

# The vegetation ecology of Ezemvelo Nature Reserve, Bronkhorstspuit, South Africa

By

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Submitted in partial fulfilment of the requirements for the degree

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## **Abstract**

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A vegetation survey, based on plant communities, was conducted on the Ezemvelo Nature Reserve. The aim of the study was to identify, describe and classify plant communities of Ezemvelo Nature Reserve, and interpret them ecologically. The information derived from this study can then be used in the management of the Reserve. The floristic composition and habitat information were recorded in 210 sample plots. The data was captured in the TURBOVEG database and classified using the TWINSpan numerical classification algorithm. The resulting phytosociological tables were compiled and organised using the MEGATAB computerised table management programme according to Braun-Blanquet procedures. The data was also subjected to a Detrended Correspondence Analysis (DECORANA), processed by the PCOrd numerical ordination programme, to confirm the results of the classification. The ordination also illustrates any environmental gradients controlling the existence and distribution patterns of the different plant communities. Twenty-two major plant communities and 4 sub-communities were identified, described, and ecologically interpreted. The localities of the plant communities are indicated on map, compiled by using GIS. The plant communities on the Reserve are distributed in a mosaic of woodlands, grasslands and wetlands, based on the heterogeneous habitats created by the variations in topography, which is typical of Bankenveld vegetation.

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# 1 INTRODUCTION

## 1.1 Background

The Ezemvelo Nature Reserve is situated to the extreme north of the grassland biome in South Africa. Acocks (1988) recognised the vegetation type as Bankenveld and Bredenkamp and Van Rooyen (1998) classified it as Rocky Highveld Grassland. On the new Vegetation Map of South Africa, Lesotho and Swaziland (Mucina *et al.* 2005), this area is known as the Rand Highveld Grassland. The grassland biome covers South Africa's agriculturally most productive area. It is the country's major source of beef, crops, dairy and timber, and the majority of South Africa's population lives in the grassland biome. Mining also poses a threat as large coal and gold deposits exist in this area. The eastern parts with the higher rainfall are under extensive exotic tree afforestation. Other less apparent threats exist such as soil erosion, invasion by alien species and acid rain due to the sulphur dioxide released by the coal power stations (Neke & Du Plessis 2004). All these activities pose a serious threat to the existence of grasslands, their biodiversity and ecological process.

South Africa's grassland biome has been identified as critically endangered based on total habitat loss, degree of fragmentation and taking into account future threats (Reyers *et al.* 2001). It is in need of conservation attention as little protection is given to this biome, despite its multiple sources and severity of threats to this biologically important resource (Neke & Du Plessis 2004). It is estimated that 60 to 80% of South African grasslands are already irreversibly transformed by agriculture, forestry, urbanisation and mining (Bredenkamp 1999) while only 2.3% of grasslands are currently conserved (Low & Rebelo 1998). This is below the recommended 10% of the IUCN (Reyers *et al.* 2001).

The Bankenveld vegetation type consists of diverse plant communities such as forest in sheltered ravines, woodland, grassland and wetlands. The location of these communities is dependent on the topography and their location in the landscape (Bredenkamp & Brown 2003). This diverse landscape houses many rare species, a rich biodiversity and provide habitat for many organisms. However, the urban and industrial centres of Gauteng as well as the major gold and coal mines are situated in this vegetation type. Reyers *et al.* (2001) estimated that 33.6% of Bankenveld is transformed and only 0.8% is protected (Reyers *et al.* 2001). This includes nature reserves such as Witbank, Suikerbosrand, Rustenburg, Abe Bailey, Boskop Dam and Rietvlei Nature Reserves.

The 11 000 ha Ezemvelo Nature Reserve is therefore an important conservation area in this biome. The diverse habitats provided by the Reserve are refuges for many birds, invertebrates, amphibians and plant species, including two Red Listed plant species, *Frithia humulis* and *Encephalartos middelburgensis* (Pfab & Victor 2002). The Reserve therefore needs to be properly managed to prevent its degradation by factors such as invasive alien species and veld degradation by overgrazing.

## **1.2 Objectives**

The aim of this study was to collect and scientifically analyse vegetation data to provide information on the vegetation of Ezemvelo Nature Reserve. This information will expand the current knowledge on the grassveld biome and more specifically the Bankenveld. This thesis provides a description of the study area, an explanation on the preferred methodology and a discussion on grasslands and Bankenveld in South Africa. The plant communities of the Reserve are identified and described, indicating their floristic composition and habitat features. A vegetation map was compiled for future use in management of the Reserve.



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## 2 STUDY AREA

### 2.1 Location

Ezemvelo Nature Reserve is located on the border of the Gauteng and Mpumalanga Provinces, South Africa. The Reserve is situated north of National Route 4, between Bronkhorstspuit (Gauteng) and Witbank (Mpumalanga) (Figure 2.1). The Reserve is located between the latitudes of 25° 38' 24" S and 25° 44' 24" S and the longitudes of 28° 55' 48" E and 29° 02' 24" E. The Wilge River, a tributary to the Olifants River flows through the Reserve. The extent of the Nature Reserve is approximately 11 000 ha.

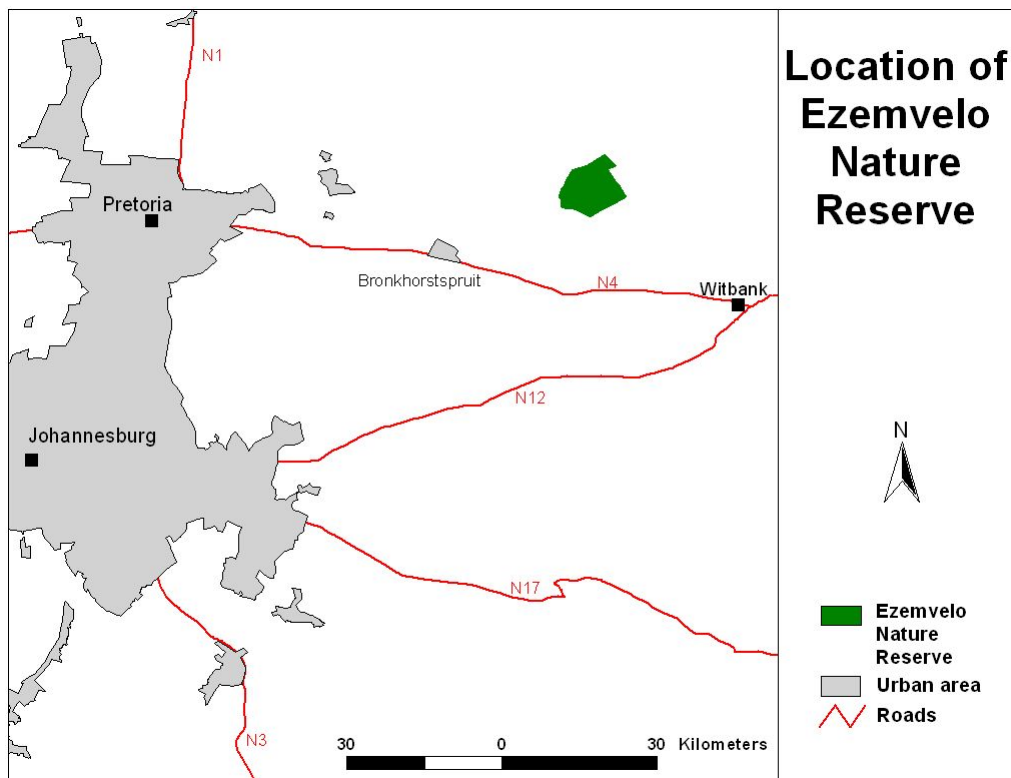


Figure 2.1. Locality map.

### 2.2 Climate

The climate of an area indicates the prevailing weather conditions over a long period of time, including the daily, seasonal and annual variations. Climate shapes the vegetation patterns by influencing the plant's life cycle with factors such as light, temperature and moisture (Schulze 2003).

Southern Africa's climate is influenced by the mean circulation patterns of the atmosphere over the subcontinent and deviations from this mean circulation patterns. The mean circulation pattern of the atmosphere over southern Africa is anticyclonic (high pressure). This is interrupted by a weak heat-induced low pressure in the central interior during summer (Tyson & Preston-Whyte 2000).

## Temperature

Air temperature influences the distribution of humans, animals and plants (Buckle 1996). Topography and aspect influence the temperature. Temperature varies with height with the general trend of being colder the higher the altitude. Aspect affects the amount of heat the ground can absorb. There is a marked difference in south and north facing slopes as in the southern hemisphere the sun does not shine directly on the south facing slopes during winter (Buckle 1996).

The temperature data measured was measured at the weather station at Witbank for the last 13 years. According to these statistics the highest temperatures occur during January and February when the average daily maximum temperature is 26 °C and the average daily minimum temperature ranges between 14 and 15 °C. The lowest temperatures occur during July where the daily maximum temperature averages around 18 °C and the daily minimum temperature 4 °C.

Table 2.1. Average Temperatures measured at weather station in Witbank.

Month	Daily Maximum Temperature (°C)	Daily Minimum Temperature (°C)
January	26.05	15.15
February	26.06	14.96
March	22.99	13.44
April	22.94	10.54
May	18.57	6.9
June	18.7	4.83
July	18.11	3.89
August	21.25	6.62
September	22.20	9.48
October	25.2	11.79
November	23.3	13.43
December	23.81	14.49

## Rainfall

Tropical anticyclones bring dry subsiding air to the interior plateau of southern Africa which causes a seasonal drought between April and September. From October to March the continental high weakens and is replaced by a shallow surface low which allows moist maritime air from the east and northeast to reach the interior and cause summer rain (Buckle 1996). Therefore, Ezemvelo Nature Reserve receives its rainfall during summer.

Rainfall data for the past 46 years was obtained from the weather stations at Witbank and Bronkhorstspuit. The rainy season peaks from October to March, while the driest months are in winter, between June and August. The mean annual rainfall is 625 mm at Bronkhorstspuit and 674 mm at Witbank. The data available for Witbank is only for the past 13 years; therefore it is not as accurate as those for Bronkhorstspuit.

Table 2.2. Average rainfall for the past 13 years.

Month	Average Rainfall (mm)	
	Witbank	Bronkhorstspuit
January	144	109
February	93	88
March	81	74
April	31	46
May	19	12
June	4	7
July	2	2
August	8	5
September	12	17
October	73	74
November	95	102
December	112	89
Total	674	625

## 2.3 Topography and Hydrology

The Wilge River flows from south to north through the middle of Ezemvelo Nature Reserve (Figure 2.2). Several small streams form tributaries to the Wilge River. Many small dams and wetlands occur in the Reserve adding to the water availability and vegetation diversity. The Reserve lies at an altitude ranging from 1240 m to 1460 m above sea level. The natural long-term erosion by Wilge River formed ridges and plateaus. Where the Wilge River enters the Reserve in the south it converges with the Sterkfonteinspruit and a deeply incised gorge

was formed. From here the Wilge River meanders through the Reserve. On the east of the Wilge River is a plateau and to the west the topography is undulating with localised ridges and streams.

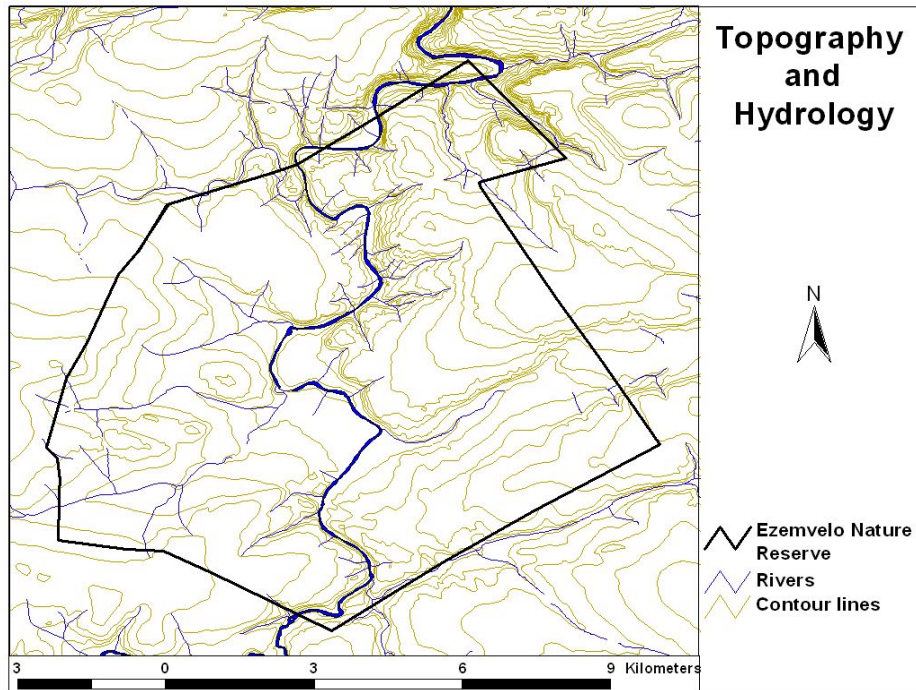


Figure 2.2. Topography and hydrology of Ezemvelo Nature Reserve.

## 2.4 Geology

The geology of the study area was obtained from the geological map of sheet 2528D (Bronkhorstspuit) and 2529C (Witbank). The Ezemvelo Nature Reserve is underlain by rocks of varying age. The oldest rocks of the Waterberg Group are overlain by Karoo sediments (Mahanyele 2001). The geological formations of the study area are indicated in Figure 2.3.

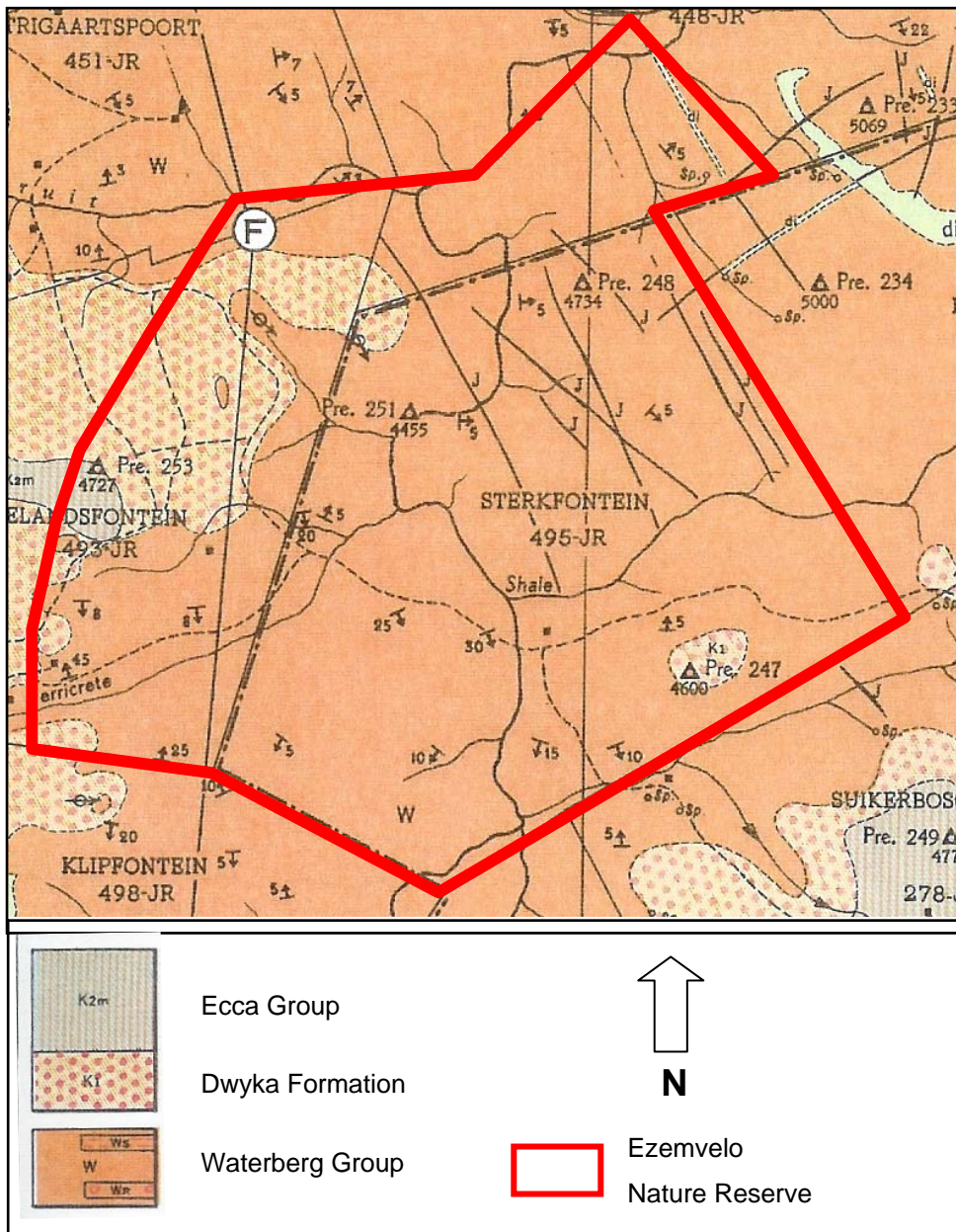


Figure 2.3. Geological Map of the study area (adapted from the 1:125 000 scale map of 2528D (Bronkhorstspuit) and 2529C (Witbank) geological map, Geological Survey).

### **Waterberg Group**

The Waterberg Group occurs in the central and northwest Transvaal and stretches into eastern Botswana (Figure 2.4). It consists of 12 formations of which only the Wilge River Formation occurs in the study area (Callaghan & Brandl 1991). The age of the Waterberg Group is estimated to be 1800 – 1700 million years old (Snyman 1996). The Waterberg Group occurs in two basins, namely the Warmbaths basin and the Middelburg basin (Callaghan & Brandl 1991). The Waterberg sediments in the study area consist of conglomerate, grit, sandstone and quartzite with sub-ordinate shale. Colours vary from reddish-brown to purple while the texture is medium- to coarse-grained. Sandstone, quartzitic

sandstone, grit, conglomerate and shale predominates (Visser *et al.* 1961; SACS 1980) and cross-bedding occurs (Visser *et al.* 1961). The distinct reddish colour is due to the presence of the iron oxides in the rock (Viljoen & Reimold 1999).

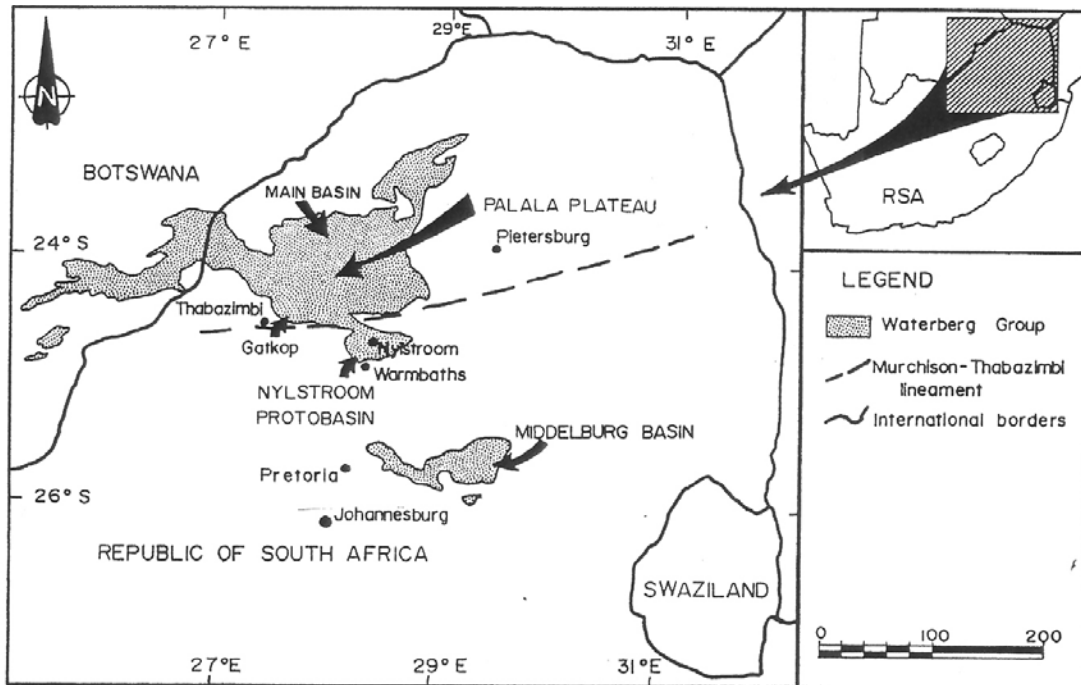


Figure 2.4. Locality map of the Waterberg Group in South Africa (As adapted from Callaghan and Brandl 1991).

### **Karoo Supergroup**

The sedimentary and volcanic rocks of the Karoo Supergroup cover approximately two thirds of South Africa. These rocks are roughly 300 to 180 million years old. The Karoo sequence of rocks is several thousands of metres thick. During the Karoo Era, South Africa was a lowland area in the midst of the supercontinent Gondwana and was linked to Antarctica, Australia and South America. The Karoo succession was terminated by the eruption of basaltic lava. The only remnants of this basaltic lava are resistant caps in Lesotho and the Drakensberg (Viljoen & Reimold 1999). The Karoo Sequence consists of the Dwyka Formation, Ecca, Beaufort and Lebombo Groups (Snyman 1996). Only the Ecca Group and Dwyka Formation are evident in the study area, therefore only they will be discussed.

### **Dwyka Formation**

During the Karoo era, sedimentation commenced with extensive deposits of Dwyka tillite. At the end of the carboniferous era the southern part of Gondwana migrated over the South Pole resulting in a major ice sheet over the Karoo basin. Evidence of glacial valleys, grooves and striations on pavements of older rock is still apparent today. Melting of these massive ice

sheets resulted in deposition of thick sequences of unsorted sediments containing rock fragments of different shapes and sizes. These ill-sorted glacial deposits are known as tillites (Viljoen & Reimold 1999). The Dwyka Group of the study area consists of tillite, shale and sandstone (Visser *et al.* 1961).

### **Ecca Group**

As Gondwana migrated further from the South Pole the glaciers receded. An inland sea covered most of the present day South Africa. The north eastern part of the Karoo basin was covered by impenetrable forests of *Glossopteris* and swamps. As the vegetation became submerged in the swamps, chemical processes broke down the plant tissue, starting the conversion to coal (Viljoen & Reimold 1999). This gave rise to the rich coal seams in the area around Witbank and Middelburg. The Ecca Group consists of middle Ecca conglomerates, grit, sandstone and shale (Visser *et al.* 1961).

## **2.5 Land Types and soils**

The Department of Agriculture and Water Supply compiled an inventory of the natural factors that determine agriculture potential. These factors are climate, terrain form and soil type. When these factors are combined land types can be delineated that is more or less uniform with regard to terrain form, soil pattern and climate. The results were published as Memoirs on the Agricultural Natural Resources of South Africa (Land Type Survey Staff, 1987). Three different land types are distinguished in the study area, namely Ba, Bb and Ib land types.

The Ba and Bb land types are characterised by undulating landscapes with a gentle slope. Red and/or yellow apedal soils dominate these land types (Land Type Survey Staff 1987). Distrophic and mesotrophic red soils are widespread, whereas duplex and marginal soils are rare. Approximately 71% of the land surface of the Ba land type is suitable for tillage with little physical limitations (Coetzee 1993). The Ib land type indicates areas where exposed rock covers 60 to 80 % of the area and is restricted to rocky outcrops and ridges (Land Type Survey Staff 1987; Coetzee 1993). Due to the high degree of rockiness and steep slope this land type is not suitable for agriculture.



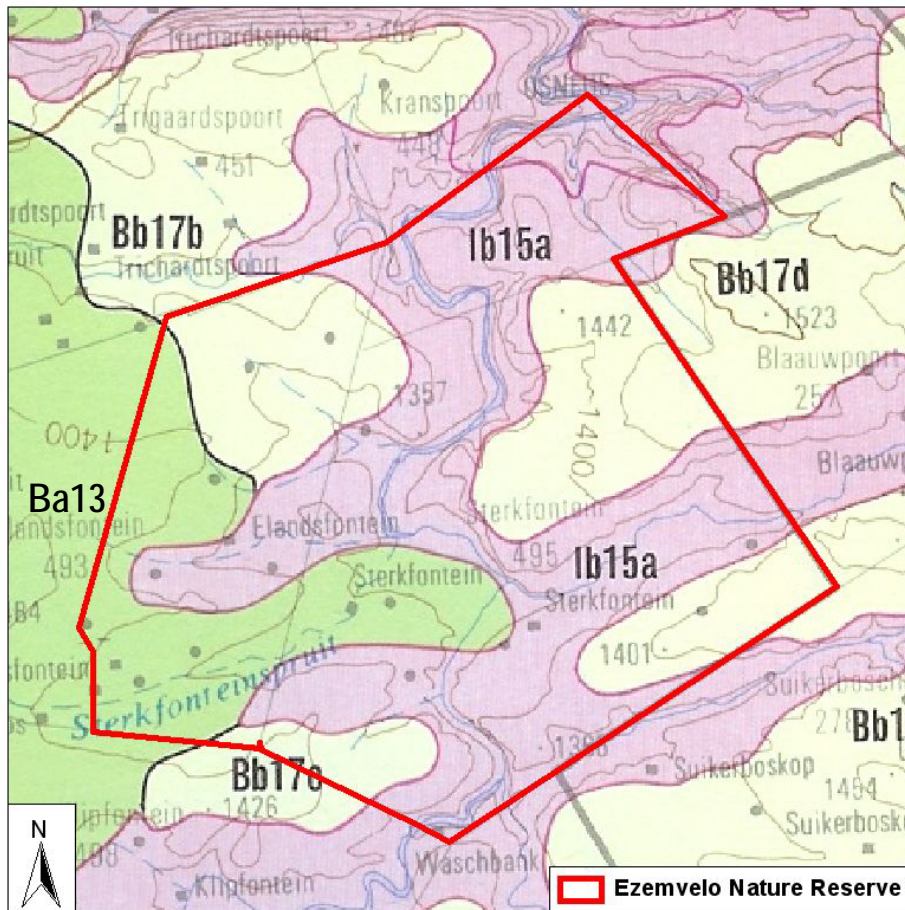


Figure 2.5. Land types of Ezemvelo Nature Reserve.

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## **3 GRASSLANDS IN SOUTH AFRICA WITH A SPECIFIC FOCUS ON BANKENVELD**

### **3.1 Introduction**

The flora of South Africa is extremely rich in diversity, both in species and ecosystems. South Africa is one of the 25 most biodiverse countries and harbours the fifth highest number of plant species in the world (Reyers *et al.* 2001). South African grasslands too show considerable diversity containing several rare and endemic plants. Five centres of floristic endemism, the Maputaland-Pondoland, Drakensberg Alpine, Barberton, Wolkberg and Sekhukhuneland (Van Wyk & Smith 2001) are located in the grassland biome. Ezemvelo Nature Reserve is located in the grassland biome, in the Bankenveld vegetation type according to Acocks (1988) and Rocky Highveld Grassland according to Bredenkamp and Van Rooyen (1998). On the new Vegetation Map of South Africa, Lesotho and Swaziland (Mucina *et al.* 2005) this area is known as the Rand Highveld Grassland. This chapter aims to present a brief discussion on the grasslands of South Africa and specifically the Bankenveld.

### **3.2 The grassland biome in South Africa**

The grassland biome, occupying 26% of South Africa, is centrally located in the country (Bredenkamp 1999) (Figure 3.1). Environmental gradients exist, causing the floristic composition, vegetation dynamics and ecosystem functioning to vary considerably across this biome, despite the relatively uniform vegetation structure. These gradients include a rainfall gradient ranging from 400 to >1200 mm per year, a temperature gradient from frost-free to snow in winter and altitude ranging from sea level to 3300 m (O'Connor & Bredenkamp 2003).

Grasslands are important to the livestock industry, and agricultural scientists historically produced considerable research on this biome. Already in 1949 Codd recognised the importance of applying ecology to agricultural problems in South Africa (Codd 1949). The Grassland Biome Project was launched in 1982, which resulted in the widespread classification of the South African grassland according to the Braun-Blanquet method (Cowling *et al.* 2003). Since then, comprehensive knowledge has been attained regarding the phytosociology of the South African Grassland, notably in the form of theses and

resulting publications (Bredenkamp 1975; Van Wyk 1983; Bezuidenhout 1988, 1993; Bloem 1988; Turner 1989; Kooij 1990; Breytenbach 1991; Du Preez 1991; Matthews 1991; Coetzee 1993; Eckhardt 1993, 1998; Fuls 1993; Myburgh 1993; Burgoyne 1995; Hoare 1997; Perkins 1997; Bester 1998; Malan 1998; Robbeson 1998; De Frey 1999; Grobler 2000; Janecke 2002; Muller 2002; Phamphe 2003).

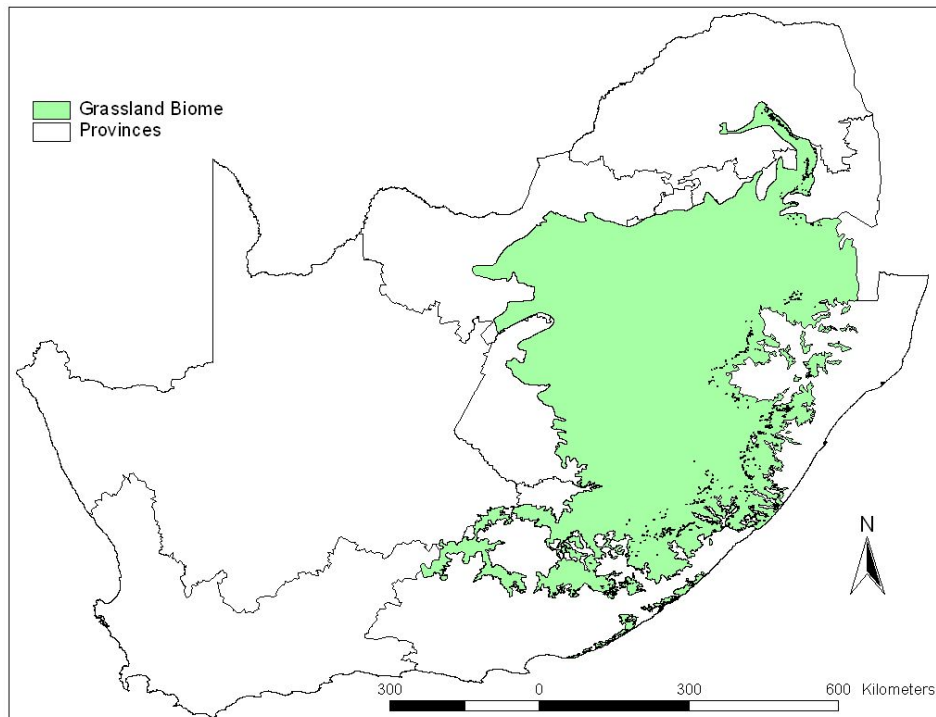


Figure 3.1. The extent of the grassland biome in South Africa.

### 3.3 Origin of South African grasslands

The origin of most temperate grasslands in western and central Europe are linked to forest clearing and subsequent management such as fire and grazing. Unlike the northern hemisphere's grasslands, South Africa's grassland is primary, and is the result of climatic conditions rather than anthropogenic actions (Bredenkamp *et al.* 2002).

During the early Cretaceous, when the fragmentation of Gondwana commenced, early angiosperms already evolved but were not prominent in the South African flora. The cycad-like Bennettitales, and to a lesser extent ferns, cycads and conifers dominated the flora. From the mid-Cretaceous, Africa was isolated from other Gondwana landmasses. The global climate was warm and angiosperms widespread and showed considerable diversity (Scott *et al.* 2003; Bredenkamp *et al.* 2002). The high latitudes of the southern hemisphere were dominated by broad-leaved angiosperm forests and a variety of conifers during the late Cretaceous (Anderson 2001).

During the Cenozoic (60-2 mya) the vegetation in southern Africa developed into the equivalent of modern day biomes (Scott *et al.* 2003). The Poaceae (grass-family) originated in the Eocene (50 mya), at the same time grazing herbivores appeared (Anderson 2001; Bredenkamp *et al.* 2002). Lower levels of nutrients and CO<sub>2</sub>, drought, high temperatures and adaptation to oxygen-poor, water-saturated habitats led to the evolution of the herbaceous and annual growth habit. These angiosperm ruderals and colonisers could successfully compete in these harsh environments. The Poaceae adapted through the presence of the intercalary meristem, a characteristic trait of the Poaceae, which provides resistance to loss of biomass through fire, herbivory or other environmental factors. Many species associated with grasslands are adapted to the same constraints by developing organs such as bulbs and rhizomes (Bredenkamp *et al.* 2002).

During the Eocene-Oligocene the Antarctic current developed, causing a major increase in the temperature gradient from the South Pole to the equator, and a massive decrease in temperatures at high southern latitudes. Also during this time, rainfall decreased and became seasonal and the Antarctic ice sheet developed (Anderson 2001; Bredenkamp *et al.* 2002; Scott *et al.* 2003). Woodland and scrub originated during the Eocene in the south-west of Africa, where dry sites were available and by the Oligocene grasslands became a widespread vegetation type in South Africa (Bredenkamp *et al.* 2002).

During the Neogene, major tectonic activity elevated the central Highveld of South Africa and formed the high-altitude mountains of the Great Escarpment in the east. This brought cooler and drier conditions to the region (Bredenkamp *et al.* 2002; Scott *et al.* 2003). The formation of the cold Benguela current brought cold water to the west coast of Africa increasing the drought to the west of the subcontinent. Anticyclones in the lower middle latitudes became stronger increasing dry climates in the area (Bredenkamp *et al.* 2002) and seasonality (Keeley & Rundel 2005). All these events and a decrease in atmospheric CO<sub>2</sub> levels caused selection for drought-resistant vegetation such as savanna and grassland at the expense of forest (Bredenkamp *et al.* 2002; Keeley & Rundel 2005). During this time, C<sub>4</sub> grasses expanded at the expense of trees and C<sub>3</sub> grasses (Cerling *et al.* 1997; Bredenkamp *et al.* 2002). C<sub>4</sub> photosynthesis is a variation of the typical C<sub>3</sub> photosynthesis. C<sub>4</sub> photosynthesis has a competitive advantage in environments with low CO<sub>2</sub> concentrations and high temperatures (Keeley & Rundel 2005; Cerling *et al.* 1997). Today, tropical and subtropical savannas and grasslands are dominated by C<sub>4</sub> grasses (Keeley & Rundel 2005) while C<sub>3</sub> grasses dominate the higher latitudes (Cerling *et al.* 1997).

During the Quaternary, the cycles of glacial and interglacial events influenced the evolution and position of plant communities and modern biomes of the southern hemisphere continents. Biome composition and boundaries shifted due to fluctuations in temperature, precipitation and seasonal distribution patterns of moisture. For example, Pleistocene pollen records from the Pretoria Salt Pan, Wonderkrater and Equus Cave indicate that grassy vegetation occupied a much greater area to the north during cooler episodes in the past. During the last glacial maximum (18 000 years ago) the large decrease in the CO<sub>2</sub>/O<sub>2</sub> ratio would have disadvantaged trees and shrubs due to increased respiration and physiological drought shifting the competitive advantage to C<sub>4</sub> grasses (Bredenkamp *et al.* 2002). This is confirmed by the hypothesis of Bond and Midgeley (2000) that increased CO<sub>2</sub> levels will have a positive effect on woody plant success and will favour tree thickening. Kerr (2001) calls attention to the fact that CO<sub>2</sub> levels cannot be the only reason for C<sub>4</sub> expansion as increasing aridity was just as important. The distribution of grasses in South Africa shows the geographic separation between C<sub>3</sub> and C<sub>4</sub> species. While C<sub>4</sub> species are abundant over most of the country (indicating higher temperatures), C<sub>3</sub> grasses are predominant in the winter rainfall region of the Western Cape and on the high altitude areas of the Drakensberg and other mountain ranges (indicating lower temperatures and more moisture) (Bredenkamp *et al.* 2002).

South African grasslands have a high level of endemic species as opposed to forest species, which indicates a long evolutionary history of the grasslands (Bredenkamp 1999) and cannot be accounted for by the hypothesis that South African grasslands are anthropogenically derived and maintained by fire.

### **3.4 Determinants of the grassland biome**

The extent of South African grasslands is limited by climatic factors and associated differences in topography, fire and grazing. Other biomes in South Africa can be distinguished from grassland based on the number of days with sufficient soil moisture for plant growth, the mean temperature of the days where soil temperature is sufficient for plant growth and the mean temperature of days too dry for plant growth (Rutherford & Westfall 1986). Based on these factors grassland can be distinguished from the Karoo by having a longer growing season with higher rainfall and higher temperatures during the non-growing season. Forest differs from grassland by receiving higher rainfall. Forests need more moisture and less radiation than grassland. In sheltered areas protected from fire, forest species may colonise the grassland. Islands of Fynbos occur in the grasslands of the eastern escarpment on nutrient-poor soils protected from fire; however fynbos predominantly occurs

in winter rainfall areas where grassland receives summer rainfall. A large portion of the grassland borders to the savanna biome and Ezemvelo Nature Reserve is located close to this boundary. Grassland tolerates a lower non-growing season temperature than savanna (O'Connor & Bredenkamp 2003; Bredenkamp 1999; Bredenkamp *et al.* 2002). Savanna species do not tolerate very low temperatures, such as those experienced during winter in the Grassland Biome area (Bredenkamp *et al.* 2002).

Many hypotheses exist regarding the absence of woody species in grasslands. Palynological and pedological data indicate that South African grasslands are not anthropogenically derived and maintained by fire. However, destruction of forest may produce grasslands, which are currently maintained by fire (O'Connor & Bredenkamp 2003). The high rainfall of the grassland biome produces a high fuel load for frequent and intense fires, which prevents species intolerant to fire from colonising. However, fire cannot be the factor excluding trees from grassland as the fire regime in the grassland and savanna biomes is similar and savanna trees are well-adapted to fire (Bredenkamp *et al.* 2002). However, the woody species of South African savanna are of tropical origin and are not adapted to cold temperatures and frost during the dry season (O'Connor & Bredenkamp 2003). In fact, Bredenkamp *et al.* (2002) state that there is no cold-adapted angiosperm or gymnosperm trees indigenous to South Africa. However, woodland patches do exist in the grassland biome and seem to be restricted to areas with differing topography such as ridges, hills and kloofs. This may be due to adiabatic cooling and temperature inversion on mountainsides. In conjunction with sheltering plants against cold temperatures, the shallow soil on steeper slopes reduces fuel loads and subsequently reduces the fire frequency and intensity. This prevents the mortality of seedlings of woody species, which are not tolerant to fire (O'Connor & Bredenkamp 2003). It is advocated that trees are absent in the southern African grasslands due to low temperatures and frost during the dry season (Bredenkamp *et al.* 2002). Therefore climate is the primary factor, with fire and topography secondary to contributing to the distribution of woody species in grassland (O'Connor & Bredenkamp 2003). In contrast to European grasslands, when South African grasslands are not managed it does not revert to forest or woodland (Bredenkamp *et al.* 2002).

Cold-resistant alien tree species such as *Pinus* sp. and *Eucalyptus camaldudensis* do well in the grassland biome (Bredenkamp *et al.* 2002). Few savanna trees are tolerant to the cold and dry conditions prevailing during the grassland biome's winter. These species that are adapted to colder conditions include *Acacia karroo*, *Cussonia paniculata*, *Diospyros lycioides*, *Euclea crispa* and *Rhus pyroides* (Bredenkamp *et al.* 2002).



### 3.5 Grassland composition

The grassland biome of South Africa can be divided into three major vegetation types. The eastern escarpment with a high altitude, high rainfall and low temperature, is covered by temperate Afro-alpine or Afro-montane grassland with a great proportion of C<sub>3</sub> species. The eastern and central plateau of South Africa of mid-altitudes has warmer temperatures and lower rainfall and is dominated by C<sub>4</sub> grasses. The western part of the country is warmer and drier and support open bunchgrass communities (Bredenkamp *et al.* 2002).

The grassland biome of South Africa is dominated by grass species although some woody species do occur on mountain slopes. *Themeda triandra* is the most dominant species and other prominent grass species include *Eragrostis curvula*, *Cymbopogon plurinodis* (= *C. pospischilii*), *Setaria sphacelata*, *Digitaria eriantha*, *Hyparrhenia hirta* and *Cynodon dactylon*. On mountain slopes *Trachypogon spicatus*, *Tristachya leucothrix*, *Panicum natalense*, *Schizachyrium sanguineum*, *Loudetia simplex*, *Monocymbium ceresiiforme*, *Alloteropsis semialata* and *Eulalia villosa* are prominent. All the above-mentioned species are present on Ezemvelo Nature Reserve. Karroid shrubs such as *Stoebe vulgaris* may become dominant at degraded and overgrazed sites. Sedges dominate the wetland areas (O'Connor & Bredenkamp 2003).

In the drier areas differences in geology, topography and land type influence plant community distribution (Bezuidenhout 1988), whereas in the wetter areas of this biome the position in the landscape determine the distribution of plant communities (Fuls *et al.* 1993). In general grasses growing in high rainfall areas are unpalatable (sour), tufted and reproduce by means of seed. In more arid areas the grasses are more palatable (sweet), flower later in the season and most of the tufted species reproduce vegetatively by means of rhizomes (O'Connor & Bredenkamp 2003).

Within the grassland biomes, sweet and sour grasses are recognised, based on their suitability for grazing. Sweet grasses occur on fertile soils and are preferred by animals. It has a high nutritional value throughout the year and a low fibre content. Sour grasses lose its nutritional value in the winter as it occurs on infertile soil. For this reason it is avoided by animals. Sweet veld occurs in the drier warmer areas with little rainfall. Sour veld occurs in the cooler, high-rainfall areas (>625 mm) of South Africa, where sour grasses are dominant. High rainfall leads to leaching of nutrient from the soil. During cold winters the nutrients are transported from the leaves to the underground parts of grasses, where they are stored until spring (Bredenkamp 1999; Low & Rebelo 1998).

### 3.6 Bankenveld/ Rocky Highveld Grassland

The vegetation of the Ezemvelo Nature Reserve and its surrounding area is transitional of the grassland of the high inland plateau and savanna of the low inland plateau (Figure 3.2). The area is characterised by rocky hills and ridges such as the Magaliesberg, Timeball Hill, Daspoort, Suikerbosrand and Witwatersrand. The soil is shallow and rocky. These rocky outcrops and surface rock gave the veld type its name Bankenveld or 'klipveld' (Louw 1951; Acocks 1988; O'Connor & Bredenkamp 2003) and Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1998). This vegetation type is located to the extreme north of the grassland biome in South Africa (Figure 3.2) and central to grassland to the south, Drakensberg to the east, savanna to the north and Kalahari to the west, and its species composition is representative of all these areas (Bredenkamp & Brown 2003). This vegetation type covers 24 063 km<sup>2</sup> (Bredenkamp & Van Rooyen 1998) of which only 0.8% is protected (Reyers *et al.* 2001). It mainly occurs at an altitude ranging from 1500 to 1600 m above sea level. Summer rain brings 650 to 750 mm rainfall per year and temperatures vary between –12°C and 39°C (Bredenkamp & Van Rooyen 1998).

The single common feature across the Bankenveld is shallow, leached, acid lithosols (Bredenkamp & Van Rooyen 1998). Deeper soils are limited and this veld type provides little grazing value as the high rainfall, frosty winters and regular burning renders this veld type particularly sour (Acocks 1988).

The great variety in topography and the resulting creation of a variety of microhabitats created by the rocky outcrops resulted in a large diversity of plant communities where no single species attain dominance (O'Connor & Bredenkamp 2003). Bredenkamp and Brown (2003) noted that Bankenveld vegetation consists of a mosaic of grassland and woodland communities controlled by microclimatic conditions that exist in the topographically heterogeneous landscape. Woodland communities occur in warm sheltered valleys and slopes, whereas grasslands occur on the cold, exposed plateaus and plains. Several studies suggest that a close affinity exist between certain grassland and woodland communities, especially if they exist on the same substrate (Bredenkamp 1975; Coetzee, 1993; Grobler 2000). The woody species, of sour bushveld affinity, that occur on the ridges and hills led Acocks (1988) to believe it is a 'false grassveld' where the climax of this veld type was open *Acacia caffra* savanna. He advocated that if fire was excluded from this grassland type it would develop into savanna. This statement is rejected by Coetzee (1993), O'Connor & Bredenkamp (2003), Bredenkamp (1999) and Bredenkamp & Brown (2003) as there is no

difference in the fire regimes between the grassland and savanna and it is rather the colder climate with frost during the non-growing season that exclude the woody species. The woodland communities occur on warmer locations such as sheltered valleys, kloofs and on slopes. Woody species are often associated with rocky areas where they are better protected against harsh conditions such as fire and frost (Bredenkamp and Brown 2003). The woody species show affinity to the Sour Bushveld and Sourish Mixed Bushveld described by Acocks (1988) when comparing it to species from communities in the Bushveld described by Theron (1973), Coetzee *et al.* (1976), Van der Meulen (1979), Van Rooyen (1983) and Westfall *et al.* (1985). Research suggest that the vegetation of the Bankenveld often changed in the past, ranging from savanna during warm interglacial phases to cool open grassland during glacial maxima. Wetter phases also provided the opportunity for the establishment of forests (Bredenkamp & Brown 2003).

The Bankenveld is related to the other grassland veld types described by Acocks (1988) (Bezuidenhout 1993; Coetzee 1993). The grass species of this vegetation type are also related to the Drakensberg flora (O'Connor & Bredenkamp 2003; Bredenkamp & Brown 2003) and the Kalahari Thornveld (Bredenkamp & Brown 2003).

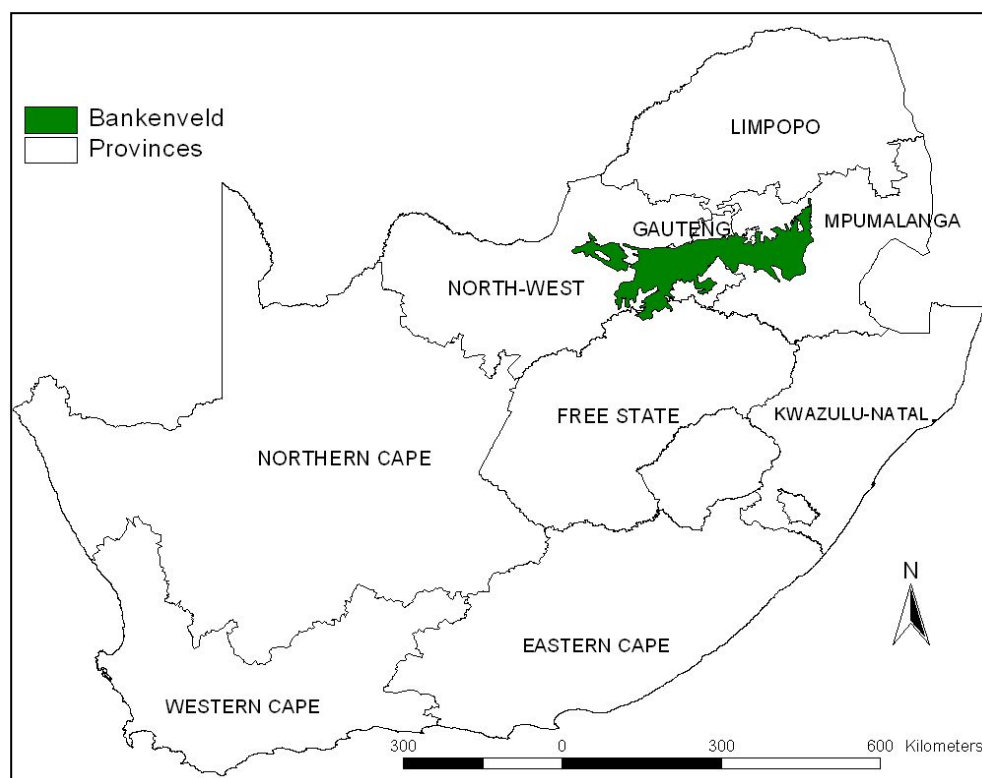


Figure 3.2. Location of Bankenveld in South Africa.

Bredenkamp & Brown (2003) identified six major physiognomic types in the Bankenveld, all of which do occur on Ezemvelo Nature Reserve:

1. Mixed, Short Grassland on flat to slightly undulating plains, rounded summits or in broad, shallow, alluvial valleys.
2. Tall Grassland occurs on well-drained, nutrient poor soils, or areas with strong human influence.
3. Cool Temperate Bushveld is situated on the cooler south-facing slopes of hills and ridges or on high-altitude areas.
4. Warm Temperate Bushveld occurring on warm north-facing slopes of hills and ridges, especially in the transition area to the savanna biome.
5. Temperate Microphyllous Bushveld on clayey deeper soils along river banks, on alluvial valley floors or at the foot of slopes on deeper colluvial soils.
6. Temperate Forest occurring along streams in deep sheltered kloofs and valleys.

### **3.7 Conclusion**

South Africa's grasslands are very diverse with many rare and endemic species, habitats and vegetation types. South African grasslands are primary and not anthropogenically derived. It originated in the Neogene due to increasing aridity and temperatures and lower CO<sub>2</sub> levels. Climate is the main determinant of the boundaries of the grassland biome with fire, topography and grazing playing a secondary role. Trees are absent from the grassland biome primarily because South African trees are from a tropical origin and are not adapted to cold and frost. Woody species do occur in warmer, sheltered valleys and ridges. The vegetation of the Bankenveld/Rocky Highveld Grassland is transitional between the grassland biome to the savanna. It consists of a mosaic of grassland and woodland communities based on their habitat preferences. Due to the diverse variety of species, plant communities and available habitat, this vegetation type should be conserved. The Ezemvelo Nature Reserve contains many elements of the Bankenveld, including a complex topography resulting in a great variety of habitats and plant communities.

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## 4 METHODOLOGY

### 4.1 Introduction

A plant community consists of a combination of plant species associated with each other and is restricted to a particular physical environment determined by climate, sunlight (energy), nutrients in the soil, geology, geomorphology and water availability for plants (Kent & Coker 2000; Bredenkamp 2001). Each plant community is unique in terms of plant species composition and their relative abundance (Bredenkamp 2001). Plant communities can be distinct, easily separable units or plant communities can occur in gradients as a result of continuity in environmental factors (Bredenkamp & Brown 2001).

A vegetation type or plant community can be seen as an area in which the climate, landscape, soil and plant species composition are homogeneous to such a degree that it has the same grazing and browsing value and potential for plant biomass production (Van Rooyen 2002). The vegetation and its abiotic environment form the habitat for animals and specific combinations of the plant species will determine the presence of specific animals. Vegetation is an easily recognisable expression of the ecology and the series of interactions and relationships among organisms and their environment and can be seen as the physical representation of the ecosystem (Bredenkamp 2001). Therefore it is important to know the vegetation before any conservation planning can be done. Because each plant community has its own floristic composition, physiognomy and habitat conditions, each community should be managed differently, as the different communities react differently to environmental conditions and utilisation by animals. For sound management purposes it is imperative to distinguish between the different plant communities, as each will need separate management (Bredenkamp & Brown 2001).

This is the reason a plant community approach has been chosen as the preferred method for this study.

### 4.2 Background Information

The distribution of plant communities is closely related to environmental conditions (Daubenmire 1968; Gauch 1982). To understand the distribution of plant communities, it is inevitable to consider the environmental variables such as geology, topography and climate.

Aerial photographs were obtained from the Chief Directorate: Surveys and Mapping of the Department of Land Affairs. The most recent photographs (2003) on a scale of 1:50 000 were used. The photos were scanned and georeferenced in ArcGIS Version 9. The geology was described making use of the 1:125 000 geological map sheets of 2528D Bronkhorstspuit and 2529C Witbank (Geological Survey of South Africa 1961). Climatic data was obtained from the South African Weather Bureau. The land type maps of 2526 Rustenburg and 2528 Pretoria were used to distinguish the land types of the study area. A land type is an area which is uniform with respect to terrain form, soil pattern and climate (Land Type Survey Staff 1987).

### **4.3 Classification and Ordination**

Two broad types of data analysis are used for the analysis of vegetation data, namely classification and ordination. Classification is based on the Clementsian view that plant communities are clearly recognisable and definable entities, which repeat themselves over a given region of the earth. In classification it is assumed that there are distinct communities present at a site and that each of these communities will be clearly defined in the phytosociological table. The aim of classification is to group together a set of individuals (quadrats or vegetation samples) on the basis of their attributes (their floristic composition). The end product should be a set of groups derived from the individuals where every individual within a specific group is more similar to other individuals in that group than to any individuals in any other group (Kent & Coker 2000). Ordination follows Gleason's viewpoint that the distributions of plant species change gradually along an abiotic gradient, such as soil moisture. The ordination arranges the vegetation samples in relation to each other, in terms of their similarity in species composition and their associated environmental conditions (Kent & Coker 2000). Present-day viewpoints see vegetation as a complex mosaic of continuity and discontinuity. Methods for classification and ordination are techniques for data reduction and data exploration. They are used to look for a pattern and order in a set of data. Classification and ordination are not antagonistic and incompatible data processing techniques. Ordination and classification can be performed on the same data set (Kent & Coker 2000). The data analysis in this study includes both classification and ordination of the vegetation data.

### **4.4 Data Collection**

#### **Distribution, number and size of sample plots**

Ezemvelo Nature Reserve was stratified into relatively homogeneous vegetation units and habitat units on the basis of physiography and physiognomy using aerial photographs and

ground surveys. Sample plots were placed in each of the identified habitat units. The location of these plots was chosen visually and subjectively to ensure that it gives a representative view of the plant species and abundance in that unit. The plot must be in a homogenous unit regarding floristic composition, plant structure and habitat. Ecotones and obvious habitat and vegetation heterogeneity were avoided, as homogeneous vegetation is a prerequisite for sample plot location according to Braun-Blanquet (Werger 1974). A vegetation and habitat survey was conducted in each of these identified units. The vegetation surveys were conducted according to the Braun-Blanquet vegetation sampling method (Werger 1974).

The number of sample plots in a given area depends on the scale of the survey, heterogeneity of the area and the accuracy required for the classification of the data (Bredenkamp 1982). The number of sample plots in each identified habitat unit depended on the size of the unit. The number of plots was chosen to ensure that the unit was equally represented with the other units. A total of 210 plots were surveyed. The size of each plot depended on the habitat unit. In grassland and bushveld koppies the size of the plots were approximately 200 m<sup>2</sup> (10x20 m) and in wetland areas 4 m<sup>2</sup> (2x2 m). These are the generally recognised plot sizes for these vegetation types in South Africa.

### **Sampling Method**

The Zürich-Montpellier or Braun-Blanquet approach to the study of vegetation has proved to be an efficient and reliable method for vegetation survey and classification (Werger 1974). It is commonly used in South Africa and has been applied with great success specifically in the Grassland Biome (Bezuidenhout 1988; Bredenkamp 1975; Eckhardt 1993; Kooij 1990; Perkins 1997). The Braun-Blanquet method (Westhoff & Van der Maarel 1973; Mueller-Dombois & Ellenberg 1974; Werger 1974) was used as the sampling technique in this study.

Data collection took place between January 2005 and May 2005, as well as between January 2006 and March 2006. A list of observations of a sample plot with all its floristic and associated environmental data is called a relevé (Eckhardt 1993).

Data collected includes:

- A general impression of the habitat. This will give an indication of the abiotic characteristics of the plot, which can later help in describing the plant communities. Vegetation is dependent on its physical habitat (Daubenmire 1968; Gauch 1982). These include the following:
  - Geology

- Rockiness in percentage
- Soil characteristics
- Aspect (N, NE, E, SE, S, SW, W, NW)
- Gradient in degrees
- GPS points for location of the plot on a map.
- Other characteristics of note in the plot were also recorded such as erosion, trampling, disturbance, animal activities, invasion by alien species and any other notable characteristics.
- A floristic survey of all the plant species and their Braun-Blanquet cover abundance were noted in each sample plot. The following Braun-Blanquet cover abundance scale were used (Mueller-Dombois & Ellenberg 1974):
  - r – one individual with a very small cover
  - + – 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 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
- A quantitative point survey of the grass layer was carried out to determine the frequency of the grass species and other relevant herbaceous species.
- A photograph was taken for visual representation of the vegetation.

### **Species Identification**

All the species on the Reserve were identified as far as possible. The plant species were identified in the veld or at the H.G.W.J. Schweickerdt Herbarium at the University of Pretoria. Various references were consulted including Van Wyk & Malan (1997), Van Wyk & Van Wyk (1997), Pooley (1998) and Van Oudtshoorn (2002). The names of the taxa are in accordance with Germishuizen & Meyer (2003).

## **4.5 Data Analysis**

### **4.5.1 Classification**

The floristic data from each sample plot were captured in the vegetation database, TURBOVEG for Windows (Hennekens 1996a; Hennekens & Schaminee 2001). The database was exported as a Cornell Condensed Species File (CC-file) into a working directory in MEGATAB (Hennekens 1996b). MEGATAB is a DOS based programme used to

analyse vegetation data and compile the floristic table. One of the classification methods, the Two-Way Indicator Species Analysis (TWINSpan) uses an ordination method, Correspondence Analysis (CA), as the basis on the classification methods (Hill 1979a). The groups of samples are split based on the results of a CA. Each of these groups is then split repeatedly up to a significant level (community or sub-community level). This method was applied to the dataset. The TWINSpan table was refined by Braun-Blanquet procedures as described in Werger (1974) and Kent & Coker (2000). The final phytosociological table indicates the different identified plant communities. A dendrogram (phylogenetic tree) was drawn to illustrate the hierarchical levels of this classification. The phytosociological table was divided into three separate tables to give a more accurate and easily representable analysis of the plant communities. A synoptic table was compiled for all the communities to indicate their relationships which cannot be recognised from the three separate tables. The entries in the synoptic table represent the constancy of the species in each community. In the table the entries represent the constancy of the species as follows:

- 1: 1 – 20%
- 2: 21 – 40 %
- 3: 41 – 60%
- 4: 61 – 80%
- 5: 81 – 100%

All entries indicating a constancy less than 20% have been omitted from the table.

#### **4.5.2 Ordination**

A Detrended Correspondence Analysis (DECORANA) ordination (Hill 1979b) were conducted on the data set, using the ordination programme PCOrd (McCune & Mefford 1999), to confirm the identification of plant communities and to illustrate the gradients between the different communities.

#### **4.6 Describing Communities**

The communities with their sub-communities were then described in terms of distribution, broad habitat, diagnostic species, species with significant indicator value and dominant species. The plant community names are based on the representative and diagnostic species and dominant species of each community. The species names are followed by a physiognomic term to describe the general vegetation of the plant community.

The results are given in three chapters, Chapter 5 for the woodland communities, Chapter 6 for the grassland communities and Chapter 7 for the wetland communities. Following the results of the classification, the plant communities are numbered sequential, Communities 1-7 in Chapter 5, Communities 8-12 in Chapter 6 and Communities 13-22 in Chapter 7. A synoptic table and various ordinations are presented as a discussion of the results in Chapter 8.

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## 5 DESCRIPTION OF THE WOODLAND COMMUNITIES

This chapter consists of a description of all the rocky and woodland communities on Ezemvelo Nature Reserve. These communities are different from the other communities on the Reserve on account of their rocky habitat or woody nature.

### 5.1 Classification

The vegetation data was classified using TWINSpan, as discussed in Chapter 4 to produce a first approximation of the plant communities. The large phytosociological table was divided into three separate tables to give a more accurate and easily representable analysis of the plant communities. Seven communities have been identified, represented by 64 relevés. One of these communities consists of two sub-communities. The communities and their species composition are shown in a phytosociological table (Table 5.1).

The communities are:

1. *Frithia humulis* – *Microchloa caffra* Community on Quartz.
2. *Populus X canescens* Dense Woodland.
3. *Combretum erythrophyllum* – *Panicum maximum* Riverine Woodland.
4. *Acacia caffra* – *Celtis africana* Bush Clumps.
5. *Heteropyxis natalensis* – *Pteridium aquilinum* Sheltered Woodland.
6. *Burkea africana* – *Ochna pulchra* – *Croton gratissimus* North-facing Slope Woodland.
7. *Loudetia simplex* – *Diheteropogon amplexans* Rocky Open Shrubland.
  - 7.1 *Loudetia simplex* – *Diheteropogon amplexans* Rocky Highveld Grassland.
  - 7.2 *Loudetia simplex* – *Protea caffra* South-facing Open Shrubland.

### 5.2 Description of plant communities

General woodland vegetation on the Reserve is characterised by the trees *Croton gratissimus* and *Heteropyxis natalensis*, the shrubs *Englerophytum magalismsontanum* and grasses such as *Setaria lindenbergiana*, *Loudetia simplex* and *Diheteropogon amplexans*. Along the rivers and on the foot of slopes *Combretum erythrophyllum*, *Panicum maximum*, *Acacia caffra* and *Celtis africana* are prominent. On the north-facing slopes *Burkea africana*, *Ochna pulchra* and *Elephantorrhiza burkei* becomes prominent.

Table 5.1. Phytosociological table of the rocky and woodland communities on Ezemvelo Nature Reserve.











### **1. *Frithia humulis*–*Microchloa caffra* Community on Quartz.**

This very sparse and rare plant community is represented by six relevés and is situated on the Ecca Shales on the Reserve. It is restricted to the extremely shallow (not deeper than one to two centimetres), gravelly quartz soils found on the rock sheets that occur on the plateau of the koppie on the western border of the study area. The vegetation occurs in small patches between the quartz gravel on rock sheets (Figure 5.1) and the cover abundance is low. No woody species occur in this community.



Figure 5.1. *Frithia humulis* between the quartz gravel.

This community is characterised by species group A (Table 5.1). The dominant and diagnostic species is *Frithia humulis*, with *Crassula schimperii* and *Microchloa caffra* also diagnostic. Other species that may be present are *Selaginella dregei*, *Cyperus rupestris* and *Sporobolus spicatus*, all lithophytic species.

The *Frithia humulis* – *Microchloa caffra* plant community does not have a high species diversity. However, *Frithia humulis* is a Red Data plant species and this community is therefore very important for conservation.

### **2. *Populus X canescens* Dense Woodland.**

This *Populus X canescens*–dominated community is represented by only two relevés only. It occurs on the dark organic soil on the banks of the Wilge River and its tributaries.

The alien invasive *Populus X canescens* is the dominant species and it forms dense monostands in the shallow streams and wetlands of the Reserve (Figure 5.2), where it

encroaches into the surrounding indigenous vegetation and replaces it completely. Few other species may be present as single individuals, for example the grass *Panicum maximum* and weedy species such as *Achyranthes aspera*, *Tagetes minuta*, *Bidens pilosa*, *Verbena bonariensis* and *Conyza albida*. Relicts of the *Combretum erythrophyllum*-*Panicum maximum* Riverine Woodland (Community 3) may still be present, for example *Gymnosporia buxifolia* and *Diospyros lycioides* in relevé 145 (species group C, Table 5.1).



Figure 5.2. A dense stand of *Populus X canescens* in a tributary of the Wilge River, as seen from the outside.

*Populus X canescens* is an alien plant species found throughout South Africa on riverbanks and in wetlands, where it forms dense stands and spreads into surrounding vegetation (Henderson 2001). It is declared as a Category 2 invader species by the Conservation of Agricultural Resources Act (Act No 43 of 1983). Regulation 15 of this Act provides for Category 2 plants to be retained in areas demarcated for that purpose. However, any plants occurring outside the demarcated areas have to be controlled.

### **3. *Combretum erythrophyllum*–*Panicum maximum* Riverine Woodland.**

This forest-like riverine community occurs along the Wilge River on the Reserve (Figure 5.3). It is represented by five relevés. The substrate is the deep, dark organic soil on the banks of the Wilge River.



Figure 5.3. The *Combretum erythrophyllum*–*Panicum maximum* Riverine Woodland community on the banks of the Wilge River.

Species group C (Table 5.1) is characteristic of this community. The diagnostic species include the trees and shrubs *Combretum erythrophyllum*, *Gymnosporia buxifolia* and *Diospyros lycioides*, the grass *Panicum maximum* and the weed *Achyranthes aspera*. Another diagnostic species is the reed *Phragmites australis*.

The dominant woody species include *Combretum erythrophyllum*, *Gymnosporia buxifolia*, *Diospyros lycioides* and *Ziziphus mucronata*. Alien encroacher species such as *Melia azedarach* and *Acacia mearnsii* are often found in the riverine vegetation. The grass *Panicum maximum* is commonly found in the herbaceous layer. As the riverine vegetation is often disturbed by flooding, weeds are commonly present, such as *Achyranthes aspera*, *Tagetes minuta* and *Conyza alba*.

Most of the riparian vegetation along the larger rivers in the Bankenveld can be classified as *Combretum erythrophyllum* Riparian Forest (Bredenkamp & Brown 2003). Alien invaders such as *Populus* species, *Acacia mearnsii* and *Melia azedarach* are often present along these river systems. The dense woody layer and regular disturbances along rivers resulted in a poorly developed herbaceous layer.

Examples of this vegetation were described from the Magaliesberg area by Coetzee (1975), from the Witwatersrand area by Behr & Bredenkamp (1988) and from the Johannesburg Northern Metropolitan area by Bredenkamp & Brown (1998b).

#### **4. *Acacia caffra*–*Celtis africana* Bush Clumps on Foot of Slope.**

Within the Reserve, bush clumps often occur on deep organic loamy soil, on the foot of north-facing slopes with a gradient of 3° to 18° (Figure 5.4). Many areas of this community show signs of disturbance, due to its close proximity to the camping area and roads on the Reserve (Figure 5.5). This community is represented by four relevés and is characterised by species group D (Table 5.1).



Figure 5.4. The *Acacia caffra*–*Celtis africana* Bush Clumps.

The tall trees *Acacia caffra* and *Celtis africana* are diagnostic and dominant, while the shrubby *Isoglossa grantii* is also diagnostic. The woody species *Ziziphus mucronata*, *Euclea crispa*, *Gymnosporia buxifolia*, *Rhus leptodictya* are often present in this community. Commonly occurring grasses in the community include *Setaria lindenbergiana* and *Eragrostis curvula*. The weeds *Achyranthes aspera*, *Lantana camara*, *Tagetes minuta*, *Zinnia peruviana* and *Bidens pilosa* (species group I, Table 5.1) occur regularly in the herbaceous layer.



Figure 5.5. The undergrowth beneath the *Acacia caffra*–*Celtis africana* Bush clumps. Note the presence of the weeds *Tagetes minuta*, *Solanum eleagnifolium* and *Achyranthes aspera*.

This type of vegetation is classified as the *Setaria lindenbergiana* – *Acacia caffra* Mountain Bushveld by Bredenkamp & Brown (2003). Coetzee (1993) named it the *Acacia caffra* – *Euclea crispa* Woodland of Sub-humid Cool Temperate Mountain Bushveld. The woody species are often grouped into bush clumps which occur on steep slopes of outcrops, hills and ridges with shallow and rocky soils (Bredenkamp & Brown 2003).

This community shows some similarity to the *Acacia caffra* – *Eragrostis chloromelas* Open Woodland that Smit *et al.* (1997) described from the Witbank Nature Reserve. Descriptions of this community are given by Bezuidenhout *et al.* (1988) from the Vredefort Dome area, Bezuidenhout & Bredenkamp (1991) from the North-West Province grasslands and Grobler *et al.* (2002a) from the Johannesburg-Pretoria area. Particularly good examples are provided by Coetzee (1975) from the Rustenburg Nature Reserve, Bezuidenhout *et al.* (1994a) from the slopes of the hills and ridges (Fb land type) in the North-West Province, and by Coetzee *et al.* (1995) from the Magaliesberg in the Pretoria area.

##### **5. *Heteropyxis natalensis* –*Pteridium aquilinum* Sheltered Woodland.**

This community occurs in the moist, sheltered kloofs and slopes of the Reserve. It is present along the Wilge River in the narrow gorge which is also the location of the Penduka hiking trail, and other sheltered areas (Figure 5.6). The environmental conditions are cooler, moister and more sheltered than the other rocky communities on the Reserve (Figure 5.7). The soil is

shallow, though with a high organic content. The substrate is very rocky with the average rockiness being 66%. The large rock boulders provide refuge and shelter for plants. This community is represented by 13 relevés.



Figure 5.6. The narrow gorge along the Wilge River on the south of the Reserve.



Figure 5.7. *Heteropyxis natalensis* –*Pteridium aquilinum* Sheltered Woodland at a small tributary to the Wilge River in the kloof of the Penduka trail.

This community is characterised by the presence of species group F (Table 1). The diagnostic species include the woody species *Brachylaena rotundata*, *Combretum apiculatum*, *Diospyros whyteana*, *Nuxia congesta* and *Apodytes dimidiata* and also the liana *Rhoicissus tridentata*. Diagnostic herbaceous species include the fern *Pteridium aquilinum*, the sedges *Cyperus esculentus* and *Cyperus sphaerospermus* and the succulent *Crassula setulosa* which grows in the drier rock crevices. Other prominent tree species in this community are *Heteropyxis natalensis*, *Rhus leptodictya*, *Croton gratissimus* and *Englerophytum magalismontanum*. Prominent herbaceous species include the grasses *Setaria lindenbergiana* and *Eragrostis gummiflua*, as well as the fern *Pteridium aquilinum* which is dominant in some stands of this community.

The *Heteropyxis natalensis*–*Pteridium aquilinum* Sheltered Woodland community of Ezemvelo Nature Reserve has floristic similarity with the *Coleochloa setifera*–*Cheilanthes hirta* Open Shrubland as described by Coetzee (1993). It occurs on steep south-facing rocky slopes where drainage lines or seepages increase the amount of water available to the vegetation.

#### **6. *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland.**

This woodland community is situated on the warmer northern slopes of the Reserve (Figure 5.8). The soil is shallow and rocky with the average rockiness 44%, ranging between 20% and 80%. The slope ranges from 2° to 20°, with an average of 12°. This community is represented by 18 relevés.

The *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland community is characterised by species group G where many diagnostic species were identified. These include the woody *Burkea africana*, *Ochna pulchra*, *Gymnosporia tenuispina*, *Diplorhynchus condylocarpon*, *Strychnos pungens*, *Ozoroa paniculosa*, *Cryptolepis oblongifolia*, *Ficus ingens*, *Morella serrata* and *Dovyalis caffra*. Diagnostic grasses are *Enneapogon scoparius*, *Melinis repens*, *Eragrostis chloromelas* and *Sporobolus africanus*. Diagnostic forbs include the succulents *Kalanchoe paniculata* and *Crassula swaziensis*, the geophyte *Ledebouria* species and the herbaceous *Pavonia transvaalensis*, *Hibiscus aethiopicus*, *Pollichia campestris*, *Cryptolepis oblongifolia* and the weed *Solanum incanum*.



Figure 5.8. *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland.

*Burkea africana*, *Ochna pulchra*, *Croton gratissimus*, *Combretum molle*, *Elephantorrhiza burkei* and *Englerophytum magalismontanum* are prominent trees in this community. *Enneapogon scoparius*, *Setaria lindenbergiana*, *Loudetia simplex*, *Diheteropogon amplectens* and *Aristida transvaalensis* are prominent grass species. Conspicuous herbaceous species include *Bulbostylis hispidula*, *Pellaea calomelanos* and *Stylochiton natalensis*. Weeds such as *Tagetes minuta*, *Lantana camara*, *Zinnia peruviana* and *Bidens pilosa* are often present. Representatives of species groups H, I, N and O (Table 5.1) also commonly occur in this community.

Bredenkamp and Brown (2003) classified this type of vegetation as *Ochna pulchra*–*Englerophytum magalismontanum* Warm Temperate Mountain Bushveld. Coetzee (1993) described a similar community as *Burkea africana*–*Ochna pulchra* Woodland of Sub-humid Warm Temperate Mountain Bushveld. It occurs on the warm northern slopes in the northern part of the Bankenveld and represents a transition from grassland to the savanna biome. The woody layer is well developed, whereas the herbaceous layer has a low cover.

Examples of this vegetation were described from the scarps and slopes of the Jack Scott and Rustenburg Nature Reserves by Coetzee (1974; 1975), from the Suikerbosrand Nature Reserve by Bredenkamp & Theron (1978), the Warm Temperate Mountain Bushveld within the Pretoria-Witbank-Heidelberg areas by Coetzee (1993), Melville Koppies Nature Reserve



by Ellery (1994), from the natural areas of the western local Metropolitan Council of Gauteng by Bredenkamp & Brown (1998a) and within various natural urban open spaces in Gauteng by Grobler *et al.* (2002).

### **7. *Loudetia simplex*–*Diheteropogon amplexans* Rocky Open Shrubland.**

This shrubland community occurs mostly on rocky south-facing slopes of the Reserve. It consists of two sub-communities:

7.1 *Loudetia simplex*–*Diheteropogon amplexans* Rocky Highveld Grassland.

7.2 *Loudetia simplex*–*Protea caffra* South-facing Open Shrubland.

Species group J (Table 1) is characteristic of this community. Several diagnostic species were identified. These include the grasses *Trachypogon spicatus*, *Melinis nerviglumis*, *Cymbopogon excavatus*, *Themeda triandra*, *Panicum natalense* and *Tristachya biseriata*, all typical of Bankenveld (Bredenkamp and Brown 2003). *Rhus magalismsontana* and the geoxylphyte *Parinari capensis* are also diagnostic, as well as the forbs *Xerophyta retinervis*, *Selaginella dregei*, *Indigofera comosa*, *Senecio venosus*, *Senecio oxyriifolius*, *Rhynchosia monophylla* and *Hypoxis rigidula*.

Grasses dominate this community, including *Loudetia simplex*, *Diheteropogon amplexans*, *Trachypogon spicatus*, and *Melinis nerviglumis*. Dominant herbaceous species include *Xerophyta retinervis* and *Selaginella dregei*. Prominent woody species include *Protea caffra*, *Rhus magalismsontana*, *Elephantorrhiza burkei*, *Mundulea sericea*, *Heteropyxis natalensis* and *Englerophytum magalismsontanum*.

Acocks (1988) classified this as a false grassveld type belonging to the central variation of the Bankenveld, while Werger & Coetzee (1978) classified it as Upland (Temperate) Sub-humid Mountain Bushveld. Many authors described this vegetation, including Coetzee (1974, 1975) from the Magaliesberg area, Bredenkamp & Theron (1978) from the Suikerbosrand, Behr & Bredenkamp (1988), from the Witwatersrand, Bezuidenhout *et al.* (1994b) from the Gatsrand area in North-West Province, Coetzee (1993) and Coetzee *et al.* (1995) and Bredenkamp & Brown (1998a,b) from the natural areas of the Northern and Western Metropolitan Local Council and Grobler *et al.* (2002 and 2006) within various natural open spaces in Gauteng. Bredenkamp and Brown (2003) described it as *Tristachya biseriata*–*Protea caffra* Cool Temperate Mountain Bushveld occurring on south-facing slopes throughout the Bankenveld.

### **7.1. *Loudetia simplex*–*Diheteropogon amplexens* Rocky Highveld Grassland.**

This sub-community occurs on the extended rock sheets on the slopes of the Reserve. The slope ranges from 3° to 6° and are less steep than those of the *Loudetia simplex*–*Protea caffra* South-facing Open Shrubland (sub-community 7.2). Rockiness ranges from 45% to 70%. This sub-community differs from sub-community 7.2 due to the presence of the diagnostic species group K and the absence of species group L. This sub-community is represented by six relevés.

Diagnostic species of this sub-community include the grasses *Sporobolus pectinatus*, *Elionurus muticus*, *Eragrostis nindensis* and *Brachiaria serrata*, and the forbs *Fadogia homblei*, *Zornia milneana*, *Mariscus congestus* and *Cyperus rupestris*. This sub-community is dominated by the grasses *Loudetia simplex* and *Diheteropogon amplexens*. Other prominent species include *Xerophyta retinervis* and *Englerophytum magalismsontanum*.

### **7.2 *Loudetia simplex*–*Protea caffra* South-facing Open Shrubland.**

This sub-community occurs on the south-facing slopes on the ridges of the Reserve. The soil is shallow and many rocks occur, with an average rockiness of 54%. It is situated on steeper slopes than the *Loudetia simplex*–*Diheteropogon amplexens* Rocky Highveld Grassland, which may account for the difference in species composition. Rocks and boulders provide protection for the seeds to germinate (Perkins 1997). This may be the reason for the absence of *Protea caffra* in the *Loudetia simplex*–*Diheteropogon amplexens* Rocky Highveld Grassland.



Figure 5.9. *Loudetia simplex* – *Protea caffra* South-facing Open Shrubland.

Species group L is characteristic of this sub-community. The diagnostic species are the woody *Protea caffra*, the grass *Cymbopogon nardus* = (*C. validus*), the forbs *Helichrysum setosum*, *Plectranthus madagascariensis* and *Stachys natalensis*, as well as the geophyte *Haemanthus humilis*. Prominent woody species include *Protea caffra*, *Elephantorrhiza burkei*, *Heteropyxis natalensis* and *Englerophytum magalismsontanum*. Dominant grass species occurring in this sub-community are *Loudetia simplex* and *Diheteropogon amplectens*.

The *Loudetia simplex-Protea caffra* South-facing Open Shrubland sub-community shows similarities with the *Protea caffra-Protea roupelliae-Themeda triandra* Open Savanna community found on the stony slopes of the Kwazulu-Natal Drakensberg foothills and spurs (Perkins 1997). It also corresponds to the *Protea caffra-Athrixia elata* Open Woodland as described by Coetzee (1993).

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## 6 DESCRIPTION OF GRASSLAND COMMUNITIES

This chapter discusses and describes the grassland communities of the Ezemvelo Nature Reserve.

### 6.1 Classification

Through the use of TWINSpan in the computer programme MEGATAB, 110 relevés from the collected 210 relevés, were classified as grassland. The results are shown in a phytosociological table (Table 6.1).

The floristic analysis revealed five major grassland communities and two sub-communities (8.1 and 8.2). The classification of these communities are:

8. *Loudetia simplex*–*Trachypogon spicatus* Rocky Highveld Grassland Major Community.
  - 8.1 *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland.
  - 8.2. *Loudetia simplex*–*Elionurus muticus* Mixed Grassland.
9. *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland.
10. *Burkea africana*–*Eragrostis curvula* Bush Clumps.
11. *Eragrostis curvula*–*Eragrostis plana* Moist Degraded Grassland.
12. *Acacia dealbata* Riverine Woodland.

### 6.2 Description of plant communities

The most abundant and conspicuous grass species throughout the Reserve are *Eragrostis curvula*, *Setaria sphacelata* and *Elionurus muticus*. *Themeda triandra* and *Eragrostis gummiiflua* are also present. Although situated within the Bankenveld some of these grasslands, especially those on deeper soils without rocks are rather representative of the *Cymbopogon-Themeda* Veld Type (Acocks 1988), and especially the *Hyparrhenia hirta* Anthropogenic Grassland (Bredenkamp & Brown 2003). The grassland on rocky areas within this region represents the Bankenveld (Acocks 1988) or Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1998).





Table 6.1. Phytosociological Table of the Grasslands on Ezemvelo Nature Reserve.





## **8. *Loudetia simplex*–*Trachypogon spicatus* Rocky Highveld Grassland Major Community.**

This community occurs on the rocky outcrops and rock sheets of Ezemvelo Nature Reserve, and represents typical Bankenveld (Acocks 1988) or Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1998). The soil is shallow and gravelly.

This vegetation is characterised by species group A (Table 6.1) and the diagnostic species are the typical Rocky Highveld Grassland grass species *Loudetia simplex*, *Trachypogon spicatus*, *Diheteropogon amplexans*, *Bewisia biflora*, *Tristachya biseriata*, *Melinis nerviglumis*, *Digitaria monodactyla* and *Urelytrum agropyroides*. The forbs *Chaetacanthus burchellii*, *Chlorophytum fasciculatum*, *Crinum graminicola*, *Pentanisia angustifolia*, *Xerophyta retinervis* and *Parinari capensis* are also diagnostic species.

This grassland community is classified as Moist Cool-temperate Grassland by Werger & Coetzee (1978). This community is comparable to the *Monocymbium ceresiiforme*–*Loudetia simplex* Grassland described by Bredenkamp and Brown (2003). Coetzee (1993) described a similar community as the *Bewisia biflora* – *Digitaria brazzae* Grassland (Moist Cool Temperate Grassland). Further examples of this grassland type were described by Coetzee (1974) from the Jack Scott Nature Reserve, Coetzee (1975) from the Rustenburg Nature Reserve, Bredenkamp & Theron (1978) from the grasslands of the Suikerbosrand Nature Reserve, Bezuidenhout *et al.* (1994) from the grasslands of the North-West Province, Grobler *et al.* (2002) from the urban open space areas of Gauteng and Myburgh (1993) from the high altitude areas in the eastern Bankenveld of Mpumalanga.

### **8.1 *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland**

This sub-community is represented by 13 relevés. This vegetation is dominated by grasses with a few shrubby woody species (Figure 6.1). *Protea caffra* is the only woody species that attains a tree-like nature (Figure 6.2). This is a mixed short grassland found on the rocky midslopes of ridges. The soils are shallow with a high rock cover.

Species group B is characteristic of this sub-community, while species from species groups A, F and J (Table 6.1) are strongly represented. Several diagnostic species were identified for this sub-community. Diagnostic woody species include *Protea caffra*, *Vangueria infausta*, *Englerophytum magalismontanum*, *Protea welwitschii*, *Rhus magalismontana*, *Ancylobotrys capensis* and *Lopholaena coriifolia*. Diagnostic grasses are *Sporobolus pectinatus*, *Sporobolus festivus* and *Microchloa caffra*, while diagnostic forbs include *Selaginella dregei*,

*Pearsonia sessilifolia*, *Senecio venosus*, *Stylochiton natalensis*, *Zornia milneana*, *Cyperus rupestris*, *Cyanotis speciosa* and *Kyphocarpa angustifolia*.



Figure 6.1. *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland with *Protea welwitschii*.



Figure 6.2. *Protea caffra* in the *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland.

The woody species, for example *Vangueria infausta*, *Englerophytum magalismontanum*, *Protea welwitschii*, *Rhus magalismontana*, *Ancylobotrys capensis* and *Lopholaena coriifolia*

occur scattered throughout this grassland but most of them remain low (1-1.5 m) and shrubby, except for *Protea caffra* which may occur in scattered groups where it may reach tree height (2-4 m) (Fig 6.2). Grasses are dominant and include *Loudetia simplex*, *Trachypogon spicatus*, *Diheteropogon amplexans*, *Elionurus muticus* and *Eragrostis gummiflua*. Prominent forbs include *Xerophyta retinervis* and *Selaginella dregei*.

### **8.2. *Loudetia simplex*–*Elionurus muticus* Mixed Grassland.**

This sub-community is represented by 15 relevés. The soil is a brown loam, mostly sandy. The slope is relatively flat and ranges between 1° and 5°. The percentage rockiness is not as high as in the *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland. Rocks occur mostly as gravel but some rock sheets may be present. Grasses dominate this sub-community and the few woody species present are scattered and inconspicuous (Figure 6.3).



Figure 6.3. *Loudetia simplex*–*Elionurus muticus* Mixed Grassland.

This sub-community is characterised by species group C (Table 6.1). The diagnostic species include the forbs *Chascanum hederaceum* and *Gnidia caffra*. The presence of species from species group E (Table 6.1) also differentiates this community from the *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland. These species are more typical of the communities representing the *Cymbopogon-Themeda* Veld Type (Acocks 1988) on the deeper soils without rocks and indicate that this community has floristic affinities to the *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland on the Reserve.

Species from species groups A, F, J and M are also well represented. Although *Loudetia simplex*, *Trachypogon spicatus* and *Diheteropogon amplexans* are still dominant, the grasses *Themeda triandra*, *Elionurus muticus*, *Eragrostis gummiflua* and *Eragrostis curvula*, are also prominent, indicating the relationship with the communities found on the deeper soils. Prominent forb species include *Xerophyta retinervis* and the woody dwarf shrub *Stoebe vulgaris*, an encroacher species on disturbed soils.

### **9. *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland.**

The *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland is represented by 47 relevés. This tall anthropogenic grassland community occurs on the relatively flat plains where the slope ranges from 1° to 4°. It is commonly found in somewhat moister lower-lying depressions within the Reserve. Gravel is the only rocky elements in this community. The soil is a deep, not-rocky clay loam, which were ploughed in the past. This community has changed from natural grassland to a disturbed secondary grassland (Figure 6.4) due to previous ploughing or overgrazing. Some of the stands represent old planted pastures. The weedy dwarf shrub *Stoebe vulgaris* and the anthropogenic tall grass *Hyparrhenia hirta* formed dense stands throughout this community indicating disturbance. Although situated within the Bankenveld region, this grassland is rather representative of the *Cymbopogon-Themeda* Veld Type (Acocks 1988), or the Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1998).

Species group D (Table 6.1) is characteristic of this community and several diagnostic species were identified. These species include the grasses *Eragrostis chloromelas*, *Hyparrhenia filipendula*, *Imperata cylindrica*, *Andropogon chinensis* and *Cymbopogon excavatus*. Diagnostic forbs are *Helichrysum rugulosum*, *Limeum viscosum*, *Oxalis corniculata*, *Cucumis zeyheri*, *Hypochaeris radicata*, *Conyza podocephala*, *Oxalis obliquifolia*, *Phyllanthus parvulus*, *Solanum sisymbriifolium*, *Gladiolus elliotii*, *Dichapetalum cymosum*, *Nemesia* species, *Striga elegans*, *Ceratotheca triloba*, *Eriosema salignum*, *Polygala hottentotta* and *Vernonia poskeana*. Most of these species are pioneers, indicating that this community is secondary and still in successional stage. Some species, for example *Imperata cylindrica*, *Conyza podocephala* and *Nemesia* species indicate the slightly moister conditions.



Figure 6.4. *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland.

This community is dominated by the grasses *Eragrostis chloromelas*, *Eragrostis curvula*, *Setaria sphacelata*, *Cynodon dactylon*, *Hyparrhenia filipendula*, *Hyparrhenia hirta* and *Digitaria eriantha*. Woody species include the dwarf shrub *Stoebe vulgaris*. Both *Stoebe vulgaris* and *Hyparrhenia hirta* indicate a degraded condition or low successional status.

*Hyparrhenia* species is very useful for thatching purposes but provides poor grazing and becomes more unpalatable later in the growing season (Van Oudtshoorn 2002). A treatment action or management solution to return the veld to a better grazing condition and higher plant species diversity is yet to be found. Disturbed grassland or other disturbed areas such as road reserves or old fields, not cultivated for some years, are usually *Hyparrhenia*-dominated. Although some of these tall grasslands appear to be quite natural, they are mostly associated with an anthropogenic influence from recent or even iron-age times (Bredenkamp & Brown 2003). Very often “natural” *Hyparrhenia*-dominated grasslands occur on ancient lands in the Central Variation of the Bankenveld (Acocks 1988) where the inhabitants had a mosaic of cultivated lands and grazing of domestic stock. These degraded sites developed into to *Hyparrhenia*-dominated grassland, which tends to be stable for a very long time (Bredenkamp & Brown 2003).

*Hyparrhenia*-dominated grassland mostly has low species richness, with only a few other species able to establish or survive in the shade of the dense sward of tall grass. Most of these species are relict pioneers or early seral species (Bredenkamp & Brown 2003). This is



illustrated by the species from species group L (Table 6.1) which include the grasses *Cynodon dactylon*, *Hyparrhenia hirta* and *Sporobolus africanus*, the weedy forbs *Cyperus esculentus*, *Pseudognaphaleum luteo-album*, *Richardia brasiliensis*, *Cleome monophylla*, *Verbena bonariensis*, *Gomphocarpus physocarpus*, *Bidens pilosa*, *Schkuhria pinnata*, *Cleome rubella*, *Gomphrena celosioides* and *Conyza albida*.

Examples similar to this type of grassland in the Bankenveld were described from the Jack Scott Nature Reserve (Coetzee 1975), Suikerbosrand Nature Reserve (Bredenkamp & Theron 1978), the eastern Bankenveld (Myburgh 1993) from the Pretoria-Heidelberg-Witbank area (Coetzee 1993, Coetzee *et al.* 1995), Witbank Nature Reserve (Smit *et al.* 1997) and from the Lichtenburg area (Bezuidenhout *et al.* 1994).

#### **10. *Burkea africana*–*Eragrostis curvula* Bush Clumps.**

This community occurs near the sandy plains, close to the foot slopes of the hills, on deep, reddish brown, sandy loam soil. The topography is relatively flat to gently sloping and very little to no rocks occur on the soil surface. This community is represented by 13 relevés. The most conspicuous feature of this community is the *Burkea africana* tree clumps within the grassland (Figure 6.5). These bush clumps are utilised by game for shade and shelter and the deep sandy soil for burrows. Signs of grazing, sleeping and trampling abound under these trees. This contributes to the disturbed nature of the herbaceous layer.

Species group G (Table 1) is diagnostic of this community. The diagnostic species are the woody *Burkea africana*, *Rhus pyroides*, *Euclea crispa*, *Rhus leptodictya*, *Faurea saligna*, *Ilex mitis*, *Terminalia sericea*, *Rhoicissus tridentata* and *Diospyros lycioides*. The diagnostic herbaceous species include *Tagetes minuta*, *Agathisanthemum bojeri*, *Hibiscus calyphyllus* and *Commelina erecta*.

The dominant woody species is *Burkea africana*. The dominant grasses are *Eragrostis curvula*, *Setaria sphacelata* and *Melinis repens*. *Fadogia homblei* is strongly associated with the *Burkea africana* bush clumps. Weedy species of this community include *Tagetes minuta*, *Agathisanthemum bojeri*, *Solanum incanum*, *Pseudognaphalium luteo-album*, *Conyza albida*, *Bidens pilosa*, *Gomphocarpus physocarpa* and *Richardia brasiliensis*.

The *Burkea africana* – *Eragrostis curvula* Bush Clumps community has strong floristic affinity to the Sourish Mixed Bushveld (Acocks 1988) found on sandy plains (Coetzee 1993).



Figure 6.5. *Burkea africana* – *Eragrostis curvula* Bush Clumps.

### **11. *Eragrostis curvula*–*Eragrostis plana* Moist Degraded Grassland.**

This community occurs at localities with moister conditions than the previous grassland communities. Some of the relevés in this community occur on the riverbanks and in the floodplain of the Wilge River (Figure 6.6). It is represented by 23 relevés and species group K is characteristic of this community.

Diagnostic species include the hygrophilous grasses *Cymbopogon nardus*, *Pennisetum sphacelatum* and *Eragrostis plana*, the sedges *Cyperus rotundus* and *Kyllinga alata* and the weedy hygrophilous forbs *Verbena brasiliensis*, *Helichrysum* species, *Oxalis* species and *Cirsium vulgare*.

Dominant grass species include *Eragrostis curvula*, *Cynodon dactylon*, *Pennisetum sphacelatum* and *Cymbopogon nardus*. In some relevés *Hyparrhenia hirta* forms dense stands. Prominent herbaceous species include *Verbena bonariensis*, *Richardia brasiliensis*, *Pseudognaphalium luteo-album*, *Cyperus esculentus* and *Cyperus rotundus*.

The invasive alien trees *Eucalyptus camaldudensis* form dense stands next to the Wilge River (Figure 6.7). Other weeds in this community include *Solanum incanum*, *Conyza albida*, *Gomphrena celosioides*, *Schkuhria pinnata*, *Bidens pilosa*, *Gomphocarpus physocarpus*, *Verbena bonariensis*, *Richardia brasiliensis*, *Pseudognaphalium luteo-album* and *Cirsium vulgare*. *Stoebe vulgaris* is also present. *Eragrostis plana* is an unpalatable grass but the

associated *Cynodon dactylon* is well grazed. Overgrazing and seasonal flooding and drying may cause degradation of this grassland. This can be seen in the dominance of weedy forbs and the presence of *Stoebe vulgaris*.



Figure 6.6. *Eragrostis curvula*–*Eragrostis plana* Moist Degraded Grassland. The line of trees in the background indicates the Wilge River.



Figure 6.7. *Eucalyptus* stands in the *Eragrostis curvula*–*Eragrostis plana* Moist Degraded Grassland.

The *Eragrostis curvula*–*Eragrostis plana* Disturbed Moist Grassland corresponds to the *Eragrostis plana* Moist Grassland of Bredenkamp and Brown (2003). This community is restricted to flat plains and floodplains of rivers with moist deep, poorly drained soils. It is located adjacent to wetlands especially in the east and south of the Bankenveld where the rainfall is high. Coetzee (1993) described this community as *Eragrostis gummiflua*–*Cynodon dactylon* Grassland.

## 12. *Acacia dealbata* Riverine Woodland.

This community of alien wattle occurs on the banks of the Wilge River. It forms dense stands encroaching into the natural indigenous vegetation along the River, and only a few herbaceous species grow under these trees (Figure 6.8).



Figure 6.8. *Acacia dealbata* Riverine Woodland.

Species group O represents this community. *Acacia dealbata* is the dominant and diagnostic species. Other diagnostic species include the grass *Panicum maximum*. *Cynodon dactylon* and *Eragrostis inamoena* are also present.

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## 7 DESCRIPTION OF WETLANDS COMMUNITIES

This chapter describes the wetland communities of Ezemvelo Nature Reserve. Wetlands differ from other plant communities by their waterlogged soil conditions, and the presence of species adapted to this habitat.

### 7.1 Classification

The wetlands of the Ezemvelo Nature Reserve are represented by 36 relevés. The results of the classification are given in a phytosociological table (Table 7.1). The floristic analysis resulted in the identification of 10 wetland communities. These are classified as follows:

13. *Hyparrhenia tamba*–*Imperata cylindrica*–*Paspalum urvillei* Dry Disturbed Wetland.
14. *Ischaemum fasciculatum* Wetland.
15. *Pennisetum macrourum* Wetland.
16. *Typha capensis*–*Paspalum urvillei* Wetland.
17. *Imperata cylindrica* Seepage Wetland.
18. *Paspalum urvillei*–*Eragrostis inamoena* – *Mariscus keniensis* Narrow Rocky Wetland.
19. *Leersia hexandra*–*Eragrostis plana* Wetland.
20. *Floscopa glomerata*–*Leersia hexandra* Drainage Line Wetland.
21. *Phragmites australis*–*Thelypteris confluens* Tall Dense Wetland.
22. *Schoenoplectus corymbosus* Wetland.

### 7.2 Description of plant communities

The wetlands on the Reserve occur adjacent to rivers, streams and as seepages. The soil is saturated with water and the plants are hydrophilic, i.e. adapted to living in water-saturated conditions. The most common plant species of the wetlands is the grass *Paspalum urvillei*. The number of species occurring within every wetland community is less than in the adjoining grassland and the rocky and woodland communities within the Reserve.

Table 7.1. Phytosociological table of the wetland communities on Ezemvelo Nature Reserve.





### 13. *Hyparrhenia tamba*–*Imperata cylindrica*–*Paspalum urvillei* Dry Disturbed Wetland.

This grass-dominated wetland community (Figure 7.1) occurs on areas adjacent to the terrestrial grassland, on the driest soil conditions of all the wetland communities found on the Reserve. It is represented by five relevés and is characterised by species group A (Table 7.1).



Figure 7.1. *Hyparrhenia tamba*–*Imperata cylindrica*–*Paspalum urvillei* Dry Disturbed Wetland.

The grasses *Hyparrhenia tamba* and *Eragrostis chloromelas* are diagnostic species, as well as the sedges *Kyllinga alba* and *Cyperus esculentis* and the forbs *Cleome maculata*, *Conyza albida*, *Cirsium vulgare* and *Helichrysum rugulosum* and the dwarf shrub *Stoebe vulgaris*. Noteworthy is that the forb species, as well as *Stoebe vulgaris* and *Eragrostis chloromelas* can be considered as pioneer or lower successional species, indicating the low successional status of this wetland.

*Hyparrhenia tamba*, *Imperata cylindrica* and *Paspalum urvillei* are the dominant grasses. Other prominent species include *Hibiscus calyphyllus*, *Verbena bonariensis* and the sedge *Kyllinga alba*.

Although this vegetation is classified with the wetlands of the Reserve, this vegetation may also be regarded as moist grassland, rather than wetland.

#### 14. *Ischaemum fasciculatum* Wetland.

*Ischaemum fasciculatum* forms dense stands (Figure 7.2) forms dense stands in this wetland community. It occurs next to streams on wet clay soils where and is represented by four relevés.



Figure 7.2. *Ischaemum fasciculatum* Wetland.

Species group B (Table 7.1) characterises this community. The diagnostic species are the grasses *Ischaemum fasciculatum* and *Miscanthus junceus* and the forbs *Nidorella anomala* and the dwarf shrub *Morella serrata*.

The grass *Ischaemum fasciculatum* forms dense stands and is the dominant species of this community. Another grass species that may be locally present in this community is *Miscanthus junceus*. *Verbena bonariensis* may also be present.

#### 15. *Pennisetum macrourum* Wetland.

The *Pennisetum macrourum* Wetland community occurs in standing water next to shallow streams where the soil type is dark clay. Four relevés represent this community. *Pennisetum macrourum* is the dominant species (Figure 7.3).

Species group C (Table 7.1) is characteristic of this community. The diagnostic species are the grass *Pennisetum macrourum*, the sedge *Mariscus congestus* and the forb *Oldenlandia lancifolia*. Prominent sedges are *Mariscus congestus* and *Mariscus keniensis*.



Figure 7.3. *Pennisetum macrourum* Wetland.

#### **16. *Typha capensis*–*Paspalum urvillei* Wetland**

This wetland community occurs in standing water, on the edges of water bodies. It is represented by five relevés. *Typha capensis* is very prominent (Figure 7.4).



Figure 7.4. *Typha capensis*–*Paspalum urvillei* Wetland.

This community is characterised by species group E (Table 7.1). Diagnostic species are *Typha capensis*, the sedge *Kyllinga alata* and the weedy forb *Verbena brasiliensis*. The dominant species are *Typha capensis* and the grasses *Leersia hexandra* and *Paspalum urvillei*. The prominent herbaceous species are *Persicaria attenuata* and the sedge *Kyllinga alata*.

Smit *et al.* (1997) described this community as *Typha capensis*–*Agrostis lachnanta* Marshland from the Witbank Nature Reserve.

### **17. *Imperata cylindrica* Seepage Wetland**

This community occurs on somewhat drier conditions on the outer edge of wetland vegetation where the soil is a brown clay loam. It is represented by two relevés.

Species group G (Table 7.1) is characteristic of this community and the only diagnostic species is *Imperata cylindrica* which is also the dominant species (Figure 7.5). Other species include the grass *Paspalum urvillei* and the dwarf shrub *Stoebe vulgaris*.



Figure 7.5. *Imperata cylindrica* Seepage Wetland.

**18. *Paspalum urvillei*–*Eragrostis inamoena*–*Mariscus keniensis* Narrow Rocky Wetland.**

Rocky slopes in or next to a narrow stream in a narrow kloof forms the habitat for this community (Figure 6.6). It is represented by four relevés and characterised by species group H (Table 7.1).

The diagnostic species of this wetland community are the grasses *Eragrostis inamoena* and *Paspalum scrobiculatum* and the sedges *Fimbristylis dichotoma*, *Fuirena pubescens* and *Cyperus denudatus*. The dominant grasses are *Eragrostis inamoena*, *Paspalum urvillei* and *Leersia hexandra*. The dominant sedge is *Mariscus keniensis*. No herbaceous species other than grasses and sedges are found in this community.



Figure 7.6. *Paspalum urvillei*–*Eragrostis inamoena*–*Mariscus keniensis* Narrow Rocky Wetland.

**19. *Leersia hexandra*–*Eragrostis plana* Wetland.**

This community occurs in clay soil in a standing pool of water. It is represented by a single relevé. Species group J (Table 7.1) is characteristic of this community. The only diagnostic species is *Eragrostis plana*. It is dominated by the two grasses *Leersia hexandra* and *Eragrostis plana*.

The *Leersia hexandra*–*Eragrostis plana* Wetland is also described by Coetzee (1993) as *Leersia hexandra*–*Eragrostis plana* Wetland. This wetland occurs in permanently water-saturated conditions.

**20. *Floscopa glomerata*–*Leersia hexandra* Drainage Line Wetland.**

This community occurs in the water of shallow drainage lines on the Reserve (Figure 7.7).

*Floscopa glomerata* is prominent (Figure 7.8). It is represented by five relevés.



Figure 7.7. *Leersia hexandra* in the foreground and *Typha capensis* in the background.



Figure 7.8. *Floscopa glomerata*–*Leersia hexandra* Drainage Line Wetland.

This community is characterised by species group K (Table 7.1). Diagnostic species are *Floscopa glomerata*, the alien grass *Pennisetum clandestinum* and *Juncus* species and *Pycreus nitidus*. The dominant herbaceous species is *Floscopa glomerata*, *Persicaria lapathifolia* and *Juncus* species. Dominant grasses are *Leersia hexandra*, *Bothriochloa insculpta*, *Agrostis lachnantha* and *Paspalum urvillei* and a prominent sedge is *Schoenoplectus corymbosus*.

#### **21. *Phragmites australis* – *Thelypteris confluens* Tall Dense Wetland.**

This community occurs in the wide, deep streams of the Reserve. It is dominated by tall dense stands of the reed *Phragmites australis* and it is represented by six relevés.

Species group N (Table 7.1) is characteristic of this community. This community is totally dominated by the diagnostic and conspicuous, tall reed *Phragmites australis*. The fern *Thelypteris confluens* is also diagnostic.



Figure 7.9. *Phragmites australis*–*Thelypteris confluens* Tall Dense Wetland.

*Phragmites australis* dominated reed communities are widespread in southern Africa, and also found in other parts of the world (Rickey & Anderson 2004). When disturbance takes place or there is a change in the chemical composition of the water or soil or hydrological



regime this species forms a monostand that can eradicate other wetland species (Marks *et al.* 1994).

Bloem (1988) found this community on the Verlorenvlei Nature Reserve north of Dullstroom, Mpumalanga. The community grew in water deeper than 30cm.

## **22. *Schoenoplectus corymbosus* Wetland.**

This sedge dominated community occurs in streams on clay soils. It is totally dominated by the sedge *Schoenoplectus corymbosus* (Figure 7.9), which is also the only diagnostic species.



Figure 7.10. *Schoenoplectus corymbosus* Wetland.

### 7.3 References

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## 8 DISCUSSION

### 8.1 Introduction

The Bankenveld Veld Type consists of a variety of vegetation types and is quite heterogeneous in terms of floristic and plant community composition, even representing different biomes (Bredenkamp & Brown 2003). It is therefore not unusual for the Ezemvelo Nature Reserve to have a large diversity in habitats occurring in a mosaic distribution pattern. The results of this study confirm to the statement of Bredenkamp and Brown (2003) that Bankenveld can be interpreted as “a mosaic of grassland and woodland communities controlled by (micro-) climatic conditions that exist in the topographically heterogeneous landscape”. Both the grassland and savanna biomes, as well as the forest biome, contributed to the floristic diversity of the Bankenveld and there is a large overlap in species composition in the grassland and woodland communities, especially on geologically similar substrates (Bredenkamp 1975; Bredenkamp & Theron 1978; Bredenkamp & Brown 2003).

The vegetation of Ezemvelo Nature Reserve includes grassland on the plains, wetlands in the floodplains and streams and woodland vegetation on the slopes of the ridges and hills, while elements of forest may be found in the deep valleys along the Wilge River (Figure 8.1).

The vegetation data was classified using TWINSPLAN as discussed in Chapter 4 to produce a first approximation of the plant communities. The large phytosociological table was divided into three separate tables to give a more accurate and easily representable analysis of the plant communities. These tables represent the rocky and woodland communities, the grassland and the wetland. The vegetation of Ezemvelo Nature Reserve was classified into 22 plant communities, indicating the diversity of habitats and floristics within the Reserve. Two of the communities could be subdivided into two sub-communities. The results of this classification are confirmed by the results obtained through an ordination of the data. The results are ecologically interpretable and confirm and correspond to the results of other studies in the Grassland Biome and Bankenveld Veld Type.

### 8.2 Classification

Applying the Braun-Blanquet phytosociological method, 22 major plant communities could be identified. A schematic representation of the hierarchical classification and the associated environmental characteristics of the plant communities are given in Figure 8.2.

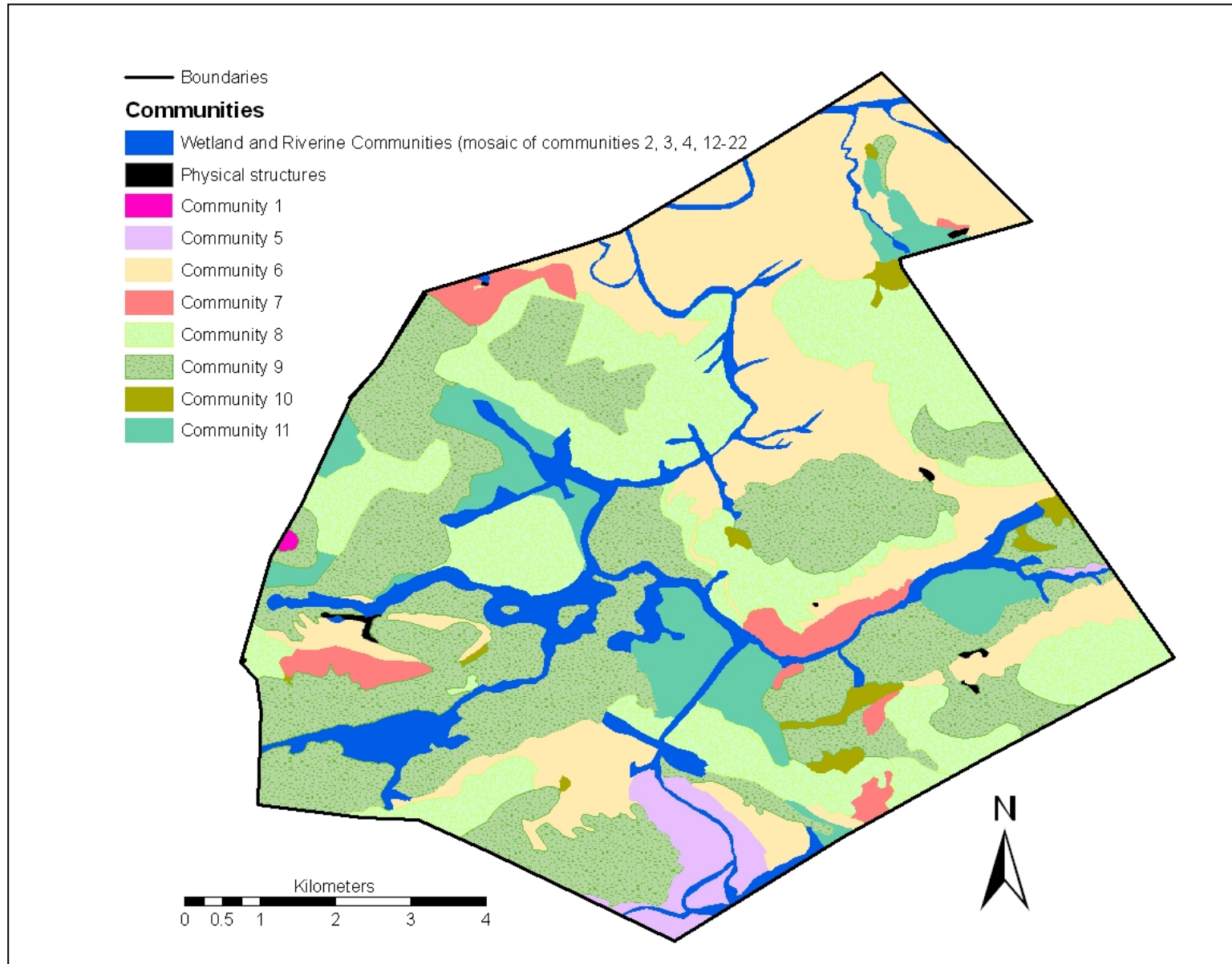


Figure 8.1. Distribution of plant communities on Ezemvelo Nature Reserve.

The first division was between the wetland and terrestrial communities. The wetland differs from the terrestrial communities due to their very specific species composition and their waterlogged habitat conditions. The wetland communities can be divided into deep water communities and shallow water communities.

The first division between the terrestrial communities separated the *Frithia humulis*–*Microchloa caffra* Quartz Community (Community 1) from the rest of the terrestrial plant communities found on the Reserve. The remaining communities can be divided into woodland and grassland communities. The results of the floristic classification generally correlate well to the differences in physical environmental parameters. The woody vegetation can be divided between vegetation growing on wet, deep soil and vegetation growing on drier, shallow and rocky soil. The grassland vegetation can be divided between dry communities and wet communities.

### Vegetation of the Ezemvelo Nature Reserve

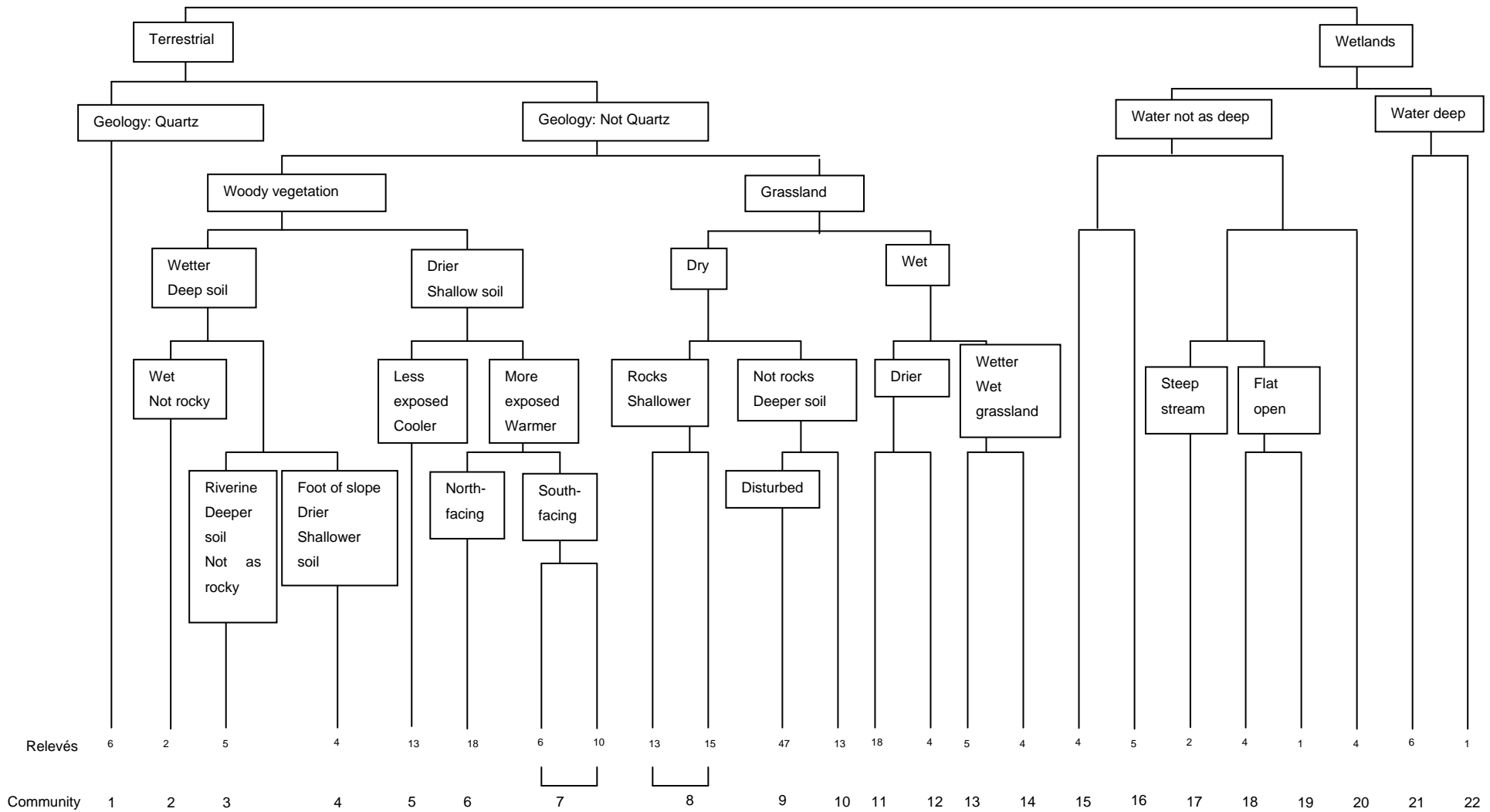


Figure 8.2. Dendrogram illustrating the hierarchical classification of the communities on Ezemvelo Nature Reserve.

### 8.3 Synoptic Table

The grassland, wetland, as well as rocky and woodland vegetation of Ezemvelo Nature Reserve were analysed and described separately. To determine the floristic relationships between these three different vegetation types (based on growth form, habitat and species composition) a synoptic table of all 22 communities was prepared (Table 8.1). This table shows the floristic relationships between the different communities and simplifies any effort to identify similarities in habitat. Comparisons could indicate how different communities could be grouped together, especially with the aim of management of the Reserve.

The *Combretum erythrophyllum*–*Panicum maximum* Riverine Woodland (Community 3) and the *Acacia caffra*–*Celtis africana* Bush Clumps (Community 4) are floristically related (species group E, Table 8.1). This may be ascribed to the deep and organic substrates of these communities.

The *Acacia caffra*–*Celtis africana* Bush Clumps (Community 4) is also floristically related to the *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland (Community 6) (species group K, Table 8.1). This shows its floristic affinity with the vegetation of the north-facing slopes.

*Loudetia simplex*–*Diheteropogon amplexans* Rocky Open Shrubland (Community 7) is related to the *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland (Community 6) (species group M, T, U & AC, Table 8.1) and the *Heteropyxis natalensis*–*Pteridium aquilinum* Sheltered Woodland (Community 5) (species group N, Table 8.1). This indicates the rocky habitat and the presence of woody trees and shrubs in all communities.

The *Loudetia simplex*–*Trachypogon spicatus* Rocky Highveld Grassland (Community 8) is floristically related to the *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland (Community 6) and the *Loudetia simplex*–*Diheteropogon amplexans* Rocky Open Shrubland (Community 7) (species groups S, T, X & AB Table 8.1). This shows its relation to the rocky communities and confirming a floristic relationship between grassland and savanna communities occurring on similar geological substrates, as was shown by Bredenkamp (1975) and Bredenkamp and Theron (1978). This community is also related to the *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland (Community 9) (species groups W & X, Table 8.1), the *Burkea africana*–*Eragrostis curvula* Bush Clumps (community 10)

(species groups AA, AB, AE, AK & BI, Table 8.1) and the *Eragrostis curvula-Eragrostis plana* Moist Degraded Grassland (community 11) (species groups AH, AI & BI, Table 8.1) which is why it was classified with the grasslands.

The *Burkea africana-Eragrostis curvula* Bush Clumps (Community 10) is furthermore also floristically related to the woodland communities (species groups AC, AD, AE, AH & AO, Table 8.1). The *Acacia dealbata* Riverine Woodland is related to the riverine woodland communities (*Combretum erythrophyllum-Panicum maximum* Riverine Woodland (Community 3) and *Acacia caffra-Celtis africana* Bush Clumps (Community 4)) situated on moist deep soil (Species Group AL, AM & AN, Table 8.1).

The wetland communities are related to grassland communities, mostly through the presence of herbaceous species.



Table 8.1. Synoptic table of the communities of the Ezemvelo Nature Reserve.







#### 8.4 Ordination and habitat interpretation

The classification is supported by the results of the DECORANA ordination done by using the programme PCOrd. The ordination provides a further understanding of the vegetation and associated habitat gradients between plant communities (Figure 8.3). The results of an ordination indicate the position of the relevés in a multi-dimensional space, with the relevés that are floristically most similar projected close to each other, while relevés that are very different projected far from each other. The result is therefore a gradient of relevés, with the most different relevés positioned at the poles of the axes and all other relevés positioned somewhere in between.

Although the different communities are largely restricted to specific areas in the ordination diagram, the clustering towards the left hampered interpretation of floristic relationships, and also the relationships between plant communities and environmental factors. Due to the strong discontinuity shown in the ordination diagram, between the *Frithia humulis*–*Microchloa caffra* Quartz Community and the rest of the communities indicating that these communities are floristically quite different, it was decided to conduct the ordinations of the rest of the communities separately.

A DECORANA ordination (Figure 8.3) of all the relevés except the *Frithia humulis*–*Microchloa caffra* Quartz Community shows the wetland communities clearly separated from the terrestrial communities. The wetland communities are numbered as Communities 14 and 15 (Communities 15 – 22 were grouped as Community 15 as PCOrd only provides the option of 15 Communities). There is no clear division between these communities but rather a moisture gradient from left to right. The grassland and woodland communities are clustered towards the left. This confirms the statement of Bredenkamp (1975), Bredenkamp & Theron (1975) and Bredenkamp and Brown (2003) that a close affinity exists between certain grassland and bushveld communities, especially if these communities exist on the same geological substrate.

Separate DECORANA ordinations were prepared for the rocky and woodland communities, the grassland communities and the wetland communities (Fig 8.4, 8.5 and 8.6 respectively). These will be discussed separately below. The limited habitat data that was collected were used to interpret the results obtained from the DECORANA ordination.

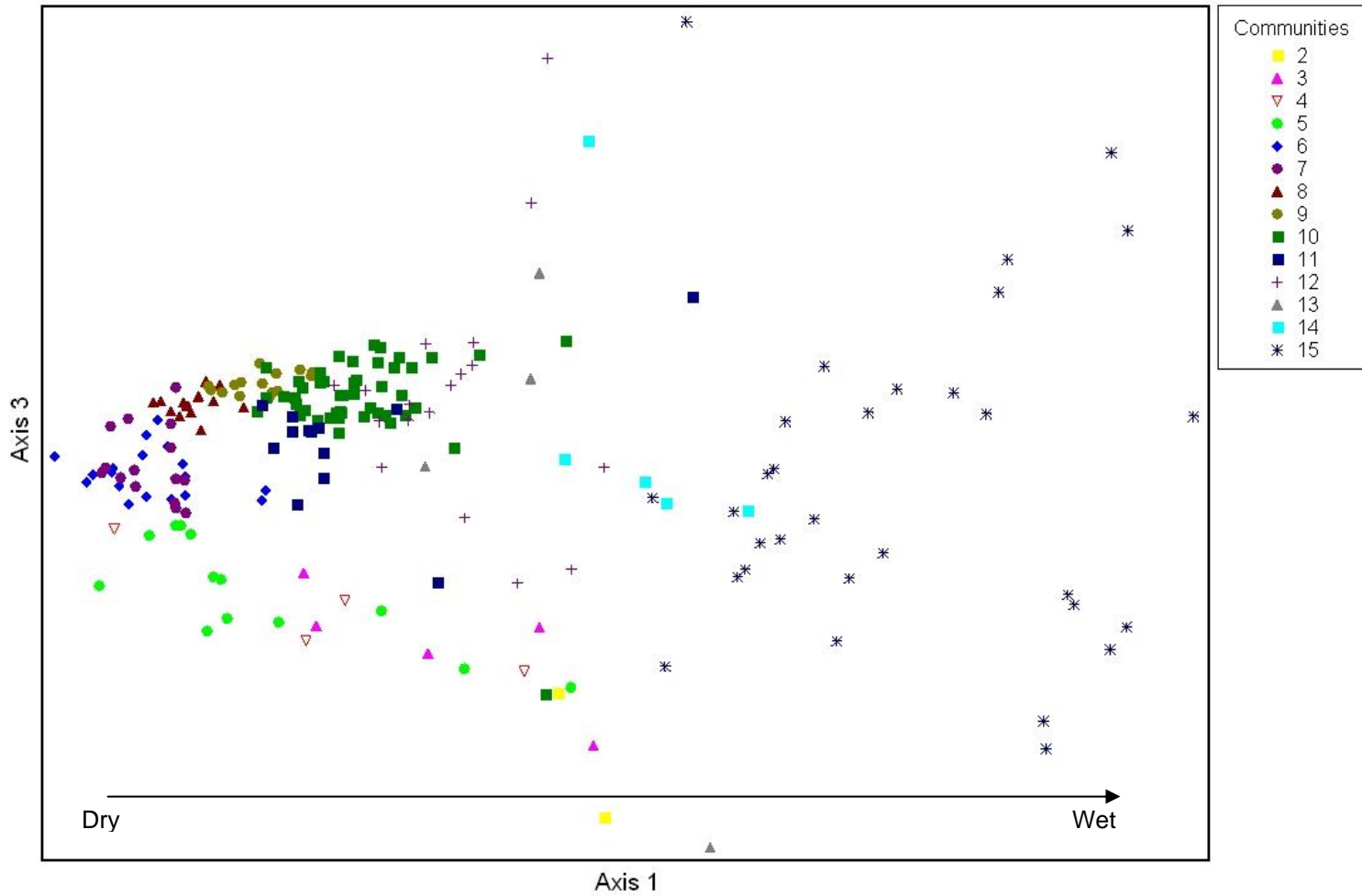


Figure 8.3. DECORANA ordination of all the relevés except the *Frithia humulis*–*Microchloa caffra* quartz community, with the communities overlain.

#### 8.4.1 Rocky and Woodland Communities

The woodlands of the Ezemvelo Nature Reserve are characterised by trees and shrubs. The woody vegetation can be divided into vegetation on the slopes of the ridges and hills and the vegetation on the foot of slopes and along the rivers, where the soil is deeper than on the rocky slopes. The succulent nature and quartz gravelly habitat of the *Frithia humulis*–*Microchloa caffra* Community on Quartz is completely different from the rest of the vegetation.

The woody and rocky vegetation was divided into seven communities:

1. *Frithia humulis*–*Microchloa caffra* Community on Quartz.
2. *Populus X canescens* Dense Woodland.
3. *Combretum erythrophyllum*–*Panicum maximum* Riverine Woodland.
4. *Acacia caffra*–*Celtis africana* Bush Clumps on Foot of Slopes.
5. *Heteropyxis natalensis*–*Pteridium aquilinum* Sheltered Woodland.
6. *Burkea africana*–*Ochna pulchra*–*Croton gratissimus* North-facing Slope Woodland.
7. *Loudezia simplex*–*Diheteropogon amplectens* Rocky Open Shrubland.

The floristic data of the woodlands and rocky areas was subjected to DECORANA ordination and the results of this ordination are displayed in Figure 8.4.

The *Frithia humulis*–*Microchloa caffra* quartz community and *Populus X canescens* Dense Woodland community were omitted from this ordination as they skew the results of the ordination. This disguises the differences between the other relevés. Some discontinuity can be observed between the plant communities; however the general trend is that of an environmental gradient. To the right of the diagram is the *Combretum erythrophyllum*–*Panicum maximum* Riverine Woodland which occurs on the banks of the Wilge River as well as the *Acacia caffra*–*Celtis africana* Bush Clump which occurs on the foot of slopes on deeper alluvial soils. Deep, organic soil forms the habitat for both these communities.

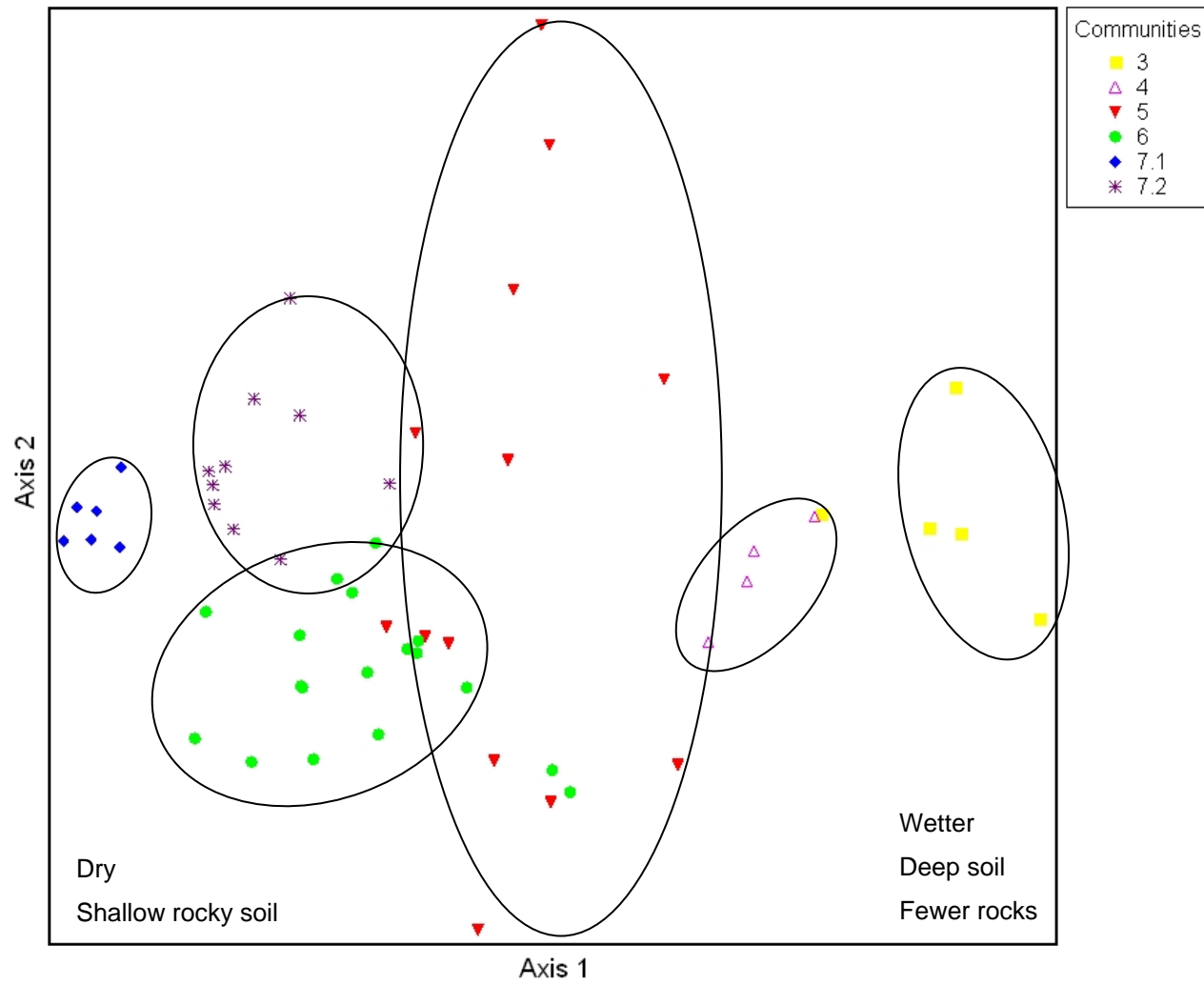


Figure 8.4. DECORANA ordination of the woodland and rocky communities of Ezemvelo Nature Reserve.



The *Loudetia simplex–Diheteropogon amplexens* Rocky Highveld Grassland occurs on the left of the diagram. This sub-community occurs on rock sheets with shallow soil. The *Burkea africana–Ochna pulchra–Croton gratissimus* North-facing Slope Woodland and *Loudetia simplex–Protea caffra* South-facing Open Shrubland is situated to the right of the *Loudetia simplex–Diheteropogon amplexens* Rocky Highveld Grassland. This community and sub-community differ from the *Loudetia simplex–Diheteropogon amplexens* Rocky Highveld Grassland by preferring to be situated between boulders and on steeper slopes.

The *Heteropyxis natalensis–Pteridium aquilinum* Sheltered Woodland is situated in the middle of the ordination diagram. It is very diverse in species and its location on the Ezemvelo Nature Reserve. To the top of the diagram are the relevés dominated by *Pteridium aquilinum*.

The first axis denotes soil depth and rockiness of which two groups of communities can be distinguished: the communities occurring in the deep soil near the rivers and the communities that occur on the slopes and crest of the Reserve, where shallow soil can be found between the boulders.

#### **8.4.2 Grassland Communities**

The grassland communities occur on the exposed plains and hill crests of the Reserve. They are situated on the areas with deeper soil and less rockiness than the rocky and woodland communities and prefer areas drier than the wetlands. This vegetation type is dominated by grasses and forbs although shrubs and trees also occur. These trees occur localised in specific habitats. For example, *Burkea africana* occurs on the deep red sandy soil near the foot of hills and *Acacia dealbata* and *Eucalyptus camaldudensis* near the rivers. Grass species that are common throughout the Ezemvelo Nature Reserve grassland are *Eragrostis curvula*, *Elionurus muticus*, *Setaria sphacelata* and *Melinis repens*.

The grassland vegetation can be divided in the following five communities:

8. *Loudetia simplex–Trachypogon spicatus* Rocky Highveld Grassland Major Community

- 8.1 *Rhus magalismontana*–*Loudetia simplex* Rocky Grassland
- 8.2. *Loudetia simplex*–*Elionurus muticus* Mixed Grassland
9. *Eragrostis curvula*–*Stoebe vulgaris* Degraded Grassland
10. *Burkea africana*–*Eragrostis curvula* Bush Clumps
11. *Eragrostis curvula*–*Eragrostis plana* Moist Degraded Grassland
12. *Acacia dealbata* Riverine Woodland

The floristic data of the grasslands were subjected to DECORANA ordination and the results of this ordination are displayed in Figures 8.5. Some relevés were omitted from this ordination as they cause the rest of the relevés to cluster together which prevents any interpretation of the differences between the relevés. These relevés are numbers 111, 114, 151, 171 185, 189 and 201. After removal of the relevés it was found that the communities are more or less grouped together with a general trend of a moisture and rockiness environmental gradient.

The *Loudetia simplex*–*Trachypogon spicatus* Rocky Grassland is situated to the right of the diagram. The soil of this community is shallow and plants establish between the rock sheets. The *Eragrostis curvula*–*Cynodon dactylon* Moist Degraded Grassland and *Burkea africana*-*Eragrostis curvula* Bush Clumps occur to the left of the diagram. Both of these communities occur on deeper soil without rocks. Therefore it can be concluded that environmental gradient on the first axis is associated with soil depth and rockiness. The relevés to the bottom of the diagram is located in a wet habitat contrary to the relevés to the top of the diagram in a drier habitat.

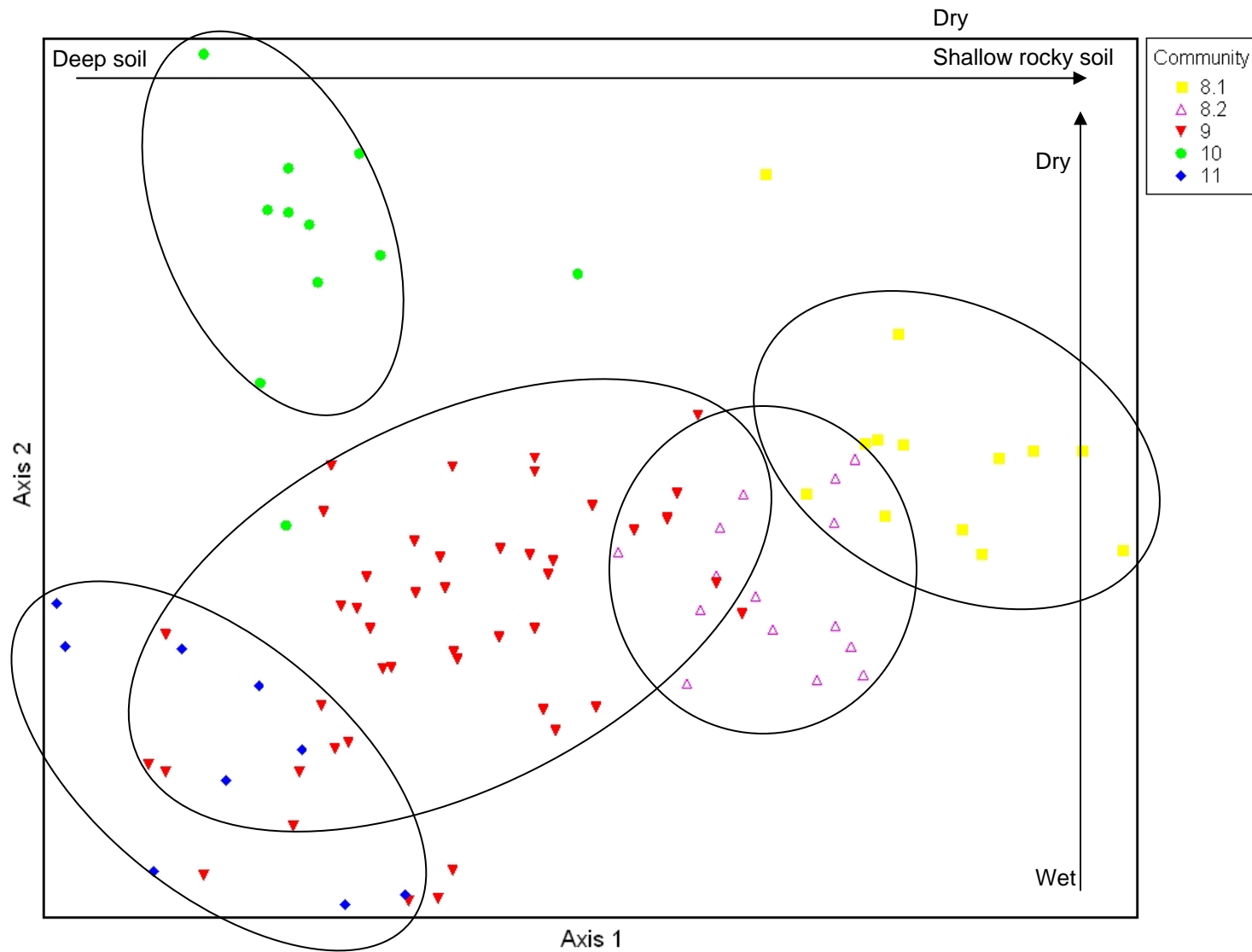


Figure 8.5. DECORANA ordination of the grassland communities of Ezemvelo Nature Reserve, with the communities overlaid.

### 8.4.3 Wetland Communities

The wetlands on Ezemvelo Nature Reserve are characterised by sedges and hydrophilic grasses. It is found on floodplains and around the streams and rivers on the Reserve. It is difficult to interpret differences between these communities ecologically and to link them to differences in environmental characteristics.

Ten wetland communities were identified on the Ezemvelo Nature Reserve:

13. *Hyparrhenia tamba*–*Imperata cylindrica*–*Paspalum urvillei* Dry Disturbed Wetland.
14. *Ischaemum fasciculatum* Wetland.
15. *Pennisetum macrourum* Wetland.
16. *Typha capensis*–*Paspalum urvillei* Wetland.
17. *Imperata cylindrica* Seepage Wetland.
18. *Paspalum urvillei*–*Eragrostis inamoena*–*Mariscus keniensis* Narrow Rocky Wetland.
19. *Leersia hexandra*–*Eragrostis plana* Wetland.
20. *Floscopa glomerata*–*Leersia hexandra* Drainage Line Wetland.
21. *Phragmites australis*–*Thelypteris confluens* Tall Dense Wetland.
22. *Schoenoplectus corymbosus* Wetland.

On the left of the diagram (Figure 8.6) are the *Hyparrhenia tamba*–*Imperata cylindrica*–*Paspalum urvillei* Dry Disturbed Wetland and the *Ischaemum fasciculatum* Wetland. During the classification these two communities were grouped with the grasslands. However, their environmental characteristics and species composition corresponds more with the wetlands and therefore they are described as wetlands. To the right of the diagram are the *Phragmites australis*–*Thelypteris confluens* Tall Dense Wetland and all the other communities are grouped towards the centre of the diagram.

The ordination represents a gradient from the left of the diagram, which is moist grassland, to the right of the diagram, which represents wet, deeper streams. This is representative of the environmental conditions present on Ezemvelo Nature Reserve. It is interesting to note that the wetland communities are widely scattered over the ordination diagram indicating large floristic differences between them. Wetland communities are often dominated by a single or only a few species, with a low species richness, resulting in totally different communities with little shared relationships. This confirms the results of Bloem (1988) and Cilliers & Bredenkamp (2003).

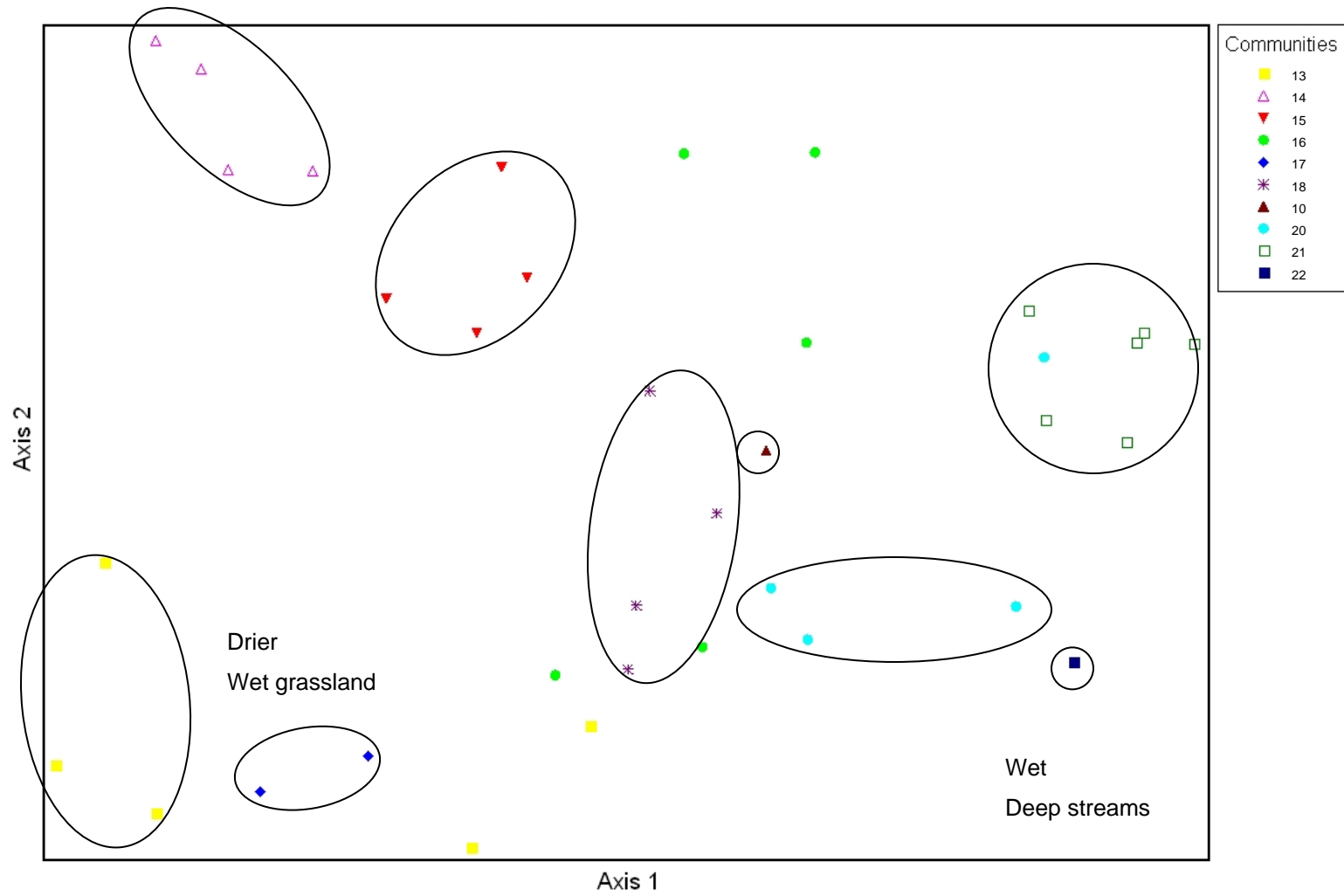


Figure 8.6. DECORANA ordination of the wetland communities on Ezemvelo Nature Reserve.

## 8.5 References

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## 9 CONCLUSION

A plant community consists of a combination of abiotic factors such as soil, rockiness and climate and biotic factors such as plant and animal species composition with each element influencing another. Therefore a plant community can be seen as an ecosystem and these should be managed effectively to ensure the future well-being of the organisms. The plant communities of the Ezemvelo Nature Reserve were identified, described and ecologically interpreted, resulting in a detailed vegetation map. Therefore, the objectives of the study were satisfactorily attained. The information gained in this thesis will contribute to the information available for managing the Reserve and will aid in the development of a game management plan, including carrying capacity and management of grazing.

The Braun-Blaunquet approach proved to be an accurate and effective way to identify and classify plant communities based on their floristics. An ordination was successfully used to confirm and refine the classification and to determine any environmental gradients. All plant communities could be related to specific environmental conditions and the communities are therefore floristically and ecologically distinguishable and interpretable. Most of the plant communities identified in this study were also described from other localities.

The vegetation of Ezemvelo Nature Reserve is typical of Bankenveld/Rocky Highveld Grassland veld type (Acocks 1988; Bredenkamp & Van Rooyen 1998) although some grassland communities correspond to the *Cymbopogon–Themeda* veld type (Acocks 1988). The results of this study confirm to the statement of Bredenkamp and Brown (2003) that Bankenveld can be interpreted as a mosaic of grassland and woodland communities in a topographically heterogeneous landscape with heterogeneous microclimatic conditions. Floristic elements of the grassland, savanna and forest biomes are present on the Reserve which confirms the statement of Bredenkamp (1975), Bredenkamp & Theron (1978) and Bredenkamp & Brown (2003) that there is a large overlap in the species composition of grassland and woodland communities, especially on geologically similar substrates.

As large areas of the Reserve, specifically the ridges, Wilge River and wetlands, are in a good condition and provide habitat for many plant and animal species, the future management and conservation of Ezemvelo Nature Reserve are important. It is recommended that the numerous alien and invasive species such as *Populus x canescens* and *Eucalyptus camaldudensis* on the Reserve be eradicated, with follow-up measures to ensure the veld returns to its natural condition. It is also recommended that the optimal

stocking rates for the Reserve be determined to prevent overgrazing and further degradation of degraded areas and future degradation in the natural vegetation.



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## **SUMMARY**

### **The vegetation ecology of Ezemvelo Nature Reserve, Bronkhorstspuit, South Africa**

by

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### **Magister Scientia**

A vegetation survey, based on plant communities, was conducted on the 11 000 ha Ezemvelo Nature Reserve, which is located in the Bankenveld veld type. The aim of the study was to identify, describe and ecologically interpret the plant communities of Ezemvelo Nature Reserve.

The study area was stratified into homogeneous vegetation units and sample plots were placed in a random stratified manner within the different units. The floristic composition and habitat information were recorded in 210 sample plots according to the Braun-Blaunquet method. The data was captured in the TURBOVEG database and classified using the TWINSPLAN numerical classification algorithm. The resulting phytosociological tables were compiled and organised using the MEGATAB computerised table management programme. The data was also subjected to a Detrended Correspondence Analysis (DECORANA) processed by the PCOrd numerical ordination programme to confirm the results of the classification and show any environmental gradients controlling the existence and distribution patterns of the different plant communities.

Twenty-two major plant communities and 4 sub-communities were identified, described, and ecologically interpreted. The location of the communities is indicated on a map compiled by means of GIS. The plant communities on the Reserve are distributed in a mosaic of woodlands, grasslands and wetlands, based on the heterogeneous habitats created by the variations in topography.

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## SPECIES LIST

### PTERIDOPHYTA

#### ANEMIACEAE

*Mohria caffrorum* (L.) Desv.

#### DENNSTAEDTIACEAE

*Pteridium aquilinum* (L.) Kuhn

#### PTERIDACEAE

*Cheilanthes hirta* Sw.

*Cheilanthes involuta* (Sw.) Schelpe & N.C.Anthony

*Cheilanthes viridis* (Forssk.) Sw.

*Pellaea calomelanos* (Sw.) Link

#### SELAGINELLACEAE

*Selaginella dregei* (C.Presl) Hieron.

#### THELYPTERIDACEAE

*Thelypteris confluens* (Thunb.) Morton

### GYMNOSPERMS

#### ZAMIACEAE

*Encephalartos middelburgensis* Vorster, Robbertse & S. van der Westh.

### ANGIOSPERMS

#### ACANTHACEAE

*Chaetacanthu burchellii* Nees

*Chaetacanthus costatus* Nees

*Crabbea angustifolia* Nees

*Hypoestes forskoolii* (Vahl) R.Br.

*Isoglossa grantii* C.B.Clarke

*Justicia anagalloides* (Nees) T.Anderson

#### AMARANTHACEAE

*Achyranthes aspera* L.

*Ageratum conyzoides* L.

*Celosia* L.

*Gomphrena celosioides* Mart.

*Kyphocarpa angustifolia* (Moq.) Lopr.

#### AMARYLLIDACEAE

*Boophone disticha* (L.f.) Herb.

*Crinum graminicola* I.Verd.

*Haemanthus humilis* Jacq.

*Scadoxus puniceus* (L.) Friis & Nordal

#### ANACARDIACEAE

*Lannea discolor* (Sond.) Engl.

*Lannea edulis* (Sond.) Engl.

*Ozoroa paniculosa* (Sond.) R.Fern & A.Fern.

*Rhus dentata* Thunb.

*Rhus gracillima* Engl.

*Rhus lancea* L.f.

*Rhus leptodictya* Diels

*Rhus magalismontana* Sond.

*Rhus pyroides* Burch.

*Rhus rigida* Mill. var. *rigida*

*Rhus zeyheri* Sond.

#### ANTHERICACEAE

*Anthericum* L.

*Chlorophytum fasciculatum* (Baker) Kativu

#### AQUIFOLIACEAE

*Ilex mitis* (L.) Radlk.

#### APIACEAE

*Ciclospermum leptophyllum* (Pers.) Sprague

## APOCYNACEAE

*Ancylobotrys capensis* (Oliv.) Pichon  
*Brachystelma rubellum* (E.Mey.) Peckover  
*Cryptolepis oblongifolia* (Meisn.) Schltr.  
*Diplorhynchus condylocarpon* (Müll.Arg.) Pichon  
*Gomphocarpus fruticosus* (L.) Aiton f.  
*Gomphocarpus glaucophyllus* Schltr.  
*Gomphocarpus physocarpus* E.Mey.  
*Pachycarpus schinzianus* (Schltr.) N.E.Br.  
*Pentarrhinum insipidum* E.Mey.  
*Raphionacme hirsuta* (E.Mey.) R.A.Dyer ex E.Phillips  
*Vinca major* L.

## ARACEAE

*Stylochaeton natalensis* Schott

## ARALIACEAE

*Cussonia paniculata* Eckl. & Zeyh.  
*Cussonia spicata* Thunb.  
*Cussonia transvaalensis* Reyneke

## ASPARAGACEAE

*Asparagus* L.  
*Asparagus africanus* Lam.  
*Asparagus falcatus* L.  
*Asparagus suaveolens* Burch.  
*Asparagus virgatus* Baker

## ASPHODELACEAE

*Aloe* L.  
*Aloe marlothii* A.Berger  
*Aloe verecunda* Pole Evans  
*Trachyandra* Kunth

## ASTERACEAE

*Acanthosperm glabratum* (DC.) Wild



*Acanthosperm hispidum* DC.  
*Artemisia afra* Jacq. ex Willd.  
*Bidens bipinnata* L.  
*Bidens pilosa* L.  
*Brachylaena rotundata* S.Moore  
*Cirsium vulgare* (Savi) Ten.  
*Conyza albida* Spreng.  
*Conyza podocephala* DC.  
*Dicoma anomala* Sond.  
*Dicoma macrocephala* DC.  
*Felicia muricata* (Thunb.) Nees  
*Gamochaeta pennsylvanica* (Willd.) Cabrera  
*Garuleum woodii* Schinz  
*Gazania Gaertn*  
*Geigeria burkei* Harv.  
*Gerbera jamesonii* Bolus ex Adlam  
*Helichrysum aureonitens* Sch.Bip.  
*Helichrysum callicomum* Harv.  
*Helichrysum nudifolium* (L.) Less.  
*Helichrysum rotundatum* Harv.  
*Helichrysum rugulosum* Less.  
*Helichrysum setosum* Harv.  
*Hypochaeris radicata* L.  
*Lactuca inermis* Forssk.  
*Lopholaena coriifolia* (Sond.) E.Phillips & C.A.Sm.  
*Nidorella anomala* Steetz  
*Nidorella hottentotica* DC.  
*Schistostephium crataegifolium* (DC.) Fenzl ex Harv.  
*Schistostephium heptalobum* (DC.) Oliv. & Hiern  
*Schkuhria pinnata* (Lam.) Cabrera  
*Senecio barbertonicus* Klatt  
*Senecio inaequidens* DC.  
*Senecio inornatus* DC.  
*Senecio isatideus* DC.  
*Senecio oxyriifolius* DC.  
*Senecio venosus* Harv.  
*Seriphium plumosum* L.

*Sonchus* L.

*Tagetes minuta* L

*Ursinia nana* DC.

*Vernonia galpinii* Klatt

*Vernonia natalensis* Oliv. & Hiern

*Vernonia oligocephala* (DC.) Sch.Bip. ex Walp.

*Vernonia poskeana* Vatke & Hildebr.

*Zinnia peruviana* (L.) L.

#### BRASSICACEAE

*Cycloptychis virgata* (Thunb.) E.Mey. ex Sond.

*Lepidium africanum* (Burm.f.) DC.

#### BUDDLEJACEAE

*Buddleja salviifolia* (L.) Lam.

*Nuxia congesta* R.Br. ex Fresen.

#### CACTACEAE

*Cereus jamacaru* DC.

*Opuntia ficus-indica* (L.) Mill.

#### CAMPANULACEAE

*Wahlenbergia undulata* (L.f.) A.DC.

#### CAPPARACEAE

*Cleome maculata* (Sond.) Szyszyl.

*Cleome monophylla* L.

*Cleome rubella* Burch.

#### CARYOPHYLLACEAE

*Dianthus mooiensis* F.N.Williams

*Pollichia campestris* Aiton

#### CELASTRACEAE

*Gymnosporia buxifolia* (L.) Szyszyl.

*Gymnosporia polyacantha* (Sond.) Szyszyl.

*Gymnosporia tenuispina* (Sond.) Szyszyl.

*Maytenus undata* (Thunb.) Blakelock

#### CELTIDACEAE

*Celtis africana* Burm.f.

#### CHENOPODIACEAE

*Chenopodium album* L.

#### CHRYSOBALANACEAE

*Parinari capensis* Harv.

#### COMBRETACEAE

*Combretum apiculatum* Sond.

*Combretum erythrophyllum* (Burch.) Sond.

*Combretum molle* R.Br. ex G.Don

*Combretum zeyheri* Sond.

*Terminalia sericea* Burch. ex DC.

#### COMMELINACEAE

*Commelina africana* L.

*Commelina benghalensis* L.

*Commelina eckloniana* Kunth

*Commelina erecta* L.

*Commelina* L.

*Cyanotis speciosa* (L.f.) Hassk.

*Floscopa glomerata* (Willd. ex Schult. & Schult.f.) Hassk.

#### CONVOLVULACEAE

*Convolvulus* L.

*Ipomoea obscura* (L.) Ker Gawl.

*Ipomoea ommaneyi* Rendle

*Ipomoea pellita* Hallier f.

*Ipomoea purpurea* (L.) Roth

*Xenostegia tridentata* (L.) D.F.Austin & Staples

#### CRASSULACEAE

*Crassula capitella* Thunb.

Crassula L.

Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp.

Crassula setulosa Harv.

Crassula swaziensis Schönland

Kalanchoe paniculata Harv.

Kalanchoe thyrsoflora Harv.

#### CUCURBITACEAE

Cucumis hirsutus Sond.

Cucumis L.

Cucumis zeyheri Sond.

#### CYPERACEAE

Bulbostylis hispidula (Vahl) R.W.Haines

Coleochloa setifera (Ridl.) Gilly

Cyperus congestus Vahl

Cyperus denudatus L.f.

Cyperus esculentus L.

Cyperus keniensis Kük.

Cyperus margaritaceus Vahl

Cyperus obtusiflorus Vahl

Cyperus rotundus L.

Cyperus rupestris Kunth

Cyperus sphaerospermus Schrad.

Fimbristylis dichotoma (L.) Vahl

Fuirena pubescens (Poir.) Kunth

Kyllinga alata Nees

Kyllinga alba Nees

Pycreus nitidus (Lam.) J.Raynal

Rhynchospora holoschoenoides (Rich.) Herter

Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J.Raynal

Schoenoplectus muricinux (C.B.Clarke) J.Raynal

#### DICHAPETALACEAE

Dichapetalum cymosum (Hook.) Engl.

## DIPSACACEAE

*Scabiosa columbaria* L.

## EBENACEAE

*Diospyros lycioides* Desf.

*Diospyros whyteana* (Hiern) F.White

*Euclea crispa* (Thunb.) Gürke

*Euclea undulata* Thunb.

## ERIOSPERMACEAE

*Eriospermum flagelliforme*

## EUPHORBIACEAE

*Acalypha angustata* Sond.

*Acalypha glabrata* Thunb.

*Acalypha villicaulis* Hochst.

*Clutia pulchella* L.

*Croton gratissimus* Burch.

*Dalechampia capensis* A.Spreng.

*Jatropha* L.

*Phyllanthus maderaspatensis* L.

*Phyllanthus parvulus* Sond.

*Spirostachys africana* Sond.

*Tragia rupestris* Sond.

## FABACEAE

*Abrus precatorius* L. subsp. *africanus* Verdc.

*Acacia ataxacantha* DC.

*Acacia caffra* (Thunb.) Willd.

*Acacia dealbata* Link

*Acacia karroo* Hayne

*Acacia mearnsii* De Wild.

*Burkea africana* Hook.

*Chamaecrista mimosoides* (L.) Greene

*Crotalaria* L.

*Crotalaria sphaerocarpa* Perr. ex DC.

*Elephantorrhiza burkei* Benth.

*Elephantorrhiza elephantina* (Burch.) Skeels  
*Eriosema cordatum* E.Mey  
*Eriosema salignum* E.Mey.  
*Erythrina lysistemon* Hutch.  
*Indigofera adenoides* Baker f.  
*Indigofera comosa* N.E.Br.  
*Indigofera filipes* Benth. ex Harv.  
*Indigofera oxytropis* Benth. ex Harv.  
*Indigofera spicata* Forssk.  
*Lotononis foliosa* Bolus  
*Mundulea sericea* (Willd.) A.Chev.  
*Neorautanenia ficifolius* (Benth.) C.A.Sm.  
*Ophrestia* H.M.L.Forbes  
*Pearsonia sessilifolia* (Harv.) Dummer  
*Rhynchosia monophylla* Schltr.  
*Rhynchosia nitens* Benth.  
*Rhynchosia totta* (Thunb.) DC.  
*Rhynchosia venulosa* (Hiern) K.Schum.  
*Sphenostylis angustifolia* Sond.  
*Tephrosia longipes* Meisn.  
*Tephrosia lupinifolia* DC.  
*Tephrosia rhodesica* Baker f.  
*Vigna vexillata* (L.) A.Rich.  
*Zornia linearis* E.Mey.  
*Zornia milneana* Mohlenbr.

#### FLACOURTIACEAE

*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.  
*Dovyalis zeyheri* (Sond.) Warb.  
*Scolopia zeyheri* (Nees) Harv.

#### GENTIANACEAE

*Chironia purpurascens* (E.Mey.) Benth. & Hook.f.  
*Sebaea bojeri* Griseb.  
*Sebaea longicaulis* Schinz

#### GERANIACEAE

*Pelargonium luridum* (Andrews) Sweet

#### HETEROPYXIDACEAE

*Heteropyxis natalensis* Harv.

#### HYACINTHACEAE

*Dipcadi viride* (L.) Moench

*Ledebouria marginata* (Baker) Jessop

*Ledebouria ovatifolia* (Baker) Jessop

*Ledebouria revoluta* (L.f.) Jessop

#### HYPOXIDACEAE

*Hypoxis argentea* Harv. ex Baker

*Hypoxis iridifolia* Baker

*Hypoxis multiceps* Buchinger ex Baker

*Hypoxis rigidula* Baker

#### HYPERICACEAE

*Hypericum aethiopicum* Thunb.

*Hypericum lalandii* Choisy

#### ICACINACEAE

*Apodytes dimidiata* E.Mey. ex Arn. subsp. *dimidiata*

#### IRIDACEAE

*Anomatheca* Ker Gawl.

*Gladiolus dalenii* Van Geel

*Gladiolus ecklonii* Lehm.

*Gladiolus elliotii* Baker

*Hesperantha grandiflora* G.J.Lewis

#### JUNCACEAE

*Juncus* L.

#### LAMIACEAE

*Becium obovatum* (E.Mey. ex Benth.) N.E.Br.

*Clerodendrum glabrum* E.Mey.  
*Clerodendrum triphyllum* = *Rothea hirsute*  
*Hemizygia pretoriae* (Gürke) M.Ashby  
*Leonotis leonurus* (L.) R.Br.  
*Leonotis ocymifolia* (Burm.f.) Iwarsson  
*Leucas glabrata* (Vahl) Sm.  
*Plectranthus madagascariensis* (Pers.) Benth.  
*Pycnostachys reticulata* (E.Mey.) Benth.  
*Salvia* L.  
*Stachys natalensis* Hochst.  
*Tetradenia riparia* (Hochst.) Codd

#### LOBELIACEAE

*Cyphia stenopetala* Diels  
*Monopsis decipiens* (Sond.) Thulin

#### LORANTHACEAE

*Tapinanthus* (Blume) Rchb.

#### MALPIGHIACEAE

*Sphedamnocarpus pruriens* (A.Juss.) Szyszyl.  
*Triaspis hypericoides* (DC.) Burch.

#### MALVACEAE

*Hibiscus aethiopicus* L.  
*Hibiscus calyphyllus* Cav.  
*Hibiscus cannabinus* L.  
*Hibiscus engleri* K.Schum.  
*Hibiscus pusillus* Thunb.  
*Pavonia burchellii* (DC.) R.A.Dyer  
*Pavonia transvaalensis* (Ulbr.) A.Meeuse  
*Sida alba* L.  
*Sida dregei* Burt Davy

#### MELIACEAE

*Melia azedarach* L.



MESEMBRYANTHEMACEAE

*Frithia humilis* Burgoyne

*Phyllobolus congestus* (L.Bolus) Gerbaulet

MOLLUGINACEAE

*Limeum viscosum* (J.Gay) Fenzl

MORACEAE

*Ficus ingens* (Miq.) Miq.

MYROTHAMNACEAE

*Myrothamnus flabellifolius* Welw.

MYRSINACEAE

*Myrsine africana* L.

MYRICACEAE

*Morella serrata* (Lam.) Killick

MYRTACEAE

*Eucalyptus camaldulensis* Dehnh.

OCHNACEAE

*Ochna pulchra* Hook.

OLACEAE

*Ximenia caffra* Sond.

ONAGRACEAE

*Ludwigia palustris* (L.) Elliott

ORCHIDACEAE

*Bonatea speciosa* (L.f.) Willd.

OROBANCHACEAE

*Striga elegans* Benth.

## OXALIDACEAE

- Oxalis corniculata* L.  
*Oxalis depressa* Eckl. & Zeyh.  
*Oxalis obliquifolia* Steud. ex Rich.

## PEDALIACEAE

- Ceratotheca triloba* (Bernh.) Hook.f.  
*Dicerocaryum eriocarpum* (Decne.) Abels  
*Sesamum triphyllum* Welw. ex Asch.

## PITTOSPORACEAE

- Pittosporum viridiflorum* Sims

## PLANTAGINACEAE

- Plantago* L.

## POACEAE

- Agrostis lachnantha* Nees  
*Alloteropsis semialata* (R.Br.) Hitchc.  
*Andropogon chinensis* (Nees) Merr.  
*Andropogon eucomus* Nees  
*Andropogon huillensis* Rendle  
*Andropogon schirensis* A.Rich.  
*Aristida bipartita* (Nees) Trin. & Rupr.  
*Aristida congesta* Roem. & Schult.  
*Aristida congesta* Roem. & Schult.  
*Aristida diffusa* Trin.  
*Aristida stipitata* Hack.  
*Aristida transvaalensis* Henrard  
*Arundinella nepalensis* Trin.  
*Bewsia biflora* (Hack.) Gooss.  
*Bothriochloa insculpta* (A.Rich.) A.Camus  
*Brachiaria serrata* (Thunb.) Stapf  
*Cymbopogon excavatus* (Hochst.) Stapf ex Burtt Davy  
*Cymbopogon nardus* (L.) Rendle  
*Cymbopogon pospischilii* (K.Schum.) C.E. Hubb.  
*Cynodon dactylon* (L.) Pers.

*Digitaria eriantha* Steud.  
*Digitaria monodactyla* (Nees) Stapf  
*Diheteropogon amplectens* (Nees) Clayton  
*Echinochloa pyramidalis* (Lam.) Hitchc. & Chase  
*Eleusine coracana* (L.) Gaertn.  
*Elionurus muticus* (Spreng.) Kuntze  
*Enneapogon scoparius* Stapf  
*Eragrostis chloromelas* Steud.  
*Eragrostis curvula* (Schrud.) Nees  
*Eragrostis gummiflua* Nees  
*Eragrostis inamoena* K.Schum.  
*Eragrostis lappula* Nees  
*Eragrostis lehmanniana* Nees  
*Eragrostis nindensis* Ficalho & Hiern  
*Eragrostis plana* Nees  
*Eragrostis racemosa* (Thunb.) Steud.  
*Eragrostis rigidior* Pilg.  
*Eragrostis superba* Peyr.  
*Eulalia villosa* (Thunb.) Nees  
*Eustachys paspaloides* (Vahl) Lanza & Mattei  
*Harpochloa falx* (L.f.) Kuntze  
*Heteropogon contortus* (L.) Roem. & Schult.  
*Hyparrhenia filipendula* (Hochst.) Stapf  
*Hyparrhenia hirta* (L.) Stapf  
*Hyparrhenia tamba* (Steud.) Stapf  
*Imperata cylindrica* (L.) Raeusch.  
*Ischaemum fasciculatum* Brongn.  
*Leersia hexandra* Sw.  
*Loudetia simplex* (Nees) C.E.Hubb.  
*Melinis nerviglumis* (Franch.) Zizka  
*Melinis repens* (Willd.) Zizka  
*Microchloa caffra* Nees  
*Miscanthus capensis* (Nees) Andersson  
*Miscanthus junceus* (Stapf) Pilg.  
*Monocymbium cerasiiforme* (Nees) Stapf  
*Panicum coloratum* L.  
*Panicum dregeanum* Nees

*Panicum maximum* Jacq.  
*Panicum natalense* Hochst.  
*Paspalum dilatatum* Poir.  
*Paspalum distichum* L.  
*Paspalum scrobiculatum* L.  
*Paspalum urvillei* Steud.  
*Pennisetum clandestinum* Hochst. ex Chiov.  
*Pennisetum macrourum* Trin.  
*Pennisetum sphacelatum* (Nees) T.Durand & Schinz  
*Perotis patens* Gand.  
*Phragmites australis* (Cav.) Steud.  
*Pogonarthria squarrosa* (Roem. & Schult.) Pilg.  
*Schizachyrium jeffreysii* (Hack.) Stapf  
*Schizachyrium sanguineum* (Retz.) Alston  
*Setaria lindenbergiana* (Nees) Stapf  
*Setaria sphacelata* (Schumach.) Moss  
*Sporobolus africanus* (Poir.) Robyns & Tournay  
*Sporobolus festivus* A.Rich.  
*Sporobolus pectinatus* Hack.  
*Themeda triandra* Forssk.  
*Trachypogon spicatus* (L.f.) Kuntze  
*Tragus berteronianus* Schult.  
*Tricholaena monachne* (Trin.) Stapf & C.E.Hubb.  
*Trichoneura grandiglumis* (Nees) Ekman  
*Triraphis andropogonoides* (Steud.) E.Phillips  
*Tristachya biseriata* Stapf  
*Tristachya leucothrix* Nees  
*Tristachya rehmannii* Hack.  
*Urelytrum agropyroides* (Hack.) Hack.

#### POLYGALACEAE

*Polygala hottentotta* C.Presl  
*Polygala transvaalensis* Chodat  
*Polygala uncinata* E.Mey. ex Meisn.

#### POLYGONACEAE

*Oxygonum dregeanum* Meisn.

*Oxygonum sinuatum* (Hochst. & Steud. ex Meisn.) Dammer

*Persicaria attenuata* (R.Br.) Soják

*Persicaria decipiens* (R.Br.) Wilson

*Persicaria lapathifolia* (L.) Gray

#### PORTULACACEAE

*Portulaca oleracea* L.

*Portulaca quadrifida* L.

#### PROTEACEAE

*Faurea saligna* Harv.

*Protea caffra* Meisn.

*Protea welwitschii* Engl.

#### RHAMNACEAE

*Rhamnus prinoides* L'Hér.

*Ziziphus mucronata* Willd.

#### RANUNCULACEAE

*Clematis brachiata* Thunb.

#### ROSACEAE

*Leucosidea sericea* Eckl. & Zeyh.

#### RUBIACEAE

*Agathisanthemum bojeri* Klotzsch

*Anthospermum hispidum hispidulum* E.Mey. ex Sond.

*Canthium gilfillanii* (N.E.Br.) O.B.Mill.

*Canthium mundianum* Cham. & Schltld.

*Fadogia homblei* De Wild.

*Kohautia amatymbica* Eckl. & Zeyh.

*Kohautia caespitosa* Schnizl.

*Kohautia cynanchica* DC.

*Kohautia virgata* (Willd.) Bremek.

*Oldenlandia herbacea* (L.) Roxb.

*Oldenlandia lancifolia* (Schumach.) DC.

*Pachystigma pygmaeum* (Schltr.) Robyns

*Pavetta zeyheri* Sond.  
*Pentanisia angustifolia* (Hochst.) Hochst.  
*Pygmaeothamnus zeyheri* (Sond.) Robyns  
*Richardia brasiliensis* Gomes  
*Rothmannia capensis* Thunb.  
*Spermacoce natalensis* Hochst.  
*Tricalysia lanceolata* (Sond.) Burt Davy  
*Vangueria cyanescens* Robyns  
*Vangueria infausta* Burch.  
*Vangueria parvifolia* Sond.

#### RUTACEAE

*Vepris lanceolata* (Lam.) G.Don  
*Vepris reflexa* I. Verd.  
*Zanthoxylum capense* (Thunb.) Harv.

#### SALICACEAE

*Populus X canescens* (Aiton) Sm.

#### SANTALACEAE

*Osyris lanceolata* Hochst. & Steud.  
*Thesium utile* A.W.Hill

#### SAPINDACEAE

*Pappea capensis* Eckl. & Zeyh.

#### SAPOTACEAE

*Englerophytum magalismsontanum* (Sond.) T.D.Penn.  
*Mimusops zeyheri* Sond.

#### SCROPHULARIACEAE

*Hebenstretia angolensis* Rolfe  
*Jamesbrittenia* Kuntze  
*Nemesia fruticans* (Thunb.) Benth.  
*Selago densiflora* Rolfe  
*Sutera* Roth  
*Zaluzianskya elongata* Hilliard & B.L.Burt

## SOLANACEAE

*Datura stramonium* L.  
*Solanum lichtensteinii* Willd.  
*Solanum mauritianum* Scop.  
*Solanum nigrum* L.  
*Solanum retroflexum* Dunal  
*Solanum retroflexum* Dunal  
*Solanum seforthianum* Andrews  
*Solanum sisymbriifolium* Lam.

## STERCULIACEAE

*Dombeya rotundifolia* (Hochst.) Planch.  
*Hermannia depressa* N.E.Br.  
*Hermannia lancifolia* Szyszyl.

## STRYCHNACEAE

*Strychnos madagascariensis* Poir.  
*Strychnos pungens* Soler.

## TILIACEAE

*Corchorus asplenifolius* Burch.  
*Grewia occidentalis* L.  
*Triumfetta* L.

## THYMELAEACEAE

*Gnidia caffra* (Meisn.) Gilg  
*Gnidia capitata* L.f.  
*Gnidia sericocephala* (Meisn.) Gilg ex Engl.

## TYPHACEAE

*Typha capensis* (Rohrb.) N.E.Br.

## VELLOZIACEAE

*Xerophyta retinervis* Baker  
*Xerophyta viscosa* Baker

## VERBENACEAE

*Chascanum hederaceum* (Sond.) Moldenke

*Lantana camara* L.

*Lantana rugosa* Thunb.

*Verbena bonariensis* L.

*Verbena brasiliensis* Vell.

## VISCACEAE

*Viscum* L.

## VITACEAE

*Cyphostemma setosum* (Roxb.) Alston

*Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm.

## ZYGOPHYLLACEAE

*Tribulus zeyheri* Sond.