

THE VEGETATION ECOLOGY OF URBAN OPEN SPACES IN GAUTENG

by

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Submitted in fulfilment of the requirements

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MAGISTER SCIENTIAE

In the Faculty of

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A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity.

A Sand County Almanac
Aldo Leopold
1949



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

**Dedicated to my Family and Friends
and All who assisted me along the way**

ABSTRACT

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A vegetation survey of natural woodland and grassland was undertaken in the urban areas of the Gauteng Province, where 7,3 million of the 38,5 million people of South Africa live. Relevés were compiled in 132 stratified random sample plots in selected open spaces in the study area. A TWINSpan classification, refined by Braun-Blanquet procedures, indicated six woodland communities represented by 72 relevés, and eight grassland communities represented by 59 relevés. The identification, classification and description of these plant communities are important for the continued conservation of open spaces in the urban environment in order to integrate landscape ecological mapping and urban spatial planning processes.

The study further recorded a high number of species. It indicated that the natural areas in the urban environment have a high conservation status and maintain a high species richness. This information could in future be used for further biodiversity studies in the Province. Species with low occurrence were specifically listed and can be used to inform "red data" status research initiatives.

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CHAPTER 1

INTRODUCTION

In certain European countries landscape ecological mapping and evaluation has become an essential part of the planning process (Spellerberg, 1992). Through this process, disturbance to areas with vulnerable habitats or species could be restricted and undue fragmentation of wildlife habitat, avoided (Helliwell, 1973). The classification of vegetation types and subtypes in a biome is important since it would result in ecological interpretable units which can be used for environmental planning, management and conservation (Matthews, 1991).

Two theories that deliberated and researched fragmentation and isolation of natural areas are landscape ecology and island biogeography. The science of landscape ecology, (Forman & Godron 1981), describes how human activities change the scale and pattern of a mosaic of patches in the landscape to influence and change natural equilibrating systems to non-equilibrating systems (Urban, O'Neill & Shugart 1987). Similarly, the theory of island biogeography (McArthur & Wilson 1967) elaborates on the impact of fragmentation and isolation on eco-systems and how this negatively affects eco-system functioning. In light of the above, it should be stated that the knowledge of the state of vegetation in the urban environment will allow for the monitoring and detection of eco-system degradation, which will lead to assessing the effectiveness of policy and legislation regarding land-uses and consequent eco-system fragmentation (Goldsmith 1995). Changes to policies and legislation to prevent degradation could then be initiated.

People's need for open spaces have increased over the years with emphasis on contact with nature, the study thereof and the aesthetic satisfaction of scenic landscapes. Natural areas in or near cities are needed not only for study purposes and for urban beauty but also due to the public's growing understanding and concern about environmental change and the disadvantages of changed non-functioning eco-systems (Goudie, 1994).

The natural urban areas in Gauteng presently support a high plant species richness as is evident from the studies done in this area, listed below. Of the 67 red data plant species recorded for the Gauteng Province, approximately 55 occur in the urban environment (Gauteng, 2000a). Soulé (1989) maintains that the conservation of small

remaining wild habitats could slow down the extinction rate of animals and plants. This confirms the importance of surveying and conserving the small vegetation habitats of the urban environment and confirms the need for involvement of environmental, conservation and planning authorities in planning and conserving natural urban areas.

A number of studies have been done on smaller urban areas of Gauteng. These include published papers and unpublished reports. Some of these studies include the Melville Koppies Nature Reserve (Ellery 1992, 1994), Lonehill, Sandton, Groenkloof and The Willows (Bredenkamp 1991, 1992, 1997a & b) as well as projects on a larger area by Bredenkamp and Brown (1998a & b) on the vegetation of the Johannesburg Western and Northern Metropolitan Local Council areas. A vegetation assessment was further done by Behr and Bredenkamp (1988) on the Witwatersrand National Botanical Garden in Roodepoort. The study area of a vegetation assessment of the Ib and Ba landtypes by Coetzee *et al.* (1994) overlaps with this study area but does not specifically refer to urban natural areas. The vegetation of the Suikerbosrand Nature Reserve (Bredenkamp & Theron 1978, 1980) also shows resemblance with the vegetation of this study area.

Further afield, Cilliers & Bredenkamp (1999a) described the vegetation of natural areas in the Potchefstroom municipal area. They analysed the spontaneous vegetation of intensely managed urban open spaces (Cilliers & Bredenkamp 1999b), the ruderal and degraded natural vegetation on vacant lots (Cilliers & Bredenkamp 1999c), the vegetation of the railway reserves (Cilliers & Bredenkamp 1998), the vegetation on road verges on an urbanisation gradient (Cilliers & Bredenkamp 2000) and the wetland plant communities in the Potchefstroom Municipal area (Cilliers *et al.* 1998). Other urban vegetation studies in South Africa include the vegetation of the ridges of Klerksdorp by Van Wyk *et al.* (1997), the vegetation of the Durban municipal area by Roberts (1993) and in Bloemfontein, Free State (Dingaen, 1999). These studies all indicate that a wide variety of ecosystems function in small and often isolated natural areas. These studies further indicate in general terms that the content of the study should inform land-use planning and conservation planning in the urban environment.

The study area is situated in the Gauteng Province, the smallest of 9 provinces of South Africa, covering an area of only 16 191km². Approximately 7,3 million of the

38,5 million people in SA live in Gauteng. According to the information contained in the Gauteng Municipal Structure Status Quo report, which is based on the 1996 census, the estimated population for Gauteng is 7 348 426, of which 96% are urban and 4% are non-urban (Gauteng 2000b). It is therefore understandable that the biggest threat to the natural areas in the Gauteng urban environment is urbanisation. In the urban environment, and on the urban edge, complete habitats are constantly lost and impacts associated with human activities such as trampling, exotic plant invasion and often ill-advised management practices are common characteristics of these areas.

The objective of this study was therefore to investigate the vegetation ecology in the urban environment of Gauteng in order to identify the various vegetation types and sub-types occurring here. In addition, the localities of these plant communities were used to determine the environmental characteristics, which shaped these communities in order to improve the natural vegetation database in the Gauteng urban environment. Such a comprehensive study has not previously been undertaken in the study area. This information should contribute to conservation of different types of natural habitat in urban areas and beyond, ensuring that nature conservation is incorporated into land-use planning initiatives.

The results of this study are in the form of manuscripts, which have been submitted for publications in a scientific journal. Details of the study area, methods, results, discussion and references are presented as individual chapters. An overview of the principal findings as well as recommendations regarding urban open spaces is included in chapter 6.

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CHAPTER 2

STUDY AREA

Location

The study area is located between 27° 40'E to 28°25'E and 25°40'S to 26°20'S approximately in the centre of the Gauteng province (Figure 1). The 1: 250 000 topographical maps affected are the 2528 Pretoria, 2626 West Rand, 2628 East Rand and 2526 Rustenburg maps. The study area principally includes the Pretoria-Midrand-Johannesburg urban areas though it expands westwards towards Krugersdorp.

The area is predominantly situated in the Grassland biome (Rutherford & Westfall 1986) but partly includes the Magaliesberg in the north, which is located in the Savanna biome (Rutherford & Westfall 1986). Acocks (1988) recognises three veld types in the study area namely Sourish Mixed Bushveld (Veld Type 19), Sour Bushveld (Veld Type 20) and Bankenveld (Veld Type 61). Bredenkamp and Van Rooyen (1996b, d & e) recognise 3 vegetation types in this area, namely Mixed Bushveld, Moist Cool Highveld Grassland and Rocky Highveld Grassland (Figure 2). Other vegetation types in the Gauteng province include Clay Thom Bushveld and Moist Clay Highveld Grassland (Figure 2) (Bredenkamp & Van Rooyen 1996a & c).

Altitudes in Gauteng vary from 1 081m to 1 899 above sea level, with a mean altitude of 1 512m (Gauteng 2000). The altitude of the study area is however between 1 400 to 1 800 m above sea level.

Drainage

The two major catchments that drain the study area, are the Crocodile River and Vaal River primary catchment areas with the main rivers and tributaries the Crocodile, Jukskei, Blesbokspruit, Suikerbosrand, Klip and Vaal rivers. The Crocodile river eventually drains to the east coast and the Vaal river to the west coast which places the study area on a major water shed of South Africa.

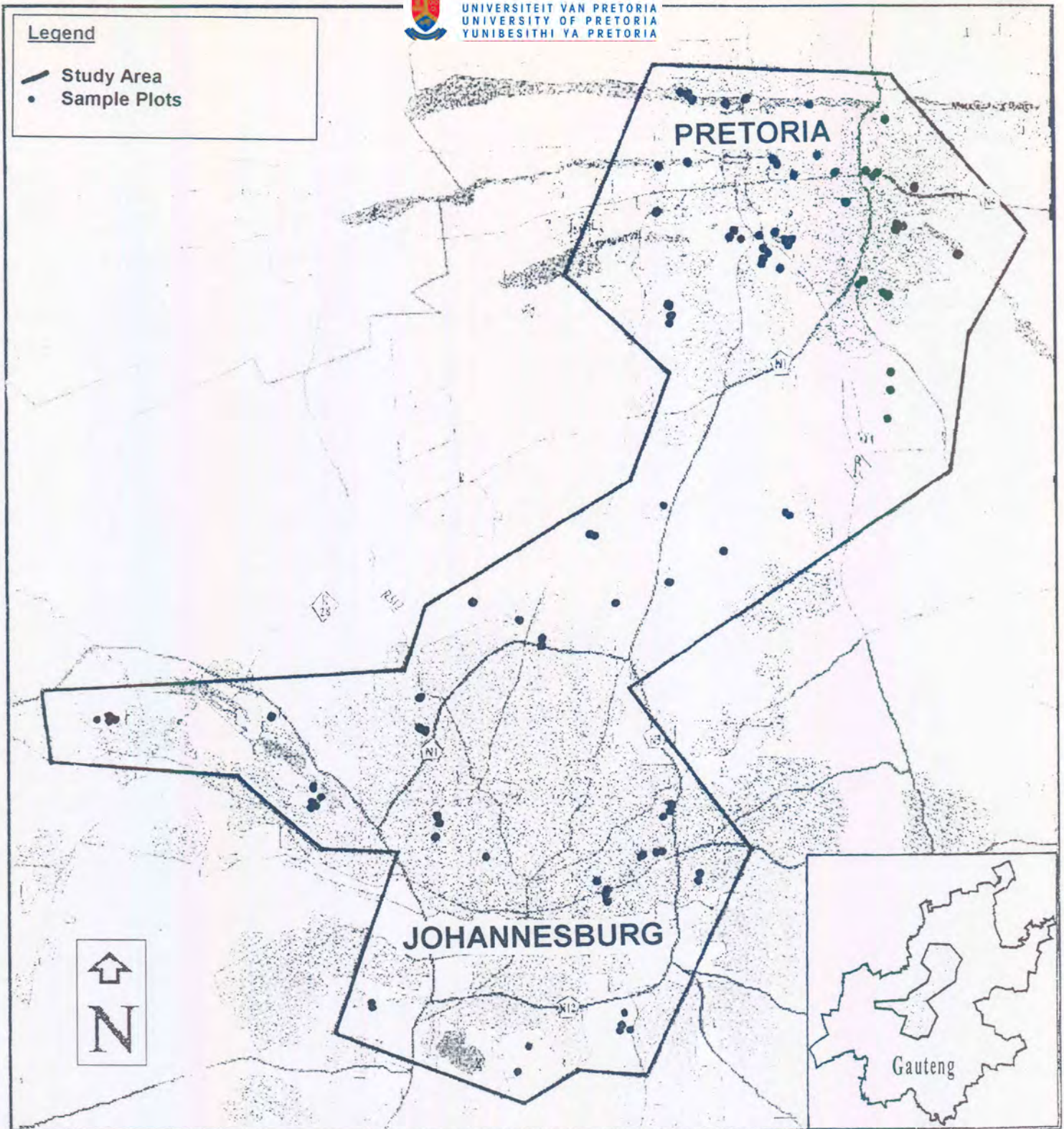


Figure 1. The study area is located within the Gauteng Province and 132 sample plots were placed in the various urban open spaces in order to describe the vegetation found growing there (Scale 1:670 000).

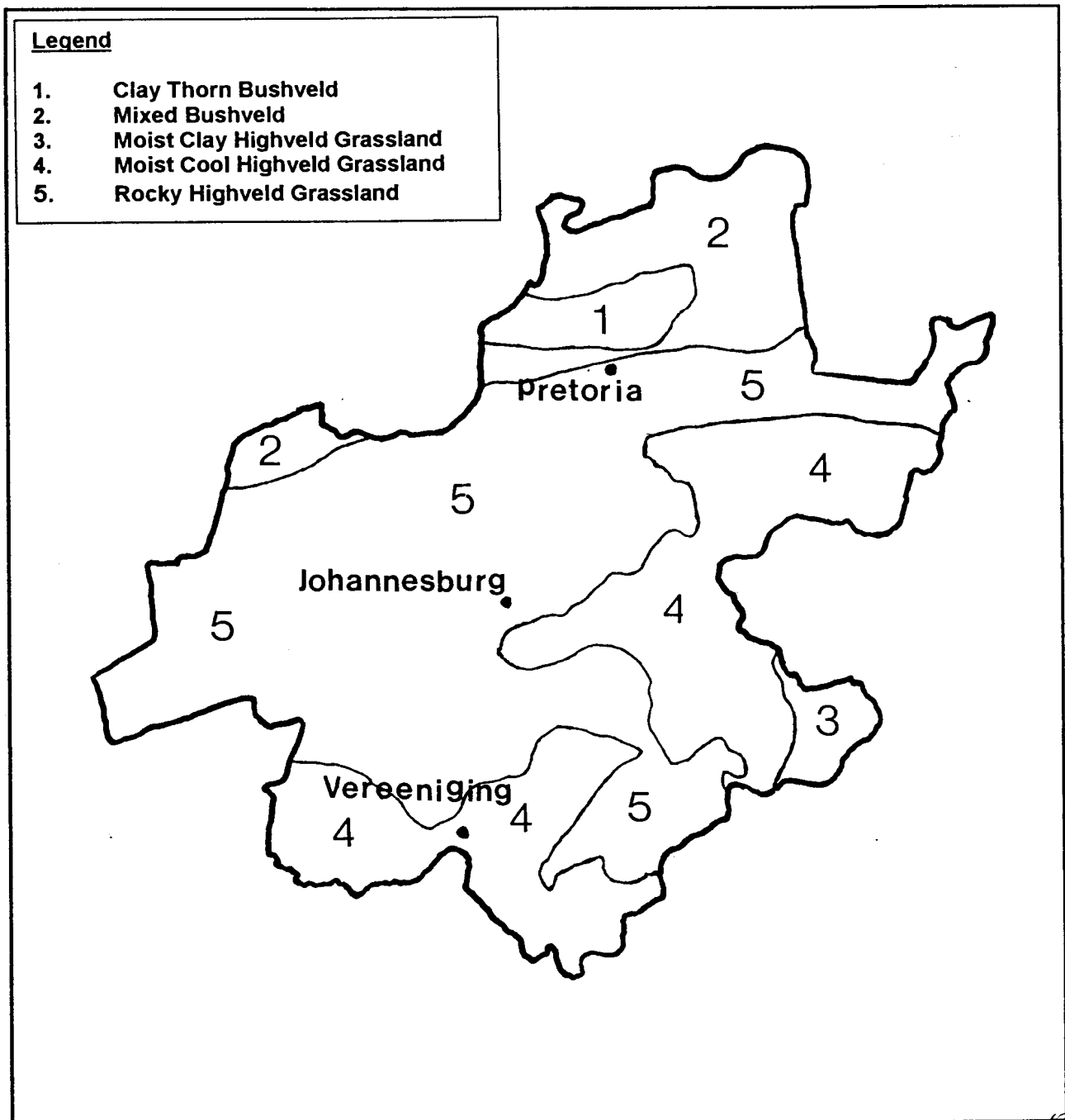


Figure 2. The five dominant vegetation types occurring in the Gauteng Province. Seventeen percent of the Province is covered by bushveld, whereas grassland comprises 83% of the area (Adapted from the National Botanical Institute, 1996).

Geology

In the Pretoria area the main geological formations are the Daspoort, Timeball Hill and Magaliesberg formations from the Pretoria Group. In the Centurion area, dolomite and chert from the Chuniespoort Group are found. Halfway House Granites are found from Johannesburg towards Midrand. South of Johannesburg, a number of geological formations occur in predominantly east-west striking bands. These include the Klipriviersberg and Platberg Groups from the Ventersdorp Supergroup, the Orange Grove formation, Hospital Hill Subgroup, Government Subgroup and Jeppestown Subgroup from the West Rand Group (Witwatersrant Supergroup) and the Turffontein and Johannesburg Subgroups from the Central Rand Group (Witwatersrant Supergroup) (Department of Mineral and Energy Affairs 1984).

Land type

The land type classes observed in this study area relate to the Map units Aa–Ai which have Red-yellow apedal, freely drained soils, Map units Ba–Bd which have a Plinthic catena, while upland duplex and margalitic soils are rare and Map units Ia–Ic which are Miscellaneous land classes. The most important land type classes represented in this study area were Ab1, Bb1, Bb2, Ba7, Ba9, Ib3, Ib7, Ib41 and Ib43. (Landtype survey staff 1985,1987a&b,). Table 1 indicates the underlying geology of the main land types observed.

Topographic description

The country around Pretoria is characterised by ridge and valley topography. Prominent ridges include the Daspoort rant, Pierneefrant, Bronberg and Magaliesberg. The central business district (CBD) of Pretoria lies between the Langeberge and Daspoortrant. Both are prominent quartzite ridges that stretch for considerable distances further to the south-east and south-west of the city. South of the CBD, from the Fountains Valley in the direction of Midrand, the topography rises gently with the Groenkloof and Voortrekkerhoogte Nature reserves forming prominent open spaces. From here, southwards, the landscape is typically open and flat, with

the only hills of note, the Zwartkop in the far west, as well as Alwyn Kop, Bays Hill and Smuts Koppie and other less prominent ridges.

Johannesburg has a gently rolling topography and the geology in the study area is mainly granite. In the Leeukop-Khayalami vicinity a number distinct koppies are visible in an otherwise gentle rolling landscape. Occasional high ridges and hills are found to the west, east and south of Johannesburg.

They include the Linksfield ridge, Bill Steward Nature Reserve, Yeoville ridge and Langermanskop to the east and the Melville Koppies Nature reserve, Northcliff ridge and Bush hill ridge to the west. A high ridge, known as the Roodepoort (or Protea) ridge to the west of Johannesburg, stretches from Krugersdorp in the west to Edenvale in the east. The Klipriviersberg is an impressive east west striking small mountain range in the far south of Johannesburg and Alberton. The Orlando hill is situated to the west of this mountain range. Further to the south the topography is relatively subdued. The landscape also plays host to the flat-topped slimes dams of the gold mines that existed in the area.

Soils

The main soil families found in the study area are Mispah, Southwold, Trevanian, Glenrosa, Williamson, Msinga, Klipfontein, Sandvlei, Robmore, Glendale and Platt with a clay content ranging between 10–30% (Landtype survey staff 1985,1987a & b).

Climate

Climatic data from the Pretoria Forum WB, Johannesburg Joubert Park, Krugersdorp Kroningspark and Leeukop Johannesburg weather stations were used. No temperature data were available from the Leeukop weather station in the Midrand area (Weather Bureau, 2000).

Temperature

The mean annual temperature varies across the province from 14.8°C in the south to 18.7°C in the north. Situated in the high altitude interior plateau, Gauteng is subject to larger variation in temperature than coastal areas.

The average minimum temperature for the province is 9.8°C although an absolute minimum of -8°C has been recorded at Johannesburg International Airport. The average maximum temperature is 24.5°C but a maximum of 36°C has been recorded in Pretoria (Gauteng 1997).

The mean monthly temperature in the study area for the weather stations listed below is 16.8°C with a mean maximum of 22.6°C and a mean minimum of 10.8°C (Table 2).

Precipitation

The mean annual rainfall in Gauteng is 670 mm per year (Gauteng 1997). Table 3 indicates the maximum, minimum and mean rainfall for the Pretoria Forum WB, Johannesburg Joubert Park and Krugersdorp Kroningspark weather stations (1961–1990) and the mean rainfall for the Leeukop Johannesburg weather stations (1951–1999).

Table 1: The underlying geology of the main land types observed in the study area (Department of Mineral and Energy Affairs 1984)

Landtype	Underlying geology
Ab1b	Dolomite, chert, shale and quartzite of the Chuniespoort Group, Transvaal Sequence.
Ba7	Shale, quartzite, siltstone, chert and hornfels of the Silverton, Daspoort and Timeball Hill Formations (Transvaal Sequence) and diabase.
Ba9a	Shale, quartzite, hornfels and chert of the Pretoria Group, diabase, andesite of the Hekpoort Formation (Transvaal Sequence).
Bb1b	Granite and migmatite of the Halfway House Intrusion and quartzite, shale and siltstone of the Pretoria Group, andesite of the Hekpoort Formation, diabase and some occurrence of dolomite and chert.
Bb2c	Granite, gneiss and migmatite of the Halfway House Granite.
Ib3a	Quartzite of the Magaliesberg Formation, shale, slate and hornfels of the Silverton Formation, diabase sills, quartzite of the Daspoort formation. Sporadic occurrence of shale and siltstone of the Strubenkop Formation.
Ib7a	Quartzite, shale and siltstone of the Pretoria Group, andesite of the Hekpoort Formation, diabase and some occurrence of dolomite and chert
Ib41	Witwatersrand quartzite, slate, grit and conglomerate predominantly; sporadic occurrence of Black Reef quartzite, shale, grit and conglomerate in the west. Basement Complex granite, amphibolite, serpentinite, talc schist and Ventersdorp lava also occur sporadically, Occasional diabase sills in Witwatersrand Supergroup.
Ib43	Ventersdorp lava, breccia and tuff

Table 2: Average daily temperature between 1961 and 1990 as provided by the Weather Bureau (2000).

Month	Weather stations								
	Pretoria Forum WB 1330m			Johannesburg Joubert Park 1753m			Krugersdorp Kroningspark 1699m		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Jan.	28.6	17.5	23.0	25.3	15.4	20.4	28.1	14.6	20.4
Feb.	28.9	17.2	22.6	24.9	15.0	19.9	25.5	14.2	19.8
Mar.	27.0	16.0	21.5	23.8	14.0	18.9	24.3	12.9	18.6
Apr.	24.1	12.2	18.2	20.9	11.4	16.1	21.3	9.4	15.4
May.	21.9	7.8	14.9	18.6	8.5	13.5	19.1	5.6	12.4
Jun.	19.1	4.5	11.8	15.7	5.6	10.6	16.3	2.4	9.4
Jul.	19.6	4.5	12.0	16.4	5.8	11.1	16.9	2.4	9.6
Aug.	22.2	7.6	14.9	18.9	7.8	13.4	19.4	4.7	12.0
Sep.	25.5	11.7	18.6	22.3	10.7	16.5	22.9	8.7	15.8
Oct.	26.6	14.2	20.4	23.2	12.2	17.7	24.0	10.9	17.4
Nov.	27.1	15.7	21.4	23.8	13.5	18.6	24.5	12.5	18.6
Dec.	28.0	16.8	22.4	25.0	14.6	19.8	25.7	13.7	19.7
Yearly	24.0	12.1	18.5	21.6	11.2	16.4	22.2	9.3	15.7



Table 3: The rainfall for 4 weather stations in the study area

Month	Weather stations					
	Pretoria Forum WB1330m			Johannesburg Joubert Park 1753m		
	Max.	Min.	Mean	Max.	Min.	Mean
Jan.	490	39	136	328	52	149
Feb.	218	25	75	292	18	100
Mar.	173	17	82	207	14	95
Apr.	115	0	51	161	5	63
May.	60	0	13	78	0	16
Jun.	56	0	7	66	0	10
Jul.	20	0	3	23	0	4
Aug.	30	0	6	103	0	9
Sep.	75	0	22	185	0	30
Oct.	159	10	71	225	1	78
Nov.	188	19	98	216	37	122
Dec.	199	34	110	263	26	126
Yearly	913	372	674	1174	498	802

Table 3 continue: The rainfall for 4 weather stations in the study area

	Weather stations					
	Leeukop Johannesburg 1496m			Krugersdorp Kroningspark 1699m		
Month	Mean	-	-	Max.	Min.	Mean
Jan.	118.8	-	-	440	30	138
Feb.	96.6	-	-	204	24	96
Mar.	85.1	-	-	227	13	96
Apr.	52.9	-	-	145	5	64
May.	14.8	-	-	124	0	17
Jun.	6.8	-	-	43	0	8
Jul.	3.6	-	-	31	0	4
Aug.	7.7	-	-	57	0	8
Sep.	19.5	-	-	122	0	24
Oct.	69.0	-	-	163	15	69
Nov.	106.5	-	-	210	27	102
Dec.	107.4	-	-	210	29	110
Yearly	699.6	-	-	1056	427	736

Site description

The following short descriptions are provided for each of the areas where surveys were done, in alphabetical order. Local authority boundaries and local authority names change rapidly and are therefore loosely used. The sizes used per site included the all-natural sections of the site and/or only those sections of the site located in the urban environments. Reference is made to some exotic infestation, although the sites were predominantly undisturbed. Suburbs are indicated according to the Pretoria, Centurion and Midrand (1997/1998) and Witwatersrand (1996/1997) Map Studio books.

Albert's Farm

Albert's Farm is located in Northcliff, Johannesburg. It is a 77 ha open space consisting of a mosaic of natural vegetation and recreational areas. Fifty-three species were recorded on 2 sample plots. Presently this park is used by people for a variety of recreational activities and is characterised by a variety of features and habitats. These include a dam with fishing and picnic infrastructure. The Montgomery river and associated wetland runs through the southern part of the property. The farm Waterfal 79 on which Alberts Farm open space is situated, previously belonged to the Alberts family who sold this part of the farm to the Johannesburg City Council in 1952 for £60 000 for 110.64 acres (Allan Buff, pers comm). The exotic vegetation includes large patches of *Populus x canescens* (grey poplar), *Arundo donax* (giant reed) and to a lesser extent *Acacia meamsii* (black wattle).

Beaulieu hill

The Beaulieu hill refers to an area located on the farm Witpoort 406 JR in Midrand. It is 2 ha in size. 92 species were recorded on 3 sample plots. This site was selected due to it being identified as a "sensitive" area in a metropolitan open space study done by the local authority. The site was zoned as "agriculture" at the time of the survey and consisted of three adjoining smallholdings. Subsequently, one section of this koppie was used for the construction of an upmarket residential developed and

the vegetation severely disturbed. Giant eagle owls were observed during the survey in the closed woodland at the lower end of the site. A variety of exotic species was encountered in the closed woodland with specific reference to the cactus *Cereus peruvianus* (queen of the night) from South America.

Bill Steward Nature Reserve

The Bill Steward Nature Reserve is located in Bedfordview, Johannesburg. The Site is 75 ha in size. Seventy-seven species were recorded on 3 sample plots. The site itself is a north-east running ridge with a plateau and a north western slope. The site is completely surrounded by urban development. This site forms a visual landmark in the Gillooly's Farm area as it is visible from the N3, N2, R21 and N12 highways. A power line runs all along this nature reserve. The site is utilized by the public for passive recreation.

Blougat Nature Area

The Blougat Nature Area is 119 ha in size and the Blougat spruit runs through it. This Nature Area is situated directly adjacent to the extending residential suburbs of Munsieville. It is further situated directly east of the Krugersdorp Game Reserve, the Delporton industrial area and Krugersdorp Airfield. Ninety-five species were recorded here on 4 sample plots.

* Allan Buff. Manager: Cemeteries and Crematoriums. Johannesburg Metropolitan Local Council.

The site is unfenced, and the informal settlements on the immediate border of this site, presents a grave concern for the future existence of the site. Pollution on the higher lying slopes also presents constant pollution sources to the Blougat Spruit. The riverine vegetation is severely encroached by *Acacia meamsii* (black wattle) and *Pennisetum clandestinum* (kikuyu grass).

Bronberg Nature Area

The Bronberg is a natural ridge to the east of Pretoria running through the suburbs Faerie Glen, Wapadrand and Lynnwood. It is 362 ha in size and hundred and ninety two species were recorded here on 6 sample plots. This ridge is under extreme pressure for development and attempts are made to conserve it. The ridge includes the Faerie Glen Nature Reserve to the west, which is accessible to the public for passive recreation. The section of the Bronberg surveyed for this study extends up to the suburbs just east of the major Hans Strydom road eastern bypass.

Bush Hill Koppie Nature Reserve

The Bush Hill Koppie Nature Reserve is a 25 ha north-south stretching ridge just west of the N1 highway in Boskruin, Randburg. Forty-one Species were recorded on 2 sample plots. The western slope is more or less completely built up and shows signs of infestation by exotic vegetation such as *Acacia meamsii* (black wattle) and *Eucalyptus* sp. The crest area is very small due to the steep western and eastern slopes joining at the top of the ridge. The site is further completely surrounded by urban development. The site is not accessible for utilization by the public.

Clayville

The Clayville site is located in the suburb of Clayville, Olifantsfontein. Fifty-five species were recorded here on 2 sample plots. This site is prone to be developed in the near future.

Colbyn valley Nature Area (CVNA) – ridge only

The CVNA is approximately 51 ha in size (excluding the flatter and wetter areas to the south of the ridge). The area is a west-east stretching ridge in the Colbyn suburb of Pretoria in close proximity to the N4 and N1 crossing and is an extension of the Daspoortrant. Eighty-six species were recorded on 2 sample plots. Also located on this ridge to the west, is the Union Building and to the east, the National Botanical Gardens. The northern slope of the site is developed as a residential area. The close vicinity of residential development, has made the CVNA susceptible to impacts by such as exotic vegetation with reference to escaped garden plants as well as human related activities like footpaths, trampling and litter. Rare plant species occur on this site.

Daspoort rant

In the urban areas of Pretoria, the Daspoort rant covers 180 ha undeveloped land and is located to the north of Danville and south of the Pretoria Gardens suburbs of Pretoria. Hundred and seven species were recorded on 4 sample plots. This ridge was initially protected by the Greater Pretoria Guideplan – a guideplan that formally protected ridges and rivers in the Pretoria area until November 1995. This ridge has therefore to a large extent been conserved. Presently Local Authority Land Development Objective planning guidelines keeps this ridge free from development. The vegetation shows no major signs of degradation. It further forms an important feature in the landscape of Pretoria.

DBSA

The DBSA site refers to the grasslands visible to the west of the N1 highway, south of the Development Bank of South Africa (DBSA) at the Olifantsfontein offramp in Midrand. 35 species were recorded on 1 sample plot. The site shows signs of agricultural activities with reference to old ploughed lands. This site is prone to be developed in the near future.

Erasmuskloof

The Erasmuskloof site is a natural 103 ha piece of land visible to the east of the N1 highway and north of Rigel road, in Pretoria. Forty-four species were observed on 2 sample plots. The land is zoned as “agriculture” and may be developed in future. The southwestern part of the site is heavily infested with *Acacia meamsii* (black wattle).

Fourways Gardens

The Fourways Gardens Nature Reserve is 12 ha in size and is situated inside the Fourways Gardens residential development in Fourways, Johannesburg. Twenty-nine species were recorded on 1 sample plot. Zebra and ostrich are kept on this area.

Glen Austin Pan

The Glen Austin Pan and immediate surrounding area, is approximately 10 ha in size and is located on the Glen Austin Agricultural Holdings in Midrand. The Glen Austin pan has been protected for the high species diversity of birds observed on this pan every year. Unfortunately the surrounding areas have to a large extent been impacted upon by agricultural activity and a low number of plant species occur here (14 on 1 sample plot). This area may be extended as conservation area in future.

Golden Harvest Park

The Golden Harvest Park is 50 ha (including/excluding hill) in size and predominantly a recreational park for the public. A fairly small natural hill occurring in the Park was surveyed and 25 species were recorded here on 1 sample plot. This site is located on the Golden Harvest Agricultural Holdings in Randburg, Johannesburg.

Groenkloof Nature Reserve

The Groenkloof Nature Reserve is located directly south of Pretoria and is 400 ha in size. Hundred and seventy species were recorded here on 7 sample plots. The Nature Reserve is extensively used for active and passive recreational activities.

Klapperkop

Klapperkop refers to a strip of natural land located south and above the Groenkloof suburb of Pretoria. This site is bordered by the Johann Rissik drive, Klapperkop Fort Military Museum and Monument Golf Course to the south and Nelson Mandela drive to the west. It measures 155 ha in size, and 123 species were recorded on 5 sample plots.

Klipriviersberg Alberton

The section of Klipriviersberg located in Meyersdal, Alberton, to the south of Johannesburg, is 1100 ha in size. Ninety-eight species were recorded on 4 sample plots. This site is situated between the N12 (to Kimberley), R59 (to Vereeniging) Brackenhurst and Glenvista townships. A Management Framework has recently been completed for the area, dividing it up in zones in order to allow for mixed land-uses. The site is under immense pressure for development. The measured 1100 ha of present natural land will therefore be reduced in future to accommodate development. Disturbances on this area relate informal and ill-planned roads, reservoirs and a rock-crushing site.

Klipriviersberg Nature Reserve

The Klipriviersberg Nature Reserve is located to the south of Johannesburg and in the vicinity of suburbs like Mondeor, Glenvista and Kibler Park. It is 525 ha in size, and 120 species were recorded on 4 sample plots. This nature reserve is home to some red data species. The local council is in the process of extending this nature reserve to include adjoining sections of the Klipriviersberg not included in the present protected area. The area is under major pressure for development.

Kloofendal Nature Reserve

The Kloofendal Nature Reserve is a 105 ha nature reserve located in Roodepoort, Johannesburg. Hundred and fifty five species were recorded on 6 sample plots. This nature reserve is used extensively for passive recreation.

Kwaggasrant

The Kwaggasrant is a ridge to the west of the City Centre of Pretoria and directly south of the suburb of Atteridgeville and north of Laudium. It is bordered by the Pretoria Industrial area and Langeberge to the east. It is 285 ha in size, and 92 species were recorded on 3 sample plots. An old fort (Kwaggakop fort) is located on a highpoint of this ridge. This ridge links onto the Skurweberge in the west.

Langermanskop

The Langermanskop is a 32 ha hill located in the Kensington suburb of Johannesburg. Hundred and three species were recorded on 4 sample plots. This site is completely surrounded by development and forms a visual relief in the otherwise built up area of Kensington. Invasion by garden plants and other infestation e.g. *Arundo donax* (giant reed) on the edges of this area are real impacts. Other impacts relate to unmanaged footpaths, trampling and litter.

Linksfield ridge

The Linksfield ridge is a 95 ha west east running ridge visible from the Gillooly's Farm interchange in the Edenvale – Bedfordview area to the east of Johannesburg. Hundred and thirty species were recorded on 4 sample plots. An interesting historical fact of this area, is that two neighbouring farms here belonged to the Gillooly and Bezuidenhout families respectively. Both the original Gillooly and Bezuidenhout farmsteads are conserved and the initial communication trail between these two farms can still be observed on the ridge (Allan Buff[®] pers comm). Presently the "Mervin King" and "Dassie" trails cross the Linksfield ridge. No dassies are seen on this ridge anymore. To the south of the ridge is an unusual meander of the Jukskei

River only a few kilometres away from the origin of this river (Noel Hutton* pers comm). To the east of the ridge, the grave Mr Ferro, one of the first prospectors in Johannesburg, can be found. The initial objective of the Harvey Nature Reserve, which forms the western part of this site, was to conserve indigenous flora of the area.

Lonehill Nature Reserve

The Lonehill Nature Reserve is a 6 ha natural area in the Lonehill suburb to the north of Johannesburg. Fifty-three species were recorded on 2 sample plots. The major feature of the Reserve is the granite hills. These granites formed 3 1000 million years ago, and are the most ancient rock on the earth crust, namely archaic granite (Bredenkamp 1992). A large population of dassies occur on this nature area and due to the absence of predators, have increased to such an extent that they cause damage to the vegetation. The site is managed and is accessible for public utilization for recreation.

Magaliesberg Protected Natural Environment (MPNE)

The MPNE is a west east running ridge and mountain running from Bronkhorstspuit in the south east, through Pretoria to Rustenburg in the west. A large section of the Magaliesberg is protected by the Environmental Conservation Act (1989) as a "Protected Natural Environment". The ridge running through urban areas in the Pretoria area was measured to be 1063 ha. Hundred and fifty species were recorded on 8 sample plots. The MPNE was proclaimed for the first time in 1977 as a "Nature Area". This quartzite ridge has high landscape value to the city of Pretoria. Due to the longitudinal shape of the ridge in the study area and the close proximity of a densely populated city, the ridge and specifically the edges of the MPNE have suffered from impacts such as trampling, litter, exotic vegetation, unmanaged footpaths and off-road vehicle tracks. Carruthers (1990) describes the natural and cultural history of the Magaliesberg in his book *The Magaliesberg*.

* Allan Buff. Manager: Cemeteries and Crematoriums. Johannesburg Metropolitan Local Council.

* Noel Hutton. Parks and Recreation. Johannesburg Metropolitan Local Council.

McDonalds

The McDonalds site refers to a 2 ha piece of land located behind the McDonalds fast food shop in Halfway House, Midrand. This is the only remaining site in Midrand where large boulders, previously characteristic of sites in Midrand, can be observed. Twenty-eight species were observed on 1 sample plot. The site will probably be developed in future unless it is specifically bought by the local council for conservation purposes.

Meintjieskop

Meintjieskop refers to a specific section and high point of the Daspoortrant ridge located just east of the city center of Pretoria in the Riviera and Rietondal suburbs. The Union Building is situated on the southern slope of Meintjieskop. This section is 96 ha in size. Thirty eight species were recorded on 1 sample plot. This ridge has been encroached upon by residential development especially on the southern slopes and crest. The northern slopes are the least impacted upon.

Melville Koppies Nature Reserve

The Melville Koppies Nature Reserve is 150 ha ridge in the Melville suburb of Johannesburg. Hundred and thirty two species were recorded on 3 sample plots. In comparison to other urban nature areas, this Nature Reserve is extensively managed and utilised for educational purposes by the public. An additional section of the ridge east of D.F.Malan Drive, is called the Louw Geldenhuys View site. This site is also partially managed as nature area and as extension of the Melville Koppies Nature Reserve. This ridges is also known for its iron and stone age sites.

Miar land

Miar's land is a large tract of land (380 ha) visible to the west of the N1 highway at the Allandale offramp in Midrand. Seventy-four species were recorded on 2 sample plots. This land was included in the study as it was indicated that development is not likely to here in the near future and it is a natural grassland. The site also includes section of the Jukskei river to the south and lower part of the site which has large

specimens of *Combretum erythrophyllum* on its banks. The land is zoned as “agriculture”.

Moreleta Kloof Nature Area

The Moreleta Kloof Nature Area is 90 ha in size and situated in the Moreleta Park suburb of Pretoria. Ninety species were recorded on 3 sample plots. The Moreleta spruit runs through the middle of the nature area. There is limited infestation of exotic plants in the drainage line in comparison to other rivers in the urban areas of Gauteng. A large wetland is visible downstream. Clear signs of management was observed and the site is extensively utilised by the public for recreational activities. An education centre is located on the site.

Murrayfield

The Murrayfield site is a 9 ha piece of natural land located in the Murrayfield suburb in the eastern suburbs of Pretoria. Seventy-five species were recorded on 2 sample plots. The site is surrounded by urban development.

National Botanical Institute (NBI)

The NBI is located on and along the eastern most section of the Daspoort ridge. It is 92 ha in size and located in the Silverton and Scientia suburbs of Pretoria. Hundred and thirty one species were recorded on 4 sample plots.

Northcliff ridge

The Northcliff ridge (previously known as Aasvoëlkop) is 10 ha in size. It is located in the Northcliff suburb of Johannesburg and is the highest natural point in Johannesburg. The ridge is completely surrounded by development. Ninety-one species were recorded on 3 sample plots. The Northcliff ridge is extensively used for various forms of recreation including it being used as a major viewpoint of Johannesburg. The infrastructure developed for recreation are not sufficient to sustain the large numbers of people visiting the area and therefor litter and trampling

are some of the major impacts to this area. 17th Century Tswana iron-age settlements have been found on the ridge.

Orlando hill

The Orlando hill is a 55 ha hill located directly south of the Orlando power station and dam, as well as south of the Vista University and Soweto College of Education in Soweto, Johannesburg. Eighty-eight species were recorded on 3 sample plots. This hill was initially one of three hills that were undeveloped in the area. According to Allan Buff* (pers comm), the Nunsfield Church was situated between two of these hills in Pimville. Here Enoch Sontonga, choirmaster, teacher, photographer, preacher and composer of the National Anthem Nkosi Sikelele iAfrika used to take the children up one of the hills for Bible lessons. The koppie was later known as Thaba Bosio which means "Mountain of the night time" and probably referred to religious reflections at night. Enoch died on 18 April 1905 and his grave is in the Braamfontein cemetery (Sharper & Walker, 1996). Thaba Bosio has unfortunately been developed, and only the surveyed hill at Orlando as well as the hill in Devland is still undeveloped. Many people visit this hill to harvest plants.

Piameefrant

The Piameefrant is a west east running ridge in the Villieria suburb of Pretoria. It is situated between the Magaliesberg and Daspoortrant ridges. It is 37 ha in size. Hundred and twenty seven species were recorded on 5 sample plots.

Quagga spruit open space

* Allan Buff, Manager: Cemeteries and Crematoriums. Johannesburg Metropolitan Local Council.

The Quagga spruit open space and recreational area is located between Quagga street and Van Dalsen street in the Wespark suburb of Pretoria. The area is 50 ha in size and 57 species were recorded on 1 sample plot. A small portion of the area presently acts as a urban park with picnic facilities. Another section of land along the Quagga spruit and to the north of the spruit, has predominantly natural vegetation. The riverine vegetation shows disturbance due to exotic infestation.

Rietfontein Hospital site

The Rietfontein Hospital site includes 80 ha of natural grassland along the N3 in Edenvale. Hundred and one species were recorded on 4 sample plots. In 1894 this land was bought by the Transvaal Republic to establish a hospital for smallpox cases as well as plague and venereal diseases in later years. The first leper hospital in Transvaal was built here in 1897. In the following years infectious epidemic diseases, tuberculosis and many other infectious diseases were treated here (Unknown, 1994). Approximately 6 000 bodies are buried here and has potential health risks should they be exhumed (Allan Buff* pers comm). This matter has put a halt to the proposed mixed-use development planned for the site (Urban Planning Services 1995). The riverine vegetation is invaded by exotic vegetation. Old fallow lands have rehabilitated successfully.

Rietfontein Nature Reserve

The Rietfontein Nature Reserve is a 40 ha natural north-south stretching ridge visible from the N1 highway and located in the Paulshof suburb of Sandton, Johannesburg. Sixty-seven species were recorded on 2 sample plots. A potential road might cross this Nature Reserve in future and may jeopardize the future conservation of this area. The site is accessible to the public for passive recreational activities.

Roodepoort ridge

The Roodepoort ridge is a north-west to south-east running ridge in Roodepoort, Johannesburg area. The portion of the ridge referred to in this study (from the Witwatersrand Botanical Gardens in the west to just east of Christaan de Wet road near Kloofendal) is 673 ha in size. Seventy species were recorded on 2 sample plots.

The Roodepoort ridge is a highly visual natural feature in Johannesburg. The ridge has suffered major encroachment by urban development. Attempts are presently made by various government departments to limit further construction on the ridge. The Kloofendal Nature Reserve to the south, is in close proximity to the Roodepoort ridge. The Roodepoort ridge is home to the unique *Protea roupelliaea* which shows a Drakensberg element in this vegetation. The largest *P. roupelliaea* population of 5 populations, recorded in Gauteng, is situated on the Roodepoort Ridge on the border of Roodepoort and Krugersdorp and has a high conservation status (Hankey & Turner 1998).

Ruimsig Butterfly Reserve

The Ruimsig Butterfly Nature Reserve is 12 ha in size and located in the Ruimsig suburb of Roodepoort. Thirty species were recorded on 1 sample plot. This reserve is the first in Africa proclaimed to protect a unique grassland habitat for insects not commonly found on the Witwatersrand (Henning 1994). The site is conserved and managed for the rare butterfly *Aloeides dentatis* (Swierstra) (Lycaenidae) and has limited access to the public for passive recreational activities. Vegetation surveys were done here by Deutschlander & Bredenkamp (1999).

Strubenkop

The Strubenkop hill is a 10 ha undeveloped hill in the Lynnwood suburb of Pretoria. Fifty-two species were recorded on 2 sample plots. Due to this site being used by the public as viewpoint, and no infrastructure exists on this hill to accommodate recreational activities, trampling and litter have impacted and changed the vegetation of this area substantially. Some tree planting was observed, although with trees not natural to the area.

Voortrekker Monument Nature Reserve

This Nature reserve is approximately 273 ha in extent. Eighty-five species were recorded on 4 sample plots. This Nature Reserve with the Voortrekker Monument, is a landmark in Pretoria.

Van Riebeeck Nature Reserve (Rietvlei dam)

The Van Riebeeck Nature Reserve (or Rietvlei dam) is a 3160 ha nature reserve located south-east of Pretoria and east of the R21 Johannesburg International Airport Highway at the Irene off-ramp. Hundred and nine species were recorded on 3 sample plots. The reserve is used extensively by the public for passive recreation.

Yeoville Ridge

The Yeoville Ridge is 46 ha in size and is a west east running ridge in the Yeoville and Observatory suburbs of Johannesburg. Sixty-seven species were recorded on 2 sample plots. It is the second highest natural point in Johannesburg after the Northcliff ridge. An Indian memorial was constructed on this ridge in memory of all the Indians that died in the Anglo-Boer war. Inscriptions are written in three different languages on the memorial (Noel Hutton* pers comm). This ridge was never formally conserved, but was kept free from development due to its steep gradients. The site is used for recreational activities – although no signs of management were observed. A major infestation of *Acacia mearnsii* (black wattle) was observed at the lower and southern end of the site

Zwartkop Training Facility/Nature Reserve

The Zwartkop Training Facility and surrounding nature area, belongs to the South African Air force and is 560 ha in size. Hundred and fifteen species were recorded on 3 sample plots. It is located west of the suburb Valhalla and south of the Voortrekkerhoogte military base in Pretoria. It is located on the farm Zwartkop 356JR. The Hennops River runs past the site at the southern and lower part of the site. The riverine vegetation is disturbed.

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CHAPTER 3

METHODS

The Braun-Blanquet method of vegetation survey and classification, developed in the middle of the twentieth century (Whittaker 1978) was used in this study to identify plant communities, sub-communities and variants. The method was applied for collecting data on species composition and environmental characteristics in the analytical phase, and synthesising the data collected in the second phase by numerical analysis and tabulation and presenting the results in phytosociological tables.

Analytical phase

Number and distribution of sample plots

The sample plots were randomly stratified using 1: 50 000 aerial photography. Due to the general small size and accessibility of the sites, a visual evaluation of the sites added to the stratification process. The stratification units were based on homogenous floristic composition. The sites were therefore chosen to exclude obvious heterogeneity in the physical environment and floristic composition. This survey technique is strongly recommended by Werger (1974) and Bredenkamp (1982), due to the fact that it enables efficient sample in heterogeneous vegetation (Braun – Blanquet 1964). The sample plots were placed in homogenous vegetation because information of one vegetation entity only, and not of mixtures, is required (Werger, 1974). Plot sizes of 200 m² were used in the grassland and bushveld biome according to Bredenkamp and Theron (1978) who propose plot sizes which may vary from 200 m² in woody areas to 16m² in grassland vegetation. The vegetation was sampled from December 1998 to April 1999. Relevés were compiled in 132 plots of which 73 were located in woodland areas and 59 in grassland areas. The areas were further generally undisturbed areas in the urban environment zoned to be conserved or agricultural areas. The latitude and longitude of each sample plot were determined using the Global Positioning System.

Floristic analysis

Total floristic composition was recorded for every sample plot. All species identifiable at the time of the survey were noted.

Vegetation cover

The cover abundance was determined according to the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974), which has 8 classes and symbols:

- r Very rare and with a negligible cover (usually a single individual)
- + Present but not abundant and with a small cover value (less than 1% of the quadrat area)
- 1 Numerous but covering less than 1% of the quadrat area, or not so abundant and covering 1-5% of the quadrat area.
- 2 Covering between 5 and 25% of the quadrat area independent of abundance
 - 2a Covering between 5 and 12% of the quadrat area independent of abundance
 - 2b Covering between 13 and 25% of the quadrat area independent of abundance
- 3 Covering 26-50% of the quadrat area independent of abundance
- 4 Covering 51-75% of the quadrat area independent of abundance

5 Covering 76-100% of the quadrat area independent of abundance

Vegetation structure

A total percentage cover of the tree, shrub and herbaceous layer was estimated. The percentage open land was included in this estimation. The coverage of the layers was based on an aerial cover where the canopies are vertically projected onto the ground (Werger, 1974). With regard to the vegetation structure, the average height of the tree, shrub and herbaceous components was estimated and recorded independently.

Habitat analysis

The slope, aspect and topography were recorded on site. Exotic plants and disturbance factors were also recorded. The 1: 250 000 geological survey maps 2626 West Rand, 2628 East Rand, 2526 Rustenburg and 2528 Pretoria (Department of Mineral and Energy Affairs 1984) were used as guideline for the identification of geological formations.

Land types and associated geology and soil information were obtained from Land types of the Maps 2628 East Rand 2630 Mbabane (Land type Survey Staff, 1987), Land types of the Maps 2626 Wes-Rand 2726 Kroonstad (Land type Survey Staff, 1985) and Land types of the Maps 2526 Rustenburg 2528 Pretoria (Land type Survey Staff, 1987).

The soil series and associated clay contents of the A horizon were also obtained from 1: 250 000 Land type Survey Staff (1985 & 1987a&b).

Wetlands and riverine vegetation were not surveyed in this study.

Synthesis

In order to obtain a first approximation of the plant communities, the computer programme TURBOVEG (Hennekens 1996a) and the TWINSPAN classification

algorithm (Hill 1979) were used for capture, processing and presentation of phytosociological data. Further refinement was achieved by using Braun-Blanquet procedures. The final classification was obtained by using and applying MEGATAB (Hennekens 1996b), a visual editor for phytosociological tables. Two distinct major vegetation types were identified after the first approximation, namely grassland and woodland communities. These data sets were then separated and classified separately, using TWINSpan, and refining these results with Braun-Blanquet procedures (Behr & Bredenkamp 1988).

Species that were only encountered 7 and less times during the study, or which are not diagnostic for a specific community or group of communities are excluded from the phytosociological tables but are listed in appendices. Names and authors of taxa are in accordance with Arnold & De Wet (1993).

Literature

Plants were identified by using the field guides Palgrave (1983), Van Gogh & Anderson (1988), Van Wyk & Malan (1988), Fabian (1997), Van Wyk & Van Wyk (1997), Bromilow (1995) and Van Oudshoorn (1992). Main vegetation types were described according to Bredenkamp & Van Rooyen (1996a, b & c) and Acocks (1988) and biomes according to Rutherford & Westfall (1986).

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CHAPTER 4

RESULTS

Natural Grassland vegetation and plant species richness of open spaces in urban areas of Gauteng, South Africa.

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Abstract

A vegetation survey of natural grasslands was undertaken in the urban areas of Gauteng, where 7,3 million of the 38,5 million people in SA live. Relevés were compiled in 132 sample plots placed in randomly selected open spaces in the study area. A TWINSpan classification, refined by Braun-Blanquet procedures, indicated eight grassland communities, represented by 59 relevés. A hierarchical classification, description and ecological interpretation of these plant communities are presented. The identification, classification and description of these plant communities are important for development planning and for the continued conservation of open spaces in the urban environment.

Key words: Braun Blanquet analysis, classification, plant communities, urban open spaces, TWINSpan

Introduction

Gauteng is the smallest of the 9 provinces of South Africa, covering an area of only 16 191km². Approximately 7,3 million of the 38,5 million people in SA live in Gauteng (Gauteng 2000). It is therefore understandable that urbanisation and its associated impacts are the biggest threats to the natural environment that still persist in the Gauteng urban areas. Kowarik (1990) confirms this by stating that human impact has been recognised as one of the most important influences on the composition of vegetation in urban environments. These impacts often include the loss of complete habitats due to the construction of residential, industrial or other developments. Natural areas adjacent to urban areas suffer equally of human related activities such

as trampling due to footpaths, exotic plant invasion including escapees from gardens and also management practices such as mowing natural grasslands and changing natural veld fire frequency.

In European countries landscape ecological mapping and evaluation has become an essential part of the planning process (Spellerberg 1992). This assists in restricting disturbance from areas with vulnerable habitats or species and prevent undue fragmentation of wildlife habitat (Helliwell 1973). However, until recently, vegetation surveys in urban areas in South Africa were unknown. After a pioneer survey in the Durban Municipal Area (Roberts 1993), surveys were undertaken in urban areas of Potchefstroom (Cilliers & Bredenkamp 1998, 1999a, b, c, 2000, Cilliers *et al.* 1998) and Klerksdorp (Van Wyk, *et al.* 1997) in the North-West Province and in Bloemfontein (Dingaen 1999) in the Free State.

Limited vegetation studies, mostly unpublished, have been done on small areas in urban Gauteng (Behr & Bredenkamp 1988, Ellery 1992 & 1994, Bredenkamp 1991, 1992, 1997a & b, Bredenkamp & Brown 1998a & b). Surveys of natural grassland vegetation in the Gauteng Province, though not included in urban areas include those of Bredenkamp & Theron (1978 & 1980) and Coetzee *et al.* (1993a & b, 1994 & 1995). A comparison of the results of these studies indicates that patches of natural vegetation do occur in urban Gauteng.

The present study reports on a wider assessment of the vegetation of the urban areas of Gauteng and also attempts to assess the high species richness in urban areas within the grassland biome. The purpose of this study was to assess the variation in vegetation and thereby identify the plant communities of different types of habitat present in the urban areas of Gauteng. This information should help to motivate conservation actions, ensuring that nature conservation is incorporated into land-use planning initiatives within the urban environment.

Study area

The study area is located between 27° 40'E to 28°25'E and 25°40'S to 26°20'S approximately in the centre of the Gauteng province (Figure 1). The area includes open spaces covered with grassland vegetation within the cities of Pretoria, Midrand,

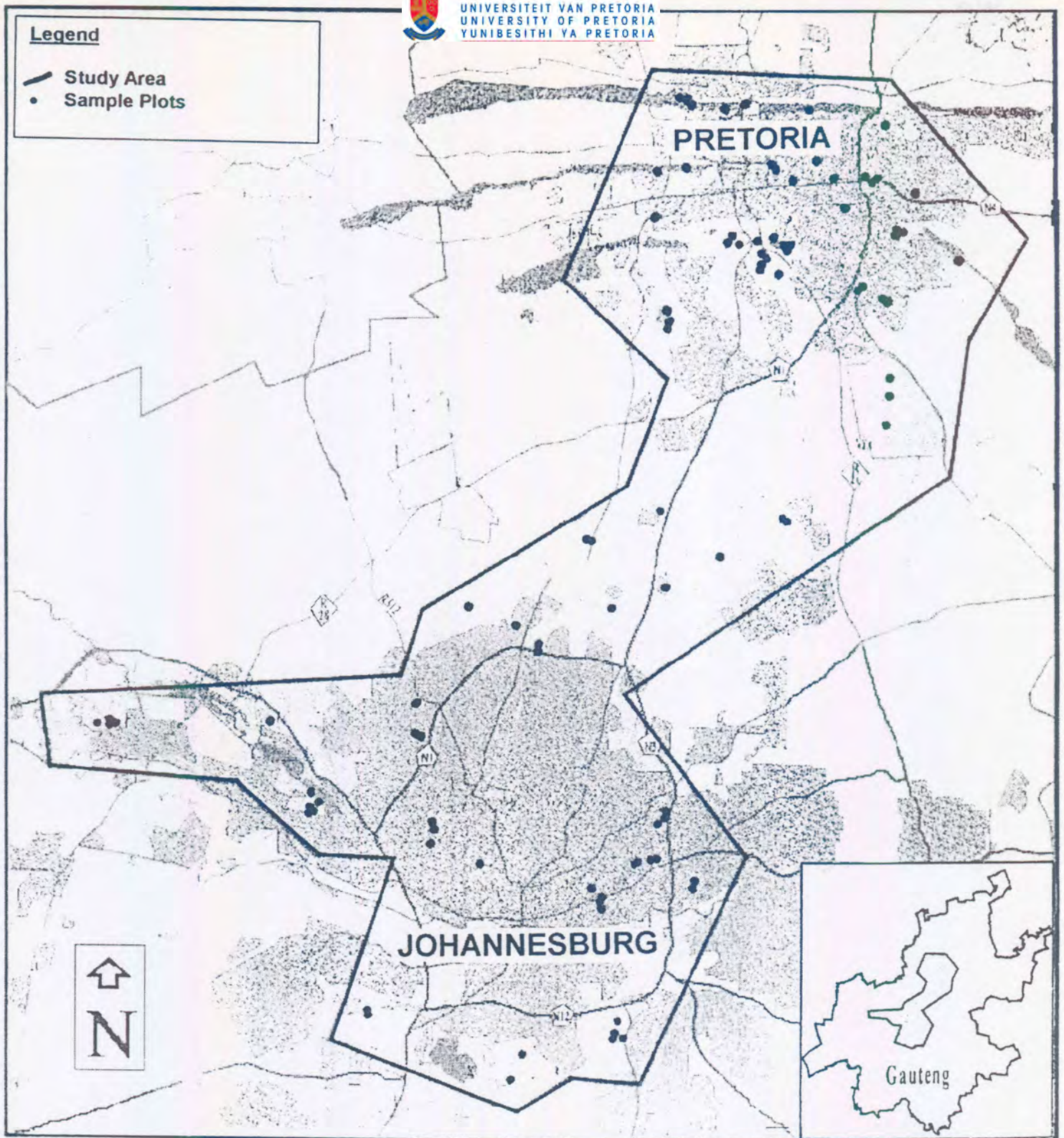


Figure 1. The study area is located within the Gauteng Province and 132 sample plots were placed in the various urban open spaces in order to describe the vegetation found growing there (Scale 1:670 000).

Johannesburg and also parts of the West Rand. Altitudes in Gauteng vary from 1081m to 1899 above sea level, with a mean altitude of 1 512m (Gauteng 2000). The altitude of the study area is however between 1 400 to 1 800 m above sea level.

Acocks (1988) described the vegetation of the study area as "False" Grassland of the Central variation of Bankenveld (Veld Type 61b). Patches of woodland vegetation are found at sheltered sites on hillslopes and rocky outcrops in this Veld Type. Bredenkamp & Van Rooyen (1996c) described this vegetation as the Rocky Highveld Grassland vegetation type, which covers the largest part of the study area. A small intrusion of Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1996b) occurs in the southeastern corner of the study area. The area, therefore, predominantly represents the Grassland Biome (Rutherford & Westfall 1986). The open and closed woodland patches in the grassland biome resemble the vegetation of the Waterberg Moist Mountain Bushveld (Bredenkamp & Van Rooyen 1996d) also described by Acocks (1988) as Sour Bushveld (20). The woodland component of the area is further represented by the Mixed Bushveld vegetation type (Bredenkamp & Van Rooyen 1996a) representing the savanna biome (also described as Sour Bushveld (20) by Acocks in 1988) in the northern Magaliesberg region of the study area.

Currently only 0.29% of Moist Cool Highveld Grassland is conserved and 1.38% of Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1996b & c).

The mean monthly temperature in the study area for the weather stations listed below is 16.8°C with a mean maximum of 22.6°C and a mean minimum of 10.8°C. The mean winter temperature in the study area is 13.8°C and mean summer temperature, 25.6°C (Weather Bureau 2000). Mean annual rainfall in Gauteng is measured at 670 mm per year (Gauteng, 1997). The geology of the area includes the rock types dolomite, chert, quartzite, granite, diabase, shale and andesitic lava. The most important land type classes in this study area are Ab1, Bb1, Bb2, Ba7, Ba9, Ib3, Ib7, Ib41 and Ib43 with Ib land types often associated with ridge areas and Ab, Ba and Bb land types with flat undulating landscapes. The main soil forms found in the study area are Mispah, Southwold, Trevanian, Glenrosa, Williamson, Trevanian, Glendale, Msinga, Klipfontein, Sandvlei, Robmore, Glendale and Platt, which have

an A horizon clay content ranging from 10–30% (Land Type Survey Staff 1985 & 1987a & b).

Methods

The open spaces within the study area were identified. These areas were subsequently delineated on 1 : 50 000 aerial photographs. These open space areas were then stratified into relatively homogeneous areas, and sample plots were randomly allocated to these open spaces within each relatively homogeneous area. 59 of a total of 132 sample plots were located in grassland. Due to the general small size and accessibility of the sites, a heterogeneous site with more than one plant community was further stratified by visual evaluation. The sites were relatively undisturbed and many could be important to conserve. Some sites are presently utilized for agricultural purposes. Plot sizes of 200 m² were used in accordance with Bredenkamp and Theron (1978). Wetlands and riverine vegetation were excluded for this study.

Total floristic composition was noted for every sample plot. Additionally, the average height and percentage cover of the tree, shrub and herbaceous components were estimated and recorded. The percentage cover of bare soil was also estimated and recorded. The coverage of the tree layer was based on an aerial cover where the canopies are vertically projected onto the ground (Werger, 1974). The same technique was used for the shrub and herbaceous component. The dominant tree, shrub, and herbaceous species were noted and the cover/abundance for each species was estimated according to the Braun Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974).

Environmental data included slope inclination measured in degrees, topography including hills, slopes and crests, aspect (north, south, west, east and aspects in between) and disturbance factors such as exotic vegetation, trampling and erosion. Information on geology, land type, soil series, and clay contents were obtained from Land type Survey Staff (1985 & 1987).

The computer programme TURBOVEG (Hennekens 1996a) and the TWINSpan classification algorithm (Hill 1979) were used for capture, processing and presentation of phytosociological data. Further refinement was achieved with Braun Blanquet procedures by using MEGATAB (Hennekens 1996b), a visual editor for phytosociological tables.

Names and authors of taxa are in accordance with Arnold & De Wet (1993). For the purposes of this study, *Aloe greatheadii* var. *davyana* and *Aloe transvaalensis* were clumped as one species and referred to *Aloe greatheadii* var. *davyana*.

Species occurring 7 times and less in the sample plots surveyed, are considered as infrequent in the survey area, and are recorded in Annexure A.

Results and Discussion

The grasslands of the entire study area are characterized by a mixture of grass species. General species present in these grasslands are listed under Species Group N (Table 1). The bunch grasses *Themeda triandra*, *Brachiaria serrata*, *Diheteropogon amplexans*, *Trachypogon spicatus*, *Eragrostis racemosa*, *Elionurus muticus*, *Tristachya leucothrix*, *Eragrostis chloromelas*, *Heteropogon contortis*, *Hyparrhenia hirta*, *Setaria sphacelata* and *Eragrostis curvula* are often present in a mixture and one or more of these species may be locally dominant, depending on local habitat conditions and degree of disturbance.

A great variety of herbaceous forbs or semi-woody dwarf shrubs is often present in these grasslands. These include the xerophytic sedge *Bulbostylis burchellii*, the succulents *Cyanotis speciosa* and *Aloe greatheadii* var. *davyana*, the geophyte *Ledebouria revoluta*, the asteraceous forbs *Senecio venosus*, *Nidorella hotenttotica*, *Helichrysum rugulosum*, *Gerbera viridifolia*, *Helichrysum coriaceum*, *Vernonia oligicephala* and the exotic annual weed *Tagetes minuta*, the encroacher dwarf shrub *Stoebe vulgaris* and a variety of other forbs e.g. *Wahlenbergia caledonica*, *Scabiosa columbaria*, *Chaetacanthus costatus*, *Pentanisia angustifolia*, *Pearsonia sessilifolia*, *Thesium utile* and *Pollichia campestris*. Scarcer species occurring throughout the area, are indicated under Species Group N in the Appendix.

Two major plant communities were identified, namely the *Loudetia simplex* – *Melinis nerviglumis* Major Grassland and the *Cymbopogon excavatus* – *Themeda triandra* Major Grassland.

The *Loudetia simplex* – *Melinis nerviglumis* Major Grassland is represented by plant communities that are mainly associated with shallow lithosols on rocky quartzite, dolomite or chert ridges and hills. This grassland represents typical Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1996c) and in the Acocks (1988) classification, typical Bankenveld grassland. Scattered tree or bush-clump communities may occur in this grassland.

The plant communities of the *Cymbopogon excavatus* – *Themeda triandra* Major Grassland are on the contrary, generally associated with lower lying and flatter undulating plains of the Bb land type where the soils are deeper and often not-rocky. This vegetation is mainly found on average slopes of 0–5° on Glenrosa, Klipfontein and Sandvlei soil series and is mainly found on the plains south of Pretoria. This grassland represents typical Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1996b) and typical *Cymbopogon-Themeda* Veld (Acocks 1988). No tree communities occur in this grassland.

Classification

Eight plant communities were identified within the two Major Grassland types (Table 1). The hierarchical classification of these communities is as follows:

1. *Loudetia simplex* – *Melinis nerviglumis* Major Grassland Community
 - 1.1 *Melinis repens* – *Diheteropogon amplexans* Grassland Community
 - 1.1.1 *Pogonarthria squarrosa* – *Melinis repens* Grassland Sub-community
 - 1.1.2 *Ochna pulchra* – *Ancylobotrys capensis* Grassland Sub-community
 - 1.2 *Andropogon schirensis* – *Monocymbium cerasiiforme* Grassland Community
 - 1.2.1 *Aristida transvaalensis* – *Cymbopogon validus* Grassland Sub-community
 - 1.2.2 *Andropogon schirensis* – *Pentanisia angustifolia* Grassland Sub-community

1.2.2(a) *Protea caffra* variant

2. *Cymbopogon excavatus* – *Themeda triandra* Major Grassland Community

2.1 *Hermannia depressa* – *Themeda triandra* Grassland Community

2.1.1 *Senecio isatideus* – *Themeda triandra* Grassland Sub-community

2.1.2 *Hypoxis rigidula* – *Themeda triandra* Grassland Sub-community

2.2 *Eragrostis gummiflua* – *Hyparrhenia hirta* Grassland Community

Vegetation description

1. *Loudetia simplex* – *Melinis nerviglumis* Major Grassland Community

Habitat

The *Loudetia simplex* – *Melinis nerviglumis* Major Grassland is found on shallow soils of rocky crests and slopes (average slope of 14^o), of higher lying, quartzite, dolomite or chert ridges and hills, on a variety of aspects. These areas mostly represent the Ib7a and Ib41 Land Types, where the predominant soil series are Mispah Ms10, Southwold Cv26, Platt Gs14, Glenrosa Gs15 and Robmore Gs18 and Trevanian Gs17 with a clay content of 10-30%. The Ib land type generally indicates a very high surface rock cover and a lack of soil (Land Type Survey Staff 1985, 1987a & b).

Vegetation

The vegetation is typically dominated by a mixture of grass species, of which the bunch grasses *Trachypogon spicatus*, *Diheteropogon amplexans*, *Tristachya leucothrix*, *Melinis nerviglumis*, *Panicum natalense*, *Loudetia simplex* and *Schizachyrium sanguineum* are locally prominent. Dominance varies considerably from one locality to the next, and one or more of these grass species may attain dominance in local patches. These patches occur scattered throughout the distribution range of this major plant community.

This major community is characterized by Species group A (Table 1). The diagnostic species are mostly the bunch grasses *Melinis nerviglumis*, *Panicum natalense*, *Loudetia simplex*, *Urelytrum agropyroides* and *Schizachyrium sanguineum*. These grasses are classified as Increaser 1 species (Trollope *et al.* 1990), indicating the sour and under-utilized (grazing) nature of this vegetation (Van Oudtshoorn 1999). The shrub *Lopholaena coriifolia*, the geophytic suffrutescent *Parinari capensis* and the forbs *Tephrosia longipes*, *Commelina africana* and *Senecio oxynifolius* are also diagnostic species. This major plant community is exceptionally rich in plant species - an average of 43 plant species was recorded per 200 m².

A number of the species recorded in the *Eragrostis racemosa* – *Digitaria monodactyla* Grassland Communities of Bredenkamp & Theron (1978) shows resemblance to this community as well as the *Themeda triandra* – *Panicum natalense* Sub-community of Deutschlander & Bredenkamp (1999).

The *Loudetia simplex* – *Melinis nerviglumis* Major Grassland Community shows resemblance to the *Bewsia biflora* – *Digitaria brazzae* Grassland (Coetzee 1995). The species composition indicates that this vegetation is typical Bankenveld (Acocks 1988) or Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1996c).

The north-facing grassland vegetation community of the Fort Klapperkop area in Pretoria (Bredenkamp 1997b) shows a weak resemblance to plant community 1 and 1.1 below, although the grassland of south-facing slopes (Bredenkamp 1997b) does not show any resemblance to the grassland communities identified in this study. Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this vegetation unit. A comparison is provided below in Table 2 and 3.

This major grassland is represented by two communities:

- 1.1 The *Melinis repens* – *Diheteropogon amplexans* Grassland on hills and slopes slightly lower altitudes (1300–1500 m) to the north of the study area, showing affinity to savanna vegetation and

1.2 The *Andropogon schirensis* – *Monocymbium cerasiiforme* Grassland of hills and ridges of cooler higher altitudes (1500–1800 m) to the south of the study area showing affinity to Drakensberg Afro-montane vegetation.

1.1 *Melinis repens* – *Diheteropogon amplexans* Grassland Community

Habitat

This community is located at 1300–1500 m above sea level, on the crests or moderately steep slopes of rocky ridges, mostly on the warmer aspects, in the Pretoria area. It was mostly recorded in land type Ib7a and to a lesser extent in land type Ba7b, indicating shallow soil of the Mjispah Ms10, Trevanian Qs17, Glendale Sd21 and Msinga Hu26 soil series, with a relatively low clay content of 12–25%.

This vegetation, although being predominantly grassland on exposed, cooler, higher lying crests or upper slopes, tends to merge into the woodland/savanna communities found on the more sheltered, lower lying, warmer valley-slopes, and could be considered as a transitional type between the grassland and savanna biomes.

Vegetation

The species that dominate this grassland are the bunch grasses *Loudetia simplex*, *Melinis repens*, *Diheteropogon amplexans*, *Themeda triandra*, *Trachypogon spicatus* and *Tristachya leucothrix*. A great variety of forb species are present, though these are seldom dominant. Very conspicuous, however, is the fibrous monocotyledonous shrubby *Xerophyta retinervis*, which is found scattered throughout the distribution range of this community. Small, stunted trees and shrubs may also be present. This community is very rich in species, with an average of 45 species recorded per 200m².

This grassland community is characterized by Species group B (Table 1). The species that are diagnostic include the shrubby *Xerophyta retinervis* and *Protasparagus suaveolens*, the annual pioneer grass *Melinis repens* and the forbs,

Rhynchosia monophylla, *Chaetacanthus setiger*, *Vernonia galpinii* and *Indigofera zeyheri* and the succulent *Kalanchoe thyrsiflora*.

Two Sub-communities were recognized:

1.1 1 *Pogonarthria squarrosa* – *Melinis repens* Grassland Sub-community

Habitat

Within the general habitat described for plant communities 1 and 1.1, this sub-community was found in the northern (warmer) part of the study area, on shallow to moderately steep, north and west-facing warmer slopes on rocky ridges within land type lb7a.

Vegetation

The species that dominate this sub-community are the grasses *Schizachyrium sanguineum*, *Melinis repens*, *Pogonarthria squarrosa*, *Brachiaria serrata* and *Diheteropogon amplexans*. *Xerophyta retinervis* and the forbs *Senecio venosus* and *Nidorella hottentotica* are conspicuously present in most stands of this sub-community. Very conspicuous are the scattered small, stunted trees *Acacia caffra* and *Burkea africana* and the shrubby *Asparagus suaveolens* that occur throughout this grassland sub-community, indicating affinity to the savanna vegetation to the north.

The average number of species recorded in this plant community per 200 m² is very high, namely 51.

This sub-community is characterized by Species group C (Table 1). The species that are diagnostic are the trees, *Acacia caffra*, *Rhus zeyheri* and *Burkea africana*, the shrubby *Cryptolepis oblongifolia*, the grass *Pogonarthria squarrosa*, the forbs *Sphenostylis angustifolia*, *Indigofera hedyantha*, *Helichrysum setosum*, *Acalypha villicaulis*, *Phyllanthus parvulus*, *Vernonia staehelinoides* and *Lantana rugosa*, and the geophyte *Boophane disticha*.

1.1.2 *Ochna pulchra* – *Ancylobotrys capensis* Grassland Sub-community

Habitat

Within the general habitat described for plant communities 1 and 1.1, this sub-community was mainly found in the Ba7b but also in Ib3, Ba9a and Ib7a land types, on shallow soils on crests or warmer slopes of ridges and hills.

Vegetation

The species that dominate this plant community are the grasses *Diheteropogon amplectens*, *Tristachya leucothrix*, *Themeda triandra* and *Melinis repens*.

As in the case of the *Pogonarthria squarrosa* – *Melinis repens* Grassland Sub-community, are small scattered trees and shrubs conspicuously present. Contrary to the previous sub-community, the species are the trees *Ochna pulchra* and *Mundulea sericea* and the shrub *Ancylobotrys capensis*. *Xerophyta retinervis* is also very conspicuous in this sub-community. The average number of species recorded in this plant community per 200 m² is 43.

This sub-community is characterized by species group D (Table 1). The species that are diagnostic are the trees *Ochna pulchra* and *Mundulea sericea*, the shrubby *Ancylobotrys capensis*, the grass *Aristida bipartita*, the succulents *Euphorbia schinzii*, *Anacampseros subnuda* and *Kalanchoe paniculata*, and the forbs *Commelina erecta*, *Sutera palustris*, *Phymaspermum athanasioides*, *Cleome maculata* and *Pelargonium dolomiticum*.

1.2 *Andropogon schirensis* – *Monocymbium cerasiiforme* Grassland Community

Habitat

This community is found on cooler high altitude (1500–1800 m) rocky outcrops on gradual to steep slopes, mostly on cooler aspects. The presence of *Protea caffra* and *Protea roupelliae* indicates an affinity with the Drakensberg Highveld Sourveld (Sourveld) vegetation (Acocks 1988).

This plant community was predominantly recorded in land types lb41 or lb7. These land types indicate a lack of soil and is characterized by soil series Mispah Ms10, Platt Gs14, Trevanian Gs17, Glenrosa Gs15 and Robmore Gs18, all of which have a clay content of 10–20%.

Vegetation

As in the case of the *Melinis repens-Diheteropogon amplexans* Grassland Community, this grassland is also dominated by a variety of grass species of which one or more may attain local dominance. The general grass species that may dominate locally in patches are *Loudetia simplex*, *Melinis nerviglume*, *Panicum natalensis*, *Schizachyrium sanguineum*, *Andropogon schirensis*, *Monocymbium cerasiiforme*, *Alloteropsis semialata* subsp. *eckloniana*, *Themeda triandra*, *Brachiaria serrata*, *Diheteropogon amplexans* and *Trachypogon spicatus*.

This vegetation is characterized by Species group E (Table 1), with the grasses *Andropogon schirensis*, *Monocymbium cerasiiforme*, *Alloteropsis semialata* subsp. *eckloniana*, *Digitaria monodactyla* and *Aristida canescens* subsp. *canescens*, and the forbs *Hemizygia pretoriae* subsp. *pretoriae*, *Vernonia sutherlandii* and *Acalypha angustata* var. *glabra* as the most prominent diagnostic species.

The average number of species recorded per 200 m² is 55.

Two sub-communities, one which has a variant, were identified.

1.2.1 *Aristida transvaalensis* – *Cymbopogon validus* Grassland Sub-Community

Habitat

This sub-community is found at high altitudes on very rocky gradual to steep slopes (e.g. up to 35° on hills in the Bill Steward Nature Reserve) of ridges and hills in the Johannesburg and Krugersdorp areas. As this vegetation may be present on all aspects (less so on cooler slopes), the warmer north-facing aspects may have scattered individuals of shrubs or small trees. This plant community was

predominantly recorded in the land type Ib41, indicating the rocky nature and the lack of soil.

Vegetation

Within the mixture of prominent grass species in the *Andropogon schirensis* – *Monocymbium cerasiiforme* Grassland Community, the grasses *Sporobolus pectinatus*, *Cymbopogon validus* and *Aristida transvaalensis* are dominant and also diagnostic, indicating the very rocky nature of the habitat.

This vegetation is characterized by Species group F (Table 1). The many species that are restricted to this habitat indicate the uniqueness of this sub-community. In addition to the diagnostic dominant grass species mentioned above, some other prominent diagnostic species are the succulent *Crassula setulosa* var. *setulosa*, the geophyte *Gladiolus pretoriensis*, the forbs, *Sutera caerulea* and *Indigofera oxytropis* and the xerophytic ferns *Pellaea calomelanos* and *Cheilanthes hirta*, the shrubs *Rhus rigida*, *Englerophytum magalismontanum*, *Tapiphyllum parvifolium*, *Vangueria infausta* and *Nuxia congesta*. All of these species indicate the very rocky habitat of this sub-community.

The average number of species recorded in this plant community per 200m² is 44.3.

The *Landolfia capensis* – *Aristida transvaalensis* rock sheet community that Bredenkamp (1991), described from the Rietfontein Nature Reserve compares well with this community.

The *Protea caffra* – *Loudetia simplex* - *Aristida transvaalensis* community and associated subcommunities described by Behr and Bredenkamp (1988) also shows resemblance to this community. A number of the species recorded in the *Canthium gilfillanii* – *Aristida transvaalensis* – *Cymbopogon marginatus* savanna communities identified by Bredenkamp & Theron (1978) further coincides with this community.

1.2.2 *Andropogon schirensis* – *Pentanisia angustifolia* Grassland Sub-Community

Habitat

This sub-community is found on gradual to steep slopes of ridges and rocky hills on southern to western and north-eastern slopes in Johannesburg and south of Pretoria. This vegetation is restricted to gradual to steep slopes (37°) on rocky slopes of ridges and hills. This plant community was predominantly recorded in land types lb41 and lb7a, indicating the rocky nature and the lack of soil. The typical soil series of these land types are Mispah Ms10, Platt Gs14, Trevanian Gs17, Glenrosa Gs15 and Robmore Gs18, all having a clay content of 10–20%.

Vegetation

The species that dominate the plant community are the grasses *Panicum natalensis*, *Loudetia simplex*, *Melinis nerviglume*, *Schizachyrium sanguineum*, *Urelytrum agropyroides*, typical of the *Loudetia simplex*-*Melinis nerviglume* Major Grassland Community, and also *Andropogon schirensis*, *Alloteropsis semialata* and *Monocymbium cereciiforme* of the *Andropogon schirensis*-*Monocymbium cereciiforme* Grassland Community, while the more widely distributed *Brachiaria serrata*, *Trachypogon spicatus*, *Themeda triandra*, *Eragrostis racemosa*, *Diheteropogon amplexans* and *Tristachya leucothrix* are also abundantly present.

This vegetation is characterized by Species group G (Table 1). The species that are diagnostic of this plant community are the grass *Triraphis andropogonoides* and the forbs *Crassula capitella* subsp. *nodulosa*, *Felicia muricata*, *Indigofera setiflora*, *Graderia subintegra*, *Nolletia rarifolia* and *Indigofera filipes*. None of the diagnostic species are prominent.

The average number of species recorded in this plant community per 200m² is 40.4.

1.2.2 (a) *Protea caffra* variant

Habitat

The habitat of this Variant is similar to that of the *Andropogon schirensis* – *Pentanisia angustifolia* Grassland Sub-Community and is restricted to south-facing slopes in the

(warmer) Pretoria area on southern and north-eastern slopes in the (cooler) Johannesburg and Krugersdorp areas.

Vegetation

The vegetation of this Variant is very similar to that of the sub-community, though the prominent presence of *Protea caffra* and/or *Protea roupelliae* (species group H, Table 1) is diagnostic. The occurrence of these two *Protea* species indicates an affinity with Drakenberg vegetation, and therefore some affinity to the Afro-montane phytochorium.

The average number of species recorded in this plant community per 200m² is 41.

Bredenkamp (1991) identified the *Protea caffra* – *Melinis nerviglume* savanna in the Rietfontein Nature Reserve, which shows some similarity to this sub-community. Bredenkamp & Brown (1998a & 1998b) demonstrated the presence of *Protea* dominated plant communities in the Greater Johannesburg Metropolitan Area, and Behr & Bredenkamp (1988) described *Protea caffra* dominated plant communities in the Witwatersrand National Botanic Garden, which show high resemblance to this plant community. Coetzee *et al.* (1993) found that in the Gauteng area, *Protea caffra* occurs on north facing slopes only at altitudes above 1 450 m where it is cooler, though at lower latitudes or lower altitudes this species is, however, restricted to the generally cooler south facing slopes.

2. *Cymbopogon excavatus* – *Themeda triandra* Major Grassland Community

Habitat

The plant communities of the *Cymbopogon excavatus* – *Themeda triandra* Major Grassland are generally associated with relatively lower lying but still high altitude and flatter undulating plains of the Bb land type and the soils are deeper and, not-rocky. This vegetation is mainly found on average slopes of 0–5° on Glenrosa, Klipfontein and Sandvlei soil series and is mainly found in Midrand and in the southern parts of the study area and to a lesser extent in the northern parts of the Pretoria area.

Vegetation

This grassland represents typical Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1996b) and typical *Cymbopogon-Themeda* Veld (Acocks 1988). No tree communities occur in this grassland.

The species that dominate locally are the grasses *Themeda triandra*, *Elionurus muticus*, *Eragrostis racemosa*, *Heteropogon contortus*, *Brachiaria serrata*, *Hyparrhenia hirta* and *Eragrostis chloromelas*.

This Major Community is characterized by Species group I (Table 1). The species that are diagnostic of this plant community are the grass *Cymbopogon excavatus* and the forbs *Helichrysum nudifolium*, *Striga elegans* and *Crabbea angustifolia*.

The average number of species recorded in this plant community per 200m² is 43.

The *Cymbopogon excavatus-Themeda triandra* Major Grassland Community found on the Ba land type further shows much resemblance with the *Helichrysum rugulosum* – *Conyza podocephala* Grassland (Coetzee 1995), also found on the BA land type especially with the *Themeda triandra* – *Ledebouria revoluta* grassland community and its sub-communities. Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg with resemblance to this vegetation unit. A comparison is provided in Tables 2 and 3.

Two communities are recognized within this major grassland:

- 2.1 The *Hermannia depressa* – *Themeda triandra* Grassland is found on less disturbed sites, indicating vegetation in the climax stage and
- 2.2 The *Eragrostis gummiflua* – *Hyparrhenia hirta* Grassland found on more disturbed sites indicating early disclimax stages of this vegetation.

2.1 *Hermannia depressa* – *Themeda triandra* Grassland Community

Habitat

This community is found on gradual slopes of all aspects, in leached areas, at the foot of ridges and hills and on high altitude plateaus. This plant community occurred in a variety of land types but was specifically recorded from deeper clay soils of the Bb1b Land Type.

Vegetation

The dominants are similar to those of the *Cymbopogon excavatus* – *Themeda triandra* Major Community, with *Themeda triandra* overwhelmingly prominent, matching the good condition and climax state of this vegetation.

This community is, however, characterized by Species group J (Table 1). The species that are diagnostic are the inconspicuous forbs *Hermannia depressa*, *Ipomoea crassipes*, *Tephrosia capensis* var. *capensis* and *Vernonia natalensis*.

The average number of species recorded in this plant community per 200 m² is 43.

Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg with some resemblance to this community. A comparison is provided in Table 2 and 3 below.

Two sub-communities were recognised:

2.1.1 *Senecio isatideus* – *Themeda triandra* Grassland Sub-Community

Habitat

This plant community has a limited distribution in the Pretoria and Johannesburg areas, often on high altitude, on rocky plateaus of rocky outcrops. It is found on flat terrain or gradual south to west-facing slopes. It was recorded in predominantly the Ib43a but also in the Ib7a and Ab1b land types. The soil type is mostly Mispah Ms10 with a clay content of 15–25%.

Vegetation

The species that dominate the plant community are the grasses *Themeda triandra*, *Brachiaria serrata*, *Hyparrhenia hirta*, and *Trachypogon spicatus*.

This vegetation is characterized by Species group K (Table 1), which includes many species. The most conspicuous diagnostic species are the forbs *Senecio isatideus*, *Schistotephium crataegifolium*, *Ajuga ophrydis*, *Senecio inornatus*, *Crabbea acaulis*, *Acalypha* sp., *Gnidia capitata* and *Sida dregei* and *Solanum panduriforme*, the succulent *Crassula alba* and the dwarf shrub *Rhus discolor*. Many of these species are typically found at higher altitudes and indicate a Afro-montane affinity.

The average number of species recorded in this plant community per 200 m² is 40.

2.1.2 *Hypoxis rigidula* – *Themeda triandra* Grassland

Habitat

This plant community was found on lower lying gradual slopes throughout the study area on a variety of aspects. A low clay content of soil is associated with this plant community. This plant community was recorded in a variety of land types and specifically in Bb1b.

Vegetation

Species that dominate this plant community are the grasses *Themeda triandra*, *Brachiaria serrata*, *Eragrostis chloromelas*, *Cymbopogon excavatus*, *Elionurus muticus* and *Eragrostis racemosa* as well as the forb *Hermannia depressa*.

This vegetation is characterized by Species group L (Table 1). Diagnostic species include the forbs *Hypoxis rigidula*, *Ipomoea ommaneyi*, *Dicoma zeyheri*, *Conyza podocephala*, *Becium obovatum*, *Acalypha punctata*, *Cephalaria zeyheriana*, *Anthericum fasciculatum*, *Kohoutia amatymbica*, *Aster harveyanus*, *Ledebouria marginata*, *Ledebouria ovatifolia*, *Eriosema cordatum*, *Gladiolis* sp., *Senecio affinis* and *Justicia anagalloides*, *Verbena bonariensis* and *Indigofera burkeana*. This plant community was also rarely found in association with the tree *Acacia karroo*.

The *Eragrostis racemosa* – *Digitaria tricholaenoides* Grassland and *Themeda triandra* – *Ledebouria ovatifolia* Grassland described by Coetzee (1995) show resemblance to this community. Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this community. A comparison is provided in Table 2 and 3.

The average number of species recorded in this plant community per 200 m² is 45.

2.2 *Eragrostis gummiflua* – *Hypharrhenia hirta* Grassland Community

Habitat

This plant community has a limited distribution throughout the study area and is restricted to moist drainage lines, bottomland areas or areas marginal to wetlands. It is further also found on disturbed, overgrazed or previously ploughed areas. It was recorded in the Bb2c land type, especially in the Centurion, Midrand and Edenvale areas. A high clay content is characteristic of the soils associated with this plant community.

Vegetation

The species that dominates this plant community are the grasses *Hypharrhenia hirta*, *Eragrostis racemosa*, *Elionurus muticus*, *Eragrostis chloromelas*, the forb *Nidorella hottentotica* and the shrub *Stoebe vulgaris*.

This vegetation is characterized by Species group M (Table 1). The diagnostic species are the grasses *Eragrostis gummiflua*, *Aristida congesta*, *Sporobolus fimbriatus*, *Cynodon dactylon* and *Trichoneura grandiglumis*, the forbs *Monsonia angustifolia*, *Commelina africana*, *Euphorbia striata*, *Hermannia lancifolia*, the exotic *Richardia brasiliensis*, and the shrubby *Pollicia campestris*.

The average number of species recorded in this plant community per 200m² is 40.

The *Eragrostis curvula* – *Cynodon dactylon* Grassland (Bredenkamp 1992) from the Lonehill Nature Reserve in Sandton compares well with this community.

Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this community. A comparison is provided in Table 2 and 3.

Concluding remarks

Ellery (1992) and (1994) described the vegetation on the Melville Koppies Nature Reserve and adjoining areas. No clear comparison could be drawn between the grassland communities identified by Ellery (1992, 1994) on the Melville Koppies Nature Reserve and the grassland communities identified in this study. The woodland communities from this Reserve, however, compare well with the open and closed woodland communities identified by Grobler, *et al.* (2001).

Bredenkamp & Brown (1998a) described the vegetation to the west of Johannesburg and identified 22 communities. Table 2 presents a comparison of some communities to communities identified in this study. Due to the fact that Bredenkamp & Brown (1998a & 1998b) did not make use of Braun Blanquet tables, the extent of comparison provided below, is a subjective comparative evaluation based on species composition.

Table 2: Comparative table of Bredenkamp & Brown (1998a) and this study

Bredenkamp & Brown (1998a)	This study (community)	Extent of comparison (weak/strong)
Grassland	1 and 2	strong
<i>Themeda triandra</i> grassland	2.1.2	strong
Other grassland type communities	None	-

Bredenkamp & Brown (1998b) describe the vegetation to the north of Johannesburg and identify 13 communities. Table 3 presents a comparison of some communities and communities identified in this study.

Table 3: Comparative table of Bredenkamp & Brown (1998b) and this study

Bredenkamp & Brown (1998b)	This study	Extent of comparison (weak/strong)
<i>Hyparrhenia hirta</i> grassland	2.	weak
<i>Hyparrhenia hirta</i> grassland	2.1.2	strong
<i>Trachypogon spicatus</i> grassland	2.1	weak
Other grassland type communities	None	-

The common species of the *Eragrostis racemosa* – *Digitaria monodactyla* Grassland community of Bredenkamp & Theron (1978) coincides well with the common species recorded for the grassland species of this study as presented in Table 1 under Species Group N. Similarly, the *Euclea crispa* – *Rhoicissus tridentata* Savanna communities and *Trachypogon spicatus* – *Themeda triandra* Grassland Communities of Bredenkamp & Theron (1980) coincide with the species of this study. No clear comparison could however be drawn between specific communities of Bredenkamp & Theron (1980) and the communities identified for this study. The species the Ruimsig Entomological Reserve as described by Deutschlander & Bredenkamp (1999) shows resemblance to the common species of this study. The *Themeda triandra* – *Panicum natalense* Sub-community has similarities with the *Loudetia simplex* – *Melinis nerviglumis* Major Grassland Community of this study and the *Hyparrhenia hirta* – grassland has similarities with the *Cymbopogon excavatus* – *Themeda triandra* Major Grassland community of this study.

The list of species that was recorded only 7 times and less in the sample plots, associated with each vegetation unit, is presented in Annexure A. These records can be used as reference to identify species in need of research regarding their

ecological status (endangered, rare etc.). Known scarce species can also be linked to the vegetation unit in which they were observed. These vegetation types can then be approached with greater care with regards to urban development and they can even be conserved in the urban environment.

Conclusion

The classification procedures followed, resulted in clearly defined vegetation units that can be related to the environmental factors observed. This classification contributes to the limited knowledge that presently exists for the vegetation of urban open spaces in Gauteng. The results of this study can be used as a baseline study and future studies can be measured against it. The species richness determined per 200m² per vegetation type could also be used to determine environmental and ecological degradation and actions could be taken to manage these changes.

The results of this study could further be used to determine how the size and shape of surrounding land-uses have influenced and are influencing the vegetation of urban open spaces. The results of such a study could assist in guiding development in future open spaces in a constantly expanding urban environment.

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Table 1 : A phytosociological table of the grassland communities of the urban open spaces of Gauteng.

Community Number	1.				2.		
	1.1		1.2		2.1	2.2	
	1.1.1	1.1.2	1.2.1	1.2.2	2.1.1	2.1.2	
Releve number	1|1	1	|	|	1 11|	1 | 11 1|	| 111
	3581|0	13015|	576666779678|	44922213|	799222|	913581|	112449 31|6000
	5802|	9521644|	902579455112|	01183942|	324556|	690187|	134898273285|4012

 Species Group A

Loudetia simplex	+.++|+++.	+.+|	..+ab.a++++|	1+ba.+++|	++.+1+|	.....|	.....|	.....|
Melinis nerviglumis	1..+|+..+.	++|	++++a+++++.	|+..+.+++|	+++.+|	..+...|	..+...+.	.....|
Panicum natalensis	++..|	..+..+.	|+++++.++.	++|++b++.	|+1++a|	..+...|	..+...+.	.....|
Schizagyrium sanguineum	++1+|	....+++|	++..+++1++++|	.....1+|	+a+b+.	..+...|	.....+.	.....|
Urelytrum agroperoides	...|	+...+++|	+.+++.	++..+.	|+++++|	.....|	+.....+.	.....|
Parinari capensis	..+++|	+..+.	1|+.....++.	..+.	.....a.+|	..+..+.	.....+.	.....|
Tephrosia longipes	..+|	+...+.	|+.....+.	.....+.	.....+.	.....|	.....+.	.....|
Commelina africana	..++|	..+..+.	|++..+.	+++.	.....+|	.....|	.....+.	.....|
Senecio oxyriifolius	...+|	..+++.	|++..+.	.....+.	.....+.	.....|	.....+.	.....|
Lopholaena coriifolia	....|	+..+.	.....+.	.....+.	.....+.	.....|	.....+.	.....|

Species Group B

Melinis repens	++ba|	1+++++|	.....|	.....|	+.....+|	.....|	.....1..+.	|+..+
Xerophyta retinervis	++++|	+1+++1+|	.....+.	.....|	.....a.+.	.....|	.....+.	.....|
Rhynchosia monophylla	++..+|	++++.	.....|	.....|	.....+1|	.....+|	.....+.	.....|
Asparagus suaveolens	++++|	..+.	+++.	.....|	.....+.	.....+.	.....+.	.....|
Chaetacanthus setiger	+...|	++++.	.....|	.....|	.....|	.....|	.....+.	.....|
Vernonia galpinii	..+..|	++..+.	.....|	.....|	.....+++.	.....|	.....+.	.....|
Kalanchoe thyrsoiflora	..++|	..+.	+++.	.....|	.....|	.....|	.....+.	.....|
Indigofera zeyheri	+...|	+..+.	.....|	.....|	.....+.	.....|	.....+.	.....|

Species Group C

Pogonarthria squarrosa	..+3+|	+.....|	.....|	.....|	.....|	.....|	.....+.	.....|
Sphenostylis angustifolia	..+++|	.....|	.....|	.....|	.....+1.	.....|	.....+.	.....|

Indigofera hedyantha	+++	|	.....	|	.....	|	.....	|	+. . . . .	|	.....	|	+a. . . . .	|	.....
Vernonia staehelinoides	+++	|	.....1	|	.....	|	.....	|	+. . . . .	|	.....	|	.....	|	.....
Acacia caffra	1+	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Burkea africana	++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Cryptolepis oblongifolia	..++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Lantana rugosa	+. .	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Acalypha villicaulis	..++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Helichrysum setosum	+. .+	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Phyllanthus parvulus	..++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Boophane disticha	..++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Rhus zeyheri	1. . .	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....

Species Group D

Ochna pulcra	....	|	+++1	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Euphorbia schinzii	....	|	.b+	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Ancylobotrys capensis	....	|	+++.+	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Phymaspermum athanasioides	....	|	a..3b.	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Mundulea sericea	....	|	a.bb	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Aristida bipartita	....	|	++.+	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Commelina erecta	....	|	...+++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Sutera palustris	....	|	...+++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Anacampseros subnuda	....	|	...++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Kalanchoe paniculata	....	|	...++	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Pelargonium dolomiticum	....	|	+. .	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....
Cleome maculata	+. .	|	+. .	|	.....	|	.....	|	.....	|	.....	|	.....	|	.....

Species Group E

Andropogon schirensis	+. .	|	.....	|	...+++b.	|	..++	|	..+b.	|	a+alb+++	|	.....	|	+. . . . .
Alloteropsis semialata	....	|	.....	|	..+. . . . .	|	..++	|	+++	|	..+.	|	.....	|	+. . . . .
Monocymbium cerasiiforme	....	|	.....	|	..+. . . . .	|	..++	|	+. 1. . . . .	|	+. . a. +	|	.....	|	+. . . . .
Hemizygia pretoriae	....	|	.....	|	..+. . . . .	|	..++	|	..++	|	..+. . . . .	|	.....	|	+. . . . .
Digitaria monodactyla	....	|	.....	|	..+. . . . .	|	..++	|	..+. . . . .	|	..++	|	.....	|	+. . . . .
Acalypha angustata	+. .	|	.....	|	..+. . . . .	|	..++	|	.....1	|	..+. . . . .	|	.....	|	..+. . . . .
Aristida canescens	+. .	|	.....	|	..+. . . . .	|	..++	|	..+. . . . .	|	..+. . . . .	|	.....	|	..+. . . . .
Vernonia sutherlandii	....	|	.....	|	..+. . . . .	|	..++	|	..+. . . . .	|	..+. . . . .	|	.....	|	..+. . . . .

Species Group F

Sporobolus pectinatus	....|..+..+|++++.+++1+++|+..+...|+.+...|.....|.....|.....|.....
Aristida transvaalensis	....|.....|.b+b+bbb++a1|.+.+.+|a.....|.....|.....|.....|.....
Cymbopogon validus	.+.+|+...+..|1111b++++.++|...+b..b|.....|+.....|.....|.....|+...
Crassula setulosa	....|.....|+++++++.+++.+|...+...|.....|.....|.....|.....|.....
Pellaea calomelanos	+...|.+.+.++|.+.+++++...|+...++..|.....|.....|.....|.....|+....
Rhus rigida	....|.....|+++++.+...|.....|.....|.....|.....|.....|.....|.....
E. magalismsontanum	.+...|.....|.a...1b.r...|.+.+...|.....|.....|.....|.....|.....|.....
Indigofera oxytropis	+...|+.....|.+.+.+.+.+|.a.....|.....|.....|.....|.....|.....|.....
Cheilanthes hirta	....|.....|.+.+.+.+.+|.....|.....|.....|.....|.....|.....|.....
Aristida sp.	....|1.....|.....+.+.+|.....|.....|.....|.....|.....|.....|.....
Zornia linearis	....|.....|.+.+.+.+.+|.....|.....|.....|.....|.....|.....|.....
Sutera caerulea	....|.....|.11+.....|.....|.....|.....|.....|.....|.....|.....
Nuxia congesta	....|.....|.bb..1.....|.....|.....|.....|.....|.....|.....|.....
Vangueria infausta	....|.++...|ab...+.+...|.....|.....|.+.+...|.....|.....|.....|.....
Gladiolus permeabilis	....|..+.+...|.+.+++.....|.+.+...|.....|.+.+...|.....|.....|.....|.....
Eragrostis sp.	....|.....|.....+.+.+|.....|.....|.....|.....|.....|.....|.....
Enneapogon scoparius	....|.....|.+++.....|.+.+...|.....|.++.....|.....|.....|.....|.....
Dianthus mooiensis	....|..+.+...|.+++.....|.+.+...|.....|.....|.....|.+.+.....|.....|.....
Taphiphyllum parvifolium	....|.a...+...|.1.....|.....|.....|.....|.....|.....|.....|.....

Species Group G

Indigofera setiflora	....|.....|.....|+++.....|++++.+|.....|...+.....|.....
Graderia subintegra	....|.....|.....|+++.....|.+.+.+|...+.+|...+.+|...+.+|.....
Felicia muricata	....|.....|.....|.+.+...|.+.+...|1.++..|...+.+|...+.+|.+.+|...+.+
Nolletia rarifolia	....|.....|.....|.+.+...|.+.+...|.+.+...|.....|...+.+...|.+.+...|.....
Triraphis andropogonoides	..+|.+.+...|.....|.....|.+.+...|.+.+...|.+.+...|.....|...+.+...|.+.+...|.....
Indigofera filipes	....|.....|.....|.+.+...|.+.+...|.+.+...|.....|.....|.....|.+.+...|.....
Crassula capitella	....|.....|.....|+++.....|.+.+...|.....|.....|...+.+.....|.+.+...

Species Group H

Protea caffra	+...|.....|.+.3..+.....|a3bbb+bb|.....3|.....|.....|.....|.....
Protea roupelliae	....|.....|.....|.1.....|.....|.....|.....|.....|.....|.....

Species Group I

Cymbopogon excavatus	..+.	..1...+	.....	.....	...+..	.ba.11	++++.++++...	.1..
Helichrysum nudifolium	....	.....	.....	+..+....	.....	+++...	+++.....+..	...++
Striga elegans	....	.....	.....	.....	.....	.....+	+++..+++.+.+	...++
Crabbea angustifolia	....	.....+	.....	.....	.....	...++.	.....+....+.+	...++

Species Group J

Hermannia depressa	....	.....	.....	.....	.....	.+.+.+	.++.++.++++.	....
Ipomoea crassipes	....	.....	.....	.....+	.....	.+.+++	++++++++. ....	...+
Tephrosia capensis	....	.....	.....	.....	.....	++.+.+	.+.+.+. ....	...+
Vernonia natalensis	....	.....	.....	.....	.....	++.....	++.....++.....	....

Species Group K

Senecio isatidius	....	.....	.....	.....	.....	11...+	.....	....
Sida dregei	....	.....	.....	.....	.....	.+.+.+	.....+. ....	....
Solanum panduriforme	....	.....	.....	.....	.....	...+++	.....+. ....	....
Rhus discolor	....	.....	.....	.....	.....	.+.+.+	.....+. ....	....
Senecio inornatus	....	.....	.....+	.....	.....	++.....	.+. ....+. ....	....
Schist. crataehifolium	....	.....	.....	.....	.....	++.....	......λ	....
Crabbea acaulis	....	.....	.....	.....	.....	.+.+.+	.....+. ....	....
Gnidia capensis	.+.	.....	.....	.....	.....	...+.+	.....+. ....	....
Crassula alba	....	.....	.....	.....	.....	++.....	.....	....
Acalypha sp.	....	.....	.....	.....	.....	++.....	.....	....
Ajuga ophrydis	....	.....	.....	.....	.....	++.....	.....	....
Corchorus asplenifolius	....	.....	.....	.....	.....	.+.+.+	.....	....
Lipocarpa rehmannii	....	.....	.....	.....	.....	...+.+	.....	....

Species Group L

Hypoxis rigidula	+.+	.....	|m++.....+	.....+	.....+	1.....	|1+.1+++....	...++
Becium obovatum	.+.++++	.+.+++	+++++++....	...+
Ipomoea ommanyi	++.	.....	+++..++.....	.....+	.....+	.....	+++..++..+++..	...+
Dicoma zeyheri	....	.....	.....	.....+	.....	.....+	+++..+++. ....	....
Conyza podocephala	....	.....	.....	.....	.....	...+.+	.+.+. ....++.	....
Senecio affinis	+..	.....	.....+	.....+	.....+	.....	...++++.+. ....	....
Justicia anagalloides	....	.....	.....	.....	.....	.....	+.+.+.+. ....	....
Verbena bonariensis	....	.....	.....	.....	.....	.....	.....+. ....+++	....

Aster harveyanus	.....	.....	.....	.....	..+..	+.....	.....++..++..	.....
Ledebouria marginata	.....	.....	.....	.....	.....	.....	++++.....	.....
Ledebouria ovatifolia	.....	.+.....	.....+.....	.....	.....	.....	+++..+.....	.+..
Eriosema cordatum	.....	.....	.....+.....	.....	.....	.....	+...+...+...	.....
Acalypha angustata	.....	.....	.....	.....	.....	.....	..+...+.....	.....
Cephalaria zeyheriana	.....	.....	.....	.....	.....	.....	..+..+.....	.....
Anthericum fasciculatum	.....	..+.....	.....	.....	.....	.....	++...+.....	.....
Kohoutia amatymbica	.....	.....	.....	.....	..+..	.....	+.....++..	.....
Gladiolus sp.	.....	.....	.....	.....	.....	.....	..+...+.....	.....
Acacia karroo	.....	.....	.....	.....	.....	.....	.....3..	.....
Indigofera burkeana	.....	.....	.....	.....	.....	.....	.....b..	.....

Species Group M

Eragrostis gummiflua	.....	.....	.....+.....	.....	.....	.....	.....	|b+a+
Cynodon dactylon	.....	.....	.....	.....	+...+	..++..	+..+.....+..	|++++
Aristida congesta	.....	.....	.....+.....	.....	.....	.....	.....+.....	|++++
Monsonia angustifolia	.....	+.....	.....	.....	.....	..+..+	.....	|.+++
Triraphis andropogonoides	.....	..++.....	.....	.....	.....	.....	.....	|.+++
Richardia brasiliensis	.....	.....	.....+.....	.....	+.....	.....	.....+.....	|.+++
Pollichia campestris	.....	.....	.....	.....+.....	.....	.....	.....	|.++.
Commelina africana	.....	.....	.....	.....	.....	.....	.....	|+..+
Euphorbia striata	.....	.....	.....	.....	.....	.....	.....	|..++
Hermannia lancifolia	.....	.....	.....	.....	.....	.....	.....	|.+++
Sporobolus fimbriatus	.....	.....	.....+.....	.....	.....	.....	.....	|b...

Species Group N

Themeda triandra	..+b|b+++a..	|++.....	+++++ba+	|+ab+++|	43++3b|	ab31+ab.b.+3|	+++.
Brachiaria serrata	+1+1|.+.a++|	.+.+++++.1+	|+a+++aa+	|a+a++b|	1+a+++|	+++++a+++.	..b+
Diheteropogon amplexans	+++|+b+ab1a|	+++++++b++|	+++1+.b1+	|++++.|	+.....|	+..+....	.....
Bulbostylis burchellii	++.+|+a+++|	a+.1++++.+	|+++....	+....	++..+.	++..+..	|+..++
Trachypogon spicatus	..+|+3.+1.	|+++++.++1+	|bbb+.+++|	.a++++|	+aa.++|	1+.+.++++.	.....
Eragrostis racemosa	.+.+|.....	|+++++.+++|	+..+....	+++++|	++1..+|	+++a++++.	|.+++3
Elionurus muticus	..+|.+++..+|	a++..+..+.	|..++++.+	|+.+++|	+...1+	+++++++.	|+aa.
Cyanotis speciosa	..+|.+.+.++|	+++++.++++|	.+.+++.+	|+..++..	++..+++|	..+..++..	|..+.+
Tristachya leucothrix	+a..|+..+++1+	...+++...+.	|b+a+++++	|++..++|	.....|	+++3..++..	.....
Ledebouria revoluta	...+|..+..++|	..++..++..++|	+..+++++	|+..+...	...++|	...+++++.	|.++.
Senecio venosus	+++|++..+++|	..+.+.+++..	|.1+.+.+	|+..+++.	.....|	..+.+++..	|.+.+
Eragrostis chloromelas	...+|b.....	|++..+++..b+b|	.....	|..++b.	...b++|	++a..+....	|+1++

Heteropogon contortis	..++|..+.+.|...++..+.++|. ....+.|+.+.|+...+a|++1.+++++.|+++.
Hyparrhenia hirta	...a|....+.+|...+.+.+++|+.....|.....|++b3+|.....a+1a+|.1+3
Chaetacanthus costatus	+1..|.....1+|....+. ....+|.+.++1|.1++|.+.++.|...+++11....|...+
Nidorella hottentotica	+++1|.....|...++.....|...+.+.|.+.++.|+.+.+.|+.+.++a+|.++1
Pentanisia angustifolia	+...|.....|...+. ....+|.1...+++|..+++|.+. ....|++++++a+...|.++.
Polllicia campestris	+++|.....|+. ....+|. ....+.|+++.+.|.++++.|...+++.+.|. ...+
Helichrysim rugulosum	..a|+. ....+|.++.....+|+.+.+.|. ....|...+++.|a...+.+.b3|+...
Setaria sphacelata	..+.|+. ....a|+.+.+.+.|.+. ....|.+.+.|+++.++|.11.a...+.b.+|+...
Eragrostis curvula	..+.|.+++...|.a.++++.+.|. ...b....|.....|.....|+.+.1...+.b.3|+...
A.greatheadii var. davyana	+.++|.l++..|.+.+. ....+|+...+++|. ...++|.++...+|...+. ....+|. ...
Vernonia oligocephala	....|.....+.|. ....+|.+++.+.|.+. ....|.+.+++|+++.1...b.+|. ...
Wahlenbergia undulata	....|...+.+.|. ...+. ....+|. ...+.|. ....+.|.+. ....|. ...+.+. ....+|+.++
Tagetes minuta	+.++|.....|.+.+.+. ....+|. ...+.+.|. ...+.|. ...+.|. ....+++.|. ...
Pearsonia sessilifolia	+...|.....+|.+.++....+.|.++....|.....|.+. ....|.+.+.++....|. ...
Thesium utile	....|.....+.|. ...+. ....+|.+++.++|.+. ....|.....|++....+++...|. ...
Stoebe vulgaris	....|.....|. ...+. ....+|+.....|.+. ....|.+. ....|++++...+. ....|.ba
Scabiosa columbaria	....|.....|. ...+. ....+|. ....+.|. ....+.|. ...+.|++++.+.+.|. ...
Helichrysum coriaceum	....|.....|. ....+.|. ....+.|.+.+.+.|.+.+.|.+++.+.+.+.|. ...
Gerbera viridifolia	....|.....|. ...+++....|. ...+.+.|.+.+.|. ....|.+.+.+.+.+.|. ...



Annexure A

Infrequent species occurring 7 times and less in the surveyed grassland sample plots.

Scarce species associated with Species group A

<i>Bidens pilosa</i>	<i>Rhus magalismsontana</i>	<i>Hemizygia canescens</i>
<i>Stylosanthes fruticosa</i>	<i>Digitaria brazzae</i>	<i>Dichapetalum cymosum</i>
<i>Cleome monophylla</i>	<i>Solanum mauritianum</i>	<i>Limeum viscosum</i>
<i>Leonotis ocyimifolia</i>	<i>Jamesbrittenia burkeana</i>	<i>Scadoxus puniceus</i>
<i>Indigofera melanadenia</i>	<i>Urochloa mosambicensis</i>	<i>Aristida diffusa</i>
<i>Tragopogon dubius</i>	<i>Stachys natalensis</i>	<i>Pollichia campestris</i>
<i>Helichrysum cerastioides</i>	<i>Dipcadi ciliare</i>	<i>Brachylaena rotundata</i>
<i>Combretum molle</i>	<i>Crassula swaziensis</i>	<i>Commelina livingstonii</i>

Scarce species associated with species group B

<i>Lantana camara</i>	<i>Helichrysum cerastioides</i>	<i>Thesium magalismsontanum</i>
<i>Lotononis longiflora</i>	<i>Commelina</i> sp.	

Scarce species associated with species group C

<i>Zanthoxylum capense</i>	<i>Cussonia paniculata</i>	<i>Halleria lucida</i>
<i>Ranunculus multifidus</i>	<i>Vahlia capensis</i>	<i>Ipomoea obscura</i>
<i>Vernonia poskeana</i>	<i>Sporobolus</i> sp.	<i>Lanea edulis</i>

Scarce species associated with Species group D

<i>Portulaca kermesina</i>	<i>Tephrosia elongata</i>	<i>Crassula lanceolata</i>
<i>Huernia hystrix</i>	<i>Indigofera comosa</i>	<i>Eulophia ovalis</i>
<i>Lepidium bonariense</i>	<i>Merremia tridentata</i>	<i>Opuntia ficus-indica</i>
<i>Bothriochloa insculpta</i>	<i>Indigofera comosa</i>	<i>Zaluzianskya maritima</i>
<i>Indigastrum costatum</i>	<i>Raphionacme</i> sp.	<i>Physalis</i> sp.
<i>Asparagus</i> sp.	<i>Eriospermum</i> sp.	<i>Vernonia staehelinoides</i>
<i>Barleria pretoriensis</i>	<i>Becium angustifolium</i>	<i>Ceratotheca triloba</i>
<i>Sida cordifolia</i>	<i>Indigofera hedyantha</i>	<i>Lantana camara</i>
<i>Clerodendrum</i> sp.	<i>Panicum maximum</i>	

Scarce species associated with Species group E

<i>Eragrostis nindensis</i>	<i>Anthospermum hispidulum</i>	<i>Aloe verecunda</i>
<i>Asclepias stellifera</i>	<i>Tapiphyllum parvifolium</i>	<i>Gnidia sericocephala</i>

Scarce species associated with Species group F

<i>Clematopsis scabiosifolia</i>	<i>Harpochloa falx</i>	<i>Urginea depressa</i>
<i>Urginea</i> sp.	<i>Conyza bonariensis</i>	<i>Indigofera spicata</i>
<i>Cyperus rotundus</i>	<i>Enteropogon monostachyus</i>	<i>Berkheya seminivea</i>
<i>Psammotropha myriantha</i>	<i>Thesium</i> sp.	<i>Araujia sericifera</i>
<i>Diheteropogon filifolius</i>	<i>Ceropegia rendallii</i>	<i>Osyris lanceolata</i>
<i>Heliophila rigidiuscula</i>	<i>Eragrostis sclerantha</i>	<i>Helichrysum</i> sp.
<i>Bonatea speciosa</i>	<i>Raphionacme galpinii</i>	<i>Raphionacme hirsuta</i>
<i>Crotalaria lotoides</i>	<i>Cyphia stenopetala</i>	<i>Myrsine africana</i>
<i>Zaluzianskya katharinae</i>	<i>Cineraria</i> sp.	<i>Anthericum</i> sp.
<i>Wahlenbergia denticulata</i>	<i>Sisymbrium</i> sp.	<i>Chloris</i> sp.
<i>Vernonia</i> sp.	<i>Geigeria burkei</i>	
<i>Plectranthus madagascariensis</i>		

Scarce species associated with Species group G

<i>Lotononis eriantha</i>	<i>Eriosema burkei</i>	<i>Helichrysum melanacme</i>
<i>Indigofera zeyheri</i>	<i>Hyparrhenia tamba</i>	<i>Thesium utile</i>
<i>Schmidtia pappophoroides</i>	<i>Scilla nervosa</i>	<i>Crassula</i> sp.
<i>Brachystelma</i> sp.	<i>Indigofera melanadenia</i>	<i>Acanthospermum australe</i>

Pearsonia aristata
Cymbopogon plurinodis

Indigofera oxytropis
Pearsonia sessilifolia

Senecio erubescens

Scarce species associated with Species group H

Euclea crispa
Senecio sp.
Solanum retroflexum
Schizachyrium jeffreysii
Hypochaeris radicata

Helichrysum cephaloideum
Senecio consanguineus
Eragrostis micrantha
Andropogon appendiculatus
Monsonia sp.

Walafriida tenuifolia
Cynoglossum sp.
Rhus rimosa
Gnidia microcephala

Scarce species associated with Species group I

Polygala hottentotta
Cyperus sp.
Barleria macrostegia

Senecio variabilis
Acalypha glabrata

Cyperus obtusiflorus
Delosperma sp.

Scarce species associated with Species group J

Ziziphus zeyheriana
Hermannia coccocarpa
Lippia javanica
Ziziphus zeyheriana
Turbina oblongata

Nidorella anomala
Polygala amatymbica
Pearsonia cajanifolia
Waltheria indica

Vigna vexillata
Rhus zeyheri
Gladiolus crassifolius
Aerva leucura

Scarce species associated with Species group K

Hibiscus trionum
Aster harveyanus
Satyrium sp.
Argyrolobium species
Berkheya radula
Floscopa glomerata

Cucumis hirsutus
Pearsonia cajanifolia
Sebaea grandis
Barleria sp.
Hypericum lalandii

Hibiscus aethiopicus
Pennisetum sphacelatum
Senecio scitulus
Felicia sp.
Verbena brasiliensis

Scarce species associated with Species group L

Berkheya insignis
Scilla sp.
Peucedanum magalismsontanum
Sida alba
Chaetacanthus burchellii
Helichrysum miconiifolium
Oenothera rosea
Typha capensis
Euphorbia clavarioides
Lotononis foliosa
Aristida adscensionis
Turbina oblongata
Lactuca inermis
Eucomis autumnalis
Eragrostis biflora
Trichocladus grandiflorus
Centella asiatica
Senecio inaequidens

Pachycarpus schinzianus
Cynoglossum hispidum
Salvia runcinata
Andropogon schirensis
Hypoxis acuminata
Pygmaeothammus zeyheri
Paspalum dilatatum
Sonchus sp.
Polygala sp.
Bothriochloa bladonii
Setaria sp.
Chascanum hederaceum
Lipocarpa rehmannii
Hibiscus aethiopicus
Hypoxis sp.
Hibiscus microcarpus
Chironia purpurascens

Tolpis capensis
Evolvulus alsinoides
Indigofera hedyantha
Senecio coronatus
Chenopodium album
Cynanchum africanum
Rhynchosia vendae
Cyperus obtusiflorus
Chortolirion angolense
Crepis hypochoeridea
Rhynchosia adenodes
Eragrostis superba
Solanum elaeagnifolium
Clerodendrum triphyllum
Indigofera sp.
Celtis africana
Cycnium tubulosum

Scarce species associated with Species group M

Cynoglossum sp.
Oxalis sp.
Indigofera comosa
Pennisetum clandestinum
Eriosema salignum
Neorautanenia ficifolius
Lotononis laxa
Barleria sp.

Mariscus congestus
Solanum rigescens
Kohautia virgata
Acalypha angustata
Litogyne gariepina
Haplocarpha scaposa
Tephrosia acaciifolia
Tephrosia capensis

Oxalis corniculata
Gomphrena celosioides
Lepidium sp.
Dicoma macrocephala
Crabbea ovalifolia
Perotis patens
Ledebouria revoluta



Scarce species associated with Species group N

<i>Coleochloa setifera</i>	<i>Microchloa caffra</i>	<i>Tritonia nelsonii</i>
<i>Bewsia biflora</i>	<i>Digitaria diagonalis</i>	<i>Diospyros lycioides</i>
<i>Dicoma anomala</i>	<i>Sonchus dregeanus</i>	<i>Eragrostis capensis</i>
<i>Dianthus mooiensis</i>	<i>Gerbera piloselloides</i>	<i>Pentarrhinum insipidum</i>
<i>Lotononis</i> sp.	<i>Rhynchosia totta</i>	<i>Gazania krebsiana</i>
<i>Canthium gilfillanii</i>	<i>Sphenostylis angustifolia</i>	<i>Helichrysum setosum</i>
<i>Helichrysum kraussii</i>	<i>Indigofera hilaris</i>	<i>Conyza albida</i>
<i>Ipomoea bathycolpos</i>	<i>Digitaria eriantha</i>	<i>Teucrium trifidum</i>
<i>Nemesia fruticans</i>	<i>Oldenlandia herbacea</i>	<i>Kohautia</i> sp.
<i>Brachiaria nigropedata</i>	<i>Striga asiatica</i>	<i>Helichrysum dasymallum</i>
<i>Sonchus wilmsii</i>	<i>Lotononis calycina</i>	<i>Cucumis zeyheri</i>
<i>Rhynchosia nitens</i>	<i>Oxalis obliquifolia</i>	<i>Rhus pyroides</i>
<i>Indigofera</i> sp.	<i>Delosperma herbeum</i>	<i>Lotononis foliosa</i>
<i>Maytenus heterophylla</i>	<i>Clematis brachiata</i>	<i>Chascanum hederaceum</i>
<i>Walafrida densiflora</i>	<i>Physalis viscosa</i>	<i>Eragrostis plana</i>
<i>Senecio erubescens</i>	<i>Cyperus esculentus</i>	<i>Zinnia peruviana</i>
<i>Chlorophytum cooperi</i>	<i>Melia azedarach</i>	<i>Kalanchoe</i> sp.
<i>Hypericum aethiopicum</i>	<i>Digitaria tricholaenoides</i>	<i>Geigeria burkei</i>
<i>Tephrosia rhodesica</i>	<i>Asclepias adscendens</i>	<i>Pygmaeothamnus zeyheri</i>
<i>Felicia muricata</i>	<i>Tephrosia capensis</i>	<i>Rhus lancea</i>
<i>Bothriochloa radicans</i>	<i>Euryops laxus</i> [†]	<i>Osteospermum muricatum</i>
<i>Striga bilabiata</i>	<i>Aristida meridionalis</i>	<i>Setaria lindenbergiana</i>
<i>Elephantorrhiza burkei</i>	<i>Schkuhria pinnata</i>	<i>Sida rhombifolia</i>
<i>Solanum elaeagnifolium</i>	<i>Kohautia caespitosa</i>	<i>Gnidia</i> sp.
<i>Dombeya rotundifolia</i>	<i>Elephantorrhiza elephantina</i>	<i>Gazania krebsiana</i>
<i>Pseudognaphalium luteo-album</i>		

Infrequent species occurring more than 7 times in the grassland sample plots.

<i>Oxalis depressa</i>	<i>Tephrosia elongata</i>	<i>Athrixia elata</i>
<i>Senecio lydenburgensis</i>	<i>Conyza</i> sp.	

CHAPTER 5

RESULTS

Natural woodland vegetation and plant species richness of open spaces in the urban areas Gauteng, South Africa

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Abstract

A vegetation survey of the natural woodlands was undertaken in the urban areas of Gauteng. Relevés were compiled in 132 stratified random sample plots in selected open spaces within the study area. A TWINSpan classification, refined by Braun-Blanquet procedures, indicated six woodland communities, represented by 72 relevés. The identification, classification and description of these plant communities are important for the continued conservation of open spaces in the urban environment.

Key words: Braun Blanquet analysis, classification, plant communities, urban open space, TWINSpan.

Introduction

Although the smallest of the 9 provinces of South Africa, covering an area of only 16 191km², Gauteng has a population of approximately 7,3 million people making it the most densely populated province in South Africa (Gauteng 2000a). It is therefore understandable that urbanisation and its associated impacts are the biggest threats to the natural areas that still persist in the Gauteng urban areas. Kowarik (1990) confirms this by stating that human impact has been recognised as one of the most important influences on the composition of vegetation in urban environments. These impacts often include the loss of complete habitats due to the construction of residential, industrial or other developments. Natural areas adjacent to urban areas are equally stressed due to human related activities such as trampling due to footpaths and exotic plant invasions including escapees from gardens. Management

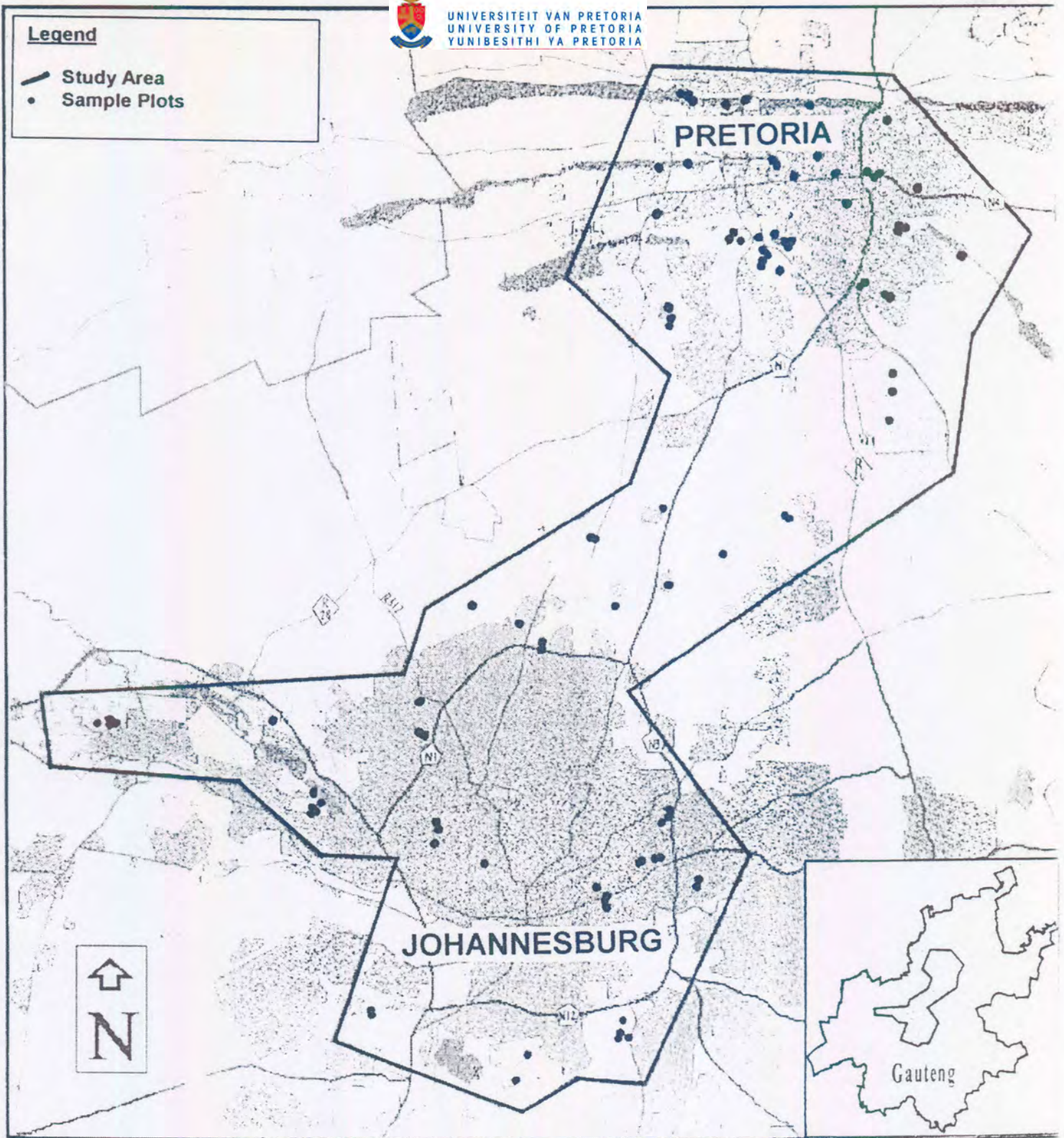


Figure 1. The study area is located within the Gauteng Province and 132 sample plots were placed in the various urban open spaces in order to describe the vegetation found growing there (Scale 1:670 000).

practices such as mowing natural grasslands and changing natural veld fire frequency also has a big influence on these natural ecosystems.

In the past, little attention has been paid to the natural environment when making decision on the planning and management thereof. This lack of inclusion of the natural environment in urban development planning has led to the wasteful exploitation of our natural resources (Bredenkamp & Brown, 1998a & b). In European countries landscape ecological mapping and evaluation has however become an essential part of the planning process (Spellerberg, 1992). Such planning assists in restricting disturbance from areas with vulnerable habitats or species and prevent undue fragmentation of wildlife habitat (Helliwell, 1973). However, until recently, vegetation surveys in urban areas in South Africa were unknown. After a pioneer survey in the Durban Municipal Area (Roberts 1993), surveys were undertaken in urban areas of Potchefstroom (Cilliers & Bredenkamp 1998, 1999a, b, c, 2000, Cilliers *et. al.* 1998) and Klerksdorp (Van Wyk, Cilliers & Bredenkamp, 1997) in the North-West Province and in Bloemfontein (Dingaen, 1999) in the Free State.

The natural areas of the Gauteng Province, is continually under threat of development and presently support a high number of different species. Limited vegetation studies, mostly unpublished, have been done on small areas in the urban Gauteng (Behr & Bredenkamp 1988, Ellery 1992 & 1994, Bredenkamp 1991, 1992, 1997a & b, Bredenkamp & Brown 1998a & b). Surveys of natural woodland vegetation in the Gauteng Province though not including urban areas include those of Bredenkamp & Theron (1978 & 1980) and Coetzee *et.al.* (1993a & b, 1994 & 1995). A comparison of the results of these studies indicate that patches of natural vegetation do occur in urban Gauteng.

The present study reports on a wider assessment of the vegetation of the urban areas of Gauteng attempting to assess the high species richness in urban areas and to consolidate the studies previously done in the study area. The purpose of this study was therefore to assess the variation in vegetation and thereby identify the plant communities of different types of habitat present in the urban areas of Gauteng. This information will help to motivate conservation actions, ensuring that nature conservation strategies is incorporated into land-use planning initiatives within the urban environment.

Study area

The study area is located between 27° 40'E to 28°25'E and 25°40'S to 26°20'S approximately in the center of the Gauteng province (Figure 1) and includes Pretoria, Midrand, Johannesburg and parts of the West Rand. Altitudes in Gauteng vary from 1081m to 1899 above sea level, with a mean altitude of 1512m (Gauteng 2000). The altitude of the study area is however between 1 400 to 1 800 m above sea level.

Acocks (1988) described the vegetation of the study area as “False” Grassland of the Central variation of Bankenveld (Veld Type 61b). Patches of woodland vegetation are found at sheltered sites on hillslopes and rocky outcrops within this Veld Type. Bredenkamp & Van Rooyen (1996a) described this vegetation as the Rocky Highveld Grassland vegetation type, which covers the largest part of the study area. A small intrusion of Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1996b) occurs in the southeastern corner of the study area. The area, therefore, predominantly represents the Grassland Biome (Rutherford & Westfall 1986). The open and closed woodland patches in the grassland biome resemble the vegetation of the Waterberg Moist Mountain Bushveld (Bredenkamp & Van Rooyen 1996b) also described by Acocks (1988) as Sour Bushveld (20). The woodland component of the area is further represented by the Mixed Bushveld vegetation type (Bredenkamp & Van Rooyen 1996a) representing the savanna biome (also described as Sour Bushveld (20) by Acocks (1988) in the northern part of the study area.

Currently, only 3.05 % of Mixed Bushveld and 8.55% of the Waterberg Moist Mountain Bushveld is conserved (Bredenkamp & Van Rooyen 1996a & d).

The mean monthly temperature in the study area for the weather stations listed below is 16.8°C with a mean maximum of 22.6°C and a mean minimum of 10.8°C. The mean winter temperature in the study area is 13.8°C and mean summer temperature, 25.6°C (Weather Bureau 2000). Mean annual rainfall in Gauteng is measured at 670mm per year (Gauteng 1997). The geology of the area includes the rock types dolomite, chert, quartzite, granite, diabase, shale and andesitic lava. The most important Land Type classes in this study area are Ab1, Bb1, Bb2, Ba7, Ba9,

Ib3, Ib7, Ib41 and Ib43 with Ib Land Types often associated with ridge areas and Ab, Ba and Bb Land Types with flat undulating landscapes. The main soil forms found in the study area are Mispah, Southwold, Trevanian, Glenrosa, Williamson, Trevanian, Glendale, Msinga, Klipfontein, Sandvlei, Robmore, Glendale and Platt, which have an A horizon clay content ranging from 10–30% (Land Type Survey Staff 1985 & 1987a & b).

Methods

The open spaces within the study area were identified and delineated using 1:50 000 aerial photographs. These areas were then stratified into relatively homogeneous areas, and sample plots were randomly allocated within each homogeneous area. A total of 73 of the 132 sample plots were located within woodland vegetation. Due to the small size and accessibility of some of the sites, these sites with more than one plant community were further stratified by visual evaluation. Plot sizes of 200 m² were used in accordance with Bredenkamp and Theron (1978). Wetlands and riverine vegetation were excluded for this study.

Total floristic composition was noted for every sample plot. Additionally, the average height and percentage cover of the tree, shrub and herbaceous components were estimated and recorded. The percentage cover of bare soil was also estimated and recorded. The coverage of the tree layer was based on a crown cover where the canopies are vertically projected onto the ground (Werger, 1974). The same technique was used for the shrub and herbaceous component. The dominant tree, shrub, and herbaceous species were noted and the cover/abundance for each species was estimated according to the Braun Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974).

Environmental data included slope inclination measured in degrees, topography including hills, slopes and crests, aspect (north, south, west, east and aspects in between) and disturbance factors such as exotic vegetation, trampling and erosion. Information on geology, Land Type, soil series, and clay contents were obtained from Land Type Survey Staff (1985 & 1987).

The computer programme TURBOVEG (Hennekens 1996a) and the TWINSpan classification algorithm (Hill 1979) were used for capture, processing and presentation of phytosociological data. Further refinement was achieved with Braun Blanquet procedures by using MEGATAB (Hennekens 1996b), a visual editor for phytosociological tables. These results are captured in Table 1.

Infrequent species occurring 7 times and less in the sample plots surveyed, are recorded in Annexure A.

Names and authors of taxa are in accordance with Arnold & De Wet (1993). For the purposes of this study, *Aloe greatheadii* var. *davyana* and *Aloe transvaalensis* were clumped as one species and referred to as *Aloe greatheadii* var. *davyana* due to similar distribution pattern and appearance of these species making differentiation difficult.

Results and Discussion

A mixture of tree, shrub and herbaceous species characterize the woodland areas of the entire study area. General species present in the woodland components are listed under Species Group K (Table 1).

The vegetation of the woodland communities is characterized by the presence of the small trees *Diospyros lycioides*, *Canthium gilfillanii*, *Zanthoxylum capensis*, *Rhus leptodictya*, *Maytenus heterophylla* and *Rothmannia capensis*, together with the exotics *Lantana camara* and *Solanum mauritianum*.

The small shrub *Protasparagus suaveolens*, the forbs *Commelina africana*, *Helichrysum rugulosum* the succulent *Aloe greatheadii* var. *davyana*, the slender twining herb *Pentarrhinum insipidum*, the exotics *Tagetes minuta*, *Bidens pilosa*, the noxious weed *Cuscuta campestris* and the fern *Pellaea calomelanos* are also often encountered, while common grasses include *Melinis repens*, *Melinis nerviglumis*, *Themeda triandra*, *Setaria sphacelata*, *Cymbopogon validus*, *Panicum maximum*, *Hyparrhenia hirta*, *Eragrostis curvula*, *Brachiaria serrata*, *Heteropogon contortis*, and *Digitaria eriantha*. These species are listed in Species Group K (Table 1) and will

therefore not necessarily be repeated in the description of the various plant communities.

The hills and ridges in the study area are often covered by a mosaic of open woodland on the warmer and drier north-facing slopes, closed woodland in more sheltered sites below rocky cliffs and grassland patches on more exposed areas. Closed woodland communities are also found along rivers and streams. Cooler south-facing slopes may have *Protea caffra* woodland communities, of Afromontane Drakensberg affinity.

Two major plant communities were identified namely the *Acacia caffra-Rhus pyroides* open to closed Major Woodland community and the *Combretum molle-Setaria lindenbergiana* Open to Closed Major Woodland community.

Classification

The classification obtained from the TWINSPLAN resulted in the following six plant communities that can be grouped into two major communities being identified in the woodland areas surveyed.

1. *Acacia caffra* – *Rhus pyroides* Open to Closed Major Woodland Community
 - 1.1 *Hypoestes forskoolii* – *Acacia caffra* Closed Woodland Community
 - 1.2 *Acacia caffra* – *Setaria lindenbergiana* Closed Woodland Community
 - 1.3 *Acacia caffra* – *Themeda triandra* Open to Closed Woodland Community
 - 1.3.1 *Acacia caffra* – *Themeda triandra* – *Asparagus lariginus* Open to Closed Woodland Sub-community
 - 1.3.2 *Acacia caffra* – *Themeda triandra* – *Hyparrhenia hirta* Open to Closed Woodland Sub-community
2. *Combretum molle* – *Setaria lindenbergiana* Open to Closed Major Woodland Community
 - 2.1 *Combretum molle* – *Burkea africana* Open to Closed Woodland Community

2.2 *Combretum molle* – *Englerophytum magalismontanum* Open Woodland Community

The *Acacia caffra-Rhus pyroides* Open to Closed Woodland shows strong relationships with the Sub-humid Cool Temperate Mountain Bushveld of Coetzee *et al.* (1995), and also exhibits an affinity to the Afro-montane vegetation of the Drakensberg. The *Combretum molle-Setaria lindenbergiana* Open to Closed Woodland, however, relates to the Sub-humid Warm Temperate Bushveld as described by Coetzee *et al.* (1993), and shows an affinity to the Bushveld vegetation of the Savanna Biome (Rutherford & Westfall 1986). (Discuss) Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this vegetation unit. A comparison is provided below in Table 3 and 4.

The common species associated with the *Rhus pyroides* Forest and *Canthium gilfillanii-Aristida transvaalensis-Cymbopogon marginatus* Savanna communities identified by Bredenkamp & Theron (1978), compares well with the common species of the woodland species identified for this study. Equally, the common species of Bredenkamp and Theron's *Euclea crispa-Rhoicissus tridentata* Bush and Savanna communities as well as the *Trachypogon spicatus-Themeda triandra* Grassland communities (1980) compares well with the common species identified in the woodland communities for this study. No clear comparison could however be drawn between the vegetation communities identified.

Vegetation description

1. *Acacia caffra* – *Rhus pyroides* Open to Closed Major Woodland Community

Habitat

This plant community is scattered throughout the study area, among granite boulders, rocky outcrops and hills. The slopes varied from gradual to very steep. Although 54% of the sample plots were distributed in the Bb1b, Ib7a and Ib43a Land Types. This plant community occurs in a variety of Land Types (13 in total). All these Land Types indicate a lack of soil. The soil series associated with the Land Type Bb1

are Glenrosa Gs15, Klipfontein Ms11 and Sandvlei Wa31 with a clay content of 10–15%. Land Type Ib7a is characterized by the soil series Mispah Ms10, Southwold Cv26 and Trevanian Gs17 with a clay content of 12–30%. Mispah Ms10 and Williamson Gs16 are the soil series associated with Land Type Ib43a and has a clay content of 25–30% (Land Type Survey Staff 1985, 1987a & b).

Vegetation

Species group A (Table 1) characterizes this community. The diagnostic species are trees such as *Acacia caffra*, *Celtis africana*, *Rhus pyroides*, *Ehretia rigida*, *Dombeya rotundifolia*, *Zizphus mucronata*, *Cussonia paniculata*, *Heteromorpha trifoliata* and *Euclea crispa*, forbs such as the bulbous herb *Ledebouria revoluta*, the exotic climbing perennial herb *Achyranthes aspera*, the bulbous *Scadoxus puniceus* and the weed *Conyza* sp.

The species that dominate this plant community are the trees *Rhus leptodictya*, *Celtis africana*, *Acacia caffra*, *Cathium gilfillanii* and *Zanthoxylum capense*, the shrub *Diospyros lycioides* and small shrub *Protasparagus suaveolens*, the succulent *Aloe greatheadii* var. *davyana*, the common weed *Tagetes minuta*, the asteraceous form *Helichrysum rugulosum*, and the grasses *Themeda triandra*, *Hyparrhenia hirta* and *Setaria sphacelata*.

The high occurrence of the noxious weed *Tagetes minuta* as well as other exotic weedy species *Verbena bonariensis*, *Opuntia ficus-indica*, *Conyza albida*, *Lantana camara*, *Zinnia peruviana* and *Melia azedarach* in the shrub and tree layer indicates that this plant community is susceptible to disturbance and generally not in a good condition in the study area.

The average number of species recorded in this plant community per 200m² is 37.

In general, the species composition of this community compares well with that of the *Acacia caffra* – *Euclea crispa* woodland within the Sub-humid Cool Temperate Mountain Bushveld described by Coetzee *et al.* (1994, 1995), found on north facing slopes, crests and upper south facing steep slopes of the rocky outcrops mainly within the Ib Land Type in the Pretoria area.

This community also shows resemblance with the *Acacia caffra* – *Setaria spacelata* Closed woodland described by Coetzee *et al* (1995), the *Acacia caffra* – *Setaria sphacelata* Closed woodland in the Roodeplaatdam Nature Reserve (Van Rooyen 1984), the vegetation on the Bronberg in Pretoria (Bredenkamp 1997), the *Olea europaea* – *Cymbopogon excavatus* savanna and *Olea europaea* - *Schistotephium heptalobium* bush clumps vegetation of the Rietfontein Nature Reserve (Bredenkamp 1991), the *Acacia robusta* woodland (Ellery 1994) and the *Acacia caffra* vegetation of the Fort Klapperkop Area in Pretoria (Bredenkamp 1997b). The Kloof communities: *Rhus pyroides* Forests, *Rhus pyroides-Buddleja salviifolia-Celtis africana* Forest and *Dombeya rotundifolia-Ziziphus mucronata* savanna identified by Bredenkamp & Theron (1978) shows resemblance to this community. Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this vegetation unit. A comparison is provided below in Table 3 and 4.

Three communities were recognized under this Major Woodland community:

1.1 *Hypoestes forskoolii* – *Acacia caffra* Closed Woodland Community

Habitat

This woodland community is found on gradual to moderately steep slopes and a variety of aspects of hills, ridges and between granite boulders as well as along rivers in lower lying areas in the Pretoria, Midrand, Sandton and Randburg areas. A low clay content was observed in the soils associated with this plant community with special reference to the ridge and hill areas. This plant community was predominantly found in Land Type Bb1b.

Vegetation

This community is characterized by the presence of the trees *Combretum erythrophyllum* and *Rhamnus prinoides* (along rivers), *Acalypha glabrata*, *Pavetta gardeniifolia* var. *gardeniifolia* and *Buddleja saligna*, the shrub *Asparagus* sp. and the

shrublet *Aerva leucura*, the herb *Hypoestes forskalii*, the erect *Cyperus esculentus* the shrubby perennial herb *Hibiscus calyphyllus*, the exotic climber *Araujia sericifera* and the grass *Setaria megaphylla* (Species group B Table 1)

Prominent species in this plant community are the trees *Rhus pyroides*, *Celtis africana*, *Acacia caffra*, *Euclea crispa*, *Canthium gilfillanii*, *Rhus leptodictya*, *Zanthoxylum capense*, the shrub *Diospyros lycioides* and erect woody shrublet *Protasparagus suaveolens*, and the exotic climbing perennial herb *Achyranthes aspera* and noxious weed *Tagetes minuta*.

The average number of species recorded in this plant community per 200m² were 32.

Showing resemblance to this community is the *Combretum erythrophyllum* - *Celtis africana* Major Community described by Behr & Bredenkamp (1988) from the Witwatersrand Botanic Garden in Roodepoort and the *Celtis africana* – *Ziziphus mucronata* community (Bredenkamp 1997b) from the Fort Klapperkop area in Pretoria. This vegetation community as well as community 1.2 below, was observed on the Lonehill Nature Reserve and does not show a strong resemblance to the four woodland communities described by Bredenkamp (1992) for this Reserve. This may be due to the fact that Bredenkamp (1992) conducted a more detailed assessment on this small nature reserve. Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this vegetation unit. A comparison is provided below in Table 3 and 4.

1.2 *Acacia caffra* – *Setaria lindenbergiana* Closed woodland Community

Habitat

This closed woodland community has a limited distribution in the study area. It was observed on steep to very steep north and south-facing slopes of hills and ridges throughout the study area except in the Midrand - Fourways area. It is generally associated with the Land Type Ib43a.

Vegetation

The species group C (Table 1) is diagnostic for this plant community. The diagnostic species are the grass *Setaria lindenbergiana* and the climber shrub *Rhoicissus tridentata*.

The most prominent species in this plant community include the trees *Acacia caffra*, *Celtis africana* and *Euclea crispa*, the shrub *Diospyros lycioides* and the bulbous herb *Ledebouria revoluta*, the noxious weed *Tagetes minuta* and the succulent *Aloe greatheadii* var. *davyana*. Disturbance to this plant community was recorded at most of the sites, with specific reference to the low herbaceous cover under the trees.

An average of 31 species per 200 m² were recorded for this plant community.

This community is related to the *Setaria lindenbergiana* – *Ehretia rigida* Bush clumps (Coetzee 1995), the *Setaria lindenbergiana* – *Acacia caffra* Woodland described by Coetzee (1975) from the Rustenburg Nature Reserve and the *Olea europaea* – *Cymbopogon excavatus* savanna and *Olea europaea* - *Schistotephium heptalobium* bush clumps vegetation of the Rietfontein Nature Reserve (Bredenkamp 1991).

1.3 *Acacia caffra* – *Themeda triandra* Open to closed woodland Community

Habitat

This open to closed woodland sub-community was found distributed throughout the study area on a variety of aspects, on gradual to moderately steep slopes of hills and ridges. It was recorded predominantly on Land Types lb7a, lb43 and lb41. These Land Types indicate a lack of soil and is characterized by soil series Mispah Ms10, Platt Qs14, Trevanian Qs17, Glenrosa Qs15 and Robmore Qs18 with a clay content of 10–20%.

Vegetation

The diagnostic species for the community are the tree *Rhus zeyheri*, the grasses *Eragrostis chloromelas*, *Aristida congesta* subsp. *barbicollis*, the perennial herb



Hypoxis rigidula, the sparsely branched *Nidorella hottentotica*, the forbs *Graderia subintegra*, *Pearsonia sessilifolia* subsp. *sessilifolia*, *Justicia anagalloides*, *Crabbea angustifolia* and *Scabiosa columbaria*, the small shrub *Lantana rugosa* and exotic shrub *Solanum elaeagnifolium* (Species group D – Table 1).

The woody layer is dominated by trees *Rhus pyroides*, *Canthium gilfillanii*, *Rhus leptodictya*, and the shrub *Diospyros lycioides*, together with the shrublet *Asparagus suaveolens*. The succulent *Aloe greatheadii* var. *davyana*, the asteraceous *Helichrysum rugulosum*, the noxious weed *Tagetes minuta* and the grasses *Themeda triandra*, *Hyparrhenia hirta*, *Brachiaria serrata* and *Setaria sphacelata* are also dominant.

The average number of species recorded in this plant community per 200m² was 41.

In certain parts of the plant community stands of *Protea caffra* (Species Group F) and the scarcer *Protea roupelliae* (Species Group F) are prominent, indicating an affinity with the Drakensberg Highveld Sourveld (Sourveld) vegetation as described by Acocks (1988).

The *Olea europaea* – *Cymbopogon excavatus* savanna and *Olea europaea* - *Schistotephium heptalobium* bush clumps vegetation of the Rietfontein Nature Reserve (Bredenkamp, 1991) also show resemblance to this community.

Two sub-communities are recognized:

1.3.1 *Acacia caffra* – *Themeda triandra* – *Asparagus lariginus* Closed Woodland Sub-community

Habitat

This sub-community is found on gradual north and south-facing slopes predominantly in the Pretoria area, but also in Clayville, Fourways and Alberton. This plant community is associated with closed woodland in association with rocky outcrops. This plant community was recorded in a variety of Land Types but more so in Ib7a and Ib43a.

Vegetation

Species that dominate the plant community are the trees *Acacia caffra*, *Celtis africana* and *Ehretia rigida*, the shrublet *Asparagus suaveolens*, the grasses *Themeda triandra*, *Setaria sphacelata*, the succulent *Aloe greatheadii* var. *davyana* and the asteraceous *Helichrysum rugulosum*. *Rhus pyroides* is locally dominant and *Panicum maximum* is sometimes prominent.

Species group E (Table 1) is diagnostic for this community. The diagnostic tree species are *Acacia karroo*, the shrub *Asparagus larcinus* that forms impenetrable thickets, the slender shrub *Sida dregei*, the erect shrublets *Hibiscus lunarifolius* and *Teucrium trifidum*, the herbaceous shrublet *Pavonia burchellii*, the twining forb *Clematis brachiata*, the forb *Conyza podoccephala* and the exotic weeds *Oxalis corniculata* and *Conyza albida*.

The average number of species recorded in this plant community per 200m² was 36.

The *Acacia karroo* – *Lippia javanica* closed woodland (Coetzee 1995) shows resemblance to this community.

1.3.2 *Acacia caffra* – *Themeda triandra* – *Hyparrhenia hirta* Open to closed woodland Sub-community

Habitat

This sub-community is found throughout the study area on a variety of aspects and on gradual to steep slopes of ridges and hills and rocky outcrops. This plant community was recorded on a variety of Land Types and specifically in lb7a and lb41.

Vegetation

Species group F (Table 1) is diagnostic for this vegetation. The diagnostic species are the trees *Kiggelaria africana*, *Protea caffra*, *Protea roupelliae* and *Rhus pyroides* the shrublets *Athrixia elata*, *Pentanisia angustifolia*, *Rhus discolor*, and *Lippia javanica* shrub, the forbs *Chaetacanthus costatus*, *Vernonia galpinii* and *Rhynchosia totta*, and the grasses *Tristachya leucothrix*, *Eragrostis racemosa*, *Cynodon dactylon*, *Elionurus muticus* and *Alloteropsis semialata* subsp. *eckloniana*.

The plant community is dominated by the tree species *Rhus leptodictya* and *Canthium gilfillanii* the shrub *Diospyros lycioides*, the succulent *Aloe greatheadii* var. *davyana*, the asteraceous *Helichrysum rugulosum* and the grasses *Setaria sphacelata*, *Melinis repens*, *Melinis nerviglumis*, *Themeda triandra*, *Hyparrhenia hirta* and *Brachiaria serrata*.

The average number of species recorded in this plant community per 200m² is 44.

This community shows resemblance with the *Protea caffra* – *Athrixia elata* open woodland (Coetzee 1995) from the Pretoria area. The common species of the *Tracypogon spicatus*-*Themeda triandra* Grassland of Bredenkamp & Thereon (1980) compares well with this community. Bredenkamp & Brown (1998a & b) described vegetation to the west and north of Johannesburg indicating resemblance to this vegetation unit. A comparison is provided below in Table 3 and 4.

2. *Combretum molle* – *Setaria lindenbergiana* Open to Closed Major Woodland Community

Habitat

This plant community is found on a mostly north facing aspect on gradual to very steep slopes in kloofs, between granite boulders and on rocky outcrops, drainage lines, at the foot of quartzite ridges and hills and on rocky outcrops in the Pretoria and Johannesburg area. This plant community is distributed through nine different Land Types but mainly in Ib7a and Ba7b. Land Type Ib7a is described in detail in community 1. The Land Type Ba7b indicate a lack of soil with associated soil series

including Mispah Ms10, Trevanian Qs17, Glendale Sd21 and Msinga Hu26 with a clay content of 12–25%.

Vegetation

The diagnostic species of this plant community are the trees *Combretum molle*, *Vangueria infausta*, *Ochna pulchra*, *Combretum zeyheri*, *Nuxia congesta*, *Lannea discolor* and *Englerophytum magalismontanum*. Other species include the shrub *Ochna pretoriensis*, the upright shrublet *Indigofera melanadenia*, and the succulents *Kalanchoe paniculata*, *Crassula swaziensis* and *Euphorbia schinzii*, forbs such as the tufted *Coleochloa setifera*, *Commelina erecta*, *Oldenlandia herbacea* var. *herbacea* and grasses such as *Setaria lindenbergiana* and *Loudetia simplex* (Species group G - Table 1).

The species that dominate this plant community are the succulent *Aloe greatheadii* var. *davyana*, the noxious weed *Tagetes minuta*, the herb *Commelina africana* and the scrubby *Xerophyta retinervis*, the fern *Pellaea calomelanos*, and the grasses *Cymbopogon validus*, *Melinis repens*, *Melinis nerviglumis* and *Diheteropogon amplectens*.

The average number of species recorded in this plant community per 200m² was 38.

Invasion of exotic vegetation was often recorded for this plant community. Invasive exotic species include *Lantana camara*, *Cereus peruviana* and *Jacaranda mimosifolia*.

In general, this community compares well with the Sub-humid Warm Temperate Mountain Bushveld found on north facing slopes, crests and upper south facing steep slopes of the rocky outcrops mainly within the Ib Land Type (Coetzee *et al.* 1995). Resembling this community is the *Burkea africana*–*Bequartiodendron magalismontanum* open woodland (Coetzee 1994), the *Sporobolus pectinatus*–*Chaetacanthus setiger* community (Coetzee 1993) the *Canthium gilfillanii*–*Combretum molle* savanna community from the Witwatersrand National Botanic Garden (Behr & Bredenkamp 1988) the vegetation on the Bronberg in Pretoria

(Bredenkamp 1997a) and *olia-Englerophytum*, *Burkea africana-Combretum molle*  *rotundata-Burkea africana* communities (Bredenkamp 1997b) from the Fort Klapperkop Area.

Two sub-communities were recognized:

2.1 *Combretum molle* – *Burkea africana* Open to Closed Woodland Community

Habitat

This sub-community is predominantly found on shallow to moderate steep northern to north-eastern slopes of ridges and hills in the Pretoria area. It was mainly recorded in Land Type Ib7a as described in community 1.

Vegetation

Species group H (Table 1) is diagnostic for this sub-community. Diagnostic species include the trees *Burkea africana* and *Strychnos pungens* and the dwarf shrubs *Rhynchosia nitens* and *Helichrysum kraussii* and geoxylic suffrutescent and poisonous *Dichapetalum cymosum*.

The most prominent species in this plant community are the trees *Combretum molle* and *Vangueria infuasta*, the shrubs *Xerophyta retinervis*, the succulent *Aloe greatheadii* var. *davyana*, the fern *Pellaea calomelanos* and the grass *Melinis nerviglumis*.

The average number of species recorded in this plant community per 200m² is 40.

2.2 *Combretum molle* – *Englerophytum magalismsontanum* Open Woodland Community

Habitat

This sub-community was found on northern gradual to very steep (55° and 50° at Bush Hill hill in Randburg and on Northcliff hill in Northcliff) slopes on top of ridges

and hills and in drainage lines on ridges in the Pretoria and Johannesburg areas. The plant community was recorded specifically in Land Types Ba7b, Ib3a and Ib41. The soil series is mainly Mispah Ms10 with a clay content of 10–20% also indicating the lack of soil and shallow soils on rock.

Vegetation

This sub-community is characterized by Species group I (Table 1). Diagnostic species associated with this plant community are the trees *Pittosporum viridiflorum*, *Croton gratissimus*, *Osyris lanceolata* and *Pouzolzia mixta* and the shrubs *Ancylobotrys capensis* and *Rhus magalismontana* and the sbrublet *Waltheria indica*. Other species include forbs like the succulent *Crassula setulosa*, *Vernonia sutherlandii*, *Cyperus* sp. and *Sutera caerulea* and the grasses *Aristida transvaalensis* and *Enneapogon scoparius*.

Species that dominate the plant community are the trees *Combretum molle*, *Vangueria infausta*, *Canthium gilfillanii* and *Diospyros lycioides* the grasses *Cymbopogon validus*, *Melinis repens* and the forb *Commelina africana*.

The average number of species recorded in this plant community per 200m² is 36.

The *Bequartiodendron magalismontanum* shrub land of Ellery (1994) compares well with this community.

Concluding remarks

A comparison between the vegetation of the Western Metropolitan Local Council area Bredenkamp & Brown (1998a) and the communities identified in this study is given in Table 3. A similar comparison between the communities identified in this study and those described by Bredenkamp & Brown (1998b) for the Northern Metropolitan Local Council area is provided in Table 4. Due to the fact that Bredenkamp & Brown (1998a & 1998b) did not make use of Braun Blanquet tables,

the extent of comparison provided below, is a subjective comparative evaluation based on species composition.

Table 3 A comparison between the vegetation of the Western Metropolitan Local Council area Bredenkamp & Brown (1998a) and the communities identified in this study

Bredenkamp & Brown (1998)	This study community number	Extent of comparison (clear /unclear)
<i>Protea caffra</i> treeveld	1.3.2	Weak
<i>Protea roupelleae</i> treeveld	1.3 and 1.3.2	Weak
Bush clumps	1	Strong
Mixed <i>Acacia caffra</i> savanna	1	Weak
Other woodland Type communities	None	None

Table 4 A comparison between the vegetation of the Northern Metropolitan Local Council area Bredenkamp & Brown (1998b) and the communities identified in this study

Bredenkamp & Brown (1998)	This study community number	Extent of comparison (clear /unclear)
Natural bush clumps	1 Common species (Species Group K)	Strong Strong
Dense woody agricultural holdings	1 1.3.2 Common species (Species Group K)	Strong (only tree species) Weak Weak
<i>Protea caffra</i> treeveld	1 1.3.2 Common species (Species Group K)	Weak Weak Weak
<i>Protea caffra</i> hill	1	Weak

	1.3.2 Common species (Species Group K)	Strong (especially herbaceous layer) Strong
Ridge savanna	1 Common species (Species Group K)	Weak Strong
Riparian vegetation	1 1.1 Common species (Species Group K)	Strong Strong Strong
Other woodland Type communities	none	None

The species of the Ruimsig Entomological Reserve in Roodepoort, showed resemblance to the woodland species identified in this study (Deutschländer & Bredenkamp 1999). Besides this, no clear comparison could be drawn between the vegetation communities identified in both studies. This could be due to the more detailed study done by Deutschländer and Bredenkamp (1999) for this nature reserve.

General discussion

The sites chosen were relatively undisturbed and many could be important to conserve. Some sites are presently utilized for agricultural purposes.

Species group J indicates a floristic relationship between the *Acacia caffra*–*Themeda triandra*–*Hyparrhenia hirta* Open to Closed Woodland (Species Group F) and the *Combretum molle*–*Setaria lindenbergiana* Open to Closed Woodland (Species Group G).

The classification procedures followed, resulted in clearly defined vegetation units that can be related to the environmental factors observed. This classification contributes to the limited knowledge that presently exists for the vegetation of urban open spaces in Gauteng. The results of this study can be used as a baseline study and future studies can be measured against it. The species richness determined per 200m² per vegetation type could also be used to determine environmental and ecological degradation and actions could be taken to manage these changes.

The results of this study could further be used to determine how the size and shape of surrounding land-uses have influenced and are influencing the vegetation of urban open spaces. The results of such a study could assist in guiding development in future open spaces in a constantly expanding urban environment.

The list of species that was not recorded only 7 times and less in the sample plots, associated with each vegetation unit, is presented in Annexure A. These records can be used as reference to identify species in need of research regarding their ecological status (endangered, rare etc.). Known infrequent species can also be linked to the vegetation unit in which they were observed. These vegetation types can then be approached with greater care with regards to urban development and they can even be conserved in the urban environment.

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Table 1 A phytosociological table of the woodland vegetation of the urban areas of Gauteng

Community Number	1.					2.	
	1.1	1.2	1.3.1	1.3	1.3.2	2.1	2.2
	1	1	1	1111	11	11	1
	380212902	480	5991	112344581128	4612	1489227252	577578 3430123
	475472037	54870791	680234390101	835466668679129	57862590937311	863672303407689	
Species Group A							
<i>Celtis africana</i>	ta.++.a.+	.1++.+++	++++11a+la+	+.t.+..t.	.....	++...+++.+.	+.++.....+
<i>Acacia caffra</i>	..b.1+.+3	|b.33b3bb	|b3bab+a.3b33	+.+.b..a	.....	+3.1+.....+	..1..1+.....
<i>Rhus pyroides</i>	+a1+++.b	|+.aa+..+	....a1.++b1	+.a+ab.	.3a.++.	.....	+.t.+.....+
<i>Euclea crispa</i>	.1+.+++1b	|b..++aa	|aa++.....+	1+.....	a.b..++.	.....	++.....
<i>Ledebouria revoluta</i>	+	.....	+.++++.	+	.....	++++.++	.....
<i>Ehretia rigida</i>	+.+.+.3.	11+....	+.1.++b..1.	.....	11+.....	.....	+.t.+.....+
<i>Achyranthus aspera</i>	+.+++..b	+++t.++.	....+++t.++.	.....	+1.....	+.t.+.....	.....
<i>Scadoxus puniceus</i>	....+a1+	....+	....+....	....	+.t.+.t.	....	....
<i>Dombeya rotundifolia</i>	..b.+++.	+1..1++.	+.t.+.t.	.....	+.3..	....	....
<i>Conyza sp.</i>	..t.+++.	..t.+++.	....+++.	....	....	....	....
<i>Ziziphus mucronata</i>	..t.+.t.	+.t.+.t.	....	....	....	....	....
<i>Cussonia paniculata</i>	....++.	....	....	....	....	....	....
<i>Heteromorpha trifoliata</i>	..1..a.	..t.+++.	....	....	....	....	....
Species Group B							
<i>Hypoestes forskalii</i>	.a.+.al	b|+.t.+++.	.....	.....	....	....	....
<i>Protasparagus sp.</i>	..t.+++.	..t.+++.	.....	....	....	....	....
<i>Combretum erythrophyllum</i>	bb.....	+.t.+++.	.....	....	....	....	....
<i>Cyperus esculentus</i>	+.b.+.t.	....	....	....	....	....	....
<i>Aerva leucura</i>	+.t.+++.	....	....	....	....	....	....
<i>Pavetta gardeniifolia</i>	+.t.+++.	+.t.+++.	....	....	....	....	....
<i>Araujia sericifera</i>	++.....	+.t.+++.	....	....	....	....	....
<i>Setaria megaphylla</i>	.b.....	1.+.t.+++.	....	....	....	....	....
<i>Buddleja salviifolia</i>	....+.b.	....	....	....	....	....	....
<i>Rhamnus prinoides</i>	b.....	+.t.+++.	....	....	....	....	....
<i>Acalypha glabrata</i>	..3.....	....	....	....	....	....	....

Species group C

Setaria lindenberghiana|ab+.b311|.++..a.....|.....3...|...b3b+.a.....|33+...+ba.a+b+.
 Rhoicissus tridentata|.++++a+|.++.....|.....+.+.+.|.....|.....|.....

Species group D

Eragrostis chloromelas|.....a..|.+.+.+.+.+.|.+.+.+.+.+.+.|.l.++......+.|......+......+...
 Hypoxis rigidula|......+.|.+......+.+.|......+.+.+.1+.|.+......|......+.+.+
 Nidorella hottentotica|......|.+......+.|......+.+.+.+.|......+......+.|......+......+
 Graderia subintegra|......|.+......+.|......+.+.+.+.|......+......+.|......+......+
 A.congesta subsp. barbica+.|......|...a+.....|......+b+.....|......+......|......+......+
 Lantana rugosa+.|.+......|...+++.....|...+.+.+.+.+.|...+.+.+.|......|......+......+
 Rhus zeyheri+.|......|.a.l.....|...a.....+.+.1...|......b.....|......+......+
 Pearsonia sessilifolia|......|......+.+.+.|......+.+.+.|......+......|......+......+
 Justicia anagalloides|......|.+......|......+.+.|......+......|......+......|......+......+
 Crabbea angustifolia|......|......+.+.|......+.+.|......+......|......+......|......+......+
 Solanum elaeagnifolium|......|......|......|......|......|......|......|......|......|......|
 Scabiosa columbaria|......|......|......|......|......|......|......|......|......|......|

Species group E

Protasparagus laricinus|......|.b+.++aa.l.|.....|......|......|......|......|
 Sida dregei+.|......+.|.+.+.+.+.+.|......+......|......+......+.|......|......|
 Hibiscus lunarifolius|......|......|......|......|......|......|......|......|......|
 Clematis brachiata+.|.+......|.+......|......|......|......|......|......|......|......|
 Conyza albida|......|......+.+.|......|......|......|......|......|......|......|
 Teucrium trifidum|......|......|......|......|......|......|......|......|......|
 Pavonia burchellii+.|......+.|......|......|......|......|......|......|......|......|
 Conyza podoccephala|......|......|......|......|......|......|......|......|......|
 Oxalis corniculata|......|......|......|......|......|......|......|......|......|
 Acacia karroo+.|......|......|......|......|......|......|......|......|......|

Species group F

Tristachya leucothrix|......|......|......|......|......|......|......|......|......|
 Eragrostis racemosa|......|......|......|......|......|......|......|......|......|
 Athrixia elata|......|......|......|......|......|......|......|......|......|
 Trachypogon spicatus|......|......|......|......|......|......|......|......|......|
 Cynodon dactylon|......|......|......|......|......|......|......|......|......|
 Chaetacanthus costatus|......|......|......|......|......|......|......|......|......|
 Elionurus muticus|......|......|......|......|......|......|......|......|......|
 Protea caffra|......|......|......|......|......|......|......|......|......|
 Lippia javanica+.|.+......|.+......|......|......|......|......|......|......|......|
 A. semialata subsp. ecklo|......|......|......|......|......|......|......|......|......|

Pentania angustifolia	.....|.....|.....|...+.....+++.+..|.....|.....+.
Kiggelaria africana	.....|.....|.....|+..+.....a.|.....|.....
Rhynchosia totta	.....|.....|...+.....|+.....+..+|.....+..|.....
Vernonia galpinii	.....|.....|.....|+.....+.....|.....+..|.....+.....+
Rhus discolor	.....|.....|.....|.....l+|.....|.....
Protea roupelliae	.....|.....|.....|.....b...|.....|.....

Species Group G

Combretum molle	..b.....|.....|b...b.....|.....l...+...|b...b+++..l++|+b3+a+...b+b..
Vangueria infausta	....+++.+|.l.....|.....|.....++l.....|..+++.+..+|ba|+l.....+++.b+++
Englerophytum magalismontanum	.....|.....+|.....|.....+.....|.....+b...++..|b++..l+abb++aaa
Ochna pulcra	.....|.....|.....|.....+.....|:+++..b3+b+bb.|+++..+..+....
Loudetia simplex	.....|.....|.....|.....+.....|+.....+b...++|.....+.....+++
Lannea discolor	.....|.....|.....|.....|b+...++..+..|+bb.+.....
Kalanchoe paniculata	.....|.....|.....|.....|+.....++.....|++..++.....
Euphorbia schinzii	.....|+.....|.....|.....|+.....+++|.....++..+....
Ochna pretoriensis	.....|.....+|.....|.....|.....a+|..+l++...b....
Combretum zeyheri	.....|.....|.....|.....|.....+..aa..b...|+bb.....
Commelina erecta	.....|+.....|...+.....|.....+.....|.....++...|++..+..+..+....
Oldenlandia herbacea	..+.....|.....|.....|.....|.....+..++...|+.....+++..
Nuxia congesta	..a+.....|.....a|.....|b.....|+.....b.....|.....+bl..+..
Coleochloa setifera	.....|.....|.....|.....|+.....|.....++..+|.....++.....
Indigofera melanadenia	.....|.....|.....|.....|.....l...+..|...+.....a.....
Crassula swaziensis	.....|.....|.....|.....|.....a..|.....+..l..+

Species Group H

Burkea africana	.....|.....|.....|.....|+a11b..b+.1a3+..|+1+.+.....
Strychnos pungens	.....|.....|.....|.....|...+l..l+.alba|+..+.....
Melichrysium kraussii	.....|.....|.....|.....+.....|.....l..t..b...+|+.....
Rhynchosia nitens	.....|.....|.....|.....|...a...+a...+|+l.....
Dichapetalum cymosum	.....|.....|.....|.....+...|..++..++.....|++.....+....

Species Group I

Ancylobotrys capensis	.....|.....|.....|.....|.....a..+...|++...b11.+...+
Aristida transvaalensis	..a.....|.....|.....|...+.....|.....+.....|...+..+..l+ba.+l.
Crassula setulosa	..+.....|.....+i..|.....|.....+.....|.....+.....|...++...+...++.
Rhus magalismontana	..+.....|.....|.....|...l.....|.....+.....|+.....a...+..+
Croton gratissimus	.....|.....|.....|.....|.....|.....|b+.3b.....
Waltheria indica	.....|.....|.....|.....|.....|.....|+.....+++.....
Cyperus sp.	l.....|.....|.....|.....+.....|+.....|.....|+..l+.....
Osyris lanceolata	.....|+.....|.....+..|.....+.....|.....+.....|+..+..+.....

Maytenus heterophylla	.+.+. . . | .+.+.+. | .+++ .+.+. | . . . . . ba. | . . . . .+++ . . . | .b.
Digitaria eriantha	. . . . . | +.+. . . | . . . . .t.a. . .a | .+. . . .+. . . . . | .1a. . .+. .+.+. | .a+.+. . . .
Bidens pilosa	. . . . .b+. | +. . . . . | .+.+.+. . . | . . . . .+. . . . . | +. . . . . | . . . . .+. . . . .+++
Lantana camara	. . . . .+++ . | . . . . . | .+. . . . .t. | . . . . .+.+. . . . | .+. . . . .+.+. | .+.+. . . .
Rothmannia capensis	. . . . .1. | .+.+. . .3 | .+. . . .+. | . . . . .1. . . . | a.1. . . | +. . . .+
Solanum mauritianum	. . . . .+++ | .+. . . . | .+. . . .+. | . . . . .+. . . . . | +. . . . . | . . . . .
Cuscuta campestris	+ . . . . .+++ | +. . . . . | .+.+. . .+. | . . . . . | . . . . .+. . . . | . . . . .



Scarce species associated with species group A

Helichrysum nudifolium	Cyathula uncinulata	Physalis viscosa
Eriosema cordatum	Oenothera rosea	Amaranthus hybridus
Asparagus setaceus	Felicia muricata	Crassula sp
Kalanchoe rotundifolia	Verbena bonariensis	Solanum pseudocapsicum
Lipocarpha rehmannii	Aloe marlothii	Verbena tenuisecta
Ozoroa paniculosa	Cussonia spicata	Olea europaea
Helichrysum sp.	Tephrosia capensis	Bonatea speciosa
Delosperma sp.	Scolopia zeyheri	Vernonia oligocephala
Senecio affinis	Plantago lanceolata	Oxalis sp.
Delosperma herbeum	Grewia occidentalis	Solanum rigescens
Sutera palustris	Opuntia ficus-indica	Ipomoea ommaneyi
Oxalis depressa	Sida rhombifolia	Conyza bonariensis

Scarce species associated with Species group B

Ulmus parvifolia	Melilotus alba	Cassine transvaalensis
Euclea undulata	Hibiscus calyphyllus	Kyllinga alba
Maytenus tenuispina	Sesamum triphyllum	Passiflora subpeltata
Calpurnia aurea	Pennisetum clandestinum	Macfadyeni unguis-cati
Maerua cafra	Cannabis sativa	Chlorophytum polyphyllum
Ipomoea purpurea	Mirabilis jalapa	Setaria verticillata
Acokanthera oppositifolia	Helichrysum cerastioides	Viscum rotundifolium
Rhynchosia sp.	Anagallis arvensis	Acokanthera oblongifolia
Agrimonia procera	Lablab sp.	Tarchonanthus camphoratus
Kedrostis africana		

Scarce species associated with Species group C

Brachiaria nigropedata	Hibiscus trionum	Crassula alba
Isoglossa grantii	Alectra orobanchoides	Tarchonanthus camphoratus
Melia azedarach	Sphedamocarpus pruriens	Sida cordifolia
Commelina modesta	Myrsine africana	Monechma serotinum
Gnidia capitata		

Scarce species associated with Species group B and C

Chlorophytum bowkeri	Schmidtia pappophoroides	Coccinia adoensis
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Scarce species associated with Species group D

Helichrysum aureonitens	Helichrysum melanacme	Oenothera tetraptera
Dicoma zeyheri	Lepidium bonariense	Chenopodium album
Turbina oblongata	Gomphocarpus fruticosus	
Hermannia depressa	Tephrosia rhodesica	

Scarce species associated with Species group E

Bewsia biflora	Scilla nervosa	Ziziphus zeyheriana
Pseudognaphalium luteo-album	Artemisia afra	Verbena brasiliensis
Maytenus sp.	Solanum rigescens	Cyathula uncinulata
Pupalia lappacea	Xysmalobium undulatum	Hibiscus lunarifolius
Senecio harveianus	Tephrosia longipes	Hypoxis hemerocallidea
Hypoxis acuminata	Striga elegans	Gnidia kraussiana
Indigofera zeyheri	Persicaria lapathifolia	Urochloa mosambicensis
Sida alba	Bidens formosa	Capsella bursa
Cynoglossum lanceolatum	Galinsoga parviflora	Lithospermum sp.
Jasminum sp.	Tapinanthus natalitius	Bulbine angustifolia
Crabbea hirsuta	Priva cordifolia	Raphionacme hirsuta
Euclea natalensis	Tragus berteronianus	Oxalis obliquifolia
Bryophyllum delagoense		

Scarce species associated with Species group F

Vernonia poskeana	Hemizygia pretoriae	Microchloa caffra
Wahlenbergia undulata	Walafrida densiflora	Schoenoplectus corymbosus
Gomphocarpus tomentosus	Sphenostylis angustifolia	Crassula swaziensis
Digitaria brazzae	Lotononhis longiflora	Indigofera oxytropis
Indigastrum burkeanum	Floscopa glomerata	Hebenstretia angolensis
Helichrysum callicomum	Stoebe vulgaris	Maytenus undata

<i>Rhus dentata</i>	<i>Trochomeria macrocarpa</i>	<i>Indigostrum costatum</i>
<i>Cephalaria zeyheriana</i>	<i>Lotononis calycina</i>	<i>Aster harveyanus</i>
<i>Gerbera piloselloides</i>	<i>Hermannia grandistipula</i>	<i>Ledebouria revoluta</i>
<i>Rhus rimosa</i>	<i>Ledebouria ovalifolia</i>	<i>Lotononis foliosa</i>
<i>Senecio coronatus</i>	<i>Sporobolus pectinatus</i>	<i>Senecio lydenburgensis</i>
<i>Senecio erubescens</i>	<i>Digitaria diagonalis</i>	<i>Heliophila variabilis</i>
<i>Hermannia floribunda</i>	<i>Paspalum scrobiculatum</i>	<i>Senecio consanguineus</i>
<i>Sonchus wilmsii</i>	<i>Peucedanum sp.</i>	<i>Conyza canadensis</i>
<i>Harpochloa falk</i>	<i>Psammotropha myriantha</i>	<i>Zaluzianskya katharinae</i>
<i>Cyanotis sp.</i>	<i>Dipcadi ciliare</i>	<i>Jasminum angulare</i>
<i>Indigofera spicata</i>	<i>Indigofera hilaris</i>	<i>Indigofera melanadenia</i>
<i>Cotoneaster pannosus</i>	<i>Heliophila rigidiuscula</i>	<i>Lannea edulis</i>
<i>Thesium sp.</i>	<i>Lotononis sp.</i>	<i>Sporobolus festivus</i>
<i>Crotalaria brachycarpa</i>	<i>Ficus ingens</i>	<i>Pyracantha sp.</i>

Scarce species associated with Species group G

<i>Ceropegia rendallii</i>	<i>Indigofera adenoides</i>	<i>Cymbopogon plurinodis</i>
<i>Indigofera melanadenia</i>		

Scarce species associated with Species group H

<i>Salacia rehmannii</i>	<i>Helichrysum kraussii</i>	<i>Aloe pretoriensis</i>
<i>Cleome maculata</i>	<i>Euryops laxus</i>	<i>Elephantorrhiza burkei</i>
<i>Acalypha sp.</i>	<i>Panicum coloratum</i>	<i>Hyparrhenia filipendula</i>
<i>Physalis sp.</i>	<i>Rumex sp.</i>	<i>Strychnos cocculoides</i>
<i>Ximenia caffra</i>	<i>Adromischus umbraticola</i>	<i>Talinum caffrum</i>
<i>Acacia robusta</i>	<i>Gomphrena celosioides</i>	<i>Becium angustifolium</i>
<i>Salacia rehmannii</i>	<i>Tephrosia sp.</i>	<i>Jacaranda mimosifolia</i>
<i>Cucumis hirsutus</i>	<i>Crassula capitella</i>	<i>Sonchus dregeanus</i>
<i>Crabbea acaulis</i>	<i>Mariscus sp.</i>	<i>Pavetta zeyheri</i>
<i>Andropogon appendiculatus</i>	<i>Diospyros whyteana</i>	<i>Halleria lucida</i>
<i>Jamesbrittenia burkeana</i>	<i>Pseudognaphalium luteo-album</i>	

Scarce species associated with Species group I

<i>Nolletia rarifolia</i>	<i>Aristida canescens</i>	<i>Aristida meridionalis</i>
<i>Plectranthus madagascariensis</i>	<i>Hibiscus engleri</i>	<i>Limeum viscosum</i>
<i>Chlorophytum cooperi</i>	<i>Cotyledon orbiculata</i>	<i>Stapelia gigantea</i>
<i>Leonotis sp.</i>	<i>Pygmaeothamnus zeyheri</i>	<i>Zornia linearis</i>
<i>Tapiphyllum parvifolium</i>	<i>Commelina livingstonii</i>	<i>Mimosa zeyheri</i>
<i>Commelina diffusa</i>	<i>Asparagus capensis</i>	<i>Commelina diffusa</i>
<i>Flaveria bidentis</i>	<i>Maytenus polyacantha</i>	<i>Indigofera adenoides</i>
<i>Senecio oxyriifolius</i>	<i>Sphedamnocarpus pruriens</i>	<i>Ficus sp.</i>
<i>Cassine transvaalensis</i>	<i>Disperis micrantha</i>	<i>Elephantorrhiza burkei</i>
<i>Cyperus rotundus</i>	<i>Ceratotheca triloba</i>	<i>Ficus abutilifolia</i>
<i>Oxygonum sinuatum</i>	<i>Rhus magalismontana</i>	<i>Aristida diffusa</i>
<i>Cyphostemma lanigerum</i>	<i>Secamone gerrardii</i>	<i>Asclepias sp.</i>
<i>Clerodendrum glabrum</i>	<i>Dichrostachys cinerea</i>	<i>Euphorbia ingens</i>
<i>Pittosporum viridiflorum</i>	<i>Chenopodium murale</i>	<i>Indigofera comosa</i>
<i>Leonotis ocymifolia</i>	<i>Schoenoplectus corymbosus</i>	<i>Stachys natalensis</i>
<i>Kalanchoe sp.</i>	<i>Murdannia simplex</i>	<i>Talinum sp.</i>
<i>Striga bilabiata</i>	<i>Barleria pretoriensis</i>	<i>Kohautia sp.</i>
<i>Conyza albida</i>	<i>Argyrolobium pauciflorum</i>	<i>Stapelia leendertziae</i>
<i>Tragia rupestris</i>	<i>Nemesia fruticans</i>	<i>Conyza bonariensis</i>
<i>Andropogon sp.</i>	<i>Stylosanthes fruticosa</i>	<i>Aeollanthus buchnerianus</i>

Scarce species associated with Species group J

<i>Becium obovatum</i>	<i>Chaetacanthus setiger</i>	<i>Helichrysum setosum</i>
<i>Andropogon schirensis</i>	<i>Elephantorrhiza elephantina</i>	<i>Eragrostis rigidior</i>
<i>Portulaca kermesina</i>	<i>Tephrosia elongata</i>	<i>Solanum incanum</i>
<i>Mariscus congestus</i>	<i>Digitaria diagonalis</i>	<i>Lopholaena coriifolia</i>
<i>Urelytrum agropyroides</i>	<i>Ursinia nana</i>	<i>Indigofera spicata</i>
<i>Clematopsis scabiosifolia</i>	<i>Boophae disticha</i>	<i>Thesium magalismontanum</i>
<i>Indigofera comosa</i>	<i>Vernonia natalensis</i>	<i>Dais cotinifolia</i>
<i>Lippia rehmannii</i>	<i>Erythrina lysistemon</i>	<i>Rhynchosia monophylla</i>
<i>Tephrosia multijuga</i>	<i>Merremia tridentata</i>	<i>Aristida sp.</i>



Sutera pallescens

Lippia sp.

Dicoma anomala

Scarce species associated with Species group K

Phymaspermum athanasioides
Commelina sp.
Sarcostemma viminale
Sporobolus fimbriatus
Acalypha villicaulis
Solanum sp.
Ipomoea crassipes
Indigofera sp.
Dovyalis zeyheri
Rhynchosia monophylla
Indigofera cryptantha
Acacia ataxacantha
Vigna vexillata
Cereus peruvianus
Helichrysum dasymallum

Cleome monophylla
Aristida congesta
Cheilanthes hirta
Euphorbia heterophylla
Vernonia sutherlandii
Senecio barbertonicus
Thesium utile
Mundulea sericea
Gladiolus sp.
Gerbera viridifolia
Solanum seaforthianum
Ipomoea obscura
Viscum rotundifolium
Anthericum sp.
Commelina benghalensis

Zinnia peruviana
Pogonarthria squarrosa
Phyllanthus parvulus
Euphorbia striata
Psydrax livida
Momordica balsamina
Helinus integrifolius
Helichrysum coriaceum
Cucumis zeyheri
Sporobolus stapfianus
Pappea capensis
Dodonaea angustifolia
Canthium mundianum
Ipomoea sp.

Species not recorded less than 7 times and also not included in main phytosociological table.

Tephrosia longipes
Kalanchoe thyrsiflora
Maytenus polyacantha
Cymbopogon excavatus

Cryptolepis oblongifolia
Solanum retroflexum
Tritonia nelsonii
Rhus rigida

Schkuhria pinnata
Eragrostis sp.
Solanum panduriforme



CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

According to Diamond (1975) the number of species that a natural area can hold at equilibrium is a function of its area and degree of isolation. He further indicates how the shape, and consequently the edge effect, and connectivity with other natural areas might affect ecosystem and populations. Soulé (1987) further claims that populations are vulnerable to extinction should they be isolated. The functionality of corridors has been widely debated by various authors (Simberloff & Cox 1987; Soulé & Gilpin 1991; Sutcliffe & Thomas 1996; Diamond 1975). The applicability of these statements on the fragmented and isolated natural areas in urban Gauteng has not been investigated to date, and raises a concern as to the potential slow degradation of ecosystems that might be occurring owing to development pressure on the open spaces investigated in the study area.

This phytosociological study of the vegetation of the natural urban open spaces of urban Gauteng has indicated that a significant source of plant diversity as well as vegetation types still exists in the confines of the urban environment. This information can further be used to assist in studies regarding isolation and fragmentation of natural remnants in the Gauteng urban environment.

The Braun Blanquet method was applied in this study and resulted in 14 plant communities and 1 variation being identified. All the plant communities and the variation could be related to specific environmental factors and are therefore ecologically distinguishable. The classification is supported by the results obtained by the computer programme TURBOVEG and the TWINSpan classification algorithm (Hill 1979). With these plant communities identified, this study contributes greatly to the limited knowledge of the synecology of the urban open spaces of Gauteng.

Two main vegetation units were identified in the study area namely woodland and grassland dominated communities.

The hills and ridges in the study area were often covered by a mosaic of open woodland on the warmer and drier north-facing slopes, closed woodland in more sheltered sites below rocky cliffs and grassland patches on more exposed areas.

Closed woodland communities were also found along rivers and streams. Cooler south-facing slopes may have *Protea caffra* woodland communities, of Afromontane Drakensberg affinity. These woodlands represented Mixed Bushveld and Waterberg Moist Mountain Bushveld elements (Bredenkamp & Van Rooyen 1996d & a) and according to the Acocks (1988) classification, species occurring here are typical of Sour Bushveld.

A mixture of tree, shrub and herbaceous species characterized the woodland areas of the entire study area. The common species of the woodland communities included the presence of the small trees *Diospyros lycioides*, *Canthium gilfillanii*, *Zanthoxylum capensis*, *Rhus leptodictya*, *Maytenus heterophylla* and *Rothmannia capensis*, in association with the exotic species *Lantana camara* and *Solanum mauritianum*. The small shrub *Protasparagus suaveolens*, the forbs *Commelina africana*, *Helichrysum rugulosum*, the succulent *Aloe greatheadii* var. *davyana*, the slender twining herb *Pentarrhinum insipidum*, the exotic species *Tagetes minuta*, *Bidens pilosa*, the noxious weed *Cuscuta campestris* and the fern *Pellaea calomelanos*, were also often encountered. The common grasses including *Melinis repens*, *Melinis nerviglumis*, *Themeda triandra*, *Setaria sphacelata*, *Cymbopogon validus*, *Panicum maximum*, *Hyparrhenia hirta*, *Eragrostis curvula*, *Brachiaria serrata*, *Heteropogon contortis*, and *Digitaria eriantha*, were recorded in the study area.

Two major woodland communities were identified in the study area. These included the *Acacia caffra-Rhus pyroides* open to closed Major Woodland community and the *Combretum molle-Setaria lindenbergiana* Open to Closed Major Woodland community.

The *Acacia caffra-Rhus pyroides* open to closed Major Woodland community was scattered throughout the study area, among granite boulders, rocky outcrops and hills. The slopes varied from gradual to very steep. This plant community was mainly distributed in the Bb1b, Ib7a and Ib43a Land Types which indicated a lack of soil. The main soil series were Glenrosa, Klipfontein, Sandvlei Mispah Southwold Trevanian with a clay content ranging between 10–30% (Land Type Survey Staff 1985, 1987a & b).

The *Combretum molle*-*Setaria lindenbergiana* Open to Closed Major Woodland community was generally found on a north facing aspect on gradual to very steep slopes in kloofs. This occurred between granite boulders and on rocky outcrops, drainage lines, at the foot of quartzite ridges and hills and on rocky outcrops in the Pretoria and Johannesburg area. This plant community was mainly distributed on the lb7a and Ba7b Land types indicating a lack of soil. The main soil series were Mispah, Trevanian, Glendale and Msinga with a clay content of 12–25%.

The grassland vegetation type of the entire study area was characterized by a mixture of grass species. The common species associated with this grasslands, included the bunch grasses *Themeda triandra*, *Brachiaria serrata*, *Diheteropogon amplexans*, *Trachypogon spicatus*, *Eragrostis racemosa*, *Elionurus muticus*, *Tristachya leucothrix*, *Eragrostis chloromelas*, *Heteropogon contortis*, *Hyparrhenia hirta*, *Setaria sphacelata* and *Eragrostis curvula* which was often present in a mixture. One or more of these species could be locally dominant, depending on local habitat conditions and degree of disturbance.

A great variety of herbaceous forbs or semi-woody dwarf shrubs were often present in these grasslands. These included the xerophytic sedge *Bulbostylis burchellii*, the succulents *Cyanotis speciosa* and *Aloe greatheadii* var. *davyana*, the geophyte *Ledebouria revoluta*, the asteraceous forbs *Senecio venosus*, *Nidorella hotenttotica*, *Helichrysum rugulosum*, *Gerbera viridifolia*, *Helichrysum coriaceum*, *Vernonia oligicephala* and the exotic annual weed *Tagetes minuta*, the encroacher dwarf shrub *Stoebe vulgaris* and a variety of other forbs e.g. *Wahlenbergia caledonica*, *Scabiosa columbaria*, *Chaetacanthus costatus*, *Pentanisia angustifolia*, *Pearsonia sessilifolia*, *Thesium utile* and *Pollichia campestris*.

Two major plant communities were identified, namely the *Loudetia simplex* – *Melinis nerviglumis* Major Grassland and the *Cymbopogon excavatus* – *Themeda triandra* Major Grassland.

The *Loudetia simplex* – *Melinis nerviglumis* Major Grassland was represented by plant communities that are mainly associated with shallow lithosols on rocky quartzite, dolomite or chert ridges and hills. This grassland represented typical Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1996c) the Acocks (1988)

classification of typical Bankenveld grassland. Scattered tree or bush-clump communities often occurred in this grassland.

The plant communities of the *Cymbopogon excavatus* – *Themeda triandra* Major Grassland were on the contrary, generally associated with lower lying and flatter undulating plains of the Bb land type where the soils were deeper and often not-rocky. This vegetation was mainly found on average slopes of 0–5° on Glenrosa, Klipfontein and Sandvlei soil series and was mainly found on the plains south of Pretoria. This grassland represents typical Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1996b) and typical *Cymbopogon-Themeda* Veld (Acocks 1988). No tree communities occurred in this grassland.

A summary of the vegetation communities observed in the various areas surveyed, are attached as Annexure A (Table 1 and 2).

Infrequently occurring species were listed per identified community. These lists indicated plant communities with which infrequently occurring species are associated. For example *Scadoxus puniceus* was associated with the *Loudetia simplex* – *melinis nerviglumis* grassland, *Eulophia ovalis* was associated with the *Ochna puchra* – *Ancylobotrys capensis* grassland and *Chortolirion angolense* was associated with the *Hypoxis rigidula* – *Themeda triandra* grassland.

The value of these records is that they could be included in the red data records for the Gauteng Province. In addition, the vegetation communities that were associated with the presence of red data species can in future be identified for conservation purposes.

The high number of infrequently occurring weedy species, further indicates that the natural areas were generally in a good condition.

A summary of all the communities identified in the study area are as follows:

Grassland

1. *Loudetia simplex* – *Melinis nerviglumis* Major Grassland Community

- 1.1 *Melinis repens* – *Diheteropogon amplectens* Grassland Community
 - 1.1.1 *Pogonarthria squarrosa* – *Melinis repens* Grassland Sub-community
 - 1.1.2 *Ochna pulchra* – *Ancylobotrys capensis* Grassland Sub-community
- 1.2 *Andropogon schirensis* – *Monocymbium cerasiiforme* Grassland Community
 - 1.2.1 *Aristida transvaalensis* – *Cymbopogon validus* Grassland Sub-community
 - 1.2.2 *Andropogon schirensis* – *Pentanisia angustifolia* Grassland Sub-community
 - 1.2.2(a) *Protea caffra* variant
2. *Cymbopogon excavatus* – *Themeda triandra* Major Grassland Community
 - 2.1 *Hermannia depressa* – *Themeda triandra* Grassland Community
 - 2.1.1 *Senecio isatideus* – *Themeda triandra* Grassland Sub-community
 - 2.1.2 *Hypoxis rigidula* – *Themeda triandra* Grassland Sub-community

Woodland

1. *Acacia caffra* – *Rhus pyroides* Open to Closed Major Woodland Community
 - 1.1 *Hypoestes forskoolii* – *Acacia caffra* Closed Woodland Community
 - 1.2 *Acacia caffra* – *Setaria lindenberghiana* Closed Woodland Community
 - 1.3 *Acacia caffra* – *Themeda triandra* Open to Closed Woodland Community
 - 1.3.1 *Acacia caffra* – *Themeda triandra* – *Asparagus lancinus* Open to Closed Woodland Sub-community
 - 1.3.2 *Acacia caffra* – *Themeda triandra* – *Hyparrhenia hirta* Open to Closed Woodland Sub-community
2. *Combretum molle* – *Setaria lindenberghiana* Open to Closed Major Woodland Community

2.1 *Combretum molle* – *Burkea africana* Open to Closed Woodland Community

2.2 *Combretum molle* – *Englerophytum magalismsontanum* Open Woodland Community

An urgent need to conserve Rocky Highveld Grassland and Moist Cool Highveld Grassland (Bredenkamp & Van Rooyen 1996c & b) in the study area is identified. Presently more wooded areas like ridges and rivers form part of formally conserved open spaces than grassland areas. The public perception that woodland is of more conservation value than grassland further exasperates this problem.

A variety of factors are presently affecting the urban open spaces in Gauteng. These include isolation from other natural areas, fragmentation of ecosystems, mis-management of these areas, size and shape of the areas, as well as human related impacts like trampling, litter and dumping. All these factors can lead to an increase of exotic species and the decline of indigenous woodland and grassland species.

The affects of isolation on wild plant populations can be devastating as illustrated by Drayton & Primack (1996). For a 400ha woodland park in Metropolitan Boston, at least 5 km from other protected areas and strongly affected by human activity, the area has lost 36% of its indigenous species and 64 new, mostly exotic species were recorded, over a period of 100 years.

The natural areas in Gauteng appear to be being fragmented by increasing development. The consequences of fragmentation vary with time since isolation, distance from other remnants of natural vegetation and the degree of connectivity with other remnants (Saunders, Hobbs & Margules 1990). One of the major aspects of fragmentation important for conservation, is the edge effect and the increased vulnerability of the fragmented ecosystem to extrinsic disturbances (Lord & Norton 1990) of which larger areas are being less adversely affected by the fragmentation process (Saunders et al. 1990). The impacts of fragmentation on species richness has not been researched in any of the major South Africa cities.

Ill-advised management of open spaces like uncontrolled veld fires, constant mowing of natural grassland and the mis-management of exotic infestations adds to the disturbance of natural patches in the urban environment. Due to the traditionally low

budget allocated to the management of natural open spaces, the managers of these areas may continue to manage natural areas on an ad hoc basis. This could lead to the continued degradation of natural area and the loss of species richness in the urban open spaces.

The close proximity of high human population to natural open spaces has rarely been to the benefit of these areas. Only on rare occasions has the surrounding community taken charge of the urban open spaces and assisted with the conservation and management of these areas against vagrants, trampling, exotic infestations and dumping. Structures to accommodate such co-operative management initiatives could however facilitate the continued involvement of neighbouring landowners in open spaces and the continued existence of the species richness recorded for many of the open spaces.

Riverine ecosystems in the urban Gauteng are presently highly impacted upon and are in urgent need for rehabilitation and conservation. The riverine areas surveyed for this study, indicated that a high percentage of exotic species. These habitats are generally exposed to a range of negative impacts associated with the urban environment including increased and polluted run-off due to hardened surfaces, subsequent excessive erosion of riverbanks and water pollution due to informal housing and industries on the riverbanks.

With the promulgation of new environmental legislation that requires Environmental Impact Assessments for certain development-related activities, the need for proper decision-support tools for government institutions was realised. The Gauteng Department of Agriculture, Conservation, Environment and Land Affairs subsequently developed a Gauteng Open Space Project (Gauteng 2000) to assist in managing the natural resources and land-use planning in the province. This project was based on a set of ecological parameters that provides an ecological value on each piece of open land in the Gauteng province, which is presently used to assist in guiding development in the province. The inventory of natural areas as well as the species recorded for each site, can be used as baseline data that will indicate environmental degradation.

Enlarging the inventory and subsequent understanding of natural vegetation in the urban environment will allow for faster detection of ecosystem degradation as well as determining the conservation value of different sites. This is confirmed by Matthews (1991) who states that the classification of vegetation types and subtypes in a biome is important since it would result in ecological interpretable units which can be used for environmental planning, management and conservation. The information regarding vegetation units in the urban environment should however be presented in a format that is easily accessible to decision-makers.

The surveying of the vegetation habitats in urban environments should receive high support from governing bodies. Soulé (1987) supports this statement by stating that the conservation of small remaining wild habitats, could slow down the extinction rate of animals and plants. It is further stated that management of remnants will become increasingly difficult if the surrounding area has adversely been changed or impacted upon. Placing the natural open spaces firmly within the context of the surrounding landscape and attempting to develop complementary management strategies seems to be the only way to ensure the long-term viability of remnant natural areas (Saunders et al. 1990).

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Annexure A

Table 1: Woodland communities distribution in the study area.

Plant community nr →	1.	1.1	1.2	1.3	1.3.1	1.3.2	2.	2.1	2.2
Area name									
Magaliesberg	*		*	*		*	*	*	*
NBI/Silverton ridge	*		*				*		*
Colbyn hill							*		*
Pierneefrant	*		*				*	*	*
Witwatersberg	*			*	*		*	*	
Kwaggaspruit	*			*	*				
Kwaggasrant							*	*	
Meintjieskop							*		*
Strubenkop	*			*		*	*	*	
Murrayfield							*	*	
Moreleta Kloof	*	*							
Faerie Glen NR	*	*		*	*		*	*	
Bronberg									
Erasmuskloof									
Daspoort ridge									
Groenkloof NR	*	*	*	*	*	*	*	*	
Groenkloof erf							*	*	
Klapperkop							*	*	
Voortrekker Monument	*			*	*	*			
Zwartkop NR	*			*	*				
Van Riebeeck NR	*			*	*	*			
McDonalds	*	*							
Glen Austin pan									
Miar's land									
DBSA									
Clayville	*			*	*				
Beaulieu hill/Witpoort	*	*		*		*			
Fourways Gardens	*			*	*				
Rietfontein NR	*	*							
Lone Hill NR	*	*							
Rietfontein Hospital									
Linksfield ridge							*		*
Yeoville ridge	*			*		*			
Langermanskop							*		*
Bill Steward									
Klipriviersberg Alberton	*		*	*		*			
Klipriviersberg NR	*			*	*				
Melville hills	*		*	*		*			
Northcliff ridge							*		*
Alberts Farm									
Orlando hill	*		*	*		*			
Golden Harvest Park	*	*							
Bush Hill hill	*	*					*		*
Ruimsig Butterfly NR									
Roodepoort ridge							*		*
Kloofendal NR	*			*		*			
Blougat Nature Area							*		*



Table 2: Grassland communities distribution in the study area

Plant community nr →	1.	1.1	1.1 .1	1.1 .2	1.2	1.2 .1	1.2 .2	1.2 .3	2.	2.1	2.1 .1	2.1 .2	2.2
Area name													
Magaliesberg	*	*		*									
NBI/Silverton ridge	*	*		*					*	*		*	
Colbyn hill	*	*		*									
Pierneefrant	*	*		*									
Witwatersberg	*	*		*									
Kwaggaspruit													
Kwaggasrant	*	*	*		*		*	*					
Meintjieskop													
Strubenkop													
Murrayfield	*	*		*									
Moreleta Kloof	*				*		*						
Faerie Glen NR									*	*		*	
Bronberg	*	*	*										
Erasmuskloof	*				*		*	*					
Daspoort ridge													
Groenkloof NR	*	*	*										
Groenkloof erf													
Klapperkop	*	*		*									
Voortrekker Monument									*	*	*		
Zwartkop NR									*	*		*	
Van Riebeeck NR									*	*		*	
McDonalds													
Glen Austin pan									*	*		*	
Miar's land									*				*
DBSA									*				*
Clayville									*	*	*		
Beaulieu hill/Witpoort									*	*		*	
Fourways Gardens													
Rietfontein NR	*				*		*	*					
Lone Hill NR									*				*
Rietfontein Hospital									*	*		*	
Linksfeld ridge	*				*	*							
Yeoville ridge	*				*		*	*					
Langermanskop	*				*	*							
Bill Steward	*				*	*							
Klipriviersberg Alberton									*	*	*		
Klipriviersberg NR									*	*	*		
Melville hills										*		*	
Northcliff ridge	*				*	*	*	*					
Alberts Farm	*				*	*	*						
Orlando hill									*	*	*		
Golden Harvest Park													
Bush Hill hill													
Ruimsig Butterfly NR									*	*		*	
Roodepoort ridge	*				*		*	*					
Kloofendal NR	*				*		*						
Blougat Nature Area	*				*	*	*						

CHAPTER 6

SPECIES LIST

A species list of all the species recorded or collected during the survey is presented below. 600 species were recorded of which 55 were exotic species. Exotic taxa are marked with asterisks.

PTERIDOPHYTA

Adiantaceae

Cheilanthes hirta
Lipocarpha rehmannii (Ridl.) Goetgh.
Pellaea calomelanos

MONOCOTYLEDONAE

Commelinaceae

Commelina africana L. var. *africana*
Commelina africana L. var. *barberae* (C.B.Clarke) C.B.Clarke
Commelina africana L. var. *krebsiana* (Kunth) C.B.Clarke
Commelina benghalensis L
Commelina diffusa Burm.f. ssp. *diffusa*
Commelina erecta L
Commelina livingstonii C.B.Clarke
Commelina modesta Oberm
Cyanotis speciosa (L.f.) Hassk
Floscopa glomerata (Willd. ex Schult. & Schult.f.) Hassk
Murdannia simplex (Vahl) Brenan

Cyperaceae

Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke
Coleochloa setifera (Ridl.) Gilly
Cyperus esculentus
Cyperus obtusiflorus Vahl var. *obtusiflorus*
Cyperus rotundus
Cyperus rupestris Kunth var. *rupestris*
Kyllinga alba Nees
Mariscus congestus (Vahl) C.B.Clarke
Schoenoplectus corymbosus (Roth ex Roem. & Schult.) J.Raynal

Liliaceae

Aloe greatheadii Schönland var. *davyana* (Schönland) Glen & D.S.Hardy
Aloe marlothii A.Berger ssp. *marlothii*
Aloe pretoriensis Pole-Evans
Aloe transvaalensis Kuntze
Aloe verecunda Pole-Evans



Anthericum species
Asparagus capensis L. var. capensis
Asparagus laricinus Burch.
Asparagus setaceus (Kunth) Jessop
Asparagus suaveolens Burch.
Bulbine angustifolia Poelln.
Chlorophytum bowkeri Baker
Chlorophytum cooperi (Baker) Nordal
Chlorophytum fasciculatum (Baker) Kativu
Chlorophytum polyphyllum (Baker) Kativu
Chortolirion angolense (Baker) A. Berger
Dipcadi ciliare (Zeyh. ex Harv.) Baker
Eucomis autumnalis
Ledebouria marginata (Baker) Jessop
Ledebouria ovalifolia (Schrad.) Jessop
Ledebouria ovatifolia (Baker) Jessop
Ledebouria revoluta (L.f.) Jessop
Scilla nervosa (Burch.) Jessop
Urginea depressa Baker

Typhaceae

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

Amaryllidaceae

Boophane disticha (L.f.) Herb.
Scadoxus puniceus (L.) Friis & Nordal

Hypoxidaceae

Hypoxis acuminata Baker
Hypoxis hemerocallidea Fisch. & C.A.Mey.
Hypoxis iridifolia Baker
Hypoxis rigidula

Velloziaceae

Xerophyta retinervis Baker

Iridaceae

Gladiolus crassifolius Baker
Gladiolus permeabilis D.Delaroche ssp. *edulis* (Burch. ex Ker Gawl.) Oberm.
Gladiolus pretoriensis Kuntze
Tritonia nelsonii Baker

Orchidaceae

Bonatea speciosa (L.f.) Willd. var. *antennifera* (Rolfe) Somerv.
Disperis micrantha Lindl.
Eulophia ovalis Lindl. ssp. *ovalis*
Satyrion species

Poaceae

Alloteropsis semialata (R.Br.) Hitchc. ssp. *eckloniana* (Nees) Gibbs-Russ.
Andropogon appendiculatus Nees
Andropogon chinensis (Nees) Merr.
Andropogon schirensis A.Rich.
Aristida adscensionis L.
Aristida bipartita (Nees) Trin. & Rupr.
Aristida canescens
Aristida congesta Roem. & Schult. ssp. *barbicollis* (Trin. & Rupr.) De Winter
Aristida congesta Roem. & Schult. ssp. *Congesta*
Aristida diffusa
Aristida meridionalis Henrard
Aristida transvaalensis Henrard
Bewsia biflora (Hack.) Gooss.
Bothriochloa bladhii (Retz.) S.T.Blake
Bothriochloa insculpta (A.Rich.) A.Camus
Bothriochloa radicans (Lehm.) A.Camus
Brachiaria nigropedata (Ficalho & Hiern) Stapf
Brachiaria serrata (Thunb.) Stapf
Chloris species
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Cymbopogon plurinodis (Stapf) Stapf ex Burtt Davy
Cymbopogon validus (Stapf) Stapf ex Burtt Davy
Cynodon dactylon (L.) Pers.
Digitaria brazzae (Franch.) Stapf
Digitaria diagonalis (Nees) Stapf var. *diagonalis*
Digitaria eriantha Steud.
Digitaria monodactyla (Nees) Stapf
Digitaria tricholaenoides Stapf
Diheteropogon amplexans (Nees) Clayton
Diheteropogon filifolius (Nees) Clayton
Ehrharta erecta
Elionurus muticus (Spreng.) Kunth
Enneapogon scoparius Stapf
Enteropogon monostachyus
Eragrostis biflora Hack. ex Schinz
Eragrostis capensis (Thunb.) Trin.
Eragrostis chloromelas Steud.
Eragrostis curvula (Schrad.) Nees
Eragrostis gummiflua Nees
Eragrostis micrantha Hack.
Eragrostis nindensis Ficalho & Hiern
Eragrostis plana Nees
Eragrostis racemosa (Thunb.) Steud.
Eragrostis rigidior Pilg.
Eragrostis sclerantha
Eragrostis superba Peyr.
Eustachys paspaloides (Vahl) Lanza & Mattei
Harpochloa falx (L.f.) Kuntze
Heteropogon contortus (L.) Roem. & Schult.
Hyparrhenia filipendula
Hyparrhenia hirta (L.) Stapf
Hyparrhenia tamba (Steud.) Stapf
Loudetia simplex (Nees) C.E.Hubb.



Melinis nerviglumis (Franch.) Zizka,
Melinis repens (Willd.) Zizka ssp. grandiflora (Hochst.) Zizka
Microchloa caffra Nees
Monocymbium ceresiiforme (Nees) Stapf
Panicum coloratum
Panicum maximum Jacq.
Panicum natalense Hochst.
Paspalum dilatatum Poir.
Paspalum scrobiculatum L.
*Pennisetum clandestinum Chiov.
*Pennisetum sphacelatum (Nees) T.Durand & Schinz
Perotis patens Gand.
Pogonarthria squarrosa (Roem. & Schult.) Pilg.
Schizachyrium jeffreysii (Hack.) Stapf
Schizachyrium sanguineum (Retz.) Alston
Schmidtia pappophoroides Steud.
Setaria lindenbergiana (Nees) Stapf
Setaria megaphylla (Steud.) T.Durand & Schinz
Setaria nigrirostris (Nees) T.Durand & Schinz
Setaria sphacelata (Schumach.) Moss var. sphacelata
Setaria verticillata (L.) P.Beauv.
Sporobolus festivus A.Rich.
Sporobolus fimbriatus (Trin.) Nees
Sporobolus pectinatus Hack.
Sporobolus stapfianus Gand.
Themeda triandra Forssk.
Trachypogon spicatus (L.f.) Kuntze
Tragus berteronianus Schult.
Trichoneura grandiglumis
Triraphis andropogonoides (Steud.) E.Phillips
Tristachya leucothrix Nees
Urelytrum agropyroides (Hack.) Hack.
Urochloa mosambicensis (Hack.) Dandy

DICOTYLEDONAE

Ulmaceae

Celtis africana Burm.f.
Ulmus parvifolia Jacq.

Moraceae

*Cannabis sativa
Ficus abutilifolia (Miq.) Miq.
Ficus ingens

Urticaceae

Pouzolzia mixta Solms

Proteaceae

Protea caffra Meisn. ssp. caffra
Protea roupelliae



Loranthaceae

Tapinanthus natalitius (Meisn.) Danser ssp. zeyheri (Harv.) Wiens
Viscum rotundifolium L.f.

Santalaceae

Osyris lanceolata Hochst. & Steud.
Thesium magalismontanum Sond.
Thesium utile A.W.Hill

Olacaceae

Ximenia caffra

Polygonaceae

Oxygonum sinuatum (Hochst. & Steud. ex Meisn.) Dammer
*Persicaria lapathifolia (L.) Gray
*Rumex species

Chenopodiaceae

Chenopodium album L.
Chenopodium murale L.

Amaranthaceae

*Achyranthes aspera L. var. aspera
Aerva leucura Moq.
Amaranthus hybridus
*Cyathula uncinulata (Schrad.) Schinz
*Gomphrena celosioides
*Pupalia lappacea

Nyctaginaceae

*Mirabilis jalapa L

Phytolaccaceae

Rivina humilis L.

Molluginaceae

Limeum viscosum (J.Gay) Fenzl ssp. viscosum var. glomeratum (Eckl.
& Zeyh.) Friedrich

Aizoaceae

Psammotropha myriantha Sond.

Mesembryanthemaceae

Delosperma herbeum (N.E.Br.) N.E.Br.

Portulacaceae

Anacampseros subnuda

Portulaca kermesina N.E.Br.

Talinum caffrum (Thunb.) Eckl. & Zeyh.

Illecebraceae

Pollichia campestris Aiton

Carophyllaceae

Dianthus mooiensis F.N.Williams ssp. *kirkii* (Burt Davy) Hooper

Ranunculaceae

Clematis brachiata Thunb.

Clematopsis scabiosifolia (DC.) Hutch. ssp. *stanleyi* (Hook.)

Brummitt

Ranunculus multifidus Forssk.

Brassicaceae

**Capsella bursa-pastoris* (L.) Medik.

Heliophila rigidiuscula Sond.

Heliophila variabilis Burch. ex DC.

**Lepidium bonariense* L.

Sisymbrium species

Capparaceae

Cleome maculata (Sond.) Szyszyl.

Cleome monophylla L.

Maerua cafra (DC.) Pax

Crassulaceae

Adromischus umbraticola-

**Bryophyllum delagoense* (Eckl. & Zeyh.) Schinz

Cotyledon orbiculata L. var. *oblonga* (Haw.) DC.

Crassula alba

Crassula capitella Thunb. ssp. *nodulosa* (Sch"nland) Toelken

Crassula lanceolata

Crassula setulosa Harv. var. *setulosa*

Crassula swaziensis Sch"nland

Kalanchoe paniculata Harv.

Kalanchoe rotundifolia (Haw.) Haw.

Kalanchoe thyrsoflora Harv.

Vahliaceae

Vahlia capensis

Pittosporaceae

Pittosporum viridiflorum Sims

Hamamelidaceae

Trichocladus grandiflorus Oliv.

Rosaceae

**Agrimonia odorata* Wallr.
**Cotoneaster pannosus* Franch.
**Pyracantha* species

Chrysobalanaceae

Parinari capensis Harv. ssp. *Capensis*

Mimosaceae

Acacia ataxacantha DC.
Acacia caffra (Thunb.) Willd
Acacia karroo Hayne
Acacia nilotica (L.) Willd. ex Delile ssp. *kraussiana* (Benth.)
Brenan
Acacia robusta Burch. ssp. *robusta*
Dichrostachys cinerea
Elephantorrhiza burkei Benth
Elephantorrhiza elephantina (Burch.) Skeels

Caesalpinaceae

Burkea africana Hook.

Fabaceae

Argyrolobium pauciflorum Eckl. & Zeyh. var. *pauciflorum*
Chamaecrista comosa E.Mey. var. *capricornia* (Steyaert) Lock
Chamaecrista comosa E.Mey. var. *comosa*
Crotalaria brachycarpa (Benth.) Burt Davy ex I. Verd.
Crotalaria lotoides Benth.
Eriosema burkei Benth.
Eriosema cordatum E.Mey.
Eriosema salignum E.Mey.
Erythrina lysistemon Hutch.
Indigofera adenoides Baker f.
Indigofera comosa N.E.Br
Indigofera cryptantha
Indigofera daleoides Benth. ex Harv. var. *daleoides*
Indigofera filipes Benth. ex Harv.
Indigofera hedyantha Eckl. & Zeyh.
Indigofera hilaris Eckl. & Zeyh.
Indigofera melanadenia Benth. ex Harv.
Indigofera oxytropis Benth. ex Harv.
Indigofera setiflora Baker



Indigofera spicata Forssk.
Indigofera zeyheri Spreng. ex Eckl. & Zeyh.
Indigastrum burkeanum (Benth. ex Harv.) Schrire
Indigastrum costatum (Guill. & Perr.) Schrire ssp. theuschii
(O.Hoffm.) Schrire
*Lablab purpureus (L.) Sweet ssp. uncinatus Verdc.
Lotononis calycina (E.Mey.) Benth
Lotononis eriantha Benth.
Lotononis foliosa Bolus
Lotononis laxa Eckl. & Zeyh.
Lotononis longiflora Bolus
*Melilotus alba Desr.
Mundulea sericea (Willd.) A.Chev.
Pearsonia aristata (Schinz) Dummer
Pearsonia cajanifolia (Harv.) Polhill ssp. cajanifolia
Pearsonia sessilifolia (Harv.) Dummer ssp. sessilifolia
Rhynchosia adenodes Eckl. & Zeyh.
Rhynchosia minima (L.) DC. var. prostrata (Harv.) Meikle
Rhynchosia monophylla Schltr
Rhynchosia nitens Benth
Rhynchosia totta (Thunb.) DC. var. totta
Rhynchosia vendae C.H.Stirt.
Sphenostylis angustifolia Sond.
Stylosanthes fruticosa (Retz.) Alston
Tephrosia acaciifolia Baker
Tephrosia capensis (Jacq.) Pers. var. capensis
Tephrosia elongata E.Mey. var. elongata
Tephrosia longipes Meisn. ssp. longipes
Tephrosia multijuga R.G.N.Young
Tephrosia rhodesica
Vigna vexillata
Zornia linearis E.Mey.

Geraniaceae

Monsonia angustifolia E.Mey. ex A.Rich.
Pelargonium dolomiticum R.Knuth

Oxalidaceae

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

Rutaceae

Zanthoxylum capense (Thunb.) Harv.

Meliaceae

*Melia azedarach L.

Malpighiaceae

Sphedamnocarpus pruriens (Juss.) Szyszyl. ssp. galphimiifolius
(Juss.) P.D.de Villiers & D.J.Botha



Polygalaceae

Polygala amatymbica Eckl. & Zeyh.
Polygala hottentotta C.Presl
Polygala uncinata E.Mey. ex Meisn.

Dichapetalaceae

Dichapetalum cymosum (Hook.) Engl.

Euphorbiaceae

Acalypha angustata Sond.
Acalypha glabrata
Acalypha punctata
Acalypha villicaulis Hochst. ex A.Rich.
Croton gratissimus Burch. var. *gratissimus*
Euphorbia clavarioides Boiss. var. *truncata* (N.E.Br.) A.C.White
R.A.Dyer & B.Sloane
Euphorbia heterophylla L.
Euphorbia ingens E.Mey. ex Boiss.
Euphorbia schinzii Pax
Euphorbia striata
Phyllanthus parvulus Sond.
Tragia rupestris Sond.

Anacardiaceae

Lannea discolor (Sond.) Engl
Lannea edulis
Ozoroa paniculosa
Rhus dentata Thunb.
Rhus discolor E.Mey. ex Sond.
Rhus lancea L.f.
Rhus leptodictya Diels
Rhus magalismsontana Sond. ssp. *magalismsontana*
Rhus pyroides Burch. var. *dinteri* (Engl.) Moffett
Rhus rigida Mill. var. *dentata* (Engl.) Moffett
Rhus rimosa Eckl. & Zeyh.
Rhus zeyheri Sond.

Celastraceae

Cassine aethiopica Thunb.
Cassine transvaalensis (Burt Davy) Codd
Maytenus heterophylla (Eckl. & Zeyh.) N.Robson
Maytenus polyacantha (Sond.) Marais
Maytenus tenuispina (Sond.) Marais
Maytenus undata (Thunb.) Blakelock

Hippocrateaceae

Salacia rehmannii Schinz

Sapindaceae

Dodonaea angustifolia L.f.
Pappea capensis Eckl. & Zeyh.

Rhamnaceae

Helinus integrifolius (Lam.) Kuntze
Rhamnus prinoides L'H,r.
Ziziphus mucronata Willd. ssp. *mucronata*
Ziziphus zeyheriana Sond.

Vitaceae

Cyphostemma lanigerum (Harv.) Desc. ex Wild & R.B.Drumm.
Rhoicissus tridentata (L.f.) Wild & R.B.Drumm. ssp. *cuneifolia*
(Eckl. & Zeyh.) Urton

Tiliaceae

Corchorus asplenifolius Burch.
Grewia occidentalis L.

Malvaceae

Hibiscus aethiopicus L. var. *ovatus* Harv.
Hibiscus calyphyllus Cav.
Hibiscus engleri K.Schum.
Hibiscus lunarifolius Willd.
Hibiscus microcarpus Garcke
**Hibiscus trionum* L.
Pavonia burchellii (DC.) R.A.Dyer
Sida alba L.
Sida cordifolia L.
Sida dregei Burt Davy
Sida rhombifolia L.

Sterculiaceae

Dombeya rotundifolia (Hochst.) Planch. var. *rotundifolia*
Hermannia coccocarpa (Eckl. & Zeyh.) Kuntze
Hermannia depressa N.E.Br.
Hermannia floribunda Harv.
Hermannia grandistipula (Buchinger ex Hochst.) K.Schum.
Hermannia lancifolia Szyszyl.
Waltheria indica L.

Ochnaceae

Ochna pretoriensis E.Phillips
Ochna pulchra Hook.



Hypericaceae

Hypericum aethiopicum Thunb. ssp. *sonderi* (Bredell) N. Robson
Hypericum lalandii Choisy

Flacourtiaceae

Dovyalis zeyheri (Sond.) Warb.
Kiggelaria africana L.
Scolopia zeyheri (Nees) Harv.

Turneraceae

Tricliceras longipedunculatum

Passifloraceae

Passiflora subpeltata Ortega

Cactaceae

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

Thymelaceae

Dais cotinifolia L.
Gnidia capitata L.f.
Gnidia kraussiana
Gnidia microcephala Meisn.
Gnidia sericocephala (Meisn.) Gilg ex Engl

Combretaceae

Combretum erythrophyllum (Burch.) Sond.
Combretum molle R.Br. ex G. Don
Combretum zeyheri Sond.

Onagraceae

**Oenothera rosea* L'H, r. ex Aiton
**Oenothera tetraptera* Cav.

Araliaceae

Cussonia paniculata Eckl. & Zeyh. ssp. *paniculata*
Cussonia spicata Thunb.

Apiaceae

Centella asiatica (L.) Urb.
Heteromorpha trifoliata (H.L. Wendl.) Eckl. & Zeyh.
Peucedanum magalismsontanum Sond.

Myrsinaceae

Myrsine africana L.

Primulaceae

**Anagallis arvensis* L.

Sapotaceae

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

Ebenaceae

Diospyros lycioides Desf. ssp. *guerkei* (Kuntze) De Winter
Diospyros lycioides Desf. ssp. *lycioides*
Diospyros whyteana (Hiern) F.White
Euclea crispa (Thunb.) Gürke ssp. *crispa*
Euclea natalensis
Euclea undulata

Oleaceae

Jasminum angulare Vahl
Olea europaea

Loganiaceae

Nuxia congesta R.Br. ex Fresen.
Strychnos cocculoides Baker
Strychnos pungens Soler.

Buddlejaceae

Buddleja saligna Willd.
Buddleja salviifolia (L.) Lam.

Gentianaceae

Chironia purpurascens (E.Mey.) Benth. & Hook.f. ssp. *humilis*
(Gilg) I.Verd.
Sebaea grandis (E.Mey.) Steud.

Apocynaceae

Acokanthera oblongifolia (Hochst.) Codd
Acokanthera oppositifolia (Lam.) Codd
Ancylobotrys capensis (Oliv.) Pichon,

Periplocaceae

Cryptolepis oblongifolia (Meisn.) Schltr.
Raphionacme galpinii Schltr.
Raphionacme hirsuta (E.Mey.) R.A.Dyer ex E.Phillips

Asclepiadaceae

**Araujia sericifera* Brot.
Asclepias adscendens (Schltr.) Schltr.



Asclepias stellifera Schltr.
Brachystelma species
Ceropegia rendallii N.E.Br.
Cynanchum africanum (L.) Hoffmanns.
Gomphocarpus fruticosus (L.) Aiton f.
Gomphocarpus tomentosus Burch.
Huernia hystrix
Pachycarpus schinzianus (Schltr.) N.E.Br.
Pentarrhinum insipidum E.Mey.
Sarcostemma viminale (L.) R.Br.
Secamone gerrardii Harv. ex Benth.
Stapelia gigantea N.E.Br.
Stapelia leendertziae N.E.Br.
Xysmalobium undulatum (L.) Aiton f.

Cuscutaceae

**Cuscuta campestris* Yunck.

Convolvulaceae

Evolvulus alsinoides (L.) L. var. *linifolius* (L.) Baker
Ipomoea bathycolpos Hallier f. var. *bathycolpos*
Ipomoea crassipes Hook.
Ipomoea obscura
Ipomoea ommaneyi Rendle
**Ipomoea purpurea* (L.) Roth
Ipomoea sinensis (Desr.) Choisy ssp. *blepharosepala* (Hochst. ex A.Rich.) Verdc.
Merremia tridentata (L.) Hallier f. ssp. *angustifolia* (Jacq.) Ooststr. var. *angustifolia*
Turbina oblongata (E.Mey. ex Choisy) A.Meeuse

Ehretiaceae

Ehretia rigida (Thunb.) Druce

Boraginaceae

Cynoglossum hispidum Thunb.
Cynoglossum lanceolatum Forssk.
Lithospermum species

Verbenaceae

Clerodendrum glabrum E.Mey. var. *glabrum*
Clerodendrum triphyllum (Harv.) H.Pearson var. *triphyllum*
Chascanum hederaceum (Sond.) Moldenke var. *hederaceum*
Lantana rugosa Thunb
Lippia javanica (Burm.f.) Spreng
Lippia rehmannii H.Pearson
**Priva cordifolia* (L.f.) Druce var. *abyssinica* (Jaub. & Spach) Moldenke
**Verbena bonariensis* L.
**Verbena brasiliensis* Vell
**Verbena tenuisecta* Briq
**Lantana camara* L

Lamiaceae

Aeollanthus buchnerianus Briq
Ajuga ophrydis Burch. ex Benth
Becium angustifolium (Benth.) N.E.Br
Becium obovatum (E.Mey. ex Benth.) N.E.Br. ssp. obovatum var.
obovatum
Hemizygia canescens (Guerke) M.Ashby
Hemizygia pretoriae (Guerke) M.Ashby ssp. Pretoriae
Leonotis ocymifolia (Burm.f.) Iwarsson var. raineriana (Vis.)
Iwarsson
Plectranthus madagascariensis (Pers.) Benth. var. ramosior Benth
Stachys natalensis Hochst. var. natalensis
Salvia runcinata L.f
Teucrium trifidum Retz

Solanaceae

Physalis viscosa L
*Solanum elaeagnifolium Cav
Solanum incanum L
*Solanum mauritianum Scop
Solanum panduriforme E.Mey
*Solanum pseudocapsicum L
Solanum retroflexum Dunal
Solanum rigescens Jacq
*Solanum seaforthianum Andrews

Scrophulariaceae

Alectra orobanchoides Benth
Cycnium tubulosum (L.f.) Engl
Graderia subintegra Mast
Halleria lucida L
Jamesbrittenia burkeana (Benth.) Hilliard
Nemesia fruticans (Thunb.) Benth
Striga asiatica (L.) Kuntze
Striga bilabiata (Thunb.) Kuntze
Striga elegans Benth
Sutera caerulea (L.f.) Hiern
Sutera pallescens Hiern
Sutera palustris Hiern
Zaluzianskya katharinae Hiern
Zaluzianskya maritima (L.f.) Walp

Selaginaceae

Hebenstretia angolensis Rolfe

Campanulaceae

*Macfadyeni unguis-cati (L.) A.H.Gentry-
Walafrida densiflora (Rolfe) Rolfe
Walafrida tenuifolia Rolfe



Bignoniaceae

**Jacaranda mimosifolia* D.Don

Pedaliaceae

Ceratotheca triloba (Bernh.) Hook.f
Sesamum triphyllum Welw. ex Asch. var. *triphyllum*

Acanthaceae

Barleria macrostegia Nees
Barleria pretoriensis C.B.Clarke
Chaetacanthus burchellii Nees
Chaetacanthus costatus Nees
Chaetacanthus setiger (Pers.) Lindl
Crabbea acaulis N.E.Br
Crabbea angustifolia Nees
Crabbea hirsuta Harv
Crabbea ovalifolia Ficalho & Hiern
Hypoestes forskaolii (Vahl) R.Br
Isoglossa grantii C.B.Clarke
Justicia anagalloides (Nees) T.Anderson

Plantaginaceae

**Plantago lanceolata* L.

Rubiaceae

Anthospermum hispidulum E.Mey. ex Sond
Canthium gilfillanii (N.E.Br.) O.B.Mill.
Canthium mundianum Cham. & Schltld
Kohautia amatymbica Eckl. & Zeyh
Kohautia caespitosa Schnizl. ssp. *brachyloba* (Sond.) D.Mantell
Kohautia virgata (Willd.) Bremek
Oldenlandia herbacea (L.) Roxb. var. *herbacea*
Pentanisia angustifolia (Hochst.) Hochst.
Pavetta gardeniifolia A.Rich. var. *gardeniifolia*
Pavetta zeyheri Sond
Psydrax livida (Hiern) Bridson
Pygmaeothamnus zeyheri (Sond.) Robyns var. *zeyheri*
**Richardia brasiliensis* Gomes
Rothmannia capensis Thunb
Tapiphyllum parvifolium (Sond.) Robyns
Vangueria infausta Burch. ssp. *Infausta*

Dipsacaceae

Cephalaria zeyheriana Szab
Scabiosa columbaria L

Cucurbitaceae

Coccinia adoensis (A.Rich.) Cogn
Cucumis hirsutus Sond

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