land type. According to Fitzpatrick *et al*. (1986), this land type receives around 659.5 mm of rainfall per annum, while the Ib land type receives between 600 - 676 mm.

2.5.2 Temperature

The broken topography of the reserve results in the variation of local climate. Direct solar radiation varies with aspect, leading to north-facing slopes receiving more direct sunlight than south-facing slopes. This is more prominent in winter when the mean maximum temperature on the north-facing slopes is noticeably higher than on the south-facing slopes, which is 25.5°C versus 22.6°C. Temperatures on north-

facing slopes are above 20°C for longer periods and are below 10°C for shorter periods compared to south-facing slopes (Eksteen, 2003).

Temperatures differ significantly between higher and lower lying areas. The December mean daily maximum temperatures for higher and the lower lying areas are 29.8°C (absolute max = 39.7°C) and 26.5°C (absolute max = 36.1°C) respectively. July mean daily minimums for high and low lying areas are 8.1°C (absolute min = -1.3°C) and 2.0°C (absolute min = -11.7°C) respectively (Eksteen, 2003). Temperature data was sourced from the weather station located at the main office of the reserve for the study period.

2.6 Topography and geology

The five geological systems underlying the LNR give rise to extremely hilly terrain with deeply carved drainage lines. According to Eksteen (2003) the geological formations found on the reserve include the:

- Rhyolite group - this group underlies the mountains to the north of the Loskop Dam. Granitic lava formed a dense reddish-brown rock with stripes that represent the flow-structure of the original lava and weathers to form sandy-loam soils.
- Granophyre intrusions - Granophyre intrusive rock underlay the hills of Lombardsbay and weathers to form sandy-clay soils.
- Formation Loskop Sediments - these are soft Felspatic sandstone interlayered with shale and conglomerates mainly found on the valley bottoms. It weathers to form sandy to sandy-loam soils.
- Waterberg group - is characterized by rough, reddish to purple Sandstone and Quartzite. Shale rocks in this group often occur between other layers. Conglomerates are also common and found in the eastern and south-eastern parts of the reserve. This group weathers to form rough sandy to sandy-loam soils, whilst the shale weathers into sandy-clay soils.

- Diabase/Dolerite - Dolerite rocks are dense and dark in colour, and weathers to form clayey soils.

The Rooiberg group is the predominant geological formation found in the study area (Figure 2.7). Rhodes (1975) described the lower part of the Rooiberg group as a massive felsite, which, in some places was thicker than a kilometre, without inter-bedded tuffs or sandstones. He also described the upper part of the unit as composed of vesicular or flow-banded felsic lava flows containing quartzite xenoliths and intercalated volcanic breccia, ash-flows and sedimentary units.

The Rooiberg group is predominantly composed of volcanic flows of up to 400 m thick, which are inter-bedded with thin, laterally extensive sedimentary strata. The Rooiberg group on the reserve was further studied by Ericksson *et al*. (1994), who described the group as only a few meters thick, and predominantly comprised of sandstones, with smaller proportions of mud rocks and chert. These sand stones are recrystallized to quartzite and display circles, ripple marks, mud cracks, planar and trough cross-bedding, and channel fill.

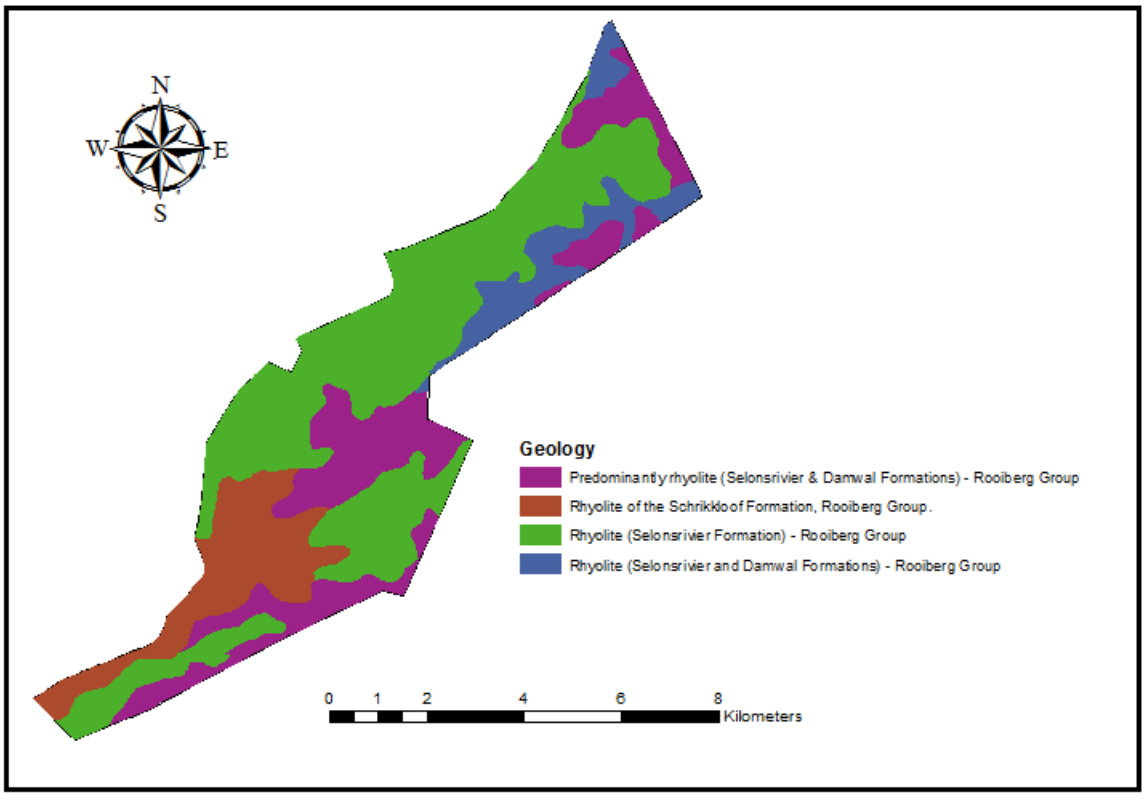


Figure 2.7: Geology map of the study area

2.7 Soils

The topography and weathering of the different geological substrates result in very complex soil patterns. The soil types vary significantly over short distances in the reserve. The underlying sandstone and rhyolite rock types give rise to commonly observed acid soils. Soil types vary from a sloping mass of loose rocks at the base of a cliff to soils just below the ridges, and very shallow soils on the steeper slopes and ridges to deeper soils closer to the valley bottoms. Soil depth has a major influence on the types of vegetation that may occur (Eksteen, 2003).

According to Land type Survey staff (1988), the generalized broad soil patterns found on the Nooitgedacht study area are: Glenrosa and/or Mispah soil forms with rare or absent lime in the entire landscape and intermittent miscellaneous soils throughout the system; and Miscellaneous land classes described as rocky areas with miscellaneous soils (Figure 2.8).

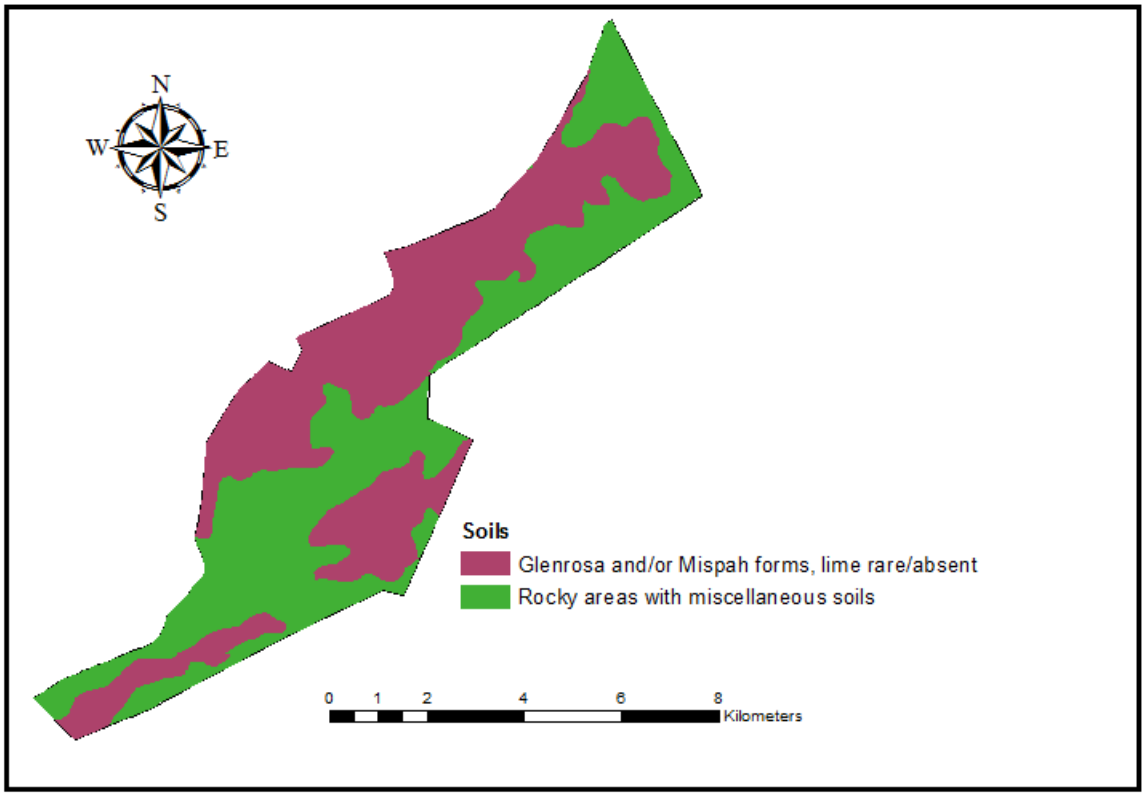


Figure 2.8: Soil map of the study area

The plateau areas were characterized by relatively shallow, sandy to sandy-loam soils with a pH of 3.5 - 4.5 pH, whilst foothills and valley floors have deeper soils, classified as sandy-loam to sandy-clay soils with a pH of 4.5 - 5.5. A variety of slope types are present because of the broken topography, which also lead to a variety of soil types. Soil depth has been identified as a major influence on the vegetation types that occur in the reserve. The terrain varies 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 (Eksteen, 2003).

Chapter 3

3 METHODOLOGY

A vegetation classification study was undertaken to identify, classify and describe the different plant communities found on the Nooitgedacht study area, and to produce a vegetation map. Vegetation classification is concerned with recognizing and describing the different plant communities present in an area. A number of classification methods have been developed by ecologists from Europe and North America (Kent, 2012). According to Shimwell (1971), four major schools for classifying vegetation evolved during the 1900 - 1960 period:

- The Zürich-Montpellier (Braun-Blanquet) School - established by Professor Braun-Blanquet in 1928. He developed a vegetation classification system that is today widely used by many researchers worldwide.
- The Uppsala School - based in Scandinavia and whose origin can be traced back to the work of Von Post (1862). This centre of research in Uppsala educated many students who produced numerous papers on the plant communities of Sweden (Lawesson, Diekmann, & Eilertsen, 1997).
- The Raunkaier School - established by the Danish ecologist Christen Raunkaier who was well known for his work on vegetation life forms. He developed a classification method for plants based on the position of their perennating organs in relation to the soil surface. This classification that is based on plant life forms is commonly referred to as Raunkaier's classification (Raunkaier, 1928).
- The Hybrid Schools – various researchers adopted the methodologies of the Zürich-Montpellier School to meet their specific needs (Kent, 2012).

These methods were subjective in their vegetation classification process and even though their approaches differ; most of them have converged on the Braun-Blanquet technique of the Zürich-Montpellier school (Kent, 2012). The Zürich-Montpellier school of phytosociology developed a hierarchy of classification systems that are

used in many countries throughout the world. It is considered a successful approach in identifying and classifying plant communities, but as with any other method or technique it was not exempt to criticism, especially regarding the lack of formal documentation of the steps that were involved (Kent, 2012).

Westhoff & Van der Maarel (1978) summarized the basic principles of the Zürich-Montpellier (Braun-Blanquet) approach as follows:

- Plant communities are recognized as different ecosystems based on their floristic composition as vegetation.
- Floristic composition of a plant community is also determined by environmental factors. Some species have certain mutual relationships and are referred to as diagnostic or differential species.
- Diagnostic species are used to organize plant communities in hierarchical classes and forms the basic unit used to identify the plant community (Weger, 1974).

In practice, this approach consists of sample plots (with a certain minimum size) placed within a homogenous vegetation stand. In the plots, canopy cover estimations are done for each species using a cover-abundance scale. As far as possible, all qualitative and quantitative characteristics of the vegetation (density, biomass, structure and others) are also recorded. The data collected is then analysed using multivariate statistics and from which the vegetation units are extracted and the composition, differentiation and characterization of associations listed (Westhoff & Van der Maarel, 1978).

The Braun-Blanquet approach was used for this study and a total number of 170 sample plots of 100 m^2 were placed in the study area on a randomly stratified basis (Bezuidenhout, 1993; Brown & Bredenkamp, 1994). The size of the sample plots were adequate as predetermined for surveys in the savannah vegetation (Weger, 1974; Coetzee, 1975). The data collection surveys were done during two growing seasons from November 2010 to April 2012.

3.1 Sample site selection and plot size

The study area was stratified into relatively homogenous physiographic-physiognomic vegetation units using a 1:50 000 stereo aerial photograph. From this stratification, sampling sites were randomly apportioned within the different stratified units and their co-ordinates determined using Google earth. More sample sites were placed in larger units than smaller units (Brown *et al*., 2013). An aerial photograph indicating the location of the proposed sampling sites was printed out and carried with the researcher during field surveys. Sample sites were representative of the homogenous physiographic-physiognomic vegetation units determined during stratification. Ecotone areas were avoided as far as possible. If the sampling site selected on the aerial photograph did not fall within a homogenous representative vegetation stand, the plot was moved to the nearest locality that was representative of the vegetation stand (Brown *et al.*, 2013).

3.2 Data Sampling

3.2.1 Floristic and environmental data

The following information was recorded for each sample plot: the location; altitude; plot number and co-ordinates using a Global Positioning System (GPS). Photographs were taken of each sample plot to obtain a visual representation of the area. A brief description of the sample site and its surrounding area was recorded. Based on visual observations of the sample sites, dominant plant species were identified and the percentage cover of the different vegetation layers (tree, shrub, herb and grass) was recorded.

All plant species occurring within each sample plot were recorded and a cover abundance value assigned for each species using the modified Braun-Blanquet cover abundance scale (Mueller-Dombois & Ellenberg, 1974) - Table 3.1. The percentages cover for rockiness, tree, shrub, grass and forb layers were also estimated (Westfall, 1981).

Table 3.1: Modified Braun-Blanquet cover abundance scale (Westfall, 1981)

Scale	Description
r	One individual with a very small cover percentage
+	Present, but not abundant with a crown cover of less than 1% of the plot
1	Any amount of individuals with a crown cover between 1% and 5% of the plot
2a	Any amount of individuals with a crown cover between 5% and 12% of the plot
2b	Any amount of individuals with a crown cover between 12% and 25% of the plot
3	Any amount of individuals with a crown cover between 25% and 50% of the plot
4	Any amount of individuals with a crown cover between 50% and 75% of the plot
5	Any amount of individuals with a crown cover between 75% and 100% of the plot

The degree of soil erosion was estimated using the four erosion classes in Table 3.2.

Table 3.2: Modified soil erosion classification (Fitzpatrick *et al.*, 1986)

Class	Description
1	No erosion or very little sheet erosion.
2	Moderate loss of topsoil and/or some slight dissection by run-off channels or gullies.
3	Severe loss of topsoil and/or marked dissection by run-off channels or gullies.
4	Total loss of topsoil and exposure of sub-soil and/or deep intricate dissection by gullies.

The slope of the terrain was measured in degrees using a clinometer, and classified according to Table 3.3.

Table 3.3: Modified slope unit classification (Westfall, 1981)

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

The aspect of the locality of each plot was determined using a compass, and noted in the eight compass directions, namely: North, Northeast, East, Southeast, South, Southwest, West and Northwest. The soil was classified as sandy, sandy loam, loam, clayey, clayey loam, and clayey sandy loam. The numbers of trees in different height classes were counted within each plot.

Other data collected included the occurrence of alien/protected/threatened plant species; accessibility of the area by wildlife through observing signs of grazing, browsing, trampling, droppings and paths; signs of veld fires. According to Brown & Bredenkamp (2003), the main habitat variables that are correlated with differences in floristically defined plant communities are geology, topography (landform, aspect and slope) and altitude.

Plant species were identified using various plant identification books (Van Wyk & Malan, 1997; Van Wyk & Van Wyk, 1997; Bromilow, 2001; Klopper *et al.* 2006; Schmidt, Lötter & McCleland, 2007; Van Oudtshoorn, 2012). Some species were identified on site while others were collected. All unidentified specimens were given field numbers, recorded, and pressed (using a plant press) for later identification.

3.2.2 Tree Density

The Total Tree Density (TTD) of each tree species was determined by counting the number of trees per species present within each sample plot. For the purpose of this study the woody stratum was divided into three classes, namely: Lower (0-1m), Middle (>1-3m) and Upper classes (>3m) according to Brown & Bredenkamp (1994). Trees and shrubs were distinguished from each other using the guidelines set by Edwards (1983).

3.2.3 Veld Condition Assessment

The Ecological Index Method (Foran, Tainton, & Booysen, 1978; Voster, 1982; Smit, 1989) was used to determine the veld condition of each plant community. A

minimum of 400 step-point surveys were completed per plant community (Mentis, 1984; Danckwerts, 1989). According to Tainton (1988) this method can be adapted for use in a variety of vegetation types. It is an ecologically based method and one of the preferred methods in conservation areas. The basis of this method is the assumption that defoliation is the key environmental factor that has an effect on the succession stages of grass, and that plants respond equally to the impact of defoliation.

3.3 Data analysis

3.3.1 Floristic data

Floristic and habitat data was captured using TURBOVEG (Hennekens, 1996). All relevé data was exported as a Cornell Condensed species file into JUICE 7.0 (Tichy, 2002). This programme is used for editing, classifying and analysing floristic data into a phytosociological table. A modified TWINSPAN (Roleček *et al*., 2009) classification was done to derive a first approximation of the plant communities. Whittaker's beta diversity was used and pseudo-species cut-levels were set at 0-15-25-50-70. The total inertia was selected to normalize the data and the dissimilarity figures were set between 160 and 24, and placed in clusters (Whitaker, 1977).

TWINSPAN is a divisive clustering method, which measures the aspects of heterogeneity of the clusters (Roleček *et al*., 2009). The type of fidelity measure used was a phi-coefficient of association which is based on the presence and absence of species and not based on cover-abundance data. The final classification settings were used to compile a phytosociological table in the JUICE program to improve the interpretation of the relationships between different plant communities (Westhoff & Van der Maarel, 1978). The phytosociological table was further refined following the Braun-Blanquet procedures (Mueller-Dombois & Ellenberg, 1974) to indicate the different plant communities, sub-communities and variants. No rearrangement of clusters and relevés were done with only the manual rearrangement of species being affected to the phytosociological table.

Alien plants observed in and close to the sample plots were recorded during the field surveys.

3.3.2 Tree density

Tree density was calculated for each plant community per height class, and expressed as individuals per hectare (ind/ha). The formula used was:

$$\text{Tree density} = \frac{\text{(Total number of trees per plant community x 10 000m}^2\text{)}}{\text{Total size of sample plots for plant community.}}$$

3.3.3 Veld condition

The ecological index method is based on multiplying species frequency with relative index values. Based on the results of the step point method (Mentis, 1984; Danckwerts, 1989), a species list of all the grasses found in each plant community was compiled. All grass species were then divided into ecological classes based on the following criteria (Tainton, 1999; Bothma, 2002): Decreaser (grass species which predominate in a veld that is in a good condition but decreases when the veld condition deteriorates as a result of over or underutilization); Increaser I (grass species that increase when the veld is underutilized); Increaser II (grass species that increase when the veld is moderately overutilized); and Increaser III (species that are not dominant in a veld that is in good condition but becomes dominant when the veld is severely overgrazed).

Relative index values for each ecological group were assigned for each ecological group (Brown, 1997) - Table 3.4. A composite of non-grasses called forbs (herbaceous plants, sedges) were grouped as Encroacher species. In areas where there was no herbaceous plant within a 30 cm radius of each point it was recorded as ‘bare ground’.

Table 3.4: Ecological Index Values per ecological group

Ecological groups	Mean Score (MS)
Decreaser	10
Increaser I	7
Increaser II	5
Increaser III	1
Encroachers	0.5
Bare soil	0

To calculate the Veld Condition Score (VCS), species frequency was multiplied by relative index value as per ecological grouping (Table 3.4). 'An ecological index value of less than 40% indicates veld that is in a poor condition, greater than 40% to 60% index value indicates veld in a moderate condition, and any value above 60% indicates veld that is in a good condition' (Bothma, 2002).

3.3.4 Determining the grazing capacity

Data from the Ecological Index Method was incorporated into the Graze model, which was developed by Brown (1997) to calculate the grazing capacity for game for each plant community, and for the total study area. This model utilizes the veld condition index, plant community size, the percentage canopy cover of the trees; shrubs and herbaceous layer cover, the accessibility of the terrain to game together with the rainfall and fire regime of a specific plant community data to determine the grazing capacity thereof (Brown, 1997).

3.3.5 Naming and describing plant communities

According to Brown *et al*. (2013) it is important to follow basic rules when naming plant communities to avoid confusion and to enable consistency. The first name of each community was based on the name of the dominant plant found in the community; the second name was from the plant that dominates the structure in the cluster or community. The sub-communities were named starting with the community

name, followed by a characteristic or dominant species for the sub-community (Weber, Moravec, & Theurillat, 2000).

3.3.6 Descriptions of the plant communities

The guidelines as stated by Brown *et al*. (2013) were adopted, whereby the locality and habitat (geology, land type, soil, rock cover, altitude, erosion) was described followed by the characteristic species with reference to the phytosociological table. The plant community descriptions further list the prominent and/or conspicuous species, their cover, growth form and other information collected during field sampling.

A vegetation map of the identified plant communities was produced using the Desktop ArcGIS 10 (ESRI, 2014).

CHAPTER 4

4 VEGETATION CLASSIFICATION

The modified TWINSPAN (Hill, 1979) classification resulted in identification of 11 different plant communities that can be grouped into seven major plant communities (Figure 4.1). A total of 649 different species (Annexure B) were recorded within the 170 sample sites for the study area (Figure 4.2). The phytosociological table is presented in Table 4.1.

4.1 Classification results

Plant communities identified during the classification process were:

1 *Sporobolus africanus-Buddleja salviifolia* Wetland.
2 *Panicum maximum-Senegalia caffra* Riverine Woodland.
   2.1 *Panicum maximum-Senegalia caffra-Olea europaea* subsp. *africana* sub-community
   2.2 *Panicum maximum-Senegalia caffra-Searsia leptodictya* sub-community.
3 *Eragrostis curvula-Hyparrhenia hirta* Old field Grassland.
4 *Setaria sphacelata-Lannea discolor* Open Woodland.
   4.1 *Setaria sphacelata-Lannea discolor-Englerophytum magalismontanum* sub-community.
   4.2 *Setaria sphacelata-Lannea discolor-Senegalia burkei* sub-community.
5 *Pygmaeothamnus zeyheri-Rhoicissus tridentata* Rocky Shrubland.
6 *Tristachya leucothrix-Faurea saligna* Open Woodland.
7 *Elionurus muticus-Loudetia simplex* Open Grassland.
   7.1 *Elionurus muticus-Loudetia simplex-Tristachya biseriata* sub-community.
   7.2 *Elionurus muticus-Loudetia simplex-Aristida diffusa* sub-community.
   7.3 *Elionurus muticus-Loudetia simplex-Gladiolus elliotii* sub-community.

Common species generally occurring in all the plant communities are listed in species group R (Table 1) and include the grasses: *Themeda triandra, Melinis nerviglumis, Bewsia biflora, Cymbopogon caesius* and the forbs *Pellaea calomelanos, Commelina africana, Mariscus congestus, Lantana rugosa, Helichrysum kraussii* and *Felicia muricata*. These species were recorded in all seven plant communities with various cover abundance values. The grass *Melinis nerviglumis* is the most prominent species and is only excluded in sub-community 2.1.

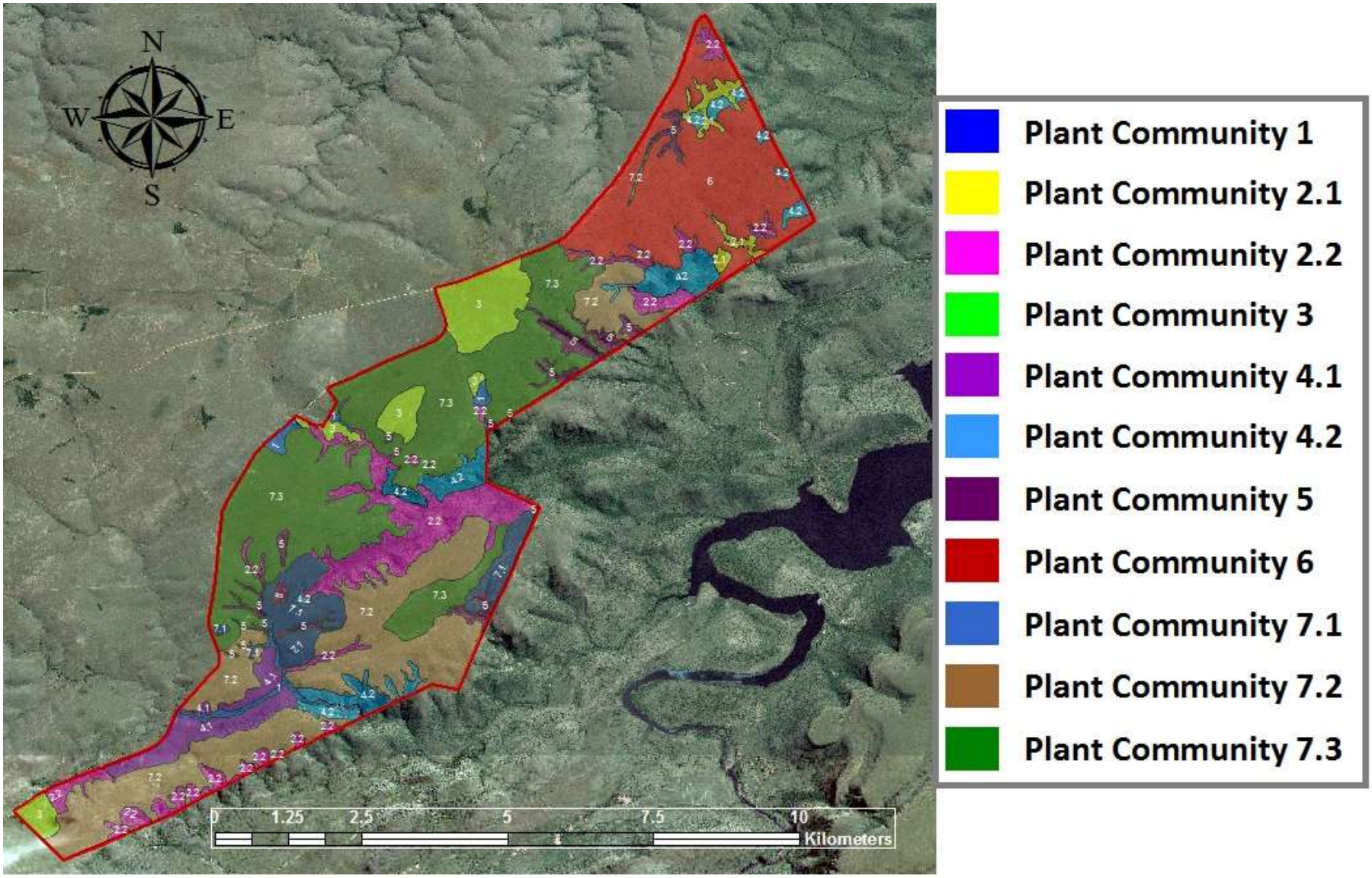


Figure 4.1: Vegetation map for the Nooitgedacht section

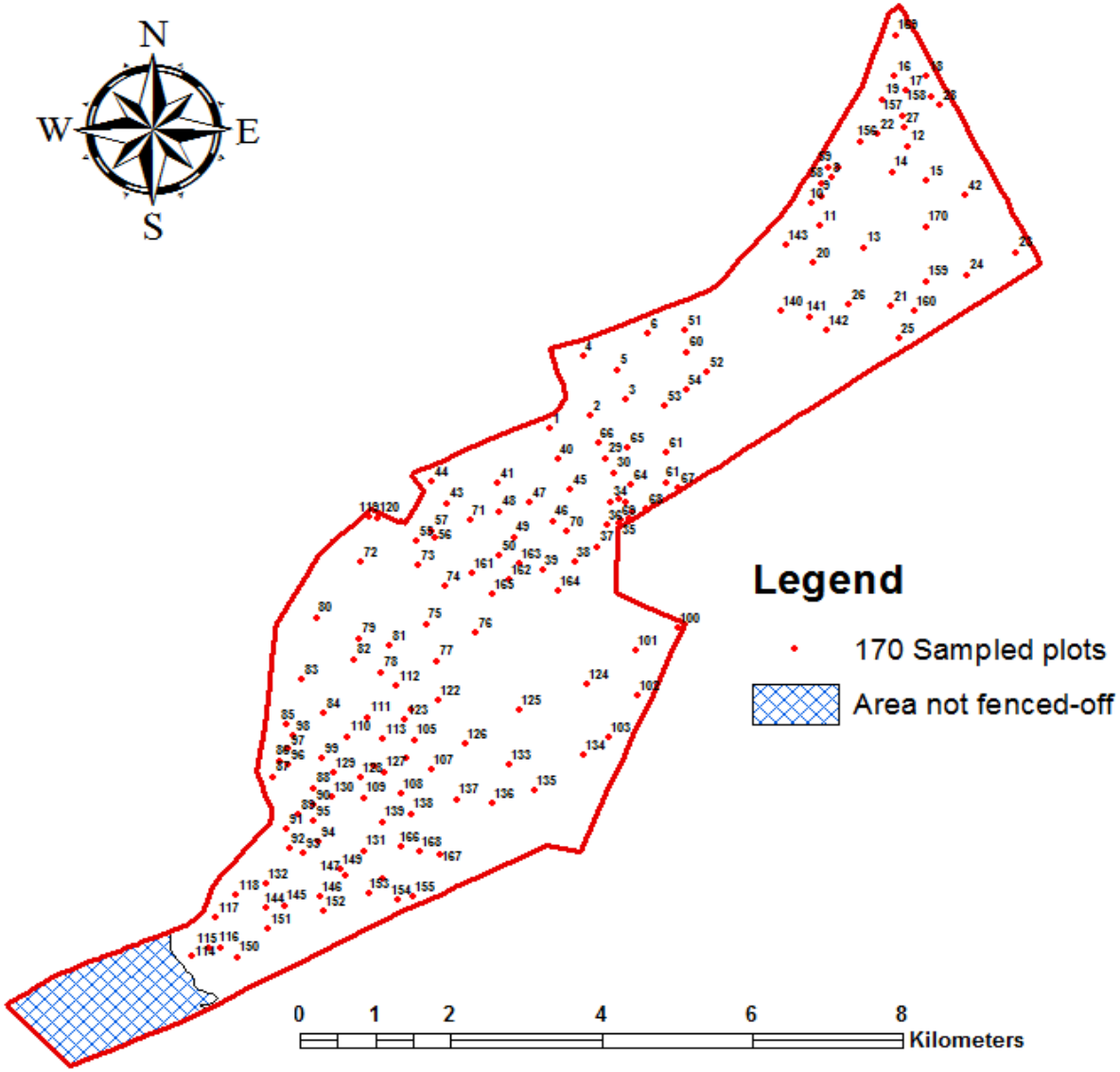
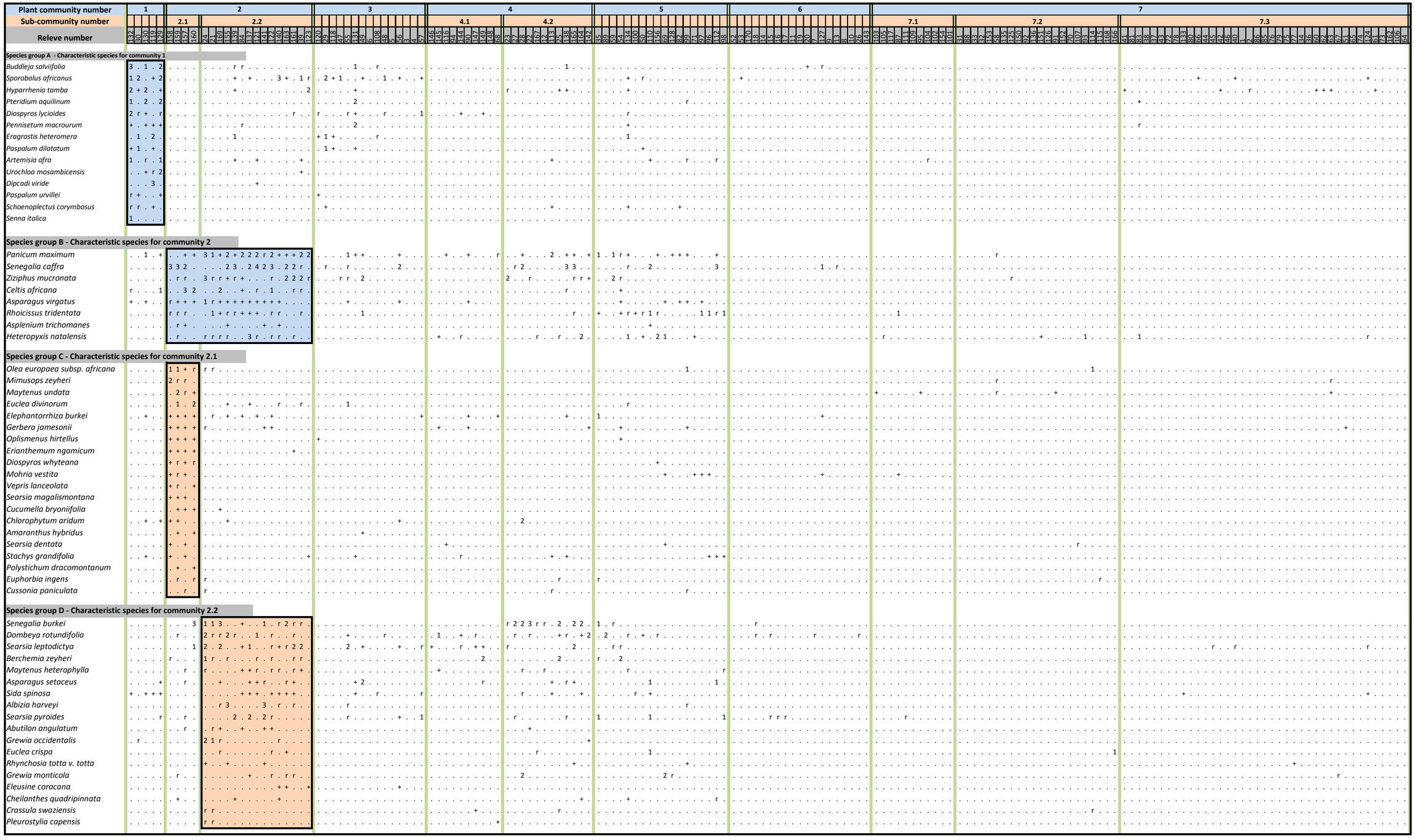


Figure 4.2: Locality map of the 170-sampled plots

Table 4.1: The phytosociological table of the Nooitgedacht section as per the Juice program classification



Plant community number	1	2	2	3	4	4	5	6	7	7	7
Sub-community number		2.1	2.2		4.1	4.2			7.1	7.2	7.3
Releve number	132 30 130 119 129	158 159 157 160	24 21 169 155 139 84 137 121 141 122 140 163 161 39 123	120 29 118 47 55 131 49 6 108 48 5 56 3 4 57	146 145 116 94 144 90 147 149 148 68	23 27 28 22 167 12 113 25 138 165 164 142	35 89 59 54 134 100 50 110 156 69 128 82 99 71 97 96 112 98	52 53 170 18 14 15 16 17 11 19 20 7 127 9 13 8 10 26 143	103 105 117 87 111 109 95 104 102 154 101	31 88 33 32 153 58 135 125 150 92 136 151 126 91 152 70 107 93 114 115 168 166	41 81 83 38 37 43 72 78 133 80 66 44 45 42 46 40 1 2 86 85 76 79 75 77 34 36 60 62 63 67 51 65 74 124 61 73 162 106 64
Species group E - Characteristic species for community 3											
Cynodon dactylon	.+.2.	....	..........++.1.	.+32....r+.+..+	....	....	...........+....r.	....	....	...........+..........	.......+.+......................+......
Eragrostis curvula	..+.+	....	..........+..+.	...++.+22.1+.2+	.......+..	........+1..	.1.......r++..+...	++................+	+..........	+.....+...............	+.++...+1.2+.++1....r.........+........
Aristida congesta s. congesta	.....	....	.r........+....	.......r+.2+.1r	2	....	...1........+.++..	....	....	....	.......+r.......2r..........+..........
Eragrostis gummiflua	.....	....	....	r++r..+..2.....	....	....	...rr.....r...2r+.	.+....r............	+..........	+.....................	..rrr..1..1.....r2...........1++.......
Elephantorrhiza elephantina	.....	....	....	+r+++.+..r..++.	....	....	.....+............	......r.r....+..+..	+.......+..	.....r................	....+.+..++..++rr..+++.+.1+..+.....+...
Schkuhria pinnata	..++.	....	1.....+...++..+	..+++++.++.+...	....	.....1......	..........++......	+................+.	....	....	.................r.....................
Kyllinga alba	.r...	....	....	+++.....++.....	....	........+...	....+.............	....	....	..+...................	......................+.+..............
Gerbera piloselloides	.....	....	......+........	...++.+..+..r..	....	....	+.......+.........	+1+..r..r.........+	....	....	r.....++...+.+..r....+....++..+.+.++...
Hibiscus trionum	+..+.	....	...........+.r.	..+...+........	+++.++.+..	+rr...+1+...	.......r......+.++	.+.................	....	....	....
Gladiolus crassifolius	.....	.+..	....	...+...+..1..r.	....	....	.+.....r..........	........r...+......	..........+	....	....+.......1...+.............+...+....
Gomphocarpus tomentosus	.....	....	....	...+..+r.+.+...	....	.r.r........	......+...........	....	....	....	...++.........................+........
Senecio barbatus	+....	....	......+........	...r+...r......	....	...+........	.......r+.........	..+.r.......+1.....	++...++.+..	.+.........++.........	...++........+....+.+.++.+......++.++..
Vachellia karroo	..r.r	....	.r.............	....r..r...+..1	....	....	....	....	....	....	....
Eragrostis plana	.....	....	....	.++.....r......	....	....	....	....	....	....	.................................r.....
Pogonarthria squarrosa	.....	....	....	.....r.r..+.r.r	.........+	....	.......r..r.......	+++.1+21.........+.	....	.....+r...............	........+.......1+...........rr........
Aristida congesta s. barbicollis	.....	....	...........r...	.....r..+..+.1.	....	....+...+...	............+.++..	.r..r............1.	....	.+..r.................	+.+.............r..rr..+.+......r......
Asparagus laricinus	.....	....	....	...r+......+..+	....	...r........	...........+r.11.1	...1...1...........	...1.......	....	.r.........................+..+......r.
Ficus cordata	.....	....	....	...2...........	.........+	....	....	....	....	....	....
Eragrostis chloromelas	.....	....	........+.2+...	.......1..2.21.	....	.........+..	.........+..+...+.	rr....1....+.......	....	....+.................	......2+r+......2++.r+.+.....+.+.......
Leonotis ocymifolia v. raineriana	.....	....	.............r.	......r....+...	...r..+.+r	....	...........+..+...	....	....	....	....
Chloris pycnothrix	....+	....	...........+...	...........2..+	....	....	....	....	....	....	....
Species group F - Characteristic species for community 4											
Andropogon chinensis	.....	....	....	....	2r...2+++.	+22..4.++.++	.........+....+..+	....	....	+.1++.................	...+.r..................++.............
Lannea discolor	.....	....	..r......rr....	....r..........	222r+.2.1.	.rr.+3331..2	..1..r..2.........	........1rr.....r.r	....	.....2................	...+......................2............
Englerophytum magalismontanum	.....	....	....	....	22r...+r.3	....r..r..r.	..2+rr............	...r...............	..........r	.....2.r..............	.....................................r.
Combretum molle	.....	....	2.r...+........	....	++r1..2.22	r.r.+..2.1..	1.r......2..2.....	...r....r....r.....	..........r	.....1..........r.....	........r........................r.....
Burkea africana	.....	.r..	..r...r........	....	.+2.2.+.3.	.r.r........	.rr...............	....+r.......r.....	....	...................r..	....
Combretum apiculatum	.....	....	....	....	+......31.	2r..rr.....2	....	....	....	....	....
Phymaspermum acerosum	+....	....	..r.....+.+....	....+r.........	.+.+++.++.	rrr.+r+r..++	.+.....++.++++1++.	.....rr.rr.........	......+..++	.....+...+.......+.+++	..+.................+..................
Tapiphyllum parvifolium	.....	....	........r......	....	.+r.+.+..+	....r......+	.++..r..r.+.1...1.	....	.r......r.r	.....2.r..r....+.....r	..........r............................
Wahlenbergia virgata	.....	....	....	............rr.	+..+...++.	...rr+......	....	...r............r+.	....	........+++...+..+..++	..............................+........
Species group G - Characteristic species for community 4.1											
Diplorhynchus condylocarpon	.....	....	....	....	22...2..r.	....	....	....	....	....	....
Mundulea sericea	.....	....	....	....	.......1r2	..+.+.......	+....+......+....2	.........r...1..r..	...r......+	......+....rr1...r..r.	...+...................................
Aloe marlothii	.....	....	....	........r......	.+r1..+1..	.r..........	....	....	....	...........r.r.......r	....
Strychnos cocculoides	.....	....	..2............	....	r....2r...	....	....	....	....	.....2................	....
Peltophorum africanum	.....	....	.............r.	....+..........	2+....+...	....	.2...r.....2......	....	....	....	....
Senecio venosus	.....	....	....	...+...........	.+.+++.++.	++.r+..+....	r+1......+.+++1.r+	...+.r..1....1..++.	....	.....1.........2.2..+.	.+.......+..........+.+.+..............
Ectadiopsis oblongifolia	.....	....	.......+.......	....	++.+.+.++.	....	.....+............	....	+..+.++...r	.......+..+.++.+..+..+	...........+...........................
Boophane disticha	.....	....	....	....	..+....+..	..r.........	..+.........+...r.	....	....	........++...+...+....	.........+..+..........................
Acalypha villicaulis	.....	....	....	....	+.....+.+.	r...........	....	....	....	.....+................	....
Aloe ferox	.....	....	....	....	++..r.+.+.	...........+	.....r............	....	....	..................r...	....
Mimulus gracilis	.....	....	....	............r..	++....+.+.	....	.......+......++++	+.r...............+	+..2..++...	.............+...++...	..+........+......+r.....+....+..+.....
Species group H - Characteristic species for community 4.2											
Indigofera cryptantha	.....	....	....	....	....	1....1.2....	....	.................1.	....	....	....
Kalanchoe thyrsiflora	.....	....	....	.........r.....	.+.....+..	....+.+.++..	...........+..+...	....	....	..+.+...++......+...+.	...........+.................r.........
Dovyalis caffra	.....	....	....	....	....	...r...r....	............r.+...	.............r.....	....	........+.............	....
Crotalaria brachycarpa	.....	....	.......+.......	....	.....+....	...r+.....+.	..............+...	........r.r.+......	+......+...	....	....................................r+.
Zinnia peruviana	..+..	....	.............++	...........+...	....	.....1++....	..........+.......	..............r....	....	....	....
Evolvulus alsinoides	.....	....	....	....	....	..r....1....	....	....	....	+.....................	....
Gnidia kraussiana	.....	....	.........+.....	....	+.........	......+.++..	+.................	....	....	....	....

Plant community number	1	2		3	4		5	6	7		
Sub-community number		2.1	2.2		4.1	4.2			7.1	7.2	7.3
Releve number	132 30 130 119 129	158 159 157 160	24 21 169 155 139 84 137 121 141 122 140 163 161 39 123	120 29 118 47 55 131 49 6 108 48 5 56 3 4 57	146 145 116 94 144 90 147 149 148 68	23 27 28 22 167 12 113 25 138 165 164 142	35 89 59 54 134 100 50 110 156 69 128 82 99 71 97 96 112 98	52 53 170 18 14 15 16 17 11 19 20 7 127 9 13 8 10 26 143	103 105 117 87 111 109 95 104 102 154 101	31 88 33 32 153 58 135 125 150 92 136 151 126 91 152 70 107 93 114 115 168 166	41 81 83 38 37 43 72 78 133 80 66 44 45 42 46 40 1 2 86 85 76 79 75 77 34 36 60 62 63 67 51 65 74 124 61 73 162 106 64
Species group I - Characteristic species for community 5											
Pygmaeothamnus zeyheri	. . + . .	. . . .	. . . . . . + . . . r	. . . . 1 1 . . . r	. . . r . . . . + .	r r . . . . +	. 2 + . r 1 + ... 1 . + . . 1	. . . . r . r . . .	1 . . . . r . r	. . . . . 1 1 . . . . + ...	. . . . r . . . . 1 . . . .
Gladiolus permeabilis	. . . . .	. . . .	. . . . + ...	. . + ...	. . . .	. . . .	. 2 . . . . . + . + . + . + . + . +	. . . .	. . . + . . + . . . r	. . . . + ... + ...	. + ... + ... + + . + ...
Ozoroa sphaerocarpa	. . . . .	. . . .	. . . .	. . . . 2	. . . r	2 2 2 . . . . r .	. . . . . 2 r . . . . 2 2 . 2	. . . .	1 . . r . . . . r . .	. . . . . 1 . . . . 1 + . .	. . . . 1 . . 2 . . . .
Eustachys paspaloides	. . . . .	. . . .	. . . .	. . . . . . + ...	. . . .	. . . . . . + 1 + + . .	. . + ... 2 . . + . + . + +	. . . .	. . . .	. . . .	. . . .
Schistostephium crataegifolium	. . . . .	. . . .	. . . .	. . . 2 . . . . . + ...	. . . .	. . . + ... + .	. . . . + ... 2 . . r .	. . + . . 1 . 2 + ... 2 . . .	. . . . . + ...	. . . .	. 2 . . . + . . + + ... + ... + ... + . + .
Drimiopsis burkei	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . + ... + + . +	. . . . r	. . . .	. . . .	. . . .
Digitaria diagonalis	. . . . .	. . . .	r . . . . r . . .	. . . r	. . . .	. . . . + .	. . . . . . r . + ... + . + . +	. . . . r	. . . . + ...	. . . .	. . . . . + ... r . r . . . . 1 . . + 2 .
Croton gratissimus	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . . r 1 . . .	2 r . . . r 2	. . . .	. . . .	. . . .	. . . . 1 . . . .
Cucumis zeyheri	. . . . +	. . . .	. . . .	. . . + ... + r +	. . . .	. . r r	. . . . . . + + . . . + . . . + . +	. r . . . . r	. r . . . . . r . . .	. . . .	+ . . . . + + ... + ... + ... + ...
Setaria megaphylla	1	. . + .	. . . . + + + ...	. . . .	+ + + . + ...	. . . . . . + + + + . .	. . . r . . . . . 3 . . 2	. . . .	. . . .	. . . .	. . . .
Hypoxis rigidula	. . . . .	. . . .	. . . . + ...	. . + ... r . . . . . 2 .	. . . .	. . . .	. . . . r + . + + . . . + . . . + r	. . + . . 1 . . . . +	. . . . + ...	. . . .	. . . . + . . . + ... + . . . + ... + ...
Oxalis depressa	. . . . +	. . . .	. . . . + + ...	. . + + + ...	. . . .	. . . . + .	. . . . . + . . + + + + + . + + + +	. + ...	. . . .	. . . . +	. . . . 1 . . . . r . . . . + .
Eragrostis capensis	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . r . . + ...	. . . . r	. . . .	. . . . . + ... r . . . + . . + . .	. . . . + . + ... + .
Chamaecrista comosa	+ . + . .	. . . .	. . . . + ...	. . . . . + . . + ...	. + . . + ...	. . . .	. . . . + . . . + . + . . 1	. . . . r	+ . . + + + ...	. . . . . . + ... + + ...	. . . . + . . + . . + + . + . .
Rhynchosia nitens	. . . . .	. . . .	. . r . . + ...	. . . .	1 2	r . . . 2 r	+ . . . . 2 . + ...	. . . .	. . . .	. . . .	. . . . . + ...
Digitaria eriantha	. . . . .	. . . .	. . . . +	. . . .	. . . .	. . . .	r 2 . . . . + ...	. . . .	. . . .	. . . .	. . . . 1 . . . .
Tragia sonderi	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . 2 . . 2	. . . .	. . . .	. . . .	. . . .
Convolvulus farinosus	. . . . .	. . + .	+ . . . . + ...	. . . .	. . . .	. . . . . r	. . . . + . . . + ...	. . . 2	. . + ...	. . . .	. . . .
Drimiopsis atropurpurea	. . . . .	. . . .	. . . .	. . . .	+ . . + ...	. . . .	. + ... + ... + ...	. . . .	. . . . . . + r . + .	. . . . + ... + . + ...	. . . .
Ochna pulchra	. . . . .	. . . .	. . . . r	. . . .	r . 3	. . . .	1 . . . . r	. . . .	. . . .	. . . .	. . . . r . . . .
Species group J											
Brachiaria brizantha	+ . 1 . +	. . . +	. . . . 1 . 1 . . + + . . . +	. . . . 2 + . + . + 1 + . 1 r	. . + . . 1 . . + r	4 . 1 . + . + . 1 . . .	. 3 + . + . + 1 . . . + + 1 . + 2 .	1 . + . . . 2 + . + ...	+ . . . . r	. . . . + ...	. . . . r . + ... + ... + ...
Tagetes minuta	. . . . .	. + . .	r . . . . + + . . . + . + + +	. . . r + . + ...	. + . + . + . . + +	+ + r + . r . + + + + .	. . + . . + + + + . + + + 2 + . . +	1 . . . . . r r . r . . . . + . . + .	. . . . + .	. . . + ... + ...	. . . . + ...
Sida dregei	+ . + . .	. . + .	1 . + + + . + + + . + . . + +	. . . + + . + ... + . . .	. . . . + + ...	+ . . r . 1 + . + + + .	. + + r + . . . + + ... +	. . . 2 . + r . . . . r . . . +	. . . .	. . . .	. . . . + . . + ... + . .
Bidens pilosa	+ . + . +	. . + .	. . . . . + . . + . + + . + +	. . . . + + + ... + . + +	. . + ...	. . . . . r + . + . . .	+ . + . + r . . . . + + . + . . + .	+ + . 2 . . . r r . . . . . . + . . .	. . . + ... + .	. . . .	. . . .
Verbena bonariensis	+ . + + +	+ . + .	. r . . + . + . + . + + + . +	+ . + r . + + . + . . + . . +	. . . .	. . r r	. . . . + . + ... + .	1 . + . r . . . . + +	. . + ... r . . .	. . . .	. . + ... + ... r .
Solanum panduriforme	. r + . +	. . . .	r . + . . + . . . + . + + + .	. . + + + . + + . . 1 + . + .	. . . .	. + r r . . . r . . + .	. . . . + . . + + + + . . + .	. + . . r . . r . . . . . . + . . + .	. . . .	. . . .	+ . . . . + ... + + + + ... + . . + . . + + ... + . .
Cussonia spicata	. . . . .	. r . .	. r 2 . . . . r . .	. . . .	. . . + r	. r r . . . . r .	. . . . . . r	. . . .	. . . .	. . . .	. . . .
Species group K - Characteristic species for community 6											
Faurea saligna	. . . . .	. . . .	r . . . . r . .	. . . . r 2 2	. . . r	. . . r r . . r . . 2 .	. r . . . . . . 3 . . 2 . 2	. r 3 . 3 2 2 2 2 r 2 . 2 . 2 . 2 . .	2 . . . r	. . . 1 . . . . r .	. . . r . . . . 2 . . . .
Lippia javanica	. . . . .	. . . .	2 . . . . + ... + .	. . . r . . + . . + ...	. . . . + . .	r + r 1 . . . + + + + +	+ . . . . r . . . + . + . 1 . . . +	+ . + 2 1 1 + 2 . . + . + r + . r + +	. 1 . . . . . r . . .	. + . + ...	. . . + . . . + ... r . . + . 1 . . . .
Dichrostachys cinerea	. . . . .	. . . .	. . r	. . . .	. . . .	r + + 2 . 2 . 2	. . 1 . . . . . + ...	. . . r + r r r . r r 2 . . r 1 r . .	. . . .	. . . .	. . . .
Tephrosia capensis	. . . . .	. . . .	. . . .	. . . .	. . . .	1 . . . + 1 . . + + . .	. . . .	+ . . 4 . + . r . + . + . . . 1 . . .	. . . .	+	. . . . + ...
Acrotome hispida	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . . + . . .	. . . .	. . . + r r . . . r 1 + . + . . . 3 .	. . . .	. . . . + ...	. . . . + + ... + ... + ...
Eragrostis rigidior	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . 2 r 3 . . . . 2 . . .	. . . .	. . . .	. . . . r . . . .
Helichrysum melanacme	. . . . .	. . . .	. . . . + . . .	. . . .	. . . .	. . . .	. . . .	. . . . 2 2 2 . . . . 1 +	. . . .	. . . .	. . . . + ...
Osteospermum muricatum	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . + ...	. . . . r . 1 . 2 . + 2 . . . . 2 . +	. . . . . + ...	. . . . . r	. . . . 2 . + . . + . . + . . . + ... + . . .
Hypoxis iridifolia	. . . . .	. . . .	. . . .	. . . + ...	. . . . +	. . . .	. . . . + . + ...	. . . r . . . . . . 1 r . . r r . . .	. . . . + ...	. . . .	. r + . . . r . . + ... r . . . . + . . .
Helichrysum coriaceum	. . . + .	. . . .	. . . .	. . . . + . . . + . r	. . . .	. . . .	. . . .	. . . 2 1 . . + ... r . 1 r . .	. + ... + . . .	. . . .	. . . . 2 . . . . + . . . + ... 1 .
Rhynchosia monophylla	. . . . .	. . . .	. . . . + . . .	. . . .	. . . . + . .	. . . .	. . + . . + ...	. . . . . r . . . 2 . + . + . + r . .	. . . . + . .	. . . . . + ... + ... + ...	. . . . + . + . . + ...
Polygala hottentotta	. . . . .	. . . .	. . . .	. . . + ...	. . . .	. . . .	. . . .	. . . + 2 . . . . r . . . . + r	+ . . . . . . + + . +	. . . . + + . . . + ...	. . . . . + + . . + ... + + . . . + . + ... + . + + ...
Andropogon schirensis	. . . . .	. . . .	. . . . + ...	. . . .	. . . . + ...	. . . .	. . + . . . + ...	. + . 1 + ... 1 . 2 2 . .	. . . .	. . . . . . + . . . + ...	. . . . + + . + ... + + ... + r + . + + + + . . +
Dicoma zeyheri	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. + + . r 1 1	. . . .	. . . .	. . . .
Hypoxis argentea	. . . . .	. . . .	. . . . + . + ...	. . . .	. . . .	. . r	. . . . r	. . . . . . r 1 . . . . r r . .	. . . .	. . . .	. . . .
Gladiolus sericeovillosus s. calvat	. . . . .	. . . .	. . . .	. . . r	. . . .	. . . . . 1	. . . .	+ . . r r . . . . + . . . r	. . . .	. . . .	. . . . r . . . .
Oldenlandia herbacea	. . . . .	. . . .	. . . .	. . . .	. + . . + . . . + .	. . r . + ... +	. . . . . + ... 1	r . . . . . . r . . r . . . . . . 1 +	. . . .	+ . . + 1 . . . . . . + . . + ... + +	. . . . 2 . . + + ... + ... + + ... +
Eriosema cordatum	. . . . .	. . . .	. . . . + . + ...	. . + . + ... r 1 .	. . . .	. . . .	. . . . . + + ... + ...	. + + . . r	. . . . + . .	. . . + ... + ...	+ . + ... + + ... + . . + + . 2 + . . . 1 . . . + . r r 1 . + + .
Ozoroa paniculosa	. . . . .	. . . .	. . . . +	. . . + ...	. . . + ...	. . . . . + ...	. . . .	+ + ... + .	. . . .	. . . + ... + + . . .	+ . . . + . . . + . . 1 . . + + ... + . . . + . . + . + ...
Melhania prostrata	. . . . .	. . . .	. . . .	. . . . r . . 2	. . . .	. . . .	. . . .	+ 2 + ...	. . . .	. . . .	. . . . + ...
Species group L - Characteristic species for community 7											
Elionurus muticus	. . . . .	. . . .	. . . .	. . . .	. . . + ...	. . . .	r . + ...	. . . .	. . + . + + + + + + .	+ . + 1 + + . . r + + + . + r + 1 . + + . .	+ + + 1 + . r . . . . . + + + r . . + + . . + + + + . + + + . + + . . 1 . + +
Cyperus rupestris	. . . . .	. . . .	. . . .	. . + ...	. . . .	. . . .	. . . . + ...	. . . .	. + ... + ...	. . . . . + . + . + . . + + . . + . + . . .	. . . . . . + + . . + 1 . . . . . . + + 2 + . + ... + . . + . . . + . . .
Trichoneura grandiglumis	. . . . .	. . . .	. . . .	. . . . . r	. . . .	. . . .	. . . .	. . . .	r . . . . + .	+ + . + + + + . + + + + r + . . + . + . + .	. . . . + . r + + ... + . r . . r . . . . +
Species group M - Characteristic species for community 7.2											
Aristida diffusa	. . . . .	. . . .	. . . .	. . . .	. r . . r 1	. . . . + ...	. . . . + ...	. . . . r . . . + .	. . . .	. . . . + 2 2 . + . + + . 2 . 2 + ... 2	. . . . 1 . . . . + ...
Helichrysum sessilioides	. . . . .	. . . .	. . . .	. . . .	+ . . + . r + . + .	. . . .	. . . . . + . r	. . . .	. . + ...	. . . + + . r + + . + . + + . . + + + + . +	. . . . + ...
Maytenus tenuispina	. . . . .	. . . .	. . . . . + ...	. . . .	. . . . + . . + . .	. . . .	. . . .	. . . .	. . . . . . + ...	. . . . . 2 . . r . . 1 . . . . . . 1 + . .	. . . .
Parinari capensis	. . . . .	. . . .	. . . .	. . . + ...	+ . . . . + . . . r	. . . .	. . . .	. . . .	. . + . . . + ...	. . . . + . . + . + + . . r + . + . + . . .	. . . 1 . . . + . + . . 2 . . + 1 . + ... + . . r . . . r . . . r .
Myrothamnus flabellifolia	. . . . .	. . . .	. . . .	. . + ...	. . . . + . . . + .	. . . . + ...	1 . . . . + . . . + ...	. . . . 1	. . . .	. + . . . 1 . . . + ... + + ... + +	. . . . + ...
Lopholaena coriifolia	. . . . .	. . . .	. . . .	. . . . r	. . . .	. . . .	. . . . 1 .	. . . r . . . . r	. . . .	. . . . . . 1 . r . r . . . . . . r . . r .	. . . . r . . . . + ... r . . . . r +
Clerodendrum triphyllum	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . + . + ... + ...	. . . . r + . + ...
Rendlia altera	. . . . .	. . . .	. . . .	. . . .	+ . . . + ...	. . . .	. . . . . + ...	. . . . . . r	+	. . . . r . + ... + ... + ... +	. . . .
Anacampseros subnuda	. . . . .	. . . .	. . . .	. . . .	. . . . + .	. . . .	. . . .	. . . .	. . . .	+ . . . . . . + + . . . + r . . + . + . . r	. . . .
Kohautia amatymbica	. . . . .	. . . .	. . . .	. . . . + ...	. . . .	. . . . + . . .	. . . . + ...	. . . .	. + + ...	. . . . . . + + . . + . + . . . 1 . + + . .	. . . .
Cyanotis speciosa	. . . . .	. . . .	. . . .	. . . .	. . . .	. . . .	+ . . . . + .	. . . .	. . . .	+ . + . . . + ...	. . . .
Monocymbium ceresiiforme	. . . . .	. . . .	. . . .	. . + ...	. . . .	. . . .	. . . .	. . . .	. . . . r .	. . . . r . . . . + . . .	. . . . + + ... r r . . . . + ... + . . 1 . . . +

Plant community number	1	2		3	4		5	6	7		
Sub-community number		2.1	2.2		4.1	4.2			7.1	7.2	7.3
Releve number	132 30 130 119 129	158 159 157 160	24 21 169 155 139 84 137 121 141 122 140 163 161 39 123	120 29 118 47 55 131 49 6 108 48 5 56 3 4 57	146 145 116 94 144 90 147 149 148 68	23 27 28 22 167 12 113 25 138 165 164 142	35 89 59 54 134 100 50 110 156 69 128 82 99 71 97 96 112 98	52 53 170 18 14 15 16 17 11 19 20 7 127 9 13 8 10 26 143	103 105 117 87 111 109 95 104 102 154 101	31 88 33 32 153 58 135 125 150 92 136 151 126 91 152 70 107 93 114 115 168 166	41 81 83 38 37 43 72 78 133 80 66 44 45 42 46 40 1 2 86 85 76 79 75 77 34 36 60 62 63 67 51 65 74 124 61 73 162 106 64
Species group N - Characteristic species for community 7.3											
Gladiolus elliotii	.....	....	....	....	....	....	....	.......r...........	......+..+.	....	.++...+..1.........+.+++..1.+.+...11...
Indigofera comosa	.....	....	....	....	....	....	+.................	....	....	....	1..+1......+++1+.......................
Lotononis foliosa	.....	....	....	....	....	....	....	....	....	....	1+....+..+.+.+.1..+......+.............
Wahlenbergia undulata	.....	....	....	..........r....	....	...+........	....	r.....r.......1..1.	....	...+..................	.....1.....+.+.....+.....r.............
Lycopodium clavatum	.....	....	....	....	....	....	....	.........2.........	.........+.	.+......+.............	...++.........+...........+........+..+
Searsia wilmsii	.....	....	....	....	+...+.....	....	.....+............	...............rr..	....	....	+...........+.++..++..+....+.....+..+..
Striga elegans	.....	....	....	....	....	....	...........+......	.................+.	.......+...	....	.............+......+...+...r..........
Ophrestia oblongifolia	.....	....	......+........	.....+.........	....	....	....	.+r................	....	....	.........+..+..+.......................
Hypericum lalandii	.....	....	....	....	....	....	...............+..	....	....	...................+..	...+.......+........+............+...+.
Acalypha angustata	.....	....	....	....	....	....	.+................	....	....	.................+....	.........................+.....+..+...+
Pearsonia sessilifolia s. filifolia	.....	....	....	....	....	....	.......r..........	....	....	....	............................+..+..+..+.
Eclipta prostrata	.....	....	....	..........r..r.	....	....	.............+...+	....	....	....	....................+.2...+............
Solanum sisymbrifolium	.....	....	....	......+........	....	....	....	....	...+.......	.+....................	..++...........+.......................
Scilla nervosa	.....	....	....	....	....	....	.....+............	....	..........+	....................+.	....................r+.................
Species group O											
Tristachya leucothrix	.....	....	....	....	....	...1...r....	..1r..............	r2.4444443.3.32342.	....	.....+................	.......+........+....+++..+1+1..+.2....
Protea caffra	.....	....	....	....	....	....	....	........r.3.r.....2	...12......	...2r.................	...rr..........r.......2..332.3...3....
Vernonia oligocephala	.....	....	....	..++......r....	....	.+r+........	....	..+2+..21..2......+	.r...+.....	....	.++..1++.+++11+.r.++++..++.....+.+.++.+
Dicoma anomala	.....	....	....	........+......	....	....	............r.....	..+.r++..r.....rr+r	..+.++.r.+.	....+r...+++.+......+.	...+..+....+.....r++..+..+.++++++.+.++1
Polygala uncinata	.....	....	....	........+.+....	...+......	....	....	...2++++..r.+.....+	.....++.+..	....	....+.......+..r.r.+..+................
Becium obovatum	.....	....	....	.....+..+......	........+.	.........+..	.................+	..+.........+.2+1++	.+.+..+.++.	+......+...++++.+.+++.	++.++..++...+++.r.+..........1...++...+
Sebaea grandis	.....	....	......+........	....+..........	...+......	..rr........	..+............+..	.+.1r.+.r.+...r.r..	...+...+..+	+........+....+..+..+.	....+....................+.....+..+....
Helichrysum acutatum	.....	....	...........+...	....	...+......	....	....	.....++.....+.r...+	..++.......	....+.........+.......	........++........+..+.......++........
Species group P											
Trachypogon spicatus	.....	....	....	...+...........	....	....+.......	.+rr....+.r+......	r++r132222.1.11.2.3	..++..+..+.	+.11+r+2++2++.++.+.+++	+2++1+++++2+r+++++++..+++++++++++11++.+
Vernonia natalensis	.....	....	....	.....+.1+......	....	....	.+rr....+.r+......	r++r132022.2.31.0.4	..++..+..+.	+.31+r+3++3++.++.+.+++	+3++3+++++3+r+++++++..+++++++++++11++..
Panicum natalense	...+.	....	....	....	1	........2...	......r.2.r..r2+..	+..2..r1.2..+2.31.+	...+......1	..2..r.+...12.+.....+.	2..+221..++.+2+2+..1.2+...2+.r++.+.1+2+
Aristida transvaalensis	.....	....	....+..........	.........+.....	....	....	...r++1....+.+..++	....	+.......+..	+..+...+....+.....++..	..r....+.................r.+..++..+...+
Phymaspermum athanasioides	.....	....	....	....	....	r...........	..+....r+....+...+	..+1r1...1r1+2.111+	.+++1++++1+	..+..+++++.++++1+++++.	.+..++...++++.+.r+122+.++.++.++.+++++++
Urelytrum agropyroides	.....	....	....	....	....	....	..rr..rr..........	.r....1......2..1.+	.++.++.1.+3	..1+.r++r.+++.+++.r+++	+2++r++...+.++..r.++r..++.++...+.++++++
Gazania krebsiana	.....	....	....	....	....	....	........+...r+....	.++.r+...2.+..r..++	+++.+.++.+.	+......+...+...++.....	++.++1+.+++++.+..r++++++.++.+++.r++.+.+
Species group Q											
Loudetia simplex	.....	....	r..............	....	3333332333	.11....+....	..2r21..1.1..2+++.	+...2.23r534.4.4242	2233++3233r	2333333333333333333333	..+.2.r1+.+..+1r..12....2r3333r333332.3
Brachiaria serrata	....+	....	....	...+...........	..+++..++.	2122.1......	...r.+++1..+r.1...	+2.231.r3312.23332+	.1++1+222++	++1+1..+++.1++22+.1++r	+1+++1+..1+1++++1.+++1++++111+2++1++1.+
Tristachya biseriata	.....	....	....	........+......	.++2+.....	....	.+.....++.........	..+...............+	+3222323+++	+..+..+222.22+2.22+2++	+.+..+...+.+.+....++.....+.......2..2++
Schizachyrium sanguineum	.....	....	....	...r..+3++1.12.	...++.++.r	....	.++r.+..+++1.+.+.+	++++.r2r2+.+.1+22++	.++2+.+++2+	22.1+++++++++2.+.+++++	+2+.1++r3++112123++.+++11+++++++++++++
Diheteropogon amplectens	.....	....	....+.....+....	....	.1++++.++r	..rr+..r+.+.	.....+.r++.++2++.+	r+.2++1+21.1+r212r.	+++++1++++1	1++++r.+++r+++++++++++	++++++++.+++r+1+rr++.+11.+++++.++.+++.+
Digitaria monodactyla	.....	....	....	.......r+r.....	...2......	....	r..r.......+......	+r..2......1.2.....	..+........	+..++.2+..1+1.r.222+++	1++2+1r2.+122121..++r.+2+r..2+++rr.+...
Indigofera filipes	.....	....	....	....	++..++.++.	....+...r...	...............r..	...........1...1...	..+..+.++..	........+1r+....+..1++	.2....+.22+......r22.1+.........1..+...
Sphenostylis angustifolia	.....	....	....	.....+..+...r..	.+.+......	+1...+.+....	.....++r+......+..	+...r..1...1.r..+++	.+.2+++1+++	+2+++++++++++++2+++1++	++.222...++.1.12rr+++.+.+1.++.++..+++.+
Xerophyta retinervis	.....	....	....+..........	....	++.+++++.+	+...+..+....	r.+..+.r.1...+++++	................1..	+...+.+.+..	+++++1r++++++2+++1++++	.........+........+r...+.....+.....+...
Zornia linearis	.....	....	....	........+.....+	....+.....	..r.....+...	.....+......+.....	............+...r..	+r+..+..+..	.+......+r..+.....+...	+...+......++..+rr.....+............r.+
Species group R											
Setaria sphacelata	.+...	....	41..3..+2....+.	+.++...23r...r+	+r222++22.	34342.+331++	2+1.+1+33.3.2323+3	1+3223213..2221.222	++.1+2++.++	+.++.+++..2.++.+.2++.+	+++++++++2r.++.+..++.+22+2.+++1+2+.2.2.
Hyparrhenia hirta	.1+.+	....	......+++..3++.	+1+22224+232341	...+++...r	+.r.+.++..1.	....3+2+.++2++3+++	23+13.2.2.........+	..+2+......	.+....+............+..	2+3...332+32.2.222..r2+++1+...+..++....
Themeda triandra	.....	.+.2	.+2.+..........	........+1r....	+12+++.1+.	22223r+1+22+	..+r.3....2...222+	+++3222324.3+222.1+	321+32+22.2	11+21+2+2++.1+++2+1122	11+++++.++++++1+r.++.+1.+++2+21+22++232
Eragrostis racemosa	....+	....	...........1...	.++...+r+.2.+1.	+...+....r	2...+...+.+.	.....+++..+++.++..	+12.233212.2.2.2213	2+2..11++21	1+1+2++++1.1+...++++++	1++1112222.121+2++44.22.11+.12+21+++++2
Melinis nerviglumis	..r..	....	..........+2r..	...++..22+2++2r	+r+1+1+++r	1221+.2++.++	+.+r11+++++.++++++	+++2111r12.1+12212+	++++r+++++.	+++++++++2+++2+1+122++	++r+.++++++.++++2++r.+...++++++.r++++.+
Pellaea calomelanos	.....	..++	.1..++....+....	...r.....+.....	++++++++++	++..+r+1++.+	+.+r+.+++++1+++++.	.......rr...+r.r...	...+..+.++.	+++..1+.+++.++++++.+.+	...........+...+.......................
Commelina africana	..+.+	....	..+.+.+.+.+..++	......+.+......	+.+.+++...	......+.++++	.....++.+++...++.+	............+.....+	+..........	++..+++.+.........+.++	........+..............++...+....+.+..+
Mariscus congestus	+.+.+	+++.	...++...+.+....	..+..+...+.....	...+.....+	.....r+...+.	...++..+++.+..+..+	.........1....r.1..	.++.+++r.+.	....+...+..+....2.+..+	..+++1+1..2......+.......+..+1......+..
Lantana rugosa	..+.+	....	..r...+++..+++.	....+++.r.....+	....	.1r1.......+	.++r+.+2+.+.2..++.	+++1...+1r....2..2.	...++......	....................+.	.....++.............+..+..+.+.+..+.....
Bewsia biflora	.....	....	r...+..........	...+..+........	..+.......	.......+....	.2...+.++....++..+	3++22.2222.2...323+	111++2222+2	++++.r+++.+211+.1+22+.	++2111+..3+211.11.33333322222+312222++1
Cymbopogon caesius	....+	....	.......+..r...+	...+...++...2.2	.r.....+..	.r.1+r......	.+.r..r++r++..++..	+1.2+122+1.132412+.	++.+++++.+.	+++++++.+...+++++.+.+.	.3+++2++.2+++.+++++++1+++++..++++++r++1
Helichrysum kraussii	.....	....	..r.+.+...r+r..	...+.+.1..r+r1.	...+......	.1rr.r......	..........+..1....	..+2.12331.2+.2..+.	......+....	+..++......+..+.......	.++..+.+.++1.++1r.++............++..r.+
Felicia muricata	.....	....	.............+.	..+.....+..+...	.+........	+..r+....1r.	......+.........r.	+.....+2.........++	....+...r..	..........+..++...+.+.	.+.........+............+...+..........

4.2 Description of plant communities

4.2.1 *Sporobolus africanus*-*Buddleja salviifolia* wetland

This small plant community covers approximately 1.3% (58 ha) of the study area. It is found within seasonally wet drainage channels and seepages at an altitude ranging from 1 285 to 1 406 m.a.s.l., on the south-western side of the study area, with patches present in the east, central sections and central western boundary side. An artificial dam located in the central western boundary forms part of this plant community.

The estimated tree cover range for this community varies between 0% and 5% range, with an average of 1%, while the shrub layer cover ranges from 10% to 60% (Ave. 28%). The grass layer was estimated to cover between 20% and 65% range with an average of 34%, and the forb layer from 10% to 50% (Ave. 32%). Rocks cover ranges between 5% and 10% with an average of 6%. This community had relatively good vegetation cover in most areas.

It occurs within the Ib10 and Ib17 land type (Land Type Survey Staff, 1988) and is characterized by shallow to moderately shallow soil. The soils range from clayey-loam to clayey. Erosion was observed on the northern part of the study

area, near the artificial dam. This is due to the trampling activities by wild animals, and was estimated at class level 4 (Table 3.2). This class level may lead to deep intricate dissection, which may result in a gully formation, should it be left unattended (Fitzpatrick *et al*., 1986).

The area is accessible to wildlife and characterized by relatively flat to gentle mid slopes with a gradient of between 0° and 9° (Table 3.3). High animal activities were recorded, with animal signs ranging from fresh to old animal droppings, moderate grazing levels and relatively high trampling. Animals observed grazing and browsing in the area during field surveys included the buffalo, tsessebe, sable and kudu.

Characteristic species for this community are from species group A (Table 4.1) and include:

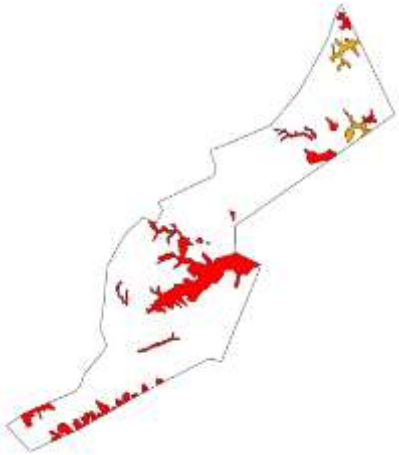
Buddleja salviifolia	***Sporobolus africanus***
Hyparrhenia tamba	***Pteridium aquilinum***
Diospyros lycioides	***Pennisetum macrourum***
Eragrostis heteromera	***Paspalum dilatatum***
Artemisia afra	***Urochloa mosambicensis***
Dipcadi viride	***Paspalum urvillei***
Schoenoplectus corymbosus	***Senna italica***

A total of five sample sites represent this community. The average number of different plant species recorded per sample plot was 27. The vegetation is characterised by the dominance of the shrub *Buddleja salviifolia* (species group A), which often grows on rocky hillsides, along forest margins and watercourses; and the grass *Sporobolus africanus* (species group A). *Buddleja salviifolia* is a semi-evergreen, multi-stemmed shrub that grows to between four and eight meters high (Van Wyk & Van Wyk, 1997). Other prominent species include the woody *Diospyros lycioides* (species group A); the grasses *Hyparrhenia tamba, Pennisetum macrourum, Eragrostis heteromera, Paspalum dilatatum, Urochloa*

mosambicensis, Paspalum urvillei (Species group A) and the forbs *Pteridium aquilinum, Artemisia afra, Dipcadi viride* and *Schoenoplectus corymbosus* (species group A).

Alien species recorded in this plant community include the trees *Melia azedarach* in close proximity to sample site 132, *Agave americana* in close proximity to sample site 129 and *Populus* x. *canescens* stands in the running stream near to sample site 30.

4.2.2 *Panicum maximum*-*Senegalia caffra* riverine woodland



This community occurs scattered throughout study area. It covers an area of 526 ha, which is 11.8% of the study area. The vegetation is mainly dominated by the tree *Senegalia caffra* and the grass *Panicum maximum* (species group B). Prominent species include the woody species *Ziziphus mucronata, Dombeya rotundifolia* and *Celtis africana* (species group B).

Species belonging to species group B (Table 4.1) are characteristic for this plant community and include:

Panicum maximum	***Senegalia caffra***
Ziziphus mucronata	***Celtis africana***

Asparagus virgatus	***Rhoicissus tridentata***
Asplenium trichomanes	***Heteropyxis natalensis***

This vegetation is characterised by the dominance of the tree *Senegalia caffra* (species group B) and the grass *Panicum maximum* (species group B). Other local prominent species include the trees *Ziziphus mucronata, Celtis africana*, *Heteropyxis natalensis* (species group B)*, Senegalia burkei, Dombeya rotundifolia, Searsia leptodictya, Albizia harveyi*, *Searsia pyroides* (species group D); the grasses *Setaria sphacelata* (species group R), and forbs *Asparagus virgatus* and *Rhoicissus tridentata* (species group B).

Two sub-communities are identified for this plant community, namely:

- *Panicum maximum-Senegalia caffra-Olea europaea* subsp. *africana* sub-community.
- *Panicum maximum-Senegalia caffra-Searsia leptodictya* sub-community.

4.2.2.1 *Panicum maximum-Senegalia caffra-Olea europaea* subsp. *africana* sub-community

The *Panicum maximum-Senegalia caffra-Olea europaea* subsp. *africana* sub-community is located on the north and north-eastern side of the study area. It

covers approximately 55 ha, and forms 10.1% of plant community 2. Altitude ranges from 1 206 to 1 310 m.a.s.l.

The estimated tree cover ranges between 70% and 80% with an average of 75%, and is represented by a dense woody habitat. The shrub cover estimation varies between 20% and 30% range (Ave. 28%); grass cover between 5% and 10% (Ave. 8%) and forb cover between 5% and 30% (Ave. 18%). Rock cover ranges between 10% and 30% (Ave. 19%). There is very little grass cover under the closed tree canopies due to poor sunlight penetrating to the ground.

This sub-community occurs on the Ib10 land type, which is characterised by miscellaneous shallow soil and described as sandy-loam to sandy-clayey-loam (Land Type Survey Staff, 1988). Erosion signs were recorded along game paths. There are visible signs of previous veld fires in the area.

The area is accessible to wildlife and comprises of relatively gentle midslopes with a gradient ranging from 4° to 9° (Table 3.3). Various animal tracks leading to a stream were observed within this sub-community, and no animals were seen during the field surveys.

Species of characteristic significance to this sub-community are from species group C (Table 4.1), and include:

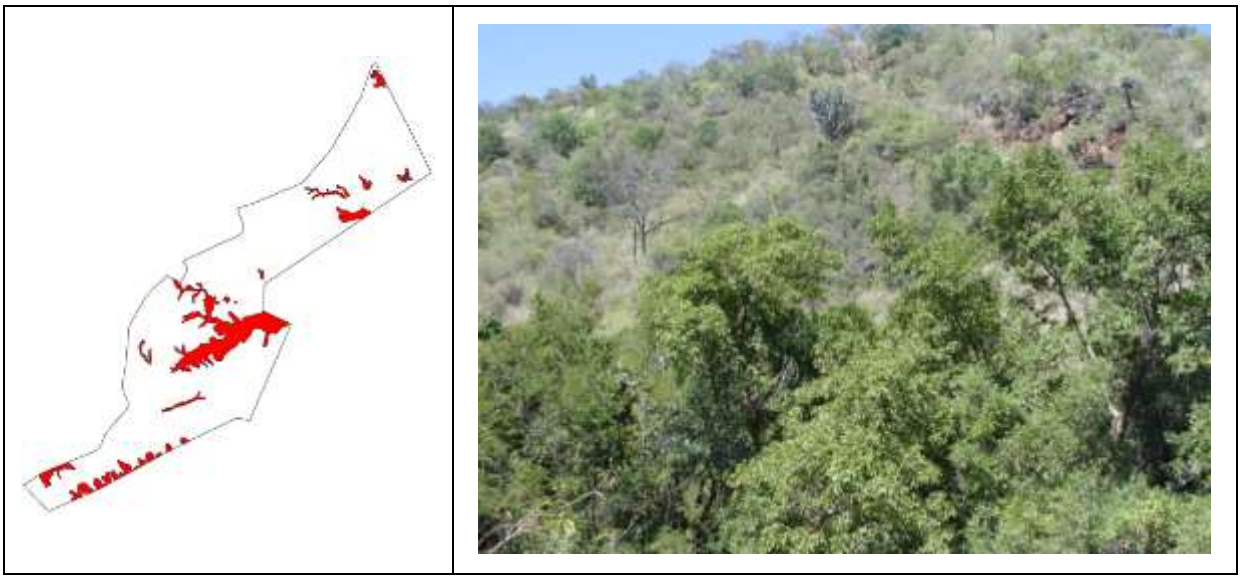
Olea europaea* subsp. *africana	***Mimusops zeyheri***
Maytenus undata	***Euclea divinorum***
Elephantorrhiza burkei	***Gerbera jamesonii***
Oplismenus hirtellus	***Erianthemum ngamicum***
Diospyros whyteana	***Mohria vestita***
Vepris lanceolata	***Searsia magalismontana***
Cucumella bryoniifolia	***Chlorophytum aridum***
Amaranthus hybridus	***Searsia dentata***
Stachys grandifolia	***Polystichum dracomontanum***

Euphorbia ingens ***Cussonia paniculata***

A total of four sample sites represented this sub-community. An average of 36 different plant species was recorded per sample plot. The vegetation is characterised by the dominance of the trees *Senegalia caffra* (species group B) and *Olea europaea* subsp. *africana* (species group B). Other species that are locally prominent include the woody *Celtis africana* (species group B), *Mimusops zeyheri, Maytenus undata* and *Euclea divinorum* (species group C). The grass layer is not well-developed mainly due to the high woody cover with only *Panicum maximum* (species group B) present in some localities.

Opuntia ficus-indica is the only alien plant species recorded for this sub-community.

4.2.2.2 *Panicum maximum-Senegalia caffra-Searsia leptodictya* sub-community



The *Panicum maximum-Senegalia caffra-Searsia leptodictya* sub-community is mainly located in the central part of the study area, with patches in the northern and north-eastern sections as well as the southern and south-western sections. It covers an area of 471 ha, which is 89.5% of plant community 2. Altitude varies

between 1 272 and 1 382 m.a.s.l. on the east and south-east to north-west facing slopes.

Estimated tree cover for this open to closed woodland ranges between 20% and 90%, with an average of 65% and shrub cover ranges between 10% and 70% (Ave. 32%). The grass cover ranges from 10% to 60%, with an average of 20%, and the forb cover ranges between 10% and 50% (Ave. 27%). Rock cover is estimated at 20% to 55%, with an average of 26%. The habitat ranges from open to closed woodlands with rocky outcrops and slopes. The forest floor in closed canopy areas has little to no grass due to accumulation of dead organic material and poor sunlight penetration.

This sub-community is located in the Ib10 land type and is characterised by miscellaneous shallow soil (Land Type Survey Staff, 1988). Soil ranges from sandy-loam to sandy-clayey-loam. There were no signs of soil erosion observed in the area and visible signs of previous veld fires were recorded.

The habitat is accessible to wildlife and occurs on relatively gentle midslopes with a gradient of 4° to 9° (Table 3.3). It is restricted to rocky slopes dominated by woody vegetation. Animal paths were observed going to-and-from the stream in the area. Animals sighted during field surveys were sable antelope.

Characteristic species of this sub-community are from species group D (Table 4.1) and include:

Senegalia burkei	***Dombeya rotundifolia***
Searsia leptodictya	***Berchemia zeyheri***
Maytenus heterophylla	***Asparagus setaceus***
Sida spinosa	***Albizia harveyi***
Searsia pyroides	***Abutilon angulatum***
Grewia occidentalis	***Euclea crispa***
Rhynchosia totta v. totta	***Grewia monticola***

Eleusine coracana	***Cheilanthes quadripinnata***
Crassula swaziensis	***Pleurostylia capensis***

Fifteen sample plots were surveyed within this sub-community with an average of 33 different plant species recorded per sample plot. The vegetation is dominated by the woody species *Senegalia caffra* (species group B), *Searsia leptodictya* (species group D) and the grass *Panicum maximum* (species group B). Other species that are prominent include the woody *Senegalia burkei, Ziziphus mucronata, Heteropyxis natalensis* (species group B), *Dombeya rotundifolia, Albizia harveyi* (species group D), the grass *Setaria sphacelata* (species group R) and the forbs *Sida dregei* (species group J) and *Pallaea calomelanos* (species group Q).

Alien plants recorded in this sub-community are *Acacia mearnsii* (close to sample site 84), *Populus* x*. canescens* (close to sample site 138), *Melia azedarach* (close to sample site 132) and *Jacaranda mimosifolia,* recorded in homestead areas on a non-fenced-off section of the reserve, and near the Nooitgedacht picket.

A closely related woodland community *Rhus leptodictya-Senegalia caffra* woodland on a Fb land type was described by Bezuidenhout, Bredenkamp & Theron (1994) in the former western Transvaal grassland. The community in the study area showed affinity with the one described by Bezuidenhout, Bredenkamp & Theron (1994) due to the presence of *Searsia leptodictya* and dominance of *Senegalia caffra*. The *S. leptodictya-Senegalia caffra* woodland is one of the communities corresponding with the Andersite Mountain Bushveld (SVcb11) described by Mucina & Rutherford (2006), dominated by species such as *Vachellia karroo, Senegalia caffra* and *Ziziphus zeyheriana.* According to Cilliers, Van Wyk & Bredenkmap (1999), the *Rhus leptodictya-Senegalia caffra* woodland community is threatened by disturbances such as animal trampling, soil compaction, uncontrolled fires and firewood collection.

4.2.3 *Eragrostis curvula-Hyparrhenia hirta* old field grassland

The *Eragrostis curvula-Hyparrhenia hirta* old field grassland occurs on the central and western border as well as the south-western border of the study area. It covers approximately 252 ha, which comprises 5.7% of the study area. The altitude ranges from 1 272 to 1 450 m.a.s.l. This plant community occurs on north, west, and east facing slopes. The area was previously utilized for the planting of crops and has since been incorporated into the reserve and left fallow. It is dominated by *Hyparrhenia hirta*, the most common thatch grass species in south Africa (Van Oudtshoorn, 2012). This grass is currently harvested by the local communities for thatch purposes.

The estimated cover for the tree layer ranges between 5% and 20%, with an average of 4%. The shrub layer covers ranges between 10% and 20% (Ave. 8%); the grass layer ranges between 50% and 90% (Ave. 63%) and forb cover ranges between 10% and 20% (Ave. 12%). No large rocks or outcrops were present with gravel covering between 5% and 10% of the area.

This community is found on the Fa7 land type, which is characterized by shallow to moderately shallow soil on hard rock. Soils are well-drained, varying from

sandy-loam to sandy-clayey-loam. There were no obvious signs of soil erosion present in this community. Signs of previous veld fire occurrences were evident.

The area is accessible to wildlife and is relatively flat, occurring on gentle mid slopes and foot slopes with a gradient of 0° to 9° (Table 3.3). There were signs of moderate to high grazing and trampling, as well as old and fresh animal droppings. Animals sighted in this area during field surveys include zebra, blesbok and sable antelope.

Species from species group E are characteristic for this community (Table 4.1), and include:

Cynodon dactylon
Aristida congesta* subsp*. congesta
Elephantorrhiza elephantina
Kyllinga alba
Hibiscus trionum
Gomphocarpus tomentosus
Vachellia karroo
Pogonarthria squarrosa
Asparagus laricinus
Eragrostis chloromelas
Chloris pycnothrix
Eragrostis curvula
Eragrostis gummiflua
Schkuhria pinnata
Gerbera piloselloides
Gladiolus crassifolius
Senecio barbatus
Eragrostis plana
Aristida congesta* subsp*. barbicollis
Ficus cordata
Leonotis ocymifolia v. raineriana

A total of fifteen sample sites represent this plant community with an average of 30 different plant species recorded per sample plot. The vegetation is dominated by the anthropogenic grass *Hyparrhenia hirta* (species group Q). Trees identified within this community occur as small clumps on rocky outcrops which could not be ploughed, and include *Faurea saligna* (species group K). Other prominent species include the grasses *Sporobolus africanus* (species group A), Cynodon *dactylon, Eragrostis curvula, Aristida congesta* subsp. *congesta* (species group E), *Brachiaria brizantha* (species group J), *Schizachyrium sanguineum* (species group Q), and *Melinis nerviglumis* (species group R). The forbs include *Schkuria*

pinnata (species group E), *Verbena bonariensis,* and *Solanum panduriforme* (species group J).

Termite mounds are prominent throughout the area. A patch of this plant community found near private land had a higher number of forb species, indicative of disturbed conditions. According to discussions with the farm workers from the private land (Doornnek farm portion), this section was previously used for citrus orchards. Most of the alien plants recorded in the area are found around the remains of old homestead areas.

Alien species recorded for this community include *Melia azedarach* (in close proximity to sample sites 55), *Populus* x*. canescens* (in close proximity to sample site 131), *Eucalyptus paniculata* and *Bambusa balcooa* (in close proximity to sample sites 56 and 57)*, Agave sisalana* (two individuals in close proximity to sample site 48) *Pinus pinaster* (in close proximity to sample site 49) and *Acacia mearnsii* near sample site 57.

Similar grassland communities associated with this community have been described previously by a number of researchers, including Bezuidenhout, Bredenkamp & Theron (1994), who described the *Hyparrhenia hirta-Eragrostis plana* grassland in the Fb land type in the former Western Transvaal. The *Eragrostis curvula-Hyparrhenia hirta* old field community in the study area shows affinity due to the presence of *Eragrostis plana* and the dominance of *Hyparrhenia hirta.*

Cilliers, Van Wyk & Bredenkamp (1999) also described a similar grassland type (*Hyparrhenia hirta* grassland) in the Potchefstroom municipality. The similarity in these habitats is the instabilities due to previous farming activities which lead to vegetation degradation.

4.2.4 *Setaria sphacelata*-*Lannea discolor* open woodland

The *Setaria sphacelata*-*Lannea discolor* open woodland is located on the north-eastern, central, southern and south-eastern sections of the study area. It covers approximately 393 ha, comprising 8.8% of the study area. It is located between 1 217 and 1 391 m.a.s.l. on north-east to north facing slopes. This plant community is restricted to the north and/or south facing midslopes with gradients ranging from gentle (4° - 9°) to moderately (10° - 15°) steep slopes (Table 3.3) with rocks covering between 30% and 50% of the area.

The characteristic plant species for this plant community are from species group F (Table 4.1) and include:

Andropogon chinensis
Englerophytum magalismontanum
Burkea africana
Phymaspermum acerosum
Wahlenbergia virgata
Lannea discolor
Combretum molle
Combretum apiculatum
Tapiphyllum parvifolium

The vegetation is characterised by the dominance of the tree *Lannea discolor* (species group F) and the grass *Setaria sphacelata* (species group R). Other species that are locally prominent include the woody *Englerophytum*

magalismontanum, Combretum molle, Burkea africana, and Combretum apiculatum (species group F); the grass *Andropogon chinensis* (species group F) and the forb *Phymaspermum acerosum* (species group F).

This major plant community is divided into two sub-communities:

- *Setaria sphacelata*-*Lannea discolor*-*Englerophytum magalismontanum* sub-community.
- *Setaria sphacelata*-*Lannea discolor*-*Senegalia burkei* sub-community.

4.2.4.1 *Setaria sphacelata*-*Lannea discolor*-*Englerophytum-magalismontanum* sub-community

This sub-community is located on the south-western section of the study area. It covers approximately 148 ha, comprising 3.3% of the *Setaria sphacelata*-*Lannea discolor* open woodland at altitudes ranging between 1 329 and 1 391 m.a.s.l.

The tree layer cover ranges between 30% and 60%, the shrub layer between 10% and 50%, the grass layer between 10% and 40% and forbs between 10% and 30%. Average rock cover was estimated at 40% and ranged between 30% and 50%. Rocky outcrop areas are prominent in this sub-community.

Animals observed in the area were buffalo. There are signs of previous veld fires recorded in the area.

The sub-community occurs on the Ib10 and Ib17 land types, and is mostly found on the north-east and north facing rocky slopes of the study area. The soils range from sandy-loam to sandy-clay-loam. Very little erosion has been observed while signs of previous veld fires were recorded.

The slopes had steep gradients ranging between 4° and 25° (Table 3.3), and are not easily accessible to animals. Low to moderate grazing levels were recorded. Signs of animals recorded include old animal droppings. No animals were observed during field surveys.

The characteristic species of this sub-community are found in species group G (Table 4.1), and include:

Diplorhynchus condylocarpon
Aloe marlothii
Peltophorum africanum
Ectadiopsis oblongifolia
Acalypha villicaulis
Mimulus gracilis
Mundulea sericea
Strychnos cocculoides
Senecio venosus
Boophane disticha
Aloe ferox

A total of ten sample sites were surveyed in the sub-community and an average of 35 different plant species was recorded per sample plot. The vegetation is characterised by the dominance of the trees *Lannea discolor, Englerophytum magalismontanum* (species group F) and the grasses *Loudetia simplex* (species group Q) and *Setaria sphacelata* (species group R). Other species that are locally prominent include the woody *Diplorhynchus condylocarpon, Strychnos cocculoides, Peltophorum africanum* (species group G), and the forbs *Senecio venosus* (species group G) and *Pellaea calomelanos* (species group R).

Alien plant species recorded for this sub-community include *Acacia mearnsii*, occurring in close proximity to sample site 117, and *Jacaranda mimosifolia* located in close proximity to sample site 118.

Filmalter (2010), described an almost similar plant community: *Lannea discolor-Diplorhynchus condylocarpon* sub-community (6.1) on the north and south facing slopes with vegetation dominated by *Diplorhynchus condylocarpon*. Species recorded in the sub-community (4.1) and shared by the sub-community from Filmalter (2010)'s study, include: *Combretum molle, Lannea discolor, Burkea africana* (species group F) and *Aloe marlothii* and *Diplorhynchus condylocarpon* (species group G).

4.2.4.2 *Setaria sphacelata*-*Lannea discolor*-*Senegalia burkei* sub-community

This open to closed woodland plant community is located on the north-eastern and southern parts of the study area. It covers approximately 245 ha, which is 5.5% of the study area. It occurs at altitudes between 1 217 and 1 357 m.a.s.l., on the north, south-west and south-east facing rocky slopes.

The tree layer cover ranges between 40% and 70%, the shrub layer cover ranges between 10% and 50%, the grass layer between 20% and 60% and forb layer between 10% and 60%. Rock cover ranges between 30% and 50%, with an average of 39%. The slopes of this sub-community are characterised by loose stones of 10 to 50 cm in diameter.

The *Setaria sphacelata-Lannea discolor-Senegalia burkei* sub-community occurs on the Fa7, Ib10 and Ib13 land types. The soil varies between sandy-loam and loam. Very little to no signs of soil erosion were recorded, however, mild localised sheet erosion was observed on the disturbed rocky areas, along animal paths and at destroyed termite mounds. The occurrence of frequent fires is evident in the area, and dead stands of *Dichrostachys cinerea* were recorded.

This sub-community is accessible to animals and is characterised by gentle midslopes (4° - 9°) to steep slopes (16° - 25°) - Table 3.3. Animal signs observed include trampling and grazing, though no animals were physically observed during field surveys.

Plant species from species group H (Table 4.1) are characteristic to the *Setaria sphacelata-Lannea discolor-Senegalia burkei* sub-community and include:

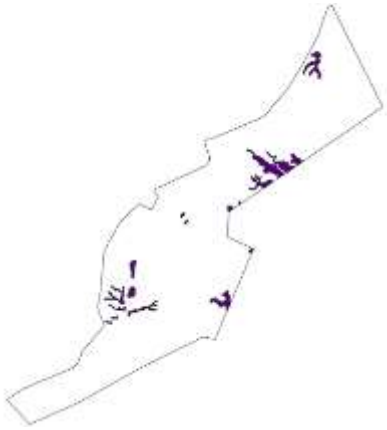
Indigofera cryptantha
Dovyalis caffra
Zinnia peruviana
Gnidia kraussiana
Kalanchoe thyrsiflora
Crotalaria brachycarpa
Evolvulus alsinoides

Twelve sample sites represent this sub-community. An average of 39 different plant species per sample plot was recorded. The vegetation is characterised by the dominance of the trees *Senegalia burkei* (species group D) and *Lannea discolor* (species group F) and the grasses *Setaria sphacelata* and *Themeda triandra* (species group R). Other species that are locally prominent include the trees *Combretum apiculatum, Combretum molle* (species group F), the grasses

Andropogon chinensis (species group F), *Brachiaria brizantha* (species group J), *Brachiaria serrata* (species group Q) and the forbs *Indigofera cryptantha* and *Pellaea calomelanos* (species group R).

No alien plant species were recorded for this sub-community.

4.2.5 *Pygmaeothamnus zeyheri-Rhoicissus tridentata* rocky shrubland



This plant community occurs as open shrub habitats. It is located on the south-eastern side of the study area, with patches located on the northern, eastern border, central, south-eastern border and south-western sections of the study area. It covers an area of 141 ha, comprising 3.7% of the study area. The altitude ranges between 1 325 and 1 430 m.a.s.l., on the south-west and north to north-east facing slopes.

Tree layer cover ranges between 30% and 60% with an average of 43%. The shrub cover ranges between 10% and 40% (Ave. 25%), the grass layer between 10% and 50% (Ave. 36%), and the forbs between 10% and 40% (Ave. 18%). Rock cover ranges between 20% and 45%, with an average of 31%.

The Ib land types (Ib10, Ib13 and Ib17) are represented in this area. These land types are characterized by shallow to moderately shallow and deep soils on more than 60% rock cover. The soil varies from fine-sandy-loam and sandy-loam to sandy-clayey-loam. The area has patches of rocky outcrops. Minimal signs of soil erosion were observed along game paths, with signs of previous veld fire occurrences being evident.

The area is characterised by gentle (4° - 9°) to moderate (10° - 15°) midslopes of red rocks that are accessible to wildlife (Table 3.3). The area is moderately grazed, with moderate trampling, grazing signs, and animal tracks. Animals sighted in the area include klipspringers and common reedbuck.

Characteristic plant species for this plant community are from species group I (Table 4.1) and include:

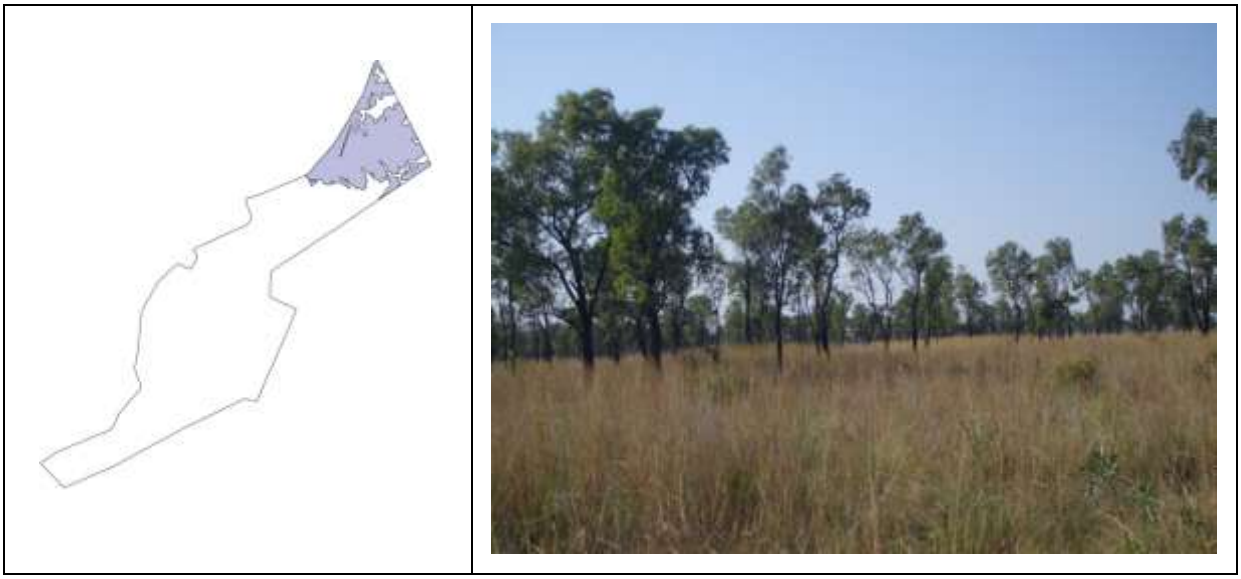
Pygmaeothamnus zeyheri	***Gladiolus permeabilis***
Ozoroa sphaerocarpa	***Eustachys paspaloides***
Schistostephium crataegifolium	***Drimiopsis burkei***
Digitaria diagonalis	***Croton gratissimus***
Cucumis zeyheri	***Setaria megaphylla***
Hypoxis rigidula	***Oxalis depressa***
Eragrostis capensis	***Chamaecrista comosa***
Rhynchosia nitens	***Digitaria eriantha***
Tragia sonderi	***Convolvulus farinosus***
Drimiopsis atropurpurea	***Ochna pulchra***

A total of 18 sample sites were surveyed with an average of 41 different plant species recorded per sample plot. The vegetation is characterised by the prominence of the sprawling shrub *Rhoicissus tridentata* (species group B) and the dwarf shrub *Pygmaeothamnus zeyheri* (species group I), and the grasses *Setaria sphacelata* (species group R) and *Loudetia simplex* (species group Q). Other species that are locally prominent include the trees *Faurea saligna* (species group K)*, Ozoroa sphaerocarpa, Croton gratissimus* (species group I),

the grasses *Eustachys paspaloides, Setaria megaphylla* (species group I), *Melinis nerviglumis* (species group R) and the forbs *Pellaea calomelanos* and *Lantana rugosa* (species group R).

Alien plants recorded in this community include *Acacia mearnsii* (in proximity to sample sites 82 and 99), *Populus x. canescens* (in proximity to sample site 134), *Jacaranda mimosifolia* (in proximity to sample site 58), and *Agave sisalana* near sample site 50.

4.2.6 *Tristachya leucothrix-Faurea saligna* open woodland



The *Tristachya leucothrix-Faurea saligna* community occurs on open woodland areas. It is located on the northern section of the study area. It covers approximately 708 ha, comprising 15.9% of the total study area. The altitude ranges between 1 251 and 1 441 m.a.s.l. on the north-west and west to south-west facing slopes.

Tree cover range is estimated between 25% and 45%, with an average of 37%. The shrub layer cover ranges between 10% and 40% (Ave. 19%), and the grass layer between 30% and 70% (Ave. 60%), and forb cover ranges between 10%

and 50% (Ave. 31%). Rock cover ranges between 10% and 40%, with an average of 18%.

The land types associated with this community include Fa7 and Ib13. The soil varies from fine-sandy-loam to sandy-clayey-loam. The Ib13 land type has shallow to moderately deep soil. Soil erosion is minimal. The area has relatively good grass cover. There was evidence of frequent veld fires resulting in dying stands of *Dichrostachys cinerea,* and a similar scenario was recorded for sub-community 4.2.

This community is easily accessible to animals as the landscape ranges from relatively flat (0° - 3°) to gentle (4° - 9°) midslopes (Table 3.3). There are signs of mild to moderate trampling by large mammals and digging activities by small mammals. No animals were observed during field surveys.

Characteristic plant species for this plant community are from species group K (Table 4.1) and include:

Faurea saligna	***Lippia javanica***
Dichrostachys cinerea	***Tephrosia capensis***
Acrotome hispida	***Eragrostis rigidior***
Helichrysum melanacme	***Osteospermum muricatum***
Hypoxis iridifolia	***Helichrysum coriaceum***
Rhynchosia monophylla	***Polygala hottentotta***
Andropogon schirensis	***Dicoma zeyheri***
Hypoxis argentea	***Gladiolus sericeovillosus* subsp. *calvat***
Oldenlandia herbácea	***Eriosema cordatum***
Ozoroa paniculosa	***Melhania prostrata***

In this plant community, 19 sample sites were surveyed. An average of 40 different plant species per sample plot was recorded. The vegetation is dominated by the tree *Faurea saligna* (species group K) and the grasses *Tristachya leucothrix* (species group O) and *Brachiaria serrata* (species group Q).

The grasses *Trachypogon spicatus, Panicum natalense* (species group P), *Loudetia simplex* (species group Q) are co-dominant. Other species that are locally prominent include the woody *Dichrostachys cinerea, Ozoroa paniculosa, Lippia javanica* (species group K), *Protea caffra* (species group O), the grasses *Eragrostis rigidior, Andropogon schirensis* (species group K), *Setaria sphacelata, Themeda triandra, Eragrostis racemosa, Bewsia biflora, Cymbopogon caesius* (species group R) and the forbs *Tephrosia capensis, Helichrysum melanacme, Osteospermum muricatum, Vernonia oligocephala* (species group O), *Phymaspermum athanasioides* (species group P) and *Helichrysum kraussii* (species group R).

No alien plants were recorded for this plant community.

This community was classified by Theron (1973) as *Protea caffra-Tristachya biseriata* bush savannah. Two sub-communities were distinguished in Theron's classification: *Protea caffra-Senegalia caffra-Faurea saligna-Tristachya biseriata* and *Protea caffra-Tristachya biseriata-Loudetia simplex* bushveld savannah. The first sub-community is dominated by *Faurea saligna* trees and is located in the plains and valleys of the larger reserve section, as well as on top of the ridges.

The *Tristachya biseriata–Faurea saligna* community in the study area shows affinity with the one described by Theron (1973) due to the presence of the tree *Faurea saligna,* the shrub *Lippia javanica,* the forb *Rhynchosia monophylla,* and the grasses *Andropogon schirensis* and *Tristachya biseriata*, the latter dominating in both communities.

4.2.7 *Elionurus muticus-Loudetia simplex* open grassland

This grassland community covers an area of 2 379 ha, comprising 53.4% of the study area. This is the largest community in the study area. It occurs on the central and southern sections of the study area at altitudes ranging between 1 318 and 1 466 m.a.s.l. The community is restricted to gentle slopes, mountain plateaus and/or crests.

The *Elionurus muticus-Loudetia simplex* open grassland is differentiated by the occurrence of the following characteristic plants from species group L (Table 4.1):

Elionurus muticus
Cyperus rupestris
Trichoneura grandiglumis

The vegetation is dominated by the grasses *Loudetia simplex* (species group Q) and *Bewsia biflora* (species group R), while *Themeda triandra* (species group R) and *Urelytrum agropyroides* (species group P) are prominent throughout the community. The woody layer is not well-developed with small clumps of the tree *Protea caffra* (species group O) prominent in some locations.

This grassland community can be divided into three sub-communities:

- *Elionurus muticus-Loudetia simplex-Tristachya biseriata s*ub-community
- *Elionurus muticus-Loudetia simplex-Aristida diffusa* sub-community
- *Elionurus muticus-Loudetia simplex-Gladiolus elliottii* sub-community.

4.2.7.1 *Elionurus muticus-Loudetia simplex-Tristachya biseriata* sub-community

The *Elionurus muticus-Loudetia simplex-Tristachya biseriata* sub-community is located in the central southern and central south-western border of the study area. It covers approximately 202 ha, comprising 4.5% of the *Elionurus muticus-Loudetia simplex* open grassland. It occurs at altitudes ranging between 1 318 and 1 466 m.a.s.l. on the north to north-east facing slopes.

Trees cover ranges between 10% and 30%, the shrubs between 5% and 20%, the grasses between 50% and 80%, and the forbs cover between 10% and 20%. Rock cover ranges between 10% and 25%, and rocky areas are prominent on slopes with loose rocks.

This sub-community occurs on the Fa7 and Ib10 land types, and is characterized by shallow to moderately shallow soil on a hard, fractured or weathering rock

(Land Type Survey Staff, 1988). Very little to no signs of soil erosion were recorded. The grass layer is well established protecting the soil from being eroded. Signs of previous veld fires were prominent.

Slopes range from flat (0° - 3°) to gentle (4° - 9°) midslopes (Table 3.3), making the area accessible to animals. Moderately low to medium grazing signs were recorded in recently burnt areas. There were signs of trampling, digging activities and recent fires. No animals were sighted during field the surveys.

This plant community has no characteristic species group and is characterized by the absence of species from species groups O and P (Table 4.1). A total of eleven sample plots represent this sub-community with an average of 34 different plant species per sample plot.

The vegetation is dominated by the grasses *Loudetia simplex, Tristachya biseriata* (species group Q), *Themeda triandra* and *Bewsia biflora* (species group R. Prominent species include the grasses *Brachiaria serrata* (species group Q), *Eragrostis racemosa* (species group R) and the forb *Sphenostylis angustifolia* (species group Q). This sub-community is also distinguished from the other two sub-communities by the absence of the grass *Digitaria monodactyla* (species group Q).

Alien plant species recorded include: *Agave americana* (in the proximity to sample site 129), *Populus* x*. canescens* and *Acacia mearnsii (*in the proximity to sample site 117)*.*

4.2.7.2 *Elionurus muticus-Loudetia simplex-Aristida diffusa* sub-community

This sub-community is located on southern, south-eastern and north-eastern side of the study area and covers approximately 926 ha, comprising 20.8% of the *Elionurus muticus-Loudetia simplex* open grassland. It occurs at altitudes ranging between 1 316 and 1 440 m.a.s.l. on the south, north, and north-east facing slopes.

Cover estimated for trees is between 5% and 15%, the shrub cover is between 5% and 30%, the grass cover between 30% and 80%, and the forb covers between 5% and 40%. Rock cover ranges between 10% and 40%, with an average of 22%. Reddish quartz rock patches are prominent on steep slopes, and are indicated as bare patches from aerial photographic view point (Figure 4.3).

Figure 4.3: Red quartz rock of the Rooiberg formation in the study area

All four land types (Fa7, Ib10, Ib13 and Ib17) occurring in the study area are represented in this sub-community. The soil varies from fine-sandy-loam to sandy-clayey-loam. There is very little to no signs of soil erosion.

All areas are accessible to wildlife. Rocky slopes range from flat plateau/crests (0° to 3°) to gentle (4° - 9°) and moderately steep (16° - 25°) midslopes (Table 3.3). Signs of animal activities recorded include grazing, trampling, digging and droppings. Animals sighted during field surveys include zebra, tsessebe, common duiker and eland. There are recorded signs of recent veld fires.

The sub-community is characterised by species found in species group M (Table 4.1) and include:

Aristida diffusa	***Helichrysum sessilioides***
Maytenus tenuispina	***Parinari capensis***
Myrothamnus flabellifolia	***Lopholaena coriifolia***
Clerodendrum triphyllum	***Rendlia altera***

Anacampseros subnuda	***Kohautia amatymbica***
Cyanotis speciosa	***Monocymbium ceresiiforme***

A total of twenty-two sample sites represent this sub-community. An average of 36 different plant species was recorded per sample plot. The vegetation is totally dominated by the grass *Loudetia* simplex (species group Q) while the grasses *Themeda triandra, Eragrostis* racemosa (species group R), *Tristachya biseriata, Brachiaria serrata* (species group Q), and *Aristida* diffusa (species group M) are locally prominent. The forbs *Pellaea calomelanos, Commelina africana* (species group R), and *Xerophyta retinervis* (species group Q) are present throughout this community though mostly absent in sub-communities 7.1 and 7.3.

Alien species recorded include *Populus* x*. canescens* (in proximity to sample site 135), *Acacia mearnsii* (in proximity to sample site 114) and *Jacaranda mimosifolia* (in the vicinity of sample site 58). These species are located near to the Nooitgedacht picket, located on the northern side of the study area.

Harworthia koelmanorum plants were recorded on the north-west midslopes of this sub-community.

4.2.7.3 *Elionurus muticus-Loudetia simplex-Gladiolus elliottii* sub-community

This sub-community is located on the central sections of the study area. It covers 1 251 ha, comprising 28.1% of the *Elionurus muticus-Loudetia simplex* open grassland, at altitudes ranging between 1 370 and 1 455 m.a.s.l., on north-east, west, south-west and north facing slopes.

Estimated tree cover ranges between 10% and 40%, the shrub layer between 5% and 10%, the grass layer between 60% and 80%, and the forb cover ranges between 5% and 30%, while rock covers between 5% and 25% range.

This sub-community occurs within the Fa7 land type, and is characterised by shallow soil on hard, fractured or weathering rock materials. The soil consists of fine-sandy-loam to sandy-clay-loam. Very little to no signs of erosion was recorded. There are signs of previous veld fires that burnt in September 2010, causing mortalities to *Protea caffra* trees.

The area is accessible to wildlife and occurs on a relatively flat plateau (0° - 3°) with gentle (4° - 9°) midslopes (Table 3.3). *Protea caffra* seedlings (lower height class) are establishing in the area. Grazing and trampling activities are at

moderate to low levels. Game paths leading to a water point were observed, and animal sighted during surveys include white rhino, buffalo, tsessebe, and warthog.

Characteristic species for this sub-community are from species group N (Table 4.1), and include:

Gladiolus elliottii	***Indigofera comosa***
Lotononis foliosa	***Wahlenbergia undulata***
Lycopodium clavatum	***Searsia wilmsii***
Striga elegans	***Ophresia oblongifolia***
Hypericum lalandii	***Acalypha angustata***
Pearsonia sessilifolia	***Eclipta prostata***
Solanum sisymbrifolium	***Scilla nervosa***

A total of thirty-nine sample plots were surveyed within this sub-community and an average of 36 different plant species was recorded per plot. This grassland is dominated by the grasses *Bewsia biflora* and *Eragrostis racemosa* (species group R) with *Loudetia simplex, Schizachyrium sanguineum, Digitaria monodactyla* (species group Q) and *Hyparrhenia hirta* (species group R) co-dominating. Prominent forbs include *Phymaspermum athanasioides, Gazania krebsiana* (species group P), *Sphenostylis angustifolia* (species group Q) and *Helichrysum kraussii* (species group R).

Alien plants recorded for this sub-community include *Acacia mearnsii* (in proximity to sample sites 51, 80, 81 and 83), and one tall *Pinus pinaster* tree in the vicinity of sample site 75.

4.3 Description of woody vegetation

The evaluation of the woody components in veld is essential to assist in assessing the condition of a veld type (Brown, 1997). The species composition and the density of the woody vegetation has been described to provide basic information on the present woody structure and to facilitate the management of the area (Brown & Bredenkamp, 2004).

According to Kent (2012), woody plant density has the following effects on savannah areas: moderate tree density leads to good herbaceous layer production; enhances nutrient cycling and is beneficial to grass species capable of thriving under shade. However, an increase in tree density will have the opposite results. Large diversity in species composition of the woody layer is beneficial to an ecosystem in terms of biodiversity and its ecosystem functioning. It is even better when the dominant woody species are browseable. This results in increased browsing potential of an area. However, a dense woody layer would have negative impacts on the condition of the veld (Brown & Bredenkamp, 2004), which may result in bush encroachment problems.

Data collected for all the woody plants found on each sample included the species name and the number of individuals for each species within each of the three height classes (Annexure C). The woody vegetation for each plant community is discussed below:

4.3.1 *Sporobolus africanus*-*Buddleja salviifolia* wetland (1)

Sporobolus africanus-Buddleja salviifolia plant community had a total of 420 ind/ha in the middle height class, and 200 ind/ha for the lower height class (Figure 4.4). No woody plants were recorded in the upper height class. *Buddleja salviifolia* had the highest number of individuals per hectare (180 ind/ha) in the medium height class, 120 ind/ha in the lower class height, while the *Diospyros*

lycioides recorded 80 ind/ha in the middle height class and 40 ind/ha in the lower height class.

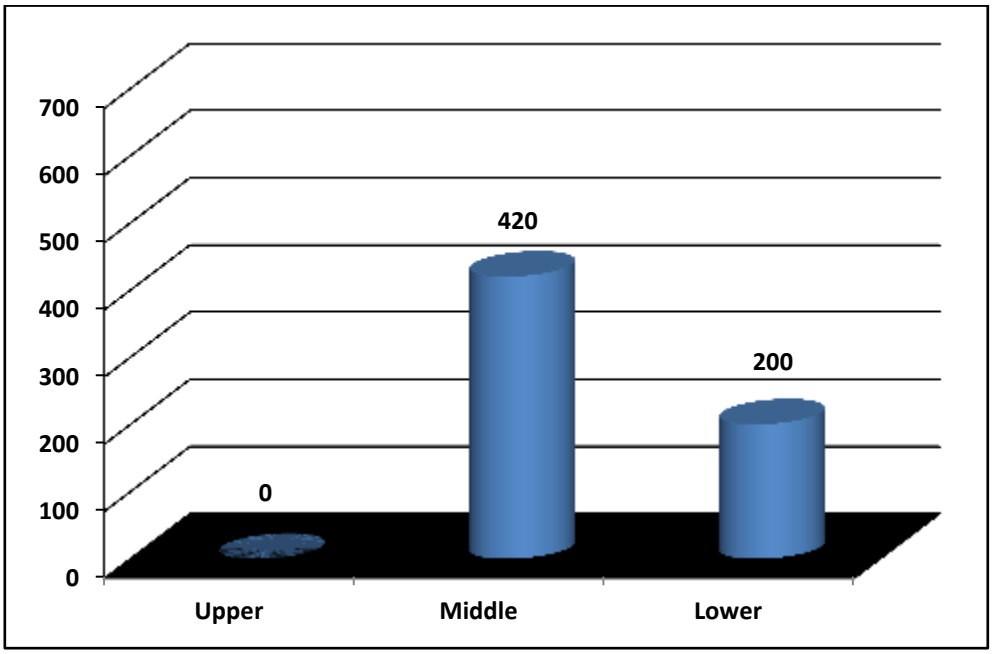


Figure 4.4: Number of ind/ha within the different height classes in plant community 1

A total of seven different woody species were recorded for this plant community.

4.3.2 *Panicum maximum*-*Senegalia caffra*-*Olea europaea* subsp. *africana* sub-community (2.1)

In this sub-community, a total of 600 ind/ha was recorded in the upper height class, 350 ind/ha in the middle height class, and 500 ind/ha in the lower height class (Figure 4.5). The main dominant woody species was the *Senegalia caffra* with 75 ind/ha in the upper height class and 100 ind/ha in the middle height class. The second dominant woody species *Olea europaea* subsp. *africana* has a total of 50 ind/ha in the upper height class, 25 ind/ha in the middle height class, and 50 ind/ha in the lower height class.

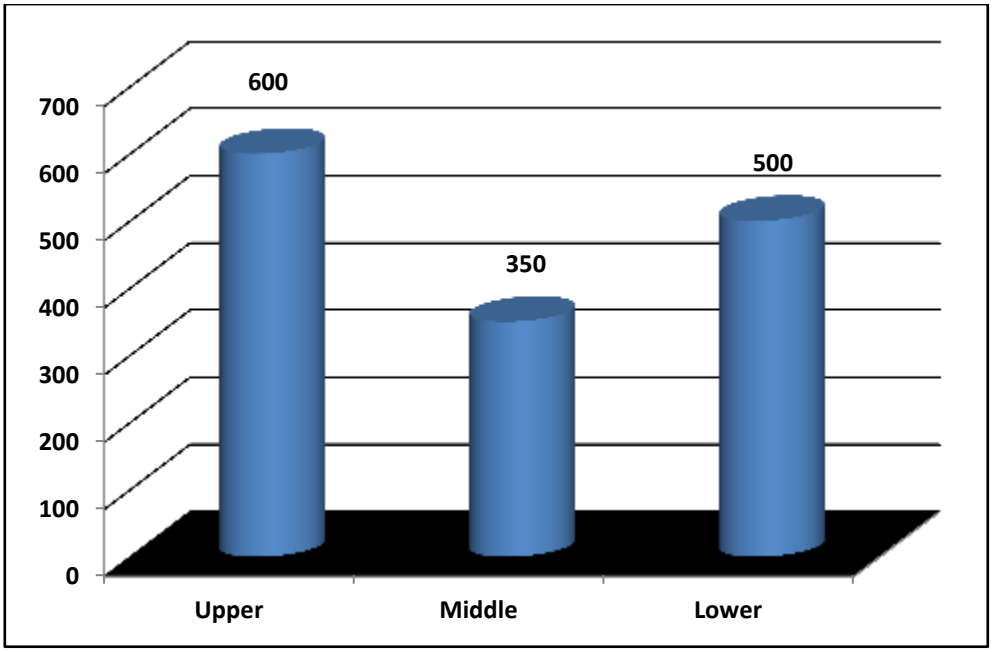


Figure 4.5: Number of ind/ha within the different height classes in sub-community 2.1

A total of twenty-two different woody species were recorded for this sub-community.

4.3.3 *Panicum maximum-Senegalia caffra-Searsia leptodictya* sub-community (2.2)

Panicum maximum-Senegalia caffra-Searsia leptodictya sub-community had an even distribution of woody species per height class with 340 ind/ha in the upper height class, 393 ind/ha in the middle height class, and 300 ind/ha in the lower height class (Figure 4.6). The prominent *Searsia leptodictya* community had 33 ind/ha under the upper height class, 47 ind/ha in the middle height class, and 7 ind/ha in the lower height class.

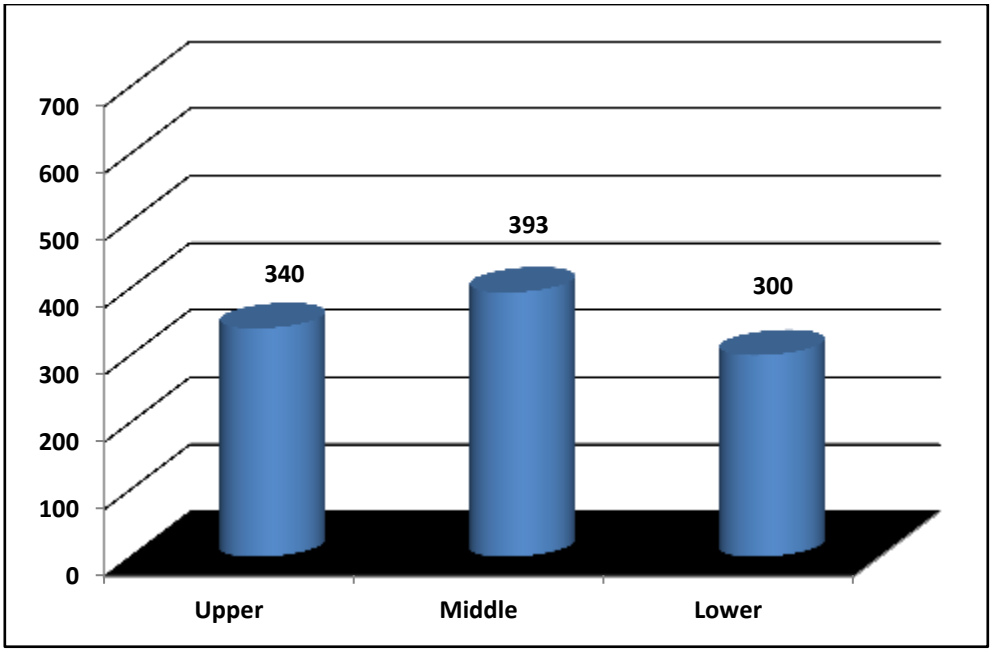


Figure 4.6: Number of ind/ha within the different height classes in sub-community 2.2

A total of thirty-six different woody species were recorded in this sub-community.

4.3.4 *Eragrostis curvula-Hyparrhenia hirta* old field grassland (3)

This is a grass dominated plant community with a total of 253 ind/ha. Most woody species occur as clumps on rocky outcrops. A total of 100 ind/ha were recorded in the upper height class, 40 ind/ha in the middle height class, and 113 ind/ha in the lower height class (Figure 4.7). The woody species prominent in this community include *Ziziphus mucronata* (20 ind/ha – upper height class, 0 ind/ha – middle height class, 7 ind/ha – lower height class) and *Searsia leptodictya* (27 ind/ha – upper height class, 0 ind/ha – middle height class, 13 ind/ha – lower height class).

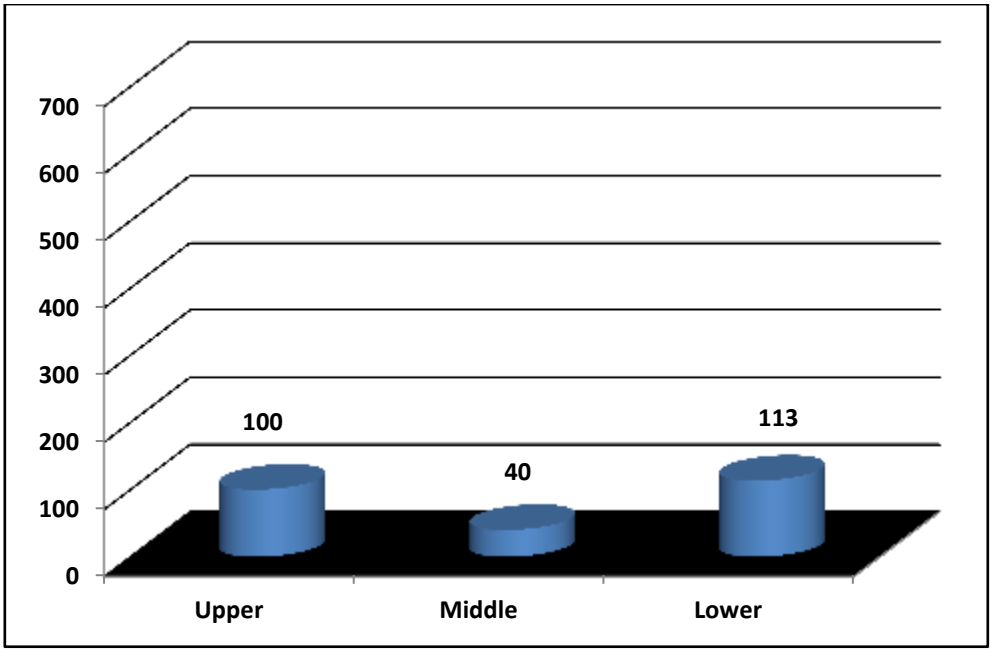


Figure 4.7: Number of ind/ha within the different height classes in plant community 3

A total of sixteen different woody species were recorded in this community.

4.3.5 *Setaria sphacelata*-*Lannea discolor*-*Englerophytum magalismontanum* sub-community (4.1)

The *Setaria sphacelata*-*Lannea discolor*-*Senegalia burkei* sub-community has 350 ind/ha in the upper height class, 520 ind/ha in the middle height class, and 160 ind/ha in the lower height class (Figure 4.8). *Lannea discolor* dominated this sub-community by 90 ind/ha in the upper height class, 70 ind/ha in the middle height class, and 0 ind/ha in the lower height class. Other dominant woody species found in this sub-community includes *Englerophytum magalismontanum* (40 ind/ha – upper height class, 40 ind/ha – middle height class, 10 ind/ha – lower height class) and *Diplorhynchus condylocarpon* (70 ind/ha – upper height class, 80 ind/ha – middle height class, 0 ind/ha in the lower height class).

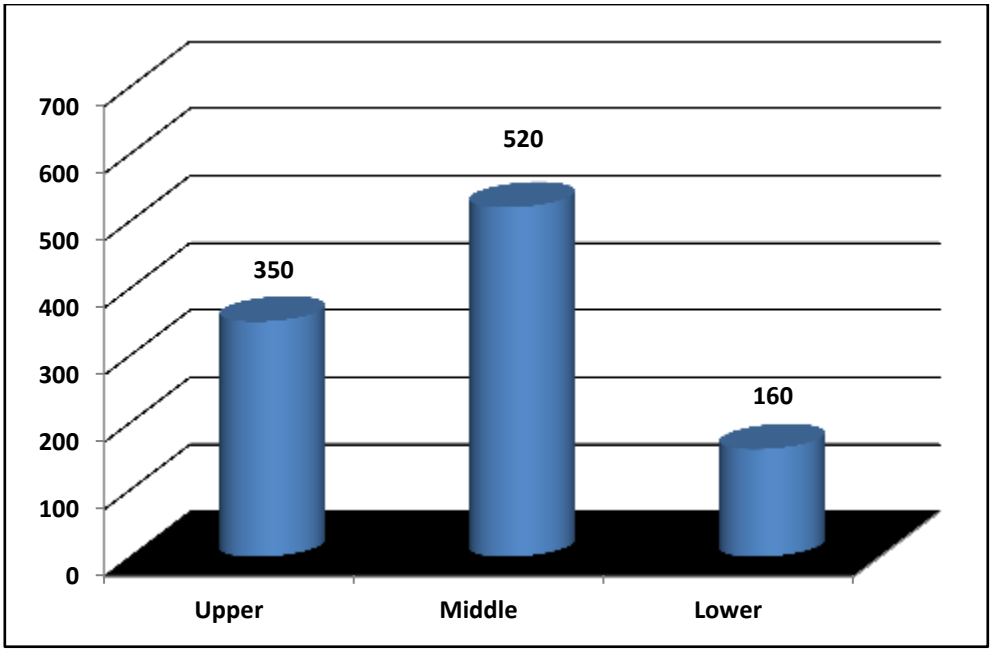


Figure 4.8: Number of ind/ha within the different height classes in sub-community 4.1

A total of twenty-five different woody species were recorded for this sub-community.

4.3.6 *Setaria sphacelata*-*Lannea discolor*-*Senegalia burkei* sub-community (4.2)

This sub-community had 408 ind/ha in the upper height class, 533 ind/ha in the middle height class, and 400 ind/ha in the lower height class (Figure 4.9). *Lannea discolor* dominated this sub-community with 75 ind/ha in the upper height class, 50 ind/ha in the middle height class, and 75 ind/ha in the lower height class. The other dominant *Senegalia burkei* has 92 ind/ha in the upper height class, 58 ind/ha in the middle height class, and 75 ind/ha in the lower height class.

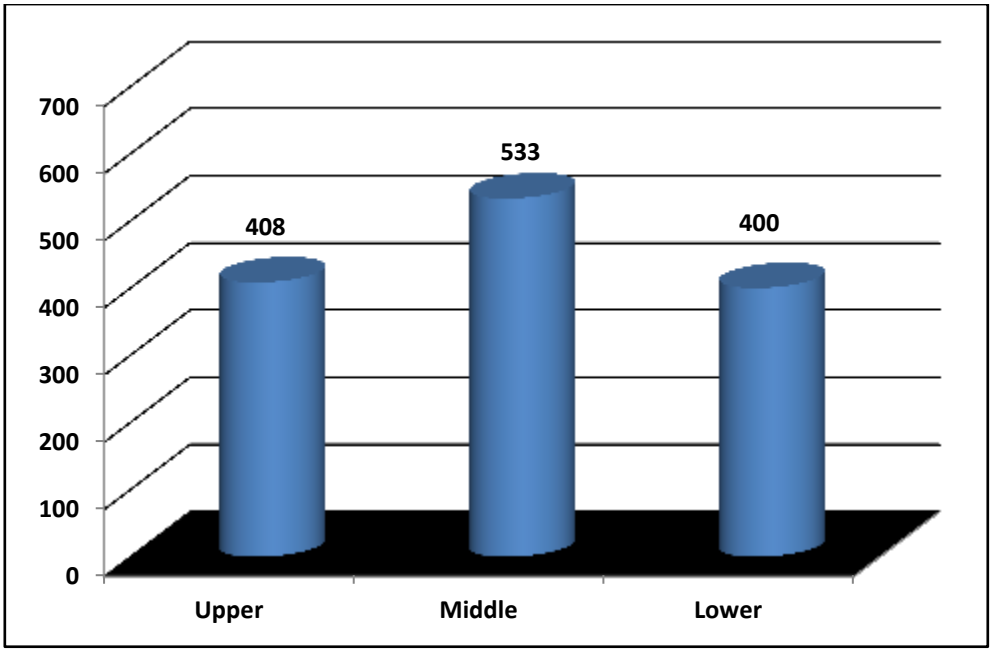


Figure 4.9: Number of ind/ha within the different height classes in sub-community 4.2

A total of twenty-seven different woody species were recorded for this sub-community.

4.3.7 *Pygmaeothamnus zeyheri-Rhoicissus tridentata* rocky shrubland (5)

A total of 261 ind/ha were recorded in the upper height class, 311 ind/ha in the middle height class, and 244 ind/ha in the lower height class (Figure 4.10). *Rhoicissus tridentata* recorded 12 ind/ha in the middle height class and 28 ind/ha in the lower height class.

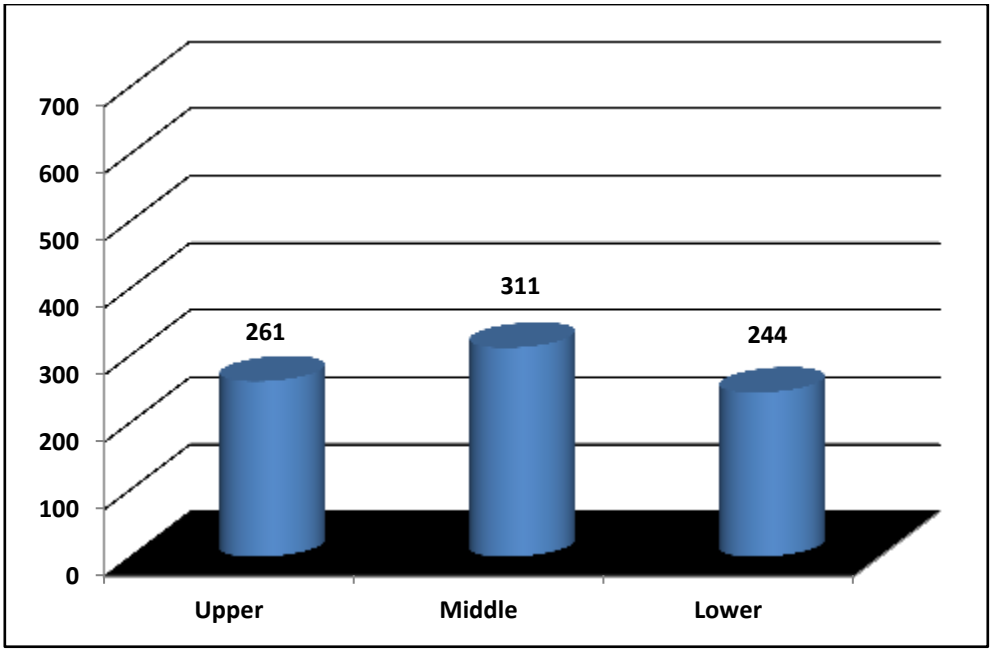


Figure 4.10: Number of ind/ha within the different height classes in plant community 5

A total of thirty-seven different woody species were recorded for this plant community.

4.3.8 *Tristachya leucothrix-Faurea saligna* open woodland (6)

The *Tristachya leucothrix-Faurea saligna* open woodland community has 137 ind/ha in the upper height class, 163 ind/ha in the middle height class, and 600 ind/ha in the lower height class (Figure 4.11). The dominant tree *Faurea saligna* has 42 ind/ha in the upper height class, 53 ind/ha in the middle height class, and 279 ind/ha in the lower height class. Other prominent woody species recorded in this community include *Dichrostachys cinerea* (21 ind/ha – upper height class, 58 ind/ha – middle height class, and 79 ind/ha in the lower height class) and *Protea caffra* (47 ind/ha- upper height class, 5 ind/ha – middle height class, 5 ind/ha – lower height class).

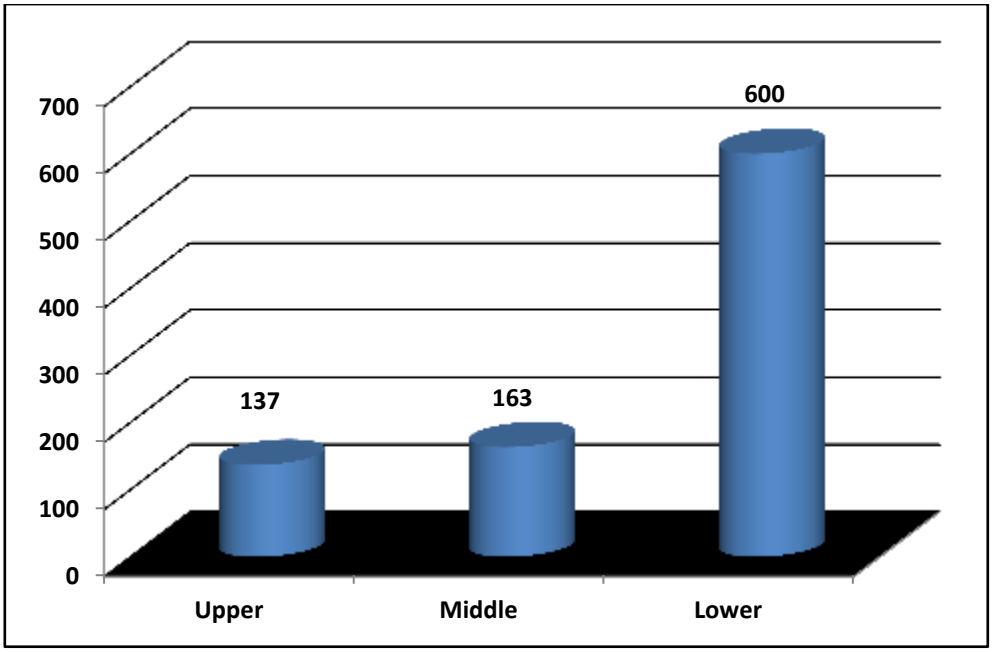


Figure 4.11: Number of ind/ha within the different height classes in plant community 6

This plant community had a total of sixteen different woody species.

4.3.9 *Elionurus muticus-Loudetia simplex-Tristachya biseriata* sub-community (7.1)

This grassland has 18 ind/ha in the upper height class, 9 ind/ha in the middle height class, and 127 ind/ha in the lower height class (Figure 4.12). The recorded prominent woody plants for this sub-community include *Protea caffra* (18 ind/ha – upper height class, 0 ind/ha – middle height class, 27 ind/ha – lower height class), *Faurea saligna* (0 ind/ha – upper height class, 0 ind/ha – middle height class, 36 ind/ha – lower height class) and *Tapiphyllum parvifolium* (0 ind/ha – upper height class, 9 ind/ha – middle height class, 18 ind/ha – lower height class).

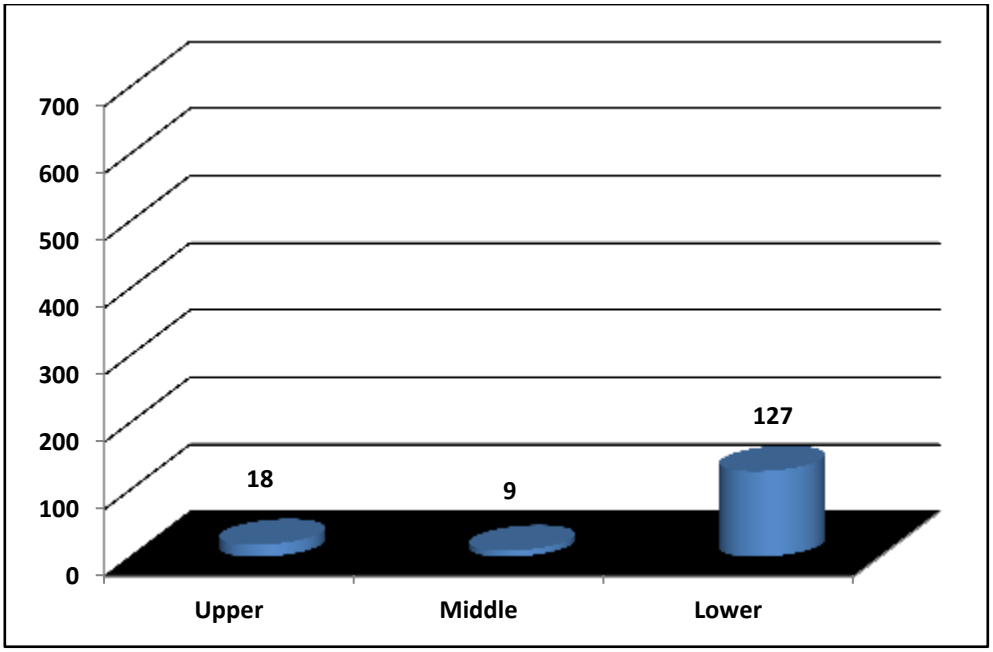


Figure 4.12: Number of ind/ha within the different height classes in sub-community 7.1

A total of eight different woody species were recorded for this sub-community.

4.3.10 *Elionurus muticus-Loudetia simplex-Aristida diffusa* sub-community (7.2)

This sub-community has a total of 41 ind/ha in the upper height class, 64 ind/ha in the middle height class, and 105 ind/ha in the lower height class (Figure 4.13). The prominent woody species recorded include *Strychnos cocculoides* (5 ind/ha for each of the three height classes), *Lopholaena coriifolia* (0 ind/ha – upper height class, 14 ind/ha – middle height class, 14 ind/ha – lower height class), *Protea caffra* (3 ind/ha – upper height class, 0 ind/ha - middle and lower height classes), and *Mundulea sericea* (0 Ind/ha – upper height class, 5 Ind/ha – middle height class, 14 Ind/ha – lower height class).

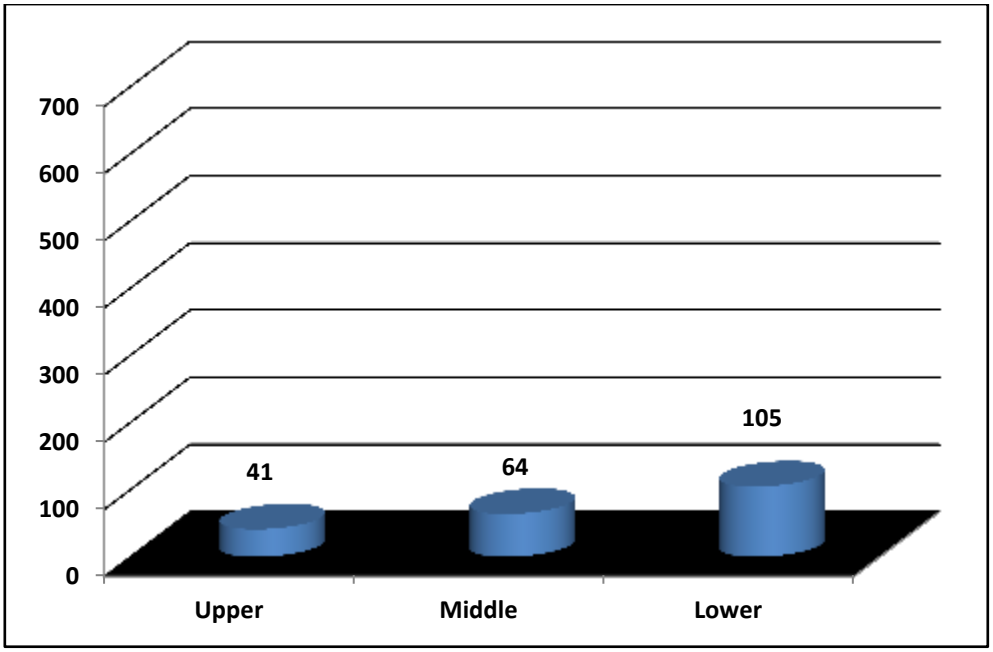


Figure 4.13: Number of ind/ha within the different height classes in sub-community 7.2

A total of sixteen different woody species were recorded for this sub-community.

4.3.11 *Elionurus muticus-Loudetia simplex-Gladiolus elliotii* sub-community (7.3)

This sub-community has a total of 46 ind/ha in the upper height class, 8 ind/ha in the middle height class, and 64 ind/ha in the lower height class (Figure 4.14). The prominent woody species recorded for this sub-community was *Protea caffra* with 46 ind/ha in the upper height class, 0 ind/ha in the middle height class, and 3 ind/ha in the lower height class.

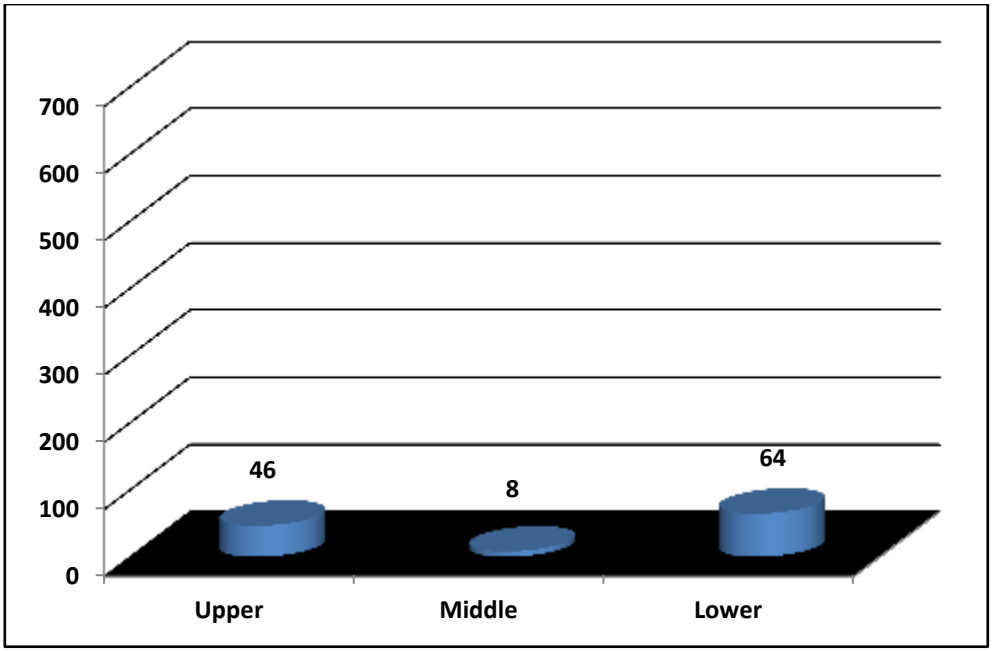


Figure 4.14: Number of ind/ha within the different height classes in sub-community 7.3

A total of fourteen different woody species were recorded for this sub-community.

4.4 Ordination analysis

Ordination, another technique for data analysis, is used to determine the relationships between the identified plant communities and the environmental variables from the sampled sites (Carleton, 1984). According to Gauch (1982), ordination is used to summarise vegetation data by producing a low-dimensional ordination space where samples are plotted on a graph as points. The closer the spaces between points the more similar they are while far apart distances represent dissimilarities.

Peet (1980) mentioned that ordination facilitates subjective classification of vegetation data, and Gauch (1982) suggested that ordination also assists to interpret patterns in species composition.

Ordination was used to further interpret the plant community composition in relation to environmental gradients. The key environmental variables used include rockiness, altitude, soil depth and soil moisture. According to McCune,

Grace, & Urban (2002), the distance measures of the sample sites (similarity and dissimilarity) can be categorised into metric, semi-metric and non-metric. The ordination for data analysis was done using the Bray-Curtis distance measure (Bray & Curtis, 1957) on the habitat and species data. An ordination biplot representing a two-dimensional NMS biplot of sampled plots (Figure 4.15) with each polygon colour representing the seven plant communities of the study area: green (plant community 1), black (plant community 2), red (plant community 3), indigo (plant community 4), yellow (plant community 5), purple (plant community 6) and turquoise (plant community 7).

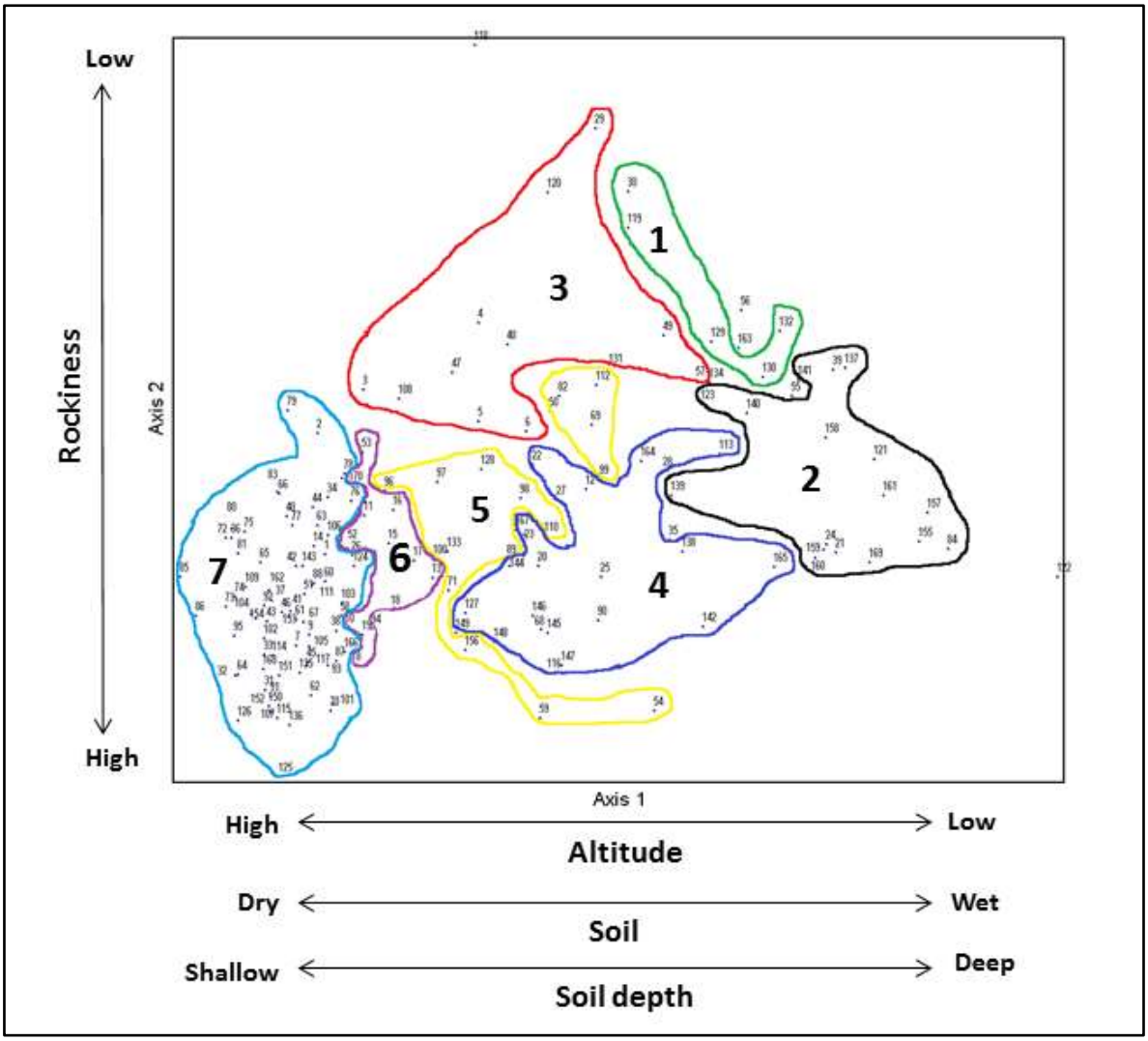


Figure 4.15: Ordination analysis results for the study area

4.5 Discussion

4.5.1 Plant communities

Four structural vegetation units were identified in the study area, namely; grasslands, shrublands, woodlands and wetlands (Table 4.2).

Table 4.2: Vegetation structures identified for the study area

Structural type	Plant Community	Size
Woodland	**Plant communities 2, 4 and 6**	**1 627 Ha**
Shrubland	**Plant community 5**	**141 Ha**
Grassland	**Plant communities 3, and 7**	**2 631 Ha**
Wetland	**Plant community 1**	**58 Ha**

The study area is representative of Highveld grassland vegetation, with trees and shrubs restricted mostly to rocky outcrops, ridges, and riparian areas. Species that are characteristic to this type of vegetation according to Schmidt, Lotter & McCleland (2007), and which were also recorded in the study area include amongst others *Englerophytum magalismontanum, Searsia zeyheri, Diospyros lycioides, Euclea crispa, Dombeya rotundifolia, Ziziphus zeyheriana, Elephantorrhiza elephantina* and *Pappea capensis*.

Bredenkamp & Brown (2006) listed the woody *Protea caffra, Faurea saligna, Englerophytum magalismontanum, Diplorhynchus condylocarpon, Croton gratissimus, Pseudolachnostylis maprouneifolia,* as characteristic species to the Sour Mountain Bushveld of the Moist Broad-leaved savannah on sandy, nutrient poor soils. This vegetation type occurs in areas of >600mm rain on nutrient poor soils derived from sandstone and quartzite.

From the eleven identified plant communities in the study area, four (plant communities 3, 6 and sub-communities 2.2 and 4.1) were previously described

by different researchers (Theron, 1973; Bezuidenhout *et al*., 1994; Cilliers *et al*., 1999; Filmalter, 2010;), while seven are regarded as new plant communities (plant communities 1, 5 and sub-communities 2.1, 4.2, 7.1, 7.2 and 7.3).

Floristic affinities exist between the different plant communities as presented in Table 4.1. Plant community 2, 4.2 and 5 have affinities due to the presence of some species from species group B. The grass *Panicum maximum*, a shade loving grass that grows mainly under tree canopies and characteristic of woody habitats (Van Oudtshoorn, 2012), is prominent in all three communities as well as the tree *Ziziphus mucronata*. These communities have a well-developed woody layer and a loamy type of soil. Community 2.2 and 4.2 have a strong relationship in terms of their woody component with the tree *Senegalia burkei* (species group D) prominent in both.

The Nooitgedacht area is generally dominated by grassland vegetation, covering a total of 2 631 ha (59% of the study area), compared to woodland vegetation covering 1 826 ha (41%). An average of 35 different plant species was recorded per sample plot in the Nooitgedacht study area. Plant community 5 ($\bar{x}$ = 41) and 6 ($\bar{x}$ = 40) contributed the highest averages of recorded different plant species per sample plot.

Land types and plant communities

There were associations between plant communities and the different land types observed in the study area. Plant community 2.2 and 4.2 are primarily associated with the Ib 10 land type, while community 4.1 is mostly represented by land type Ib17. Plant communities 6, 7.2 and 7.3 are associated with the Fa7 land type (Figure 4.6). Communities 3 and 7.3 are located next to each other and occur on the Fa7 land type, which is associated with shallow to moderately shallow soil of >60% rock material and (Figure 4.1).

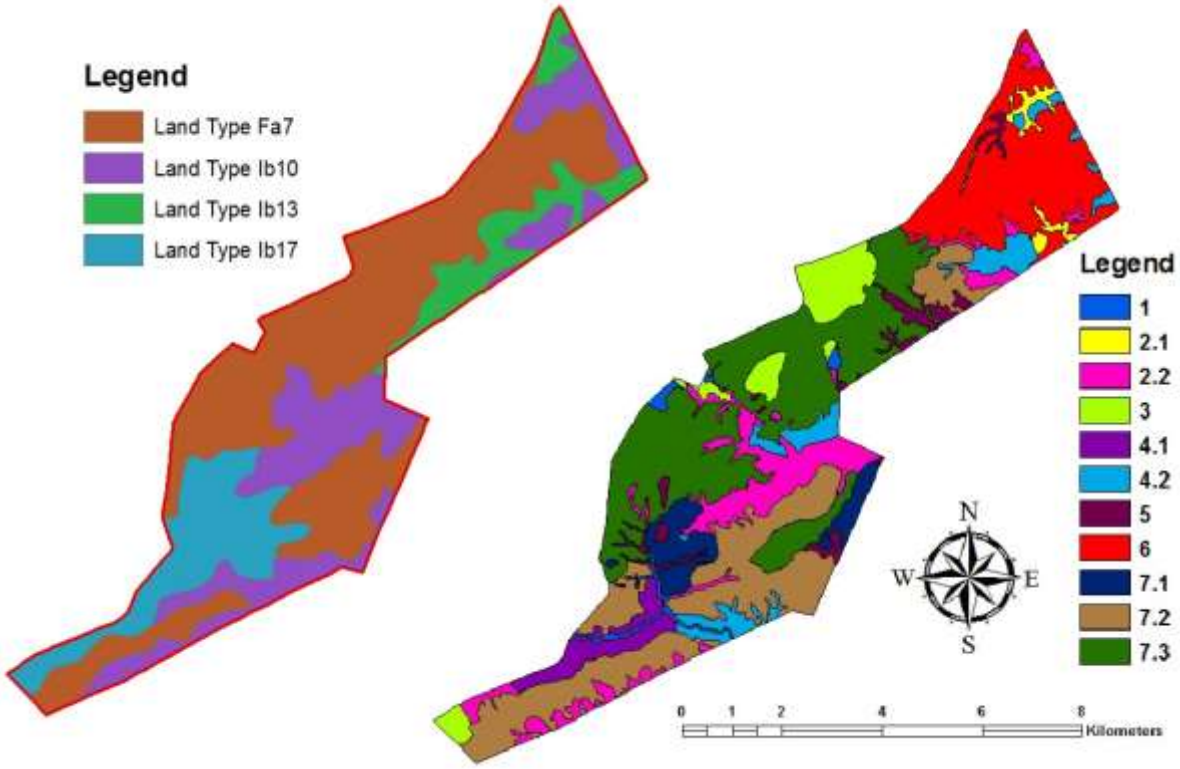


Figure 4.16: Map of the land types overlaid by the different plant communities

4.5.2 Woody vegetation

Woody species play an important role in plant community dynamics and plant and animal species composition (Brown *et al*., 2013). According to Belsky (1994), they are of utmost importance for the structure and function of a savannah ecosystem. The height of the trees within an ecosystem (plant community) is important for managers to make management decisions. Woody species 0 – 3 m are all within browseable range and are heavily influenced by fire (Smit *et al*., 2010). Trees taller than 3 m are less influenced by fire and also mostly accessible to mega herbivores such as giraffe and elephant only (Owen-Smith, 1988). Woody species density also has an influence on the veld condition and grass production potential of the vegetation (Bredenkamp & Brown, 2006). It is therefore important that these aspects of the vegetation are also studied during plant community studies.

Plant communities within the study area with the highest densities of woody species (more than 1000 ind/ha) are communities 2.1, 2.2, and 4.2. Plant communities 1, 5 and 6 have densities ranging between 600 and 900 ind/ha, while the lowest woody densities were recorded for plant communities 3, 6, 7.1, 7.2 and 7.3.

Plant community 1 recorded no woody plants in the upper height class level. This can be ascribed to the fact that this community occurs along seasonally wet drainage channels and is dominated by the shrub *Buddleja salviifolia* that seldom grows taller than 3 m. Most of the woody species are within the middle height class. This species could lead to densification and react as a pioneer species in disturbed areas. This could easily happen in areas trampled by animals coming to drink water.

Plant communities 2 and 4 had the highest woody densities. All these communities occur on gentle to midslopes and rocky outcrops with relatively high rock cover. These areas are typical of the bushveld areas and also have relatively high woody species diversity. In all of these communities except sub-community 2.1, the woody species height distribution has a normal curve with most species found within the middle height class and fewer in the lower and the upper height classes. Sub-community 2.1 however has the largest number of species within the upper height class followed by the lower and then the middle height class. This could be the result of the dominance of the woody layer by the tall trees *Olea europaea* subsp. *africana, Senegalia caffra, Mimusops zeyheri* and *Euclea divinorum*, which developed into tall trees shading and out-competing smaller individuals. The large number of species in the lower height class was found in open areas and along game and footpaths.

Plant community 6 recorded the highest number (279 ind/ha) of *Faurea saligna* in the lower height class. These high densities of shrub height *F. saligna* plants in this community may indicate possible bush encroachment/densification (Figure

4.17). These species do however occur within the “fire trap” range (Smit *et al*., 2010) and will most probably be affected and a large number killed or their growth stunted if a fire were to go through this community. The *Faurea saligna* species is regarded an indicator species of sour veld and well-drained, nutrient poor soils (Schmidt, Lotter & McCleland., 2007).

Figure 4.17: *Faurea saligna* shrubs and seedlings dominated veld

The typical grassland communities (3 and 7) had as expected low numbers of woody species. The woody species within these areas normally grew as single individuals scattered throughout the community or mostly in clumps on rocky outcrops that occur scattered through the communities.

4.5.3 Ordination

From the results obtained from the ordination analysis, the distribution of species is influenced by the identified key environmental factors. Factors that are presented include altitude, soil (depth and moisture) and rockiness (Figure 4.15). The following deductions are made from the ordination results:

Plant community 1 (*Sporobolus africanus-Buddleja* salviifolia wetland) is confined to the moist lower-lying areas of the study site represented by wetlands. These areas have low rock cover comprising a few medium-sized rocks only. A number of moist-loving and hydrophilic plant species such as the grasses *Sporobolus africanus, Eragrostis heteromera, Pennisetum macrourum*, *Paspalum urvillei,* the forbs *Artemisia afra* and *Schoenoplectus corymbosus* were recorded. It is located on deeper soils of the low lying areas.

Plant community 2 (*Panicum maximum-Senegalia caffra* riverine woodland) is a riverine woodland community occurring at low altitude and is associated with wet and deep soils. Rock cover is moderate and estimated at approximately 22%; soils have more clay content and occur on flat surface landscapes.

Flat to undulating mid plateau areas of previous cultivated lands characterise plant community 3 (*Eragrostis curvula-Hyparrhenia hirta* old field grassland). The soils are relatively deep and moist in some areas with a medium to low rock cover. Some of the sampled plots are located at high altitudes.

Plant community 4 (*Setaria sphacelata-Lannea discolor* open woodland) is characterised by habitats of between high and low altitudes with medium to deep soil. This community is associated with stoney slopes with high rock cover.

Plant community 5 (*Pygmaeothamnus zeyheri-Rhoicissus tridentata* rocky shrubland) occurs in a relatively wider range of habitats which range from high and low rock cover and altitude.

Plant community 6 (*Tristachya leucothrix-Faurea saligna* open woodland) is characterised by dry shallow soils and moderate to high altitude.

Plant community 7 (*Elionurus muticus-Loudetia simplex* open grassland) is a high altitude grassland occurring on slopes and plateaus of the study area. Rock cover is high and consists of large rocky outcrops with dry shallow soil. The grasses *Aristida diffusa* and *Loudetia simplex*, species who thrive in poor and coarse sandy soils (Van Oudtshoorn, 2012) are characteristic for these areas.

4.6 Conclusion

A total of 11 different plant communities that can be grouped into seven major plant communities were successfully identified and described within the study area. The largest part of the study area is characterised by grassland vegetation while the woody vegetation is restricted to rocky areas, valleys and kloof areas. Floristic affinities exist between the different communities which are ascribed to various environmental factors such as altitude, rockiness and aspect. Specific plant communities are associated with specific land types indicating the importance of land types as a basis for plant community delineations. Of the 11 plant communities identified in the study area, seven has not been described in the reserve.

The vegetation structure and composition of the study area is typical of the sourish mixed bushveld and Bankenveld vegetation. This is evident in the open grassland with scattered trees to open and closed woodland areas on hillsides. According to Schmidt, Lotter & McCleland (2007), the characteristic woody species associated with these habitats (Bankenveld), which were also recorded in the study area include *Senegalia caffra, Euclea crispa, Combretum molle, Dombeya rotundifolia, Searsia leptodictya, Searsia zeyheri, Protea caffra, Englerophytum magalismontanum, Vangueria infausta, Ziziphus mucronata* and *Ziziphus zeyheriana.*

The majority of woody species in the grassland communities were found to have an aggregated spatial distribution, while those of the woodland communities had

a more even spatial distribution. Most of the woody species in the lower height class grew relatively close to their potential mother plants.

These results suggest that the classification method used has produced vegetation groups that are correlated with key environmental variables. The plant communities identified for the study area changes along a gradient pattern from the high lying areas of dry and shallow soils characterised by grassland vegetation, to the low lying areas of wet and deep soils.

Chapter 5

5 VELD CONDITION AND GRAZING CAPACITY

Veld condition has been defined as the ‘state of health of the veld in terms of ecological status, resistance to soil erosion and the potential for producing forage for sustained optimum livestock production (Trollope, Trollope, & Bosch, 1990).

According to Tainton (1999), there are three main objectives for assessing veld condition. These include:

- Evaluating the impacts of management activities on veld condition and monitoring vegetation change.
- To determine the veld condition of the different plant communities present in an area.
- Evaluating veld condition to assist in making informed ecologically based decisions.

Veld condition assessment involves the determination of a condition score based on grass species composition, followed by the classification of the grass species according to their response to grazing (Voster, 1982). It is important to classify plant communities in order to quantify their condition since each plant community possess its own potential in terms of grass production and grazing capacity (Brown, 1997; Filmalter, 2010). This allows for the effective management of identified and classified plant communities, which are described and mapped (Visser, Van Hoven, & Theron, 1996; Brown *et al*., 2013).

Veld condition of an area is subject to change, depending on the prevailing conditions. These conditions include climate, water availability, grazing and browsing impacts, soil condition and type, and length of the growing season. It is important to have an initial veld condition assessment done, in order to establish

baseline figures. Follow up assessments provide information on whether the condition of an area is improving or deteriorating.

5.1 Veld Condition & Grazing Capacity

One of the objectives of this study was to determine the grazing capacity and stocking rate of the different plant communities of the study area. To achieve this, surveys were conducted using the step-point method to collect the grass species composition data. The percentages of ecological groups for each plant community was calculated, namely Decreasers, Increasers I, II and III species (Van Oudtshoorn, 2012). This data was incorporated into the GRAZE model (Brown, 1997) and used to calculate veld condition scores for each of the plant communities (Table 5.1). According to Bothma (2002), veld is considered to be in a poor condition if the veld condition is lower that 40%, in a moderate condition if it ranges between 40% to 60%, and in a good condition if it has a score higher than 60%.

The overall condition of the Nooitgedacht study area was calculated using proportional contributions of each plant community (based on area size) to the total study area. Environmental variables such as rainfall, fire history, percentage of grass cover, and accessibility of habitats to animals were incorporated into the GRAZE model to determine the grazing capacity.

The grazing capacity and stocking rate for each of the described plant communities are presented in Table 5.1. Grazing capacity is ‘considered to be the average number of animals an area can sustain over a period of time without deterioration of the vegetation or animal production, and is based on the stocking rate (Galt *et al*., 2000).

Table 5.1: Results of the Graze Model (Veld condition and Grazing capacity) for the study area

Plant community	1	2.1	2.2	3	4.1	4.2	5	6	7.1	7.2	7.3	Total
Size (ha)	58	55	471	252	148	245	141	708	202	926	1251	**4457**
Trees % cover	4	4	14	15	13	37	46	101	6	27	81	
Shrubs % cover	33	28	29	19	31	26	17	19	9	10	4	
Bush factor	0.86	0.88	0.81	0.84	0.81	0.67	0.64	0.26	0.93	0.79	0.45	
Decreasers	36	85	57	24	87	301	323	341	249	341	815	
Increasers I	60	45	47	453	85	242	226	818	192	384	1135	
Increasers II	79	67	68	249	117	53	207	433	244	591	1512	
Increasers III	23	2	2	74	7	4	17	4	2	51	21	
Encroachers	2	1	26	0	4	0	27	4	13	33	17	
Bare soil	26	8	0	1	20	1	2	21	28	0	6	
Total	226	208	200	801	320	601	802	1621	728	1400	3506	
Veld Condition Index %	**56.1**	**72.5**	**63.0**	**61.8**	**65.0**	**82.9**	**73.9**	**69.8**	**69.6**	**66.2**	**67.7**	
Grass cover %	29	13	19	71	31	40	38	60	67	64	73	
Rainfall (mm/yr)	615	615	615	615	615	615	615	615	615	615	615	
Accessibility	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
Fire (0.8\1)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Grazing Capacity												
Average year												
ha/LSU Game	8.8	13.2	9.2	6.3	7.2	5.4	5.9	7.4	6.8	5.8	5.9	
Number LSU Game	**6.6**	**4.2**	**51.3**	**40.3**	**20.5**	**45.6**	**23.9**	**95.4**	**29.8**	**160.8**	**211.2**	**689.4**
Grazing Capacity	12.8	34.7	15.0	8.9	10.8	8.0	9.0	8.1	7.9	8.4	8.0	
Below average year												
ha/LSU Game	16.0	44.5	17.5	10.7	12.6	8.9	10.0	12.4	11.3	9.7	9.9	
Number LSU Game	**3.6**	**1.2**	**26.8**	**23.6**	**11.7**	**27.6**	**14.1**	**57.2**	**17.9**	**95.5**	**126.6**	**406.0**
Total Grazing Capacity (ha/LSU)						**Game**	**6.5**					

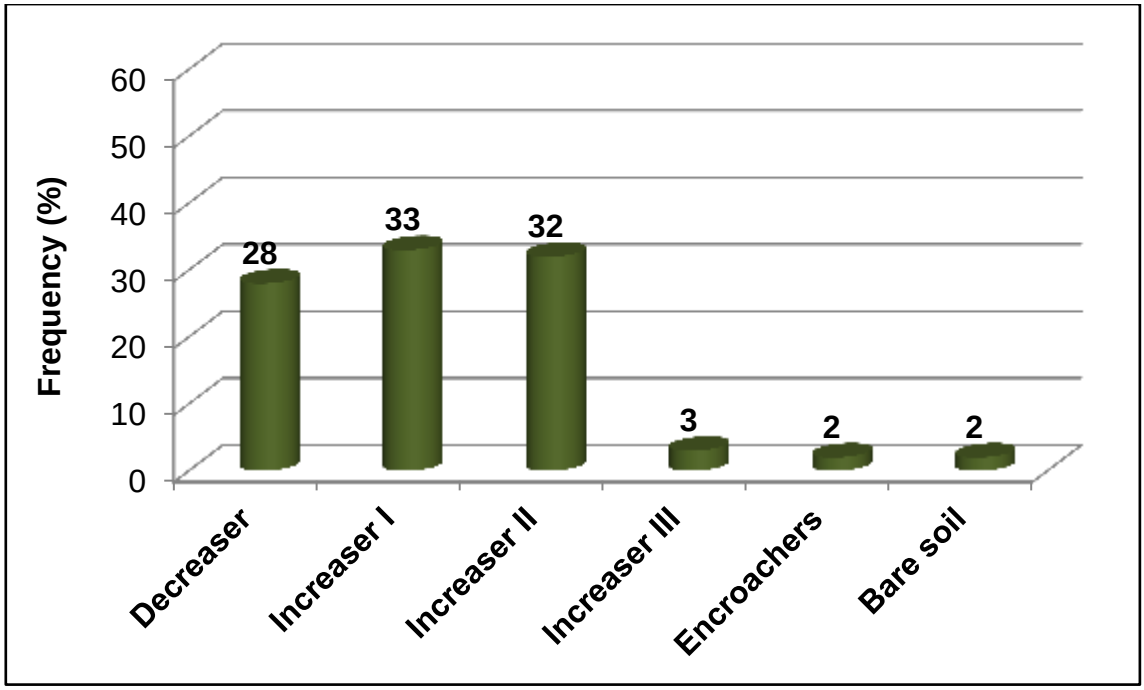


Figure 5.1: Overall frequency for the ecological groups in the study area

The total grazing capacity for the Nooitgedacht section of the reserve is 6.5 ha/LSU for game (Table 5.1). The grazing capacities of each of the different plant communities identified were calculated individually and indicated in Table 5.1. The veld condition and grazing capacity for each community is discussed below:

5.1.1 *Sporobolus africanus*-*Buddleja salviifolia* wetland (1)

The grazing capacity for this plant community is 8.8 ha/LSU (Table 5.1). The veld condition score for the area is 56.1%, indicating that this community is in a moderate condition. This can be attributed to the higher percentage of Increaser I and II grasses that together had an average of 31% frequency (Figure 5.2) while decreasers had a 16% frequency. This domination by increaser II grasses indicates that this community is moderately overutilized.

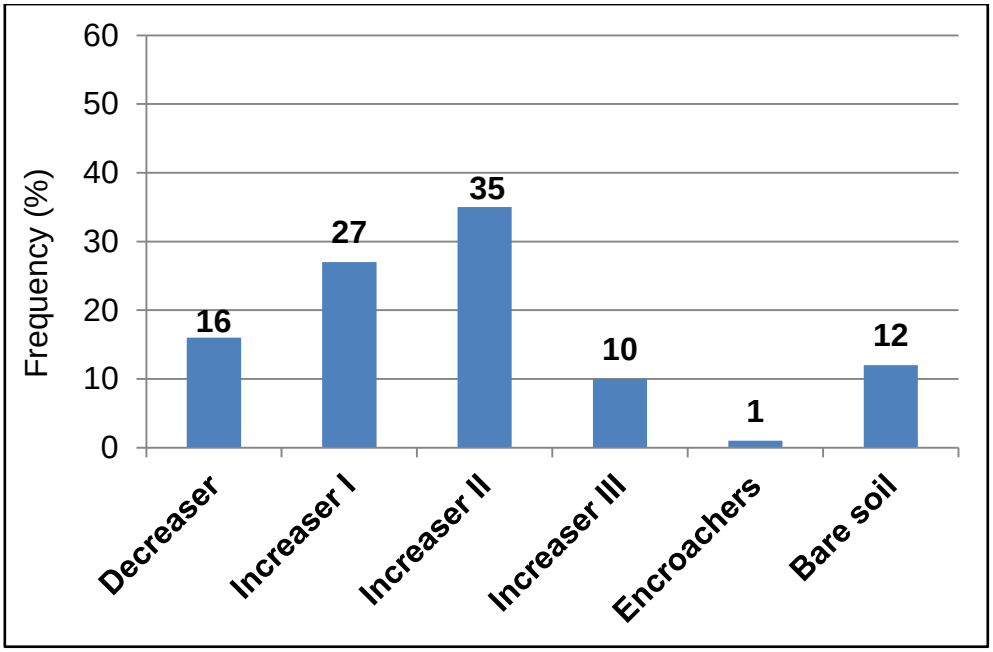


Figure 5.2: Frequencies for the ecological groups in community 1

The characteristic grass species associated with this plant community are *Sporobolus africanus, Hyparrhenia tamba, Pennisetum macrourum, Eragrostis heteromera, Paspalum dilatatum* and *Paspalum urvillei* (Species group A). These grasses range from sub-climax to climax grasses, with average to high grazing values (Van Oudtshoorn, 2012). The grass *Paspalum dilatatum* is an exotic palatable species with a high grazing value, and leaf production that can endure heavy grazing. Some of these grasses (*Eragrostis heteromera, Pennisetum macrourum, Paspalum dilatatum*) are indicators of damp and moist soil (Van Oudtshoorn, 2012). Due to this being a riverine community with sodic soil, it is expected that certain areas will be overgrazed by animals.

5.1.2 *Panicum maximum-Senegalia caffra-Olea europea* subsp. *africana* sub-community (2.1)

The grazing capacity for this plant community is 13.2 ha/LSU (Table 5.1) with a veld condition score of 72.5%, indicating that this community is in a good condition. This is attributed to the high frequency of Decreaser grasses (41%), Increaser I species had a frequency of 22%, Increaser II of 32%, and Increaser III only 1%. There was no encroacher species present with bare ground patches

having a frequency of 4% (Figure 5.3). This community is dominated by palatable grass species; however, the presence of Increaser II species is indicative of sections where moderate overutilization takes place. The grass *Panicum maximum* is mostly responsible for the higher percentage of decreaser grasses. This species is present underneath the more open canopies of the woody layer and is a highly palatable grass.

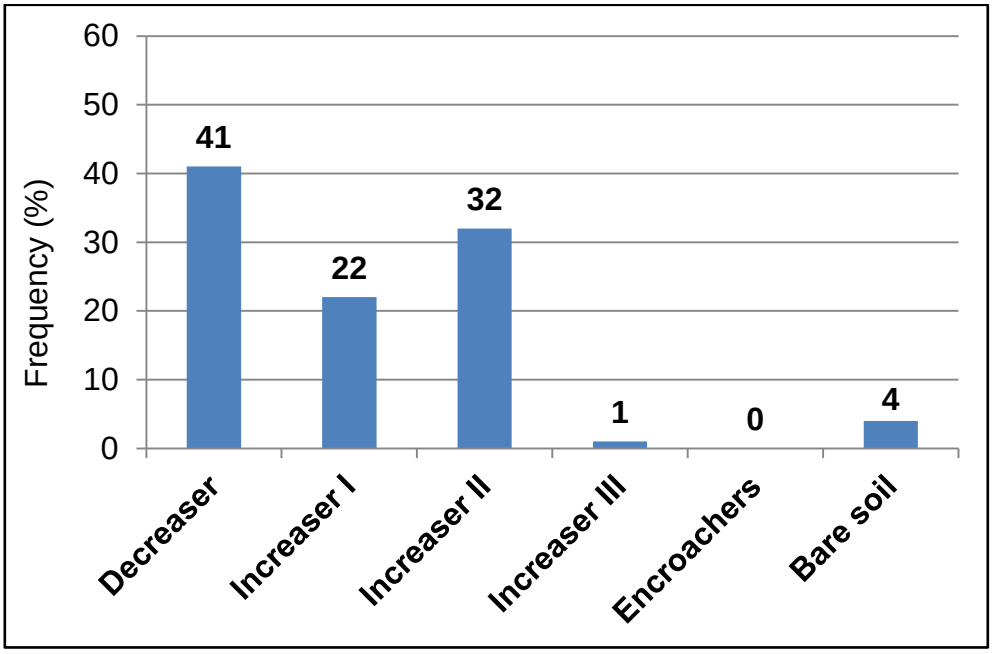


Figure 5.3: Frequencies for the ecological groups in sub-community 2.1

5.1.3 *Panicum maximum-Senegalia caffra-Searsia leptodictya* sub-community (2.2)

The grazing capacity for this plant community is 9.2 ha/LSU (Table 5.1) with a veld condition score of 63.0%, indicating that this community is in a good condition. This area is characterised by Increaser II grasses with a frequency of 34%, while an equally high frequency of 29% was recorded for the Decreasers, 24% Increaser I and 1% for Increaser III species (Figure 5.4). Encroacher species have a frequency of 13%, and no bare soil areas were recorded. The Increaser II grass species and Decreaser grass species have the highest frequencies. This community is similar to community 2.1 and is also subjected to periods of overutilization with the palatable grasses *Panicum maximum* and

Setaria sphacelata providing good grazing to animals. This community possess veld with a relatively good grass cover since no bare ground were recorded.

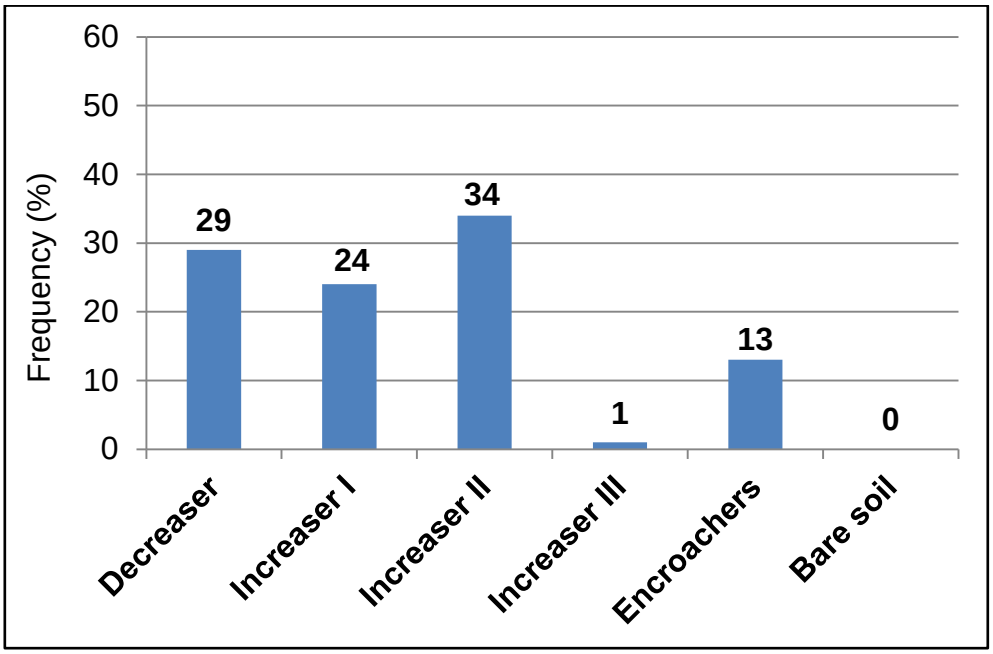


Figure 5.4: Frequencies for the ecological groups in sub-community 2.2

5.1.4 *Eragrostis curvula-Hyparrhenia hirta* old field grassland (3)

The grazing capacity for this plant community is 6.3 ha/LSU (Table 5.1) with a veld condition score of 61.8%, indicating that this community is in a moderate condition. This community is dominated by Increaser I grasses with a frequency of 57%, while Increaser II was at 31%, and Increaser III at 9%. Bare soil patches had 0% frequencies. The decreaser grasses had a low frequency of 3% (Figure 5.5). The domination of Increaser I grasses is an indication of an underutilized veld. The most prominent grass species is the anthropogenic grass *Hyparrhenia hirta*, which becomes palatable during the early growing season and after fires, but loses palatability with maturity (Van Oudtshoorn, 2012). This grass is an aggressive grower that displaces any other grass species in degraded areas.

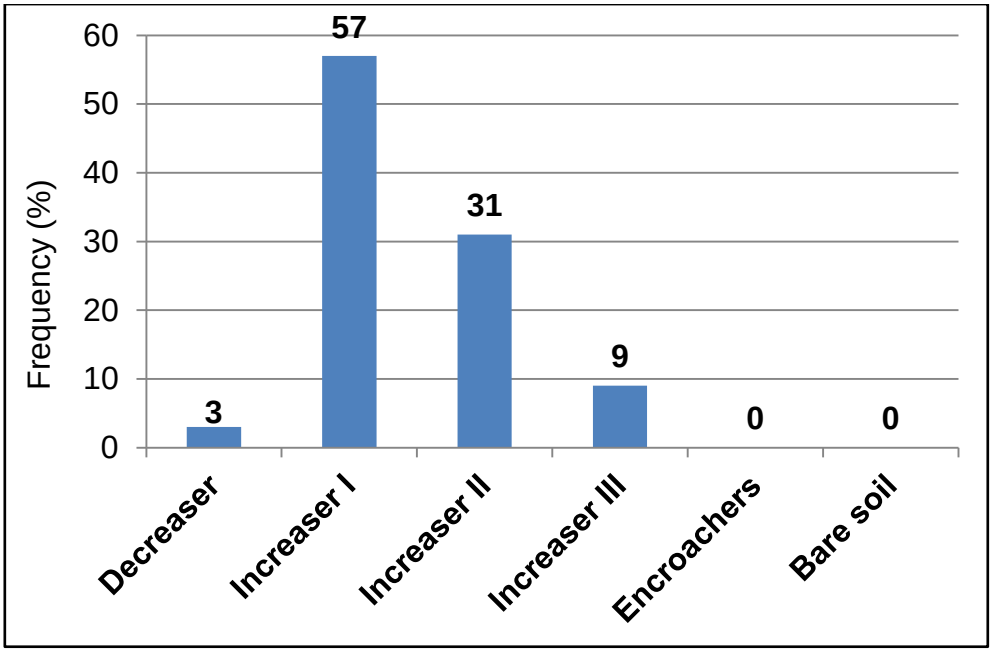


Figure 5.5: Frequencies for the ecological groups in community 3

Other grasses associated with this plant community include *Cynodon dactylon, Eragrostis curvula, Aristida congesta* subsp. *congesta, Aristida congesta* subsp. *barbicollis, Eragrostis gummiflua, Eragrostis plana, Eragrostis chloromelas* and *Chloris pycnothrix* (species group E). Most of these grasses are pioneer species, while some are sub-climax and climax grasses. The prominence of these pioneer and mostly low production grasses is indicative of the previous agricultural activities that took place in this community. Pioneer grasses are annual plants that can establish in degraded veld and under very unfavourable conditions (Van Oudtshoorn, 2012).

5.1.5 *Setaria sphacelata*-*Lannea discolor*-*Englerophytum magalismontanum* sub-community (4.1)

The grazing capacity for this plant community is 7.2 ha/LSU (Table 5.1) with a veld condition score of 65.0% (Table 5.1), indicating that this sub-community is in a good condition. Although the Increaser II grasses had the highest frequency (37%), both the decreasers and Increaser I had a frequency of 27% (Figure 5.6). The domination of Increaser II species seems to indicate that this sub-community is overutilized. However, the dominance of the Increaser II grass *Loudetia*

simplex, which is a climax grass, contributes to this high percentage of Increaser II grass species.

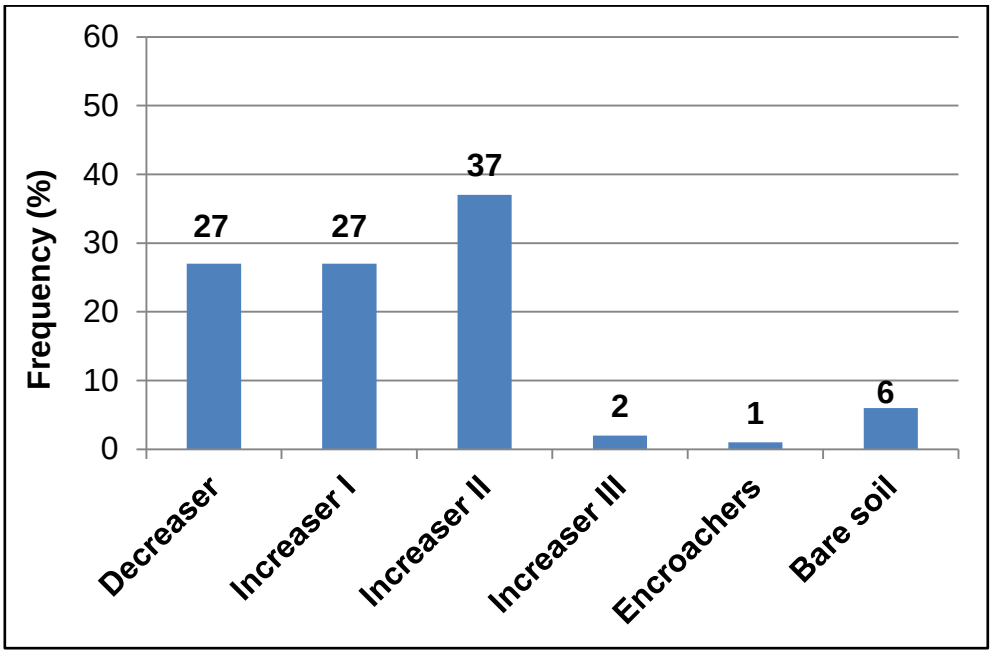


Figure 5.6: Frequencies for the ecological groups in sub-community 4.1

5.1.6 *Setaria sphacelata*-*Lannea discolor*-*Senegalia burkei* sub-community (4.2).

The grazing capacity for this plant community is 5.4 ha/LSU (Table 5.1) with a veld condition score of 82.9%, indicating that this community is in a very good condition. This can be attributed to the higher percentage of decreaser (50%) and Increaser I (40%) grasses, while the Increaser II grasses had a 1% frequency with no encroachers or bare ground (Figure 5.7).

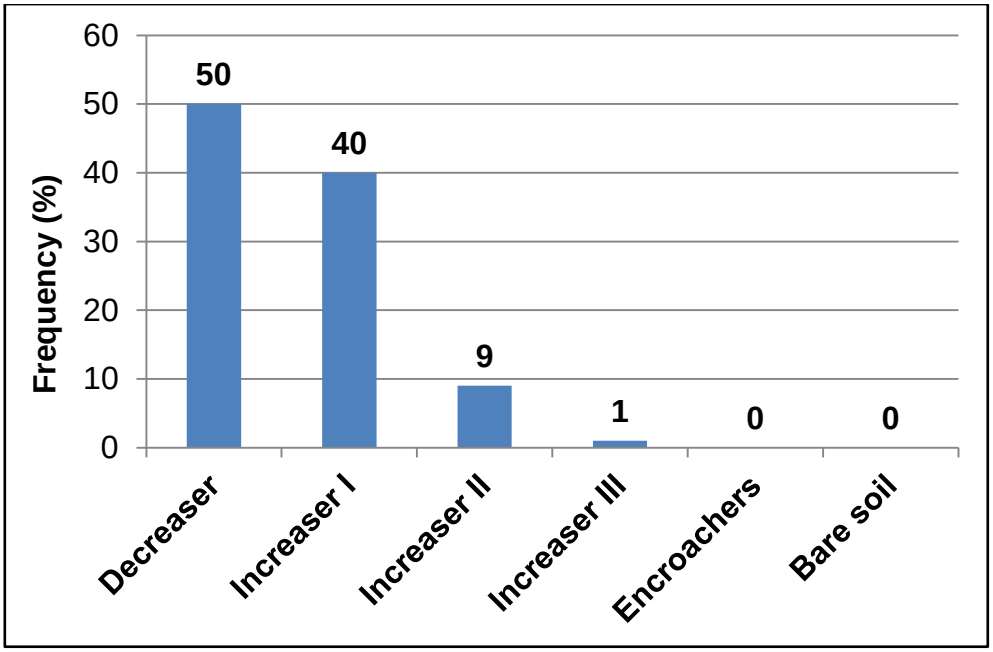


Figure 5.7: Frequencies for the ecological groups in sub-community 4.2

The herbaceous layer is dominated by the decreaser grasses *Setaria sphacelata* and *Themeda triandra* (species group R). These are climax stage grasses with high leaf production, and are very palatable. *Themeda triandra* is a fire resistant grass and may increase if the veld is frequently exposed to fires (Van Oudtshoorn, 2012).

5.1.7 *Pygmaeothamnus zeyheri-Rhoicissus tridentata* rocky shrubland (5)

This plant community has a veld condition score of 73.9% with a grazing capacity of 5.9 ha/LSU (Table 5.1). This indicates that this community is in good condition. The high score can be attributed to the higher percentage of decreaser grasses, with a 40% frequency, while the Increaser I species had 28%, Increaser II 26%, Increaser III 2%, encroacher species 3%, and 0% for bare ground (Figure 5.8). The presence of Increaser I and II, and their combined frequencies of 27% indicate that sections of this community are moderately overgrazed and dominated by the Increaser II grass *Hyparrhenia hirta.*

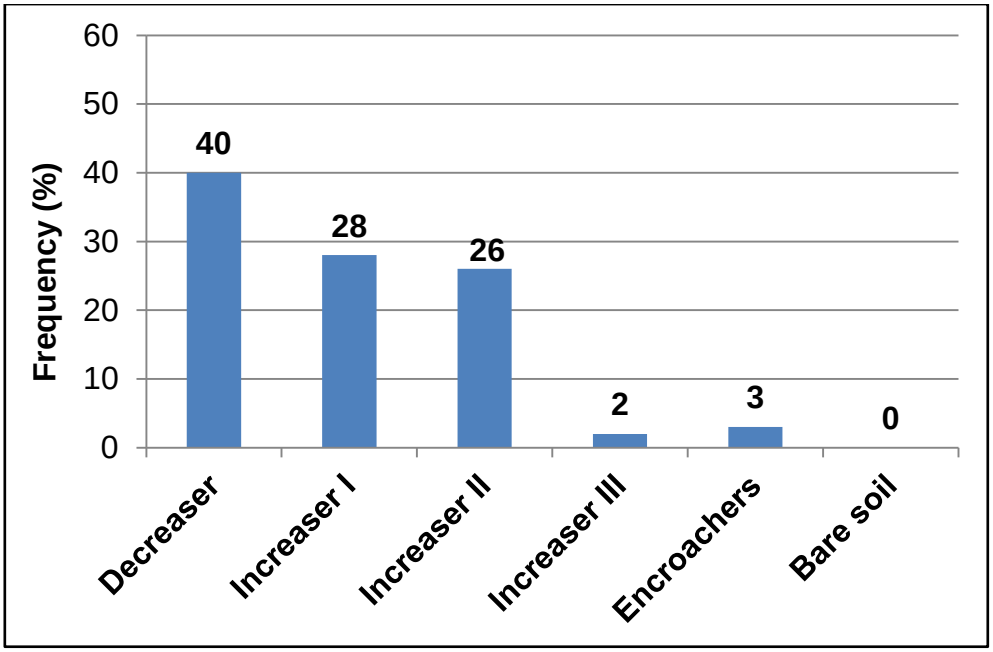


Figure 5.8: Frequencies for the ecological groups in community 5

The characteristic grasses associated with this plant community include *Eustachys paspaloides, Digitaria diagonalis, Setaria megaphylla, Eragrostis capensis,* and *Digitaria eriantha* (species group I). They generally dominate a veld that is in a stable and good condition.

5.1.8 *Tristachya leucothrix-Faurea saligna* open woodland (6)

The grazing capacity for this plant community is 7.4 ha/LSU (Table 5.1). The veld condition score for the area is 69.8%, indicating that this community is in a good condition. This is attributed to the higher percentage of Increaser I grasses with frequency of 50%, while the decreasers had a frequency of 21.0%, and Increaser II, 27%. The Increaser III and encroachers together had 0%, while bare grounds had 1% (Figure 5.9). The herbaceous layer of this community is characterised by the dominance of the climax grasses *Tristachya leucothrix, Trachypogon spicatus, Loudetia simplex* and *Brachiaria serrata*. The first two are Increaser I grasses, hence the large frequency of this ecological class. These grasses are palatable only at the beginning of the growing season, (Van Oudtshoorn, 2012) and are not utilised later in the season resulting in periods of underutilization.

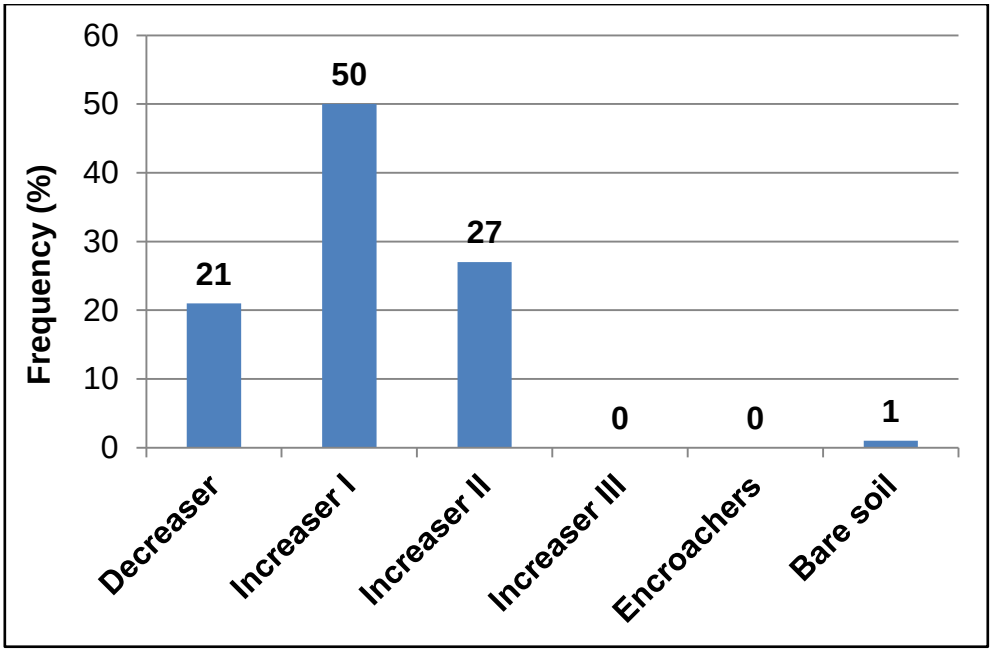


Figure 5.9: Frequencies for the ecological groups in community 6

5.1.9 *Elionurus muticus-Loudetia simplex-Tristachya biseriata* sub-community (7.1)

The grazing capacity for this plant community is 6.8 ha/LSU with a veld condition score of 69.6% (Table 5.1). The veld condition of this sub-community is in a good condition. Equal frequencies of 34% were recorded for both Decreaser and Increaser II grasses, while the Increaser I grasses had a 26% frequency with no Increaser III species, 2% Encroacher species and 4% bare ground (Figure 5.10).

The high frequency of Increaser II grasses can be attributed to the dominance of the grasses *Loudetia simplex* and *Tristachya biseriata*. The Decreaser grasses *Themeda triandra* and *Brachiaria serrata* are also abundant in this sub-community. All of the grasses are climax grasses indicating that this community is in a good condition.

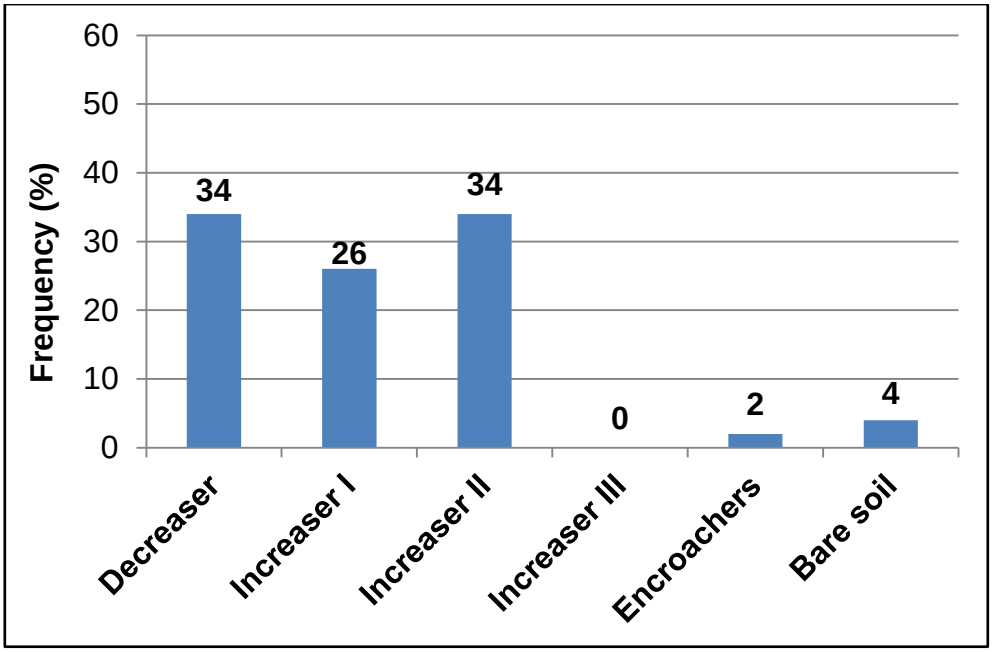


Figure 5.10: Frequencies for the ecological groups in sub-community 7.1

5.1.10 *Elionurus muticus-Loudetia simplex-Aristida diffusa* sub-community (7.2)

The grazing capacity for this plant community is 5.8 ha/LSU (Table 5.1) with a veld condition score of 66.2%, indicating that this sub-community is in good condition. The *Elionurus muticus-Loudetia simplex-Aristida diffusa* sub-community is dominated by Increaser II grasses with a 42% frequency. This is expected since the climax Increaser II grass *Tristachya leucothrix* dominated the herbaceous layer. The Decreaser grasses had a 24% frequency, Increaser I had 27% and Increaser III had 4%. The Encroachers had a 2% frequency with no bare ground (Figure 5.11). Some areas are locally overutilized, and this is substantiated by the high amount of animal activity recorded for this area.

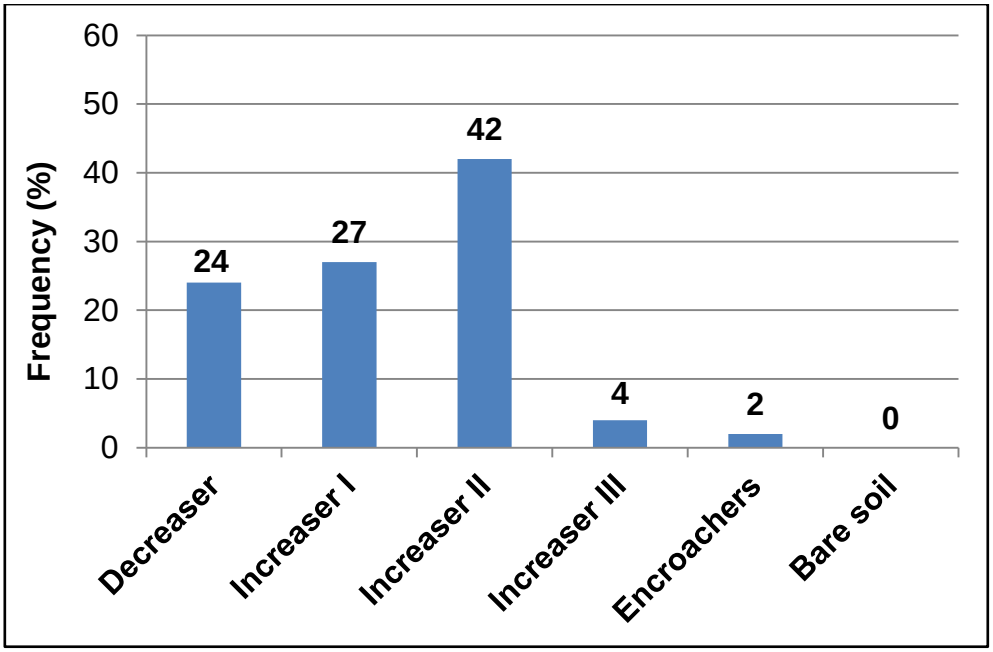


Figure 5.11: Frequencies for the ecological groups in sub-community 7.2

5.1.11 *Elionurus muticus-Loudetia simplex-Gladiolus elliotii* sub-community (7.3)

The grazing capacity for this plant community is 5.9 ha/LSU (Table 5.1). The veld condition score for the area is 67.7%, indicating that this sub-community is in a good condition. This sub-community had a higher frequency percentage of Increaser II grasses (43%), while Increaser I had 32% and Decreaser grasses 23%. Frequency percentage for encroacher species and bare ground was 0% (Figure 5.12). Although a large number of the grass species are climax grasses which are also Increaser II species, the prominence of the anthropogenic grass *Hyparrhenia hirta* in this sub-community indicates that some areas have been overgrazed in the past.

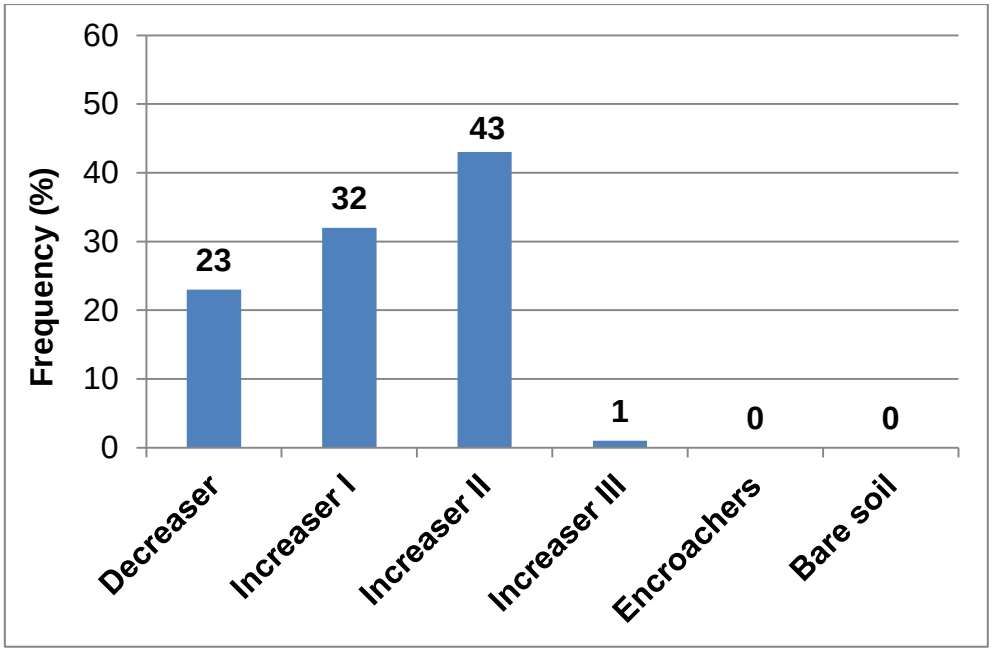


Figure 5.12: Frequencies for the ecological groups in sub-community 7.3

Other grass species associated with this plant community include *Elionurus muticus, Trichoneura grandiglumis*, *Aristida diffusa, Rendlia alteria* and *Monocymbium ceresiiforme.* They are mostly climax stage grasses with *Trichoneura grandiglumis* being a sub-climax grass (Van Oudtshoorn, 2012).

5.3 Discussion and conclusion

Plant communities 2.1, 4.2, 5 and 7.1 had the highest percentages of Decreaser grasses compared to the rest of the communities. The veld condition of these plant communities can be maintained by adhering to existing stocking rates and maintaining the existing frequency of burning. None of the other communities have low veld condition scores, though many are dominated by either Increaser I or Increaser II climax indicating that these communities are natural.

The average bare ground recorded for the study area was 2%. This indicated that the vegetation has a good cover and that the veld provides resistance to soil erosion. According to Mucina & Rutherford (2006), the central bushveld vegetation types experience low to very low soil erosion. The highest recording of 12% bare grounds was recorded in plant community 1. This is the community

occurring along the water courses and the erosion may have resulted from high levels of animal activity along these areas.

Veld in a good condition is generally resistant to soil erosion and provides valuable information about the condition of an area (Trollope, 1989). The plant community with the highest veld condition score was sub-community 4.2 (82.9%), which also had the best Grazing Capacity of 5.4 ha/LSU. The lowest veld condition score was recorded in plant community 1 (56.1%), while the lowest grazing capacity of 13.2 ha/LSU was recorded for sub-community 2.1.

The results for the Nooitgedacht area indicate that overall the veld is in a good condition (67% veld condition score) with a grazing capacity of 6.5 ha/LSU. This indicates veld that is well managed. Results from a previous study (Hondekraal section of the reserve) recorded a veld condition of 57%, which is 10% less than for the Nooitgedacht section.

In some communities certain sections are periodically overgrazed, but that is to be expected since game selectively utilise these areas and are dispersed unevenly within the veld. Although there seems to be no immediate problems with regards to the veld condition of the different communities, it is important that these areas are monitored on a regular basis to determine whether the size of the overgrazed patches are increasing, and if so, pro-active management decisions should be taken to address the causes.

Chapter 6

6 FLORISTIC ANALYSIS

Little information exists on the flora of the Nooitgedacht section. This chapter aims to provide information about the different plant taxa present in this section. Taxonomic names used in this study conform to Germishuizen & Meyer (2003).

6.1 Species composition of the study area

A total of 649 plant species, represented by 120 plant families, and 399 genera was identified in the study area. They can be grouped into the Pteridophytes (ferns and fern allies), Spermatophytes (seed/cone-bearing), Monocotyledons (flowering plants) and Dicotyledonous plants (non-flowering plants) as shown in Figure 6.1.

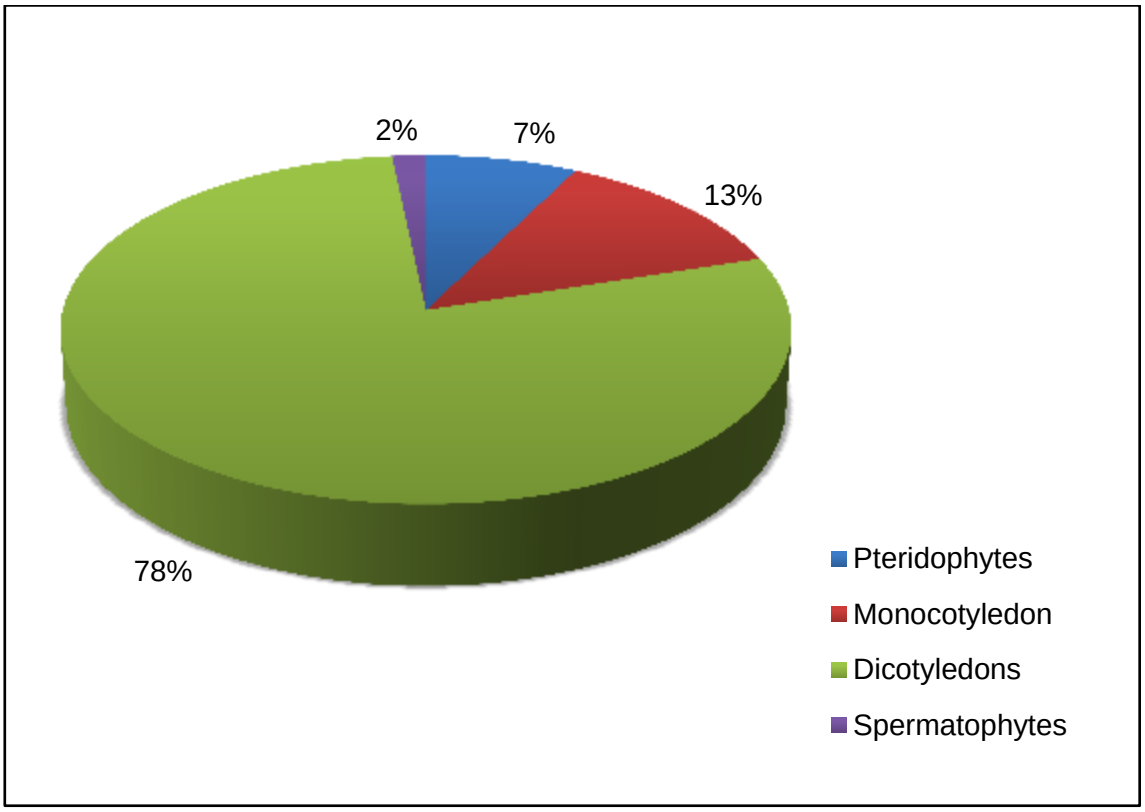


Figure 6.1: Plant divisions reflected as percentages of the total plant families' flora.

The dominant plant families ascending from the highest to lowest order are presented in Table 6.1.

Table 6.1: Most prominent plant families listed in descending order

	Family	Genera	Species
1	Poaceae	48	85
2	Asteraceae	44	75
3	Fabaceae	22	47
4	Cyperaceae	9	22
5	Acanthaceae	11	19
6	Hyacinthaceae	11	19
7	Euphorbiaceae	11	17
8	Other families (1 – 2%)	363	56%

The Poaceae is the largest plant family and is represented by 48 genera and 85 species, which is 13% of the total flora of the study area. The five most important genus names in the Poaceae family are presented in Figure 6.2. As expected, Asteraceae is the second largest plant family with 44 genera and 75 species.

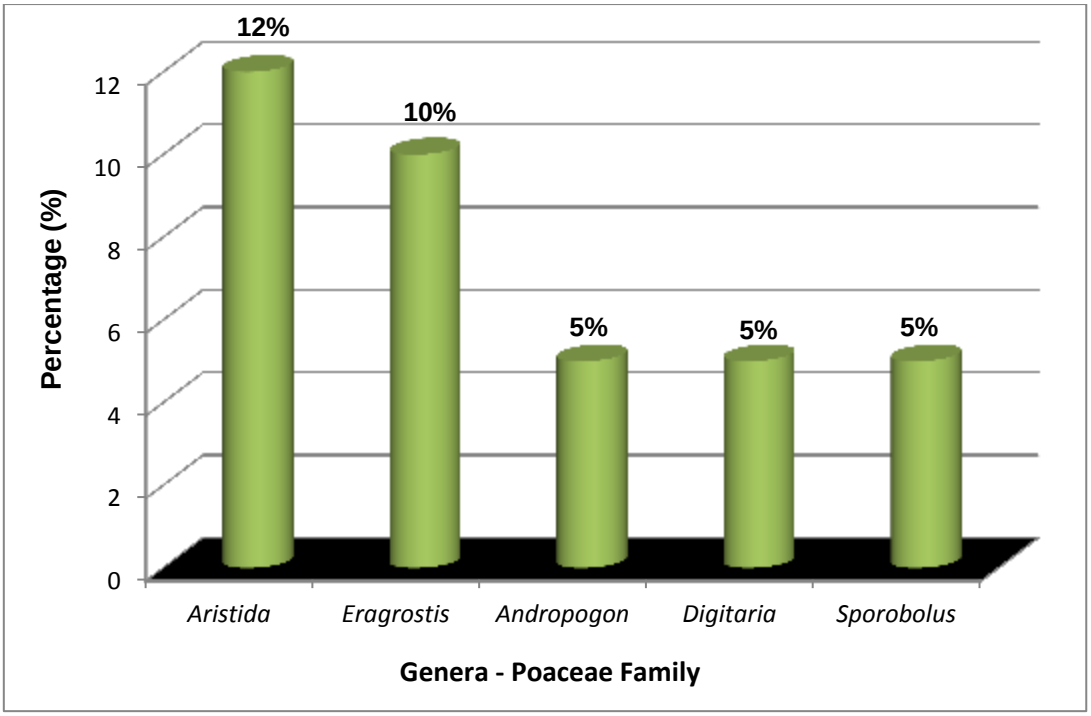


Figure 6.2: Percentages of the dominant genus names in the Poaceae family

6.2 Plant species and their economic attributes

A species list (Annexure C) was compiled for the Nooitgedacht section. Several species occurring in the study area are regarded as alien invasive species protected species and medicinal species. These categories are discussed below.

6.2.1 Medicinal plants

The use of plants for medicinal and livelihood purposes has been associated with human being for many years. Van Wyk, Van Oudtshoorn & Gericke (2009) state that natural products (plants and animals) represent more than half of all the drugs used in modern medicines, of which not less than 25% comprise of plant products. The increased human population has led to an increase in medicinal plant harvesting and as a result has negative impacts on natural plant populations. Medicinal plants are an important economic resource, trade occurring from local to international markets, which confirms their importance to healthcare, globally (Hawkins, 2008).

A total of 35 plants with medicinal potential were recorded in the study area. These plants are represented by 26 plant families, 35 genera and 35 species. The medicinal plants recorded in the study area are listed according to their associated ailments in Table 6.2 (Van Wyk, Van Oudtshoorn & Gericke, 2009). Each alphabet represents the associated ailments as follows: A - Indigestion, heartburn, nausea, colic, B - Constipation, C - Diarrhoea and dysentery, D - Worms, E - Cough, bronchitis, asthma, F - Fever, colds, influenza, G - Headache, H - Insomnia, anxiety, hysteria, convulsions, epilepsy, J - High blood pressure, K - Diabetes, L - Sterility, infertility, impotence, M - Menstrual disorder, antenatal and postnatal disorders, N - Prostate problems, benign prostatic hypertrophy, O - Urinary tract infections, kidney and bladder health, P - Haemorrhoids, Q - Rheumatism, arthritis, gout, R - Toothache, earache, sore gums, oral thrush, S - Wounds, boils, sores, rashes, burns, T - Conjunctivitis, U - Snakebite, V - Bleeding - haemostatics, W – Cancer.

Table 6.2: List of medicinal plants identified in the study area

	Species	Ailments	Family Name
1	*Vachellia karroo*	C, R	Mimosaceae
2	*Aloe ferox*	A, B, Q, T	Asphodelaceae
3	*Artemisia afra*	A, F, G, J	Asteraceae
4	*Asparagus laricinus*	H, Q	Asparagaceae
5	*Aster bakeranus*	B, D, G	Asteraceae
6	*Boophane disticha*	H, S	Amaryllidaceae
7	*Bowiea volubilis*	G, L, O	Hyacinthaceae
8	*Capparis tomentosa*	Q	Capparidaceae
9	*Conyza scabrida*	E, F, K, Q	Asteraceae
10	*Croton gratissimus*	E, F	Euphorbiaceae
11	*Dichrostachys cinerea*	C, L, R	Mimosaceae
12	*Dicoma anomala/capensis*	B, C, F, I, P, W	Asteraceae
13	*Dombeya rotundifolia*	C	Sterculiaceae

14	*Elephantorrhiza elephantina*	C, S	Mimosaceae
15	*Erythrina lysistemon*	Q, S	Fabaceae
16	*Eucomis autumnalis*	L, Q	Hyacinthaceae
17	*Gnidia kraussiana*	C, S, U	Thymelaeaceae
18	*Gomphocarpus fruticosus*	G	Asclepiadaceae
19	*Helichrysum nudifolium*	F, S	Asteraceae
20	*Heteropyxis natalensis*	F,	Heteropyxidaceae
21	*Hypoxis hemerocallidea*	M, O, W	Hypoxidaceae
22	*Lannea edulis*	C, S	Anacardiaceae
23	*Leonotis leonurus*	E, S, U	Lamiaceae
24	*Lippia javanica*	A, E, F	Verbenaceae
25	*Myrothamnus flabellifolius*	E, F, S	Myrothamnaceae
26	*Olea europea*	I, O	Oleaceae
27	*Pellaea calomelanos*	E	Pteridaceae
28	*Rhoicissus tridentata*	K, L, O	Vitaceae
29	*Scabiosa columbaria*	A, S	Dipsacaceae
30	*Sclerocarya birrea*	A, C	Anacardiaceae
31	*Senna italica*	B, F, H, O	Caesalpiniaceae
32	*Vernonia oligocephala*	A	Asteraceae
33	*Xerophyta retinervis*	E, V	Velloziaceae
34	*Xysmalobium undulatum*	C, L, O, S	Apocynaceae
35	*Ziziphus mucronata*	C, E, S	Rhamnaceae

The top five ailments recognised from the above medicinal plant species are indicated in Figure 6.3. This comprises of 11 plants, which is 13.3% of the total medicinal plants, that are associated with the treatment of wounds, boils, sores and rashes (S); 10 plants (11.2%) used to treat diarrhoea and dysentery (C); 9 plants (10.2%) used to treat fever, colds and influenza (F); 8 plants (9.2%) to treat cough, bronchitis and asthma (E); and 6 plants (7.1%) used to treat indigestion, heartburn and nausea (A) (Van Wyk *et al*., 2009).

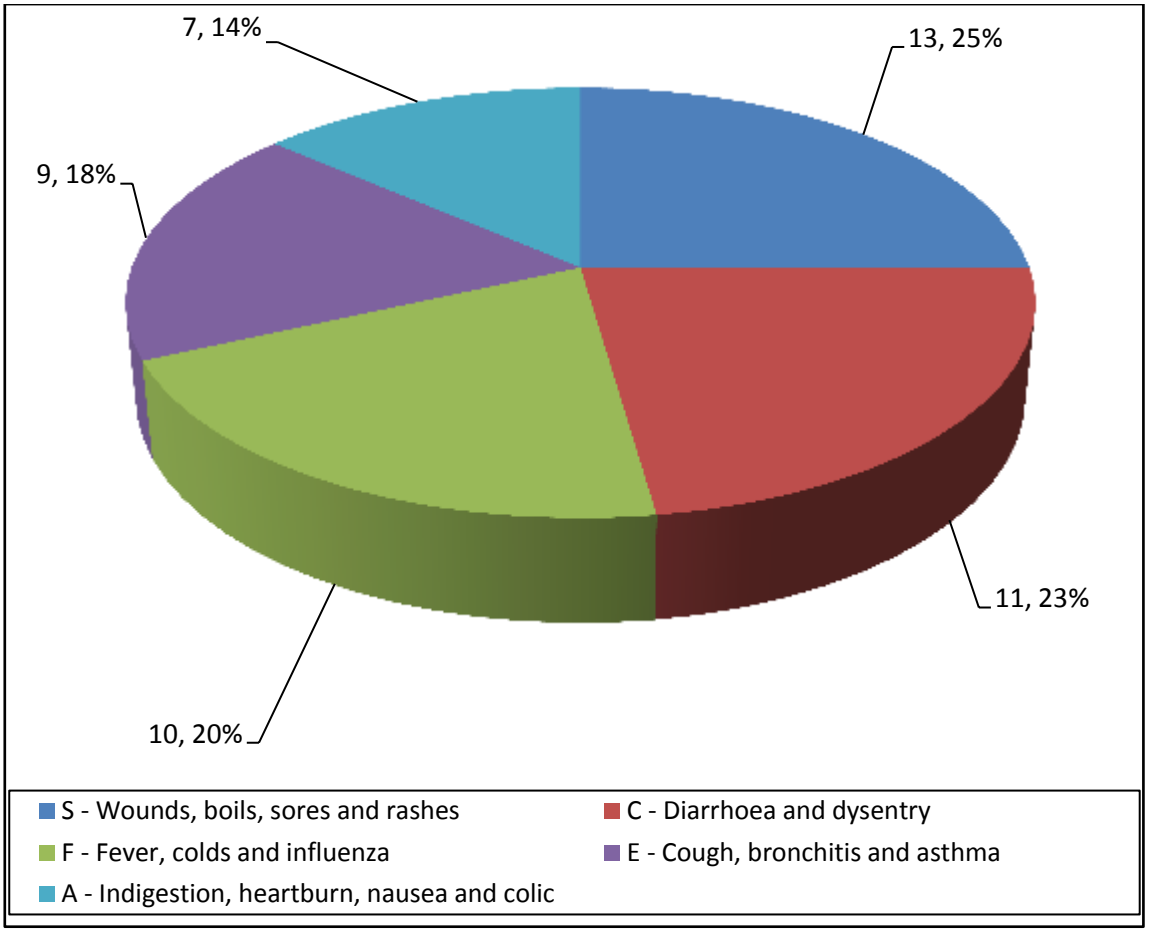


Figure 6.3: Top five medicinal plant species percentages according to ailments

6.2.2 Specially protected plants

One specially protected plant *Encephalartos middelburgensis* (Office of the Premier, 1998) was recorded in the study area. This is the only viable population in the Mpumalanga province.

6.2.3 Protected plants

A total of 26 specially protected plants (Office of the Premier, 1998) were recorded in the study area (Table 6.3). These plants are represented by eleven plant families, 15 genera and 26 species. The Iridaceae family dominated the recorded protected plants with 9 species from 2 genera, followed by the

Asphodelaceae (2 genera and 5 species), Amaryllidaceae (3 genera and 3 species), and Hyacinthaceae (2 genera and 3 species).

Table 6.3: Protected plants recorded in the study area

	Species	Family
1	*Agapanthus nutans*	Agapanthaceae
2	*Aloe arborescens*	Asphodelaceae
3	*Aloe dichotoma*	Asphodelaceae
4	*Aloe marlothii*	Asphodelaceae
5	*Aloe transvaalensis*	Asphodelaceae
6	*Berchemia zeyheri*	Rhamnaceae
7	*Boophane disticha*	Amaryllidaceae
8	*Bowiea volubilis*	Hyacinthaceae
9	*Crinum bulbispermum*	Amaryllidaceae
10	*Eucomis autumnalis*	Hyacinthaceae
11	*Gladiolus crassifolius*	Iridaceae
12	*Gladiolus dalenii*	Iridaceae
13	*Gladiolus elliotii*	Iridaceae
14	*Gladiolus permeabilis*	Iridaceae
15	*Gladiolus pole-evansii*	Iridaceae
16	*Gladiolus sericeovillosus* subsp. *calvat*	Iridaceae
17	*Gladiolus sericeovillosus* subsp. *sericea*	Iridaceae
18	*Haemanthus humilis*	Amaryllidaceae
19	*Harworthia koelmaniorum* var. *mcmurtryi*	Asphodelaceae
20	*Hesperantha baurii*	Iridaceae
21	*Hesperantha coccinea*	Iridaceae
22	*Huernia hystrix*	Asclepiadaceae
23	*Olea europaea* subsp. *africana*	Oleaceae
24	*Pterocarpus lucens* subsp. *antunesii*	Fabaceae
25	*Scilla dracomontana*	Hyacinthaceae
26	*Scilla nervosa*	Hyacinthaceae

6.2.4 Declared weeds or Invader plants

Alien invasive species pose a huge threat to the natural environment. Not only are they able to increase and reproduce at a faster rate than the indigenous species, but they are also known to use large amounts of water. These plants are divided into three categories: Category 1 species are declared weeds, totally prohibited; Category 2 are invasive species for which permission can be obtained to grow them commercially in demarcated areas, otherwise they must be removed, and Category 3 are invasive species that can be maintained if they were already growing in a particular area before March 2001 (promulgation of new regulations) and no planting of new plants is allowed (Department of Agriculture, 2001).

Thirteen alien invader plants recognised by the Office of the Premier (1998) were recorded in the study area (Table 6.4). These plants are represented by thirteen species from eleven plant families, with four species regarded as category one species, six category two species and three category three species.

Table 6.4: Invader plants identified in the study area

	Species	Family	Category
1	*Acacia mearnsii*	Mimosaceae	2
2	*Agave americana*	Agavaceae	3
3	*Agave sisalana*	Agavaceae	2
4	*Bidens pilosa*	Asteraceae	2
5	*Cirsium vulgare*	Asteraceae	1
6	*Datura ferox*	Solanaceae	1
7	*Eucalyptus paniculata*	Myrtaceae	2
8	*Jacaranda mimosifolia*	Bignoniaceae	3
9	*Opuntia ficus-indica*	Cactaceae	1
10	*Melia azedarach*	Meliaceae	3

11	*Pinus pinaster*	Pinaceae	2
12	*Pennisetum setaceum*	Poaceae	1
13	*Populus alba*	Salicaceae	2

6.3 Discussion

The dominant plant divisions recognised in the study area are dicotyledonous plants that comprise 78% of all species recorded followed by monocotyledonous plants comprising 13%, while the pteridophytes and spermatophytes comprise 7% and 2% respectively (Figure 6.1).

The most dominant plant families recorded in the study area are the Poaceae and the Asteraceae. This is similar to what was recorded in other grassland areas except that Asteraceae was found to be the largest family followed by the Poaceae as is the case for the grassland plateau areas of the Mountain Zebra National Park (Pond *et al.*, 2002) and the high altitude grassland plateaus of Platberg in the Free State (Brand, Brown, & Du Preez, 2011). The Poaceae is mainly represented by the genera *Aristida*, *Eragrostis*, *Andropogon*, *Digitaria* and *Sporobolus*.

The most dominant plant family in terms of medicinal usage is the Asteraceae, comprising of six species, followed by Mimosaceae (3 species) and Hyacinthaceae (2 species). The medicinal plants identified in the study area representing the Asteraceae family are commonly used for the treatment of fever, colds and influenza (F). Plant species under the Mimosaceae family (3 species) are associated with the treatment of diarrhoea and dysentery (C), while the Hyacinthaceae (2 species) are commonly used for treating sterility, infertility and impotence (L) (Van Wyk, Van Oudtshoorn & Gericke, 2009).

6.4 Conclusion

The dominance of the Poaceae family is not surprising since the Nooitgedacht section is dominated by grassland vegetation, covering 59% of the study area. Asteraceae family is the second most prominent, and this may be attributed to the moist grassland habitats in the area. A wide variety of common ailments are associated with a number of plants recorded in the study area, and the Asteraceae family comprise the highest number of species used for medicinal purposes. It is not unusual for grassland areas (Brand, Brown & Du Preez, 2011) that these two families are the most dominant. This floristic analysis proves that the Nooitgedacht section of the Loskop Dam nature reserve has rich species diversity and contributes to the biodiversity of the area.

Chapter 7

7 VELD AND GAME MANAGEMENT AND RECOMMENDATIONS

The results of this study should contribute to the management plan for the larger Loskop Dam nature reserve. The management plan document is one of the most important tools that serves to guide to management activities and also provides a sense of direction in decision making. The vegetation is managed for biodiversity (Brown *et al.*, 2013) and also to ensure satisfactory animal performance over a period of time by considering aspects like the controlled used of fire; type of animals involved; stocking rate; and grazing management (Tainton, 1999).

7.1 Veld management and recommendations

7.1.1 Vegetation monitoring

Vegetation monitoring was defined by Elzinga, Salzer & Willoughby (1998) as 'the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress towards meeting a management objective'. It is an important part of adaptive management and is driven by the objectives of an area. Veld condition changes and trends can be estimated by monitoring the same survey sites using an Ecological Index Method (EIM) over a period of time. This is done in order to compare the same site with itself. In general, veld with higher Veld Condition Index (VCI) is considered to be in a better condition than the opposite (Bothma, 2002). According to Lee, McGlone & Wright (2005), there are three types of biodiversity monitoring that are recognised: 1) Monitoring aimed at assessing the need for management intervention; 2) Monitoring to define available resources through habitat inventory; 3) Monitoring of status and trend and where long term monitoring results are used to address ecological questions.

Monitoring activities are undertaken within a wide range of scales depending on the stated objectives. The main aim of a vegetation monitoring program is to detect changes in species composition of the grass layer over a period of time (Tainton, 1999). The monitored changes can be as a result of climatic conditions, animal activities and/or human activities. If monitoring is properly designed to meet a certain goal, and well executed, it can be a very powerful tool to better manage available resources.

7.1.1.1 Herbaceous layer monitoring

Currently, there are approximately 50 fixed 200-point grass monitoring plots spread across the larger Loskop Dam Nature Reserve (Eksteen, 2003). These plots are monitored on a 3-year cycle at the end of the growing season. There are nine existing plots located in the study area: one plot (37) in sub-community 4.1; two plots (23 and 34) in community 6; three plots (38, 39 and 40) in sub-community 7.2 and three plots (35, 36 and 41) in sub-community 7.3. Major plant community 7 is already represented by six existing plots, while sub-community 4.1 is represented by one plot and community 6 represented by two plots. Plant communities 1, 3, 5, sub-communities 2.1, 2.2, 4.2 and 7.1 are not represented.

It is recommended that a minimum of two monitoring plots are placed in plant communities 1, 3, 5, sub-communities 2.2 and 7.1. One monitoring plot may be placed in sub-communities 2.1 and 4.2. The existing monitoring plots may remain unchanged while the new recommended plots may be located in areas that are representatives of the specific plant community they occur in. These plots should be monitored on the same intervals of 3-year cycles as the ones placed in the larger reserve sections.

7.1.1.2 Woody layer monitoring

A total of 41 Variable Quadrant monitoring plots exist and are spread across the larger part of the reserve. These plots are monitored on a 5-8 year cycle, at the end of the growing season for woody species composition and structure (Eksteen, 2003). The aim of the shrub and tree layer monitoring is to identify changes in species composition over a period of time. These fixed photo-points are placed at key sample sites in the larger reserve to monitor the woody layer structure on an annual basis.

There is no information on the existing woody monitoring plots in the study area; it is therefore recommended that a minimum of two similar monitoring plots are placed out in the woody plant communities (2, 4 and 6) of the study area for monitoring purposes. These monitoring sites should be placed in representative areas of these plant communities and may be monitored at similar intervals as outlined in the management plan for the reserve (Eksteen, 2003). There was evidence of dying *Protea caffra* trees in sub-community 7.3, it is recommended that a minimum of two monitoring fixed photo-points be placed in this area, located in the northern part of the study area.

The data collected from the herbaceous and woody layer surveys would provide additional data for adjusting the stocking rates of grazing and browsing animals, and assist in monitoring vegetation change over time.

7.1.2 Red data plant species management

Red data species are threatened species classified by the International Union for Nature Conservation (IUCN, 1996) into different categories (e.g. Critically endangered, Vulnerable, etc.). According to the South African National Biodiversity Institute (SANBI), threatened species are species facing a high risk of extinction (SANBI, 2012).

A critically endangered species *Encephalartos middelburgensis* was recorded in the study area. According to SANBI (2012), the estimated remaining wild population is 120 individuals. This is a specially protected plant according to the provincial conservation ordinance (Mpumalanga Province, 2005).

Haworthia koelmaniorum var. *mcmurtryi,* a rare plant restricted to the Highveld areas of Mpumalanga province, and protected plant under the MCA was also found in the study area. One of the three identified sub-populations that were mentioned by Biko'o, Du Plessis & Myburgh (2011) occurs in one of the communities in the study area.

Threatened species require attention to maintain or improve their endemic, rare or threatened status. In order to achieve this, it is important that their habitats are protected and any threats to their populations removed. This can be done by monitoring the associated habitats annually to maintain or improve their conditions.

7.1.3 Alien Invasive plant management

Alien invasive plants are plants of exotic origin introduced by humans into an area. Invasive alien plants have become a persistent problem in South Africa (Nietesh, 2004), and are capable of replacing indigenous species, transforming indigenous habitats and using a lot of water. When burnt, they can lead to devastating fires and cause soil erosion. Alien plant species recorded in the study area are indicated in Figure 7.1.

Landowners are legally obligated by the legislation of South Africa to control invasion by alien plants on their properties. This is regulated by various laws such as the: Regulations in terms of the Conservation Agricultural Resources Act (CARA) (South Africa, 1983) 43 of 1983; Section 31A of the Environment

Conservation Act 73 of 1989; Municipal by-laws and the National Veld and Forest Fire Act (South Africa, 1998b) 101 of 1989 and Section 28 of the National Environmental Management Act (South Africa, 1998a) 107 of 1998.

The current legislation on weeds and invasive plants is part of the CARA (South Africa, 1983). Regulation 15 and 16 under this Act were revised and amended in March 2001. The main changes involved under Regulation 15 was the replacement of the old terms 'Declared Weeds' and 'Declared Invader Plants' by the following three categories of alien plants (Bromilow, 2001):

Category 1: Declared weeds

Plants that are prohibited and must be controlled or eradicated (Except in biological control reserves designated for the breeding of their biological control agents). They serve no economic purpose and can be poisonous to humans, animals and environment. Alien plants recorded in the study area under this category include:

- *Opuntia ficus-indica* (Community 2.1)

Category 2: Declared invaders

These are alien plants with certain useful qualities such as commercial use (woodlots, animal fodder, soil stabilisation, etc.) and are only allowed in demarcated areas under controlled conditions such as biological control reserves. Alien plants recorded in the study area under this category include:

- *Acacia mearnsii* (Communities 2.2, 3, 4.1, 5, 7.1, 7.2 and 7.3)
- *Agave americana* (Communities 1 and 7.1)
- *Agave sisalana* (Communities 3, 5 and 7.3)
- *Bambusa balcooa* (Community 2.2)
- *Eucalyptus paniculata* (Community 3)
- *Pinus pinaster* (Communities 3 and 7.3)

- *Populus* x. *canescens* (Communities 1, 2.2, 5 and 7.2)

Category 3: Declared invaders

These are alien plants including ornamentals, currently growing in or have escaped from areas such as gardens with the potential to invade areas. No further planting or trade in propagative material of these species is allowed (except with special permission). Existing plants may remain (except those within the flood line of watercourses and wetlands), and must be prevented from spreading. Regulation 16 changes affected the naming of indigenous species that are implicated in 'bush encroachment'. Alien plants recorded in the study area under this category include:

- *Jacaranda mimosifolia* (Communities 2.2, 4.1, 5 and 7.2)
- *Melia azedarach* (Communities 1, 2.2 and 3)

Alien plant control projects have been implemented at LNR by the Working for Water and Working for Wetlands campaigns since 2010. Species controlled by these projects include *Acacia mearnsii, Populus x. canescens, Lantana camara* and *Eucalyptus* species. Follow-up treatments are done on an annual basis, however, *Acacia mearnsii* re-growth was observed in plant community 3 during November 2013. These were plants in the lower and the medium height classes.

Jacaranda mimosifolia is a category 3 plant occurring inside a protected area. It is recommended that the individuals occurring within the study area are eradicated. However, if this is not a preferred option, it will then be essential that the reserve management monitor the areas where these trees occur to ensure that no seedlings establish and that no seeds are washed by rain water into the rivers and streams.

There are a number of aspects to take into considerations before attempting any alien plant control operations for budgeting purposes. These include: vegetation

(density, area size, growth stages, location); terrain (slope / access, carrier volume, transport, equipment, method): labour (skilled/unskilled, number, task, rate, unit cost, availability); technique (chemical, mechanical or biological); equipment (knapsacks, foam sprayer, stem injection, nozzles, manual / mechanical, cost, maintenance); herbicides (type, rate of spray volume, carrier, technical limits, environment, climatic factors, timing, cost); costs (salaries, other benefits, training, overheads, transport, maintenance and environmental factors) and lastly, the programme in terms of duration, number of treatments, total cost for programme, budgeted cost, treated area, situation and season (Martens, Waller, & Delahunt, 2003).

Alien plants negatively affect our fresh water systems. It is recommended that priority be given to alien plants located along river courses and catchment areas of the study area. These include the *Populus* x*. canescens*, forming dense stands of tall, medium and short trees, and *Acacia mearnsii*, with some individuals located within the *Populus* x*. canescens* stands and other areas (Figure 7.1). It is suggested that treatment to these plants should involve physical cutting down of trees and the application of herbicides. Herbicides used must not affect or contaminate aquatic environments. The reserve may involve the Working for Water program to eradicate these invasive plants.

Other recorded alien plants represented as between one and five individuals per locality (Figure 7.1) should be eradicated either by ring-barking, physical removing, and/or application of herbicides.

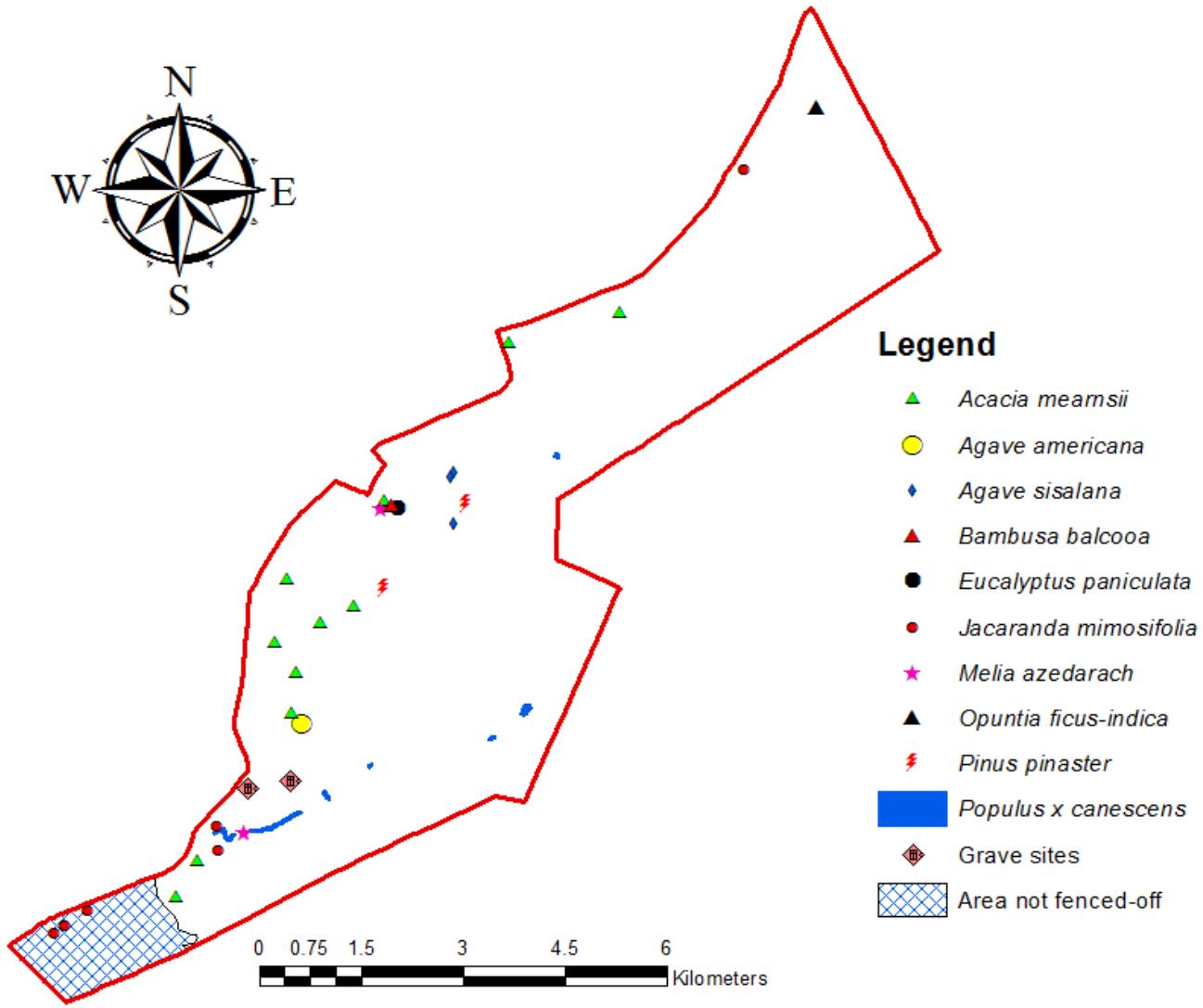


Figure 7.1: Locality map of the different alien plants in the study area

7.1.4 Fire management

Fire plays an important ecological role in plant communities (Tainton & Mentis, 1984; Trollope, 1984). Fire can be effectively used as a management tool in protected areas. It is necessary to understand fire ecology and to have insight into various factors influencing certain fire behaviour, such as: fuel load, air temperature, relative humidity, wind and terrain slope (Tainton, 1999). The main objectives to using fire in agricultural and conservation areas are: to burn off previous season's unpalatable growth; to control bush encroachment; to provide green feed for animals; to reduce moribund material, and to establish new grass cover for soil and water conservation.

Fire is a key environmental parameter that is an important part of ecological systems. It should be included in the vegetation management of protected areas. According to the Veld and Forest Act 101 of 1998 (South Africa 1998b), it is compulsory for land owners/managers to establish firebreaks along the boundaries of their properties. Firebreaks are not only burned to protect property against accidental fires, but also as an extensively used management tool.

Management blocks are burned on a 3 - 4 year frequency in the LNR. Mosaic vegetation was created with various fire-return periods. In 1999, the reserve introduced a patch mosaic burning program, which allowed the veld to randomly burn throughout the year. Patch mosaic burns were implemented in the second half of summer and were restricted only to the sour veld portions of the reserve (Eksteen, 2003). It is recommended that the mosaic burning program be continued for the study area. This will allow management to decide on whether and where to burn, especially since the Nooitgedacht section is located on an area that is highly susceptible to accidental fires. Fires should be burned in this area to create mosaic habitats and to prevent accumulation of moribund material. Management of habitats for the reserve's priority species, such as Oribi (*Ourebia ourebi*) may be supported by patch mosaic burning of specific areas (Eksteen,

2003). The reserve records show that Nooitgedacht and the Hondekraal sections are burnt at least once every two to three years, mostly through accidental fires. Regular fires that prevent moribund accumulation may minimise the likelihood of dangerous fires.

The frequent fire occurrence is evident from the number of dying woody plants that were observed in some areas. Plant species that had suffered more damage as a result include *Protea caffra* (Figure 7.2), *Dichrostachys cinerea* and *Acacia mearnsii.* This can be beneficial to the reserve in controlling bush encroachment and alien plant invasion; however it could also negatively influence indigenous woody species if applied incorrectly. These effects should be observed in the monitoring plots recommended for the woodland vegetation.

Figure 7.2: Fire impacts evident on the *Protea caffra* trees

7.1.5 Soil erosion management

Soil erosion is influenced mainly by vegetation cover, root structure, rainfall intensity, soil type and slope of land (Bothma, 2002). Vegetation reduces erosion by protecting the soil surface from raindrop impacts. Grasses have high basal cover and provide a complex network of roots immediately below the soil surface (Pressland, 1973; Roux, 1981). Trees break the force of the raindrop and also fragment the droplet preventing erosion.

There are a number of reasons that lead to reduced plant cover, and these include poor grazing practises, overstocking, not excluding animal hoofs impacts (Tainton, 1999). Any soil erosion control measures depend on the extent of veld degradation.

Localised erosion signs in need of attention were recorded in plant community 1 (Figure 7.3). This is an area that had high animal activity and, should be monitored to prevent further degradation. There is a spring in the area, which feeds water into the artificial dam (Figure 7.4).

Figure 7.3: Crusted sub-soil after loss of top soil with signs of trampling

Figure 7.4: A spring feeding into the artificial dam

The restoration of this area may improve the quality of water delivered to the artificial dam. According to Bothma (2002), erosion needs to be monitored using fixed-point photographs taken annually (same time, same point, same direction). Recovery after erosion control attempts should be monitored every second year.

There were high animal activities recorded in this area with wildlife drinking water from the spring instead of using the artificial dam (Figure 7.5). Precautionary measures need to be taken to minimise the trampling impacts by animal hoofs to allow eroded areas to recover. Animals should be encouraged to utilise the artificial dam for drinking instead of the spring in the area. This can be achieved by breaking the crusted soil and packing brushes in such a way that animals are directed away from the spring.

Figure 7.5: An artificial dam on the northern boundary of the reserve

7.1.6 Community Relations

The status of natural resource availability and sustainability is linked to the way in which it is used because of the dynamic equilibrium that exists between utilisation and renewal (IUCN, 1996). Natural resource utilisation on the LNR was assessed on an individual basis to ensure responsible use of the resources, and preferences were given to applications from local communities adjacent to the reserve to (Eksteen, 2003):

- facilitate the on-going sustainable and rational consumptive use of the prescribed natural resources within the reserve; and
- maintain records of consumption to determine and quantify levels of sustainability.

7.1.6.1 Thatch grass collection

Hyparrhenia hirta and *Hyperthelia dissoluta* are the most preferred thatching grasses in general (Sola, 2005). *Hyparrhenia hirta* is the dominant and most harvested grass in plant community 3. Requests from local communities for natural resources utilisation are facilitated by the Community Relations staff. Currently, the collection of *Hyparrhenia* grass for thatching and wood for fire is only allowed in demarcated areas under supervision of the reserve staff. The community are allocated 75% of the thatch grass collected annually, and the difference remains for the reserve. Significant amounts of resources are made available, for example, in 2002, records show that the communities utilised ± 150 000 bundles of thatch grass, ± 50 tons of wood and six carcasses of meat.

Hyparrhenia hirta is dominant to the Nooitgedacht area and provides most of the thatch grass collected by the local communities on an annual basis (Figure 7.6). Sickles are used for harvesting within the predetermined transects that are allocated to the local community members by their respective representatives. The grass processing involves pruning to remove dead leaves, shaking to

remove excess dirt as well as combing the brush and tying it into bundles. Sola (2005) mentioned that in Zimbabwe, thatch grass is harvested between June and October. This is a time when the seeds have already matured and dispersed.

Figure 7.6: Harvested bundles of *Hyparrhenia hirta* grass in plant community 3

It is recommended that a record of thatch are kept and updated on a regular basis in order to determine if the resource is being sustainably harvested time. The effect of the harvesting on the plant species composition and production could also be monitored.

7.1.6.2 Gravesite visits

The localities of grave sites recorded in sub-community 7.2 are presented in Figure 7.2. According to Mr K. Modau [1](*pers. comm.* 2014), the grave sites found on the Nooitgedacht study area have not had any requests for visits for more than 20 years. Other grave sites on the older reserve sections are frequently

[1] Modau, K. – Reserve Manager – Loskop Dam Nature Reserve
Mpumalanga Tourism and Parks Agency (MTPA)

visited by community members for ceremonies and even burials. The reserve is currently working on a policy to manage these visits. Unfortunately the reserve cannot stop further burial activities since some sections of the reserve are under land claim.

Figure 7.7: A grave at a burial site located in sub-community 7.2

Visits to the grave sites are always done in the presence of a reserve representative (field ranger); resulting in the reserve experiencing no poaching or any other incidences relating to these visits. It is recommended that these activities remain unchanged.

7.2 Game management and recommendations

The introduction of game species to the LNR is only considered if a species has a historical record of occurrence in the area and if there is available suitable habitat (Eksteen, 2003). The objective of herbivore population management is dependent on the objectives of an area, for example: to maintain a variety of game species.

7.2.1 Grazing Capacity

Grazing capacity is applied at optimum stocking-rates and the grazing spectrum is maintained in such a way that priority game species benefit in the reserve (Eksteen, 2003). Stocking rate was defined by Dankwerts & Teague (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 year. Stocking rate has an immediate effect on the quantity of forage that is available to grazers, affecting intake and animal performance (Tainton, 1999).

The stocking rate on the LNR is maintained at 11 - 12 ha/AU, in order for the reserve to sustain a game community consisting of a variety of species. The reserve management needs to ensure that the habitat and food requirements of all species are sufficiently catered for. This is achieved by controlling the number of common species to minimise competition. Population management takes place in the form of live capture and culling (Eksteen, 2003).

Game species sighted in the Nooitgedacht area (study area) during field surveys were kudu (*Tragelaphus strepsiceros*), sable antelope (*Hippotragus niger*), blesbok (*Damaliscus dorcas* subsp. *phillipsi*), zebra (*Equus Burchelli*), buffalo (*Syncerus caffer*), klipspringer (*Oreotragus oreotragus*), common reedbuck (*Redunca arundinum*), white rhino (*Ceratotherium simum*), eland (*Taurotragus oryx*), tsessebe (*Damaliscus lunatus*), duiker (*Sylvicapra grimmia*), ostrich (*Struthio camelus*) and warthog (*Phacochoerus africanus*).

According to the Graze model (Brown, 1997), the results for the Nooitgedacht section indicated that the area can sustain a grazing capacity of 6.5 ha/LSU, which is 408.8 animals within the 4 457 ha area. No game recommendations were made for this area, since there is no fence separating it from the larger reserve and the current stocking rate for the whole reserve is in accordance with that found by this study.

Chapter 8

8 CONCLUSION

Little information existed for the LNR on the flora of the Nooitgedacht section, hence this study was undertaken. The vegetation of the Nooitgedacht section of the LNR has some similarities, but mostly differs in species composition and grazing capacity from areas located in the old reserve section. The aims of the study were satisfactory achieved. The vegetation of the study area was successfully identified, classified and described. The different plant communities were interpreted and a detailed vegetation map was produced (Figure 4.1). A comprehensive plant species list of all the species present in the study area was also compiled and analysed. The result of this research provides valuable information on the present ecosystems of the study area.

The Braun-Blanquet classification system has won broad acceptance in the world. It is and has been widely used to analyse vegetation in several ecological studies. The same approach was followed to classify the different plant communities in this study and a total of eleven plant communities, which can be grouped into seven major groups were identified. Results of this study may have immediate application to reserve management and should be incorporated into the existing management plan for the reserve.

The major significance of this study is that it indicated a very strong geographical pattern of the Bankenveld (Rocky Highveld grassland) vegetation distribution. The LNR has a listed 1016 taxa, and the Nooitgedacht section has 649, which is 64% of the total reserve's taxa. The Nooitgedacht area is diverse in plant species with 194 species not listed on the current reserve's species list (Annexure B).

Results of this study indicate that the veld is well managed, however the Increaser I and II species are abundant compared to decreaser species in

general. There is limited record of fire occurrence in this area. The evidence of fire impacts on the woody layer was prominent.

Based on the results of this study, as well as between personal observations, it is recommended that studies be undertaken to:

- Adapt sample site sizes to accommodate woody species such as *Protea caffra*, since they are sparsely spread, and may require bigger plot sizes or more sample plots to be surveyed.
- Assess the livelihood strategies of the thatch grass harvesters from the area, and investigate possible challenges that the community and the reserve are facing.
- Determine the effects of thatch grass harvesting on the ecosystem (plant production, species change and animal movement).
- Ascertain the population and seed viability of the *Haworthia koelmaniorum* var. *mcmurytryi* populations, the impacts of fire intensity and frequency on the populations, as well as study the specific pollinators of these plants.
- Determine the impacts of regular fire on *Protea caffra* trees.
- Investigate the propagation and re-establishment of the specially protected plant *Encephalartos middelburgensis* and the autecology of the species.

The hypothesis that the grazing capacity of this area is higher than the one for areas located on other reserve sections has been proven. A comparison to the results from previous studies for other areas located in old sections of the reserve indicated lower grazing capacity values for such areas. A study done on the Hondekraal section by Filmalter (2010) recorded an overall veld condition score index of 56.7% compared to the 67.0% recorded in this study. This is further substantiated by the grazing capacity of 6.5 ha/LSU calculated for the Nooitgedacht area while 9.8 ha/LSU was recorded for the Hondekraal section.

The results of this study contribute not only to our knowledge of the vegetation and different ecosystems within the reserve, but also for areas outside the

boundaries of the reserve. It is expected that the results of this study be incorporated into the management plan of the reserve.

REFERENCES

Acocks, J. P. H. (1988). *Veld types of South Africa.* Botanic Research Institute, South Africa.

Adamson, R. S. (1938). Notes on the vegetation of the Kamiesberg. *Memoirs of the Botanical Survey of South Africa*, *18*, 1–25.

Bayer, A. W. (1955). The ecology of grasslands. In D. Meredith (Ed.), *The grasses and pastures of South Africa.* (pp. 539–550). Parow: Central News Agency.

Belsky, A. J. (1994). Influences of trees on savanna productivity: tests of shade, nutrients, and treegrass competition. *Ecology*, *75*, 922–932.

Bews, J. W. (1918). *The grasses and grassland of South Africa.* Davis, Pietermaritzburg.

Bezuidenhout, H. (1993). *Syntaxonomy and synecology of Western Transvaal grasslands, South Africa*. Ph.D. Thesis. University of Pretoria.

Bezuidenhout, H., Bredenkamp, G. J., & Theron, G. K. (1994). The syntaxonomy of the vegetation of the Fb land type in the western Transvaal Grassland, South Africa. *South African Journal of Botany*, *60*(3), 72–81.

Biko'o, A. A., Du Plessis, G. D. C., & Myburgh, W. J. (2011). Population size, structure and habitat features of *Haworthia koelmaniorum* var. *mcmurtryi*, an endemic plant from Mpumalanga Province, South Africa. *Koedoe*, *53*(1), 31–40.

Bothma, J. du P. (2002). *Game Ranch Management*. (J. du P. Bothma, Ed.) (4th ed.). Pretoria: Van Schaik Publishers, University of Pretoria.

Brand, R. F., Brown, L. R., & Du Preez, P. J. (2011). The Grassland vegetation of Platberg, eastern Free State, South Africa. *Koedoe*, *53*(1), 66–78.

Bray, J., & Curtis, J. (1957). An ordination of the upland forest communities of southern Wisconsin. *Ecological Monographs*, *27*(4), 325–349.

Bredenkamp, G. J. (1982). *A plant ecological study of the Manyeleti Game Reserve.* DSc. Thesis. University of Pretoria.

Bredenkamp, G. J., & Brown, L. R. (2006). Vegetation type and dynamics in African savannas. *Berichte Der Reinhold- Tüxen -Gesellschaft*, *18*, 69–82.

Bredenkamp, G., & Theron, G. (1978). A synecological account of the Suikerbosrand Nature Reserve 1. The phytosociology of the Witwatersrand geological system. *Bothalia*, *12*, 513–529.

Bromilow, C. (2001). *Problem plants of South Africa. A guide to the identification and control of more than 300 invasive plants and other weeds.* Pretoria: Briza Publications.

Brown, L. R. (1997). *A plant ecological study and wildlife management plan for Borakalalo Nature Reserve, North-west Province.* Ph.D. Dissertation. University of Pretoria, Pretoria.

Brown, L. R., & Bredenkamp, G. (1994). The phytosociology of the southern section of Borakalalo Nature Reserve, South Africa. *Koedoe*, *37*, 59–72. Retrieved from http://koedoe.co.za/index.php/koedoe/article/viewArticle/337

Brown, L. R., & Bredenkamp, G. (2004). The use of species size (SPIZE) classes in the description of the woody vegetation of a Nature reserve. *African Journal of Ecology*, *42*(4), 252–269.

Brown, L. R., & Bredenkamp, G. J. (2003). A reappraisal of Acocks Bankenveld: origin and diversity of vegetation types. *South African Journal of Botany*, *69*(1), 7–26.

Brown, L. R., Du Preez, P. J., Bezuidenhout, H., Bredenkamp, G. J., Mostert, T. H. C., & Collins, N. B. (2013). Guidelines for phytosociological classifications and descriptions of vegetation in southern Africa. *Koedoe*, *55*(1), 1–10. doi:10.4102/koedoe.v55i1.1103

Carleton, T. (1984). Residual Ordination Analysis: A Method for exploring vegetation. *Ecology*, *65*(2). Retrieved from http://www.jstor.org/stable/1941409

Chadwick, P. (1995). Adapting to Survive - The Black Backed Jackals of the Kalahari. *Africa - Environment and Wildlife*, *3*(3).

Chytrý, M., Schaminee, H. J., & Schwabe, A. (2011). Vegetation survey: A new focus for Applied Vegetation Science. *Applied Vegetation Science*, *14*, 435–439.

Cilliers, S. S., Van Wyk, E., & Bredenkamp, G. (1999). Urban nature conservation: Vegetation of natural areas in the Potchefstroom municipal area, North-West Province, South Africa. *Koedoe*, *42*(1), 1–30.

Coetzee, B. J. (1975). A phytosociological classification of the vegetation of the Rustenburg Nature Reserve. *Bothalia*, *11*, 561–580.

Coetzee, J. P. (1993). *Phytosociology of the Ba and Ib land types of the Pretoria-Witbank-Heidelberg area.* MSc Thesis. University of Pretoria, Pretoria.

Cowling, R. M., Richardson, D. M., & Pierce, S. M. (Eds.). (1945). Report of the Committee on the Preservation of the Vegetation of the South Western Cape. In *Vegetation of Southern Africa* (pp. 571–590). Cambridge: Cambridge University Press.

Cowling, R. M., Richardson, D. M., & Pierce, S. M. (2003). *Vegetation of Southern Africa.* Cambridge: Cambridge University Press.

Danckwerts, J. E. (1989). Monitoring vegetation and assessment of veld condition in grassveld. In J. E. Danckwerts & W. R. Teague (Eds.), *Veld management in the Eastern Cape* (pp. 96–99). Pretoria: Government Print.

Dankwerts, J. E., & Teague, W. R. (Eds.). (1989). *Veld management in the Eastern Cape*. Pretoria: Government Print.

Department of Agriculture. (2001). *Conservation of Agricultural Resources Act, 1983 (Act No. of 1983), Regulations: Amendment.* Government Gazette, 30 March 2001.

Dyer, R. A. (1937). The vegetation of the Divisions of Albany and Bathurst. *Memoirs of the Botanical Surveys of South Africa*, *17*, 1–38.

Edwards, D. (1967). A plant ecological survey of the Tugela River Basin, Natal. *Memoirs of the Botanical Surveys of South Africa*, *36*, 1–285.

Edwards, D. (1973). Botanical survey and agriculture. In *Proceedings of the Grassland Society of Southern Africa* (pp. 15–19). Retrieved from http://dx.doi.org/10.1080/00725560.1972.9648660

Edwards, D. (1983). A broad-scale structural classification of vegetation for practical purposes. *Bothalia*, *14*, 705–712.

Egbert, S. L., Park, S., & Price, K. P. (2002). Using conservation reserve program maps derived from satellite imagery to characterise land-scape structure. *Computer and Electronics in Agriculture*, *37*, 141–156.

Eksteen, J. J. (2002). Master Plan for Management and Development: 1st Draft. Loskop Dam Nature Reserve: Un-published report.

Eksteen, J. J. (2003). *Condensed Management Plan for Loskop Dam Nature Reserve - 1st daft.* Mpumalanga Tourism and Parks Agency, Nelspruit.

Elzinga, C., Salzer, D., & Willoughby, J. W. (1998). Measuring & Monitoring Plant Populations. Retrieved from http://digitalcommons.unl.edu/usblmpub/17/

Ericksson, P. G., Shcreiber, U. M., Reczko, B. F. F., & Snyman, C. P. (1994). Petrography and geochemistry of sandstones interbedded with the Rooiberg Felsite group (Transvaal Sequence, South Africa). *Earth and Planetary Science Letters*, 149–165.

ESRI. (2014). ArcGIS Desktop: Release 10.2.1. Redlands, CA: Environmental Systems Research Institute.

Ferrar, A. A., & Lötter, M. C. (2007). *Mpumalanga Biodiversity Conservation Plan Handbook.* Mpumalanga Tourism and Parks Agency, Nelspruit. Retrieved from http://bgis.sanbi.org/MBCP/MBCPHandbook.pdf

Filmalter, N. (2010). *A vegetation classification and management plan for the Hondekraal section of the Loskop Dam Nature Reserve.* M.Sc. Dissertation. University of South Africa.

Fitzpatrick, R. W., Hahne, H. C. H., Kirsten, W. F. A., & Hawker, L. C. (1986). Soil mineralogy. In H. M. du Plessis (Ed.), *Land types of the 2526 Rustenburg, 2528 Pretoria. Memoirs of the Botanical Survey of South Africa*. Pretoria.

Foran, B. D., Tainton, N. M., & Booysen, P. D. V. (1978). The development of a method assessing veld condition in three Grassveld types in Natal. In *Proceedings of the Grassland Society of Southern Africa* (pp. 27–33).

Galt, D. F., Molinar, J., Navarro, J., Joseph, J., & Holechek, J. L. (2000). Short duration grazing: the facts in 2000. *Rangelands*, *21*(5), 18–22.

Gauch, H. G. (1982). *Multivariate Analysis in Community Ecology.* Cambridge University Press, Cambridge, UK.

Germishuizen, G., & Meyer, N. L. (Eds.). (2003). *Plants of Southern Africa: an annotated checklist. Strelitzia* (Vol. 14). National Botanical Institute, Pretoria.

Götze, A. R., Meyer, S. S., Cilliers, S. S., & Kellner, K. (1998). *The classification of Plant Communities and Range Condition Assessment of Two New parts of Loskop Dam Nature Reserve, Mpumalanga.* Potchefstroom University: Unpublished report.

Grobler, C. H. (2006). *The vegetation ecology of urban open space in Gauteng.* MSc Thesis. University of Pretoria, Pretoria.

Hawkins, B. (2008). *Plants for life: Medicinal plant conservation and botanic gardens.* Richmond, Surrey, UK.: Rufford Maurice Laing Foundation.

Hennekens, S. M. (1996). *TURBOVEG: A software package for input, processing and presentation of Phytosociological data. Users' guide, version July 1996, IBN-DLO.* Lancaster: Wageningen and Lancaster University.

Hill, M. O. (1979). TWINSPAN: A Fortran Program for Arranging Multivariate Data in an Ordered Two-way Table by Classification of the Individuals and Attributes. *Ecology And Systematics*. doi:S

IUCN. (1996). Factors influencing sustainability. In *Proceedings of the first World Conservation Congress, 14-23 October 1996.ings of the first World Conservation Congress, 14-23 October 1996.* Montreal, Canada.

Kent, M. (2012). *Vegetation description and analysis: A practical Approach:* (2nd ed.). John Wiley & Sons, Ltd.

Killick, D. B. H. (1963). An account of the plant ecology of the Cathedral Peak areas of the Natal Drakensberg. *Memoirs of the Botanical Surveys of South Africa of South Africa1*, *1*(1-178).

Klopper, R. R., Chatelain, C., Bänninger, V., Habashi, C., Steyn, H. M., De Wet, B. C., Arnold, T. H., Gautier, L., Smith, G. F., & Spichiger, R. (2006). Checklist of the flowering plants of Sub-Saharan Africa. An index of names and synonyms. *South African Botanical Diversity Network Report* No.42. SABONET, Pretoria.

Land Type Survey Staff. (1988). Land types of the maps 2526 Rustenburg and 2528 Pretoria. Retrieved from http://koedoe.co.za/index.php/koedoe/article/viewArticle/280

Langley, S. K., Cheshire, H. M., & Humes, K. S. (2001). A comparison of single date and multi-temporal satellite image classification in a semi-arid grassland. *Journal of Arid Environments*, *49*, 401–411.

Lawesson, J. E., Diekmann, M., & Eilertsen, O. (1997). The Nordic Vegetation Survey-concepts and perspectives. In *Vegetation description and data analysis: A Practical Approach.* (Vol. 8, pp. 455–458). Oxford: John Wiley & Sons, Ltd.

Lee, W. G., McGlone, M., & Wright, E. (2005). Biodiversity Inventory and monitoring: A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation. Landcare Research Contract Report LC0405/122 (unpublished).

Louw, W. J. (1951). An ecological account of the vegetation of the Potchefstroom area. *Memoirs of the Botanical Surveys of South Africa*, *24*, 1–105.

Low, A. B., & Rebelo, A. G. (Eds.). (1996). *Vegetation of South Africa, Lesotho and Swaziland.* (2nd ed.). Pretoria: DEAT.: Department of Environmental Affairs and Tourism. Retrieved from http://www.ngo.grida.no/soesa/nsoer/Data/vegrsa/vegstart.htm

Martens, C., Waller, L., & Delahunt, K. (2003). *Alien Plant Control - An operational guideline for Land managers.* (2nd ed.). Draft - last updated Nov 2003. Unpublished doc.

McCune, B., Grace, J., & Urban, D. (2002). *Analysis of Ecological Communities.* Oregon: MjM Software Design, Gleneden Beach.

Mentis, M. T. (1984). *Monitoring in South African grasslands.* Pretoria: Council for Scientific and Industrial Research, National Scientific Programmes Unit. (South African National Scientific Programmes report; no. 91).

Mpumalanga Province. (2005). *Mpumalanga Tourism and Parks Agency Act of 2005.* Nelspruit.

Mucina, L., & Rutherford, M. C. (2006). *The vegetation of South Africa, Lesotho and Swaziland*. *Strelitzia* (Vol. 19, p. 807). doi:10.1007/s

Mueller-Dombois, D., & Ellenberg, H. (1974). *Aims and methods of vegetation ecology.* New York: Wiley.

Muir, J. (1929). The vegetation of the Riversdale area, Cape Province. *Memoirs of the Botanical Surveys of South Africa*, *13*, 1–82.

Nietesh, P. (2004). Invasive Alien Plant Species in South Africa: Impacts and Management Options. *South African Journal of Science*, *100*, 34–40.

Office of the Premier. (1998). Mpumalanga Nature Conservation Act, No. 10, *5*(384), 68–74.

Owen-Smith, N. (1988). *Megaherbivores: the influence of very large body size on ecology.* Cambridge University Press, Cambridge, UK.

Peet, R. K. (1980). Ordination as a tool for analyzing complex data sets. *Vegetation*, *42*, 171–174. Retrieved from http://ordination.okstate.edu/overview.htm

Pole Evans, I. B. (1922). The main botanical regions of South Africa. *Memoirs of the Botanical Surveys of South Africa*, *4*, 49–53.

Pole-Evans, J. B. (1936). A vegetation map of South Africa. *Memoirs of the Botanical Surveys of South Africa*, *15*, 1–3.

Pond, U., Beesley, B. B., Brown, L. R., & Bredenkamp, G. J. (2002). Floristic analysis of the Mountain Zebra National Park, Eastern Cape. *Koedoe*, *45*(1), 35–37. Retrieved from http://www.koedoe.co.za/index.php/koedoe/article/view/1027/1332

Pressland, A. J. (1973). Rainfall partitioning by an arid woodland Acacia aneura. F. Muell in southwestern Queensland. In *Veld Management in South Africa* (pp. 235–265). Pietermaritzburg: University of Natal Press.

Raunkaier, C. (1928). Dominansareal artstaethed of formationsdominanter. In *Vegetation description and data analysis: A Practical Approach.* Oxford: John Wiley & Sons, Ltd.

Rhodes, R. C. (1975). New evidence for impact origin of the Bushveld Complex, South Africa. *Geology*, *3*, 549–554.

Roleček, J., Tichỳ, L., Zelenỳ, D., & Chytrỳ, M. (2009). Modified TWINSPAN classification in which the hierarchy respects cluster heterogeneity. *Journal of Vegetation Science*, *20*, 596–602.

Rouget, M., Reyers, B., Jonas, Z., Desmet, P., Driver, A., Maze, K., … Rutherford, M. (2004). *South African National Spatial Biodiversity Assessment Technical Report. Volume 1: Terrestrial component.* Pretoria.

Roux, P. W. (1981). Interaction between climate, vegetation and runoff in the Karoo. In *Veld Management in South Africa*. Pietermaritzburg: University of Natal Press.

Rutherford, M. C. (1997). Categorization of biomes. In R. M. Cowling, D. M. Richardson, & S. M. Pierce (Eds.), *Vegetation of Southern Africa* (pp. 91–98). Cambridge. Retrieved from http://www.plantzafrica.com/frames/vegfram.htm

Rutherford, M. C., & Westfall, R. H. (1994). Biomes of the Southern Africa: an objective categorization. *Memoirs of the Botanical Survey of South Africa*, *63*, 1–94.

Rutherford, M., Mucina, L., & Powrie, L. W. (2012). The South African National Vegetation Database : History , development , applications , problems and future. *South African Journal of Botany*, *108*(1/2), 1–8.

SANBI - Threatened Species Programme. (2012). Threatened Species: A guide to Red Lists and their use in conservation. National Government.

Schmidt, E., Lötter, M., & McCleland, W. (2007). *Trees and Shrubs of Mpumalanga and Kruger National Park.* Johannesburg RSA: Jacana Media.

Shimwell, D. W. (1971). Description and Classification of Vegetation. In *Vegetation description and data analysis: A Practical Approach.* Oxford: John Wiley & Sons, Ltd.

Smit, G. N. (1989). Quantitative description of woody plants communities: Part I. An approach. *Journal of Grassland Society of Southern Africa*, *6*, 189–191.

Smit, I. P. J., Asner, G. P., Govender, N., Kennedy-Bowdoin, T., Knapp, D. E., & Jacobson, J. (2010). Effects of fire on woody vegetation structure in African savanna. *Ecological Applications*, *20*, 1865–1875.

Sola, P. (2005). The Community Resource Management Plan: A Tool for integrating indigenous knowledge systems in natural resource management. *Ethnobotany Research & Applications*, *3*, 143–154. Retrieved from www.ethnobotanyjournal.org/vol3/i1547-3465-03-143.pdf.

South Africa. (1983). *Conservation Agricultural Resources Act (CARA) 43 of 1983*.

South Africa. (1998a). *National Environmental Management Act (NEMA) 107 of 1998*.

South Africa. (1998b). *Veld and Forest Fire Act 101 of 1998*. Pretoria: Government Print.

South Africa. (2004). *National Environmental Management: Biodiversity Act 10 of 2004.* Pretoria: Government Print.

South Africa. (2011). *South African Tourism Annual Report 2010/11.* Retrieved from http://www.southafrica.net/media/en/page/annual-reports

South Africa. (2012). *South African Tourism Annual Report 2011/12*. Retrieved from http://www.southafrica.net/uploads/legacy/1/437627/SA Tourism Annual Report 2010-2011.pdf

South Africa. (2013). *South African Tourism Annual Report 2012/13*.

Stuart, S. M., & Adams, R. J. (1990). Biodiversity in sub-Saharan Africa and its islands: conservation management and sustainable use. In R. M. Cowling, D. M. Richardson, & S. M. Pierce (Eds.), *Vegetation of Southern Africa* (pp. 571–590). Cambridge: Cambridge University Press.

Tainton, N. M. (1988). A consideration of veld condition assessment techniques for commercial live-stock production in South Africa. *Journal of Grassland Society of Southern Africa*, *5*(2), 76–79.

Tainton, N. M. (1999). *Veld management in South Africa.* Pietermaritzburg: University of Natal Press.

Tainton, N. M., & Mentis, M. T. (1984). Fire in grassland. In P. D. V. Booysen & N. M. Tainton (Eds.), *Ecological effects of fire in South African ecosystems.* (Ecological., pp. 115–197). New York, Tokyo: Springer-Verlag, Berlin, Heidelberg.

Theron, G. (1973). *n' Ekologiese studie van die plantegroei van die Loskopdam Natuurreservaat*. D. Sc. Thesis. University of Pretoria.

Tichy, L. (2002). JUICE, software for vegetation classification. *Journal of Vegetation Science*, *13*, 451–453.

Tourism growth outperforms global economy in 2012. (2012). *Breaking travel news*. Retrieved from http://www.breakingtravelnews.com/focus/article/tourism-growth-outperforms-global-economy-in-2012/

Trollope, W. (1984). Veld burning as a management practice in livestock production. In *Veld Management in South Africa*. Pietermaritzburg: University of Natal Press.

Trollope, W. (1989). Assessing veld condition in the Kruger National Park using key grass species. *Koedoe-African Protected.* Retrieved from http://koedoe.co.za/index.php/koedoe/article/viewArticle/465

Trollope, W., Trollope, L., & Bosch, O. J. H. (1990). Veld and pasture management terminology in Southern Africa. *Journal of Grassland Society of Southern Africa*, *17*, 84–89.

Van Oudtshoorn, F. (2012). *Guide to Grasses of Southern Africa.* Pretoria: Briza Publications.

Van Rooyen, N., & Bredenkamp, G. J. (1988). Mixed Bushveld. In A. B. Low & A. G. Rebello (Eds.), *Vegetation of South Africa, Lesotho and Swaziland* (p. 26). Pretoria: Department of Environmental Affairs and Tourism.

Van Wyk, B., & Malan, S. (1997). *Field Guide to the Wild Flowers of the Highveld.* Cape Town: Struik Publishers.

Van Wyk, B., Van Oudtshoorn, B., & Gericke, N. (2009). *Medicinal Plants of South Africa.* (2nd ed.). Pretoria: Briza Publications.

Van Wyk, B., & Van Wyk, P. (1997). *Field Guide to the trees of Southern Africa.* Cape Town: Struik Publishers.

Visser, N., Van Hoven, W., & Theron, G. (1996). The vegetation and identification of management units of the Honnet Nature Reserve, Northern Province, South Africa. *Koedoe*, *39*, 25–42.

Von Post, H. (1862). Forsök till en systematik uppstallning af vextstallena in mellersta Sverige, Bonnier, Stockholm. In *Vegetation description and data analysis: A Practical Approach.* (1st ed.). Oxford: John Wiley & Sons, Ltd.

Voster, M. (1982). The development of the ecological index method for assessing veld condition in the Karoo. In *Proceedings of the Grassland Society of Southern Africa* (Vol. 17, pp. 84–89).

Weber, H. E., Moravec, J., & Theurillat, J. P. (2000). Internation Code of Phytosociological Nomenclature. *Journal of Vegetation Science*, *11*, 739–768.

Weger, M. J. A. (1974). On concepts and techniques applied in the Zürich-Montpellier method of vegetation survey. *Bothalia*, *11*, 309–323.

Westfall, R. H. (1981). *The plant ecology of the farm Groothoek, Thabazimbi district*. M.Sc. Dissertation. University of Pretoria.

Westhoff, V., & Van der Maarel, E. (1978). The Braun-Blanquet approach. In R. H. Whitaker (Ed.), *Classification of plant communities.* (pp. 289–399). Netherlands: The Hague: Junk.

Whitaker, R. H. (1977). Evolution of species diversity in land communities. *Evolution Biology*, *10*, 1–67.

ANNEXURES

ANNEXURE A - LOSKOP DAM NATURE RESERVE (CLIMATE DATA – 2010 TO 2012)

2 0 1 0

	Jan		Feb		March		April		May		June		July		August		September		October		November		December	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temp	18.9	28.2	19.3	31.0	17.6	30.1	16.3	25.3	11.9	24.4	6.4	17.0	8.7	16.5	8.3	25.1	12.7	31.2	16.4	31.9	19.8	30.9	19.4	28.1
Rainfall	152mm		18mm		16.5mm		203mm		19mm		0mm		0mm		0mm		0mm		14mm		161mm		314mm	
	Total Temperature						Min	14.6																
							Max	26.6																
	Total Rainfall						**897.5**																	

2 0 1 1

	Jan		Feb		March		April		May		June		July		August		September		October		November		December	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temp	19.6	27.4	20.1	29.7	16.8	32.1	13.6	24.4	10.7	23.5	4.6	20.6	4.4	21.1	6.5	23.4	10.0	29.3	12.6	28.8	15.5	30.4	16.8	29.6
Rainfall	171.8mm		119mm		64mm		98mm		29mm		0mm		0mm		18mm		0mm		51mm		44mm		112.8mm	
	Total Temperature						Min	12.6																
							Max	26.7																
	Total Rainfall						**707.6**																	

2 0 1 2

	Jan		Feb		March		April		May		June		July		August		September		October		November		December	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temp	17.9	27.8	19.1	31.1	16.2	30.3	11.4	25.4	10.0	26.9	6.7	22.7	7.1	23.3	7.8	24.1	11.6	26.3	14.4	26.4	14.1	29.1	17.3	28.4
Rainfall	156.8mm		95.5mm		89mm		15mm		0mm		0mm		0mm		0mm		121mm		189mm		68mm		108mm	
	Total Temperature						Min	12.8																
							Max	26.8																
	Total Rainfall						**842.3**																	

ANNEXURE B - NOOITGEDACHT SPECIES LIST

Nooitgedacht Section		
Mpumalanga Nature Conservation Act No. 10, 1998		
		Total
***	**Section 69(1)(a) - Protected plants**	**1**
**	**Section 69(1)(b) - Specially protected plants**	**26**
*	**Section 80(1)(a) - Invader weeds and plants**	**14**
x	**Not listed on existing LNR species list**	**194**

No.	Families	Genus & Species Name	
		A	
1	Acanthaceae	*Barleria crossandriformis*	
2	Acanthaceae	*Barleria galpinii*	
3	Acanthaceae	*Barleria obtusa*	
4	Acanthaceae	*Barleria rotundifolia*	
5	Acanthaceae	*Barleria saxatilis*	
6	Acanthaceae	*Blepharis maderaspatensis s. madera*	
7	Acanthaceae	*Blepharis subvolubilis*	
8	Acanthaceae	*Blepharis transvaalensis*	
9	Acanthaceae	*Chaetacanthus setiger*	
10	Acanthaceae	*Crabbea angustifolia*	
11	Acanthaceae	*Crossandra greenstockii*	
12	Acanthaceae	*Dicliptera clinopodia*	
13	Acanthaceae	*Hypoestes aristata*	
14	Acanthaceae	*Hypoestes forskaolii*	
15	Acanthaceae	*Isoglossa grantii*	
16	Acanthaceae	*Justicia anagalloides*	
17	Acanthaceae	*Justicia betonica*	
18	Acanthaceae	*Ruellia cordata*	
19	Acanthaceae	*Sclerochiton harveyanus*	
20	Agapanthaceae	*Agapanthus nutans***	
21	Agavaceae	*Agave americana**	x
22	Agavaceae	*Agave sisalana**	x
23	Aizoaceae	*Gisekia pharnacioides*	

24	Amaranthaceae	*Achyranthes aspera*	
25	Amaranthaceae	*Aerva leucura*	
26	Amaranthaceae	*Alternanthera pungens*	
27	Amaranthaceae	*Alternanthera sessilis*	
28	Amaranthaceae	*Amaranthus hybridus*	x
29	Amaranthaceae	*Cyathula uncinulata*	x
30	Amaranthaceae	*Gomphrena celosioides*	
31	Amaranthaceae	*Haemanthus humilis***	x
32	Amaranthaceae	*Hermbstaedtia odorata*	x
33	Amaranthaceae	*Pupalia lappacea*	
34	Amaryllidaceae	*Boophane disticha***	
35	Amaryllidaceae	*Crinum bulbispermum***	
36	Anacardiaceae	*Lannea discolor*	
37	Anacardiaceae	*Lannea edulis*	
38	Anacardiaceae	*Ozoroa dispar*	x
39	Anacardiaceae	*Ozoroa insignis*	
40	Anacardiaceae	*Ozoroa paniculosa*	
41	Anacardiaceae	*Ozoroa sphaerocarpa*	
42	Anacardiaceae	*Searsia dentata*	x
43	Anacardiaceae	*Searsia leptodictya*	
44	Anacardiaceae	*Searsia magalismontana*	
45	Anacardiaceae	*Searsia pyroides*	
46	Anacardiaceae	*Searsia wilmsii*	x
47	Anacardiaceae	*Searsia zeyheri*	
48	Anacardiaceae	*Sclerocarya birrea s. caffra*	
49	Anemiaceae	*Mohria vestita*	
50	Anthericaceae	*Chlorophytum aridum*	
51	Anthericaceae	*Chlorophytum bowkeri*	
52	Anthericaceae	*Chlorophytum cooperi*	
53	Anthericaceae	*Chlorophytum fasciculatum*	x
54	Apiaceae	*Alepidea setifera*	
55	Apiaceae	*Annesorhiza flagellifolia*	
56	Apiaceae	*Centella asiatica*	
57	Apiaceae	*Heteromorpha occidentalis*	x

58	Apocynaceae	*Acokanthera oppositifolia*	
59	Apocynaceae	*Ancylobotrys capensis*	
60	Apocynaceae	*Carissa bispinosa*	
61	Apocynaceae	*Diplorhynchus condylocarpon*	
62	Apocynaceae	*Xysmalobium undulatum*	x
63	Aquifoliaceae	*Ilex mitis*	
64	Araliaceae	*Cussonia arborea*	x
65	Araliaceae	*Cussonia paniculata*	
66	Araliaceae	*Cussonia spicata*	
67	Asclepiadaceae	*Ectadiopsis oblongifolia*	x
68	Asclepiadaceae	*Gomphocarpus fruticosus*	
69	Asclepiadaceae	*Gomphocarpus tomentosus*	
70	Asclepiadaceae	*Huernia hystrix***	x
71	Asclepiadaceae	*Pachycarpus schinzianus*	
72	Asclepiadaceae	*Pachycymbium huernioides*	x
73	Asclepiadaceae	*Schizoglossum bidens*	x
74	Asclepiadaceae	*Sphaerocodon angolensis*	x
75	Asclepiadaceae	*Stapelia leendertziae*	x
76	Asparagaceae	*Asparagus laricinus*	x
77	Asparagaceae	*Asparagus setaceus*	x
78	Asparagaceae	*Asparagus suaveolens*	
79	Asparagaceae	*Asparagus virgatus*	
80	Asphodelaceae	*Aloe arborescens***	
81	Asphodelaceae	*Aloe dichotoma***	x
82	Asphodelaceae	*Aloe ferox***	x
83	Asphodelaceae	*Aloe marlothii***	
84	Asphodelaceae	*Aloe transvaalensis***	x
85	Asphodelaceae	*Haworthia koelmaniorum v. mcmurtryi***	
86	Aspleniaceae	*Asplenium monanthes*	x
87	Aspleniaceae	*Asplenium trichomanes*	x
88	Aspleniaceae	*Athyrium schimperi*	x
89	Aspleniaceae	*Ceterach cordatum*	
90	Asteraceae	*Acanthospermum australe*	x

91	Asteraceae	*Achyrocline stenoptera*	
92	Asteraceae	*Adenostemma caffrum*	
93	Asteraceae	*Ambrosia artemisiifolia*	
94	Asteraceae	*Artemisia afra*	
95	Asteraceae	*Aster bakeranus*	
96	Asteraceae	*Athrixia angustissima*	x
97	Asteraceae	*Athrixia elata*	
98	Asteraceae	*Berkheya radula*	
99	Asteraceae	*Bidens bipinnata*	
100	Asteraceae	*Bidens pilosa**	
101	Asteraceae	*Blumea mollis*	
102	Asteraceae	*Brachychiton rotundata*	
103	Asteraceae	*Brachylaena discolor*	x
104	Asteraceae	*Callilepis laureola*	
105	Asteraceae	*Cirsium vulgare**	x
106	Asteraceae	*Conyza pinnata*	
107	Asteraceae	*Conyza scabrida*	
108	Asteraceae	*Cotula radicalis*	x
109	Asteraceae	*Crepis hypochoeridea*	x
110	Asteraceae	*Denekia capensis*	
111	Asteraceae	*Dicoma anomala*	
112	Asteraceae	*Dicoma galpinii*	
113	Asteraceae	*Dicoma zeyheri*	
114	Asteraceae	*Eclipta prostrata*	
115	Asteraceae	*Emilia transvaalensis*	
116	Asteraceae	*Euryops pedunculatus*	
117	Asteraceae	*Felicia linearis*	x
118	Asteraceae	*Felicia mossamedensis*	
119	Asteraceae	*Felicia muricata*	
120	Asteraceae	*Gazania krebsiana*	
121	Asteraceae	*Gazania krebsiana s. serrulata*	
122	Asteraceae	*Gerbera jamesonii*	
123	Asteraceae	*Gerbera piloselloides*	x
124	Asteraceae	*Gerbera viridifolia*	
125	Asteraceae	*Gnaphalium confine*	
126	Asteraceae	*Helichrysum acutatum*	x
127	Asteraceae	*Helichrysum aureonitens*	x
128	Asteraceae	*Helichrysum aureum*	x
129	Asteraceae	*Helichrysum auriceps*	x
130	Asteraceae	*Helichrysum cephaloideum*	

131	Asteraceae	*Helichrysum cooperi*	x
132	Asteraceae	*Helichrysum coriaceum*	
133	Asteraceae	*Helichrysum dasymallum*	x
134	Asteraceae	*Helichrysum harveyanum*	
135	Asteraceae	*Helichrysum kraussii*	x
136	Asteraceae	*Helichrysum nudifolium*	
137	Asteraceae	*Helichrysum rotundatum*	x
138	Asteraceae	*Helichrysum rugulosum*	x
139	Asteraceae	*Helichrysum sessilioides*	x
140	Asteraceae	*Hypochaeris radicata*	x
141	Asteraceae	*Lactuca inermis*	
142	Asteraceae	*Lopholaena coriifolia*	
143	Asteraceae	*Nidorella anomala*	
144	Asteraceae	*Phymaspermum acerosum*	x
145	Asteraceae	*Phymaspermum athanasioides*	x
146	Asteraceae	*Pseudognaphalium luteo-album*	x
147	Asteraceae	*Schistostephium crataegifolium*	
148	Asteraceae	*Schkuhria pinnata*	
149	Asteraceae	*Senecio barbatus*	
150	Asteraceae	*Senecio deltoideus*	x
151	Asteraceae	*Senecio isatidioides*	
152	Asteraceae	*Senecio scitus*	x
153	Asteraceae	*Senecio venosus*	
154	Asteraceae	*Sonchus wilmsii*	x
155	Asteraceae	*Seriphium plumosum*	
156	Asteraceae	*Syncarpha argentea*	x
157	Asteraceae	*Tagetes minuta*	x
158	Asteraceae	*Taraxacum officinale*	x
159	Asteraceae	*Vernonia africana*	x
160	Asteraceae	*Vernonia natalensis*	
161	Asteraceae	*Vernonia oligocephala*	
162	Asteraceae	*Vernonia poskeana*	
163	Asteraceae	*Xanthium strumarium*	
164	Asteraceae	*Zinnia peruviana*	

B			
165	Bignoniaceae	*Jacaranda mimosifolia**	
166	Bignoniaceae	*Rhigozum zambesiacum*	x
167	Bignoniaceae	*Tecoma capensis*	x

168	Blechnaceae	*Blechnum attenuatum v. giganteum*	x
169	Blechnaceae	*Blechnum punctulatum*	
170	Boraginaceae	*Cordia monoica*	x
171	Brassicaceae	*Sisymbrium thellungii*	x
172	Buddlejaceae	*Buddleja salviifolia*	
173	Buddlejaceae	*Gomphostigma virgatum*	
174	Burseraceae	*Commiphora africana*	
175	Burseraceae	*Commiphora glandulosa*	
176	Buxaceae	*Buxus macowanii*	

C			
177	Cabombaceae	*Brasenia schreberi*	
178	Cactaceae	*Opuntia ficus-indica**	x
179	Caesalpiniaceae	*Burkea africana*	x
180	Caesalpiniaceae	*Peltophorum africanum*	x
181	Caesalpiniaceae	*Senna italica*	x
182	Campanulaceae	*Wahlenbergia calcarea*	x
183	Campanulaceae	*Wahlenbergia cuspidata*	x
184	Campanulaceae	*Wahlenbergia krebsii*	x
185	Campanulaceae	*Wahlenbergia undulata*	
186	Campanulaceae	*Wahlenbergia virgata*	x
187	Capparaceae	*Boscia albitrunca*	
188	Capparaceae	*Cleome maculata*	
189	Capparaceae	*Cleome monophylla*	
190	Capparaceae	*Cleome rubella*	
191	Capparaceae	*Capparis tomentosa*	
192	Caryophyllaceae	*Dianthus basuticus*	x
193	Caryophyllaceae	*Dianthus mooiensis*	

194	Celastraceae	*Maytenus arbutifolia v. arbutifolia*	x
195	Celastraceae	*Maytenus arbutifolia v. sidamoensis*	x
196	Celastraceae	*Maytenus heterophylla*	
197	Celastraceae	*Maytenus nemorosa*	x
198	Celastraceae	*Maytenus senegalensis*	x
199	Celastraceae	*Maytenus tenuispina*	
200	Celastraceae	*Maytenus undata*	
201	Celastraceae	*Pleurostylia capensis*	
202	Celastraceae	*Robsonodendron eucleiforme*	x
203	Chrysobalanaceae	*Parinari capensis*	
204	Colchicaceae	*Androcymbium uniflora*	x
205	Colchicaceae	*Gloriosa superba*	
206	Combretaceae	*Combretum apiculatum*	
207	Combretaceae	*Combretum erythrophyllum*	
208	Combretaceae	*Combretum molle*	
209	Combretaceae	*Combretum zeyheri*	
210	Commelinaceae	*Aneilema hockii*	
211	Commelinaceae	*Commelina africana*	
212	Commelinaceae	*Commelina africana v. africana*	x
213	Commelinaceae	*Commelina africana v. barberae*	x
214	Commelinaceae	*Commelina africana v. krebsiana*	x
215	Commelinaceae	*Commelina eckloniana*	x
216	Commelinaceae	*Commelina erecta*	
217	Commelinaceae	*Commelina livingstonii*	x
218	Commelinaceae	*Cyanotis speciosa*	x
219	Commelinaceae	*Floscopa glomerata*	
220	Convolvulaceae	*Convolvulus farinosus*	
221	Convolvulaceae	*Evolvulus alsinoides*	
222	Convolvulaceae	*Ipomoea bolusiana*	
223	Convolvulaceae	*Ipomoea crassipes*	
224	Convolvulaceae	*Ipomoea gracilisepala*	
225	Convolvulaceae	*Ipomoea hochstetteri*	
226	Convolvulaceae	*Ipomoea magnusiana*	
227	Convolvulaceae	*Ipomoea obscura*	
228	Convolvulaceae	*Ipomoea ommaneyi*	

229	Convolvulaceae	*Ipomoea papilio*	
230	Convolvulaceae	*Ipomoea sinensis*	
231	Convolvulaceae	*Xenostegia tridentata*	x
232	Crassulaceae	*Crassula brachystachya*	x
233	Crassulaceae	*Crassula capitella*	
234	Crassulaceae	*Crassula nudicaulis*	x
235	Crassulaceae	*Crassula swaziensis*	
236	Crassulaceae	*Kalanchoe paniculata*	
237	Crassulaceae	*Kalanchoe thyrsiflora*	x
238	Cucurbitaceae	*Citrullus lanatus*	
239	Cucurbitaceae	*Corallocarpus bainesii*	
240	Cucurbitaceae	*Cucumella bryoniifolia*	
241	Cucurbitaceae	*Cucumis zeyheri*	
242	Cucurbitaceae	*Zehneria scabra*	
243	Cyperaceae	*Bulbostylis burchellii*	
244	Cyperaceae	*Bulbostylis oritrephes*	
245	Cyperaceae	*Cyperus distans*	
246	Cyperaceae	*Cyperus esculentus v. esculentus*	
247	Cyperaceae	*Cyperus obtusiflorus*	
248	Cyperaceae	*Cyperus obtusiflorus v. flavissimus*	
249	Cyperaceae	*Cyperus obtusiflorus v. obtusifloru*	
250	Cyperaceae	*Cyperus rotundus*	x
251	Cyperaceae	*Cyperus rupestris*	
252	Cyperaceae	*Cyperus schlechteri*	x
253	Cyperaceae	*Cyperus semitrifidus*	x
254	Cyperaceae	*Fimbristylis dichotoma*	
255	Cyperaceae	*Fimbristylis squarrosa*	
256	Cyperaceae	*Fuirena leptostachya*	
257	Cyperaceae	*Fuirena pubescens*	
258	Cyperaceae	*Kyllinga alba*	
259	Cyperaceae	*Kyllinga erecta*	
260	Cyperaceae	*Lipocarpha rehmannii*	x
261	Cyperaceae	*Mariscus congestus*	x
262	Cyperaceae	*Schoenoplectus brachyceras*	
263	Cyperaceae	*Schoenoplectus corymbosus*	x
264	Cyperaceae	*Scirpus ficinioides*	x

D			
265	Dennstaedtiaceae	*Pteridium aquilinum*	
266	Dichapetalaceae	*Dichapetalum cymosum*	
267	Dipsacaceae	*Cephalaria galpiniana s. simplicior*	x
268	Dipsacaceae	*Scabiosa columbaria*	
269	Dryopteridaceae	*Polystichum dracomontanum*	x

E			
270	Ebenaceae	*Diospyros lycioides*	
271	Ebenaceae	*Diospyros whyteana*	
272	Ebenaceae	*Euclea crispa*	
273	Ebenaceae	*Euclea divinorum*	x
274	Ebenaceae	*Euclea linearis*	
275	Ebenaceae	*Euclea natalensis*	
276	Elatinaceae	*Elatine triandra*	
277	Equisetaceae	*Equisetum ramosissimum*	
278	Ericaceae	*Erica caffrorum*	x
279	Ericaceae	*Erica drakensbergensis*	
280	Ericaceae	*Erica haematosiphon*	x
281	Eriocaulaceae	*Eriocaulon abyssinicum*	
282	Eriocaulaceae	*Eriocaulon maculatum*	
283	Eriospermaceae	*Eriospermum abyssinicum*	x
284	Euphorbiaceae	*Acalypha angustata*	
285	Euphorbiaceae	*Acalypha segetalis*	
286	Euphorbiaceae	*Acalypha villicaulis*	
287	Euphorbiaceae	*Bridelia mollis*	
288	Euphorbiaceae	*Croton gratissimus*	
289	Euphorbiaceae	*Dalechampia capensis*	
290	Euphorbiaceae	*Euphorbia clavarioides*	x
291	Euphorbiaceae	*Euphorbia ingens*	
292	Euphorbiaceae	*Flueggea virosa*	
293	Euphorbiaceae	*Jatropha capensis*	

294	Euphorbiaceae	*Jatropha glauca*	x
295	Euphorbiaceae	*Jatropha latifolia*	
296	Euphorbiaceae	*Jatropha natalensis*	
297	Euphorbiaceae	*Phyllanthus parvulus*	
298	Euphorbiaceae	*Pseudolachnostylis maprouneifolia*	
299	Euphorbiaceae	*Thecacoris trichogyne*	x
300	Euphorbiaceae	*Tragia sonderi*	x
301	Exormothecaceae	*Exormotheca pustulosa*	

		F	
302	Fabaceae	*Argyrolobium marginatum*	x
303	Fabaceae	*Argyrolobium megarrhizum*	
304	Fabaceae	*Bolusanthus speciosus*	
305	Fabaceae	*Bolusia ervoides*	x
306	Fabaceae	*Chamaecrista comosa*	x
307	Fabaceae	*Chamaecrista mimosoides*	
308	Fabaceae	*Crotalaria brachycarpa*	x
309	Fabaceae	*Decorsea galpinii*	
310	Fabaceae	*Dichilus strictus*	
311	Fabaceae	*Eriosema burkei*	
312	Fabaceae	*Eriosema cordatum*	
313	Fabaceae	*Eriosema salignum*	
314	Fabaceae	*Erythrina lysistemon*	
315	Fabaceae	*Indigastrum burkeanum*	
316	Fabaceae	*Indigofera arrecta*	
317	Fabaceae	*Indigofera comosa*	x
318	Fabaceae	*Indigofera cryptantha*	x
319	Fabaceae	*Indigofera daleoides*	
320	Fabaceae	*Indigofera depressa*	x
321	Fabaceae	*Indigofera filipes*	
322	Fabaceae	*Indigofera longebarbata*	x
323	Fabaceae	*Indigofera melanadenia*	
324	Fabaceae	*Lessertia depressa*	x
325	Fabaceae	*Lotononis calycina*	
326	Fabaceae	*Lotononis eriantha*	
327	Fabaceae	*Lotononis foliosa*	x
328	Fabaceae	*Lotononis laxa*	x
329	Fabaceae	*Mundulea sericea*	
330	Fabaceae	*Neorautanenia ficifolius*	

331	Fabaceae	*Ophrestia oblongifolia*	
332	Fabaceae	*Pearsonia sessilifolia s. filifolia*	
333	Fabaceae	*Pterocarpus lucens s. antunesii***	x
334	Fabaceae	*Rhynchosia caribaea*	
335	Fabaceae	*Rhynchosia harmsiana*	x
336	Fabaceae	*Rhynchosia monophylla*	
337	Fabaceae	*Rhynchosia nitens*	
338	Fabaceae	*Rhynchosia totta*	
339	Fabaceae	*Rhynchosia totta v. totta*	
340	Fabaceae	*Sphenostylis angustifolia*	
341	Fabaceae	*Tephrosia burchellii*	
342	Fabaceae	*Tephrosia elongata*	
343	Fabaceae	*Tephrosia longipes*	
344	Fabaceae	*Tephrosia macropoda v. diffusa*	
345	Fabaceae	*Tephrosia multijuga*	
346	Fabaceae	*Zornia capensis*	x
347	Fabaceae	*Zornia linearis*	
348	Fabaceae	*Zornia milneana*	x
349	Flacourtiaceae	*Dovyalis caffra*	x
350	Flacourtiaceae	*Dovyalis zeyheri*	
351	Flacourtiaceae	*Kiggelaria africana*	x

		G	
352	Gentianaceae	*Sebaea capitata*	x
353	Gentianaceae	*Sebaea grandis*	
354	Geraniaceae	*Geranium wakkerstroomianum*	x
355	Geraniaceae	*Monsonia angustifolia*	
356	Gesneriaceae	*Streptocarpus polyanthus*	
357	Gleicheniaceae	*Gleichenia polypodioides*	

		H	
358	Heteropyxidaceae	*Heteropyxis natalensis*	
359	Hyacinthaceae	*Albuca angolensis*	
360	Hyacinthaceae	*Albuca glandulosa*	x
361	Hyacinthaceae	*Albuca glauca*	

362	Hyacinthaceae	*Bowiea volubilis***	
363	Hyacinthaceae	*Dipcadi marlothii*	
364	Hyacinthaceae	*Dipcadi rigidifolium*	
365	Hyacinthaceae	*Dipcadi viride*	
366	Hyacinthaceae	*Diplachne fusca*	x
367	Hyacinthaceae	*Drimia ciliaris*	
368	Hyacinthaceae	*Drimiopsis atropurpurea*	
369	Hyacinthaceae	*Drimiopsis burkei*	
370	Hyacinthaceae	*Eucomis autumnalis***	
371	Hyacinthaceae	*Ledebouria cooperi*	
372	Hyacinthaceae	*Ledebouria ovatifolia*	x
373	Hyacinthaceae	*Ledebouria revoluta*	x
374	Hyacinthaceae	*Scilla dracomontana***	x
375	Hyacinthaceae	*Scilla nervosa***	
376	Hyacinthaceae	*Urginea macrocentra*	
377	Hyacinthaceae	*Whiteheadia species*	x
378	Hypericaceae	*Hypericum lalandii*	
379	Hypoxidaceae	*Hypoxis acuminata*	x
380	Hypoxidaceae	*Hypoxis angustifolia*	
381	Hypoxidaceae	*Hypoxis argentea*	x
382	Hypoxidaceae	*Hypoxis hemerocallidea*	
383	Hypoxidaceae	*Hypoxis rigidula*	

		I	
384	Illecebraceae	*Pollichia campestris*	
385	Iridaceae	*Babiana hypogaea var. hypogea*	
386	Iridaceae	*Babiana hypogea v. longituba*	x
387	Iridaceae	*Freesia laxa*	
388	Iridaceae	*Gladiolus crassifolius***	
389	Iridaceae	*Gladiolus dalenii***	x
390	Iridaceae	*Gladiolus elliotii***	
391	Iridaceae	*Gladiolus permeabilis***	
392	Iridaceae	*Gladiolus pole-evansii***	
393	Iridaceae	*Gladiolus sericeovillosus s. calvat***	
394	Iridaceae	*Gladiolus sericeovillosus s. serice***	
395	Iridaceae	*Hesperantha baurii***	x
396	Iridaceae	*Hesperantha coccinea***	x

397	Iridaceae	*Tritonia nelsonii*	

J			
398	Juncaceae	*Juncus effusus*	x
399	Juncaceae	*Juncus exsertus*	

L			
400	Lamiaceae	*Aeollanthus buchnerianus*	
401	Lamiaceae	*Aeollanthus rehmannii*	
402	Lamiaceae	*Becium obovatum*	
403	Lamiaceae	*Hemizygia canescens*	
404	Lamiaceae	*Hemizygia petrensis*	
405	Lamiaceae	*Leonotis leonurus*	x
406	Lamiaceae	*Leonotis ocymifolia v. raineriana*	x
407	Lamiaceae	*Leonotis ocymifolia v. schinzii*	x
408	Lamiaceae	*Plectranthus grallatus*	x
409	Lamiaceae	*Plectranthus madagascariensis*	x
410	Lamiaceae	*Stachys grandifolia*	x
411	Lamiaceae	*Stachys natalensis*	
412	Lentibulariaceae	*Utricularia arenaria*	
413	Lobeliaceae	*Monopsis decipiens*	
414	Loganiaceae	*Strychnos cocculoides*	x
415	Loganiaceae	*Strychnos madagascariensis*	x
416	Loranthaceae	*Erianthemum ngamicum*	
417	Lycopodiaceae	*Lycopodium clavatum*	x

M			
418	Malvaceae	*Abutilon angulatum*	x
419	Malvaceae	*Anisodontea scabrosa*	
420	Malvaceae	*Hibiscus calyphyllus*	
421	Malvaceae	*Hibiscus engleri*	
422	Malvaceae	*Hibiscus micranthus*	
423	Malvaceae	*Hibiscus pusillus*	
424	Malvaceae	*Hibiscus trionum*	x
425	Malvaceae	*Pavonia transvaalensis*	

426	Malvaceae	*Sida cordifolia*	
427	Malvaceae	*Sida dregei*	x
428	Malvaceae	*Sida spinosa*	x
429	Meliaceae	*Melia azedarach**	
430	Mesembryanthemaceae	*Delosperma gracile*	
431	Mimosaceae	*Senegalia burkei*	
432	Mimosaceae	*Senegalia caffra*	
433	Mimosaceae	*Senegalia dealbata*	
434	Mimosaceae	*Senegalia gerrardii*	
435	Mimosaceae	*Vachellia karroo*	
436	Mimosaceae	*Acacia mearnsii**	
437	Mimosaceae	*Senegalia nigrescens*	
438	Mimosaceae	*Albizia harveyi*	x
439	Mimosaceae	*Dichrostachys cinerea*	
440	Mimosaceae	*Elephantorrhiza burkei*	
441	Mimosaceae	*Elephantorrhiza elephantina*	
442	Moraceae	*Ficus abutilifolia*	
443	Moraceae	*Ficus cordata*	
444	Moraceae	*Ficus ingens*	
445	Moraceae	*Ficus thonningii*	
446	Myrothamnaceae	*Myrothamnus flabellifolius*	
447	Myrsinaceae	*Myrsine africana*	
448	Myrtaceae	*Eucalyptus species**	x
449	Myrtaceae	*Leptospermum scoparium**	x
450	Myrtaceae	*Syzygium guineense*	x
451	Myrtaceae	*Syzygium paniculatum*	x

		O	
452	Ochnaceae	*Ochna pulchra*	
453	Ochnaceae	*Stenoglottis fimbriata*	x
454	Olacaceae	*Ximenia caffra*	
455	Oleaceae	*Jasminum breviflorum*	

456	Oleaceae	*Olea capensis*	
457	Oleaceae	*Olea europaea* subsp. *africana*	
458	Oliniaceae	*Olinia emarginata*	
459	Onagraceae	*Oenothera jamesii*	
460	Orchidaceae	*Eulophia calanthoides*	x
461	Orchidaceae	*Pterygodium cooperi*	x
462	Oxalidaceae	*Oxalis depressa*	
463	Oxalidaceae	*Oxalis ebracteata*	x
464	Oxalidaceae	*Oxalis obliquifolia*	

		P	
465	Passifloraceae	*Passiflora subpeltata*	x
466	Pedaliaceae	*Ceratotheca triloba*	
467	Pedaliaceae	*Dicerocaryum senecioides*	
468	Pedaliaceae	*Pterodiscus speciosus*	
469	Pedaliaceae	*Sesamum alatum*	
470	Periplocaceae	*Raphionacme galpinii*	
471	Periplocaceae	*Stomatostemma monteiroae*	
472	Pinaceae	*Pinus pinaster**	x
473	Poaceae	*Agrostis lachnantha*	
474	Poaceae	*Alloteropsis semialata*	
475	Poaceae	*Andropogon chinensis*	
476	Poaceae	*Andropogon eucomus*	
477	Poaceae	*Andropogon huillensis*	
478	Poaceae	*Andropogon schirensis*	
479	Poaceae	*Anthephora pubescens*	
480	Poaceae	*Aristida adscensionis*	
481	Poaceae	*Aristida canescens*	
482	Poaceae	*Aristida congesta s. barbicollis*	
483	Poaceae	*Aristida congesta s. congesta*	
484	Poaceae	*Aristida diffusa*	
485	Poaceae	*Aristida junciformis*	
486	Poaceae	*Aristida meridionalis*	

487	Poaceae	*Aristida scabrivalvis*	
488	Poaceae	*Aristida stipitata*	
489	Poaceae	*Aristida transvaalensis*	
490	Poaceae	*Bambusa balcooa*	
491	Poaceae	*Bewsia biflora*	
492	Poaceae	*Bothriochloa bladhii*	
493	Poaceae	*Bothriochloa insculpta*	
494	Poaceae	*Brachiaria brizantha*	
495	Poaceae	*Brachiaria serrata*	x
496	Poaceae	*Chloris pycnothrix*	x
497	Poaceae	*Chloris virgata*	
498	Poaceae	*Cymbopogon caesius*	
499	Poaceae	*Cynodon dactylon*	
500	Poaceae	*Digitaria diagonalis*	
501	Poaceae	*Digitaria eriantha*	
502	Poaceae	*Digitaria longiflora*	
503	Poaceae	*Digitaria monodactyla*	
504	Poaceae	*Diheteropogon amplectens*	
505	Poaceae	*Eleusine coracana*	
506	Poaceae	*Elionurus muticus*	
507	Poaceae	*Enneapogon scoparius*	
508	Poaceae	*Eragrostis biflora*	x
509	Poaceae	*Eragrostis capensis*	
510	Poaceae	*Eragrostis chloromelas*	
511	Poaceae	*Eragrostis curvula*	
512	Poaceae	*Eragrostis gummiflua*	
513	Poaceae	*Eragrostis heteromera*	
514	Poaceae	*Eragrostis plana*	
515	Poaceae	*Eragrostis racemosa*	
516	Poaceae	*Eustachys paspaloides*	
517	Poaceae	*Fingerhuthia africana*	
518	Poaceae	*Hyparrhenia hirta*	
519	Poaceae	*Hyparrhenia tamba*	
520	Poaceae	*Hyperthelia dissoluta*	
521	Poaceae	*Imperata cylindrica*	
522	Poaceae	*Karroochloa tenella*	x
523	Poaceae	*Loudetia simplex*	
524	Poaceae	*Melinis nerviglumis*	
525	Poaceae	*Microchloa caffra*	x
526	Poaceae	*Miscanthus junceus*	
527	Poaceae	*Monocymbium ceresiiforme*	

528	Poaceae	*Oplismenus hirtellus*	
529	Poaceae	*Panicum maximum*	
530	Poaceae	*Panicum natalense*	
531	Poaceae	*Paspalum dilatatum*	
532	Poaceae	*Paspalum urvillei*	x
533	Poaceae	*Pennisetum macrourum*	
534	Poaceae	*Pennisetum setaceum**	x
535	Poaceae	*Perotis patens*	
536	Poaceae	*Phragmites australis*	
537	Poaceae	*Pogonarthria squarrosa*	
538	Poaceae	*Rendlia altera*	
539	Poaceae	*Schizachyrium sanguineum*	
540	Poaceae	*Setaria megaphylla*	
541	Poaceae	*Setaria sphacelata*	
542	Poaceae	*Setaria verticillata*	
543	Poaceae	*Sorghum bicolor*	
544	Poaceae	*Sporobolus africanus*	
545	Poaceae	*Sporobolus fimbriatus*	
546	Poaceae	*Sporobolus pyramidalis*	
547	Poaceae	*Sporobolus stapfianus*	
548	Poaceae	*Stiburus alopecuroides*	x
549	Poaceae	*Themeda triandra*	
550	Poaceae	*Trachypogon spicatus*	
551	Poaceae	*Trichoneura grandiglumis*	
552	Poaceae	*Tristachya biseriata*	
553	Poaceae	*Tristachya leucothrix*	x
554	Poaceae	*Urelytrum agropyroides*	
555	Poaceae	*Urochloa mosambicensis*	x
556	Poaceae	*Urochloa oligotricha*	
557	Poaceae	*Urochloa panicoides*	x
558	Polygalaceae	*Polygala amatymbica*	
559	Polygalaceae	*Polygala hottentotta*	
560	Polygalaceae	*Polygala uncinata*	x
561	Polygonaceae	*Persicaria lapathifolia*	x
562	Polypodiaceae	*Pleopeltis macrocarpa*	x
563	Portulaceae	*Anacampseros subnuda*	
564	Proteaceae	*Faurea saligna*	
565	Proteaceae	*Protea caffra*	

566	Pteridaceae	*Cheilanthes eckloniana*	x
567	Pteridaceae	*Cheilanthes quadripinnata*	x
568	Pteridaceae	*Doryopteris concolor*	
569	Pteridaceae	*Pellaea calomelanos*	
570	Pteridaceae	*Pteris cretica*	x

R			
571	Ranunculaceae	*Ranunculus baurii*	x
572	Ranunculaceae	*Ranunculus meyeri*	x
573	Ranunculaceae	*Ranunculus multifidus*	
574	Rhamnaceae	*Berchemia discolor*	
575	Rhamnaceae	*Berchemia zeyheri***	
576	Rhamnaceae	*Helinus integrifolius*	
577	Rhamnaceae	*Phylica parviflora*	x
578	Rhamnaceae	*Rhamnus prinoides*	x
579	Rhamnaceae	*Ziziphus mucronata*	
580	Rhamnaceae	*Ziziphus zeyheriana*	
581	Ricciaceae	*Riccia stricta*	
582	Rosaceae	*Pyracantha angustifolia*	x
583	Rubiaceae	*Galopina circaeoides*	
584	Rubiaceae	*Hyperacanthus amoenus*	
585	Rubiaceae	*Kohautia amatymbica*	x
586	Rubiaceae	*Kohautia virgata*	
587	Rubiaceae	*Oldenlandia herbacea v. herbacea*	
588	Rubiaceae	*Pavetta gardeniifolia*	
589	Rubiaceae	*Pygmaeothamnus zeyheri*	
590	Rubiaceae	*Richardia brasiliensis*	x
591	Rubiaceae	*Rothmannia capensis*	
592	Rubiaceae	*Tapiphyllum parvifolium*	
593	Rubiaceae	*Vangueria infausta*	
594	Rutaceae	*Calodendrum capense*	
595	Rutaceae	*Vepris lanceolata*	
596	Rutaceae	*Zanthoxylum davyi*	x

S			
597	Salicaceae	*Populus* x. *canescens* *	
598	Sapindaceae	*Pappea capensis*	
599	Sapotaceae	*Englerophytum magalismontanum*	
600	Sapotaceae	*Mimusops zeyheri*	
601	Scrophulariaceae	*Alectra orobanchoides*	
602	Scrophulariaceae	*Buchnera glabrata*	
603	Scrophulariaceae	*Glekia krebsiana*	x
604	Scrophulariaceae	*Ilysanthes dubia*	
605	Scrophulariaceae	*Manulea parviflora*	
606	Scrophulariaceae	*Mimulus gracilis*	
607	Scrophulariaceae	*Selago tenuifolia*	x
608	Scrophulariaceae	*Striga asiatica*	
609	Scrophulariaceae	*Striga bilabiata*	
610	Scrophulariaceae	*Striga elegans*	
611	Scrophulariaceae	*Zaluzianskya microsiphon*	
612	Selaginellaceae	*Selaginella caffrorum*	x
613	Solanaceae	*Datura ferox**	
614	Solanaceae	*Solanum incanum*	
615	Solanaceae	*Solanum panduriforme*	
616	Solanaceae	*Solanum retroflexum*	
617	Solanaceae	*Solanum sisymbriifolium*	x
618	Sterculiaceae	*Dombeya rotundifolia*	
619	Sterculiaceae	*Hermannia tomentosa*	
620	Sterculiaceae	*Hermannia woodii*	x
621	Sterculiaceae	*Melhania prostrata*	
622	Sterculiaceae	*Waltheria indica*	

T			
623	Thymelaeaceae	*Gnidia kraussiana*	
624	Thymelaeaceae	*Gnidia sericocephala*	
625	Tiliaceae	*Corchorus trilocularis*	x
626	Tiliaceae	*Grewia bicolor*	
627	Tiliaceae	*Grewia monticola*	

628	Tiliaceae	*Grewia occidentalis*	
629	Tiliaceae	*Grewia rogersii*	
630	Tiliaceae	*Grewia villosa*	x
631	Tiliaceae	*Triumfetta sonderi*	

		U	
632	Ulmaceae	*Celtis africana*	
633	Ulmaceae	*Chaetachme aristata*	
634	Ulmaceae	*Trema orientalis*	
635	Urticaceae	*Pouzolzia mixta*	

		V	
636	Vahliaceae	*Vahlia capensis*	
637	Velloziaceae	*Xerophyta retinervis*	
638	Velloziaceae	*Xerophyta viscosa*	
639	Verbenaceae	*Clerodendrum triphyllum*	
640	Verbenaceae	*Lantana rugosa*	
641	Verbenaceae	*Lippia javanica*	
642	Verbenaceae	*Lippia rehmannii*	x
643	Verbenaceae	*Verbena bonariensis*	
644	Verbenaceae	*Verbena brasiliensis*	x
645	Vitaceae	*Rhoicissus tridentata*	

		W	
646	Woodsiaceae	*Woodsia montevidensis*	x

		X	
647	Xyridaceae	*Xyris capensis*	

		Z	
648	Zamiaceae	*Encephalartos middelburgensis***	
649	Zygophyllaceae	*Tribulus terrestris*	

ANNEXURE C - WOODY SPECIES LIST

Number of individual woody plants at different height classes:

Upper (U), Middle (M) and Lower (L)

Woody species	PC 1			PC 2.1			PC 2.2			PC 3			PC 4.1			PC 4.2			PC 5			PC 6			PC 7.1			PC 7.2			PC 7.3		
	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L	U	M	L
Diospyros lycioides	0	4	2				0	0	1				0	1	1				0	1	0												
Grewia occidentalis	0	2	0				0	2	0							1	0	0														
Vachellia karroo	0	1	1							1	1	1																				
Buddleja salviifolia	0	9	6				0	3	0	0	3	1				0	1	0														
Celtis Africana	0	1	1	5	0	0	2	3	0							0	0	1	0	1	0											
Searsia pyroides	0	1	0	0	0	1	5	0	1	0	0	3				0	1	0	0	0	5	0	2	0	0	0	1					
Robinia pseudo-acacia	0	3	0																													
Rhoicissus tridentata				0	0	3	0	3	8	0	0	1				0	1	0	0	2	5				0	0	1					
Ziziphus mucronata				0	0	4	1	3	6	3	0	1				2	2	4	1	2	0							0	0	1		
Senegalia caffra				3	4	0	13	5	0	2	0	0				6	4	4	5	1	5	2	3	7								
Searsia leptodictya				1	1	1	5	7	1	4	0	2	0	4	0	0	1	0	1	0	0										0	0	2
Illex mitis				0	1	0																										
Gymnosporia buxifolia				0	0	1	0	4	3							0	0	1	0	0	1											
Maytenus alba				2	1	0																										
Rhamnus pyroides				0	0	1																										
Grewia monticola				1	0	0	0	1	1							2	0	0	0	2	0											
Cussonia paniculosa				1	0	0																										
Olea europaea subsp. *africana*				2	1	2													0	0	1							0	0	1		
Mimusops zeyheri				2	2	0																									0	1	0
Berchemia zeyheri				0	0	1	0	3	5				0	2	0				2	0	0											
Diospyros whyteana				0	2	1																										
Searsia magalismontana				1	2	0																										
Ozoroa paniculosa				0	0	4							0	1	0							0	2	1								
Dombeya rotundifolia				0	0	1	4	5	0	1	0	0	0	2	2	2	2	2	0	4	5	0	2	9								

Senegalia burkei			3	0	0	2	4	3							11	7	9	1	0	0	1	0	3														
Euclea divinorum			2	0	0	0	1	2	1	0	0							0	1	1																	
Vepris lanceolata			1	0	0																																
Heteropyxis natalensis						2	3	3							0	2	2	3	4	1								0	2	0	0	1	3				
Euclea natalensis						0	2	0																													
Grewia rogersii						0	0	2																													
Ficus ingens						0	0	1										0	2	0																	
Cussonia spicata						2	0	0				1	0	1																							
Tecomaria capensis						0	1	0																													
Maytenus undata						2	0	0																													
Syzygium guineense						1	0	0																													
Elephantorrhiza burkei						0	0	3										0	2	0																	
Combretum molle						3	0	1				4	3	3	1	4	1	4	2	1	0	0	2	0	0	1	0	0	1	0	0	2					
Pavetta gardeniifolia						0	1	0																													
Lannea discolor						1	1	0				9	7	0	9	6	9	0	2	2	1	0	1				0	2	0	0	0	3					
Olea capensis						0	0	1																													
Strychnos cocculoides						0	1	0				2	0	0													1	1	1								
Searsia zeyheri						2	0	1	0	0	1	1	0	0	3	5	3	0	0	1																	
Albezia harveyi						5	3	0																													
Sclerocarya birrea caffra						1	0	0							0	0	6				0	0	2														
Pappea capensis						0	1	0							0	3	0																				
Ximenia caffra						0	0	1										0	1	0																	
Ochna pulchra						0	0	1				0	4	0				0	1	1													0	1	0		
Commiphora glandulosa						0	2	0																													
Lopholaena coriifolia									0	0	1							0	0	1	0	0	3				0	3	3	0	0	2					
Ficus abutilifolia									0	0	3																										
Faurea saligna									0	2	2				2	3	0	9	6	5	8	10	53	0	0	4	2	0	1	0	0	3					
Ozoroa sphaerocarpa									2	0	0				3	4	2	7	1	1				0	0	1	0	1	1	0	0	2					
Protea caffra									1	0	0										9	1	1	2	0	3	3	0	0	18	0	1					
Lippia javanica									0	0	1				0	4	0	0	2	4	0	0	3														
Mundulea sericea												0	4	0				0	3	0	0	0	3				0	1	3	0	0	1					
Englerophytum magalismontanum												4	4	1				4	1	0							3	0	1								
Ficus cordata												0	1	0																							

Diplorhynchus condylocarpon					7	8	0																		
Aloe marlothii					1	0	1																		
Burkea Africana					3	11	3	0	2	1				1	0	4									
Aloe ferox					0	1	1																		
Tapiphyllum parvifolium					0	2	1	0	2	0	1	1	3				0	1	2	0	1	5			
Pseudolanchnostylis maprouneifolia					1	0	0																		
Peltophorum africana					0	3	1				3	0	1												
Combretum apiculatum					1	3	0	2	3	1	0	1	0												
Vangueria infausta					1	0	1													0	0	2			
Acacia gerrardi					0	1	0																		
Dichrostachys cinerea								5	6	1	0	5	0	4	11	15									
Croton gratissimus								0	0	1	5	2	0										0	0	3
Cussonia arboea								0	1	0															
Myrothamnus flabellifolia											0	2	0												
Aloe arborescens											0	4	0												
Combretum erythrophyllum											1	0	0												
Lippia rehmanii														0	0	7									
Maytenus albata																	0	0	1						
Maytenus tenuispina																				0	1	1			
Senegalia nigrescens																				0	2	2			
Euclea crispa																							0	0	1
Acacia mearnsii																							0	0	2