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Floristic composition and species diversity of urban vegetation in Bloemfontein, Free State, South Africa

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Background: Urban vegetation studies have, until recently, been relatively uncommon in South Africa. Yet, natural urban vegetation is constantly competing with and greatly impacted by urbanisation. This vegetation requires proper management and needs to be conserved because it is an important ecological infrastructure.

Objectives: The objectives of the study were to identify the main vegetation types within the urban open spaces in the Bloemfontein metropolitan area, and to determine the floristic composition and species diversity of the area.

Methods: A total of 248 relevés were classified using the TWINSPAN classification algorithm, and relationships between the communities and the environment were determined with the Detrended Correspondence Analysis and Canonical Correspondence Analysis computer programs. Species diversity was partitioned into α-, β- and γ-diversities.

Results: Within the study area, 77 plant families and 248 genera, with a total of 376 plant species, were identified. The largest families are Poaceae, Asteraceae and Fabaceae, whereas the largest genera are *Eragrostis, Aristida, Cyperus, Asparagus* and *Senecio*. The study area has high species richness and the most species-rich sites are found adjacent to rivers and streams, and also on the slopes of hills and ridges. The vegetation is classified under five major vegetation types and four sub-units, which show a distinct association with topography and soil texture.

Conclusion: The urban vegetation of Bloemfontein is species-rich and should be properly managed and conserved. In particular, the wetlands and rocky outcrops on hills and ridges, which are the most threatened habitats in the study area, need special management.

Introduction

Bloemfontein is a medium-sized city in the Free State province, and is situated in a region characterised by intensive commercial farming. The farming, coupled with increased urbanisation, resulted in degradation and fragmentation of the natural vegetation. An ecological approach to urban open space planning has been suggested (Florgård 2000; Poynton & Roberts 1985; Thompson 2002), which would ensure that open space areas centrally placed in cities are linked with open spaces towards the periphery of cities by dispersal corridors such as rail and roadside vegetation, including ruderal and disturbed vegetation (Poynton & Roberts 1985). Roadsides and railway tracks can have high species richness, especially in terms of rare and endangered plant species that can be harboured in such habitats (Forman & Alexander 1998; Galera et al. 2014).

The ecological approach to urban open space planning and management is a sensible and achievable objective, but it is constrained in part by lack of ecological expertise from the relevant government authorities, lack of infrastructure and financial support and also by public opinion (Cilliers, Müller & Drewes 2004). Public opinion is especially important because, for example, even though urban dwellers show a general desire for contact with nature, there is a consistently negative public perception when it comes to ruderal and spontaneous vegetation on derelict sites (Millard 2004).

There are immense benefits of conserving urban vegetation, which can be scientific, social and economic (Barbosa et al. 2007; Hunter 2007). Urban green space is also important for the overall well-being of the urban dwellers (Dearborn & Kark 2010; Fuller et al. 2007; Tzoulas et al. 2007). Open space within urban areas has beneficial effects on microclimate, hydrology, biodiversity and

ecological processes (Bolund & Hunhammar 1999; Federer 1976; Goddard, Dougill & Benton 2009; Godefroid & Koedam 2007). Therefore, cities with relatively large or many conserved open spaces may, for example, have higher species diversity, less water run-off, reduced noise and air pollution (Bolund & Hunhammar 1999; Litschke & Kuttler 2008; Tratalos et al. 2007; Whitford, Ennos & Handley 2001).

The proper management and conservation of urban open spaces requires in-depth knowledge of the spatial distribution, floristic, structural and functional compositions of the major vegetation types (VTs) within the urban environment. The present vegetation study was initiated to identify the main VTs of the open spaces within the Bloemfontein metropolitan area, and to determine the composition and diversity of plant species found in the area. Such urban vegetation studies are relatively few in South Africa, limited to those conducted by among others Roberts (1993), Cilliers, Van Wyk and Bredenkamp (1999) and Grobler, Bredenkamp and Brown (2006).

Research method and design

Study area

Bloemfontein extends from approximately 29°00′ to 29°15′ south and 26°07′ to 26°21′ east, with altitude ranging from 1350 m to 1450 m above sea level. According to the climate statistics from the South African Weather Service, the annual mean maximum and minimum temperatures are 24.6 °C and 7.6 °C, respectively. Rainfall mainly occurs in summer in the form of thunderstorms, and it averages 550 mm annually. The main geologic feature of the study area is the Karoo Supergroup, represented by the Tierberg Formation of the Ecca Group and the Adelaide Sub-Group of the Beaufort Group; there are also dolerite intrusions of the post-Karoo age (Johnson et al. 2006). Prominent soil groups are oxidic (Hutton form), plinthic (Bainsvlei form), duplex (Valsrivier, Swartland and Sterkspruit forms), cumulic (Oakleaf form), vertic (Arcadia form) and melanic (Milkwood form) (Fey 2010; Soil Classification Working Group 1991). Bloemfontein is situated in the Grassland Biome (Rutherford & Westfall 1994), and is part of the Central Variation of the Dry *Cymbopogon-Themeda* Veld (Acocks 1988). Other classifications describe Bloemfontein's vegetation as Dry Sandy Highveld Grassland (Bredenkamp & Van Rooyen 1996) and Dry Highveld Grassland (Mucina et al. 2006).

Vegetation survey

The first step of the survey entailed the stratification of vegetation prior to sampling. Stratification of the area was done on 1:50 000 scale maps and 1:30 000 aerial photographs, based on the topography and relative homogeneity of physiognomic units. The topographic units recognised were the watercourses, flat plains as well as the hills and ridges. A total of 248 relevés were compiled; 160 were compiled for the first time, while 88 were from existing data (Muller 1970; Rossouw 1983). Sample plots ranging in size between 16 m^2 for the grassland vegetation and 100 m^2 for the woody vegetation were surveyed across the study area. All plant species present in each sample plot were recorded and each was given a cover-abundance value according to the Braun–Blanquet scale (Kent & Coker 1996; Mueller-Dombois & Ellenberg 1974). Plant taxonomy generally follows Germishuizen and Meyer (2003). For each relevé, habitat attributes were also noted, including rock type (geology), terrain type (topographical position) and an estimation of the percentage of rockiness of the soil surface. Soil characteristics such as soil depth, pH, organic matter and texture were used for the study. Other noted observations included the extent of soil erosion and forms of biotic influence such as utilisation by herbivores and management practices.

Data analysis

Phytosociological data were first captured and processed in the TURBOVEG database (Hennekens 1996a), and then exported to the MEGATAB computer program (Hennekens 1996b) for classification using TWINSPAN (Hill 1979a). The result was a synoptic table that shows a hierarchical classification of the syntaxa, with each synrelevé representing a plant community. The principle of synoptic tables is based on rating the presence of each species within a community on a constancy scale (Kent & Coker 1996; Mueller-Dombois & Ellenberg 1974). An ordination technique, Detrended Correspondence Analysis (DECORANA) (Hill 1979b), was applied to the data set to illustrate floristic relationships between the plant communities and to detect possible relationships between the communities and the environment. Canonical Correspondence Analysis (CANOCO) (Ter Braak & Šmilauer 2009), an extension of DECORANA, was also carried out to further illustrate the correlations between the vegetation data and the environmental variables.

Patterns of species diversity were analysed using two types of diversity, that is, α-diversity and β-diversity, and also evenness. Two aspects of α-diversity were analysed, the first being species richness (S) that is defined as the number of species per sample plot. Because S can be exaggerated by the presence of rare species, α-diversity was also measured with the Shannon–Wiener diversity index (H'). It is a weighted expression of species richness and the proportion in which each species is represented in a sample plot, which is calculated as:

$$H' = \sum_{i=1}^{S} p_i \ln p_i, \qquad \text{[Eqn 1]}$$

where p_i is the proportion of cover in the ith species. The cover values used were based on median values (except Category r & +) of the cover categories derived from the Braun–Blanquet cover-abundance scale: 1% for Category r & + (cf. Ma 2005), 3% for Category 1 (1%–5%), 9% for Category 2a (6%–12%), 19% for Category 2b (13%–25%), 38% for Category 3 (26%–50%), 63% for Category 4 (51%–75%) and 88% for Category 5 (76%–100%). Evenness, defined as the relative abundance of species in a unit area (Stirling & Wilsey 2001; Wilsey & Stirling 2007), was used to measure the

similarity of relative abundances of species within sample plots (Sankaran 2009). It was calculated with the Pielou's evenness index (J') as

$$J' = H'/\ln S. \qquad \text{[Eqn 2]}$$

A one-way analysis of variance (ANOVA) with Tukey's honestly significant difference (HSD) test (using SPSS® software version 19) was then conducted to compare S, H' and J' between the different VTs.

Beta (β) diversity was calculated to determine species turnover or the extent to which species diversity differs within the VTs. Various measures of β-diversity have been proposed over the years, but in the present study, the Whittaker's diversity index (β_w) was used because it is widely regarded as a simple but highly effective measure of β-diversity (Magurran 2004; Van der Maarel 2005). It was calculated as:

$$\beta_w = S_{total}/S_{ave}, \qquad \text{[Eqn 3]}$$

where S_{total} is the total number of species present in each VT (γ-diversity) and S_{ave} is the average species richness (α-diversity) for each sample plot in a community.

Results

Floristic composition

The vegetation of Bloemfontein is dominated by the red grass *Themeda triandra* with *Eragrostis lehmanniana* as a constant companion. Other prominent grasses are *Aristida congesta*, *Digitaria eriantha*, *Sporobolus fimbriatus* and *Eragrostis curvula*. Forbs such as *Oxalis depressa*, *Hibiscus pusillus* and *Felicia muricata* are widespread, but they never attain dominance within the communities. It is only in localised wetland habitats where hydrophytic sedges and other forbs dominate. The vegetation is represented by 77 families and 248 genera (Table 1). The families with the highest number of genera are Poaceae, Asteraceae and Fabaceae (Table 2), while the most diverse genera are *Eragrostis*, *Cyperus*, *Aristida* and *Asparagus* (Figure 1). A total of 376 plant species were identified for the study area: 82 play a diagnostic role, 66 are companion species and a further 228 are either localised or of very rare occurrence. Of these rare species, only 175 are presented in the synoptic table (see Appendix 1); the other 53 are excluded because of their extremely rare occurrence. Eight species are declared invasives (Department of Environmental Affairs 2016), namely *Argemone ochroleuca* subsp. *ochroleuca*, *Verbena bonariensis*, *Gleditsia triacanthos*, *Cestrum laevigatum*, *Cuscuta*

TABLE 1: Composition of the vascular flora of the Bloemfontein urban areas.

Vascular flora	Families		Genera		Species	
	Number	% of total	Number	% of total	Number	% of total
Pteridophyta	6	7.8	8	3.2	10	2.7
Monocotyledoneae	16	20.8	74	29.8	123	32.7
Dicotyledoneae	55	71.4	166	66.9	243	64.6
Total	**77**	-	**248**	-	**376**	-

Source: Authors' own work

TABLE 2: A list of plant families of Bloemfontein urban areas (listed alphabetically within subdivisions) with the number of genera and species represented.

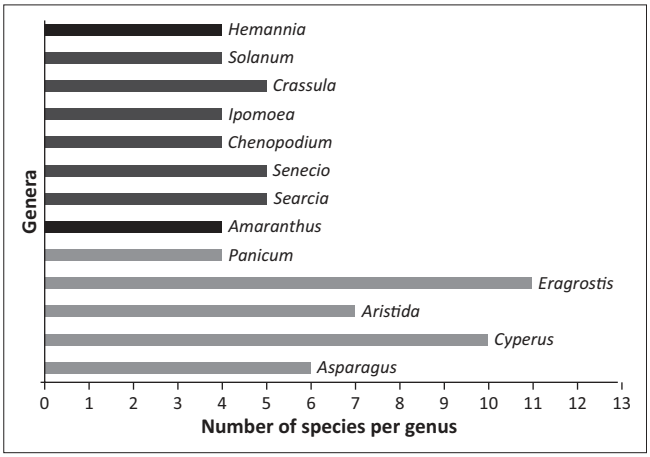
Families	Genera	Species
Pteridophyta		
Aspleniaceae	2	2
Azollaceae	1	1
Equisetaceae	1	1
Marsileaceae	1	1
Ophioglossaceae	1	1
Pteridaceae	2	4
Angiospermae		
Monocotyledoneae		
Alliaceae	1	1
Amaryllidaceae	6	6
Araceae	1	1
Asparagaceae	1	6
Asphodelaceae	2	3
Colchicaceae	1	1
Commelinaceae	1	2
Cyperaceae	6	15
Hyacinthaceae	7	10
Hypoxidaceae	1	1
Iridaceae	4	6
Juncaceae	1	1
Orchidaceae	1	1
Poaceae	39	67
Ruscaceae	1	2
Typhaceae	1	1
Dicotyledoneae		
Acanthaceae	2	2
Aizoaceae	6	8
Amaranthaceae	8	15
Anacardiaceae	1	5
Apiaceae	2	2
Apocynaceae	8	8
Araliaceae	1	1
Asteraceae	36	54
Bignoniaceae	1	1
Boraginaceae	1	1
Brassicaceae	3	4
Buddlejaceae	2	2
Cactaceae	1	3
Campanulaceae	1	1
Cannabaceae	1	1
Capparaceae	1	1
Caryophyllaceae	2	2
Celastraceae	1	1
Convolvulaceae	3	7
Dipsacaceae	1	1
Ebenaceae	2	4
Euphorbiaceae	3	5
Fabaceae	14	21
Gentianaceae	1	1
Geraniaceae	2	4
Lamiaceae	3	4
Lobeliaceae	2	2
Malvaceae	6	11
Menispermaceae	1	1
Oleaceae	2	2
Onagraceae	1	2
Oxalidaceae	1	2
Papaveraceae	2	2
Pedaliaceae	2	2

Table 2 continues on the page →

TABLE 2 (Continues...): A list of plant families of Bloemfontein urban areas (listed alphabetically within subdivisions) with the number of genera and species represented.

Families	Genera	Species
Plantaginaceae	1	1
Polygalaceae	3	4
Portulacaceae	2	3
Ranunculaceae	2	2
Rhamnaceae	1	1
Rosaceae	2	2
Rubiaceae	5	5
Salicaceae	1	2
Santalaceae	2	2
Scrophulariaceae	5	8
Solanaceae	4	9
Urticaceae	2	2
Vahliaceae	1	1
Verbenaceae	4	6
Zygophyllaceae	1	1
Total (77 families)	**248**	**376**

Source: Authors' own work



Source: Authors' own work

FIGURE 1: The most diverse genera in Bloemfontein, with four or more species. The black and grey bars indicate Dicotyledoneae and Monocotyledoneae, respectively.

campestris, *Pennisetum villosum*, *Salsola kali* and *Convolvulus arvensis*. None of the species recorded is threatened (http://redlist.sanbi.org/).

Vegetation classification and ordination

A synoptic classification of the vegetation is presented, showing only the major VTs and not the lower ranked syntaxa constituting each VT. The following five major vegetation units and four subdivisions were recognised from the study area, as summarised in Table 3:

VT 1: *Oenothera rosea–Bromus catharticus* Wetland vegetation
VT 1.1: *Rumex lanceolatus–Cyperus longus* Streambed vegetation
VT 1.2: *Vachellia karroo– Asparagus laricinus* Streambank vegetation
VT 2: *Olea europaea–Buddleja saligna* Shrubland
VT 3: *Aristida diffusa* subsp. *burkei–Crassula nudicaulis* Succulent grassland
VT 3.1 *Delosperma pottsii–Cotyledon orbiculata* Grassland
VT 3.2 *Oropetium capense–Eragrostis nindensis* Grassland

TABLE 3: Habitat characteristics of the Bloemfontein vegetation types.

Vegetation types	Habitat
1 *O. rosea–B. catharticus* Wetland vegetation	• Partly described by Rossouw (1983) • Mostly restricted to the Modder River and its tributaries • Also found in smaller streams, dams and pans
1.1 *R. lanceolatus–C. longus* Streambed vegetation	• Strongly associated with moist and deep soils • Primarily a graminoid and forb-dominated community, with isolated dense woody stands, especially on the Modder River (species composition: forbs 58%, grasses 27%, shrubs 11% and trees 4%)
1.2 *V. karroo–A. laricinus* Streambank vegetation	• Associated with relatively drier habitat conditions than *R. lanceolatus–C. longus* Streambed vegetation • Found on the streambanks and valleys, also occupies the plains adjacent to the watercourses, extending to the footslopes of hills • Associated with deep alluvial soils, especially on the valleys • Resembles dense woody stands along the banks, opening up into scrubby bushes on the plains and towards the footslopes • Consists of a large component of shrubby species and a good representation of grass and forb species (species composition: forbs 40%, grasses 22%, shrubs 29% and trees 9%) • Displays a high degree of species fidelity within the Bloemfontein area, with the highest number of diagnostic species (19 species)
2 *O. europaea–B. saligna* Shrubland	• Occurs on the slopes of hills and ridges, and also in ravines • Isolated patches also found on the footslopes and plateau • Associated with habitats characterised by dolerite rocks and boulders • Woody vegetation (species composition: forbs 23%, grasses 23%, shrubs 28% and trees 26%) • A large and widely distributed vegetation type, with a high number of diagnostic species (17 species)
3 *A. diffusa* subsp. *burkei–C. nudicaulis* Succulent grassland	• Found in the Seven Dams Conservancy, an area north of the city near the Free State Botanical Gardens • Partly described by Muller (1970) • Situated on the slopes and summits of hills and ridges, with dolerite rocks and boulders • Consists of a unique type of vegetation not found in other parts of Bloemfontein, and shares similarities with the Karoo vegetation
3.1 *D. pottsii–C. orbiculata* Grassland	• Found on the south, south-east, and west-facing slopes, and to a lesser extent the plateau • Habitat characterised by vast dolerite rock sheets, boulders and dolerite dykes • Species mostly grasses and forbs, with a low woody component (species composition: forbs 32%, grasses 34%, shrubs 30% and trees 4%)
3.2 *O. capense–E. nindensis* Grassland	• Occurs on moderately steep north and west-facing slopes of hills and valleys, also extending to the summits of hills • Habitat characterised by extensive rock sheets, boulders and dolerite dykes • Soil is particularly shallow and occurs over the rocky surface, and deeper soil is encountered in depressions on the rocks or in rock crevices • Habitat type generally not suitable for the establishment of woody species (species composition: forbs 58%, grasses 29%, shrubs 12% and trees 1%) • Differentiated by 18 diagnostic species
4 *A. congesta–T. triandra* Grassland	• Mainly found on flat open plains in the northern and western smallholdings and farming areas on the periphery of Bloemfontein city • Species composition: forbs 43%, grasses 38%, shrubs 19%, and trees 0%
5 *F. muricata–T. triandra* Grassland	• Mainly occurs on low-lying open plains on the periphery of the suburbs to the west of Bloemfontein city, also on natural fragmented areas in the south-western suburbs • Species composition: forbs 33%, grasses 49%, shrubs 17% and trees 1%

Source: Authors' own work

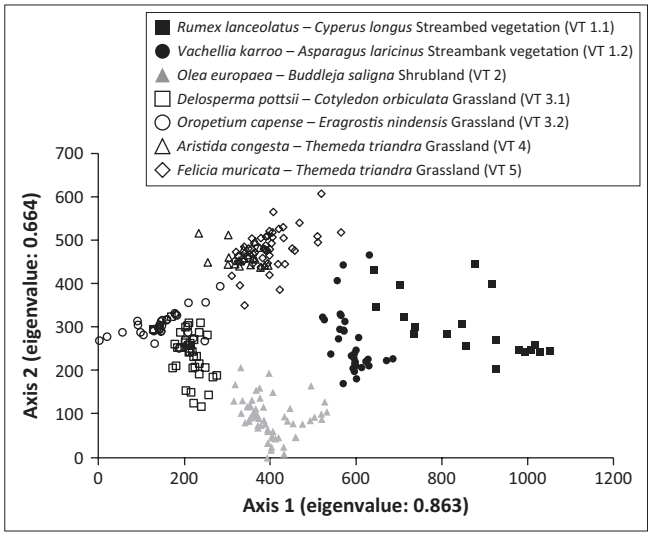
VT 4: *Aristida congesta–Themeda triandra* Grassland
VT 5: *Felicia muricata–Themeda triandra* Grassland

The DECORANA ordination plot (Figure 2) shows a clear grouping of the relevés into the VTs as classified in the synoptic table (Appendix 1). Axis 1 and Axis 2 have eigenvalues of 0.863 and 0.664, respectively. Axis 1 is positively associated with the soil moisture gradient, beginning with the *D. pottsii–C. orbiculata* Grassland and the *O. capense–E. nindensis* Grassland on the left portion of the ordination plot, which are characteristics of relatively

dry habitats. The *R. lanceolatus–C. longus* Streambed vegetation and *V. karroo–A. laricinus* Streambank vegetation are found towards the right end of the ordination plot because of their occurrence in wetter habitats. Axis 2 does not show any clear environmental trends.

Soil characteristics of vegetation types

The deepest soils were recorded in the *R. lanceolatus–C. longus* Streambed vegetation (433 mm ± 78 mm) and *V. karroo–A. laricinus* Streambank vegetation (475 mm ± 62 mm); these soils also have the highest pH of 7.2 ± 1.1 and 7.4 ± 0.9, respectively (Table 4). The *O. europaea–B. saligna* Shrubland has the highest clay content (30% ± 5%) and organic matter content (4.65% ± 2.02%). The soils of the *A. congesta–T. triandra* Grassland and the *F. muricata–T. triandra* Grassland have the highest sand content at 76% ± 12% and 66% ± 8%, respectively. These communities also occur on relatively shallower soils with the average depth of 285 mm ± 105 mm and 205 mm ± 68 mm, respectively. No soil samples were collected for the *D. pottsii–C. orbiculata* Grassland and the *O. capense–E. nindensis* Grassland. The collecting of samples was mainly restricted by the shallow nature of the soil, compounded by the extensive dolerite rocks and boulders in habitats where these communities occur. The CANOCO biplot (Figure 3) reveals community correlations with soil depth, texture (clay, sand and silt contents), pH and organic matter. Axis 1 (eigenvalue 0.618) shows correlations with soil depth and clay content. Axis 2 (eigenvalue 0.553), on the other hand, is correlated with silt, organic matter, pH and sand.



Source: Authors' own work

FIGURE 2: A Detrended Correspondence Analysis ordination of the vegetation of Bloemfontein showing the relative positions of the relevés along the first two axes (Axis 1 and Axis 2).

Patterns of species diversity

The *D. pottsii–C. orbiculata* Grassland, *O. capense–E. nindensis* Grassland, *O. europaea–B. saligna* Shrubland and *V. karroo–A. laricinus* Streambank vegetation have high α-diversity (both S and H'), with S of 20.7 ± 5.7, 21.2 ± 8.6, 23.9 ± 6.7 and 24.4 ± 6.2, respectively, and H' of 2.51 ± 0.42, 2.44 ± 0.70, 2.17 ± 0.43 and 1.96 ± 0.35, respectively (Table 5). The four VTs also have high J' (0.84 ± 0.14, 0.83 ± 0.18, 0.69 ± 0.09 and 0.62 ± 0.08, respectively) and γ-diversity (130, 115, 137 and 128, respectively). The *R. lanceolatus–C. longus* Streambed vegetation has the lowest γ-diversity (75), S (9.6 ± 4.9), H' (1.14 ± 0.61) and J' (0.50 ± 0.21). With regard to β-diversity, relatively low β_w (5.2–6.3) was measured for the *D. pottsii–C. orbiculata* Grassland, *O. capense–E. nindensis* Grassland, *O. europaea–B. saligna* Shrubland and *V. karroo–A. laricinus* Streambank vegetation. The highest β_w was recorded for *F. muricata–T. triandra* Grassland (9.3) and *R. lanceolatus–C. longus* Streambed vegetation (7.8), while the lowest β_w (5.1) was recorded for *A. congesta–T. triandra* Grassland.

Discussion

The *R. lanceolatus–C. longus* Streambed vegetation shares similarities with the *Leersia hexandra–Schoenoplectus paludicola* wetland of the slow-draining watercourses in northern Free State (Fuls, Bredenkamp & Van Rooyen 1992a). The other comparable community is the *Echinochloa holubii–C. longus* wetland of the Kroonstad area, described by Kooij et al. (1991). *V. karroo–A. laricinus* Streambank vegetation is comparable to the *V. karroo–A. laricinus* Thornveld of the Kroonstad area (Kooij et al. 1991). This community also belongs to the *V. karroo* class described by Du Preez and Bredenkamp (1991). With regard to *O. europaea–B. saligna* Shrubland, Fuls, Bredenkamp and Van Rooyen (1992b) described a related *Sporobolus fimbriatus–Tarchonanthus camphoratus* community of the dolerite hills of the northern Free State.

The low S measured for the *R. lanceolatus–C. longus* Streambed vegetation is typical of wetland communities,

TABLE 4: Soil characteristics of the Bloemfontein vegetation types.

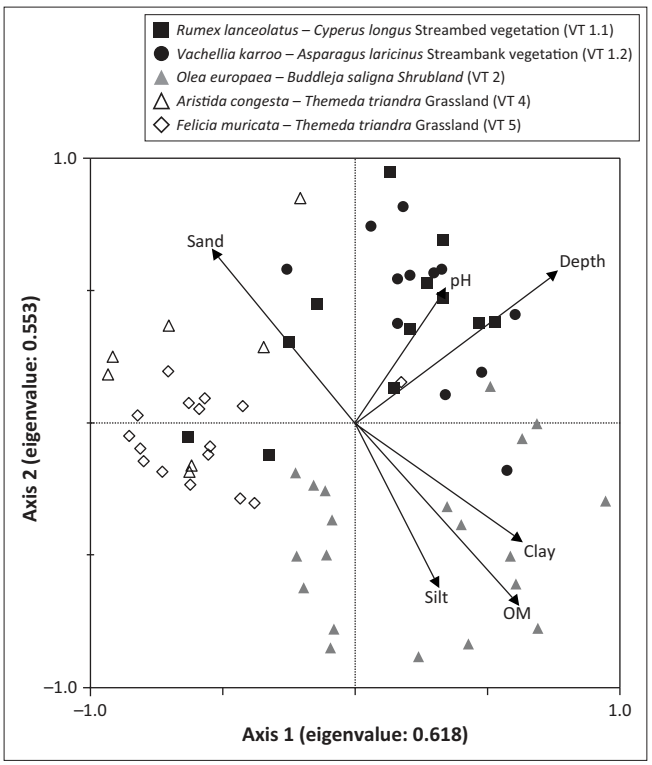
Vegetation type	Number of soil samples	Soil depth (mm)	Texture (%)			Organic matter (%)	pH
			Clay	Silt	Sand		
1.1 *R. lanceolatus–C. longus* Streambed vegetation	12	433 ± 78	24 ± 5	12 ± 5	64 ± 8	1.40 ± 0.83	7.2 ± 1.1
1.2 *V. karroo–A. laricinus* Streambank vegetation	12	475 ± 62	25 ± 8	10 ± 3	65 ± 10	1.95 ± 1.52	7.4 ± 0.9
2 *O. europaea–B. saligna* Shrubland	23	346 ± 111	30 ± 5	18 ± 4	52 ± 7	4.65 ± 2.02	6.7 ± 0.7
3 *A. diffusa* subsp. *burkei–C. nudicaulis* Succulent Grassland†	0	-	-	-	-	-	-
4 *A. congesta–T. triandra* Grassland	7	285 ± 105	15 ± 9	9 ± 6	76 ± 12	0.64 ± 0.28	6.3 ± 0.5
5 *F. muricata–T. triandra* Grassland	17	205 ± 68	20 ± 8	14 ± 5	66 ± 8	0.93 ± 0.38	6.8 ± 0.6

Source: Authors' own work

†, No soil samples were collected for vegetation type.

because only a few species are adapted to survive in habitats where the soil is permanently waterlogged. Other wetlands in the Free State are also characterised by low species richness, for example, wetland communities of the central Free State (Muller 2002), northern Free State (Fuls 1993) and north-western Free State (Kooij 1990). In contrast, riparian zones adjacent to the wetlands are ecologically diverse and harbour different plant species. The *V. karroo–A. laricinus* Streambank vegetation, in concurrence, has high species richness. Cilliers, Schoeman and Bredenkamp (1998) reported similar species richness patterns, characterised by low species richness in waterlogged soils compared to the drier river banks.

The *R. lanceolatus–C. longus* Streambed vegetation has high β_w, as there are few common species within the vegetation unit. This high species turnover can mainly be ascribed to the habitat-specific nature of hydrophytic species. The *F. muricata–T. triandra* Grassland also has high β_w, and according to Lennon et al. (2001), inflated β_w could result from large differences in species richness between sample plots. There is a high variation of *S* in the *F. muricata–T. triandra* Grassland, ranging from 1 to 19. This variation is possibly because of the disturbed and unstable nature of some habitats where parts of this vegetation unit are found, such as on roadsides and along railway tracks. For example, situations where only one species was encountered in a sample plot were along roadsides where *Enneapogon cenchroides* was found dominating.



Source: Authors' own work

FIGURE 3: A Canonical Correspondence Analysis biplot of sample plots and soil variables (depth [soil depth], clay [clay content], silt [silt content], sand [sand content], OM [organic matter content] and pH).

A high *H'* was recorded for the *D. pottsii–C. orbiculata* Grassland and the *O. capense–E. nindensis* Grassland because these communities have a fairly proportionate abundance of the key species, and hence their high evenness (*J'*) values. On the other hand, both the high γ-diversity and *S* as recorded for the *O. europaea–B. saligna* Shrubland could possibly be artefacts of sampling size and sample plot size, respectively. *H'* for this unit is comparatively lower than for the former two grassland communities because of the overwhelming dominance of *O. europaea*, *B. saligna*, *Grewia occidentalis* and *Searsia burchellii*, and hence the relatively lower evenness.

The overall species richness of the study area (376 species) is comparable to that of other urban areas in South Africa. For example, it is comparable to the 350 species reported by Van der Walt et al. (2015) for a study of the grassland fragments in the Tlokwe Municipal area in North-West Province. In the Pretoria–Johannesburg metropolitan area in Gauteng Province, Grobler (2000) reported a higher number of species (a total of 600), but this is most likely because of the larger size of the study area. It is, however, important to acknowledge that urban open spaces in South Africa may generally not harbour levels of species richness similar to those in formally designated conservation areas. For example, higher species richness was recorded in relatively much smaller areas of the Kruger National Park: 450 species in a 139-ha area of the Nkuhlu exclosures (Siebert & Eckhardt 2008) and 233 species in a 129-ha area of the Letaba exclosures (Siebert, Eckhardt & Siebert 2010). Nonetheless, Götze et al. (2008) reported species richness lower than in Bloemfontein and the other aforementioned urban areas: 219 species in the Mapungubwe National Park. Our study therefore confirms that urban vegetation in South

TABLE 5: Species diversity of the vegetation types of the Bloemfontein area.

Variable	Vegetation type†						
	1.1	1.2	2	3.1	3.2	4	5
Number of sample plots	19	31	58	37	34	20	49
Species richness (*S*)‡	9.6 ± 4.9a	24.4 ± 6.2b	23.9 ± 6.7b	20.7 ± 5.7bc	21.2 ± 8.6bc	16.8 ±8.3b	11.2 ± 3.3a
Shannon–Weiner (*H'*)‡	1.14 ± 0.61a	1.96 ± 0.35bc	2.17 ± 0.43cd	2.51 ± 0.42e	2.44 ± 0.70de	1.59 ± 0.53ab	1.27 ± 0.46a
Pielou's evenness (*J'*)‡	0.50 ± 0.21a	0.62 ± 0.08ab	0.69 ± 0.09b	0.84 ± 0.14c	0.83 ± 0.18c	0.58 ± 0.14a	0.53 ± 0.17a
γ-diversity	75	128	137	130	115	86	102
Whittaker's diversity (β_w)	7.8	5.2	5.7	6.3	5.4	5.1	9.3

Source: Authors' own work.

†, Vegetation type 1.1: *R. lanceolatus–C. longus* Streambed vegetation, 1.2: *V. karroo–A. laricinus* Streambank vegetation, 2: *O. europaea–B. saligna* Shrubland, 3.1: *D. pottsii–C. orbiculata* Grassland, 3.2: *O. capense–E. nindensis* Grassland, 4: *A. congesta–T. triandra* Grassland, 5: *F. muricata–T. triandra* Grassland.

‡, The same letters within the lines are not significantly different at $P \leq 0.05$; one relevé of Vegetation type 5 was excluded for the statistical analysis because only one species was present.

Africa can also be species rich, and should be properly managed and conserved.

Conclusion

We identified five major VTs and four sub-units in the Bloemfontein area and found the wetlands and rocky outcrops to be most threatened habitats. The *O. rosea–B. catharticus* wetlands (VT 1) possess a large number of highly palatable species and as a result are subjected to frequent overgrazing and trampling. As a conservation measure, access to these wetland areas could be restricted and this can be achieved by fencing off the most vulnerable areas. The *A. diffusa* subsp. *burkei–C. nudicaulis* grassland of the rocky outcrops (VT 3) is threatened by the expansion of Bloemfontein city to the north. This is a botanically diverse VT that occurs exclusively in the Seven Dams Conservancy, and represents an isolated type of vegetation not found in any other parts of Bloemfontein. The area should therefore be regarded as a conservation priority because of its uniqueness and high botanic diversity.

Generally, the urban vegetation of Bloemfontein is species rich and should be properly managed and conserved. There are enormous benefits that can be derived from the conservation of urban vegetation, be they scientific, social or economic. Most importantly, urban vegetation has been linked with overall human health and well-being.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

M.N.V.D. did the vegetation survey and classification, data analysis and wrote the manuscript. P.J.d.P. conceptualised the project, did part of the vegetation survey and assisted with the vegetation classification.

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Appendix starts on the next page →

APPENDIX 1

TABLE 1-A1: Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units	**1**												**2**							**3**														**4**					**5**										
	1.1						**1.2**													**3.1**						**3.2**																							
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
SPECIES GROUP A: Diagnostic species of *Oenothera rosea – Bromus catharticus* Wetland vegetation																																																	
Oenothera rosea	II	.	.	.	III	V	.	.	II	V	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus catharticus	.	.	I	.	III	V	.	II	.	II	.	V	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gomphocarpus fruticosus	.	.	I	III	.	.	.	I	.	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.
SPECIES GROUP B: Diagnostic species of *Rumex lanceolatus – Cyperus longus* Streambed vegetation																																																	
Persicaria lapathifolia	V	V	I	.	III	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus longus	.	V	V	III	V	III	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Paspalum dilatatum	.	IV	III	.	III	V	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex lanceolatus	.	II	V	III	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP C:																																																	
Asparagus laricinus	.	.	.	.	.	.	IV	V	V	V	V	V	III	III	I	III	I	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus cooperi	.	.	.	.	.	.	II	V	II	IV	V	IV	.	.	I	III	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bidens bipinnata	.	.	.	.	.	.	.	V	V	V	V	V	II	.	III	I	III	II	II	.	.	I	.	.	.	.	IV	I	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ziziphus mucronata	.	.	.	.	.	.	.	V	IV	IV	.	III	IV	.	III	.	III	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asparagus suaveolens	.	.	.	.	.	.	.	II	II	IV	IV	III	IV	III	III	V	III	IV	V	.	.	.	.	.	V	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum retroflexum	.	.	.	.	.	V	.	I	II	V	.	III	.	II	II	.	+	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria verticillata	.	.	.	.	.	.	.	III	I	IV	V	I	III	I	III	II	II	.	II	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Opuntia vulgaris	.	.	.	.	.	.	.	+	.	II	IV	III	II	II	I	III	III	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ehrharta erecta	.	.	.	.	.	.	.	II	.	.	.	III	IV	IV	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Searsia lancea	.	.	.	.	.	.	.	.	.	II	.	V	V	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	.	.	.	.	.
SPECIES GROUP D: Diagnostic species of *Vachellia karroo – Asparagus laricinus* Streambank vegetation																																																	
Vachellia karroo	II	.	I	.	.	.	IV	V	V	V	V	V	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tagetes minuta	.	.	I	.	.	.	V	V	V	V	II	IV	.	.	.	.	.	II	.	.	.	.	.	.	.	.	II	.	.	.	.	.	II	I	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.
Atriplex semibaccata	.	.	.	.	.	.	IV	IV	III	V	V	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	II	.	.	.	II	.	.	II
Lepidium africanum	.	.	I	.	.	.	II	II	II	II	.	II	.	+	.	.	I	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.
Cynodon dactylon	.	.	.	.	.	V	.	III	III	II	V	IV	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	II	.	I	.	.	.
Achyranthes aspera	.	.	.	.	.	.	.	V	II	IV	IV	III	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melica decumbens	.	.	.	.	.	.	.	II	II	IV	V	IV	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxalis corniculata	.	.	.	.	.	.	.	II	IV	V	V	V	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diospyros lycioides	.	.	.	.	.	.	.	IV	.	IV	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
berkheya pinnatifida	.	.	.	.	.	.	.	.	IV	V	IV	IV	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	II	.	.	.	.	.	II	.
Clematis brachiata	.	.	.	.	.	.	.	V	I	.	II	III	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium album	.	.	I	.	.	.	.	II	.	IV	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	.	.	.	.	.	.	.	.	.	.
Sphaeralcea bonariensis	.	.	.	.	.	III	II	I	II	.	.	III	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	II
Artemisia afra	.	.	.	.	.	.	II	II	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cynodon incompletus	.	.	.	.	.	.	.	I	III	V	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Setaria sphacelata	.	.	.	.	.	.	.	II	II	IV	.	I	.	I	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus oleraceus	.	.	.	.	.	.	.	II	II	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycium hirsutum	.	.	.	.	.	.	.	V	I	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salvia repens	.	.	.	.	.	.	.	.	III	IV	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP E:																																																	
Cheilanthes eckloniana	.	.	.	.	.	.	.	.	.	.	.	.	.	II	V	V	V	.	IV	IV	IV	III	V	V	III	.	III	V	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cotyledon orbiculata	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	III	.	.	III	.	IV	IV	II	IV	V	.	II	IV	V	IV	.	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Commelina africana	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	III	II	.	II	.	.	I	.	.	I	.	III	.	II	V	.	V	V	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Curio radicans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	I	I	.	IV	.	.	III	.	V	V	V	V	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melinis repens	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	II	IV	II	III	.	.	.	II	V	.	.	II	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	IV	.	.	.	.	.
Aloe grandidentata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	II	I	IV	IV	IV	V	.	.	II	II	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chascanum pinnatifidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	I	I	II	.	V	III	.	.	.	II	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP F:																																																	
Eustachys paspaloides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	V	IV	II	IV	IV	IV	V	III	II	III	.	III	.	.	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.
Lantana rugosa	.	.	.	.	.	.	.	.	.	.	.	.	.	I	IV	V	V	II	V	.	II	II	II	I	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Searsia ciliata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	III	V	IV	III	V	.	III	.	V	.	.	.	I	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Felicia filifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	I	II	.	.	.	V	V	IV	II	I	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pellaea calomelanos	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	II	V	.	IV	IV	I	I	II	V	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 1-A1 continues on the page →

TABLE 1-A1 (Continues...): Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units							1									2										3										4								5					
				1.1						1.2												3.1							3.2																				
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
Enneapogon scoparius	.	.	.	.	.	.	II	.	.	.	.	.	I	.	IV	III	V	IV	II	.	I	III	III	V	II	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	II	.	.	I	.	.
Hyparrhenia hirta	.	.	.	.	.	.	.	.	.	.	.	.	I	I	.	I	.	II	I	IV	II	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	II	.
Selago albida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	III	I	.	.	I	IV	V	IV	I	.	.	.	.	.	II	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.
Stapelia grandiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	III	I	.	III	.	II	II	.	.	III	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kalanchoe paniculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	II	.	V	I	.	II	II	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pollichia campestris	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	III	II	II	I	.	.	II	.	.	.	.	.	.	.	.	.	.	III	V	.	.	.	.	.	.	.	.	.	.	.	I	.	.
Hermannia cuneifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	I	.	.	.	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chrysocoma ciliata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I	I	IV	III	IV	III	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP G: Diagnostic species of *Olea europaea – Buddleja saligna* Shrubland																																																	
Olea europaea	.	.	.	.	.	.	.	.	.	II	.	IV	V	V	V	V	V	IV	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Buddleja saligna	.	.	.	.	.	.	.	.	.	.	.	.	V	V	IV	V	V	IV	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grewia occidentalis	.	.	.	.	.	.	.	.	.	.	.	I	V	V	V	V	V	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Searsia burchellii	.	.	.	.	.	.	.	.	.	.	.	.	IV	IV	V	V	V	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pavonia burchellii	.	.	.	.	.	.	.	.	.	.	.	II	V	III	IV	III	IV	IV	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euclea crispa subsp. *crispa*	.	.	.	.	.	.	.	.	.	.	.	.	III	III	IV	V	V	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cheilanthes hirta	.	.	.	.	.	.	.	.	.	.	.	.	II	V	V	V	I	.	IV	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gymnosporia polyacantha	.	.	.	.	.	.	.	.	.	.	.	.	III	III	II	III	II	II	IV	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cussonia paniculata	.	.	.	.	.	.	.	.	.	.	.	.	III	III	II	IV	III	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum tomentosum var. *coccineum*	.	.	.	.	.	.	.	.	.	II	.	I	II	I	IV	III	III	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ehretia rigida	.	.	.	.	.	.	.	.	.	II	.	I	II	I	II	IV	V	.	V	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diospyros austro-africana	.	.	.	.	.	.	.	.	.	.	.	.	I	II	II	II	I	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Searsia erosa	.	.	.	.	.	.	.	.	.	.	.	.	.	I	III	III	I	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Viscum rotundifolium	.	.	.	.	.	.	.	.	.	.	.	.	I	I	.	III	IV	II	III	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula lanceolata	.	.	.	.	.	.	.	I	.	.	.	.	I	III	I	IV	.	II	I	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asplenium cordatum	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	IV	V	I	.	I	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tarchonanthus camphoratus	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	III	III	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP H: Diagnostic species of *Aristida diffusa* subsp. *burkei – Crassula nudicaulis* Succulent Grassland																																																	
Crassula nudicaulis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	III	I	.	III	IV	III	V	IV	V	II	.	III	III	II	V	II	V	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euryops empetrifolius	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	I	.	.	I	I	I	II	.	.	.	.	II	I	V	II	II	I	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phyllanthus parvulus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	III	.	III	.	II	.	IV	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Aristida diffusa subsp. *Burkei*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	III	I	V	I	.	.	.	IV	IV	IV	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albuca setosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I	IV	II	I	II	IV	.	V	.	II	II	IV	II	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.
Cynanchum viminale subsp. *viminale*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	I	I	V	.	.	.	.	II	IV	IV	V	.	V	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia mauritanica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	I	I	IV	II	III	I	.	IV	IV	IV	V	.	IV	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heliophila carnosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	III	.	.	.	.	.	.	IV	V	.	IV	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP I: Diagnostic species of *Delosperma pottsii – Cotyledon orbiculata* Grassland																																																	
Delosperma pottsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	II	.	V	V	II	I	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbopogon caesius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	II	II	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euclea crispa subsp. *ovata*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	III	II	IV	II	IV	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Wahlenbergia albens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jamesbrittenia atropurpurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	I	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lotononis laxa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP J: Diagnostic species of *Oropetium capense – Eragrostis nindensis* Grassland																																																	
Oropetium capense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	III	V	V	IV	V	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis nindensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	II	V	V	IV	IV	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ledebouria luteola	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	IV	.	I	IV	II	II	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula dependens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	III	II	.	.	.	V	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stomatium mustellinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	III	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euryops multifidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	I	.	I	.	.	.	I	II	II	.	II	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geigeria ornativa	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	III	V	II	III	II	II	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.
Ruschia spinosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	III	V	V	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis trichophora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	II	IV	.	.	II	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.

Table 1-A1 continues on the page →

TABLE 1-A1 (Continues...): Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units						**1**										**2**										**3**										**4**								**5**					
			1.1						**1.2**													**3.1**							**3.2**																				
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
Tragus berteronianus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	.	.	II	.	V	.	.	II	II	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Strumaria tenella subsp. *orientalis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	I	II	.	.	IV	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pelargonium minimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	II	.	.	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chlorophytum fasciculatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	III	II	.	II	.	IV	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lessertia annularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	IV	.	.	V	IV	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.
Eriocephalus spinescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	IV	V	IV	.	III	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia rhombifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	II	IV	.	V	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus indecorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	III	.	.	.	III	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pelargonium aridum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	II	.	II	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP K:																																																	
Pseudognaphalium undulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	III	.	II	II	.	.	II	.	.	.	III	II	.	.	.	.	.	.	.	.	.	.	.
Monsonia angustifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	II	I	II	II	.	.	.	.	.	V	V	II	.	.	.	.	.	.	.	.	III	.	.
Ruschia hamata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	.	.	.	.	III	.	.	II	.	.	.	.	.	.	.	.	.	.	.
SPECIES GROUP L:																																																	
Osteospermum scariosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	III	II	.	.	IV	II	.	IV	.	.	III	.	.
Chloris virgata	.	.	.	.	.	.	.	.	III	IV	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	II	.	II	II	.	I	.	IV	.	.	.	II	.	.
Argemone ochroleuca subsp. *ochroleuca**	.	.	.	.	.	.	.	.	.	II	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	I	.	.	.	.	III	III	.	.
Conyza podocephala	.	.	.	.	.	III	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	III	.	.	I	.	.	.	.	.	III	.	.
SPECIES GROUP M: Diagnostic species of *Helichrysum dregeanum* – *Themeda triandra* Grassland																																																	
Helichrysum dregeanum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	.	.	.	.	.	.	.	.	.	.	III	IV	V	.	II	.	.	.	.	.	.	.	.	III	.	II
Hermannia comosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	IV	.	.	.	.	.	III	.	.	.	.	.	.	.
Moraea pallida	.	.	.	.	.	.	.	.	I	V	IV	IV	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	III	II	.	.	.	.	.	.	.	.	.	.	.	II	.
SPECIES GROUP N: Diagnostic species of *Felicia muricata* – *Themeda triandra* Grassland																																																	
Panicum coloratum	.	.	.	.	III	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	IV	V	.	.	.	.	I	.	IV	II
Pentzia globosa	.	.	.	.	.	.	.	.	III	IV	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	III	I	.	.	II	II	.	II	II	IV
Lycium cinereum	.	.	.	.	.	.	.	IV	IV	V	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	II	III	I	II	.	.
Enneapogon cenchroides	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	II	IV	III	V	.	.	.
SPECIES GROUP O: Companion species																																																	
Eragrostis curvula	.	.	.	.	III	.	II	III	IV	V	II	III	I	.	III	V	II	II	IV	I	II	III	II	.	I	.	II	.	.	.	.	I	.	V	.	.	V	.	IV	II	I	.	V	III	.	.	V	IV	.
Conyza bonariensis	.	.	I	.	III	V	IV	I	I	V	IV	III	I	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	II	IV	.	.	.	.	II	.	.	.	II	.	II	I	.	.	.
Chaenostoma caeruleum	.	.	.	.	.	III	.	I	.	II	.	.	.	I	.	.	I	.	I	I	.	I	.	.	.	.	III	.	.	II	.	I	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Themeda triandra	.	.	I	.	.	.	IV	.	IV	IV	.	.	I	I	III	II	III	IV	II	I	IV	V	III	II	.	.	IV	III	II	IV	.	III	V	IV	V	V	V	III	V	V	V	V	V	IV	III	IV	V	IV	V
Eragrostis lehmanniana	.	.	.	.	.	.	II	III	I	.	.	.	.	.	I	I	II	II	I	II	II	I	II	II	I	.	III	I	II	II	.	V	III	II	IV	.	V	.	III	IV	II	.	V	V	V	III	III	IV	IV
Oxalis depressa	.	.	.	.	.	.	.	IV	III	II	IV	III	II	IV	V	V	I	II	II	.	.	I	.	.	II	.	IV	II	V	.	.	V	V	III	IV	.	.	III	IV	III	IV	II	.	II	.	.	I	.	II
Aristida congesta	.	.	.	.	.	.	.	I	III	V	.	.	.	.	II	II	III	IV	II	I	III	II	IV	II	.	.	V	III	IV	IV	V	.	II	V	IV	II	.	IV	.	.	.	II	IV	III	II	I	.	IV	III
Digitaria eriantha	.	.	.	.	.	.	.	.	I	.	.	.	.	II	.	.	I	.	.	I	I	III	II	.	.	.	III	IV	II	IV	.	V	V	III	.	II	.	II	V	V	V	V	.	II	.	.	V	V	II
Hibiscus pusillus	.	.	.	.	.	.	.	.	II	IV	II	.	.	.	I	II	II	.	IV	.	.	.	II	I	II	.	.	.	.	.	.	.	.	II	IV	V	.	.	IV	III	II	III	II	.	II	.	IV	.	II
Sporobolus fimbriatus	.	.	.	.	.	.	.	I	III	.	.	.	.	I	II	III	I	IV	I	I	III	IV	II	I	V	.	.	.	.	.	.	I	.	.	.	V	.	.	.	.	.	IV	.	.	.	.	III	II	II
Felicia muricata	.	.	.	.	.	.	.	.	IV	II	II	.	.	.	I	.	.	.	II	.	I	II	II	.	.	.	.	.	.	.	.	.	.	II	III	V	.	II	IV	IV	I	II	.	.	II	.	IV	II	III
Nidorella resedifolia	.	.	.	.	.	.	.	.	V	.	.	I	.	I	I	.	.	.	.	.	.	I	.	.	.	.	IV	I	II	IV	.	.	III	I	III	.	V	II	III	III	II	II	.	.	III	II	.	II	.
Schkuhria pinnata	.	.	.	.	.	.	.	I	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	II	II	.	.	.	.	I	V	V	III	II	III	II	II	IV	II	II	I	III	.	II
Eragrostis obtusa	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	III	.	II	.	.	II	IV	I	.	IV	.	III	II	.	I	IV	.	.	II	I	V	II	V
Eragrostis superba	.	.	.	.	.	.	.	I	.	.	.	.	I	.	.	.	I	.	.	.	III	I	II	.	.	.	.	.	.	.	.	.	.	III	IV	.	III	III	.	II	.	IV	II	IV	.	II	.	II	.
Senecio hastatus	.	.	.	.	.	.	.	.	III	IV	.	III	.	.	.	.	.	.	.	.	I	II	.	.	I	.	II	I	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.
Nenax microphylla	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	II	.	.
Cymbopogon pospischilii	.	.	.	.	.	.	.	.	.	.	.	.	.	I	V	III	IV	.	II	.	III	II	.	.	.	.	.	I	.	II	.	.	.	.	II	.	.	.	.	.	.	II	II	.	.	.	II	II	.
Heteropogon contortus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	V	II	IV	V	IV	II	V	V	.	.	II	IV	.	II	.	.	.	III	IV	.	.	.	.	.	.	II	.	II	.	.	.	.	.
Tragus koelerioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	II	II	.	II	III	III	II	III	.	.	II	III	IV	IV	IV	III	V	III	.	V	.	.	.	.	.	.	II	.	.	.	.	.	.	.
Eragrostis chloromelas	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	I	.	.	.	III	III	I	III	III	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	IV	III	V	II	II	.	.	I	II	.
Senecio burchellii	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	I	.	.	II	II	II	.	I	III	II	IV	.	.	.	II	.	I	.	.	.	.	.	.	.	.

Table 1-A1 continues on the page →

TABLE 1-A1 (Continues...): Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units						1										2										3										4								5					
			1.1						1.2													3.1							3.2																				
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
Anthospermum rigidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	II	.	I	.	.	.	.	.	.	.	II	.	.	.	.	.	II	.	.	III	.	.	.	.	.	I	II	.
Aristida adscensionis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	IV	II	III	.	.	.	.	.	.	.	.	.	.	I	.	II	.	.	.	III	IV	.	V	IV	II	I	II	.	.
Digitaria argyrograpta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	IV	.	.	.	.	.	.	.	.	.	.	.	.	V	IV	.	.	.	II	I	II	.	.	.	.	II	.	.
Melolobium candicans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	II	.
Indigofera alternans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	V	.	III	.	I	II	.	.	.	.	II	.	.
Selago densiflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	V	.	.	II	V	IV	V	IV	III	II	II	.	I	III	.	.	.	.	III	.	II
Cyperus usitatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	IV	III	IV	.	.	.	II	.	.	.	III	.	.	II	V	.	.	.	.	.	.	.	.
SPECIES GROUP P: Rare species																																																	
Crinum bulbispermum	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus exsertus	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix babylonica	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alchemilla elongata	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Verbena aristigera	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucosidea sericea	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Typha capensis	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicoma anomala	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lemna minor	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix mucronata	V	V	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus marginatus	V	V	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pseudoschoenus inanis	V	V	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hemarthria altissima	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gomphostigma virgatum	V	IV	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Conium chaerophylloides	V	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phragmites australis	IV	II	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
*Verbena bonariensis**	II	V	.	.	.	.	.	I	.	.	.	IV	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.
Miscanthus ecklonii	II	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Equisetum ramosissimum	II	II	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ranunculus multifidus	II	II	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leptochloa fusca	.	.	I	V	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis micrantha	.	.	.	V	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eleocharis limosa	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amaranthus species	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus denudatus	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Marsilea macrocarpa	.	.	I	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum aviculare	.	.	I	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
*Gleditsia triacanthos**	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echinochloa crus-galli	.	.	I	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Amaranthus caudatus	.	.	I	.	III	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.
Alternanthera sessilis	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Agrostis lachnantha	.	.	.	.	.	V	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.
Polypogon monspeliensis	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica anagallis-aquatica	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago laciniata	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cotula microglossa	.	.	I	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio othonniflorus	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus congestus	.	.	I	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Plantago lanceolata	.	.	.	.	III	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lobelia thermalis	.	.	I	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus nanus	.	.	I	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus albus	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Medicago sativa	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
*Cestrum laevigatum**	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lactuca serriola	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Paspalum distichum	.	.	I	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Searsia pyroides	.	.	.	.	.	.	.	V	.	.	.	I	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 1-A1 continues on the page →

TABLE 1-A1 (Continues...): Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units							1									2										3									4								5					
				1.1						1.2													3.1							3.2																			
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
Pentarrhinum insipidum	.	.	.	.	.	.	.	III	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubia horrida	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Moraea simulans	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rosenia humilis	.	.	.	.	.	.	.	I	V	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Urochloa panicoides	.	.	.	.	.	.	.	.	IV	.	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Massonia jasminiflora	.	.	.	.	.	.	.	.	II	IV	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ammocharis coranica	.	.	.	.	.	.	.	.	.	IV	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solanum supinum	.	.	.	.	.	.	.	I	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.
Solanum lichtensteinii	.	.	.	.	.	.	.	I	.	II	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Antizoma angustifolia	.	.	.	.	.	.	.	I	.	II	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Alternanthera pungens	.	.	.	.	.	.	.	.	.	II	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bulbine abyssinica	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	II	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
*Cuscuta campestris**	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Colchicum melanthioides	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Duthiastrum linifolium	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Celtis africana	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Silene undulata	.	.	.	.	.	.	.	+	.	.	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gerbera piloselloides	.	.	.	.	.	.	.	.	.	.	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cineraria lobata	.	.	.	.	.	.	.	.	.	.	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Haemanthus humilis	.	.	.	.	.	.	.	.	.	.	.	.	.	III	II	V	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bonatea speciosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Clutia pulchella	.	.	.	.	.	.	.	.	.	.	.	.	III	IV	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eucomis autumnalis	.	.	.	.	.	.	.	.	.	.	.	.	II	II	.	I	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Heteromorpha arborescens var. *abyssinica*	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriospermum corymbosum	.	.	.	.	.	.	.	.	.	.	.	.	I	I	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kedrostis africana	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pupalia lappacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	II	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
*Pennisetum villosum**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hermannia bryoniifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	I	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida diffusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	I	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhigozum obovatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	II	.	I	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Commelina benghalensis	.	.	.	.	.	.	.	.	.	.	.	.	II	.	I	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Osyris lanceolata	.	.	.	.	.	.	.	.	.	.	.	.	I	I	I	.	I	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sisymbrium capense	.	.	.	.	.	.	.	.	.	.	.	I	III	III	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sebaea compacta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pegolettia retrofracta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pentzia sphaerocephala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea oblongata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio consanguineus	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	II	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.
Panicum maximum	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	I	.	II	.	.	.	I	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cineraria aspera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum deustum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium capense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis biflora	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus obtusiflorus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dicoma macrocephala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Menodora africana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elionurus muticus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Raphionacme hirsuta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kyllinga alba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Talinum caffrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.

Table 1-A1 continues on the page →

TABLE 1-A1 (Continues...): Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units						**1**										**2**										**3**										**4**								**5**					
				1.1					**1.2**													**3.1**							**3.2**																				
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
Schizocarphus nervosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus marlothianus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kohautia amatymbica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ipomoea oenotheroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia inaequilatera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.
*Salsola kali**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Argyrolobium pauciflorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum zeyheri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	II	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Triraphis andropogonoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Indigofera filipes	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Avonia ustulata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Microchloa caffra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula setulosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	II	II	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gladiolus permeabilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyphia triphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Opuntia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Drimia elata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jamesbrittenia aurantiaca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anacampseros telephiastrum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	I	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassothonna protecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trichodiadema barbatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	I	II	.	.	.	.	.	II	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albuca prasina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.
Chasmatophyllum musculinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	I	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ophioglossum polyphyllum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Jamesbrittenia pristisepala	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula corallina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pteronia species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anacampseros filamentosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Orbeopsis lutea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nerine laticoma	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tulbaghia acutiloba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio inaequidens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	I	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristida stipitata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Blepharis integrifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Harpagophytum procumbens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eriospermum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melolobium calycinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berkheya onopordifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hertia pallens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	I	.	II
Barleria macrostegia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Trichoneura grandiglumis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhynchosia nervosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pogonarthria squarrosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	III	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthephora pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hibiscus trionum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.
Crotalaria sphaerocarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	II	.	.	.	.	.	.	.
Brunsvigia radulosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.
Eragrostis gummiflua	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	II	.	.	.	.	.	.

Table 1-A1 continues on the page →

TABLE 1-A1 (Continues...): Synoptic table of the natural vegetation of Bloemfontein, Free State, South Africa.

Vegetation units							1									2										3										4								5					
			1.1						1.2													3.1							3.2																				
Number of releves	**3**	**3**	**7**	**2**	**2**	**2**	**3**	**10**	**5**	**3**	**3**	**7**	**11**	**12**	**6**	**7**	**10**	**3**	**9**	**6**	**5**	**9**	**4**	**6**	**7**	**3**	**3**	**5**	**3**	**5**	**4**	**7**	**4**	**6**	**5**	**3**	**2**	**4**	**4**	**4**	**5**	**4**	**3**	**4**	**4**	**5**	**9**	**3**	**4**
Cyperus rupestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.
Helichrysum aureonitens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Wahlenbergia androsacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Amaranthus thunbergii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Chenopodium murale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Eleusine coracana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Hypoxis argentea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Amaranthus hybridus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Dimorphotheca zeyheri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.
Eragrostis plana	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	III	II	.	.	.	.	.	.	.	.
Vahlia capensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.
Aristida bipartita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.
Setaria incrassata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I	.	.	.	.	.	.	.	II	.	.	.	.	.	.
Aristea bakeri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.
Nemesia fruticans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.
Fingerhuthia africana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	.	.	.	.	.
*Convolvulus arvensis**	.	.	.	.	.	.	.	I	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	II	II	.	.	.	.	.
Cyperus capensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	III	.	.	.	.	I	.	.
Hermannia coccocarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	II	.	II	.	II	.	.	.	.	.	.	.
Panicum schinzii	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	V	.	.	.	V	.	II
Bidens pilosa	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	III	.	.	.
Tribulus terrestris	.	.	.	.	.	.	.	.	.	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	I	.	.	.
Phyla nodiflora	.	.	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	II
Scabiosa columbaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	II	.	.	.	.	I	.	.
Salvia verbenaca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	.	.	.	.	.	II	.	.	.	.	.	IV	.	.	.
Brachiaria eruciformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	II	I	.	.	IV
Salsola aphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	II

The presence of each species within a community is rated on a constancy scale as follows: r - species present in 1–5% of the relevés of a community; + - present in 6–10% of the relevés; I - present in 11–20% of the relevés; II - present in 21–40% of the relevés; III - present in 41–60% of the relevés; IV - present in 61–80% of the relevés; V - present in 81–100% of the relevés (Mueller-Dombois & Ellenberg 1974; Kent & Coker 1996; Van der Maarel 2005)

*, indicates invasive species (Department of Environmental Affairs 2016).