The classification, mapping and description of the vegetation of the Rooipoort Nature Reserve, Northern Cape, South Africa

Author:
Hugo Bezuidenhout[1]

Affiliation:
[1]Conservation Services, South African National Parks, South Africa

Correspondence to:
Hugo Bezuidenhout

e-mail:
hugob@sanparks.org

Postal address:
South African National Parks, Scientific Services, PO Box 110040, Hadison Park, Kimberley, South Africa, 8306

Keywords:
Northern Cape; Rooipoort Nature Reserve; vegetation classification; inventory; Braun-Blanquet

Dates:
Received: 02 Mar. 2009
Accepted: 19 May 2009
Published: 17 Aug. 2009

How to cite this article:
Bezuidenhout, H., 2009, 'The classification, mapping and description of the vegetation of the Rooipoort Nature Reserve, Northern Cape, South Africa', *Koedoe* 51(1), Art. #695, 11 pages. DOI: 10.4102/koedoe.v51i1.695

This article is available at:
http://www.koedoe.co.za

ABSTRACT

The need for a scientifically-based wildlife management plan and for more knowledge on vegetation led to an investigation into the plant ecology of the Rooipoort Nature Reserve. The main aim of this study was therefore to classify, describe and map the vegetation of the reserve. The floristic data were analysed according to the Braun-Blanquet procedure using the BBPC suite. The data analysis resulted in the identification of 15 communities that can be grouped into ten major community types. This resulted in five ecology-based management units, which could assist with the compilation of an ecologically sound management plan for the reserve in order to achieve sustainable utilisation of the natural resources. The Rooipoort Nature Reserve is one of the oldest and largest private nature reserves in South Africa and as such deserves to be conserved and protected. The riverine and pan vegetation communities are considered to be endangered and are in need of special conservation and protection.

Conservation implication: The results suggest five management units, which will assist in the compilation of an ecologically sound management plan for the RNR, in order to allow sustainable utilization of natural resources.

INTRODUCTION

The Rooipoort Nature Reserve (RNR) is one of the oldest and largest private nature reserves in South Africa and has a very interesting utilisation history. In 1985 it was also declared as the fourth South African Natural Heritage Site. According to Berry and Crowe (1985), the properties comprising the RNR were consolidated in 1893. From 1893 until 1930 the estate was used primarily as a private hunting game reserve, but thereafter the estate was leased (1930–1947) for domestic stock farming, such as horses, goats and cattle. This management system involved over-grazing, which had a significant impact on the vegetation. In 1947 the estate reverted to a hunting game reserve and since the early 1950s has been developed as a private nature reserve (Berry & Crowe 1985). The RNR is well known for its contribution to archaeological conservation with important Bushman rock engravings, which is one of the richest sites of its kind in southern Africa.

The necessity for ecological classification, description and mapping of the vegetation of conservation areas has been stated by Bredenkamp and Theron (1978), Nakor (1979) and Bredenkamp and Bezuidenhout (1990). A sound knowledge of the ecology will contribute considerably to the establishment of an efficient wildlife management programme and conservation policy for the RNR. Being an old nature reserve, it should also serve as a long-term reference area for wider reconnaissance surveys in the Northern Cape region. It has considerable potential to serve as an education centre for environmental sciences and wildlife management. Although studies on various ecological aspects of RNR have been conducted by Berry (1991), Crowe, Schijf and Gubb (1981) and Fabricius and Mentis (1990; 1992), a detailed description and mapping of the area's vegetation has not been attempted. Relatively medium- and broad-scale vegetation classification of the Northern Cape was done by Gubb (1989), Smit (2000), Acocks (1953), Low and Rebelo (1996) and Mucina and Rutherford (2006). Therefore, the main aim of this study was to classify, describe, ecologically interpret and map the vegetation of the RNR using the Braun-Blanquet procedure (Mueller-Dombois & Ellenberg 1974).

THE STUDY AREA

Location and regional vegetation

The RNR is situated approximately 60 km west of Kimberley in the Northern Cape Province, South Africa. It extends from latitude 28^0 30′ to 28^0 40′S and longitude 24^0 02′ to 24^0 25′E (Figure 1). The RNR comprises 42 647 ha and is divided into an exclusive wildlife area totalling 34 500 ha and an area of approximately 8 000 ha where domestic stock (cattle) are grazed. A game-proof fence bounds the reserve on three sides and the Vaal River on the fourth side (Berry 1991). The Vaal River stretches for about 30 km on the western border of the Reserve and comprises of relatively 'pristine' riverine habitat. According to Acocks (1988), the area can be classified as Kalahari Thornveld invaded by Karoo (Veld Type 17), while a small section along the banks of the Vaal River consists of the False Orange River Broken Veld (Veld Type 40). Mucina and Rutherford (2006) mapped three vegetation units, namely the Kimberley Thornveld (SVk4) and Schmidtsdrif Thornveld (SVk6) of the Savanna Biome and the Highveld Salt Pans (AZi10) as part of the Inland Azonal Vegetation.

Physiography, geology, soils and land types

The mountainous landscape varies from upper and lower lying valleys and drainage lines, together with steep to moderately steep mountain slopes and relatively flat to undulating plateaux. Altitude varies from 1 050 m to 1 187 m. The following topographical positions are distinguished in the RNR: crest, scarp, midslope, footslope, plain, floodplain, pan and riverbank. The Vaal River, which is joined by the Harts River just outside the RNR, forms the core of the drainage system of the area.

According to Berry (1991), the RNR lies at the base and east of the Ghaap plateau. The RNR is underlain by various geological formations. Outcrops of the andesitic lavas of the Ventersdorp Supergroup

mainly occur as rocky hills (koppies), with outliers of dolomite (Transvaal Sequence) also occurring in the area (Spaggiari 1993). Some low, flat ridges of quartzite (Ventersdorp Supergroup) are also found in the study area. The northern section of the RNR is mainly underlain by aeolian sand with surface limestones and sometimes by alluvial gravels of Tertiary to Recent age covering Dwyka tillite (Helgren 1979). During the 1920s relatively rich diamond deposits were found in the ancient gravel-filled watercourses of the Vaal River. At this time the adjacent area (the deproclaimed Vaalbos National Park) was a hive of activity (Bezuidenhout 1994). It produced diamonds to the value of over £300 000 in 1913 (Wagner 1914). The heaps of mixed gravel still present in the area attest to the disturbance to which it was subjected.

The soil type varies from deep (> 0.8 m) red-brown and yellow-brown sands (Hutton and Clovelly soil forms) to shallow (< 0.3 m) and stony (Mispah, Prieska and Kimberley soil forms) while the soil on the western floodplain is moderately deep (0.3–0.8 m) and clayey (Valsrivier and Swartland soil forms). The banks of the Vaal River consist of silt-clayey soil (Oakleaf soil form) while the soil of old diamond diggings debris is very disturbed. The soil of the pans is moderately deep and very clayey with 35% clay content, and is of the Arcadia, Rensburg and Willowbrook soil forms (Soil Classification Working Group 1991).

The diversity of the study area is accentuated by the five Land Types, the Ah, Ae, Dc, Fb and Fc land types that occur in the study area. According to the Land Type Survey Staff (1986) 'A Land Type denotes an area that can be shown at 1 : 250 000 scale and that displays a marked degree of uniformity with respect to terrain form, soil pattern and climate'. The A unit refers to yellow and red apedal, freely drained soil without water tables. The Ae Land Type refers to red, high-base status soil, of which the depth varies from 0.1 to > 0.3 m. The Ah Land Type differs from the Ae Land Type in that it includes yellow soil as well and is consistently deeper than 0.3 m. The Dc Land Type indicates land where the soil has structure, such as prismacutanic, pedocutanic, vertic, melanic and red structured (Land Type Survey Staff 1986). The F unit indicates land where the dominant soil-forming processes have been rock weathering, typically giving rise to lithocutanic horizons. The Fb and Fc Land Types indicate land where lime occurs regularly (it does not need to be present in every soil) in upland and valley bottom soils. The two land types differ, with different geology types that underlie them (Land Type Survey Staff 1986). The Land Type concept has frequently provided a useful basis for description of vegetation (Bezuidenhout 1993; Breytenbach 1991; Kooij 1990).

Climate

The rainfall, mainly during summer (January to March), is erratic and can vary between as high as 700 mm per year, to lower than 300 mm per year (July to June). The average annual (July to June) rainfall for RNR based on data collected in the Vaalbos National Park (deproclaimed 2006), over nine years (1987–1995), was just over 400 mm per annum (Crowe *et al*. 1981). The temperature is less erratic than the rainfall with cold winter temperatures (coldest months June to July) as low as -4 °C while the summer temperatures (warmest months December to January) are as high as 44 °C. Frost occurs, with the earliest date recorded being 27 April and the latest date 23 September, while its duration can be as long as 107 days (Land Type Survey Staff 1986).

METHODS

By using 1:50 000 stereo aerial photographs, the study area was stratified into physiognomic-physiographic units. After a reconnaissance of the area a total number of 120 sample plots were located on a randomly stratified basis within the different homogeneous units identified from the aerial photographs. The number of sample plots allocated within each homogeneous unit depended on the size of the area; the larger the area the higher the number of sampling plots allocated to the unit. Plot sizes were fixed on 900 m^2 (30 m x 30 m) based on Bezuidenhout's (1994; 1995) recommendations. Fieldwork was done between November 2006 and the end of January 2007. In each sample plot all species were recorded and the cover-abundance of each species was assessed according to the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberge 1974). Plant species identification was done in accordance with the identification of Germishuizen and Meyer (2003). Structural terminology is based on the work of Edwards (1983). The percentage average canopy cover and height of the herbaceous layer (grasses and herbaceous plants), the shrub layer (woody species varying in height between > 0–3 m) and tree layer (woody species higher than 3 m) were also estimated. The habitat information is qualitatively described. Edaphic information noted for each relevè included geology, soil forms, soil depth (shallow < 0.3 m; moderate 0.3–0.8 m; deep > 0.8 m), slope, aspect and the rockiness of the soil surface.

The floristic data were analysed according to the Braun-Blanquet procedure using the BBPC suite (Bezuidenhout, Biggs & Bredenkamp, 1996). The numerical classification program TWINSPAN (Hill 1979), which is regarded as a successful approach for classification by several phytosociologists (Cilliers 1998; Mucina & Van Der Maarel 1989) was used to derive a first approximation of the floristic data. Further refinement of the classification was achieved by the Braun-Blanquet procedure (Bredenkamp, Joubert & Bezuidenhout, 1989; Brown & Bezuidenhout 2005). Using the phytosociological table and the habitat information gathered during the sampling period, the different plant communities were identified and described. The different plant communities are described according to their dominant species. Dominant species are those that are most conspicuous in the community and are high in one or more of the importance values (Whittaker 1978), which in this case are cover and frequency. No attempt was made to formally fix syntaxonomic names as this is normally avoided in detailed local studies (Barkman, Moravec & Rauschert, 1986; Coetzee 1983). Soil nomenclature follows the classification of the Soil Classification Working Group (1991).

The relatively homogeneous plant communities should form the basis for the compilation of wildlife and ecotourism management plans. Benchmark type relevès were identified for the various plant communities on the grounds that these relevès (species composition and habitat) represent the particular community the best. The benchmark type relevès could be used for monitoring purposes.

RESULTS

Classification

The data analysis resulted in the identification of 15 different communities that can be grouped into ten major community units. The hierarchical classification is as follows:

1. *Schmidtia pappophoroides – Themeda triandra* Grassland
2. *Schmidtia pappophoroides – Acacia erioloba* Woodland
3. *Tarchonanthus camphoratus* Shrubland
   - 3.1 *Eragrostis lehmanniana – Tarchonanthus camphoratus* Shrubland
   - 3.2 *Ziziphus mucronata – Tarchonanthus camphoratus* Shrubland
4. *Acacia mellifera – Acacia tortilis* Shrubland
5. *Acacia mellifera* Shrubland
   - 5.1 *Tarchonanthus camphoratus – Acacia mellifera* Shrubland
   - 5.2 *Digitaria eriantha – Rhigozum obovatum* Shrubland
   - 5.3 *Heteropogon contortus – Tarchonanthus camphoratus* Shrubland
6. *Diospyros lycioides* Woodland
   - 6.1 *Diospyros lycioides – Acacia karroo* Woodland
   - 6.2 *Salsola rabieana – Diospyros lycioides* Shrubland
7. *Pentzia globosa – Eragrostis truncata* Forbland

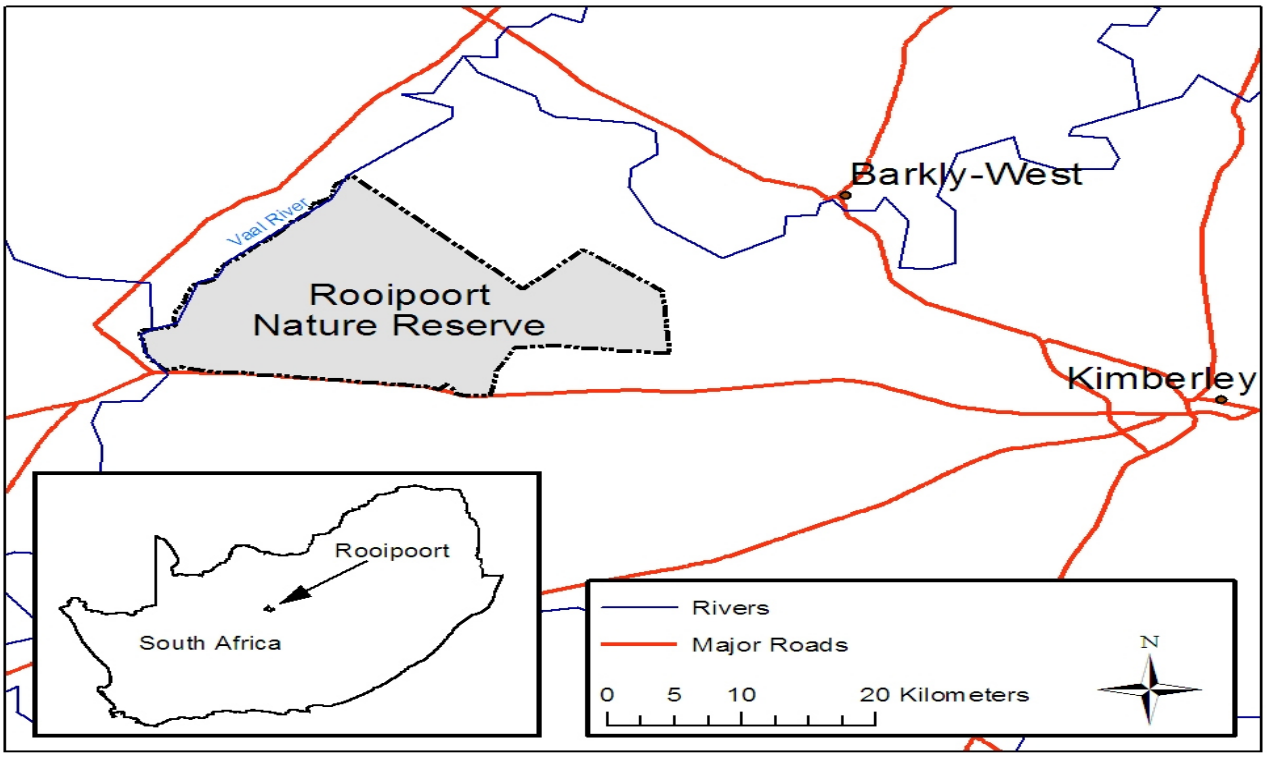

FIGURE 1
Location of the RNR

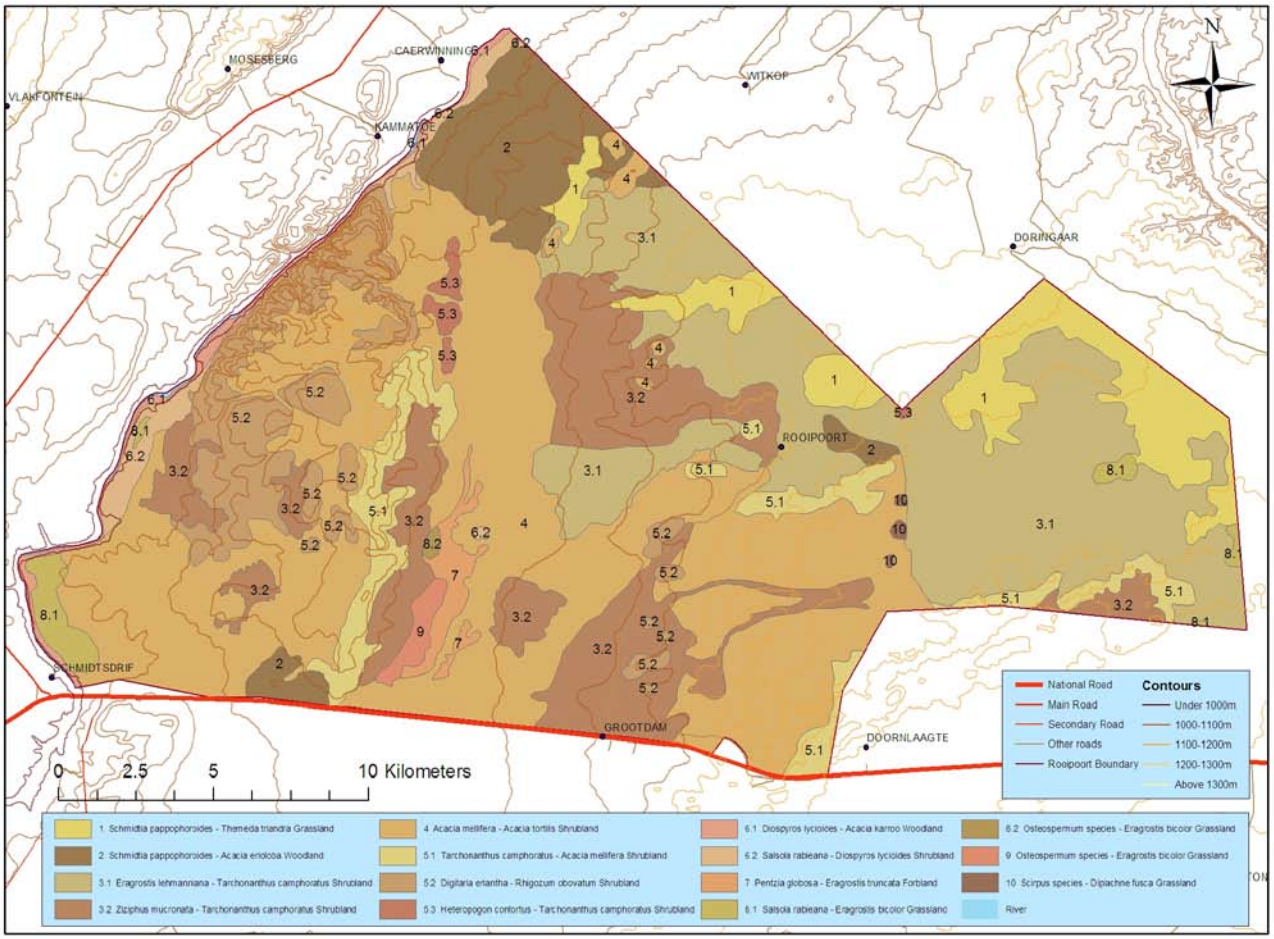

FIGURE 2
Vegetation map for the RNR

1. *Schmidtia pappophoroides – Themeda triandra* Grassland
Benchmark type: relevè 22

2. *Schmidtia pappophoroides – Acacia erioloba* Woodland
Benchmark type: relevè 28

3.1 *Eragrostis lehmanniana – Tarchonanthus camphoratus* Shrubland
Benchmark type: relevè 23

3.2 *Ziziphus mucronata – Tarchonanthus camphoratus* Shrubland
Benchmark type: relevè 57

8. *Eragrostis bicolor* Grassland
   8.1 *Salsola rabieana – Eragrostis bicolor* Grassland
   8.2 *Osteospermum species – Eragrostis bicolor* Grassland
9. *Cynodon dactylon – Sporobolus ioclados* Grassland
10. *Scirpus species – Diplachne fusca* Grassland

The following four major soil type-cum-habitats were identified as part of the associated environmental descriptions of plant communities:

A. Deep, well-drained, red-brown or yellow-brown sandy soil
B. Shallow, well-drained, yellow-brown or red-brown rocky soil
C. Moderately deep, moderately drained, dark silt-clayey soil
D. Moderately deep, poorly drained, dark clayey soil

Description of the plant communities

A. Deep, well-drained, red-brown or yellow-brown sandy soil

1. Schmidtia pappophoroides – Themeda triandra Grassland

Benchmark type: relevè 22

The *Schmidtia pappophoroides – Themeda triandra* Grassland occurs on the plain, mainly in the northern part of the study area (Figure 2) and is strongly associated with deep (> 0.8 m) to moderately deep (0.3–0.8 m) well-drained, yellow-brown or red-brown sandy (clay content < 10%) soil. The community is 2 726 ha in size and is underlain by aeolian sand covering Dwyka tillite. Surface limestone occurs sporadically. No rocks or stones on the soil surface were recorded in the relevès of this community. The dominant soil forms are Hutton and Clovelly, but the Mispah form can also occur. This Grassland is associated with the Ah Land Type.

This community is characterised by species group A (Table 1) and the diagnostic species are the grasses *Themeda triandra* and *Pogonarthia squarrosa* and the forbs *Elephanthorrhiza elephantina*, *Rhynchosia nervosa* and *Plinthus sericeus* and the geophyte *Moraea verecunda*. The poorly developed tree stratum is 5 m tall, with a canopy cover of 1%. Sparsely distributed *Acacia erioloba* and *Acacia tortilis* are the prominent trees in this community. The shrub stratum, with species such as *Grewia flava* and *Tarchonanthus camphoratus*, is poorly developed with a canopy cover of 1% and a height of 2 m. The herbaceous stratum is well developed, about 0.3 m tall with a canopy cover of 68%. The dominant grasses are *Schmidtia pappophoroides*, *Eragrostis lehmanniana*, *Stipagrostis uniplumis* and *Aristida congesta*, while the most prominent forb is *Hermannia tomentosa* (Table 1 - online supplement).

2. *Schmidtia pappophoroides – Acacia erioloba* Woodland

Benchmark type: relevè 28

The *Schmidtia pappophoroides – Acacia erioloba* Woodland is strongly associated with very deep (> 0.8 m) well-drained, yellow-brown or red-brown sandy (clay content < 10%) soil and it occurs on the plain, mainly in the northern part of the study area (Figure 2). The community is 2 388 ha in size and is

4. *Acacia mellifera – Acacia tortilis* Shrubland
Benchmark type: relevè 105

5. *Acacia mellifera* Shrubland

5.1 *Tarchonanthus camphoratus – Acacia mellifera* Shrubland
Benchmark type: relevè 76

5.2 *Digitaria eriantha – Rhigozum obovatum* Shrubland
Benchmark type: relevè 109

5.3 *Heteropogon contortus – Tarchonanthus camphoratus* Shrubland
Benchmark type: relevè 44

6. *Diospyros lycioides* Woodland
6.1 *Diospyros lycioides – Acacia karroo* Woodland
Benchmark type: relevè 95

underlain by aeolian sand covering Dwyka tillite. No rocks or stones on the soil surface were recorded in the relevès of this community. The dominant soil forms are Hutton and Clovelly. This Woodland is associated with the Ah and Ae Land Types.

This community is characterised by species group B (Table 1) and the diagnostic species are the tree *Acacia erioloba*, the grasses *Aristida stipitata* and *Eragrostis pallens* and the forbs *Indigofera daleoides* and *Pollichia campestris*. The tree stratum is 8 m tall, with a canopy cover of 6%. The dominant and most prominent tree is *Acacia erioloba* with sparsely distributed *Acacia tortilis* in this community. The shrub stratum, with *Grewia flava*, with a canopy cover of 13% and a height of 2 m, is prominent in this community. The herbaceous stratum is well developed, about 0.2 m tall with a canopy cover of 55%. The dominant grasses apart from the diagnostic grasses are *Schmidtia pappophoroides*,

6.2 *Salsola rabieana – Diospyros lycioides* Shrubland
Benchmark type: relevè 34

7. *Pentzia globosa – Eragrostis truncata* Forbland
Benchmark type: relevè 52

8. *Eragrostis bicolor* Grassland
8.1 *Salsola rabieana – Eragrostis bicolor* Grassland

8.2 *Osteospermum species – Eragrostis bicolor* Grassland
Benchmark type: relevè 56

9. *Cynodon dactylon – Sporobolus ioclados* Grassland
Benchmark type: relevè 53

Eragrostis lehmanniana, *Stipagrostis uniplumis* and *Aristida congesta* subsp. *congesta*, while the most prominent forb is *Hermannia tomentosa* (Table 1).

3. *Tarchonanthus camphoratus* Shrubland

This Shrubland, consisting of two sub-communities, is found throughout the park and is the largest in size, namely 15 088 ha (Figure 2). The *Tarchonanthus camphoratus* Shrubland occurs on moderately deep, well-drained, yellow-brown or red-brown sandy soil and is associated with midslopes and footslopes of the study area. The parent material of the soil is either aeolian sand of Tertiary to Recent age or soil that was formed *in situ*. Sporadic outcrops of limestone or andesitic lava may occur. The soil surface that is covered by rocks or stones varies from 2 to 60%.

The Shrubland is characterised by species group D (Table 1) and the diagnostic species are the tree *Ziziphus mucronata* and the grass species *Cymbopogon plurinodis*.

3.1 *Eragrostis lehmanniana – Tarchonanthus camphoratus* Shrubland

Benchmark type: relevè 23

This midslope *Eragrostis lehmanniana – Tarchonanthus camphoratus* Shrubland sub-community is associated with moderately deep (0.3–0.8 m), well-drained sandy soil. The parent material of the soil is aeolian sand of Tertiary to Recent age. Sporadic outcrops of limestone or andesitic lava may occur. Rocks or stones cover less than 2% of the soil surface. The Shrubland is associated with the Ae Land Type. The dominant soil forms are the Hutton and Kimberley forms. The size of the sub-community is 9 126 ha (Figure 2).

The diagnostic species is the conspicuous shrub *Rhus ciliata* (Species Group E; Table 1). The tall (average of 6 m) *Acacia*

tortilis and *Ziziphus mucronata* trees are prominent in the poorly developed tree stratum with a canopy cover of 2%. The well-developed shrub stratum, which is dominated by *Tarchonanthus camphoratus* is 2.1 m tall with a canopy cover of 15%. Two other prominent woody species in this stratum are *Rhus ciliata* and *Grewia flava*. In isolated patches of this sub-community, where the soil tends to become rocky and shallow, the shrub *Acacia mellifera* is more prominently present and is co-dominant with *Tarchonanthus camphoratus*. The herbaceous layer is 0.3 m tall and has a canopy cover of 60%. The dominant grass species are *Cymbopogon plurinodis*, *Schmidtia pappophoroides*, *Eragrostis lehmanniana* and *Aristida congesta* subsp. *congesta*. No dominant forbs were recorded in this sub-community.

3.2 *Ziziphus mucronata – Tarchonanthus camphoratus* Shrubland

Benchmark type: relevè 57

This sub-community *Ziziphus mucronata – Tarchonanthus camphoratus* Shrubland (size 5 962 ha) is restricted to the footslopes of the study area and is associated with the Ae and Fc Land Types. The Mispah soil form is dominant with more than 30% rock cover of the soil surface. Outcrops of andesitic lava and limestone were noted and the soil depth varies between 0.3 to 0.6 m.

This sub-community Shrubland is characterised by the presence of species from species groups D, H, L, O and P, the absence of species from species groups E, F, G and N (Table 1). These species include the trees *Ziziphus mucronata* and *Acacia tortilis* as well as the shrubs *Grewia flava*, *Ehretia rigida* and *Tarchonanthus camphoratus*, with the grasses *Cymbopogon plurinodis* and *Eragrostis lehmanniana.* The tree stratum is 4 m tall with a canopy cover of 2%, while the shrub stratum is 2.1 m tall with a canopy cover of 15%. The herbaceous layer is 0.3 m tall with a canopy cover of 60%.

B. Shallow, well-drained, yellow-brown or red-brown rocky soil

4. *Acacia mellifera – Acacia tortilis* Shrubland

Benchmark type: relevè 105

The *Acacia tortilis – Acacia mellifera* Shrubland is strongly associated with the plains and footslopes of the study area (Figure 2). The size of the Shrubland is 14 947 ha, which is the second largest community in RNR. The habitat of this Shrubland consists of shallow (< 0.3 m), well-drained, rocky soil with andesitic lava, shale and dolomitic rocks (more than 25%) on the soil surface. This Shrubland is associated with the Ae and Fc Land Types. The soil-rock complex of this Shrubland consists of rock and Mispah soil form.

The diagnostic species for this Shrubland are the tree *Boscia albitrunca*, and the shrub *Phaeoptilum spinosum* and *Asparagus* cf. *laricinus* and the forbs *Barleria rigida*, *Blepharis furcata* and *Phyllanthus parvulus* as well as the grass species *Aristida meridionalis* (Species Group G; Table 1). The poorly developed tree stratum is 5.3 m tall with a canopy cover of 2.3%. Only two tree species are prominent in this community, namely *Boscia albitrunca* and *Acacia tortilis*. The well-developed shrub stratum, with dominant shrub species *Acacia mellifera*, *A. tortilis*, *Tarchonanthus camphoratus*, *Ehretia rigida* and *Grewia flava*, is 1.8 m tall with a canopy cover of 18%. The herbaceous layer is 0.2 m tall with a canopy cover of 38%. Except for the grass species *Aristida meridionalis*, *A. congesta* subsp. *barbicollis* and *Eragrostis lehmanniana* no other grass or forb species are prominent in this Shrubland. The physiognomy of this shrubland sometimes changes to impenetrable *Acacia tortilis – A. mellifera* Thickets.

5. *Acacia mellifera* Shrubland

The *Acacia mellifera* Shrubland is strongly correlated with the mountainous areas in the study area. The total size of the community is 5 292 ha, but is distributed throughout the study area (Figure 2). The soil-rock complex consists of rock and Mispah soil form, with outcrops of andesitic lava and quartzite occurring in the community. Rocks and stones cover more than 80% of the soil surface, while the soil is shallow and well drained. The Shrubland in the study area is associated with the Ae and Fc Land Types.

The community is characterised by the diagnostic species from Species Group I (Table 1), the grass species *Heteropogon contortus* and the fern *Pellaea calomelanos*. Three sub-communities will be described in detail.

5.1 *Tarchonanthus camphoratus – Acacia mellifera* Shrubland

Benchmark type: relevè 76

The *Tarchonanthus camphoratus – Acacia mellifera* Shrubland occurs on the footslopes and lower midslopes of the andesitic lava hills in the study area (Figure 2) and is strongly associated with shallow (< 0.3 m), well-drained, yellow-brown or red-brown rocky soil. The community is 2 129 ha in size. About 80% rocks or stones were recorded on the soil surface of this community. The soil-rock complex of this Shrubland consists of rock and Mispah soil form. This Shrubland is associated with the Ae Land Type.

This community is characterised by the presence of species group I, K, L, N, O and P and the absence of species group G, H and J (Table 1). The poorly developed tree stratum is 4.7 m tall, with a canopy cover of 2%. The sparsely distributed *Acacia tortilis* is the prominent tree in this sub-community. The shrub stratum, with species such as *Grewia flava*, *Ehretia rigida*, *Acacia mellifera* and *Tarchonanthus camphoratus* is well developed with a canopy cover of 15% and a height of 1.6 m. The herbaceous stratum is well developed, 0.4 m tall with a canopy cover of 49%. The prominent grass species are *Digitaria eriantha*, *Enneapogon scoparius* and *Heteropogon contortus*, while no prominent forbs were recorded (Table 1).

The drainage lines in this sub-community support woody plant species such as *Acacia tortilis*, *A. mellifera* and *Tarchonanthus camphoratus* and perennial grass species *Themeda triandra*, *Eragrostis superba* and *Sporobolus fimbriatus*.

5.2 *Digitaria eriantha – Rhigozum obovatum* Shrubland

Benchmark type: relevè 109

This sub-community *Digitaria eriantha – Rhigozum obovatum* Shrubland (size 2 950 ha) is restricted to the upper midslopes and plateau of the andesitic lava hills of the study area and is associated with the Ae and Fc Land Types. Rock and Mispah soil form are dominant in the soil-rock complex of this sub-community, with more than 87% rock cover of the soil surface.

The diagnostic plant species for this sub-community is the shrub *Rhigozum obovatum* (Species Group J; Table 1). The poorly developed tree stratum is dominated by *Acacia tortilis* and is 4.5 m tall with a canopy cover of 2%. The shrub stratum is well developed and apart from the diagnostic shrub species, *Grewia flava*, *Ehretia rigida*, *Acacia mellifera* and *Tarchonanthus camphoratus* also are prominent. The shrub stratum is 1.2 m tall and the canopy cover is 12%, while the herbaceous stratum is 0.35 m tall and the canopy cover is 52%. The prominent grass species are *Digitaria eriantha*, *Enneapogon scoparius* and *Heteropogon contortus* and the inconspicuous forb *Pellaea calomelanos*.

5.3 *Heteropogon contortus – Tarchonanthus camphoratus* Shrubland

Benchmark type: relevè 44

This *Heteropogon contortus – Tarchonanthus camphoratus* Shrubland sub-community is associated with shallow (< 0.3 m), well-drained, rocky soil. This Shrubland occurs on the low, flat quartzite outcrops (Ventersdorp Supergroup) of the study area.

rocks or stones cover more than 80% of the soil surface. The Shrubland is associated with the Ae Land Type. The rock-soil complex is dominated by rock (lithosols) and Mispah soil form. The size of the sub-community is 213 ha (Figure 2).

The diagnostic species are the conspicuous forbs *Pegolettia retrofracta* and *Gomphocarpus fruticosus* (Species Group M; Table 1). No trees were noted and although the shrub stratum is present it is poorly developed with a height of 1 m and a canopy cover of 3%. The most prominent shrub species are *Tarchonanthus camphoratus* and *Acacia mellifera*. The herbaceous layer is 0.4 m tall and has a canopy cover of 55%. The dominant grass species are *Heteropogon contortus*, *Anthephora pubescens* and *Eragrostis lehmanniana*. No dominant forbs were recorded in this sub-community.

C. Moderately deep, moderately drained, dark silt-clayey soil

6. *Diospyros lycioides* Woodland

The Woodland is closely associated with the Vaal River and its associated floodplain. This dark soil of the Woodland is moderately deep (0.3–0.8 m), moderately drained and silt-clayey in texture. The size of the habitat, including the river (67 ha) is 996 ha (Figure 2). No or limited rocks or stones covering the soil surface was noted. It is found in the Dc and Ae Land Types of the study area.

The diagnostic species for the *Diospyros lycioides* Woodland are the shrub *Diospyros lycioides*, the shrubby forb *Lycium hirsutum* and the grass species *Cynodon dactylon* (Species Group Q; Table 1). The Woodland is divided into two sub-communities.

6.1 *Diospyros lycioides – Acacia karroo* Woodland

Benchmark type: relevè 95

The *Diospyros lycioides – Acacia karroo* Woodland sub-community is strongly associated with the moderately drained, moderately deep (0.3–0.8 m), silt-clayey, alluvial soil (clay content >10%) of the Vaal River (Figure 2). No rocks or stones were recorded on the soil surface. This sub-community associates strongly with the Vaal River system and can be related to the Dc Land Type in the study area. The dominant soil form is Oakleaf while others such as Dundee and Mispah are also present. The size of the sub-community is 329 ha.

The tree stratum is well developed and is 9 m tall with a canopy cover of 30%, while the shrub stratum is 3 m tall with a canopy cover of 18%. The diagnostic woody species are the trees *Acacia karroo*, *Combretum erythrophyllum*, *Rhus lancea* and *Salix mucronata* (Species Group R; Table 1). Other woody species present in this community are the tree *Ziziphus mucronata* and the shrub *Diospyros lycioides*. The herbaceous layer, which is very disturbed and poorly developed, is 0.2 m tall with a canopy cover of 16%. The prominent grasses are *Setaria verticillata* and *Cynodon dactylon*. The prominent diagnostic forb *Atriplex semibaccata* and the alien species, *Argemone ochroleuca* and *Datura stramonium,* also occur. The diagnostic common reed *Phragmites australis* is fairly abundant (Species Group R; Table 1).

6.2 *Salsola rabieana – Diospyros lycioides* Shrubland

Benchmark type: relevè 34

This Shrubland sub-community is restricted to the floodplain adjacent to the Vaal River, with one isolated floodplain exception near Hoffman's pan (Figure 2). It is strongly associated with moderately drained, moderately deep (0.3–0.8 m), silt-clayey (clay content > 10%) soil. The parent material is alluvium. Stones or rocks cover less than 2% of the soil surface. This *Salsola rabieana – Diospyros lycioides* Shrubland sub-community is situated in the Dc and Ae Land Types of the study area. The dominant soil form is the Valsrivier form, while other soil forms such as Mispah and Glenrosa are also present. The size of the sub-community is 600 ha.

Two grass species, *Chloris virgata* and *Panicum coloratum*, and one forb, *Salsola rabieana*, are the diagnostic species for this sub-community (Species Group S; Table 1). The herbaceous layer is well developed with a canopy cover of 44% and is 0.4 m tall. The diagnostic grass species are *Eragrostis lehmanniana* and *Aristida congesta* subsp. *barbicollis* and the forb *Pentzia globosa* are prominent in this sub-community. The tree and shrub strata, which occur on the edge of the floodplain, has a tree stratum that is 7 m tall and a canopy cover of 6%, while the shrub stratum is 2.3 m tall and has a canopy cover of 12%. The prominent woody species are the shrub/tree *Acacia tortilis*, tree/shrub *A. karroo*, the tree/shrub *Ziziphus mucronata* and the shrub *Diospyros lycioides*.

D. Moderately deep, poorly drained, dark clayey soil

7. *Pentzia globosa – Eragrostis truncata* Forbland

Benchmark type: relevè 52

The *Pentzia globosa – Eragrostis truncata* Forbland is strongly associated with the floodplain east of the Hoffman's pan (Figure 2). The soil of the community is moderately deep (0.3–0.8 m), poorly drained with a dark clayey texture, with Katspruit and Mispah as the dominant soil forms. Calcrete stones cover more than 55% of the soil surface. The size of these two forblands is 436 ha and it is associated with the Ae Land Type of the study area.

This community is characterised by three grass species, *Enneapogon desvauxii*, *Eragrostis truncata* and *Oropetium capense* and two forbs, *Pentzia globosa* and *Lycium horridum* (Species Group T; Table 1). No trees or shrubs were recorded in this community. The well-developed herbaceous stratum is 0.15 m tall and has a canopy cover of 58%. No other prominent plant species were noted in this community (Table 1).

8. *Eragrostis bicolor* Grassland

The *Eragrostis bicolor* Grassland occurs on moderately deep (0.3–0.8 m), poorly drained, dark clayey soil. It is strongly associated with isolated bare pans and old cultivated lands of the study area (Figure 2). The size of the community, which can be divided into two sub-communities, is 520 ha. No or limited rocks or stones covering the soil surface was noted. It is found in the Ae and Ah Land Types of the study area. The Katspruit, Swartland, Valsrivier and Mispah soil forms are dominant in both sub-communities.

The diagnostic species for this Grassland is the grass species *Eragrostis bicolor* (Species Group U; Table 1).

8.1 *Salsola rabieana – Eragrostis bicolor* Grassland

Benchmark type: relevè 19

The *Salsola rabieana – Eragrostis bicolor* Grassland occurs as three isolated pans in the eastern section of the study area and two old cultivated lands adjacent to the Vaal River in the western section of the study area (Figure 2). Most of the time the pans are bare, but on the edge of these pans moderately deep (0.3–0.8 m) soil has accumulated and this is where the Grassland has established. This links up with the habitat of the old cultivated lands with moderately deep (0.3–0.8 m), poorly drained, dark clayey soil. It is associated with the Ah and Ae Land Types of the study area and has a size of 483 ha. No rocks or stones were noted on the soil surface.

No diagnostic plant species was identified, but the presence of Species Group U and the absence of Species Groups T and V (Table 1) characterise this sub-community. The herbaceous

Article #695 African Protected Area Conservation and Science

stratum is well developed with a height of 0.25 m and a canopy cover of 60%. The prominent grass species *Eragrostis bicolor*, *Chloris virgata* and the forb *Salsola rabieana* have been noted in this sub-community. Individual *Acacia tortilis* trees or shrubs are sparsely distributed on the edge of these pans and in the old cultivated lands.

8.2 *Osteospermum species – Eragrostis bicolor* Grassland

Benchmark type: relevè 56

This sub-community is found to the north of Hoffman's pan on an isolated pan, with a size of 37 ha (Figure 2). The bare pan's dark coloured soil is moderately deep (0.3–0.8 m), poorly drained, with a clayey texture. Less than 2% rocks or stones cover the soil surface of the pan. The sub-community is associated with the Ae Land Type of the study area.

The diagnostic forb is an *Osteospermum* species (Species Group V; Table 1) and the grass species *Cynodon dactylon* is prominent in this pan (Species Group Q; Table 1). Most of the pan is bare, but on the edge the herbaceous stratum is well developed with a height of 0.05 m and a canopy cover of 60%. No trees or shrubs have been noted.

9. *Cynodon dactylon – Sporobolus ioclados* Grassland

Benchmark type: relevè 53

The *Cynodon dactylon – Sporobolus ioclados* Grassland is restricted to Hoffman's pan (Figure 2). The pan's dark coloured soil is moderately deep (0.3–0.8 m), poorly drained, with a clayey texture. The pan is associated with the Ae Land Type and its size is 214 ha. Calcrete rocks and stones cover 5% of the soil surface. Micro-habitats have been noted (Berry 1991), but for this study a more common broad vegetation-cum-habitat description is being given. The dominant soil forms are Katspruit, Swartland and Mispah.

The only diagnostic species for this community is the grass species *Sporobolus ioclados*. No trees or shrubs have been noted, but the herbaceous stratum is 0.25 m tall and has a canopy cover of 55%. Apart from the diagnostic grass species no other grass species or forbs were prominent.

10. *Scirpus species – Diplachne fusca* Grassland

Benchmark type: relevè 17

This Grassland occurs on three isolated pans on the border between the Grootkolk section and the larger RNR section (Figure 2). The *Scirpus* species – *Diplachne fusca* Grassland soil is moderately deep (0.3–0.8 m) and poorly drained, with a clayey texture. The dominant soil forms are Katspruit and Swartland and the size is 40 ha. No rocks or stones occur on the soil surface. The Grassland is associated with the Ae Land Type.

The grass species *Diplachne fusca* and forbs *Vahlia capensis*, *Falkia oblonga*, *Helichrysum* species and the sedge *Scirpus* species are diagnostic and prominent for these grassy pan communities (Species Group X; Table 1). No trees or shrubs were noted in these pans. The herbaceous layer is well developed and is 0.6 m tall and has a canopy cover of 88%.

DISCUSSION

Brown (1997) describes a nature reserve as an area removed from the development stream in order to conserve and protect nature and its processes. Before vegetation can be managed efficiently, relatively homogeneous vegetation communities should be identified, described and mapped, as has been done in this study. 15 plant communities have been identified and grouped into ten major communities. The plant communities are strongly correlated with four major soil type-cum-habitats. The description of the plant communities, together with the vegetation map, can serve as a basis to formulate a management programme for RNR. An understanding of the plant communities and their associated habitats is of fundamental importance for devising sound management and conservation strategies. However, the plant communities occurring in an area do not necessarily represent separate ecological management units that can be used in a management plan for a reserve, since many of these plant communities have similarities regarding species composition and habitat, and may have a complex mosaic distribution pattern. It would therefore be necessary to group these plant communities together in order to identify broad management units that can be incorporated into a management plan from where it can be managed effectively. It is important to notice that the hierarchical classification derived from the Braun-Blanquet procedure facilitates this grouping of plant communities into related and manageable ecological units. The combination of these management units is based on ecological principles whereby not only the vegetation, but also the abiotic component such as the topography, geology and soil type, must be taken into consideration (Brown 1997). It is important to survey each of these management units in order to determine their average veld condition score and tree density (King 1989). In a preliminary exercise the following management units were identified:

- Management Unit 1: Sandy plains – consisting of communities 1, 2 and 3.1
- Management Unit 2: Rocky plains and footslopes – consisting of communities 3.2 and 4
- Management Unit 3: Rocky hills – consisting of communities 5.1, 5.2 and 5.3
- Management Unit 4: River and floodplains – consisting of communities 6.1, 6.2 and 7
- Management Unit 5: Pans – consisting of communities 8.1, 8.2, 9 and 10

Veld management can be described as the utilisation and conservation of natural veld in such a way that the activity does not adversely affect the vegetation (Brown 1997). The procedure to determine and assess the veld condition of each management unit will be the second phase of the veld management plan, where the description and mapping of the vegetation communities were the first phase. The assessment of veld condition, if repeated at intervals (monitoring), may provide a descriptive measure of direction and change of the veld condition in response to current management practices (Brown 1997; Hobson 1989).

The rich variety of the described vegetation types which inhabit some of the available habitats in the Northern Cape province is reflected in the RNR faunal diversity, as was also noticed by Crowe *et al*. (1981). Unfortunately, due to poor rainfall and high temperatures it was not the ideal time for a floristic survey to compile a species list for the RNR, but the time was, however, suitable for a phytosociological study. By comparing the survey with a study done in the adjacent Vaalbos National Park (Bezuidenhout 1994), which was carried out in a relatively wet year (1993), more annual and geophytic plant species were recorded in Vaalbos National Park.

Three different pan communities were described, of which one can be sub-divided into two sub-communities. These pans are characteristic to this part of the Northern Cape and have the potential of a high carrying capacity (Berry 1991). According to Berry (1991) 'these pans act as nutrient sumps and as a result herbaceous growth on these areas is of high quality'. During the 'wet/good' years game is fairly well spread over the whole study area, but during 'dry/poor' years game tends to concentrate on the pans, which can easily lead to overgrazing.

In general, the vegetation of the study area is characterised by the presence and in some areas the dominance of the shrub *Tarchonanthus camphoratus* and the grass species *Eragrostis lehmanniana*. The riverine vegetation has a distinct species composition that is different to that of the pan vegetation.

CONCLUSION

The objectives set for this study, namely to classify, describe,

interpret and map the vegetation of the RNR using the Braun-Blanquet procedure, were attained. The Braun-Blanquet procedure proved to be an accurate and effective way whereby floristically defined plant communities could be classified and identified in the field. The description of the plant communities, together with the vegetation map, can serve as a basis to formulate a management programme for the RNR. It is recommended that the division of the reserve into ecologically sound management units should receive high priority. These management units should be used to determine veld condition and grazing capacity, in order to make recommendations for stocking rates and burning programmes in the reserve. Special vegetation communities that are important to be conserved and protected are the riverine and the pan vegetation.

If the RNR's natural resources are not well managed and protected according to ecologically sound management plans, sustainable utilisation and conservation will not be achieved. The resultant loss of the rich flora and fauna of the RNR will have detrimental results for conservation in the Northern Cape province and South Africa. The RNR strives to conserve and protect nature to the betterment of present and future generations. The result of this study together with present management strategies should enable the management of the RNR to be scientifically and ecologically sound.

ACKNOWLEDGEMENTS

Ms Shari Cade (De Beers farms), Mr Jonathan Denga (De Beers farms) and Mr Morgan Hauptfleisch (Regional Manager Farms: De Beers) are thanked for information, comments and support during the study. Dr Stephen Holness is thanked for his assistance with the maps.

REFERENCES

Acocks, J.P.H., 1953, 'Veld types of South Africa, 1st edn.', *Memoirs of the Botanical Survey of South Africa* 28, 1–192.

Acocks, J.P.H., 1988, 'Veld types of South Africa, 3rd edn.', *Memoirs of the Botanical Survey of South Africa* 57, 1–146.

Barkman, J.J., Moravec, J. & Rauschert, S., 1986, 'Code of Phytosociological nomenclature, 2nd edn.', *Vegetatio* 67, 145–195.

Berry, M.P.S., 1991, 'Rainfall orientated management for a multiherbivore grazing system', DSc thesis, University of the Witwatersrand.

Berry, M.P.S. & Crowe, T.M., 1985, 'Effects of monthly and annual rainfall on game bird populations in the Northern Cape Province, South Africa', *South African Journal of Wildlife Research* 15(3), 69–76.

Bezuidenhout, H., 1993, 'Syntaxonomy and synecology of western Transvaal grasslands', PhD dissertation, University of Pretoria.

Bezuidenhout, H., 1994, 'An ecological study of the major vegetation communties of the Vaalbos National Park, Northern Cape. 1. The Than-Droogeveldt section', *Koedoe* 37(2), 19–42.

Bezuidenhout, H., 1995, 'An ecological study of the major vegetation communities of the Vaalbos National Park, Northern Cape. 2. The Graspan-Holpan section', *Koedoe* 38(2), 65–83.

Bezuidenhout, H., Biggs, H.C. & Bredenkamp, G.J., 1996, 'A process supported by the utility BBPC for analysing Braun-Blanquet data on a personal computer', *Koedoe* 39(1), 107–112.

Bredenkamp, G.J. & Bezuidenhout, H., 1990, 'The vegetation of the Faan Meintjes Nature Reserve, Transvaal', *South African Journal of Botany* 56, 54–64.

Bredenkamp, G.J. & Theron, G.K., 1978, 'A synecological account of the Suikerbosrand Nature Reserve I. The phytosociology of the Witwatersrand geological system', *Bothalia* 12, 313–329.

Bredenkamp, G.J., Joubert, A.F. & Bezuidenhout, H., 1989, 'A reconnaissance survey of the vegetation of the plains in the Potchefstroom-Fochville-Parys Area', *South African Journal of Botany* 55, 199–206.

Breytenbach, P.J.J., 1991, 'Die fitososiologie van die Villiers-Grootvlei-omgewing', MSc thesis, University of Pretoria.

Brown, L.R., 1997, 'A plant ecological study and wildlife management plan of the Borakalalo Nature Reserve, North-West Province', PhD thesis, University of Pretoria.

Brown, L.R. & Bezuidenhout, H., 2005, 'A vegetation description and classification of the farms Ingleside and Welgedacht on the Mountain Zebra National Park, Eastern Cape', *Koedoe* 48(2), 23–42.

Coetzee, B.J., 1983, 'Phytosociology, vegetation structure and landscapes of the Central District, Kruger National Park', *Dissertationes Botanica* 69, 1–456.

Cilliers, S.S., 1998, 'Phytosociological studies of urban open spaces in Potchefstroom, North West province, South Africa', PhD thesis, Potchefstroom University for Christian Higher Education.

Crowe, T.M., Schijf, J.C. & Gubb, A.A., 1981, 'Effects of rainfall variation, fire, vegetation and habitat physiognomy on a Northern Cape animal community', *South African Journal of Wildlife Research* 11, 87–104.

Edwards, D., 1983, 'A broad-scale structural classification of vegetation for practical purposes', *Bothalia* 14, 705–812.

Fabricius, C. & Mentis, M.T., 1990, 'Seasonal habitat selection by eland in arid savanna in South Africa', *South African Journal of Zoology* 25, 238–244.

Fabricius, C. & Mentis, M.T., 1992, 'Modelling the habitat relations of kudu in arid savanna', *South African Journal of Science* 88(5), 280–284.

Germishuizen, G. & Meyer, N.L. (eds.), 2003, 'Plants of southern Africa: An annotated checklist', *Strelitzia* 14.

Gubb, A.A., 1989, 'An evaluation of Landsat MSS data for ecological land classification', MSc thesis, University of Cape Town.

Helgren, D.M., 1979, *Rivers of diamonds: An alluvial history of the lower Vaal Basin, South Africa*, The University of Chicago, Chicago.

Hill, M.O., 1979, *TWINSPAN – A Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes,* Cornell University, New York.

Hobson, F.O., 1989, 'Veld condition assessment of False Karoo', in J.E. Danckwerts & W.R. Teague (eds.), *Veld management in the Eastern Cape*, pp. 108–113, Government Printers, Pretoria.

King, P.G., 1989, 'Integrated farm planning', in J.E. Danckwerts & W.R. Teague (eds.), *Veld management in the Eastern Cape*, pp. 114–130, Government Printers, Pretoria.

Kooij, M.S., 1990, 'A phytosociological study of the north-western Orange Free State', MSc thesis, University of Pretoria.

Land Type Survey Staff, 1986, 'Land types of the maps SE27/20 Witdraai, 2720 Noenieput, 2722 Kuruman, 2724 Christiana, 2820 Upington, 2822 Postmasburg', *Memoirs on the Agricultural Natural Resources of South Africa* 3, 1–185.

Low, A.B. & Rebelo, A.G. (eds.), 1996, *Vegetation of South Africa, Lesotho and Swaziland*, Department of Environmental Affairs and Tourism, Pretoria.

Mucina, L. & Rutherford M.C. (eds.), 2006, 'The vegetation map of South Africa, Lesotho & Swaziland', *Strelitzia* 19.

Mucina, L. & Van der Maarel, E., 1989, 'Twenty years of numerical syntaxonomy', *Vegetatio* 81, 1–15.

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

National Committee for Nature Conservation, 1979, *National plan for nature conservation*, Department of Environmental Planning, Pretoria.

Smit, J.H.L., 2000, 'Fitososiologie en veldbestuur van die oostelike Kalahari doringveld', MSc thesis, University of Pretoria.

Soil Classification Working Group, 1991, 'Soil classification: A taxonomic system for South Africa', *Memoirs on the Agricultural Natural Resources of South Africa* 15, 1–262.

Spaggiari, R.I., 1993, 'Reconstruction of the Palaeo-drainage from the gravels on the Farm Droogeveldt 292, Barkly West,

Northern Cape province', BSc (Honours) thesis, Rhodes University.
Wagner, P.A., 1914, *The diamond fields of Southern Africa*, Struik, Cape Town.
Whittaker, R.H., 1978, 'Dominance types', in R.H. Whittaker, (ed.), *Classification of plant communities*, pp. 65-79, Junk, The Hague.