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Phytosociological study of Andrew's field and Tsaba-Tsaba nature reserve, Bredasdorp district, Western Cape.

by

MARGARETHA MARIA ZIETSMAN

Submitted in fulfillment of the requirements

for the degree

MAGISTER SCIENTIAE

in the Faculty of Natural and Agricultural Sciences

(Department of Botany)

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Supervisor: Prof. Dr. G.J. Bredenkamp

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The works of the LORD are great, Studied by all who have a pleasure in them.
Psalm 111: 2 (NKJV)

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Dedicated to my parents

ABSTRACT

Phytosociological study of Andrew's field and Tsaba-Tsaba nature reserve, Bredasdorp district, Western Cape.

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MARGARETHA MARIA ZIETSMAN

Supervisor: Prof. Dr. G.J. Bredenkamp

DEPARTMENT OF BOTANY
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MAGISTER SCIENTIAE

The vegetation of Andrew's Field and Tsaba-Tsaba nature reserve, Bredasdorp district, Western Cape was hierarchical classified using Braun-Blanquet procedures and TWINSPAN. The resulting 10 plant communities, 19 sub-communities and four variants, were described and ecological interpreted. The vegetation was sampled using 171 randomly stratified sample plots. The floristic composition, Braun-Blanquet cover-abundance scale of each species, and various environmental variables were recorded in each sample plot. The relation between the vegetation units and the associated environmental gradients was confirmed by DECORANA ordination, conducted on the floristic data. The conservation priority of each vegetation unit was determined by taking Red Data List species, limestone endemic species and Cape Floristic Region endemic species into consideration. The distribution of the vegetation units can mainly be ascribed to differences in the clay/sand content of the soil and the degree of exposure of the vegetation to the dominating winds (Southeastern and Northwestern) of the area.

UITTREKSEL

Fitososiologiese studie van Andrew's field en Tsaba-Tsaba natuurreservaat, Bredasdorp distrik, Wes-Kaap.

deur

MARGARETHA MARIA ZIETSMAN

Studieleier: Prof. Dr. G.J. Bredenkamp

DEPARTEMENT PLANTKUNDE

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Die plantegroei van Andrew's Field en Tsaba-Tsaba natuurreservaat, Bredasdorp distrik, Wes-Kaap, is hierargies geklassifiseer met behulp van Braun-Blanquet prosedures en TWINSPAN. Die resulterende 10 plantgemeenskappe, 19 subgemeenskappe en 4 variante, is beskryf en ekologies geïnterpreteer. Die plantegroei is gemonster deur gebruik te maak van 171 gestratifiseerd-ewekansig geplaasde monsterpersele. Die floristiese samestelling, Braun-Blanquet bedekkingsgetalsterkte van elke spesie, en verskeie omgewingsveranderlikes is aangeteken in elke monsterperseel. Die verhouding tussen die plantegroei-eenhede en die verwante omgewingsgradiënte is bevestig deur die uitvoering van DECORANA ordinering op die floristiese data. Die bewaringsprioriteit van elke plantegroei-eenheid is bepaal deur Rooidata gelysde spesies, kalksteen-endemiese spesies en Kaap Floristiese Ryk endemiese spesies in ag te neeem. Die verspreiding van die plantegroei-eenhede kan hoofsaaklik toegeskryf word aan die verskille in klei-/sand-inhoud van die grond en aan die mate van blootstelling van die plantegroei aan die dominante winde (Suidoos en Noordwes) van die gebied.

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CHAPTER 1: INTRODUCTION

A sound knowledge of the ecology of the area is an essential prerequisite for the establishment of efficient wildlife management programs and compilation of conservation policies for any area (Edwards 1972).

According to Bredenkamp *et al.* (1983) it has often been demonstrated that different ecosystems of a particular area can be recognized by the delimitation of the plant communities within the area. According to Scheepers (1983) vegetation science has been applied in the fields of nature conservation for years, but recent developments relate to the application of plant ecological knowledge to environmental management. The use of plant communities as a reliable basis for any ecological planning and management, is emphasized by Bredenkamp & Brown (2001).

To obtain knowledge of the ecology of the study area, a study of the vegetation of the area should be made on the plant community level of organization (Bredenkamp & Brown 2001). Studying the vegetation of the study area allows the following goals to be met:

- Identify, describe and classify plant communities.
- Delineate management units.
- Identify ecological sensitive areas.
- Identify bush encroached areas or areas infested with alien plants or degraded areas, all in need of rehabilitation measures.
- Identify the habitats of rare or endangered plant species
- Identify the habitats of specific animals.

LOCATION AND AREA

The study area is approximately 979 ha in extent and consists of Andrew's Field (+/-129 ha) and Tsaba-Tsaba Nature Reserve (+/-850 ha), which are adjacent areas on the same farm (portion 7 and remainder portions of 8 of the farm Zoetendalsvlei No. 280). The study area is situated on the Agulhas Plain, Bredasdorp district, Western Cape; between Struisbaai North in the south and De Mond State Forest in the north and is bordered in the west by the Bredasdorp/Struisbaai road, and in the south by the sea (Figure 1).

INFRASTRUCTURE

The infrastructure of the study area consists of a network of small gravel roads or tracks in Tsaba-Tsaba Nature reserve, and two gravel main roads in Andrew's Field. A stone wall, probably constructed by previous owners, separates Tsaba-Tsaba Nature Reserve and Andrew's Field. There is one open entrance road between the two areas. Andrew's Field contains an office, several chalets, caretaker's house, aeroplane hangers and two wind- mills. There is a small dam on Andrew's Field, and a bigger dam in Tsaba-Tsaba Nature Reserve. There is one gate into Andrew's Field and two gates into Tsaba-Tsaba Nature Reserve, from the public road. A connection road, inside the Nature Reserve, exists between the two gates of the Nature Reserve. The distribution of the infrastructure is shown in Figure 2.

PHYSIOGRAPHICAL COMPONENTS

TOPOGRAPHY

According to Jefferey (1996) the majority of the study area falls below the 10m contour with a ridge running roughly north south reaching 31m above sea level in places. An approximately 600m wide strip of unvegetated or sparsely vegetated sand dunes, separates the more stabilized, densely vegetated parts of the study area, from the sea (Jeffery 1996).

GEOLOGY

The dominant mother material of the study area is the Bredasdorp group (Malan *et al.* 1994). Two formations of the Bredasdorp group namely Strandveld and Waenhuiskrans are found in the study area (Malan *et al.* 1994). Strand and terrace deposits, not formally named as a formation, but forming part of the Bredasdorp group, is found in the form of roll-stones, in the coastal strand part of the study area (Malan *et al.* 1994).

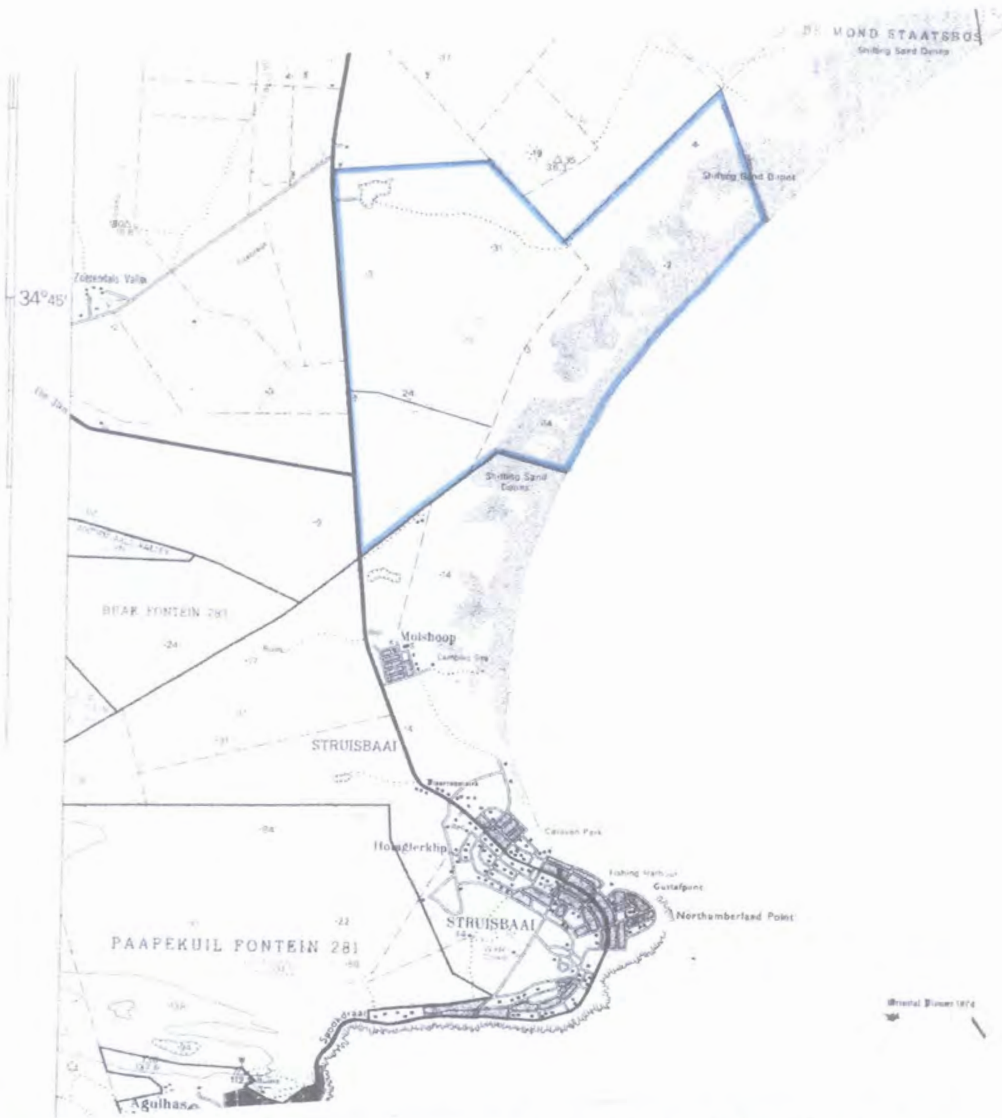


Figure 1. A map showing the exact location of Andrew's Field and Tsaba-Tsaba nature reserve.

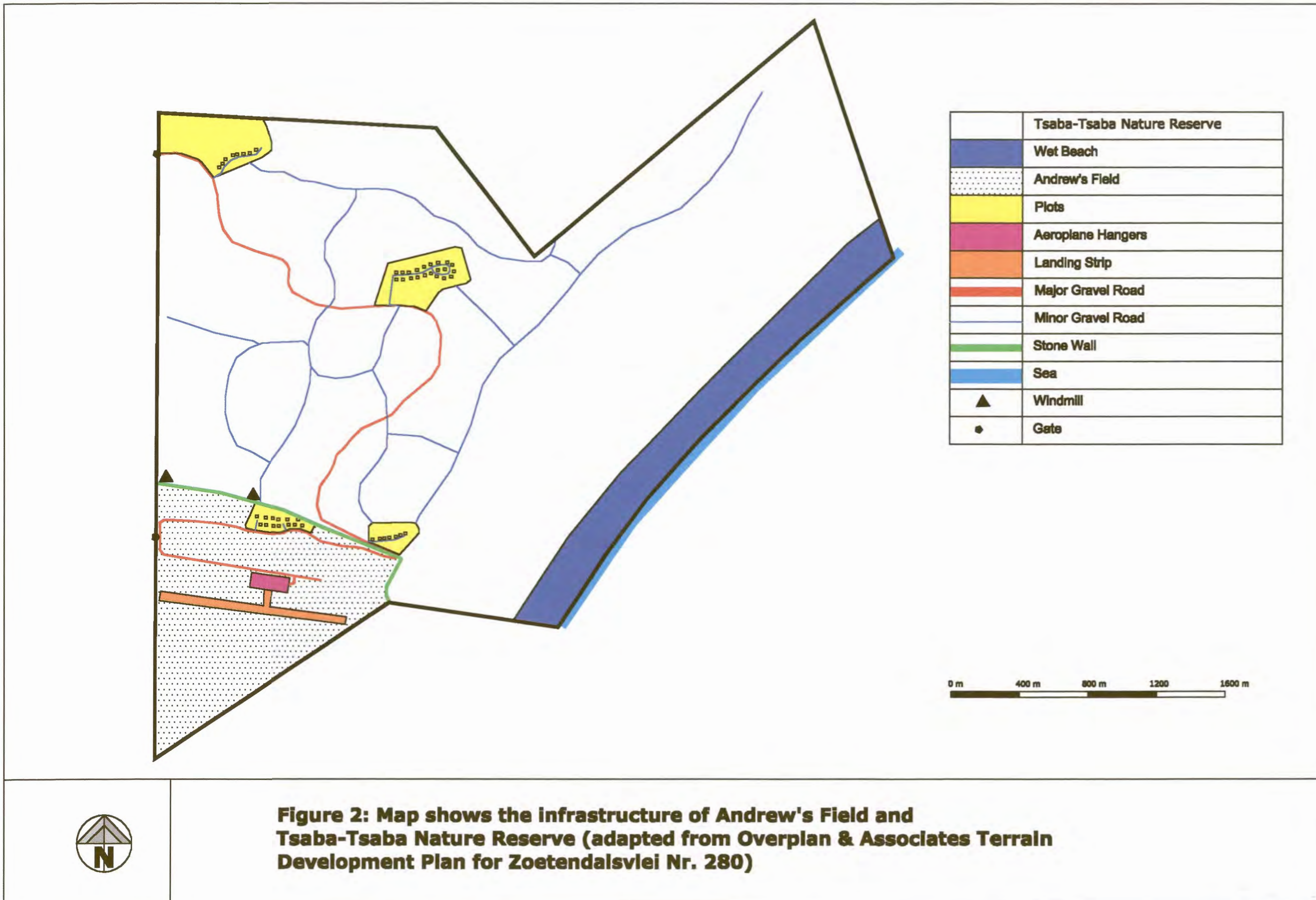


Figure 2: Map shows the infrastructure of Andrew's Field and Tsaba-Tsaba Nature Reserve (adapted from Overplan & Associates Terrain Development Plan for Zoetendalsvlei Nr. 280)

The roll-stones of Table mountain sandstone can be explained by a prior increase in sea level. The Bredasdorp group is described by Malan *et al.* (1994) as Cenozoic sediments of marine- and marine related origin, and stretches up to 22 kminland from the current coastline. The rocks are laid down discordant on marine paved rocks of the Table Mountain, Bokkeveld and Uitenhage groups (Malan *et al.* 1994).

The Standveld formation is found along the coast (Malan *et al.* 1994). It consists of white to light-gray dune sands with a high percentage shell fragments (Malan *et al.* 1994). Partial cementing of sands with a high calcium carbonate-content took place (Malan *et al.* 1994). The lythology of this formation can be described as white dune sand, strand sand with finely divided shell and alluvial stones (Malan *et al.* 1994).

The geology of the study area can be seen in Figure 3.

The Waenhuiskrans Formation day-seams next to the current coastline (Malan *et al.* 1994). The Waenhuiskrans unit stratiotype, 12.4 m deep, and locally overlaid with 1 m thick calcretes, consists of medium granulate cross-layered calcarenite with well-rounded quarts and a few glauconite grains (Malan *et al.* 1994). Large-scale eolic cross-layers is characteristic of the unit (Malan *et al.* 1994). The lythology of this formation can be described as partially calcified dune sand (Manlan *et al.* 1994).

A small portion of the study area's mother material consists of sedimentary rocks (light gray to pale-red sandy soil), underlain by the Waenhuiskrans formation (partly calcified dune sand with calcrete lenses) (Malan *et al.* 1994).

SOILS

The soil can be described as mostly either shallow sandy soil, overlying limestone, or shallow to deep sandy soil, overlying clay, silt and gravel. Four different soil forms have been distinguished in the area. Coega (Ortic A on hard bank carbonate horison), family Marydale (Lime containing A-horison); Immerpan (Melanic A on hard bank carbonate

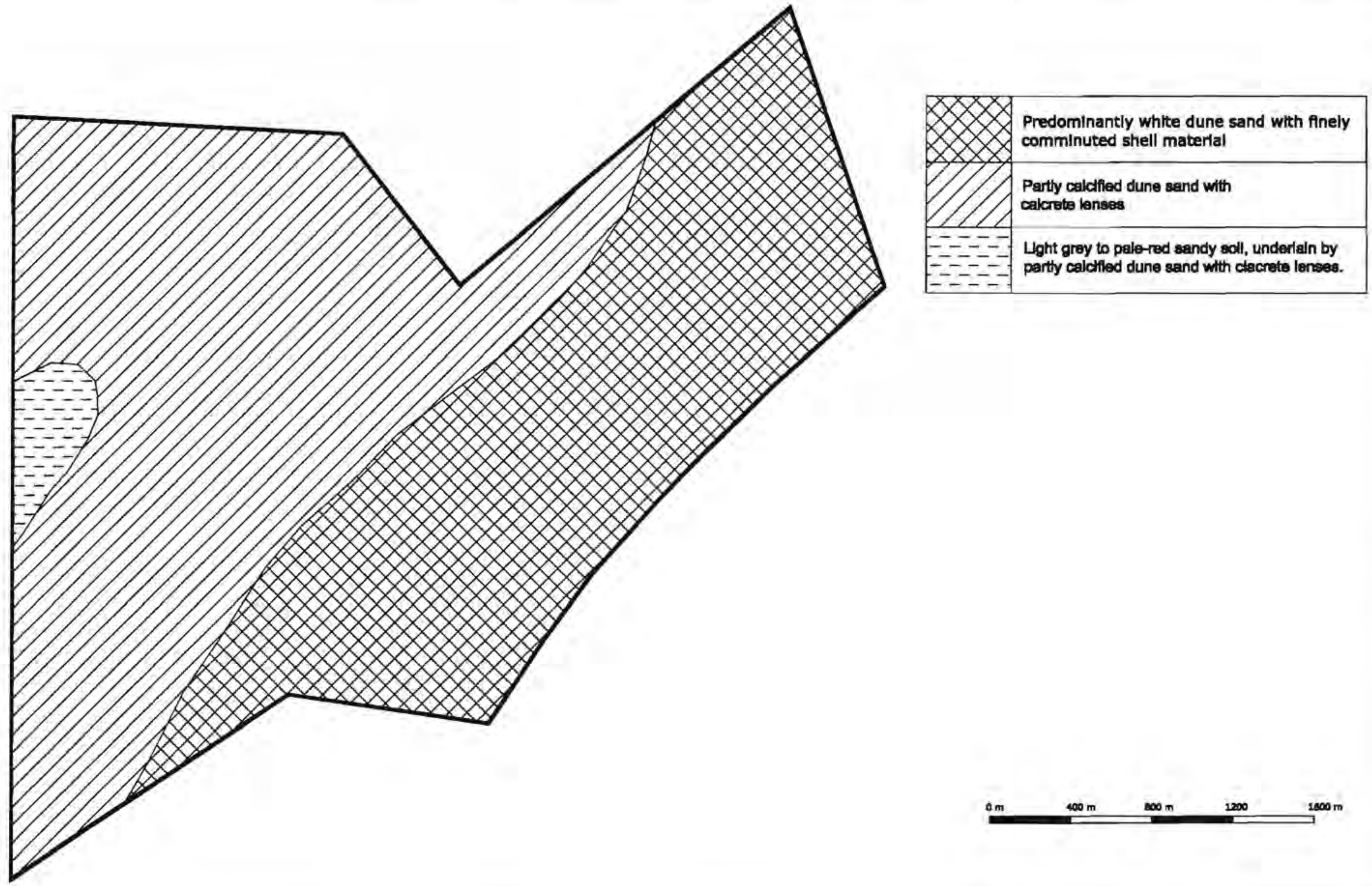


Figure 3: Geology of Andrew's Field and Tsaba-Tsaba Nature Reserve (adapted from the Council for the Geoscience, geological survey map 3420 Riversdale)

horison), family Kalkpan (Lime containing A-horison); Brandvlei (Ortic A on soft carbonate horison), family Kolke (Signs of wetness in carbonate horison) and Namib (Ortic A on regic sand), family Beachwood (Containing lime within 1500 mm from soil surface) (Macvicar 1991).

The Coega soil form is found on the limestone hills and shallow-soil limestone plain. Immerpan soil form is found on the deeper-soil, Proteoid dominated limestone plain. Brandvlei soil form is found in the marsh area, as well as the Renosterveld plain, while the Namib soil form is found on the shifting sand dune area, the dune plain and the deep sand Proteoid dominated foothills and plains.

According to Tinley (1985) two distinct sand characteristics occur in dune fields. Bare dune sands, beige or yellow in color, absorbs all rain, with no surface runoff. Grey sands, stained by humus, covered with woody vegetation, have a water repellent layer near the surface, beneath the litter, causing a massive surface runoff, when heavy rains follow a dry period (Tinley 1985). When recurring light rains previously wet the gray sands, minimum runoff, with deep percolation occurs (Tinley 1985). According to Tinley (1985) the water repelling is caused by organic skins coating individual sand particles, the hydrophobic substances originating from secondary plant products such as waxes, phenols and amines, from fungal mycelia and fungal metabolites, and substances produced as a normal consequence of litter decomposition. According to Tinley (1985) the degree of water repellency of the soil depends on the type of plants, their byproducts and breakdown products. Water repellence is also influenced by the occurrence of fire, which transforms and volatizes much of the organic matter at the soil surface (Tinley 1985).

CLIMATE

Climatic processes are of basic and fundamental importance to determine the ecological properties of any region (Heydorn & Tinley 1980). The main factors affecting the climate, conditioning air masses are: the contrasting sea surface temperatures of the two major ocean currents and the inshore circulation's (Tinley 1985). According to Heydorn & Tinley (1980) the Cape Coast can be divided into four distinct geographical regions. Using this geographical division, the study area is situated on the south coast. The south coast is a transitional zone, between tropical and temperate waters and offshore is the major retroflex area of Agulhas Current waters recurving eastwards and landwards (Heydorn & Tinley 1980).

The south coast has a warm temperate climate with all-seasons- and bimodal equinoctial rainfall (Strydom 1992).

Precipitation

According to Heydorn & Tinley (1980) the marked feature of rainfall in the Cape coastal region is the strong orographic control, where the rainfall curve closely follows the relief undulations. The low rainfall regime associated with the majority of Cape coast stations, appears to be due to the occurrence of cold inshore waters which inhibit shoreline rains.

According to Heydorn & Tinley (1980) the study area is situated in a low rainfall region, an arid inland tongue, reaching the coast.

The average monthly precipitation of the area can be seen in Table 1.
A Walter climatic diagram was compiled (Figure 4) from data obtained from Agulhas weather station.

The average annual precipitation of the area is 444 mm. As can be seen in Figure 3, the wet season is only slightly shorter than the dry season. The maximum precipitation is in June, and the minimum precipitation during February and December.

The increase of cold fronts in the winter season due to the northward shift of the 'Roaring Forties' westerly belt brings rain tot the coastal regions (Heydorn & Tinley 1980). Southwest Cape winter precipitation is associated with successions of east moving cyclones, the rain falling with pre-frontal NW winds (Heydorn & Tinley 1980).

Fog is usually associated with the development and along shore movement of coastal lows after cold water upwelling has occurred

(Heydorn & Tinley 1980). The lows contain warm, moist air off the Agulhas Current on the south and southeast coasts, which cools and condenses when flowing across the cold inshore water (Heydorn & Tinley 1980). In autumn and winter, cold air catabolic fog is formed on clear nights, intensifying at dawn (Heydorn & Tinley 1980).

According to Barbour *et al.* (1987) knowledge about the total rainfall does not always convey a clear picture of the availability of water tot the plant community. The season, atmospheric condition, type of rainfall, intensity, yearly variation, soil type and vegetation physiognomy, influences the availability of rain and distribution within the habitat (Vermeulen 1995). The presence of water repellent sands in the study area (see soils) has a big influence on the availability of precipitation to the plants.

Temperature

The average monthly temperature for the area can be seen in Table 1. The average annual maximum and minimum temperatures for the area are 6°C and 13.3°C respectively (Table 1). The maximum temperature for the area is 36.1°C, obtained in February. The minimum temperature for the area is 3.9°C, obtained in June.

Wind

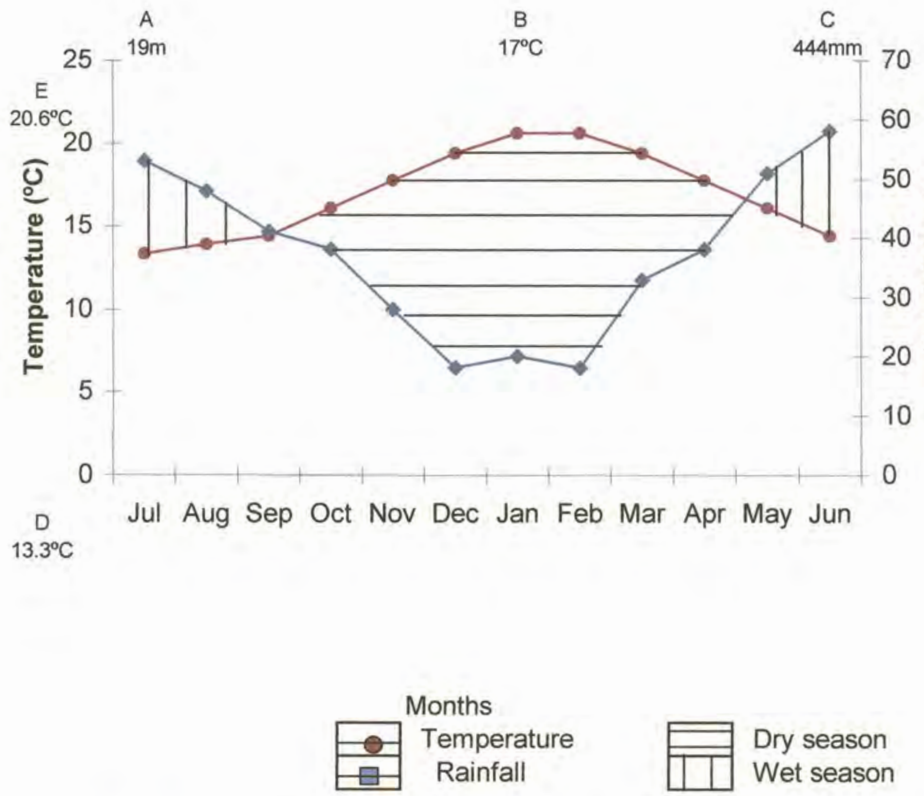
According to Scriba (1984) research has indicated that wind is an important environmental factor in vegetation research.

According to Heydorn & Tinley (1980) the wind climate along the south coast, where the study area is situated, is bi-directional. Southeasterly winds alternate with northwesterly and southwesterly winds (Heydorn & Tinley 1980).

Due to the major changes in configuration that the southern coasts show, the subcontinent is exposed to the disparate influences of cold and warm ocean currents, circumpolar westerlies and subtropical high pressure anticyclones, with neither one predominating to the exclusion of the others (Heydorn & Tinley 1980). Initial climatic asymmetry is imposed by a cold

Table 1.
The average temperature and precipitation for Andrew's Field and Tsaba-Tsaba Nature Reserve 1968 - 1994.

	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	Jun.
Temp.	13	13.9	14.4	16	18	19.4	21	20.6	19	17.8	16.1	14
Pres.	53	48	41	38	28	18	20	18	33	38	51	58



A = Altitude
B = Mean annual temperature
C = Mean annual rainfall
D = Mean daily minimum (coldest month)
E = Mean daily maximum (hottest month)

Figure 4. A Walter-climatic diagram for Andrew's Field and Tsaba-Tsaba Nature reserve.

current on the west coast, inhibiting rainfall development, and a sub-tropical warm current off the east and south coasts, enhancing convectional processes (Heydorn & Tinley 1980). The weather regime is dominated by the alternating succession of east moving cyclones from the circumpolar westerlies, interacting with subtropical high-pressure anticyclones which are centered over the South Atlantic seaward of the west coast, and over the old eastern Transvaal and adjacent South Indian Ocean (Heydorn & Tinley 1980). Both the anticyclones including the landward extension over the old Eastern Transvaal of the South Indian Ocean High, fluctuate in position, ridging in south of the subcontinent where they cause a predominance of easterly winds along the coasts particularly in summer (Heydorn & Tinley 1980).

Cold snaps occur when strongly developed cold fronts are immediately followed by an anticyclone, which advects subpolar air landwards (Heydorn & Tinley 1980). Cold snaps occur mostly in the winter with a peak in August (Jackson & Tyson 1971). The high frequency of cold fronts in the winter is due to the fact that during winter the amplitude of westerly disturbances is the greatest (Tyson 1987).

Nocturnal cold air drainage catabolic winds are typical of clear nights on all coasts, and are most frequent in the winter months (Heydorn & Tinley 1980).

The predominance of easterly winds, some of gale force, in the spring and summer, is caused by the fact that South Atlantic and Indian anticyclones ridge in systematically of the southern coast as part of the alternating cyclone-anticyclone sequence (Heydorn & Tinley 1980).

The predominance of anticyclonic and cyclonic, change in accordance with seasonal movement of the pressure systems (Heydorn & Tinley 1980). In the winter prevailing, opposing wind along the coasts blows almost parallel to the coastline (Heydorn & Tinley 1980). Gale force winds are less frequent in summer and on the south coast these strong winds are mainly SW to SE (Heydorn & Tinley 1980).

According to Heydorn & Tinley (1980) wind is probably the most important factor controlling the development of dunes; directly in transporting sand on land, as well as generating coastal currents which are important in marine sand transport.

Maritime conditions

According to Strydom (1992) the configuration and orientation of the coast plays an important role in the way it is exposed to climatic factors.
According to Heydorn & Tinley (1980) the climatic asymmetry of the Cape south coast is due to the cold Benguela currents on the west coast (inhibiting rainfall development) and the subtropical warm currents (mainly Agulhas) of the south and east coasts (enhancing convectional processes).

Radiation

According to Heydorn & Tinley (1980) the summer and winter isoline distribution of values of radiation are largely determined by the seasonal cloud cover patterns. According to Tinley (1985) cloud cover affects the radiation and isolation values, the diurnal temperature variations, evaporative power and air and ground moisture content. An increase in cloud cover results in increased "greenhouse" effect, while a decrease in cloud cover leads to greater temperature extremes (Strydom 1992). In the winter radiation density isolines are mainly zonal due to the general cloudiness over the greater part of the country's southern coasts. The southern coast of South Africa generally receives radiant flux densities below 110 x 10^5 Jm^{-2} per day^{-1} over the southwest Cape to 230 x $10^5 Jm^2$ per day^{-1} where conditions are cloudier over the southeast coast (Heydorn & Tinley 1980).

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CHAPTER 2: LITERATURE STUDY

HISTORY OF PHYTOSOSIOLOGY AND THE BRAUN-BLANQUET METHOD IN SOUTH AFRICA:

The science of Plant ecology has been practised in South Africa since the beginning of the twentieth century (Werger 1974). Of the early ecological studies in South Africa the work of Marloth in 1908 was the most significant (Werger 1974). For more than half a century South African ecology was predominantly inspired by the writings of Clements. The early twentieth century studies were mainly of an informal, descriptive kind. Early during the second half of the century Acocks conducted an ecological study of considerable local importance (Werger 1974). In 1953 Acocks published his 'Veld Types of South Africa', which classified South African vegetation into 70 veld types and 75 variations, based on a floristic comparison of stand data. According to Werger (1974) the development of statistical techniques in ecology, received attention in South Africa, shortly after the introduction of these techniques in Europe and America, for example the study of Van Vuuren (1961) on the vegetation of the Magaliesberg west of Pretoria.

According to Westhoff & Van der Maarel (1973) the systematic description of plant communities and the idea of community types can be traced from great students of plant geography like Humbolt, Swchouw, Heer and Grisebach from 1805 to1838. Two main approaches developed from their work, the physiognomic and floristic (Westhoff & Van der Maarel 1973). Through the work of students dealing with smaller scale units, in Europe, there developed the essential idea of the floristic-sociological approach: plant communities as units of classification based primarily on species composition (Westhoff & Van der Maarel 1973).

Much of the further development leading to the Braun-Blanquet approach was centred in Zurich and Montpellier, where Jozias Braun-Blanquet lived and worked (Westhoff & Van der Maarel 1973).

The Zurich-Montpellier (Braun-Blanquet) approach to the study of vegetation has proved, since the beginning of the approach in Europe, as well as other continents, to be an effective and reliable method for vegetation survey and classification (Werger 1974).The Braun-Blanquet approach however remained virtually unknown in most parts of Africa, south of the equator, until 1969 (Werger 1974). In 1969 Marinus J.A.

Werger was secunded from the Netherlands to the then Botanical Research Institute (BRI), now the National Botanical Institute (NBI), to conduct a phytosociological survey of the Upper-Orange-River, where he introduced the use of the Braun-Blanquet method to South Africa. This work resulted in a doctoral thesis (Werger 1973). Werger strongly influenced Ben J. Coetzee and George J. Bredenkamp, two students enrolled for Master degree studies at the University of Pretoria, under supervision of Prof G.K. Theron, resulting in the first theses by South African students using the Braun-Blanquet approach (Coetzee 1974b, Bredenkamp 1975). Afterwards the method was used with success in a number of small surveys, mostly on the vegetation of nature reserves or other conservation areas (Werger 1974). Due to these studies Werger (1974) foresaw the wider acceptation of the Braun-Blanquet method in South Africa, which indeed realised in a large number theses and publications by researchers of the BRI and students of various South African universities, especially the Universities of Pretoria, Stellenbosch, Free State and Rhodes.

EFFECTIVENESS OF THE BRAUN-BLANQUET METHOD:

According to Moore *et al.* (1970) the efficiency of an ecological method is defined as its capacity of yielding a maximum understanding of the complexity of vegetation and of its relation to environmental factors for a minimum of time input. The Braun-Blanquet method was found to be most efficient for a general ecological survey, being the most economical in time, yielding results at least as informative as any of the other methods tested when taken on their own (Moore *et al.* 1970, Werger 1973, 1974, Westhoff & Van der Maarel 1973).

APPLICABILITY OF BRAUN-BLANQUET TO THE WESTERN CAPE PROVINCE:

According to Boucher (1977) a vegetation study of Cape Hangklip area, using association-analysis, Braun-Blanquet and homogeneity function methods, revealed that the Braun-Blanquet method is consistently more efficient and more exact, even in the floristically rich vegetation of the South Western Cape Province of South Africa. Some of the important phytosociological studies applying Braun-Blanquet methodology in Fynbos vegetation include those of Werger *et* al. (1972) from Jonkershoek, Boucher (1978) of the Cape Hangklip area, Glyphis *et al.* (1978), Cowling (1984) from the Humansdorp area, Taylor (1984a, 1984b) from the Cape of Good Hope Nature Reserve, Boucher (1987) of coastal Fynbos, McDonald (1993a, 1993b, 1993c, 1995) from the Langeberg, Mustert *et al.* (1993) from Table Mountain, Taylor (1996) from the Cederberg and Boucher & McDonald (1982) about the western, southern and eastern Cape province.

CAPE FLORISTIC REGION:

According to Low & Rebelo (1998) the Fynbos Biome is considered by many as being synonymous with the Cape Floristic Region or Cape Floral Kingdom. The Cape Floristic Region or Cape Floral Kingdom is however a general geographical area, including Fynbos, Renosterveld, Forest, Nama Karoo, Succulent Karoo and Thicket Biomes, while the Fynbos Biome refers to only two vegetation types: Fynbos and Renosterveld (Low & Rebelo 1998).

The Cape Floristic Region is one of the world's richest regions in terms of botanical diversity (Goldblatt & Manning 2000). It is estimated that 9000 species of vascular plants are native to the Cape Floristic Region, of which almost 69% are endemic (Goldblatt & Manning 2000). The flora of the Cape Region thus comprises almost 44% of the approximately 20 500 species that occur in southern Africa (Goldblatt & Manning 2000). According to Goldblatt & Manning (2000) species richness of the Cape Region compares favourably with the species richness of areas of comparable size in the moist tropics. It is not strictly true that the Cape Floristic Region has for its size one of the richest floras in the world (Goldblatt & Manning 2000). The species richness of the Cape Floristic Region is substantially lower than some Neotropical areas like Costa Rica, Ecuador or Guatemala, but the species richness of the Cape Region is however remarkable when compared to other parts of Africa (Godblatt & Manning 2000).

Although the Cape Floristic Region or Cape Floral Kingdom contains five biomes, only the Fynbos Biome, comprising of the Fynbos and Renosterveld vegetation groups, contains most of the floral diversity (Low & Rebelo 1998).

It is distressing to realise that some three-quarters of all plant species in the South African Red Data Book occur in the Cape Floral Kingdom (Low & Rebelo 1998). According to Low & Rebelo (1998) there are 1700 plant species in the Cape Floral Kingdom threatened to some extent with extinction. Many Fynbos species are extremely localised in their distribution, with sets of such localised species organised into "centres of endemism" (Low & Rebelo 1998). According to White (1983) a

Regional Centre of Endemism is a phytochorion which has both more than 50% of its species confined to it and a total of more than 1000 endemic species.

BREDASDORP/RIVERSDALE CENTRE OF ENDEMISM

The study area is situated in the Bredasdorp/Riversdale Centre of Endemism (Cowling *et al.* 1992). According to Heydenrych (1994) the region of the Centre consists of he Agulhas Plain in the west, the Riversdale Plain in the east and the areas of Arniston/Waenhuiskrans, De Hoop, Potberg and Infanta. The Bredasdorp/Riversdale Centre of Endemism refers to a well-defined group of plants confined to the limestone of the Bredasdorp formation and associated colluvial deposits (Heydenrych 1994). Although lime-rich soils occur throughout the Bredasdorp/Riversdale Centre of endemism, limestone fynbos is not the only important and extensive vegetation type in the region (Heydenrych 1994). Small amounts of other soils (neutral and acid) supporting different vegetation types, such as acid sand proteoid fynbos, neutral sand proteoid fynbos, restioid fynbos and dune asteraceous fynbos, are also found in the region (Heydenrych 1994).

LIMESTONE FYNBOS:

According to Heydenrych (1994) Limestone Fynbos only occurs on limestone-substrates and may be seen as a rare subset of a rich, though threatened flora. According to Hilton-Taylor & Le Roux (1989) limestone fynbos is one of the most threatened vegetation types in the Cape Floristic Region.

Limestone fynbos is similar to Fynbos in consisting of an abundance of small leafed shrubs, containing Restios, Ericas and other fine leafed shrubs as well as shrubs belonging to the Protea family (Heydenrych 1994). Limestone fynbos however differs from other Fynbos by the fact that it is associated with limestone soils of the Bredasdorp Formation, which are mainly alkaline soils, in contrast with most other fynbos soils, which are acidic (Heydenrych 1994).

According to Heydenrych (1994) limestone usually protrudes as hills. These outcrops may be very small in extent or may form larger hills or plains. For the purpose of the study, conducted by Heydenrych (1994), limestone fynbos was considered to be presented by those species which are associated with exposed limestone outcrops. The study revealed that approximately 110 plant species are endemic to these limestone outcrops. Limestone fynbos also contains many species which are classified as rare (Heydenrych 1994).

According to Heydenrych (1994) the following species were found to be endemic to limestone outcrops: Letters in brackets next to species indicate the red data categories, according to Golding (2002): (CR) = Critical endangered, (EN) = Endangered, (VU) = Vulnerable, (LC) = Low concern, (DD) = Data deficient.

Limestone endemic species:

AIZOACEAE
Braunsia vanrensburgii
Ruschia calcicola

APIACEAE
Centella pottebergensis
Peucedanum sp. nov.

ASPHODELACEAE
Haworthia variegata

ASTERACEAE
Berkheya coriacea
Euryops hebecarpus
Euryops linearis
Euryops muirii (VU)
Felicia canaliculata
Felicia ebracteata (VU)
Felicia nordenstamii (VU)
Metalasia calcicola
Metalasia erectifolia
Metalasia luteola
Oedera steyniae
Osteospermum subulatum
Stoebe muirii
Syncarpha gnaphaloides

CAMPANULACEAE
Lobelia barkerae
Lobelia valida (VU)
Wahlenbergia clacarea
Wahlenbergia microphylla (VU)
Wahlenbergia squarrosa
Roella compacta (LC)

CYPERACEAE
Ficinia truncata

ERICACEAE
Acrostemon schlechteri
Acrostemon vemiosus
Erica berzelioides
Erica calcareophila
Erica curtophylla
Erica excavata
Erica gracilipes
Erica oblongiflora
Erica occulta (CR)
Erica propinqua
Erica pulvinata
Erica saxicola
Erica scytophylla
Erica uysii
Platycalyx pumila
Scyphogyne calcicola
Thoracosperma muirii

FABACEAE
Amphithalia alba
Aspalathus aciloba
Aspalathus calcarea
Aspalathus candidula
Aspalathus pallescens
Aspalathus prostrata

Aspalathus repens
Aspalathus salteri
Aspalathus sanfuinea
Indigofera hamulosa
Lebeckia sessilifolia

HYACINTHACEAE
Lachenalia muirii

IRIDACEAE
Freesia elimensis
Hesperantha juncifolia
Watsonia fergusoniae

MALVACEAE
Hermannia concinnifolia
Hermannia muirii
Hermannia trifoliata
PENAEACEAE
Brachysiphon mundii (CR)

POACEA
Pentachistus calcicola var. *calcicola*
Pentaschistus calcicola var. *hirsuta*

POLYGALACEAE
Muraltia barkerae
Muraltia calycina
Muraltia depressa
Muraltia lewsiae
Muraltia pappeana
Muraltia salsolacea
Muraltea splendens
Polygala meridionalis

PROTEACEAE
Leucadendron muirii

Leucadendron meridianum
Leucospermum patersonii
Leucospermum truncatum
Mimetes saxatilis
Protea obtusifolia

RESTIONACEAE
Thamnocortus fraternus
Thamnochrotus muirii
Thamnocortus paniculatus
Thamnocortus pluristachyus

RHAMNACEAE
Phylica laevigata
Phylica selaginoides
Phylica sp. nov.

ROSACEAE
Cliffortia burgersii (EN)

RUBIACEAE
Galium bredasdorpense

RUTACEAE
Acmadenia densiflolia (LC)
Acmadenia heterophylla
Acmadenia mundiana (LC)
Adenandra rotundifolia (LC)
Agathosma abrupta (LC)
Agathosma eriantha (VU)
Agathosma florulenta (LC)
Agathosma geniculata (VU)
Agathosma riversdalensis
Agathosma sedifolia (EN)
Agathosma sp. nov. 1
Agathosma sp. nov. 2
Agathosma sp. nov. 3

Diosma demissa (LC)
Diosma echinulata
Diosma guthriei (DD)
Diosma Haelkraalensis (CR)
Euchaetis laevigata (LC)
Euchaetis intonsa (CR)
Euchaetis longibracteata
Euchaetis meridionalis (LC)

SCROPHULAREACEAE
Sutera calciphila
Sutera subspicata

Limestone fynbos is an important, unique, rich and rare vegetation type (Heydenrych 1994). There are many factors threatening limestone fynbos vegetation, of which invasive alien plants seem to be the biggest. Other threats to limestone fynbos vegetation include land clearing, resort development, bad fire management and over-harvesting of flowers (Heydenrych 1994).

According to Heydenrych (1994) 21% of all limestone fynbos species are not conserved in state-owned nature reserves. The conservation of limestone fynbos on privately owned land, like Andrew's Field and Tsaba-Tsaba nature reserve is therefore of the utmost importance.

A study on the coastal vegetation of South Africa, with specific reference to the life cycle of coastal dune species, was conducted by Knevel (2001).

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CHAPTER 3: METHODS

INTRODUCTION

A plant community can be defined as an association with a definite floristic composition, uniform physiognomy and is bound to uniform habitat conditions (Werger 1974). A plant community is not merely a random aggregate of species, but is an organised group with a typical floristic composition and combination of growth form, structure and physiognomy (Van Wyk & Smit 2001). A plant community is the result of a unique combination of certain environmental conditions and results from the interactions of species interactions through time (Van Wyk & Smit 2001). Plant communities are conceived as types of vegetation recognised by their floristic composition (Westhoff & Van der Maarel 1973). According to Van Rooyen & Theron (1995), plant communities are units with the same species composition and structure. To be defined as a plant community, homogeneity should exist within the association. Homogeneity implies that the specific species group that is considered representable of the described plant community must exist over a fairly large area, without any detailed variation within (Kent & Coker 1996).

Because each plant community has it's own floristic composition, physiognomy and habitat conditions; each plant community should be managed differently, as different plant communities react differently to environmental changes and utilisation by animals. It is therefore essential for sound management purposes to distinguish the different plant communities, as each will need a separate management plan (Bredenkamp & Brown 2001).

According to the Braun-Blanquet method, selected representative, homogenous plots of a certain minimum area, are used to sample the vegetation of a certain area (Westhoff & Van der Maarel 1973, Werger 1974, Van Rooyen 1996).

A selection of relevès is desired that will effectively represent the variation in the vegetation under study, choosing the samples in such a way that they will not represent different plant communities disproportionately and will not include mixed, incomplete, or unstable stands (Westhoff & Van der Maarel 1973).

ANALYTICAL PHASE

In the analytical phase data is gathered in the field. The following are considered during the analytical phase:

Site selection

The selection of sample sites was done in a stratified random way, within mapped units. Relatively homogeneous physiographical-physiognomical units were mapped on aerial photographs of a 1: 10 000 scale. The sample plots were placed stratified-randomly within these units (Van Rooyen 1996).

Representativeness and Homogeneity

An important prerequisite of a physiographic-physiognomic unit is that it should be homogenous in nature, concerning the floristic composition, vegetation structure and habitat (Werger 1973, Van Rooyen 1996). No obvious boundaries or variation in stratification must be visible within a stand (Westhoff & Van der Maarel 1973), to ensure that only one plant community is represented in the sample plot. Sample plots should be selected in such a way that it represents the vegetation it forms part of, giving a more or less typical description of the vegetation in terms of both floristic composition and structure (Werger 1974). Care was therefore taken in this study to place sample plots in areas that were considered to be relatively homogeneous and representative of a particular plant community, while heterogeneity within a sample plot was avoided.

Distribution and number of sample plots

Sample plots were placed randomly in each of these physiographic-physiognomic units *pro rata* on an area basis, and the exact location of each sample plot was marked with a transparency pen on a transparency, placed over the aerial photograph. Sample plots that were placed in this way in the field sometimes lie in an area that can be locally heterogeneous concerning both floristic composition, as well as habitat conditions. In exceptional cases, sample plots were therefore moved to ensure that the most important prerequisite of the Zurich-Montpellier approach is met, namely that each sample plot must be placed in a relative homogenous area. In the study area, sample plots that should have been placed near the middle of areas highly infested with mole-rats, was shifted to as near the roads running through these areas as possible, due to the inaccessibility of these areas. The aim was to place a minimum of one to two sample plots in each mapped physiographic-physiognomic unit, to ensure a fairly strong view of the vegetation of each unit. The number of sample plots will also depend on the scale of the survey and the heterogeneity of the area (Van Rooyen 1996). In this study 171 sample plots were used to sample an area of approximately 979 ha, giving an average of 0.175 per ha, or approximately one sample plots per five ha.

Minimal area and plot size, plot form

According to Westhoff & Van der Maarel (1973) the size of a sample plot largely depends on the structure of the vegetation under study, but may also be affected by the size of the stand (community). The stand may be sufficiently small to be analysed largely in one sample plot, or if this is not possible, then the plot should be large enough that all species of regular occurrence in the stand should be present in the sample plot (Westhoff & Van der Maarel 1973). In extremely uniform phytoceoenoses (communities/associations) which are very poor in species, where differences in abundance and cover are of major concern, these differences should be considered in establishing the size of the sample plot (Westhoff & Van der Maarel 1973).

According to Werger (1974) the determination of a certain minimal size of area in which the community can be represented, is important since communities can be sampled most efficiently with plots the size of minimal area or slightly larger. If a community is sampled with plots smaller than the minimal area, is difficult to extract the community type from the data, while if the plots are larger than the minimal area, much effort is wasted (Werger 1974). The minimum-area of the sample plots can be calculated using a species-area curve (Kent & Coker 1996, Van Rooyen 1996). The minimum area would then be the area where the species-area curve becomes more or less horizontal (Werger 1974).

Because of the fact that species are rated on a cover-abundance scale with relative values in the Zurich-Montpellier method, one is not bound to either a fixed plot size or fixed plot form in sampling the vegetation (Werger 1974). It is important to adapt plot size to give a more or less typical description of the phytocoenosis that is represented by the vegetation in the plot, and that the vegetation in the plot should represent an example of one vegetation type only (Werger 1974).

In this study a plot size of 10 m^2 was used. The shape of plots was mostly square (10 x 10 m). In dense, impenetrable areas, rectangular plots of (2 x 50 m), parallel to the roads were used.

Structure

When sampling, samples should be taken in such a way that each plot adequately represents the structure of the surrounding vegetation (Werger 1974). Sometimes a vegetation can be regarded as either consisting of a mosaic of two vegetation types or as consisting of one vegetation type. An important decision regarding structural homogeneity therefore needs to be taken. For vegetation to be a mosaic of two communities locally more extensive homogenous patches of either of the two communities should be found (Werger 1974). In areas where the Thicket Biome forms a mosaic with the Fynbos Biome vegetation, care was taken to ensure that thicket and fynbos patches were surveyed separately, where possible.

An important structural character is vegetation layering (Westhoff & Van der Maarel 1973). In a sample plot as many layers are distinguished as is considered appropriate or necessary (Westhoff & Van der Maarel 1997). The Braun-Blanquet approach considers the different layers as being in mutual ecological interaction, and they cannot therefore be considered as separate, independent ecological units, and has to be analysed as a whole (Westhoff & Van der Maarel 1973, Werger 1974).

At each plot, where various vegetation layers are distinguished: their ranges in height and an estimation of the aerial cover of each layer, as well as an estimation of total aerial cover of the entire vegetation of the sample plot, including all strata, are recorded (Werger 1974).

In the study the average height and percentage cover of the following were recorded separately, but analyzed as a whole: trees/shrubs, grasses/reeds, restioids/rushes, forbs and sedges.

Floristic observations

A complete list of plant species found in each sample plot must be drawn up (Werger 1974). Correct identification of the species is essential (Van Rooyen 1996).

The relative importance of each species in the sample plot is assessed, using the cover-abundance scale, used by the Zurich-Montpellier School (Werger 1974). The scale is partly based on cover and partly on abundance (Werger 1974). Abundance relates to the density of the individuals of a given species in a plot, while cover degree is measured as the vertical projection of all aerial parts of plants of a given species as a percentage of the total plot area (Westhoff & Van der Maarel 1973).

The most commonly used cover-abundance scale used in Braun-Blanquet type surveys reads as follows:

r - Very rare, with negligible cover (usually a single individual).

+ - Present but not abundant, small cover value (less than 1 % of plot area)

1 - Numerous but covering less than 1% of quadrate area, or not so abundant, but covering 1 - 5% of quadrate.

2a - Very numerous, covering less than 5% or covering 5 - 12% of quadrate, independent of abundance.

2b - Covering 12 - 25% of quadrate area, independent of abundance.

3 - Covering 25 - 50% of quadrate area, independent of abundance.

4 - Covering 50 - 75% of quadrate area, independent of abundance.

5 - Covering more than 75% of quadrate area, independent of abundance.

(Werger 1974, Van Rooyen 1996).

In this study a relevé was compiled in every sample plot by recording all species present in the sample plot and giving a cover-abundance value to each species according to the above mentioned scale.

<u>Habitat characteristics</u>

The distribution of plants is directly determined by the physical factors of the environment (Van Rooyen 1996). It is therefore necessary to measure or observe and note the more obvious environmental factors, which might influence the distribution of plants (Van Rooyen 1996). The more precisely habitat observations are, the more clearly associations extracted from the data can be characterized ecologically later (Werger 1974). The usual identifying information such as locality, date of sampling and size of plot is noted for each sample plot. The following can also be noted for each sample plot: altitude, topographical position, slope angle and slope direction, geology, soil, erosion, rockiness of the soil, geomorphology, soil characteristics, climatic information and biotic influence (Van Rooyen 1996, Werger 1974).

In this study locality, date of sampling, altitude, topographical position, geomorphology, exposure to sun and wind, slope angle, slope direction, geology, soil, percentage rock cover and biotic influence were noted.

SYNTHETIC PHASE

Analyzing the stands is only the first step in the description of vegetation units. After collecting the relevés, they must be compared. This is the beginning of the synthetic phase, which leads to the distinction of plant communities (Westhoff & Van der Maarel 1973). Many different mathematical and statistical algorithms exist in various computer programs to classify the relevés into plant communities (Whittaker 1978)

According to Coetzee (1974a) using the Braun-Blanquet-method leads to a better understanding of the vegetation, than using normal Association Analysis processing (Coetzee & Werger 1975). The more modern TWINSPAN (Hill 1979a), a divisive, polythetic classification algorithms, is presently the most widely used numerical technique used to obtain a first approximation of the plant communities of an area, and these results are then refined by application of the classical Braun-Blanquet methodology (Behr & Bredenkamp 1988)

Relevés were classified using TWINSPAN (Hill 1979a) and refined using Braun-Blanquet procedures.

Comparison and rearrangement of relevés

In the classical Braun-Blanquet method, the field data are tabulated in a matrix, in which rows represent species and the columns relevés (Werger 1974, Westhoff & Van der Maarel 1973). The completed matrix is called a raw table (Werger 1974). The association between species is then visually studied, and the matrix rearranged so that positively associated species are grouped together, apart from the general and most infrequent species that do not show clear discriminant floristic associations, and are listed in the lower part of the table (Werger 1974). The matrix of the table is the cover-abundance values of the species found in the sample plots (Van Rooyen 1996).

The successive rearrangement of rows (species) and columns (relevés) in the matrix should be continued until a clear pattern of mutually discriminant noda of species-relevé groups is obtained (Werger 1974).

More recently the rearrangement of the raw table has been done with the aid of a numerical cluster analysis (e.g. Bredenkamp 1982).
TWINSPAN is a computer program in FORTRAN that has primarily been designed for ecologists and phytosociologists who have collected data on the occurrence of a set of species, in a set of samples (Hill 1979a).

TWINSPAN first constructs classification of samples, and then uses this classification to obtain a classification of the species according to their ecological preferences (Hill 1979a). Both classifications are then used together to obtain an ordered two-way table that expresses the species' synecological relations as succinctly as possible (Hill 1979a).

The uniform phytocoena are then distinguished and characterized in the structured table (Westhoff & Van der Maarel 1973).

A fixed pattern of groups of relevés, with a characteristic floristic composition is obtained. In this way the table is divided into nodums, where every nodum represents relevés with a similar characteristic species composition (Van Rooyen 1996). Individual relevés are commonly placed within a nodum in a specific sequence. The sequence can be according to any environmental gradient observed, or another varying character of the vegetation or habitat observed (Werger 1974). Species are usually placed in order of their presence in each nodum (Werger 1974).

The nodums obtained are tested and confirmed through correlation between the plant community represented by the nodum, to find the specific physical habitat characteristics, noted during the survey (Van Rooyen 1996). A probable vegetation gradient is determined by using a computerized ordination algorithm DECORANA (Detrended Correspondence Analysis) (Kent & Coker 1996). According to Hill (1979b) the main purpose of DECORANA is to make ordinations by the method of detrended correspondence analysis. Detrended correspondence analysis is derived from a simpler method of ordination called reciprocal averaging. The main problem of reciprocal averaging is that the second axis tends to be strongly related to the first axis, leading to the arch effect (Hill 1979b). The arch effect is avoided in Detrended correspondence analysis by demanding that there shall be no systematic relation of any kind between the higher axes and the first (Hill 1979b).

The reality of the ecological interpretation of the plant communities is checked in the veld (Van Rooyen 1996).

An ecologically meaningful vegetation type should be based on a group of relevés which at least share some sets of unifying attributes, which allow a positive definition in terms of floristics, and which are related to a coherent complex of environmental conditions (Coetzee & Werger 1975).

In this study the vegetation and habitat data were captured in the TURBOVEG database (Hennekens 1996a, Hennekens & Schaminee 2001). The floristic data were extracted to the tabular editor MEGATAB (Hennekens 1996b) and a first approximation of the plant communities of the area was obtained by applying the TWINSPAN algorithm (Hill 1979a) that is built into MEGATAB, to the data. Refinement of this result was done within MEGATAB, and this resulted in the compilation of two separate phytosociological tables.

To indicate gradients within and between plant communities, the floristic data was subjected to the DECORANA ordination (Hill 1979b), and the results are presented in ordination diagrams.

Nomenclature

Plant communities are named binomial according to the method described by Barkman *et al.* (1986).

The name-giving taxon must be present in the syntaxon concerned (Werger 1974). Species with a high degree of restriction, which are restricted to one or a few nodums, are called diagnostic species. Diagnostic species found in only one nodum are called character species, while diagnostic species in a particular table, which may be widespread in other tables are called differential species (Westhoff & Van der Maarel 1973).

It is common practice that syntaxa are named after one or two of the diagnostic species. Sometimes a prominent or constantly abundant species is used in combination with a diagnostic species (Werger 1974).

The community can also be named by combining a certain species name with the most outstanding physiognomic characteristic of that particular community and/or with the most prominent habitat characteristic of the community (Van Rooyen 1996). Edwards' structure classification is used to supply an applicable physiognomic term, which is attached to the species name, to form the final name of the community (Edwards 1983). The characteristics that are used are four growth forms (trees, shrubs, grasses and herbs), four canopy cover classes (closed, open, sparse and spread out), and four height classes (high, long, short and low) determined separately for trees, shrubs and grasses & herbs) (Van Rooyen 1996). Poaceae, Cyperaceae and Restionaceae are all included under grasses in Edwards' structural growth forms (Van Rooyen 1996).

The syntaxa were named using a dominant plant species in the vegetation unit, in combination with a diagnostic or prominent species, and adding a physiognomic term, according to the classification of Edwards (1983). In appropriate cases, like the beach vegetation syntaxon, the names of the plant species were combined with the prominent habitat characteristic.

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CHAPTER 4: RESULTS

In general the vegetation of the area can be referred to as Reed wetland, Dune Thicket/Forest, Limestone fynbos, Dune Asteraceous Fynbos, and a little bit of South and Southwest Coast Renosterveld (Low & Rebelo 1998, Cowling & Richardson 1995).

Six main different habitat types are found in the study area, namely the wetland, limestone hills, shallow limestone plain, deep-soil limestone plain, neutral sand area, undulating dune plain and Renosterveld.

A TWINSPAN analysis of the total floristic data set comprising of 171 relevés revealed two main vegetation types, namely (i) the Inland Plains and Hills and (ii) the Coastal Thicket, Dunes and Strand. To describe these two main vegetation types adequately, two separate phytosociological tables were constructed, Table 2 showing plant communities 1-4 of the Inland Plains and Hills and Table 3 showing plant communities 5-10 of the Coastal Thicket, Dunes and Strand.

CLASSIFICATION OF THE INLAND PLAINS AND HILLS OF ANDREW'S FIELD AND TSABA-TSABA NATURE RESERVE

Four plant communities were distinguished in the Inland Plains and Hills area of the study area, with the aid of the TWINSPAN program (Hill 1979a), as contained within MEGATAB (Hennekens 1996b). The second community can be subdivided into four sub-communities. The third community can be subdivided into five sub-communities. The classification is as follows:

1. *Phragmites australis* - *Juncus kraussii* short to high closed Reed Wetland community.

2. *Chondropetalum microcarpum* - *Metalasia pungens* low closed ericoid and restioid fynbos community.

2.1. *Adromischus caryophyllaceus* - *Chondropetalum microcarpum* low closed limestone fynbos sub-community.

2.2. *Passerina corymbosa* - *Chondropetalum microcarpum* low to short closed fynbos sub-community.

2.3. *Empodium gloriosum - Chondropetalum microcarpum* low to short, closed limestone fynbos sub-community.

2.4. *Eriocephalus kingesii - Chondropetalum microcarpum* low to short, closed fynbos sub-community.

3. *Leucadendron meridianum - Protea obtusifolia* low to high limestone fynbos community.

3.1. *Amphitalia alba - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.2. *Erica abietina - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.3. *Ehrharta calycina - Leucadendron meridianum* low to short limestone fynbos sub-community.

3.4. *Metalasia muricata - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.5. *Protea susannae - Leucadendron coniferum* high closed fynbos sub-community.

4. *Oedera uniflora - Elytropappus rhinocerotus* low closed Renosterveld community.

A diagrammatic presentation of the hierarchical classification and associated environmental interpretation of the plant communities can be seen in Figure 5. The community numbers in Figure 5. correspond with the plant community numbers used in the descriptions in the text.

DESCRIPTION OF PLANT COMMUNITIES

1. *Phragmites australis - Juncus kraussii* short to high closed Reed Wetland community.

The structure of the community can be described as high, dense reeds (*Phragmites australis*) in and close to the dam, both high *Phragmites australis* and medium high *Juncus kraussii* and some other low shrubs in the area immediately surrounding the dam (Photo 1). The surrounding marshy area contains medium high, dense *Juncus kraussii,* with some low shrubs in between. Height- and plant cover classes of plants are described according to the structural classification of Edwards (1983),

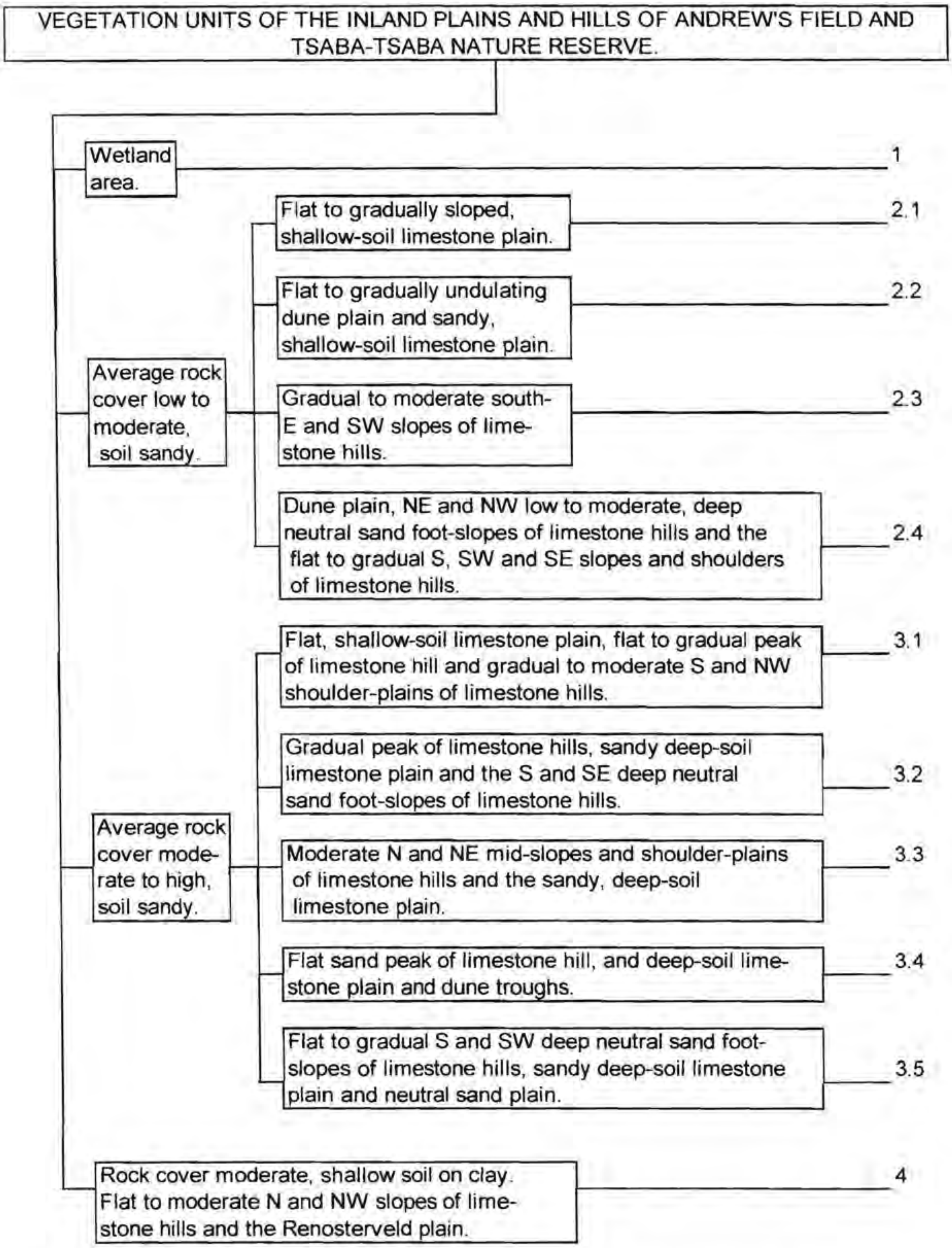

Figure 5. The hierarchical classification and associated environmental characteristics of plant communities of the inland plains and hills.

Photo 1. *Phragmites australis - Juncus krausii* reed wetland community, showing a dense stand of *Phragmites australis* in the dam, with *Juncus krausii* and *Plecostachys serpyllifolia* on the perifery.

Table 2. Phytosociological table of inland plains and hills of Andrew's field and Tsaba-Tsaba nature reserve.

	1	2				3					4
Community number		2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	3.5	
	1		1 1	1		1	1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1		1 1 1 1
Releve number	4 5	1 1 3 1 2 2 3	5 6 1 1 1 6 9 4 2 2 3 0 5	3 2 5 1 1 2 2 3 4	4 1 1 2 2 2 3 4 5	6 3 0 6	3 5 5 5 5 5 5 7 9 6 7 7 4	6 0 1 1 9 4 4 0 5 0 6 9 3 0 1 5 1	4 5 6 7	4 5 6 6 7	0 1 6 1 5
	1 7	1 5 6 6 8 5 9 0 8 2	6 1 1 2 5 8 9 3 4 2 0 0 8 2	9 3 4 4 7 5 9 8 4	3 0 4 7 8 9 0 3 1 6 7 1 6 5	9 6 8 3	6 2 2 9 3 9 8 0 6 0 2 3 7	5 6 1 4 8 2 5 2 4 5 7 7 7 7 2 1 0	8 5 0 0	8 0 4 6 1	4 3 2 8 6
Species group A											
Juncus kraussii	4 3	. . . .	. . . .	. . . .	. . . .	. + . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Plecostachys serpyllifolia	a a	. . . .	. + ... + . + ...	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Phragmites australis	5 .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Species group B											
Metalasia pungens	. .	3 + a 3 b a b b . a	. b 1 + 3 1 1 1 b 1	. 1 1 . + . 1 . .	1 . + a . . 1 . b . . a . .	. 1 . .	. . 1	. 1 . . . . 1 . .	. . . .	. . . . .	r . . . a
Indigofera meyeriana	. .	1 . + . + . + + . +	+ . + + + . + . + + r + . r	. . . + . . . + +	+ + + + + + + + + + . + + +	. . + .	. . . .	. + . + ...	. . . .	. . . . .	. . . . .
Acmadenia obtusata	. .	a . 1 3 r b 1 4 . 3	4 a . 1 1 . 4 . . . . 3 . .	. a	. 3 . a . . 4 . a . . a . 1	. 1 . .	. . . .	. . . . a	. . . .	. . . . .	. . . . .
Cymbopogon plurinodis	. .	1 . . 1 . . a . . .	. . . a . . . a a 1 . . . 1	1 . . . 1 a 1 a .	a . . . . a . a a . . . b .	. . . .	. . . . 1 3 .	. . . . a . 1	. . . .	. . . . .	. . . . .
Calopsis viminea	. .	1 . . . . a a 1 . .	. . . . . a . . a . a . . .	. . . . b 1 . . .	1 a 1 . . 1 1 . a . a a . 1	. . . .	. . . . . . 1	. . . .	. . . .	. . . . .	. . . . .
Agathosma collina	. .	. 1 . . . . . . r 1	a . . a 1 . . . . 1 5 5 . 5	. . . . . . 3 . .	a . . . 4 . . 1 . 3 3 3 . 1	. . . .	. . . . . . 1	 1	. . . .	. . . . .	. . . . .
Muraltia satureoides var. sat	. .	+ + . r a + 1 + . .	. + ... + ...	+ . + ... +	. . + + ... + ...	. . + r	+	. . . . + ... + +	. . . .	. . . . .	. . . . .
Lobelia setacea	. .	. . . + r . + . . .	. . . .	. . . .	. . + r . + . . + ...	. . . .	. . . .	. . . . + .	. . . .	. . . . .	. . . . .
Setaria sphacelata var. spha	. .	1 . . . . . . 1 . 1	. . . .	. . . . . . 1 . .	. . . r + . . . 1 1	. . . .	. . . .	. . . . 1	. . . .	. . . . .	. . . . .
Species group C											
Adromischus caryophyllaceus	. .	. + + . + . r . . r	+ . . . + ...	. . . . +	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Delosperma litorale	. .	. . . . 1 + + + . +	. . . + ...	. . . .	. . . . + . + . .	. . . .	+	. . . . + .	. . . .	. . . . .	. . . . +
Diosma guthriei	. .	a . 1 . 1 . . 1 . 3	. . . . . . 3	. . . a	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Ficinia truncata	. .	a . 1 . . b a b . .	. . . .	b	. . . .	. b . .	b 1	. . . . 1 1 . a . .	. . . .	. . . . .	 1
Aspalathus hispida	. .	. . . + . 1 . + . 1	. . . . . + ...	. + ...	. . . 1	. . 1 .	+	. . . . 1 + ...	. . . .	. . . . .	. . . . a
Helichrysum retortum	. .	. . . . . . + r . +	. . . .	+ + . + ...	. . . .	. . + .	. . . .	. . . . + . . .	. . . .	. . . . .	. . . . .
Cynodon dactylon	. .	. . . . . + . . 1 +	+ . . . . . . + ...	. . . .	. . . . + ... +	. . . .	. . . . + . .	. . . + ...	. . . .	. . . . .	. + . . +
Ruschia calcicola	. .	1 . + + ...	. . . . + ...	. . . .	. . . .	. . . .	. . . .	. . . . + ...	. . . .	. . . . .	. . . . .
Metalasia erectifolia	. .	. . . . . 1 1 . . .	. . . .	. . . .	. b	. . . .	. . . .	. . . . 1 .	. . . .	. . . . .	. . . . +
Species group D											
Passerina corymbosa	. .	. . . . . a . . . 3	. 1 3 a 1 1 1 1 a . a a . .	. . . .	. . . .	. . . .	. a	. . . . a	. . . .	. . . . .	. . a . .
Agathosma dielsiana	. .	. . . . a b	. r 1 + + 1 . + . 1 . . . 1	. . . . + . a . .	. . . .	. + . .	. . . .	. . . . 1	. . . .	. . . . .	. . . . .
Ischyrolepis triflora	. .	. . 1 . . . . . . a	b 1 . a b a . . 1 . . . 1 .	. . . .	. . . 1 . . 3	. . . .	. . . .	. . . . a	. . . .	. . . . .	 1
Wachendorfia paniculata	. .	. . . . . 1 . . . 1	. . . . . + + ... + . .	. . . .	. . . .	. . . .	. + ...	. . . . r	. r . .	. . . . .	. . . . .

Species group E											
Empodium gloriosum	. .	. . . . . a . . r .	. . . .	1 r + + + . r + +	. . . .	. . . .	. . . .	. . . . . . + ...	. . . .	. . . . .	. . . . .
Helichrysum plebeium	. .	. . . .	. . . . + ...	. . . . . + . + +	. . + ...	. . . .	. . . .	. . . . . + ...	. . . .	. . . . .	. . . . .
Gnidia oppositifolia	. .	. . . . r . +	. . . . r	. . . r . 1 . + .	. . . .	. . . .	. . . . + ...	. . . .	. . . .	. . . . .	. . . . .
Species group F											
Eriocephalus kingesii	. .	. . . 1	. b	. . . . b b . . .	1 . . . . b . b . . a . .	. . . .	. . . .	. . . . . . 1 1	. . . .	. . . . .	. . . . .
Indigofera glomerata	. .	. . . . . . r . . .	. . . . r	. . . .	. . . . . . 1 . r	. . . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Chasmanthe aetiopica	. .	. . . .	. . + ...	. . . .	. . . . . + ... + . .	. . . .	+	. . . .	. . . .	. . . . .	. . . . .
Species group G											
Helichrysum patulum	. .	. . . . 1	. . . . 1 . .	1 . 1 . . . . 1 .	. 1 . . . . . 1 . . . b .	1 1 a 1	. 1 1 a b 1 1 1 a 1 1 1 a	a a 1 1 . a + . . 1 . 1 1 1 . . a	1 1 a b	a 1 1 1 1	. 1 . . .
Crassula glomerata	. .	. . . .	+	. . . .	. . . . + ...	. . . +	+ . . + + . + + . . + . +	. + + + . . . + . + + . + + + . +	. . . .	+ r + + r	. + . . .
Leucadendron meridianum	. .	. . . .	. . . . . . 4	. . . .	. . . .	5 . . 4	. 3 b b 4 4 . . 4 . b . 3	. 4 3 . . 4 . . . . . 5 3	. b 5 .	. . . b .	. . . . .
Protea obtusifolia	. .	. . . .	. . . .	. . . .	. . . .	3 . . b	. . b b b a . . 3 . 3 . 4	. . 3 . . 3 . . . . . a . . . . a	. 3 a .	. . . . .	. . . . .
Oxalis obtusa	. .	. . . .	. . . .	. . . . +	. . . . + .	+ . . .	. + . . + . + + . . + + +	+ . . . . . + . . r	. . . .	+ . . 1 +	. . . . .
Knowltonia vesicatoria	. .	. . . .	. . . .	+	. . . .	+ . . .	. . + + + + ... +	. + + + ... + . . + .	. . . .	+ + . 0 +	. . . . .
Hemimeris racemosa	. .	. . . .	+	. . . .	. . . .	. . . .	. . . + + . . + . . . + .	r + ... + r	. . . .	+ + . . .	. . . . .
Albuca cooperi	. .	. . . .	. . . . + .	. . . .	. . . .	. . . .	r . + ...	. . . . + ... + +	. . . .	. . . . .	. . . . +
Species group H											
Osteospermum subulatum	. .	. . . .	. . . .	. . . .	. . . .	1 . . a	r . . + ... 1 + . . .	. . . .	. . . .	. . . . .	. . . . .
Salvia africana-lutea	. .	. 1 . . . . 1 . . .	. . . .	1	. . . 1 a a	. 1 . .	. . . . . . 1	. . . .	. . a .	. . . . .	. . . 1 .
Bobartia longicyma ssp. mag	. .	. . . .	. . . .	. . . .	. . . .	. + + +	. . . . + + . . .	. . . .	. . . .	. . . . .	. . . . .
Adenandra obtusata	. .	. . . .	. . . .	. 1	. . . .	. a . a	. . . 1 . . . . 1	. . . .	. . . .	. . . . .	. . . . .
Metalasia calcicola	. .	. . . .	. . . .	. . . 1	. . . .	. 3 . a	1 . b 3	. . . .	. . . .	. . . . .	. . . + .
Hermannia trifoliata	. .	. . . .	. . . .	. + ... + .	. . . .	. + + +	+ + ... + + . . .	. . . . + ...	. . . .	. . . . .	. . . + .
Hermannia concinnifolia	. .	. . . .	. . . .	. + ... + +	. . . .	+ . . +	+ + ...	. . . .	. . . .	. . . . .	. . . . .
Species group I											
Amphithalea alba	. .	. . . .	. . . .	. . . .	. . . .	1 1 1 .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Leucospermum truncatum	. .	. . . .	. . . .	. . . .	. . . .	. 1 . 1	. . . .	. . . .	. . . .	. . . . .	. . . . .
Dimorphotheca nudicaulis	. .	. . . .	. . . .	. . . .	. . . .	. + + .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Oedera capensis	. .	. . . . + ...	. . . .	. . . .	. . . .	. a . 1	. . . .	. . . .	. . . .	. . . . .	. . . . .
Erica spectabilis	. .	. . . .	. . . .	4 a	. . . .	. a . 1	. . . .	. . . .	. . . .	. . . . .	. . . . .
Centella triloba	. .	. . . .	. . . .	. . . .	. . . .	. . + +	. . . . + ...	. . . .	. . . .	. . . . .	. . . . .
Syncarpha canescens	. .	. . . .	. . . .	. + ...	. . . .	. 1 . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Erica longifolia	. .	. . . .	. . . .	. . . .	. . . .	. + . .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Erica propinqua	. .	. . . .	. . . .	. . . .	. . . .	. . + .	. . . .	. . . .	. . . .	. . . . .	. . . . .
Species group J											

Dorotheanthus bellidiformis	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . . r + . . + + .	. . . .	. . . .	. . . . .	. . . . .
Heterolepis peduncularis	. .	. . . .	. . . .	. . . .	. . . .	. . + .	+ + 1 . . . . . + ...	. . . .	. . . .	. . . . .	. . . . .
Erica abietina var. abiet	. .	. . . .	. . . .	1 . . 1 . . . 1 .	. . . .	. . . .	. . a . . . . . 1 a . . .	. + ...	. . . .	. . . . .	. . . . .
Gladiolus gracilis	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . r r . . r + ...	. . . .	. . . .	. . . . .	. . . . .
Stoebe cinerea	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . a . . 1 1 .	. . . .	. . . .	. . . . .	. . . . .
Dianthus albens	. .	. . . .	. . . .	. . . .	. . . .	. . . .	+ . + ...	. . . .	. . . .	. . . . .	. . . . .
Boophane disticha	. .	. . . .	. . . .	. . . .	. . . .	. . + .	. . . . + r	. . . .	. . . .	. . . . .	. . . . .
Aspalathus globulosa	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. + . 1	. . . .	. . . .	. . . . .	. . . . .
Zygophyllum uitenhagense	. .	. . . . . 1 . . . +	. . . .	. . . .	. . . .	. . + .	. . . . + + . . .	. . . .	. . . .	. . . . .	. . . . .
Freesia caryophyllacea	. .	. . . . . + ...	. . . .	. . . .	. . . . + .	. . . +	. . . . . . + + ...	. . . .	. . . .	. . . . .	. . . . .
Species group K											
Ehrharta calycina	. .	. . . .	. . . .	. . . .	. . . . +	. . + .	. . . . + . . . 1 .	. . . . + . . 3 . . + . . + + + +	. . . .	. . . . .	. + . . .
Moraea tripetala	. .	. . . .	. . . .	. . . .	. . . .	. . + .	. . . .	. + + . r . . . . + . . . + . . +	. . . .	. . . . .	. . . . .
Heliophila pusilla	. .	. . . .	+ . . . . . + ... + .	. . . .	. . . .	. . . .	. . . + ... + ...	. . + . + . . . + . . + . + . . +	. . . .	. . . . .	. . . . .
Senecio burchellii	. .	. . . .	+	. . . .	. . . .	. . . .	. . . .	. . . . + . . + + + +	. . . .	. . . . .	+ . . . +
Bromus diandrus	. .	. . . . + .	. . . .	. . . .	. . . .	. . . .	. . . . . . + . + ...	1 . . . + . . a . . . + ... +	. . . .	. . . . .	. . . . .
Selago fruticosa	. .	. . . .	. . . .	. + ...	. . . .	. . . .	. . . .	. . + ... + r +	. . . .	. . . . .	. . . . +
Torilis arvensis	. .	. . . .	. . . .	. . . .	. . . .	. r . .	. . . .	+ . . + ... + ... +	. . . .	. . . . .	. . . . .
Gazania pectinata	. .	. . . .	+	. . . .	. . . .	. . . .	. . . . . . + ...	. . + ... + . + . r	. . . .	. . . . .	. . . . .
Sebaea aurea	. +	. . . . + .	. . . .	. . . . . . + . .	. . . .	. . . .	r	. + . + . . . + . . . + ...	. . . .	. . . . .	. r . . +
Heliophila refracta	. .	. . . . . 1	. . . .	. . . .	. . . .	. . . +	. . . .	. . . . + . + + . . + ...	. . . .	. . . . .	. . . . .
Cassine peragua	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . 1	. . . . a a 3 . .	. 1 . .	. a . . .	. . . . .
Eragrostis sarmentosa	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . r + . . +	. . . .	. . . . .	. . . . .
Felicia aculeata	. .	. . . .	. . . .	. . . .	. . . .	. . + .	. . . . + ...	. . . . + ... r + . .	. . . .	. . . . .	. . . . .
Cerastium capense	. .	. . . .	. . . . . . + ...	. . . .	. . . .	. . . .	. . . .	. . . . + . . + . . +	. . . .	. . . . +	. . . . .
Cineraria geifolia	. .	. . . .	. . . .	. . . .	. + ...	. . . .	. . . .	. . + ... a . . . . . . + . .	. . . .	. + . . .	. . . . .
Species group L											
Protea susannae	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	a 3 4 3 .	. . . . .
Leucadendron coniferum	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . b	. . . .	4 3 3 3 .	. . . . .
Galium tomentosum	. .	. . . .	. . . .	. . . .	. . . .	. + + .	. . . . + ... +	. + + ... + ...	. . . .	1 + + . .	. . . . .
Trichogyne repens	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . . 1 + ...	. . . . 1	. . . .	a 1 . . .	. . . . .
Phylica stipularis	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . b . . . 1 .	. . . .	. . . .	1	. . . . .
Zaluzianskya villosa	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . + ...	. . . .	. . . .	. r . . r	. . . . .
Cynanchum zeyheri	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. 1 . . .	. . . . .
Gymnodiscus capillaris	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . + + .	. . . . + ...	. . . .	. . . . .	. . . . .
Erica sessiliflora	. .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . 1 . .	. . . . .

Species group M											
Phylica ericoides	. . .	a 1 a a a . a a . b	. 1 . 1 a . . 1 a . 1 . . 1	3 a 1 1 1 . . b b	1 3 3 1 a 1 1 1 a . . . 1 .	1 3 1 b	1 a a 1 . . . . a 3 1 . 1	. . 1 . 1 a 1 1 1 1	. . . .	. . . . . .	 1
Carpobrotus acinaciformis	. . .	1 1 . + + ... +	+ . . + + . . . + + . . + 1	. + + . 1 1 . + 1	a . 1 1 1 1 . + + . + + + .	+ 1 + 1	+ . + + . + + . + + . . +	. . + + + . + a . . . . . + + . +	. . . .	. . . . . .	. . . + .
Disparago anomala	. . .	a 3 1 a 4 1 3 . . 1	. 1 1 . a 1 1 a . 1	a + 1 . b . . b a	. a a 1	1 b 1 a	1 a 1 1 . . . 1 + . . .	. . 1 . 1 . . . . 1 1 . 1 .	. . . .	. . . . . .	+ . . . 1
Satyrium carneum	. . .	. . . . . a . r . +	+ . + r r + r . r . r . . .	+ . . . . +	. . . . . r r . r	+ + + .	+ . + . . + . + + . . +	. + ... + . + . + ...	. . . .	. . . . . .	+ . . . .
Limonium scabrum var. sca	. . .	. . . . . . + . . .	+ . . . . . r . + . + r + .	+ r + ... + .	. . . . + +	. . + .	+ . + ... + + . . .	. . . . + . r . + + + . + + . + +	. . . .	. . . . . .	. + . . .
Lobostemon curvifolius	. . .	. . . 1 . . + +	. . . + . . . 1 . 1 1 . . .	1 . . . + . . 1 1	. . + . . 1 . . 1 . . . a .	. 1 . .	. . . . + + + r	. . . . + . a . . a . . . . . . + .	. . . .	. 1 + . . .	. . . + .
Stipagrostis zeyheri ssp. ser	. . .	. 3 . 1 b . a . . .	. . a 4 a . . 1 . 1 . . .	. . . . 3 b . 5 .	. b . . 4 . . a 1 . . 3 .	. . . .	. . . . 1 3 .	1 1 . . 4 . 1 . . 5	. . . .	. . . . . .	 1
Clutia daphnoides	. . .	. . + . + ...	. . . . + ...	. + . + + . . + +	. + . + . + . . + . . . + .	. . + .	+ . + ... + ...	. . . . . . + . . . + ... + .	. . . .	. . . . . .	. . . . .
Arctopus echinatus	. . .	. . . .	+ . . . . + r + ...	+	. + ... + r	. . . .	. + . . + ... +	. . + . + 1 + . + . + . . . + . .	. . . .	. . . . . .	. . . . .
Crassula subulata var. sub	. . .	. . . . r . +	+ . . . . . + . r . . . + .	. . . r . 1 . + +	. . . . + .	. . + .	. . . . +	. . . . r . . + . + +	. . . .	. . . . . .	. . . . .
Aspalathus calcarea	. . .	1 . . 1 . b 1 1 . .	. 1	b 1	. . . .	1 . . .	a a . a	. . . . 1 . . . . 1 . . 1 .	. . . .	. . . . . .	. . . . .
Hermannia althaeifolia	. . .	. r . . . . r . . .	. . . .	. . . . . + . + .	r . . . . +	. . . .	. + ... + . +	. . . + + ... + + ...	. . . .	. . . . . .	. . . . .
Ficinia praemorsa	. . .	. 1 1 . . b . . .	. . . .	. a . 1	. . . .	. . + .	1 . 1 . . . . . . 1	. . . . 1 1 . 1 +	. . . .	. . . . . .	. . . . .
Indigofera brachystachya	. . .	. . . . . 1	. . . . r	+ r	. + ...	. . + +	. . + ... a a . . .	. + ... + .	. . . .	. . . . . .	. . . . .
Festuca scabra	. . .	. + ...	. . . .	. . . . +	. . . . + ...	. . . .	+ + ... + . +	+ . . . . + . . + . . .	. . . .	. . . . . .	. . . . .
Sutera calciphila	. . .	. . . .	. . . .	. . . . + +	. . . .	. 1 . 1	+ . . . . + a . . .	. . + . r . . . . + ...	. . . .	. . . . . .	. . . . .
Aspalathus pycnantha	. . .	. . 1 . . 4 3 b . .	. . + ...	. . . . + .	. . . .	. . 1 .	a	. . . . 3 .	. . . .	. . . . . .	. . . . .
Rhus laevigata var. villosa	. . .	. . . .	. . . . . . + ...	r	. . . .	1 . . .	. . . . . . + ... + . .	. . . . + . 1 . . . . + ...	. . . .	. . . . 1 .	. . . a .
Tetraria cuspidata	. . .	. . . + + ...	. . . .	. . . . . 1 . . .	. . + + ...	+ . . .	. . . . + ...	. . . . . 1	. . . .	. . . . . .	. . . . .
Lachenalia bulbifera	. . .	. . . .	+ . . . . r . r	r	. . . . r	. . . .	. . . .	. . . . + . + ...	. . . .	. r . + .	. . . . .
Pseudopentameris macrantha	. . .	. . . .	. . . .	. . . . + .	. . . . 1 .	. 1 . .	+ . . . . 1 + . . .	. . . . + .	. . . .	 3	. . . . .
Leucadendron muirii	. . .	. . . .	. . . .	. a . 3	. . . .	. . . .	3	. . 1 . . . . 4 3 . . .	. . . .	 4	. . . . .
Chironia tetragona	. . .	. . . .	. . . .	. . . .	. . . .	. . . .	+ . + ...	. . . . + .	. . . .	. . . . . .	. . . . .
Species group N											
Ischyrolepis eleocharis	. . .	3 1 b b b a a a . b	b . b a b . b b b 1 a a 1 1	3 3 1 a 1 a . b 1	a 3 a a b b b a a 1 a a 3 .	a 3 b 3	1 b 3 a 1 . a . b 3 1 . 1	. 1 a . b b . + 1 1 . . 1 1 1 1 1	. 1 . .	1 + . . +	. . . . .
Chondropetalum microcarpum	. . .	4 3 b 4 b 3 3 3 . 3	b r 3 3 3 a 1 3 3 3 . . a 3	3 3 3 3 . b 1 b 3	3 3 4 3 3 3 b a 3 b b 3 a a	1 b 4 b	3 3 3 a . . b 1	. 1 a . b . . . 1 3 1 b a 3 3	3 1 1 b	 1	. 3 . . .
Metalasia muricata	. . .	. . . .	. 1 3 . 1 . . . . 4 . . .	. . a . . b . . a	. a r 1 . a . . . b 3 . . .	. . . .	. . a a . . 4 3	. 1 . 1 1 . 4 1	b b 1 4	. 1 . . +	. . . . .
Morella quercifolia	r	. . 1 . . 1 . 1 a .	. 3 . 3 . a . 3 . 3 b . . .	a . . . . b	. 3 3 3 . . . a	1 . . 1	. . . . a . . .	3 . . . b . . 1 . . . . . . a .	. . . b	. . . . .	. . . . .
Zygophyllum flexuosum	. . .	1 1 1 + 1 r . + . +	. r . . 1	. . . . + ...	. . . . 1	. . . +	. . + ...	. . . . + + . +	. + . . .	. + . .	
Species group O											
Elytropappus rhinocerotis	. .	. . . .	. . . . 1	. . . .	. . . .	. . . .	. . . .	. . . 1 . a	. . . .	. . . . . .	5 a b a a
Oedera uniflora	. . .	. . . .	. a . . . 1	. . . .	. . . .	. . . .	. . . .	. . . 1 . . . . 1 . . .	. . . .	. . . . . .	b 4 a a .
Andropogon appendiculatus	. . .	. . . .	. . . .	. . . .	a	. . . .	. . . .	. . . .	. . . .	. . . . . .	5 . 5 . .
Falckia repens	. . .	. . . .	. . . . + ...	. . . .	. . . .	. . . .	. . . .	. . . + ... + . . .	. . . .	. . . . . .	+ + . + .
Berkheya coriacea	. . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . . . .	. . . 1 +

Tritonia deusta	. . .	…	…	…	…	…	…	…	…	…	. . r .
Euchaetis meridionalis	. . .	…	…	…	…	…	…	…	…	…	. . . a
Themeda triandra	. . .	…	…	. . . . 1 .	…	…	…	…	…	…	. . . a
Species group P											
Passerina paleacea	. . .	1 . . b . . . . . +	a . 3 3 1 . b b 4 1 b . . b	. . . 3 a + 1 . 1 4	3 . 3 b b . b 3 + . 3 b 3 r	1 1 . a	1 . a a . 1 3 . . 1 1 . .	. 1 b 3 a . b . . a . a . 1 1 . a	1 a 1 .	+ + + 1 +	. . . . .
Otholobium bracteolatum	. . .	. 1 . a	1 . 1 . . . a 1 . 1 . 3 . .	1	. . . + ... 1 1 . . 1 .	. . . 1	. 1 . . . . a	. a a . 1 a 1 . . 1 r . 1 . . b	. . 1 .	. 1 . 1 .	. . . . .
Thesidium fragile	. . .	. . . . + r . + . +	+ . . . . . . + ...	r + + ...	. . . . + ... + ...	+ . + .	+ + + . . + . + + . . .	. + . . . + . + ... + +	. . . .	. . a . 1	. . . . .
Chironia baccifera	. . .	. . . .	. . + ...	. . + ...	1 . . . . + + ...	+ . . .	. + . + . + + . + ...	. + . a . . . . +	. . . a	+ + . . .	. . . . .
Passerina rigida	. . .	. . . + ... a	. . . . a	. . . a 1 . . .	. . . . . . 1 . . a 3	. . . .	. . . . b	a . . . r	. . . .	+ + + . 1	. . . . .
Species group Q											
Asparagus capensis	. . .	1 1 1 + 1 + + + + +	+ . + + . + . + + . . . 1 r	1 + + 1 + + . . +	1 1 + + + + 1 + + . . + + .	+ + . +	+ . + + + + . + . + + . +	. + + + + + + . a + + + + + + + +	. + + .	+ + . + 1	1 + . . +
Rhus glauca	. . .	. . 1	. . a 1 . r . 1	1 . . . . . . 1 1	1 . . b . 4 + + ...	1 a a a	1 a a . b a 1 . a 1 b . 3	. 3 a a 1 a 1 a . 1 1 a b b 1 a a	. a 1 .	a a . 3 .	1 + . 1 1
Euclea racemosa	. . .	b . b	1 . a . . . 1 1 . . . 1 . .	. . 1 . . . . a 1	a . b b . 3	1 a 1 .	1 r 1 b 1 1 b . 1 1 . . 3	b 3 1 1 . 1 . . . 1 1 b 3 1 . 1	. a 1 .	a 1 1 a .	a . . 1 .
Thamnochortus insignis	. . .	. . . .	. . . . 1 . . 3 a . + a .	. a b a 3 . b .	3 . . a a . a 3 . . . b .	a . . .	. 1 a . . a 3 1 a b 4 3	3 a a 1 1 4 3 . . a 1 b . . a 1 .	. 1 1 .	b . a b	. 1 . a
Passerina galpinii	. . .	a b 1 1 1 3 a a 3 3	3 1 . . . 5 a 3 . . . 4 .	b . . . . . . 1 .	+ 5 . . . b . a . . . a . .	. . . .	1 3 . . 1 1	. . . . 1 3 . 4 . a 1 . b .	. . 1 .	. . a . .	. 3 a . 4
Rhus laevigata var. laevigata f. can	. . .	. 1 1	. . a 1	. . . . 1 1	. . a b 1 1	1 . + .	+ 1 + . 1 . 1 . . . + 1 1	1 1 . + + . . a . 1 1 . . 1 + + 1	. . . .	. . + . r	. + . 1 +
Koeleria capensis	. . .	. . . . . r . . + +	+ . + + . . . + ... + +	+ + + ... +	+ + ... + + . + . + +	. . + +	. + + . + + ...	+ . . . . + . . . + . + + .	. + . .	. a . .	r a . + +
Anthospermum aethiopicum	. . .	. . + + . a + . . +	. . . . . . + . 3	+ . . + . . + + +	1 . . . . + . + + . . .	+ . + +	+ + + ... + . + + . .	. 1 + . + . a . + . . + + + +	. . . .	. . . . .	+ . . . +
Helichrysum teretifolium	. . .	. . . . . + ...	. r . . . + . b	. . . . 3 +	…	+ + + .	1 1 1 . + + . . a . . +	. + . 1 + + . + + . + + + . 1 .	. . . .	. . . . .	. 1 + a 1
Chrysanthemoides monilifera	. . .	…	. . . . . . r	r . 1 . . + . . a	. . . . . a . . 1 1	a 1 . .	a . 1 . . . . . r . 1 .	b . 3 . . . . 1 r	1 . . 3	. a . a .	. . . a .
Pentaschistis calcicola	. . .	. . . . + . . . + .	. r + . r . + . . + ...	. . . + ...	…	. . + +	+ + + ... + ...	. . + + ... 1 . + + . + +	+ . . .	. . . . .	. + . + +
Tribolium echinatum	. . .	. . + . . . r . . .	+ . . . . + .	. . + ...	. . . . + + ...	. . . .	+ . + . + + ...	+ . . . . . . + + . + + + . . + +	. . + .	. . . . .	. . . + +
Rhus lucida	. . .	1 . a . . a	. . . . 1	1	. . . . . . 1 . . 1	1 . 1 .	+ . + . 1 . . . . a	. 1 . . a . . . . a . . + + 1	. . + .	. . a . .	. . 1 1 +
Indigofera incana	. . .	…	+ . . . . + ... + . .	. . + ... +	…	. . . .	. + ... + ... r	. . . + . r . + . + . . + + . . .	. . . .	. . . . .	. + . . +
Helichrysum dasyanthum	. . .	…	. . . 1 . . . a . . . + r .	. . . . . b . . +	. . . . b .	. . . .	. . . . a a	. . . 1 + . a . . . . . 1 1 . .	. . . .	. . .	. . + . .
Isolepis antarctica	. . .	. . . . . . a . . .	. 1	…	…	. . + +	+ + . + + . + ...	…	+ . . .	+ . . 1	. . . . +
Pelargonium myrrhifolium	. . .	…	+	. . . . 1 +	. . . . . + ...	. . . .	. + ...	. . . + ... + ... + .	. . . .	. . . . .	. + . . +
Zaluzianskya gracilis	. . .	…	+ . . . . . . + + ...	…	. . . . +	. . . +	. . . + . . . + ...	. . . + ... + . r . . .	. . . .	. . . + 1	. . . .
Euryops hebecarpus	. . .	. . . . . . 1 . 1 r	. . . . 1 1	…	…	+ + . .	. + ...	. . . . + .	. . . .	. . . . .	. + . + .
Acacia cyclops	. . .	. + ...	. a . . . . a	…	…	. . . .	…	. a . . . a . . . . 1 r .	. . 4 .	. . + . .	. . . 5 .
Anagallis arvensis	. . .	…	. . . . r	…	…	. . . .	. . . . + . . . + ...	. . + + ... + ... + . +	. . . .	. . . . .	+ . . r .
Pterocelastrus tricuspidatus	. . .	…	. . . . a	…	. b . b	. . . .	. . . . a	a . . . . 3 . 1	. . 1 .	. . . . .	1 . . . .
Ehrharta villosa var. max	. . .	…	…	…	. . . . 1	. . . .	. . . . 1 3 . . . a .	…	. . . .	. 1 a . .	+ . . . .
Olea exasperata	. . .	…	…	…	…	. . . .	. . . . a	. a . . . . a b . .	. . 1 .	. . . b .	. . . . .
Morella cordifolia	r . .	. . . . b	a . . . . b	…	…	. . . .	. . . . . 1	…	4 . . 1	. . . . .	r . . . .
Myrsine africana	. . .	…	…	. 1 . 1	…	. . . .	. . . . . 1	. . . . 1 . . .	. . . .	. . . . .	. . . . .
Robsonodendron maritimum	. . .	. . a	…	…	…	. . . .	…	. . . . . 1 . . . . . 1 . a . .	. . . .	. . . . .	. . . . .
Metalasia densa	. . .	…	…	 1	. . . . + ...	. . . .	. . . . 3 a . . . r	. 1 . . . a	. . . .	. . . 1 .	. . . . .
Asparagus lignosus	. . .	…	…	…	…	. . . .	+ . . . . + . + . . a .	. . . . + ...	. . . .	. . . + .	. . . + +

The community is situated near the corner of the western section of the northern border and western border of Tsaba-Tsaba Nature Reserve. The community is found in the wetland/marsh area, at an altitude of 3 m, and a gradient of 0°. Small, irregular white-gray and orange-brown stones and pebbles, covering 10 % are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group, and ferricrete, associated with Table mountain stones (Malan *et al.* 1994).

The soil can be described as the Coega form (Macvicar 1991).

The reed *Phragmites australis and* the rush *Juncus kraussii* as well as the shrub *Plecostachys serpyllifolia* are diagnostic for the community (Species Group A, Table 2).

The reed *Phragmites australis and* the rush *Juncus kraussii* (Species Group A, Table 2) are also dominant in the community.

The short shrub stratum shows an average canopy cover of 7% and an average height of 0.6 m. *Phragmites australis* has an average height of 2.5 m and an average canopy cover of 25%. *Juncus kraussii* has an average canopy cover of 40% and an average height of 1 m.

The plant community contains an average of only four species per relevė.

2. *Chondropetalum microcarpum - Metalasia pungens* low closed ericoid and restioid fynbos community

The structure of the community can be described as varying from predominantly low, closed ericoid and asteraceous shrubs, with low restioids in abundance, with some short shrubs sparsely scattered in the area, to having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered through the area, some tall restios and short restios in abundance.

The community is found in the greatest part of the Andrew's Field section of the study area, (with the exception of a small area at the northern border of Andrew's Field). The community is also found at the western border of Tsaba-Tsaba Nature Reserve, at the eastern section of the northern borderline of Tsaba-Tsaba, near the corner formed by the western part of the northern borderline and the western borderline of Tsaba-Tsaba. The community is also found in patches in the middle of the entire study area, reaching from the middle of the western borderline of the study area up to near the indented corner formed by the middle section and the eastern section of the northern borderline of Tsaba-Tsaba.

The community is found at an altitude of 3 – 23 m, at a gradient of 0° to 45°,on the shallow-soil limestone plain, undulating dune plain, southern, southeastern and southwestern slopes and shoulders of limestone hills, and on the northeastern and northwestern deep, neutral sand foot-slopes of limestone hills.

Small irregular white-gray pebbles, stones and rocks, and stretches of white-gray rock cover 0-40 %, on the limestone plain, is mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. Small irregular white-gray pebbles on the dune plain (cover 0 - 5%) are mostly limestone originating from the Strandveld formation of the Bredasdorp group. Small irregular white-gray pebbles, stones, small rocks and stretches of white-gray rock cover 2-60 % on the limestone hills, is mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the community can be described as the Coega and Brandvlei forms on the limestone plain, the Namib form on the dune plain and neutral sand, and the Coega and Immerpan forms on the limestone hills (Macvicar 1991).

The diagnostic species for this community (Species Group B, Table 2), include the shrubby *Metalasia pungens, Indigofera meyeriana, Acmadenia obtusata, Agathosma collina, Muraltia satureoides v. satureoides,* the forb *Lobelia setacea,* the restioid *Calopsis viminea,* and the grasses *Cymbopogon plurinodis* and *Setaria sphacelata v. sphacelata* the most prominent.

The restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the community.

The shrubs *Metalasia pungens, Acmadenia obtusata, Agathosma collina* (Species Group B, Table 2), *Diosma guthriei* (Species Group C, Table 2), *Disparago anomala, Phylica ericoides* (Species Group M, Table 2), *Morella quercifolia* (Species Group N, Table 2), *Passerina paleacea* (Species Group P, Table 2) and *Passerina galpinii* (Species Group Q, Table 2), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are further the most prominent species in the community.

The tall-, short-, and low shrub strata have an average canopy cover of 5%, 13% and 29% respectively, and an average height of 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum has an average canopy cover of 3% and an average height of 0.3 m. The short-, and low restioid strata have an average canopy cover of 4% and 7.5% respectively, and an average height of 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 1% and an average height of 0.15 m. The short-, and low grass strata have an average canopy cover of 0.5% and 10% respectively, and an average height of 0.5 m and 0.3 m respectively.

An average of 24 species per relevé was recorded for this community.

2.1 *Adromischus caryophyllaceus - Chondropetalum microcarpum* low closed limestone fynbos sub-community.

The structure of the sub-community can be described as mostly low, closed ericoid and asteraceous shrubs, with low restioids in abundance. Some short shrubs are also sparsely found in the sub-community.

The sub-community is situated near the corner of the northern and southern border of Tsaba-Tsaba and in patches near the middle of the western borderline of the study area. The sub-community is also found at the southern corner of Andrew's Field, near the corner of the northern and western borderline of Andrew's Field, and at the southeastern boundary of Andrew's Field.

The sub-community occurs at an altitude of 3 – 10 m, at a gradient of 0° to 8°, on the shallow-soil limestone plain. Small, irregular white-gray pebbles, stones and rocks and stretches of white-gray rock cover 0 - 30 %, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Coega and Brandvlei forms (Macvicar 1991).

This sub-community is characterized by Species Group C (Table 2) with the most prominent diagnostic species the shrubby *Diosma guthriei*, the succulent forb *Adromischus caryophyllaceus* and the sedge *Ficinia tuncata*.

The shrubs *Metalasia pungens* and *Acmadenia obtusata*, (Species Group B, Table 2), and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community. The shrubs *Disparago anomala*, *Phylica ericoides* (Species Group M, Table 2), and *Passerina galpinii* (Species Group Q, Table 2), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are prominent in the sub-community.

The sub-community contains an average of 28 species per relevé.

2.2 *Passerina corymbosa* - *Chondropetalum microcarpum* low to short closed fynbos sub-community.

The structure of the sub-community can be described as having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered throughout the area, with some tall restios and short restios in abundance (Photo 2).

The sub-community is found in patches at the western border of Tsaba-Tsaba Nature Reserve as well as near the corner formed by the western section of the northern borderline and the western borderline of Tsaba-Tsaba. The sub-community is also found near the middle part of the whole of the study area and near the indented corner formed by the middle section and the eastern section of the northern borderline of Tsaba-Tsaba, as well as near the eastern section of the northern borderline of Tsaba-Tsaba. On the Andrew's Field section of the study

Photo 2. *Passerina corymbosa - Chondropetalum microcarpum* sub-community, showing the typical shallow-soil limestone plain vegetation.

area, the sub-community is found on and near the southwestern border of Andrew's Field and near the northern border of Andrew's Field.

This sub-community is found at an altitude of 0 – 12 m, at a gradient of 0° to 26°, on the dune plain and the sandy, shallow-soil limestone plain. Small irregular white-gray pebbles on the dune plain (cover 0 - 5%) are mostly limestone originating from the Strandveld formation of the Bredasdorp group. Small, irregular white-gray pebbles, stones and rocks, and stretches of white-gray rock (cover 7 - 40 %) on the limestone plain, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Namib form on the dune plains and the Brandvlei form on the limestone plain (Macvicar 1991).

This sub-community is characterized by Species Group D (Table 2) with the most prominent diagnostic species the shrubby *Passerina corymbosa* and *Agathosma dielsiana* and the restioid *Ischyrolepis triflora*.

The shrubs *Metalasia pungens, Acmadenia obtusata* (Species Group B, Table 2) *Agathosma collina* (Species Group B, Table 2), *Morella quercifolia* (Species Group N, Table 2) and *Passerina paleacea* (Species Group P, Table 2), and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2), are dominant in the sub-community.

The shrubs *Phylica ericoides, Disparago anomala,* (Species Group M, Table 2), *Otholobium bracteolatum* (Species Group P, Table 2) and *Passerina galpinii* (Species Group Q, Table 2) the restioid *Thamnocortus insignis* (Species Group Q, Table 2), and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2), are also prominent in the sub-community.

The sub-community contains an average of 35 species per relevé.

2.3 *Empodium gloriosum - Chondropetalum microcarpum* low to short, closed limestone fynbos sub-community.

The structure of the sub-community can be described as having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered throughout the area, some tall restios and short restios in abundance.

The sub-community is situated near the western border of Tsaba-Tsaba Nature Reserve and near the eastern middle part of Tsaba-Tsaba. The sub-community is also found at the center part of Andrew's Field and at the northern borderline of Andrew's Field.

The sub-community is found at an altitude of 3 – 23 m, at a gradient of 0° to 45°, on the southeastern and southwestern slopes of limestone hills. Small irregular white-gray pebbles, stones, small rocks and stretches of white-gray rock cover 2 - 60 %, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Coega and Immerpan forms (Macvicar 1991). This sub-community is characterized by Species Group E (Table 2) with the most prominent diagnostic species the forb *Empodium gloriosum*.

The shrub *Phylica ericoides* (Species Group M, Table 2) and restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the community. The shrubs *Disparago anomala* (Species Group M, Table 2), *Passerina paleacea* (Species Group P, Table 2) the restoid *Thamnocortus insignis* (Species Group Q, Table 2) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 26 species per relevé.

2.4 *Eriocephalus kingesii - Chondropetalum microcarpum* low to short, closed fynbos sub-community.

The structure of the sub-community can be described as having mostly low to short, closed ericoid and asteraceous shrubs, with some taller shrubs scattered throughout the area, some tall restios and short restios in abundance (Photo 3).

The sub-community is situated near the eastern middle part of Tsaba-Tsaba Nature Reserve, at the middle section of the northern border of Tsaba-Tsaba, in the corner formed by the eastern section of the northern borderline of Tsaba-Tsaba and the coastal southeastern border of Tsaba-Tsaba, as well as at the southern borderline of Tsaba-Tsaba. The sub-community is also found at the western borderline of Andrew's Field, near the center of the northern borderline, as well as at the northern borderline of Andrew's Field.

This sub-community occurs on the southeastern and southwestern slopes of limestone hills, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills.

The sub-community is found at an altitude of 3 – 21 m, at a gradient of 0° to 16°, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills. Small irregular white-gray pebbles, cover 1 - 35% on the neutral sand and limestone hills, are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Namib form on the dune plain and neutral sand, and Immerpan and Coega forms on the limestone hills (Macvicar 1991).

This sub-community is characterized by Species Group F (Table 2) with the most prominent diagnostic species the shrubby *Eriocephalus kingesii.*

The shrubs *Acmadenia obtusata* and *Agathosma collina* (Species Group B, Table 2), *Phylica ericoides* (Species Group M, Table 2), *Passerina paleacea* (Species Group P, Table 2) the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community.

Photo 3. *Eriocephalus kingesii - Chondropetalum microcarpum* sub-community with *Agathosma collina* in flower in the front, and showing the clear transition between the dune plain and the dune vegetation.

The shrubs *Metalasia pungens* (Species Group B, Table 2), *Disparago anomala* (Species Group M, Table 2), *Morella quercifolia* (Species Group N, Table 2) and *Passerina galpinii* (Species Group Q, Table 2), the restioids *Calopsis viminea* (Species Group B, Table 2) and *Thamnocortus insignis* (Species Group Q, Table 2) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 22 species per relevé.

3. *Leucadendron meridianum* - *Protea obtusifolia* low to high limestone fynbos community.

The structure of the community varies from low, open ericoid dominated fynbos shrubland, with scattered groups of tall to high, closed proteoid dominated shrubs, to tall to high, closed proteoid dominated shrubland fynbos. High restios are found in the community, usually more abundant in the closed proteoid dominated shrubland areas of the community. Low restios are also found quite abundantly throughout the community (Photo 4).

The community is situated from the northern border of Tsaba-Tsaba Nature Reserve (at the corner formed by the northern and western borderlines of Tsaba-Tsaba Nature reserve) up to the middle of the study area, running along the western borderline of Tsaba-Tsaba and reaching up to the southern borderline of Tsaba-Tsaba. The community is also found running along the northern borderline of Tsaba-Tsaba, reaching to the middle section of the northern borderline of Tsaba-Tsaba. The community is also found and at the eastern section of the northern borderline of Tsaba-Tsaba, as well as at the indented corner formed by the middle and eastern part of the northern borderline of Tsaba-Tsaba. The community also occurs at the northern border of Andrew's Field.

The community is found at an altitude of 1 – 31 m, at a gradient of 0° to 16°. The community is found on the shallow -soil limestone plain, deep-soil limestone plain, peak of limestone hills, southern and northwestern shoulder plains of limestone hills, northern and northeastern mid-slopes

Photo 4. *Leucadendron meridianum - Protea obtusifolia* community, with (Thatch reed) *Thamnocortus insignus* in front.

and shoulder-plains of limestone hills, on the southern, southeastern and southwestern deep, neutral sand foot-slopes and plain as well as on the dune troughs between dunes.

Large irregular shaped, white-gray rocks, with some smaller stones and pebbles, as well as sheaths of rock, on the limestone hills cover 3 - 65%, and small, irregular white-gray pebbles and stones, on the limestone plains, covers 0 - 7% , are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The neutral sand and dune trough contains an average of 0% rock cover.

The soil of the community can be described as the Brandvlei form on the shallow-soil limestone plain, the Immerpan form on the deep-soil limestone plain, the Immerpan and Coega forms on the limestone hills, and the Namib form on the neutral sand and dune through areas (Macvicar 1991).

This community is characterised by Species Group G (Table 2) with the most prominent diagnostic species the shrubby *Helichrysum patulum*, the shrubby trees *Leucadendron meridianum* and *Protea obtusifolia*.

The shrubs/trees *Amphitalea alba, Leucospermum truncatum, Erica longifolia, Erica propinqua, Stoebe cinerea* and *Aspalathus globulosa* (Species Group I, Table 2), *Protea susannae* (Species Group L, Table 2), the forbs *Dimorphoteca nudicaulis* (Species Group I, Table 2), *Dorotheanthus bellidiformes, Gladiolus gracilis, Dianthus albens* (Species Group J, Table 2), and the grass *Eragrostis sarmentosa* (Species Group K, Table 2) are common species in the community.

The shrubs *Rhus glauca, Euclea racemosa* (Species Group Q, Table 2), and the restioid *Thamnocortus insignis* (Species Group Q, Table 2) are dominant in the community.

The shrubby tree *Protea susannae* (Species Group L, Table 2), the shrubs *Metalasia muricata* (Species Group N, Table 2), *Passerina paleacea* (Species Group P, Table 2), and *Passerina galpinii* (Species Group Q, Table 2), and the restioids *Ischyrolepis eleocharis* and

Chondropetalum microcarpum (Species Group N, Table 2) are further prominent species in the community.

The tall-, high-, short-, and low shrub strata have an average canopy cover of 21%, 16%, 11% and 11% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum has an average canopy cover of 4% and an average height of 0.3 m. The high-, tall-, short-, and low restioid strata have an average canopy cover of 0.5%, 6%, 2%, and 14% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 0.7% and an average height of 0.15 m. The short- and low grass strata have an average canopy cover of 1% and 3% respectively, and an average height of 0.5 m and 0.3 m respectively.

An average of 31 species per relevé was recorded in this community.

3.1 *Amphitalia alba* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

The structure of the sub-community can be described as low, open ericoid dominated fynbos shrubland, with scattered groups of tall, closed proteoid dominated shrubs.

The sub-community is situated near the corner of the northern and western border of Tsaba-Tsaba Nature reserve, adjacent to the marsh area. The sub-community is also found at the northwestern inland border, as well as near the middle of the western border of Tsaba-Tsaba Nature reserve.

The sub-community is found at an altitude of 3 – 31 m, at a gradient of 0° to 16°, on the shallow -soil limestone plain, peak of limestone hill, southern and northwestern shoulder plains of limestone hills.

Large irregular shaped, white-gray rocks, with some smaller stones and pebbles, on the limestone hills, and small irregular white-gray pebbles, on the limestone plain, cover 3 - 45%, and are mostly limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the sub-community can be described as the Brandvlei form on the limestone plain and the Coega and Immerpan forms on the limestone hills (Macvicar 1991).

This community is characterised by Species Group I (Table 2) with the most prominent diagnostic species the shrubs *Amphitalea alba, Leucospermum truncatum, Oedera capensis* and *Erica spectabilis*.

The shrubs *Leucandendron meridianum* and *Protea obtusifolia* (Species Group G, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2), are dominant in the sub-community.

Furthermore, the shrubs *Helichrysum patulum* (Species Group G, Table 2), *Metalasia calcicola* (Species Group H, Table 2), *Amphitalea alba* (Species Group I, Table 2), *Phylica ericoides* (Species Group M, Table 2), *Disparago anomala* (Species Group M, Table 2), *Rhus glauca* and *Euclea racemosa* (Species Group Q, Table 2), are also prominent in the sub-community.

The sub-community contains an average of 42 species per relevé.

3.2 *Erica abietina - Leucadendron meridianum* tall closed limestone fynbos sub-community.

The structure of the sub-community can be described as tall, closed proteoid dominated shrubland fynbos.

The sub-community is found at the northern border of Tsaba-Tsaba Nature reserve, near the marsh area; at the northwestern border, as well as near the middle of Tsaba-Tsaba Nature reserve.

The sub-community is found at an altitude of 3 – 31 m, at a gradient of 0° to 16°, on the peak of limestone hills, deep-soil limestone plain and the southern and southeastern deep, neutral sand foot-slopes of limestone hills. Small irregular white-gray pebbles and stones, on the limestone plain, and large irregular white-gray rocks, with some pebbles and stones, as well as sheaths of rock on the limestone hills cover 0 - 65%, and are limestone originating from the Waenhuiskrans formation of the Bredasdorp group. The neutral sand area contains an average of 0% rock cover. The soil of the sub- community can be described as the Immerpan form on the limestone plain, the Immerpan and Coega forms on the limestone hills, and the Namib form in the neutral sand area (Macvicar 1991).

This community is characterized by Species Group J (Table 2) with the most prominent diagnostic species the shrubby *Erica abietina* v. *abietina*, *Heterolepis peduncularis* and *Stoebe cinerea*.

The shrubs *Leucandendron meridianum* and *Protea obtusifolia* (Species Group G, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community. The shrubs *Helichrysum patulum* (Species Group G, Table 2), *Metalasia calcicola* (Species Group H, Table 2), *Phylica ericoides*, *Disparago anomala* (Species Group M, Table 2), *Metalasia muricata* (Species Group N, Table 2), *Passerina paleacea* (Species Group P, Table 2), *Rhus glauca* and *Euclea racemosa* (Species Group Q, Table 2) and the restioid *Thamnocortus insignis* (Species Group Q, Table 2) are also prominent in the sub-community.

The sub-community contains an average of 34 species per relevé.

3.3 *Ehrharta calycina - Leucadendron meridianum* low to short limestone fynbos sub-community.

The structure of the sub-community can be described as low to short, open ericoid dominated fynbos shrubland, with groups of tall to high, closed proteoid dominated shrubs. High and low restios are found quite abundantly in the sub-community (Photo 5).

The sub-community is found in the corner formed by the northern and western borderlines of Tsaba-Tsaba Nature Reserve, in patches from near the middle section of the northern borderline of Tsaba-Tsaba to the middle part of Tsaba-Tsaba. The sub-community also occurs in the

Photo 5. *Ehrharta calycina - Leucadendron meridianum* sub-community, showing a typical limestone outcrop with plants growing in potholes.

middle of the whole of the study area (Tsaba-Tsaba and Andrew's Field), near the western borderline of Tsaba-Tsaba, at the eastern part of the northern border of Tsaba-Tsaba, and also at the northern border of Andrew's Field.

The sub-community is found at an altitude of 3 – 21 m, at a gradient of 0° to 16° on the northern and northeastern mid-slopes and shoulder-plains of limestone hills and on the sandy deep-soil limestone plain. Irregular white-gray pebbles, stones and small rocks and stretches of rock, cover 1-10 % on the limestone plain and are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. Big irregular white-gray rocks, with some pebbles and stones, as well as stretches of rock, covering 0 - 60%, on the limestone hills are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the variant is the Immerplan form on the limestone plain, and the Immerpan and Coega forms on the limestone hills (Macvicar 1991).

This sub-community is characterised by Species Group K (Table 2) with the most prominent diagnostic species the shrub *Cassine peragua* and the grasses *Ehrharta calycina, Bromus diandrus* and *Eragrostis sarmentosa.*

The shrubs *Rhus glauca*, *Euclea racemosa* (Species Group Q, Table 2) and *Passerina paleacea* (Species Group P, Table 2), and the restioid *Thamnocortus insignis* (Species Group Q, Table 2) are dominant in the sub-community.

Furthermore the shrubs *Leucandendron meridianum, Protea obtusifolia* (Species Group G, Table 2), *Helichrysum patulum* (Species Group G, Table 2), *Metalasia muricata, Morella quercifolia* (Species Group N, Table 2), *Otholobium bracteolatum* (Species Group P, Table 2) and *Passerina galpinii* (Species Group Q, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) and the grass *Stipagrostis zeyheri* subsp. *sericans* (Species Group M, Table 2) are also prominent in the sub-community.

The sub-community contains and average of 33 species per relevé.

3.4 *Metalasia muricata - Leucadendron meridianum* tall closed limestone fynbos sub-community.

The structure of the sub-community can be described as tall closed proteoid dominated shrubland.

The sub-community is found near the corner formed by the northern and western borderline of Tsaba-Tsaba Nature Reserve, in patches near the middle part of the whole study area (Tsaba-Tsaba and Andrew's Field). The sub-community is also found in patches southeast of the indented corner formed by the middle and eastern part of the borderline of Tsaba-Tsaba, as well as near the southern part of the southeastern border of Tsaba-Tsaba.

The sub-community is found at an altitude of 1 – 14 m, at a gradient of 0° to 8°, on the sandy peak of a limestone hill, and on the deep-soil limestone plain and on dune troughs. Small irregular white-gray pebbles and stones, covering 3% on the limestone hill, are limestone originating from the Waenhuiskrans formation of the Bredasdorp group. There is a rock cover of 0% on the limestone plain and dune through area. The soil of the sub-community can be described as the Namib form in the dune area, the Immerpan form on the limestone plain, and the Immerpan and Coega forms on the limestone hill (Macvicar 1991).

Although no diagnostic species group could be identified, the presence of Species Group G and the absence of Species Groups H-L (Table 2) are characteristic for this sub-community.

The shrub *Metalasia muricata,* and the restioid *Chondropetalum microcarpum* (Species Group N, Table 2) are dominant in the sub-community.

The shrubs *Leucandendron meridianum, Protea obtusifolia* (Species Group G, Table 2), *Helichrysum patulum* (Species Group G, Table 2) and *Passerina paleacea* (Species Group P, Table 2) are further prominent species in this sub-community.

The sub-community has an average of only 13 species per relevé.

3.5 *Protea susannae - Leucadendron coniferum* high closed fynbos sub-community.

The structure of this sub-community can be described as high closed proteoid dominated shrubland (Photo 6).

The sub-community is situated in patches along the northern borderline of Tsaba-Tsaba Nature reserve, adjacent to the marsh area, in the corner of the northern and inland northwestern border of Tsaba-Tsaba, and in patches near the middle of the whole study area.

The sub-community is found at an altitude of 3 – 25 m, at a gradient of 3° to 8°, on the southern and southwestern deep, neutral sand foot-slopes of limestone hills, on sandy deep-soil limestone plain, and on the deep, neutral sand plain. There is a rock cover of 0% in the sub-community. The soil of the sub-community can be described as the Namib form on the neutral sand areas and the Immerpan form on the sandy deep-soil limestone plain (Macvicar 1991).

Species Group L (Table 2) is characteristic for this sub-community and the diagnostic species include the shrubby trees *Protea susannae* and *Leucadendron coniferum*, which is also dominant in this sub-community.

The shrubs *Helichrysum patulum* (Species Group G, Table 2) and *Passerina paleacea* (Species Group P, Table 2) and the restioids *Ischyrolepis eleocharis* and *Chondropetalum microcarpum* (Species Group N, Table 2) are prominent in the sub-community.

The sub-community has an average of 24 species per relevé.

4. *Oedera uniflora - Elytropappus rhinocerotus* low closed Renosterveld community.

The structure of the community can be described as low, closed asteraceous dominated renosterveld shrubland (Photo 7).

Photo 6. *Protea susannae - Leucadendron coniferum* sub-community.

Photo 7. *Oedera uniflora - Elytropappus rhinocerotus* community.

The community is found in patches near the middle part of the western borderline of the study area, as well as adjacent to the wetland area.

The plant community is found at an altitude of 3° to 18 m, at a gradient of 0 – 13°, on the northern and northwestern slopes of limestone hills, and on the Renosterveld plain. Small, irregular white-gray pebbles and stones cover 1-10%, and are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil can be described as the Brandvlei form (Macvicar 1991).

The diagnostic species are listed Species Group O (Table 2), which includes shrubs *Elytropappus rhinocerotis* and *Oedera uniflora* and the grass *Andropogon appendiculatus* which are the most dominant diagnostic species, while the shrub *Euchaetis meridionalis* and the forbs *Berkheya coriacea* and *Tritonia deusta* are also diagnostic for the community.

The shrubs *Passerina galpinii* and *Helichrysum teretifolium* (Species Group Q, Table 2) are also prominent in the community.

The tree stratum has an average canopy cover of 6% and an average height of 2.5 m. The high shrub stratum has an average canopy cover of 6% and an average height of 1.5 m, while the medium shrub stratum has an average canopy cover of 7%, and an average height of 0.75 m and the low shrub stratum has an average canopy cover of 32% and an average height of 0.4 m. The high reed-, medium reed- and low reed strata show an average canopy cover of 2%, 0.6% and 4% respectively, and an average height of 1.5 m, 0.75 m, and 0.20 m respectively. The medium grass stratum has an average canopy cover of 17% and an average height of 0.6 m while the low grass stratum has an average canopy cover of 2% and an average height of 0.25 m. The sedges have an average canopy cover of 0.5% and an average height of 0.10 m. The forb stratum has an average canopy cover of 3% and an average height of 0.15 m.

The community has an average of 25 species per relevé.

CLASSIFICATION OF THE COASTAL THICKET, DUNES AND STRAND OF ANDREW'S FIELD AND TSABA-TSABA NATURE RESERVE:

There can in general be referred to the vegetation of the area as Dune Asteraceous Fynbos, with some Limestone fynbos and Renosterveld (Low & Rebelo 1998, Mustard *et al.* 1997).

Six main different habitat types are found in the study area, namely dune plain, Renosterveld plain, limestone plain, limestone hills, dunes and strand.

Six plant communities can be distinguished (community 5 to 10). Community 5 has six sub-communities, with two variants in both sub-communities 2 and 6. Community 7 has two sub-communities.

The classification of the vegetation is as follows:

5. *Rhus glauca - Euclea racemosa* short to tall closed thicket community.

5.1. *Rhus lucida - Euclea racemosa* low to short closed thicket sub-community.

5.2. *Pterocelastrus tricuspidatus - Euclea racemosa* short to tall closed thicket sub-community.

5.2.1. *Olea exasperata - Euclea racemosa* short to high closed thicket variant.

5.2.2. *Carissa bispinosa - Euclea racemosa* short to tall closed thicket variant.

5.3. *Acmadenia obtusata - Euclea racemosa* short to tall closed thicket sub-community.

5.4. *Helichrysum dasyanthum - Euclea racemosa* low to short closed thicket sub-community.

5.5. *Acacia cyclops - Euclea racemosa* high to tall closed thicket sub-community.

5.6 .Thamnocortus insignis - *Euclea racemosa* high to tall closed thicket sub-community.

5.6.1. *Elytropappus rhinocerotus - Euclea racemosa* short to tall closed thicket variant.

5.6.2. *Leucadendron coniferum - Euclea racemosa* high to tall closed thicket variant.

6. *Chrysanthemoides monilifera - Solanum africanum* low closed dune community.

7. *Chrysanthemoides monilifera - Ehrharta villosa* var. *maxima* low to short closed dune shrub community.

7.1. *Chrysanthemoides monilifera - Rhus crenata* short to high dune shrub sub-community.

7.2. *Chrysanthemoides monilifera - Morella cordifolia low to short closed shrub* sub-community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

9. *Ammophila arenaria* low to high closed dune community.

10. *Arcthotheca populifolia - Thinopyrum distichum* short to low open strand community.

A diagrammatic presentation of the hierarchical classification and associated environmental interpretation of the plant communities can be seen in Figure 6. The community numbers in Figure 6. correspond with the description in the text.

DESCRIPTION OF PLANT COMMUNITIES

5. *Rhus glauca - Euclea racemosa* short to tall closed thicket community.

The structure of the community can be described as scattered groups of closed broad-leaved shrubs throughout the area, consisting of mostly short to tall shrubs, but having high shrubs near the center and lower shrubs near the periphery of a group.

The community is found in a mosaic with communities 2, 4, 6 and sub-community 3.4, as well as near the indented corner formed by the middle and eastern part of the northern borderline of Tsaba-Tsaba Nature Reserve and in patches near the middle part of Tsaba-Tsaba.

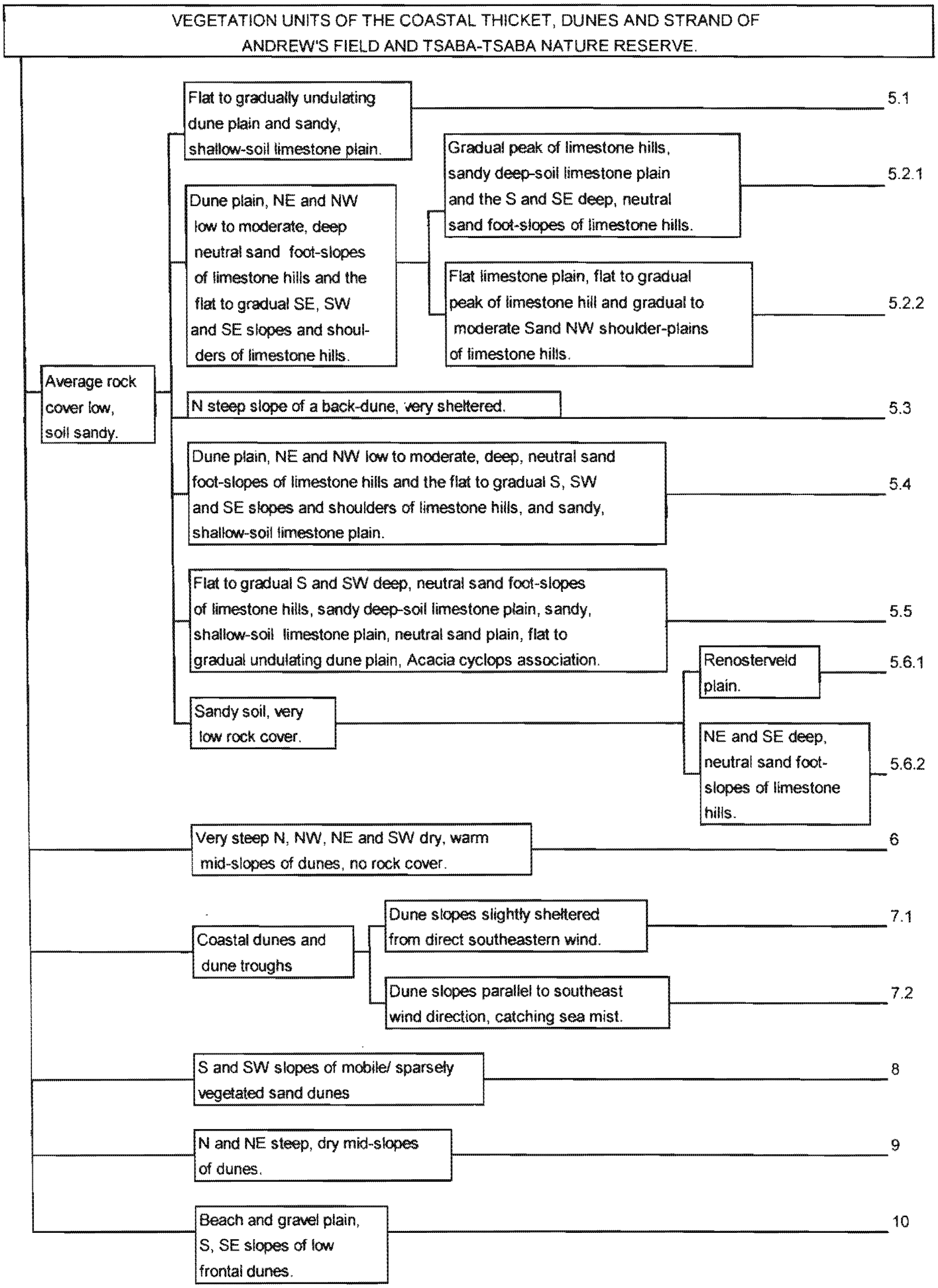

Figure 6. Hierarchical classification and associated environmental characteristics of the coastal thicket, dunes and strand of Andrew's Field and Tsaba-Tsaba nature reserve.

Table 3. Phytosociological table of coastal thicket, dunes and strand of Andrew's field and Tsaba-Tsaba nature reserve.

	5																																			6					7																							8		9			10				
	5.1							5.2									5.3	5.4							5.5				5.6													7.1								7.2																								
Community number								5.2.1					5.2.2																5.6.1						5.6.2																																					
Releve number	75	77	80	82	88	84	87	74	78	76	79	57	86	34	92	37	101	89	81	83	90	93	95	94	85	91	153	171	117	119	116	115	49	33	51	103	109	143	144	145	166	133	140	168	120	150	169	146	167	132	121	125	134	135	142	122	124	126	127	131	138	139	141	149	147	164	123	130	161	129	165	128	162	163
Species group A																																																																										
Euclea racemosa	5	5	5	4	5	5	5	5	5	5	5	1	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	.	1	5	4	5	5	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus glauca	5	5	5	5	5	.	4	5	5	1	5	5	5	5	5	5	4	5	.	5	5	.	4	5	5	4	1	.	5	5	5	5	5	4	5	4	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhus laevigata var. laev. f.ca	+	5	1	4	4	5	4	.	5	4	4	.	4	.	4	.	.	4	5	.	.	4	5	5	5	5	.	4	1	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group B																																																																										
Rhus lucida	.	.	.	.	4	5	4	1	.	.	.	.	4	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group C																																																																										
Otholobium bracteolatum	.	.	.	.	.	.	.	.	.	.	.	4	4	.	1	.	4	4	4	5	5	5	.	5	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group D																																																																										
Robsonodendron maritimum	.	.	.	.	.	.	.	5	5	4	4	.	4	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pterocelastrus tricuspidatus	.	.	.	.	5	.	.	.	.	5	5	5	5	4	4	5	.	4	.	.	.	.	.	5	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group E																																																																										
Olea exasperata	.	.	.	.	.	.	.	5	.	5	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	5	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Osyris compressa	.	.	.	.	.	.	.	5	4	.	.	4	.	.	.	5	.	.	.	.	5	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Knowltonia vesicatoria	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group F																																																																										
Carissa bispinosa	.	.	.	.	.	.	.	.	.	.	.	4	1	5	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sideroxylon inerme	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gymnosporia buxifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	1	.	.	.	.	.	.	.	.	.	.	.	.	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Panicum deustum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group G																																																																										
Acmadenia obtusata	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arctopus echinatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca scabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zaluzianskya villosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species group H																																																																										
Helichrysum dasyanthum	.	4	.	.	5	.	.	.	.	.	.	.	.	.	.	.	+	4	.	.	4	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.

Species group I														
Acacia cyclops	. . . .	. . . . .	. . 5 4	.	. . . .	5 5 5 5	. . . . 5 1	. .	. . . . .	. . . .	. 1 . . . + ...	. .	. . .	. . . . .
Protea obtusifolia	. . . .	. . . . .	. . . .	.	. . . .	. . 4 .	. . . . . .	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Passerina galpinii	. . . .	. . . . .	. . . .	.	 4	. 5 . .	. 1	. .	. . . . .	. . . . + . . .	. . . . 1 . . .	. .	. . .	. . . . .
Species group J														
Thamnochortus insignis	. . . .	. . . . .	. . . .	.	. . . .	. . . .	4 . 4 4 4 4	5 4	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Helichrysum patulum	. . . .	. 1 . . .	. . . .	.	. . . .	. . 1 .	1 . 1 4 1 .	1 1	. . . . .	. . . . . 1 . .	. . 1 . . . . 1 1 . . .	. .	. . .	. . . . .
Asparagus capensis	. . . .	. . . . +	. . . +	.	. . . .	. . . .	. + r . + +	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Passerina paleacea	. . . . 5 . 4	 1	. . . .	.	4 . . 4 . . 4	. . 1 .	r . 1 5 4 .	1 .	+	. . . .	. . . .	. .	. . .	. . . . .
Metalasia densa	. . . 5 . . .	. . . . .	. . . .	.	. . . .	. . . .	. 1 . . . 1	4 4	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Ischyrolepis eleocharis	. . . .	. . . . r	. . . .	1	. . . .	. . . .	. . . 1 5 .	5 1	. . . . .	. 1	. . 1 . . + ... +	. .	. . .	. . . . .
Cassine peragua	. . . .	. . . 5 .	. . . .	.	. . . .	. . . .	. . . . 1 4	4 .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Torilis arvensis	. . . .	. . . . .	. . . +	+	. . . .	. . . .	. + ...	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Koeleria capensis	. . . .	. . . . +	. . . .	.	. . . .	. . + .	. . + + . .	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Tribolium echinatum	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . + . +	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Species group K														
Elytropappus rhinocerotis	. . . .	. . . . .	. . . .	.	. . . .	. . . .	1 1 . 1 . 5	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Leucadendron linifolium	. . . .	. . . . .	. 4 . .	.	. . . .	. . . .	5 . 4 5 . .	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Helichrysum teretifolium	. . . .	. . . . r	. . . .	.	. . . .	. . . .	1 1 . 1 . +	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Myrsine africana	. . . .	. . . . .	. . 4 .	.	. . . .	. . . .	. 5 4 . . .	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Oedera uniflora	. . . .	. . . . .	. . . .	.	. . . .	. . . .	1 5	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Lycium afrum	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . 1 . . r	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Limoni scabrum var. sca	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . + . +	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Hermannia althaeifolia	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. + . . . +	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Rhus laevigata var. villosa	. . . .	. . . . .	. . . .	.	. . . .	. . . .	+ + ...	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Asparagus lignosus	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. + . . + .	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Euryops hebecarpus	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. + . . . +	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Pelargonium myrrhifolium	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. + . . . r	. .	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Species group L														
Eriocephalus kingesii	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . .	5 1	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Leucadendron coniferum	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . .	5 1	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Cassytha ciliolata	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . .	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Conicosia pugioniformis	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . .	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Anthospermum aethiopicum	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . +	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Viscum capense	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . .	+ +	. . . . .	. . . .	. . . .	. .	. . .	. . . . .
Protea susannae	. . . .	. . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. 5	. . . . .	. . . .	. . . .	. .	. . .	. . . . .

Agathosma collina	. . . .	 1	. . . .	.	. . . .	. . . .	. . . .	. 4	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Chondropetalum microcarpum	. . . .	 1	. . . .	.	. . . .	. . 1 .	. . . .	. 4	. . . . .	. . . . . 1 . .	. . . .	. .	. . .	. . . . . .
Salvia africana-lutea	. . . . . . 4 .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	4 .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Maytenus procumbens	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. 4	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Agathosma serpyllacea	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	4 .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Phylica stipularis	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	1 .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Trichogyne repens	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. 1	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Tephrosia capensis	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	1 .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Othonna dentata	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	1 .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Wachendorfia paniculata	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Indigofera meyeriana	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . r	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Heliophila refracta	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Crassula subulata var. sub	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Tetraria cuspidata	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Oxalis obtusa	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Gymnodiscus capillaris	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Sebaea aurea	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Microloma sagittatum	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Cineraria species	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Willdenowia glomerata	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Elegia stipularis	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Albuca cooperi	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Babiana montana	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Ficinia nigrescens	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	+ .	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Euphorbia foliosa	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Sebaea albens	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Othonna filicaulis	. . . .	. . . . . +	. . . .	.	. . . . . . + .	. . . .	. . . .	. +	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Gazania pectinata	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. r	. . . . .	. . . .	. . . .	. .	. . .	. . . . . .
Species group M														
Solanum africanum	. . . .	. . . . . .	. 1 . 1	.	. . . .	. . . .	. . . .	. 4	5 5 5 5 5	r 4 1 1 1 4 . 1	1 4 4 . . 5 . . . . r	. .	. . .	. . . . . .
Species group N														
Ehrharta villosa var. max	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	1 1	+ . . . 1	. + 1 1 4 1 1 1	. 5 1 1 . + 5 . . 1 . + 1 1 4	5 5	. . 1	. . . . . .
Stoebe cinerea	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . .	. .	. . . . .	. 1 . 4 . 1 . .	1 5 4 . . 1 . 1 1 . 1 1 1 1 .	. .	. . .	. . . . . .
Thesidium fragile	. . . .	. . . . . .	. . . .	.	. . . .	. . + .	. . . .	+ .	. . . . .	. + + + . + . .	+ + + . . + ... + + + . .	. .	. . .	. . . . . .
Species group O														
Rhus crenata	. . . .	. . . . . .	. . . .	5	. . . .	. . . .	. . . . . . r .	. 1	. . . . .	5 1 1 5 5 5 . .	1 . . . . + ...	. .	. . .	. . . . . .

Species group P														
Morella cordifolia	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. .	. . . . .	. 1 5 . . 1 . .	5 1 5 5 5 4 4 5 5 5 5 5 5 5 1	. . .	. . .	. . . . .
Lessertia frutescens	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. +	. . . . .	r . . . . 1 . . .	. 5 4 4 1 + 5 1 4 . 1 1 4 1 5	. . .	4 5 .	. . . . .
Senecio arenarius	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. .	. + . + +	. . . . . . + . . .	. + + + . + + + + + 1 . . . +	. . .	. + +	. . . . .
Pentaschistis calcicola	. . . .	. . . . . .	. . . .	+	. . . .	. . . .	+ + ...	. .	. . . . .	. + . . + . . .	+ . + + . + ... + + 5 + .	. . .	. . .	. . . . .
Euryops linearis	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. .	. . . . .	. . . . 1 . . .	. + + . 1 + r . 1 . . . 1 1 1	. . .	. . .	. . . . .
Isolepis antarctica	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	+ .	. . . . .	. + ...	+ . . . . + + . + . + + . + +	. . .	. . .	. . . . .
Species group Q														
Passerina rigida	. . . .	. . . . . .	. . . .	4	. . . .	. . . .	. . . . . .	. 1	+ . . 5 .	5 5 5 1 . 4 . 5	5 4 5 5 5 . . . 1 . . 1 . . .	. . .	. . .	. . . . .
Species group R														
Chrysanthemoides monilifera	. . . .	 4	. 5 1 5	1	5 . . . . 5 5	. . . .	5 . . 5 . 5	. 4	. 1 5 4 .	4 5 1 5 4 1 5 5	1 1 5 4 5 5 1 1 1 4 1 4 1 1 1	. . .	. . .	. . . . .
Metalasia muricata	. . . .	 1	. . . .	1	. . . . 5 . . .	5 5 4 .	. 4 r 1 4 5	. 1	. . . . .	4 1 1 1 1 5 . .	4 1 4 . . 4 . . 1 . 1 1 1 1 .	. . .	. . .	. . . . .
Chironia baccifera	+	. . . . . .	. . . .	.	. . . . + + . +	. . . .	. . + + . +	. +	. + + + +	. + . + . + . .	. + ... + + 4 . 4 4 + . +	. . .	. . .	. . . . .
Galium tomentosum	. . . .	. . . . . +	. . . .	.	+ . . . . . . +	. . + .	. . . . + .	+ .	. . . . .	. . . + ...	. . . .	. . .	. . .	. . . . .
Carpobrotus acinaciformis	. . . .	. . . . . .	. . . .	.	. . . .	. . + .	. + ...	. .	. . . . .	. + . . . + . .	. . . .	. . .	. . .	. . . . .
Species group S														
Ammophila arenaria	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. .	. . . . .	. . . .	. . . . 1 + . + ...	. . .	5 5 5	. . . . .
Species group T														
Thinopyrum distichum	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. .	. . . . .	. . . .	. . + ...	. . .	. . .	1 5 1 1 1
Arctotheca populifolia	. . . .	. . . . . .	. . . .	.	. . . .	. . . .	. . . . . .	. .	. . . . .	. . . .	. . . .	. . .	. . .	. . 4 4 1

The community is found at an altitude of 0 – 15 m, at a gradient of 0° to 45°, on the dune plain, northern slope of a back-dune, limestone plain, Renosterveld plain, and on the southern, southwestern, southeastern and western slopes and peaks of limestone hills.

The shrubs *Euclea racemosa*, *Rhus glauca* and *Rhus laevigata* (Species Group A, Table 3) are diagnostic and dominant in this community.

The shrubs *Rhus glauca* (Species Group A, Table 3), *Rhus lucida* (Species Group B, Table 3), *Robsonodendron maritumum, Pterocelastrus tricuspidatus* (Species Group D, Table 3), *Olea exasperata, Osyris compressa, Knowltonia vesicatoria* (Species Group E, Table 3), *Carissa bispinosa, Sideroxylon inerme, Gymnosporia buxifolia* (Species Group F, Table 3), *Acmadenia obtusata* (Species Group G, Table 3), *Protea obtusifolia* (Species Group I, Table 3), *Asparagus capensis, Metalasia densa, Cassine peragua, Passerina paleacea* (Species Group J, Table 3), *Elytropappus rhinocerotus, Leucadendron linifolium, Helichrysum teretifolium, Myrsine africana, Oedera uniflora, Lycium afrum, Rhus laevigata* var. *villosa, Asparagus lignosus, Euryops hebecarpus* (Species Group K, Table 3), *Eriocephalus kingesii, Leucadendron coniferum, Anthospermum aetiopicum, Viscum capense, Protea susannae, Agathosma collina, Salvia africana-lutea, Maytenus procumbens, Agathosma serpyllacea, Phylica stipularis, Trigogyne repens, Tephrosia capensis, Othonna dentata, Indigofera meyeriana*), *Microloma sagittatum* (liane) (Species Group L, Table 3), the forbs *Arctopus echinatus, Zalusianskya villosa* (Species Group G, Table 3), *Torilis arvensis* (Species Group J, Table 3), *Limonium scabrum* var. *scabrum, Hermannia althaefolia, Pelargonium myrrhifolium* (Species Group K, Table 3), the parasitic liane *Cassytha ciliolata, Conicosa pugioniformis* subsp. *muirii, Wachendorfia paniculata, Heliophyla refracta, Crassula subulata* var. *subulata, Oxalis obtusa, Gymnodiscus capillaris, Sebaea aurea, Cineraria* sp., *Albuca cooperi, Babiana montana, Euphorbia foliosa, Sebaea albens, Othonna filicaulis, Gazania pectinata* (Species Group L, Table 3), the grasses *Panicum deustum* (Species Group F, Table 3), *Festuca scabra* (Species Group G, Table 3), *Koeleria capensis, Tribolium echinatum* (Species Group J, Table 3), the restiods *Ischyrolepis eleocharis* (Species

Group K, Table 3), Willdenowia glomerata, and *Elegia stipularis* (Species Group L, Table 3) are all often found in this community.

The shrubs *Otholobium bracteolatum* (Species Group C, Table 3), *Chrysanthemoides monillifera* and *Metalasia muricata* (Species Group R, Table 3) are also prominent in the community.

The tall-, high-, short- and low shrub strata show average canopy covers of 14%, 20%, 28% and 15% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.4 m respectively. The forb stratum contains an average canopy cover of 3% and an average height of 0.3 m. The short-, and low restioid strata have an average canopy cover of 4% and 7.5% respectively, and an average height of 0.75 m and 0.4 m respectively. The sedge stratum has an average canopy cover of 1% and an average height of 0.15 m. The short-, and low grass strata have an average canopy cover of 0.5% and 10% respectively, and an average height of 0.5 m and 0.3 m respectively.

The community has an average of 13 species per relevé.

5.1 Rhus lucida - Euclea racemosa low to short closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of low to short closed broad-leaved shrubs.

The sub-community is found in a mosaic distribution pattern with sub-communities 2.1 and 2.2.

The sub-community is found at an altitude of 3 – 10 m, at a gradient of 0° to 16°, on the dune plain and shallow-soil limestone plain. Small irregular white-gray pebbles, covering 1%, are found on the dune plain. Irregular white-gray rocks, stones and pebbles, covering 1%, are found on the limestone plain. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the limestone plain is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the dune plain can be described as the Namib form, and on the limestone plain the Brandvlei and Coega forms (Macvicar 1991).

Rhus lucida (Species Group B, Table 3) is the only diagnostic species for this sub-community.

The shrubs *Euclea racemosa, Rhus glauca* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3) are dominant in the community.

The shrubs *Rhus lucida* (Species Group B, Table 3), *Helichrysum dasyanthum* (Species Group H, Table 3), *Passerina paleacea* (Species Group J, Table 3) are also prominent in the sub-community.

The sub-community contains an average of only 4 species per relevé.

5.2 Pterocelastrus tricuspidatus - Euclea racemosa short to tall closed thicket sub-community.

The structure of this sub-community can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery.

The sub-community is found scattered, in a mosaic with sub-communities 2.3 and 2.4.

The sub-community is found at an altitude of 3 – 23 m, at a gradient of 0° to 16°, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills.

Small irregular white-gray pebbles, covering 1%, are found on the dune plain. Irregular white-gray rocks, stones and pebbles covering 1 %, are found on the deep neutral sand and limestone hills. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the limestone hills is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group.

The soil on the dune plain can be described as the Namib form, and the Immerpan and Coega forms on the limestone hills (Macvicar 1991).

Species Group D (Table 3) is diagnostic for this sub-community, with the shrubby trees *Robsonodendron maritumum* and *Pterocelastrus tricuspidatus* dominant diagnostic species.

The shrubs *Euclea racemosa, Rhus glauca* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), are also dominant, while the shrub and *Otholobium bracteolatum* (Species Group C, Table 3) are prominent in the sub-community.

The sub-community contains an average of 12 species per relevé.

5.2.1. Olea exasperata - Euclea racemosa short to high closed thicket variant.

The structure of the variant can be described as scattered groups of short to high closed broad-leaved shrubs, with some lower shrubs at the periphery.

The variant is distributed in a mosaic pattern with sub-community 2.4.

The variant is found at an altitude of 3 – 23 m, at a gradient of 0° to 16°, on the dune plain, northeastern and northwestern deep, neutral sand foot-slopes of limestone hills, and the southern, southwestern and southeastern slopes and shoulders of limestone hills. Small irregular white-gray pebbles, covering 1%, are found on the dune plain. Irregular white-gray stones and pebbles, covering 1%, are found on the deep neutral sand and limestone hills. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the neutral sand and limestone hills is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the dune plain and neutral sand foot-slopes can be described as the Namib form, and the Immerpan and Coega forms (Macvicar 1991) on the limestone hill.

Species Group E (Table 3) is diagnostic, with Olea exasperata and Osyris compressa the most prominent diagnostic species.

The shrubs *Euclea racemosa, Rhus glauca* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), *Robsonodendron maritumum* (Species Group D, Table 3), are dominant in the variant.

The shrub *Pterocelastrus tricuspidatus* (Species Group D, Table 3) is also prominent in the variant.

The variant contains an average of 12 species per relevé.

5.2.2. *Carissa bispinosa - Euclea racemosa* short to tall closed thicket variant.

The structure of the variant can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery (Photos 8 and 9).

The variant is found in a mosaic with sub-community 2.3.

The variant is found at an altitude of 3 – 23 m, at a gradient of 0° to 16°, on the southwestern and southwestern slopes of limestone hills. Irregular white-gray stones, pebbles covering 1 %, are found on the limestone hills, are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the limestone hills can be described as the Immerpan and Coega forms (Macvicar 1991).

Species Group F (Table 3) is diagnostic with the shubs *Carissa bispinosa* and *Sideroxylon inerme* the most prominent diagnostic species.

The shrubs *Euclea racemosa, Rhus glauca* (Species Group A, Table 3), *Robsonodendron maritumum* and *Pterocelastrus tricuspidatus* (Species Group D, Table 3) are dominant in the variant.

The shrubs *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), the exotic shrub A*cacia cyclops* (Species Group I, Table 3) and

Photo 8. *Carissa bispinosa - Euclea racemosa* variant developed into a small Dune forest.

Photo 9. Showing the inside of the small Dune forest.

Chrysanthemoides monilifera (Species Group R, Table 3) are also prominent in the variant.

The variant contains an average of 13 species per relevé.

5.3 *Acmadenia obtusata* - *Euclea racemosa* short to tall closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery.

The sub-community is found in a small patch near the center part of the whole of the study area.

The sub-community is found at an altitude of 3 – 6 m, at a gradient of 26° to 45°, on the northern slope of a back-dune. The rock cover in the sub-community is 0%. The soil of the sub-community can be described as the Namib form (Macvicar 1991).

Species Group G (Table 3) is diagnstic for this sub-community with the shrub *Acmadenia obtusata* , the forbs *Arctopus echinatus* and *Zaluzianskya villosa* and the grass *Festuca scabra*, as diagnostic species for the sub-community.

The shrubs *Euclea racemosa* (Species Group A, Table 3), *Otholobium bracteolatum* (Species Group C, Table 3), *Rhus crenata* (Species Group O, Table 3), and *Passerina rigida* (Species Group Q, Table 3), are dominant in the sub-community.

The sub-community has an average of 18 species per relevé.

5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of low to short closed broad-leaved shrubs, with some high shrubs at the center.This sub-community is found in a mosaic distribution pattern with sub-communities 2.1, 2.2 and 2.4.

This sub-community is found at an altitude of 3 – 21 m, at a gradient of 0° to 16°, on the dune plain, sandy shallow-soil limestone plain, on the northeastern and northwestern deep neutral sand foot-slopes of limestone hills, southern, southwestern and southeastern slopes and shoulders of limestone hills. Small irregular white-gray pebbles, covering 0 - 1%, are found on the dune plain and neutral sand area. Irregular white-gray stones and pebbles, covering 1%, are found on the limestone hills. The rock on the dune plain is mostly limestone, originating from the Strandveld formation of the Bredasdorp group. The rock on the limestone hills and neutral sand is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil on the dune plain and neutral sand area can be described as the Namib form and the soil on the limestone hills as the Immerpan and Coega forms (Macvicar 1991).

Helichrysum dasyanthum (Species Group H, Table 3) is the only diagnostic species for this sub-community.

The shrubs *Euclea racemosa,* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), *Otholobium bracteolatum* (Species Group C, Table 3), are dominant in the sub-community.

The shrubs *Rhus glauca* (Species Group A, Table 3), *Pterocelastrus tricuspidatus* (Species Group D, Table 3), *Passerina paleacea* (Species Group J, Table 3), *Chrysanthemoides monilifera* (Species Group R, Table 3), are also prominent in the sub-community.

The sub-community contains an average of only 6 species per relevé.

5.5 *Acacia cyclops* - *Euclea racemosa* high to tall closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of high to tall closed broad-leaved shrubs, with some low to short shrubs at the periphery.

The sub-community is found in a mosaic with sub-communities 2.1 and 3.5.

The sub-community is found at an altitude of 3 – 25 m, at a gradient of 0° to 8°, on the shallow-soil limestone plain, deep-soil limestone plain, southern and southwestern deep neutral sand foot-slopes of limestone hills and on the neutral sand plain. Small irregular white-gray pebbles and stones, covering 1%, are found on the shallow-soil limestone plain and is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. A rock cover of 0% was found on the neutral sand area and deep-soil limestone plain. The soil on the neutral sand can be described as the Namib form, on the shallow-soil limestone plain as the Brandvlei and Coega forms, and on the deep-soil limestone plain as the Immerpan form (Macvicar 1991).

The exotic *Acacia cyclops,* the shrubby tree *Protea obtusifolia* and the shrub *Passerina galpinii* are the diagostic species for this sub-community (Species Group I, Table 3),

The shrubs *Euclea racemosa,* and *Rhus laevigata* var. *laevigata* for. *coangoa* (Species Group A, Table 3), and *Metalasia muricata* (Species Group R, Table 3) are dominant in the sub-community.

The shrub *Rhus glauca* (Species Group A, Table 3) is also prominent in the sub-community.

The sub-community contains an average of only 7 species per relevé.

5.6 Thamnocortus insignis - *Euclea racemosa* high to tall closed thicket sub-community.

The structure of the sub-community can be described as scattered groups of high to tall closed broad-leaved shrubs, with some low and short shrubs at the periphery. Low forbs and some high, low and short restiods are also present in the sub-community (Photo 10).

The sub-community is found in a mosaic with community 4 as well as near the indented corner formed by the middle and eastern part of the northern borderline of Tsaba-Tsaba Nature Reserve and in patches near the middle part of Tsaba-Tsaba.

The sub-community is found at an altitude of 3 – 20 m, at a gradient of 0° to 16°, on the Renosterveld plain and on the northeastern and southeastern deep neutral sand foot-slopes of limestone hills. Small irregular white-gray pebbles and stones, covering 0 -1%, are found on the neutral sand and Renosterveld plain and is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil of the neutral sand can be described as the Namib form and as the Brandvlei form on the Renosterveld plain (Macvicar 1991).

Species Group J (Table 3) is diagnostic for this sub-community with the restioid *Thamnocortus insignis* and the shrubs *Helichrysum patulum*,

Passerina paleacea, *Metalasia densa* the most prominent diagnostic species.

The shrubs *Euclea racemosa* and *Rhus glauca* (Species Group A, Table 3) and the restioid *Thamnocortus insignis* (Species Group J, Table 3) are dominant in the sub-community.

The shrubs Olea exasperata *(Species Group E, Table 3),* Chrysanthemoides monilifera *and* Metalasia muricata *(Species Group R, Table 3), are also prominent in the sub-community.*

The sub-community contains an average of 27 species per relevé.

Photo 10. *Thamnocortus insignis - Euclea racemosa* sub-community, showing the typical vegetation of the sandy, deep-soiled limestone plain, with *Chrysanthemoides monilifera* prominent at the back.

5.6.1 *Elytropappus rhinocerotus* - *Euclea racemosa* short to tall thicket variant.

The structure of the variant can be described as scattered groups of short to tall closed broad-leaved shrubs, with some lower shrubs at the periphery, as well as some high restiods.

The variant is distributed in a mosaic with community 4.

The variant is found at an altitude of 3 m, at a gradient of 0° to 3°, on the Renosterveld plain. Small irregular white-gray pebbles and stones, covering 1%, are found on the Renosterveld plain and is mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil can be described as the Brandvlei form (Macvicar 1991).

The diagnostic species are listed in Species Group K (Table 3), which includes the shrubs *Elytropappus rhinocerotis, Leucadendron linifolium, Oedera uniflora, Lycium afrum, Rhus laevigata* var. *villosa, Asparagus lignosus, Euryops hebecarpus,* and the forbs *Limonium scabrum* var. *scabrum, Hermannia althaeifolia* and *Pelargonium myrrhifolium.*

The shrubs *Euclea racemosa* and *Rhus glauca* (Species Group A, Table 3), the restiods *Thamnocortus insignis* (Species Group J, Table 3) are dominant in the variant.

The shrubs *Helichrysum patulum, Passerina paleacea* (Species Group J, Table 3), *Elytropappus rhinocerotis, Leucadendron linifolium* (Species Group K, Table 3) and *Chrysanthemoides monilifera, Metalasia muricata* (Species Group R, Table 3) are also prominent in the variant.

The variant contains an average of 22 species per relevé.

5.6.2 *Leucadendron coniferum - Euclea racemosa* high to tall closed thicket variant.

The structure of the variant can be described as scattered groups of high to tall closed broad-leaved shrubs, with some low to short shrubs at the periphery, as well as some high and low restiods in between.

The variant is found at a gradient of 8° to 26°, at an altitude of 3 – 6 m on the northeastern and southeastern deep neutral sand foot-slopes of limestone hills. Small irregular white-gray pebbles and stones, covering 0-1%, are mostly limestone, originating from the Waenhuiskrans formation of the Bredasdorp group. The soil can be described as the Namib form (Macvicar 1991).

A large number of species given in Species Group L (Table 3) are diagnostic for this variant, These include the shrubs *Eriocephalus kingesii, Leucadendron coniferum, Viscum capense, Protea susannae, Maytenus procumbens, Agathosma serpyllacea, Phylica stipularis, Trigogyne repens, Tephrosia capensis, Othonna dentata, Microloma sagittatum* (liane), the parasitic liane *Cassytha ciliolata,* the forbs *Conicosa pugioniformis* subsp. *muirii, Wachendorfia paniculata, Heliophyla refracta, Crassula subulata* var. *subulata, Oxalis obtusa, Gymnodiscus capillaris, Sebaea aurea, Cineraria* sp., *Albuca cooperi, Babiana montana, Euphorbia foliosa, Sebaea albens, Gazania pectinata* and the the restioids *Cannomois virgata,* and *Elegia stipularis.*

The shrubs *Euclea racemosa* and *Rhus glauca* (Species Group A, Table 3), the restiods *Thamnocortus insignis* (Species Group J, Table 3) are dominant in the variant.

The shrubs *Olea exasperata* (Species Group E, Table 3), *Cassine peragua* (Species Group J, Table 3), *Protea susannae, Agathosma collina, Salvia-africana lutea, Maytenus procumbens, Agathosma serpyllacea, Phylica stipularis* (Species Group L, Table 3), *Solanum africanum* (Species Group M, Table 3), *Chrysanthemoides minilifera* (Species Group R, Table 3) and the restioid *Chondopetalum microcarpum* (Species Group L, Table 3) are also prominent in the variant.

The variant is rich in species and contains an average of 43 species per relevé.

6. *Chrysanthemoides monilifera - Solanum africanum* low closed dune community.

The structure of the community can be described as mostly low prostrate shrubs, with some short, high and tall shrubs also present in the community (Photo 11).

The community is found in a mosaic with communities 7, 8 and 9, in the sparsely vegetated shifting sand dune area (adjacent to the coast). The community is also found in a mosaic with communities 7 and 8, in the densely vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area.

The community is situated at an altitude of 1 – 21 m, at a gradient of 26° to >45°. The community is found on the dryer (exposed to less moisture from sea, and more sunlight, than the eastern, southeastern and southern slopes, as the sea lies southeast of the coastal part of the study area) northern, northwestern, northeastern and southwestern mid-slopes of coastal dunes. A rock cover of 0% is found in the community.

The low shrub *Solanum africanum* (Species Group M, Table 3) is not only diagnostic but also dominant in the community.

The shrub *Chrysanthemoides monilifera* (Species Group R, Table 3) is also prominent in the community.

The tall-, high-, short- and low shrub strata show an average canopy cover of 6%, 5%, 5% and 51% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.15 m respectively. The forb stratum contains an average canopy cover of 1% and an average height of 0.3 m. The short grass stratum has an average canopy cover of 0.6%, and an average height of 0.75 m.

The community contains an average of only 4 species per relevé.

Photo 11. *Chrysanthemoides monilifera - Solanum africanum* community.

7. *Chrysanthemoides monilifera - Ehrharta villosa* var. *maxima* low to short closed shrub dune community.

The structure of the community can be described as low to short shrubs, with some short, high and tall shrubs also present, as well as some low forbs, and low and short grass (Photo 12).

The community is found in a mosaic with communities 6, 8 and 9 in the sparsely vegetated shifting sand dune area adjacent to the coast. The community is also found in a mosaic with communities 6 and 8 in the dense vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area.

The community is found at an altitude of 1 – 21 m, at a gradient of 3° to 45°, on coastal dunes and dune troughs (plains between dunes). A rock cover of 0% is found in the community.

The shrubs *Stoebe cinerea* and the grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3), are diagnostic for the community.

The shrub *Chrysanthemoides monilifera* (Species Group R, Table 3) is dominant in the community.

The shrubs *Solanum africanum* (Species Group M, Table 3), *Stoebe cinerea* (Species Group N, Table 3), *Morella cordifolia* (Species Group P, Table 3),

Passerina rigida (Species Group Q, Table 3) and *Metalasia muricata* (Species Group R, Table 3) are prominent in the community.

The tall-, high-, short- and low shrub strata show an average canopy cover of 6%, 10%, 29% and 16% respectively, and an average height of 2.5 m, 1.5 m, 0.75 m and 0.3 m respectively. The forb stratum contains an average canopy cover of 2% and an average height of 0.3 m. The short restioid stratum has an average canopy cover of 0.3%, and an average height of 0.2 m. The sedge stratum contains an average canopy cover of 0.5%, and an average height of 0.15 m. The high-, short-, and

Photo 12. *Chrysanthemoides monilifera - Ehrharta villosa* var. *maxima* , showing a typical example of the sparsely-vegetated dune area, with *Chrysanthemoides monilifera* in the front, and *Passerina rigida* at the top of the dune.

low grass strata have an average canopy cover of 0.5%, 2% and 2% respectively, and an average height of 1.5 m, 0.75 m, 0.3 m respectively.

The community has an average of 10 species per relevé.

7.1 *Chrysanthemoides monilifera* - *Rhus crenata* short to high shrub dune sub-community.

The structure of the sub-community can be described as short to high shrubs, with some short and tall shrubs also present, as well as some low forbs, low restios, low sedges, and low, short and high grass.

The sub-community is found in a mosaic with communities 6, 8 and 9 in the sparsely vegetated shifting sand dune area, adjacent to the coast.

The sub-community is found at an altitude of 0 – 21 m, at a gradient of 8° to 45°, on the very steep (26° - 45°) northern, northeastern, northwestern and southern slopes and moderate (8° - 16°) peaks of coastal dunes and on the gradual to moderate (3° - 16°) dune troughs. A rock cover of 0% is found in the sub-community. It can in general be said that the sub-community is found in areas that are at least slightly sheltered from the southeastern wind, carrying slat spray, either because of slope direction, or because of the presence of other nearby dunes.

The shrubs *Rhus crenata* (Species Group O, Table 3), is the only diagnostic species.

Passerina rigida (Species Group Q, Table 3), *Chrysanthemoides monilifera* (Species Group R, Table 3), *Metalasia muricata* (Species Group R, Table 3), are dominant in the sub-community.

The shrubs *Solanum africanum* (Species Group M, Table 3), *Stoebe cinerea* (Species Group N, Table 3), *Morella cordifolia* (Species Group P, Table 3), and the grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3) are also prominent in the sub-community.

The sub-community contains an average of 12 species per relevé.

7.2 *Chrysanthemoides monilifera* - *Morella cordifolia* low to short closed shrub dune sub-community.

The structure of the sub-community can be described as low to short shrubs, with some high and tall shrubs, as well as some low forbs, low restios, low sedges, and low, short and high grass (Photo 13).

The sub-community is found in a mosaic with communities 6 and 8 in the dense vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area.

The sub-community is found at an altitude of 1 – 21 m, at a gradient of 0° to 45°, on the steep to very steep (16 - >45°) southern, southwestern, northern and northeastern mid-slopes, moderate (8 - 16°) peaks of coastal dunes, and on the gradual (3 - 8°) dune troughs. A rock cover of 0% is found in the sub-community. The sub-community is mostly exposed to sea mist, and can in general be found almost parallel to the direction of the southeastern sea wind. The dune troughs on which part of the sub-community occurs, are in general much larger, more exposed, open areas, than those on which sub-community 7.1 occurs. The leaf structure and orientation of the most dominant plant species found in the sub-community (*Morella cordifolia),* is such that it enhances the ability of the plant to catch moisture, originating from seaside coming mist.

The shrubs *Morella cordifolia, Lessertia frutescens* (Species Group P, Table 3), are dominant diagnostic species, and *Chrysanthemoides monilifera* (Species Group R, Table 3) is also dominant in the sub-community.

The shrubs *Stoebe cinerea* (Species Group N, Table 3), *Passerina rigida* (Species Group Q, Table 3), and *Metalasia muricata* (Species Group R, Table 3), and the grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3) are also prominent in the sub-community.

The sub-community contains an average of 11 species per relevé.

Photo 13. *Chrysanthemoides monilifera - Morella cordifolia* sub-community with *Morella cordifolia* dominant, and showing a typical example of the densely vegetated dune area.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

The structure of the community can be described as low to high closed dune grassland.

The community is found in a mosaic with communities 6, 7 and 9. in the sparsely vegetated, shifting sand dune area adjacent to the coast, in a mosaic with communities 6 and 7, in the densely vegetated sand dune area found at the seashore and deeper inland, adjacent to the shifting sand dune area, and also in a mosaic with community 10 in the coastal strand area, adjacent to the sea.

The community is found at an altitude of 3 – 21 m, at a gradient of 16° to 45°, on the southern and southwestern slopes of coastal dunes. A rock cover of 0% is found in the community. There can in general be said that the community is found on the otherwise not-vegetated or sparsely vegetated sand dunes, or the more mobile shifting sand dunes.

The grass *Ehrharta villosa* var. *maxima* (Species Group N, Table 3) is dominant in the community.

The high-, short-, and low grass strata have an average canopy cover of 3.5%, 25%, and 15% respectively and an average height of 1.5 m, 0.75 m, and 0.3 m respectively.

The community contains an average of only 1 species per relevė.

9. *Ammophila arenaria* low to high closed dune grassland community.

The structure of the community can be described as low to high closed dune grassland (Photo 14).

The community is found in a mosaic with communities: 6, 7 and 8 in the sparsely vegetated shifting sand dune area adjacent to the coast.

Photo 14. *Ammophila arenaria* community, showing the exotic grass species.

The community is found at an altitude of 1 – 21 m, on the northern and northeastern dry, warm, mid-slopes of sand dunes, at a gradient of 16° to 45°. The rock cover is 0%. The soil can be described as the Namib form (Macvicar 1991).

The exotic grass *Ammophila arenaria* (Species Group S, Table 3) is diagnostic and dominant species in the community.

The shrub stratum has an average height of 1m and an average canopy cover of 10%. The grass stratum has an average height of 0.7 m and an average canopy cover of 44%.

The community contains an average of only 3 species per relevé.

10. *Arctotheca populifolia* - *Thinopyrum distichum* short to low open strand community.

The structure of the community can be described as short to low open strand grassveld with low forbs (Photo 15).

The community is situated in the area directly adjacent to the sea.

The community is found at an altitude of 0 – 3 m, at a gradient of 0° to 16°, on the dry beach, gravel plain behind the low frontal dunes, on the southern and southeastern slopes of low frontal dunes along the coastline. The rock cover varies from 0-50%. There is a rock cover of 0% on the beach and dunes and a rock cover of 30-50% on the gravel plain. The rocks on the gravel plain are mostly sandstone and quartzite roll-stones (in all probability deposited, by the sea, during a prior increase in sea level), originating from Table mountain sandstone, and is considered as part of the Bredasdorp group (Malan *et al.* 1994). The soil can be described as the Namib form (Macvicar 1991).

The forb *Arctotheca populifolia* and the grass *Thinopyrum distichum* (Species Group T, Table 3) are diagnostic for and prominent in the community.

Photo 15. *Arctotheca populifolia - Thinopyrum distichum* community, showing one of the gravel-plain areas of the community.

The community contains an average of only 2 species per relevé.

ORDINATION

The distribution of syntaxa along the first (x) and second (y) axes of the DECORANA ordination (Hill 1979b) can be seen in Figure 7, 8 and 9. The vegetation gradient indicated along the x-axis is associated with soil clay / sand content. The vegetation gradient along the y-axis is associated with the degree of exposure to wind. Two distinct groups of communities were distinguished: The fist group includes communities 1 to 4, (Figure 7) and are those found on the inland plains and hills of the study area. The second group includes community 5 to 10, (Figure 8), and are those found on the coastal plains, hills, dunes and strand area of the study area. The relation between the two groups of communities can also be seen in Figure 9.

The result supports the classification. The vegetation gradient revealed by the distribution of the plant communities concurs with an environmental gradient on axis 2 where plant communities found on soil with a high clay content occur at the left , and plant communities found on very sandy soil are located to the right of the diagram. The distribution of plant communities also concur with an environmental gradient on axis 3, where plant communities that are sheltered from the wind, by the presence of *Acacia cyclops* trees, or other environmental conditions (for instance sheltered by dunes all around), shows a gradient of sheltered communities at the bottom, to exposed communities at the top of the diagram.

CONCLUDING REMARKS

The plant communities (Figure 10), could all be related to specific environmental conditions and are therefore floristically and ecologically distinguishable and interpretable. Plant community variations are closely associated with differences in soil, (soil depth, % clay/sand) as well as exposure to the northwestern (land-side) and southeastern (sea-side) winds, the two dominant wind-types found in the study area.

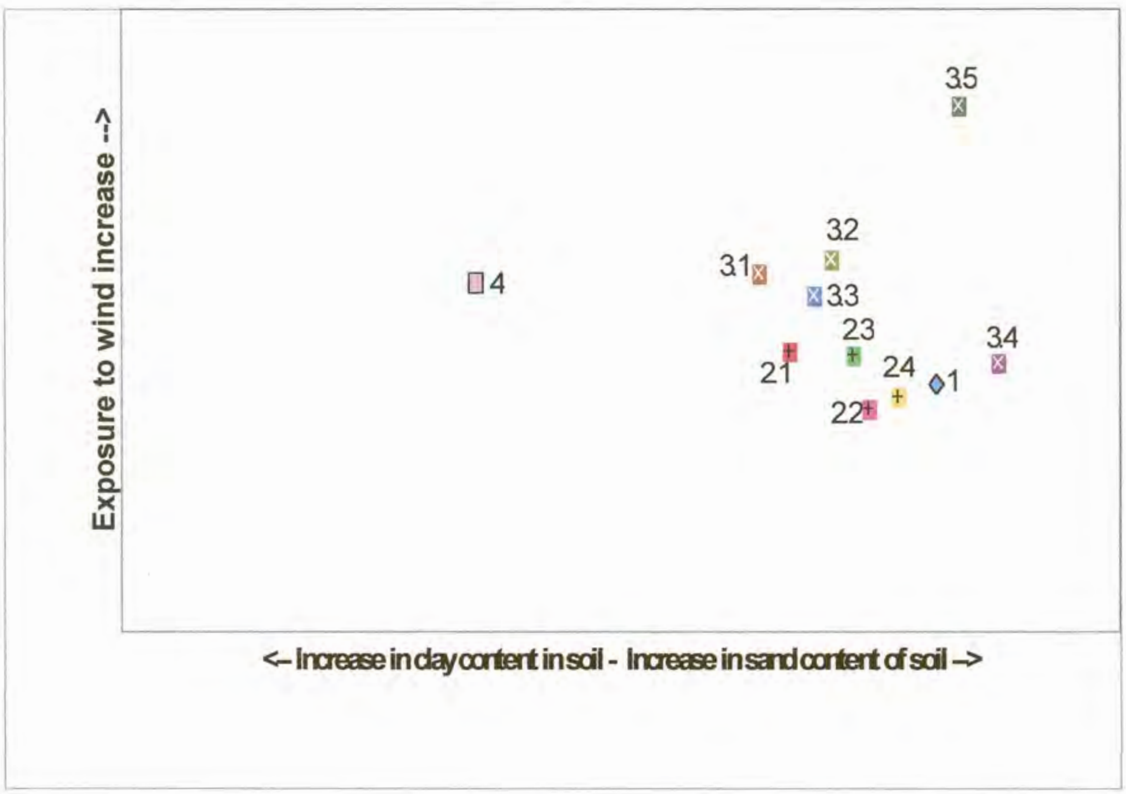

Figure 7. Ordination diagram of the inland plains and hills of Andrew's Field and Tsaba-Tsaba nature reserve, showing the distribution of the plant communities along the x and y axes.

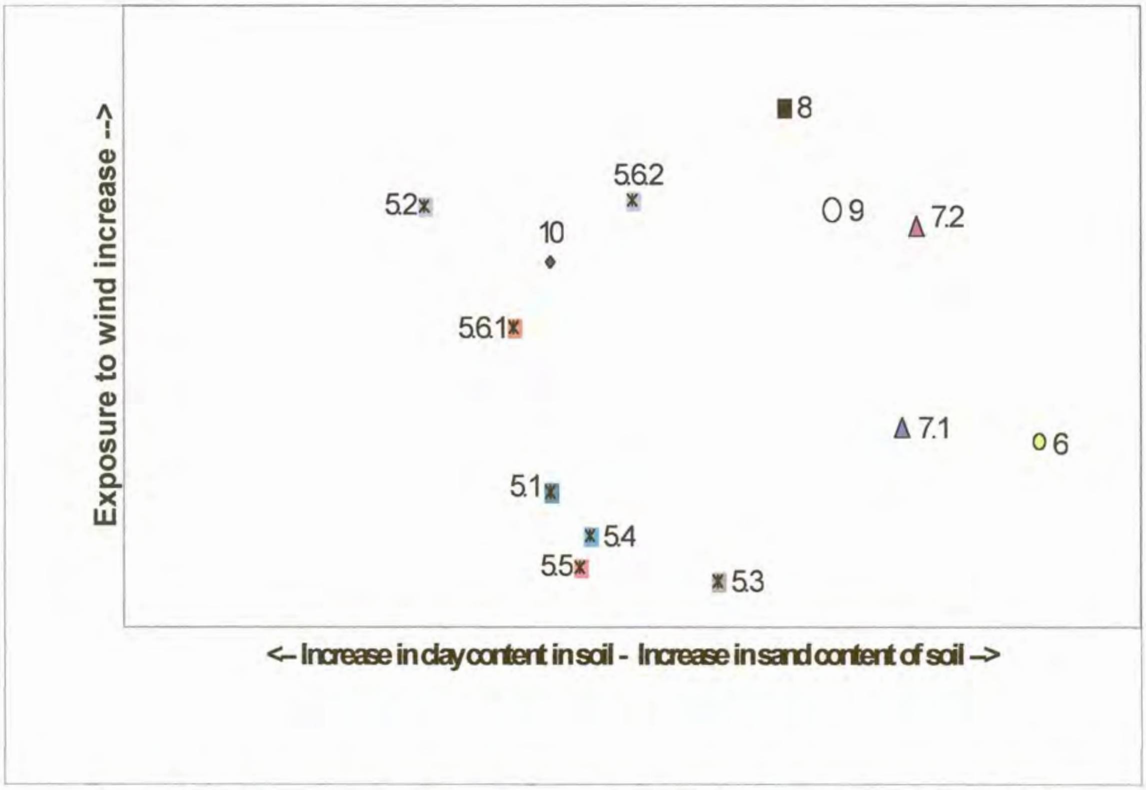

Figure 8. Ordination diagram of the coastal thicket, dunes and strand of Andrew's field and Tsaba-Tsaba Nature reserve, showing the distribution of the plant communities along the x and y axes.

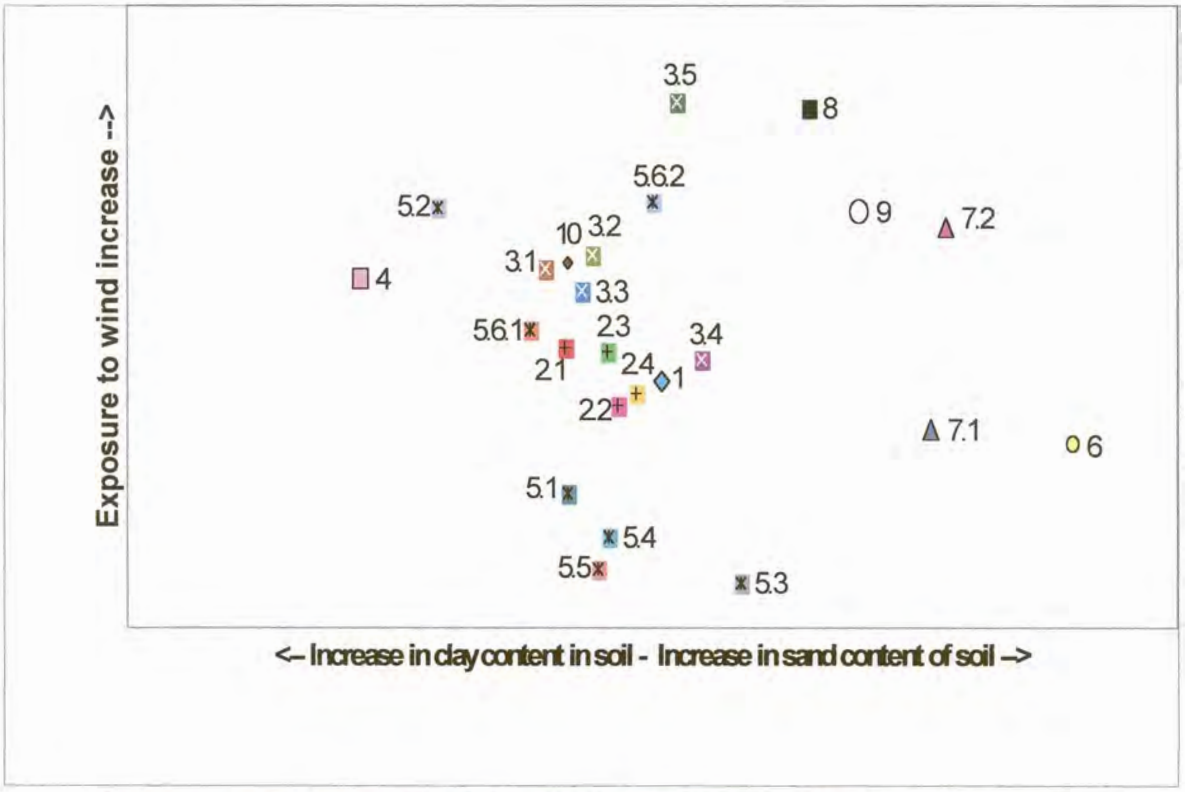

Figure 9. An x-y ordination of the plant communities of Andrew's Field and Tsaba-Tsaba nature reserve, showing the relationship between the inland plains and hills area and the coastal thicket, dunes and strand area.

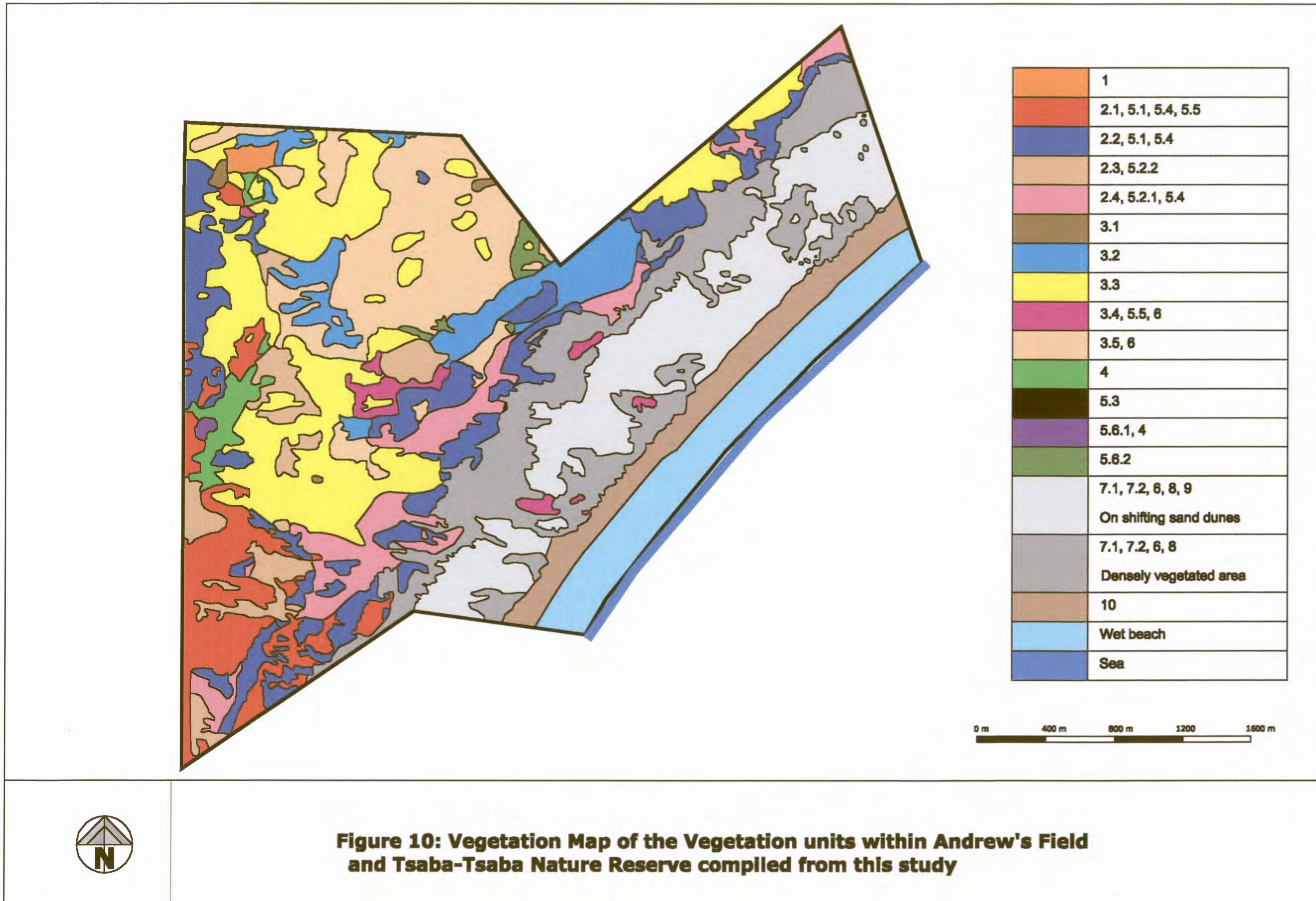

Figure 10: Vegetation Map of the Vegetation units within Andrew's Field and Tsaba-Tsaba Nature Reserve compiled from this study

KEY TO VEGETATION MAP

1. *Phragmites australis* - *Juncus kraussii* short to high closed reed Wetland community.

2.1, 5.1, 5.4, 5.5 - Mosaic of:

2.1 *Adromischus caryophyllaceus* - *Chondropetalum microcarpum* low closed limestone fynbos sub-community.
5.1 Rhus lucida - *Euclea racemosa* low to short closed thicket sub-community.
5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed thicket sub-community.
5.5 *Acacia cyclops* - *Euclea racemosa* high to tall closed thicket sub-community.

2.2, 5.1, 5.4 - Mosaic of:

2.2 *Passerina corymbosa* - *Chondropetalum microcarpum* low to short closed fynbos sub-community.
5.1 Rhus lucida - *Euclea racemosa* low to short closed thicket sub-community.
5.4 *Helichrysum dasyanthum* - *Euclea racemosa* low to short closed thicket sub-community.

2.3, 5.2.2 - Mosaic of:

2.3 *Empodium gloriosum* - *Chondropetalum microcarpum* low to short, closed limestone fynbos sub-community.
5.2.2. *Carissa bispinosa* - *Euclea racemosa* short to tall closed thicket variant.

2.4, 5.2.1, 5.4 - Mosaic of:

2.4 *Eriocephalus kingesii* - *Chondropetalum microcarpum* low to short, closed fynbos sub-community.

5.2.1. *Olea exasperata - Euclea racemosa* short to high closed thicket variant.
5.4 *Helichrysum dasyanthum - Euclea racemosa* low to short closed thicket sub-community.

3.1 *Amphitalia alba - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.2 *Erica abietina - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.3 *Ehrharta calycina - Leucadendron meridianum* low to short limestone fynbos sub-community.

3.4 *Metalasia muricata - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.5, 6 - Mosaic of:

3.5 *Protea susannae - Leucadendron coniferum* high closed fynbos sub-community.
6. *Chrysanthemoides monilifera - Solanum africanum* low closed dune community.

4. *Oedera uniflora - Elytropappus rhinocerotus* low closed Renosterveld community.

5.3 *Acmadenia obtusata - Euclea racemosa* short to tall closed thicket sub-community.

5.6.1, 4 - Mosaic of:

5.6.1 *Elytropappus rhinocerotus - Euclea racemosa* short to tall closed thicket variant.

4.*Oedera uniflora - Elytropappus rhinocerotus* low closed Renosterveld community.

7.1, 7.2, 6, 8, 9 - Sparsely vegetated mosaic of:

7.1 *Chrysanthemoides monilifera* - *Rhus crenata* short to high dune shrub sub-community.

7.2 *Chrysanthemoides monilifera* - *Morella cordifolia low to short closed shrub* sub-community.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

9. *Ammophila arenaria* low to high closed dune community.

7.1, 7.2, 6, 8 - Densely vegetated mosaic of:

7.1 *Chrysanthemoides monilifera* - *Rhus crenata* short to high dune shrub sub-community.

7.2 *Chrysanthemoides monilifera* - *Morella cordifolia low to short closed shrub* sub-community.

6. *Chrysanthemoides monilifera* - *Solanum africanum* low closed dune community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

10. *Arcthotheca populifolia* - *Thinopyrum distichum* short to low open strand community.

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CHAPTER 5: DISCUSSION

The Braun-Blanquet method was successfully applied, and resulted in 10 plant communities, 17 sub-communities and four variants.

1. *Phragmites australis* - *Juncus kraussii* short to high closed reed Wetland community.

2. *Chondropetalum microcarpum* - *Metalasia pungens* low closed ericoid and restioid fynbos community.

2.1. *Adromischus caryophyllaceus* - *Chondropetalum microcarpum* low closed limestone fynbos sub-community.

2.2. *Passerina corymbosa* - *Chondropetalum microcarpum* low to short closed fynbos sub-community.

2.3. *Empodium gloriosum* - *Chondropetalum microcarpum* low to short, closed limestone fynbos sub-community.

2.4. *Eriocephalus kingesii* - *Chondropetalum microcarpum* low to short, closed fynbos sub-community.

3. *Leucadendron meridianum* - *Protea obtusifolia* low to high limestone fynbos community.

3.1. *Amphitalia alba* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.2. *Erica abietina* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.3. *Ehrharta calycina* - *Leucadendron meridianum* low to short limestone fynbos sub-community.

3.4. *Metalasia muricata* - *Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.5. *Protea susannae* - *Leucadendron coniferum* high closed fynbos sub-community.

4. *Oedera uniflora* - *Elytropappus rhinocerotus* low closed Renosterveld community.

5. *Rhus glauca* - *Euclea racemosa* short to tall closed thicket community.

5.1. Rhus lucida - *Euclea racemosa* low to short closed thicket sub-community.

5.2. Pterocelastrus tricuspidatus - *Euclea racemosa* short to tall closed thicket sub-community.

5.2.1. Olea exasperata - *Euclea racemosa* short to high closed thicket variant.

5.2.2. *Carissa bispinosa* - *Euclea racemosa* short to tall closed thicket variant.

5.3. *Acmadenia obtusata* - *Euclea racemosa* short to tall closed thicket sub-community.

5.4. *Helichrysum dasyanthum - Euclea racemosa* low to short closed thicket sub-community.

5.5. *Acacia cyclops - Euclea racemosa* high to tall closed thicket sub-community.

5.6. Thamnocortus insignis - *Euclea racemosa* high to tall closed thicket sub-community.

5.6.1. *Elytropappus rhinocerotus - Euclea racemosa* short to tall closed thicket variant.

5.6.2. *Leucadendron coniferum - Euclea racemosa* high to tall closed thicket variant.

6. *Chrysanthemoides monilifera - Solanum africanum* low closed dune community.

7. *Chrysanthemoides monilifera - Ehrharta villosa* var. *maxima* low to short closed dune shrub community.

7.1. *Chrysanthemoides monilifera - Rhus crenata* short to high dune shrub sub-community.

7.2. *Chrysanthemoides monilifera - Morella cordifolia low to short closed shrub* sub-community.

8. *Ehrharta villosa* var. *maxima* low to high closed dune grassland community.

9. *Ammophila arenaria* low to high closed dune community.

10. *Arcthotheca populifolia - Thinopyrum distichum* short to low open strand community.

All plant communities, sub-communities and variants could be related to specific environmental conditions and are therefore ecologically distinguishable and interpretable. The classification is supported by the results of ordinations conducted with the aid of the DECORANA (Hill 1979b) computer program. A diagram showing the total hierarchical classification of vegetation units and associated environmental characteristics can be seen in Figure 11.

The vegetation of Andrew's Field and Tsaba-Tsaba nature reserve is divided into two main vegetation groups: the vegetation of the inland plains and hills (communities 1 to 4), and the coastal thicket, dunes and strand (communities 5 to 10). The vegetation of the inland plains and hills is found on limestone hills, limestone plains, neutral sand, Renosterveld plain, and on the dune plain (the sandy plain found directly behind the back-dunes, of the dune area). The thicket community (community 5) is found mostly in a mosaic with communities of the inland plains and hills.

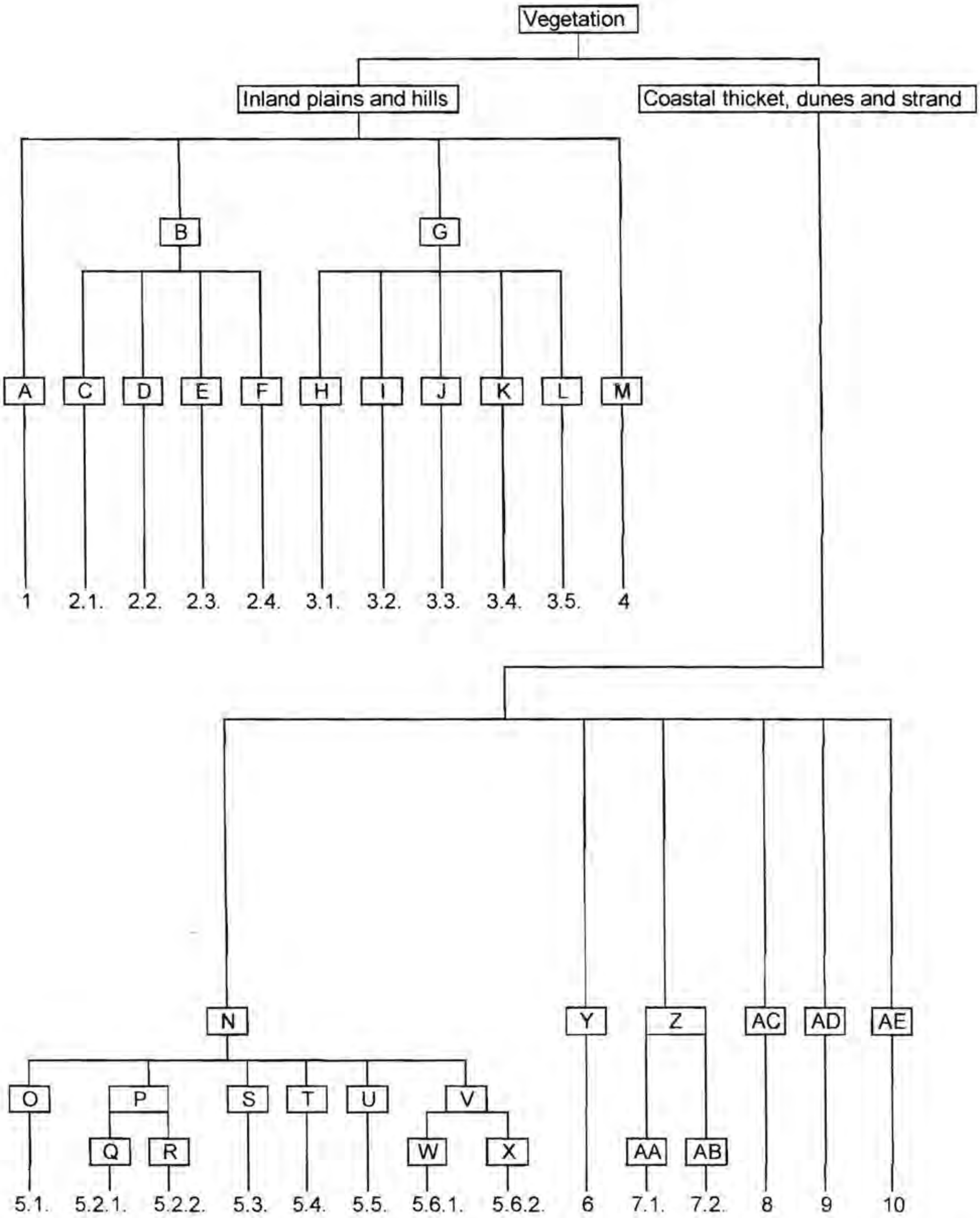

Figure 11. Summary of the total hierarchical classification and associated environmental characteristics of the vegetation of Andrew's Field and Tsaba-Tsaba nature reserve.

EXPLANATION OF FIGURE 11

A = Wetland area

B = Average rock cover low to moderate, soil sandy.

C = Flat to gradually sloped shallow soil limestone plain.

D = Flat to gradually undulating dune plane and sandy shallow-soil limestone plain.

E = Gradual to moderate SE and SW slopes of limestone hills.

F = Dune plain, NE and NW low to moderate, deep neutral sand foot-slopes of limestone hills, and the flat to gradual S, SW and SE slopes and shoulders of limestone hills.

G = Average rock cover moderate to high, soil sandy.

H = Flat, shallow-soil limestone plain, flat to gradual peak of limestone hill and gradual to moderate S and NW shoulder-plains of limestone hills.

I = Gradual peak of limestone hills, sandy deep-soil limestone plain and the S and SE deep neutral sand foot-slopes of limestone hills.

J = Moderate N and NE mid-slopes and shoulder-plains of limestone hills and the sandy, deep-soil limestone plain.

K = Flat sand peak of limestone hill, and deep-soil limestone plain and dune troughs.

L = Flat to gradual S and SW deep neutral sand foot-slopes of limestone hills, sandy deep-soil limestone plain and neutral sand plain.

M = Rock cover moderately, shallow soil on clay. Flat to moderate N and NW slopes of limestone hills and the Renosterveld plain.

N = Average rock cover low, soil sandy.

O = Flat to gradually undulating dune plain and sandy shallow-soil limestone plain.

P = Dune plain, NE and NW low to moderate, deep neutral sand foot-slopes of limestone hills and the flat to gradual S, SW and SE slopes and shoulders of limestone hills.

Q = Gradual peak of limestone hills, sandy deep-soil limestone plain and the S and SE deep neutral sand foot-slopes of limestone hills.

R = Flat, shallow-soil limestone plain, flat to gradual peak of limestone hill and gradual to moderate S and NW shoulder-plains of limestone hills.

S = N steep slope of a back-dune, very sheltered.

T = Dune plain, NE and NW low to moderate, deep neutral sand foot-slopes of limestone hills, the flat to gradual S, SW and SE slopes and shoulders of limestone hills and sandy shallow-soil limestone plain.

U = Flat to gradual S and SW deep neutral sand foot-slopes of limestone hills, sandy deep-soil limestone plain and neutral sand plain, flat to gradual undulating dune plain, Acacia cyclops association.

V = Sandy soil, very low rock cover.

W = Renosterveld plain.

X = NE and SE deep neutral sand foot slopes of limestone hills.

Y = Very steep N, NW, NE and SW dry, warm mid-slopes of dunes, no rock cover.

Z = Coastal dunes and dune troughs.

AA = Dune slopes slightly sheltered from direct southeastern wind.

AB = Dune slopes parallel to southeastern wind direction, catching sea mist.

AC = S and SW slopes of mobile / sparsely vegetated sand dunes.

AD = N and NE steep, dry mid-slopes of dunes.

AE = Beach and gravel plain, S and SE slopes of low frontal dunes.

The coastal dune and strand is found, as the name implies, on the dune and strand area adjacent to the sea.

Among the 10 plant communities, 34 plant species were identified as of conservation significance. Twenty-five limestone endemic species where present, of which four are listed in the Southern African Plant Red Data list (Golding 2002). A further 9 species, listed In the South African Plant Red Data list of 2002, were found in the study area (Chapter 9). The Agulhas plain (on which the study area is situated), is Botanically considered as an area of high irreplaceability and high vulnerability, being a rich coastal lowland with remnant patches of coastal Renosterveld and lowland fynbos, which are considered among the highest priorities for conservation in South Africa and globally (Schwegler 2003). The Agulhas Plain Centre (one of the six phytogeographic centres of the Cape flora), contains a total of 1374 species, of which 14.9% is endemic to the Cape (Goldblatt & Manning 2000). Of the 285 species recorded during the plant surveys, 138 species are endemic to the Cape, giving a figure of 48% endemism for the study area. It can clearly be seen that the study area is an area of exceptional species richness and conservation importance.

The occurrence of the Red data list and limestone endemic plant species can be seen in Tables 4 and 5 respectively. The importance of every vegetation unit containing Red data and/or limestone endemic species can be seen in Table 6.

It can clearly be seen that communities 2 to 4 are vegetation units of high conservation priority. Communities 2 and 3 are limestone vegetation and community 4 Renosterveld. Renosterveld has a very high conservation priority due to the small portion left of Renosterveld, mainly because of agricultural land clearing (Low & Rebelo 1998). The occurrence of limestone endemic species in community 5 (the thicket community) can be explained by the fact that the community is found in a mosaic with limestone vegetation units. Communities 2 to 4 should be protected due to the high percentage of endemism and Red data species present.

Community 1 is a Wetland area. According to Doust & Doust (1995) and Van Wyk *et al.* (2000) wetlands are sensitive systems that are easily disturbed and should be protected.

5.2.1. *Olea exasperata - Euclea racemosa* short to high closed thicket variant.
5.4 *Helichrysum dasyanthum - Euclea racemosa* low to short closed thicket sub-community.

3.1 *Amphitalia alba - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.2 *Erica abietina - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.3 *Ehrharta calycina - Leucadendron meridianum* low to short limestone fynbos sub-community.

3.4 *Metalasia muricata - Leucadendron meridianum* tall closed limestone fynbos sub-community.

3.5, 6 - Mosaic of:

3.5 *Protea susannae - Leucadendron coniferum* high closed fynbos sub-community.
6. *Chrysanthemoides monilifera - Solanum africanum* low closed dune community.

4. *Oedera uniflora - Elytropappus rhinocerotus* low closed Renosterveld community.

5.3 *Acmadenia obtusata - Euclea racemosa* short to tall closed thicket sub-community.

5.6.1, 4 - Mosaic of:

5.6.1 *Elytropappus rhinocerotus - Euclea racemosa* short to tall closed thicket variant.

4. *Oedera uniflora - Elytropappus rhinocerotus* low closed Renosterveld community.

Table 4. Red data list plant species occurrence in vegetation units.

Species	Occurrence in vegetation unit
Aloe brevifolia	4
Agathosma collina	2.1, 2.2, 2.3, 2.4, 3.2, 3.3
Agathosma dielsiana	2.1, 2.2, 2.3, 3.1, 3.3, 5.6.2
Agathosma serpyllacea	5.6.2
Diosma guthriae	2.1, 2.2, 2.3
Euchaetis meridionalis	4
Felicia nordenstamii	3.1
Helichrysum plebium	2.2, 2.3, 2.4, 3.3
Helichrysum pulchellum	2.2, 2.4, 3.3, 5.3, 5.6.1
Lachnaea densiflora	3.2
Satyrium carneum	2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 3.4
Solanum africanum	3.3, 5.2.2, 5.6.2, 6, 7.1, 7.2
Wahlenbergia microphylla	2.1

Table 5. Limestone endemic plant species occurrence in vegetation units.

Species	Occurrence in vegetation unit
Amphitalia alba	3.1
Aspalathus calcarea	2.1, 2.2, 2.3, 3.1, 3.2, 3.3
Berkhya coriacea	4, 5.6.1
Diosma guthriei	2.1, 2.2, 2.3
Erica propinqua	3.1
Euryops hebecarpus	2.1, 2.2, 3.1, 3.2, 3.3, 4, 5.6.1
Euryops linearis	2.2, 3.5, 7.1, 7.2
Felicia nordenstamii	3.1
Ficinia truncata	2.1, 2.3, 3.1, 3.2, 3.3, 4, 5.6.1
Hermannia trifoliata	2.3, 3.1, 3.2, 3.3, 5.6.1
Lachenalia muirii	2.2, 3.2
Leucadendron meridianum	2.2, 3.1, 3.2, 3.3, 3.4, 3.5
Leucandendron muirii	2.3, 3.2, 3.3, 3.5
Leucospermum truncatum	3.1
Metalasia calcicola	2.3, 3.1, 3.2, 4
Metalasia erectifolia	2.1, 2.4, 3.3, 5.6.1
Osteospermum subulatum	3.1, 3.2
Pentaschistis calcicola	2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 3.4, 4, 5.3, 5.6.1
Protea obtusifolia	3.1, 3.2, 3.3, 3.4, 5.5
Ruschia calcicola	2.1, 2.2, 3.3, 7.1, 7.2
Sutera calciphila	2.3, 3.1, 3.2, 3.3, 4
Wahlenbergia calcarea	3.3
Wahlenbergia microphylla	2.1

Table 6. Vegetation units with Red data plant species and/or limestone endemic plant species.

Vegetation unit	Number of Red data species	Number of limestone endemic species
2.1*#	5	8
2.2	6	8
2.3	5	8
2.4	4	1
3.1*##	3	14
3.2*	3	12
3.3#	6	12
3.4	1	4
3.5	0	3
4**	2	6
5.2.2	1	0
5.3	1	0
5.5	0	1
5.6.1	1	5
5.6.2	3	0
6	1	0
7.1	1	2
7.2	1	2

Vegetation units marked with a star (*) indicate that the vegetation unit contains one or more (depending on the number of stars) Red data plant species occurring in that vegetation unit only.
Vegetation units marked with a hash (#) indicate that the vegetation unit contains one or more (depending on the number of hashes) Limestone endemic plant species occurring in that vegetation unit only.

Communities 6 and 7 are dune communities. A single Red data species (*Solanum africanum)* is found quite abundantly in the dune area. The presence of limestone endemic species in the dune area can be explained by the fact that both the dune sands and the limestone soil are alkaline. The shifting sand dune area should be protected from disturbances, like trampling and vehicles. Protection form disturbances should also provide sufficient protection to the Red data and limestone endemic species.

The protection of community 8 can be included in the protection plan of communities 6 and 7.

Community 9 is an exotic grass community, and need not be protected at all. *Ammophila arenaria*, the dominant plant species is an European weed, commonly found on coastal dunes (Goldblatt & Manning 2000).

Although community 10 contains no rare or endemic species, the vegetation unit should be protected due to it's uniqueness, and due to the fact that the gravel-plain, found in this community only, is the breeding site of the Damara Tern bird species (Jeffery 1996).

Red data and limestone endemic species, found in community 5, would be protected in the best way by the regular burning of the vegetation unit, (with the exception of variant 5.2.2, which is a small forest, and can be conserved, due to the uniqueness thereof), to ensure that the thicket species do not take over the limestone vegetation units.

The thicket community forms part of the Dune thicket vegetation type of the Thicket Biome (Low & Rebelo 1998), while the other inland plains and hills vegetation forms part of the Fynbos Biome (Low & Rebelo). Dune thicket occurs along fairly mesic sites along dunes and at low altitudes along the coastal strip from the Western Cape into KwaZulu-Natal (Low & Rebelo 1998). According to Low & Rebelo (1998) dune thicket is also occasionally found in areas adjacent to coastal dunes. In the case of the study area, thicket was mostly found in mosaic with the vegetation of the inland plains and hills. The thicket community therefore does not only differ from the other fynbos communities concerning species composition and structure, but also in conservation importance. According to Low & Rebelo (1998) 14.49% of Dune thicket is currently being conserved, as opposed to the 1.42% of South and South-west coast Renosterveld and the 13.84% of Limestone Fynbos (Low & Rebelo 1998). As Dune thicket is found over a much larger area than Limestone fynbos, the percentage comparison does not give a good indication of the conservation need of Limestone fynbos, as opposed to Dune thicket. The area occupied by Limestone fynbos is only about 59% of the area occupied by Dune thicket. When the high percentage of endemism found in limestone fynbos is added on top of that, a very different picture can be seen.

According to Cowling & Richardson (1995) if fire could be excluded from fynbos for a century or two, many of the landscapes would become densely infested with just a few dozen species of forest and thicket shrubs and trees. Inland thicket development is therefore a feature of vegetation that has not been exposed to fire for a while. The species richness of thicket/forest is very low compared to those of fynbos and Renosterveld (Table 2 and 3), and the true thicket species like *Rhus glauca* and *Euclea racemosa,* are neither rare or endemic. Thicket forming should therefore be seen as a threat to the natural vegetation, and should not be encouraged above the conservation of the other fynbos and Renosterveld vegetation.

The presence of sub-community 5.5 (*Acacia cyclops* - *Euclea racemosa* high to tall closed thicket sub-community) is a reason of concern. Although *Acacia cyclops was* only formally recorded in six vegetation units, it occurs fairly well distributed throughout Tsaba-Tsaba nature reserve, and abundantly on Andrew's Field. Sub-community 5.5, as well as all areas containing *Acacia cyclops,* should be managed as discussed in Chapter 6 (Alien plant control).

Apart from *Acacia cyclops* and *Ammmophila areanaria* (in the dune area), a number of exotic or weed plants were found in the study area. The occurrence of these weeds in the vegetation units can be seen in Table 7. According to Bromilow (1995) and Henderson *et al.* (1987) the weed plants are mostly weeds of wheat and other cereals. These weeds have probably moved in from the surrounding Overberg farming areas. The presence of these plants in the study area can however mostly be seen as an indication of a certain degree of disturbance (Bromilow 1995). This disturbance is probably caused by flower harvesting, thatch-reed cutting, and by the cutting of Rooikrans wood. Care should be taken to reduce the impact of these activities on the study area.

Table 7. The occurrence of weed plants in the vegetation units.

Species	Vegetation unit
Anagallis arvensis	2.2, 3.2, 3.3, 4
Bromus diandrus	2.1. 3.2, 3.3
Foenicum vulgare	3.3, 5.2.1
Hordium murinum	3.1, 3.3
Orobanche minor	2.3, 2.4, 3.2
Tragus berteronianus	2.2

The presence of the indigenous plant parasite *Cassytha ciliolata* in vegetation units 3.1, 3.2, 3.3 (Appendix III), can have a detrimental effect on the vegetation if this plant is left uncontrolled. The controlling of *Cassytha ciliolata* should be met if regular prescribed burning of the area is followed (Chapter 7), but this plant can also be physically removed from the plants on which it grows as a parasite. The presence of this plant in vegetation also degrades the esthetical value of the vegetation.

Grasses can be classified according to their reaction to grazing (Van Oudtshoorn 1991). The classification of grasses according to their reaction to grazing is called the ecological status of a grass. Grasses usually react in one of two ways to grazing, they either decrease or increase in number (Van Oudtshoorn 1991). According to Trollope *et al.* (1990) following these principles, grasses are divided into the following categories:

- Decreaser - a species that is dominant in good veld, but decreases when veld is badly managed.
- Increaser I - a species dominant in poor veld, and increases with under-utilization or selective grazing.
- Increaser Ia - a species that increases under mild under-utilization or selective grazing.
- Increaser Ib - a species that increases under heavy under-utilization or selective grazing.
- Increaser II - a species that is dominant in poor veld and increases under overgrazing.
- Increaser IIa - a species that increases under light overgrazing.
- Increaser IIb - a species that increases under mild overgrazing.
- Increaser IIc - a species that increases under heavy overgrazing.
- Invader - a species not indigenous to the specific area.

A number of grasses with known ecological status, were found in some of the vegetation units in the study area. Although veld condition was not determined during the plant surveys, the relative abundance of each species in the sample plot was recorded. Accordingly, the following conclusions may be made by looking at the relative abundance and occurrence on Tables 2 and 3, as well as appendices III and IV, using grasses as indicators of veld condition:

Sub community 2.1 can be considered as poor veld that has been badly managed and over-grazed (due to a high occurrence of Increaser II species, medium occurrence of Increaser IIb species and a medium occurrence of Decreaser species).

Sub-community 2.2 can be considered as poor veld that has been mildly under-grazed (due to a high occurrence of Increaser II species and medium occurrence of Increaser IIb species).

Sub-community 2.3 can be considered as poor veld that has been badly managed and over-grazed (due to a high occurrence of Increaser II species and medium occurrence of Decreaser species).

Sub-community 2.4 can be considered as poor veld that has been badly managed, with some patches of good veld (due to a high occurrence of Increaser II species, medium occurrence of Increaser IIb species and a medium and high occurrence of Decreaser species).

Sub-community 3.1 can be considered as badly managed veld (due to a medium occurrence of Decreaser species).

Sub-community 3.2 can be considered as poor veld that has been badly managed (due to a high occurrence of Increaser II species, medium occurrence of Increaser IIb species and a medium occurrence of Decreaser species).

Sub-community 3.3 can be considered as poor veld that has been badly managed, with some pieces of good veld (due to a high occurrence of Increaser II species, medium occurrence of Increaser IIb species medium and high occurrence of Decreaser species).

Sub-community 3.5 can be considered as good veld that has been slightly badly managed (due to a medium occurrence of Decreaser species).

Community 4 can be considered as good veld that has been mildly under-grazed (due to a high and medium occurrence of Decreasers and a medium occurrence of Increaser IIb species).

Variant 5.2.2 can be considered as good veld that has been mildly under-grazed (due to a high occurrence of Decreasers and a medium occurrence of Increaser IIb species).

Variant 5.6.1 can be considered as good veld that has been badly managed and heavily overgrazed (due to a medium occurrence of Decreasers and a medium occurrence of Increaser IIc species).

It is risky to classify fynbos veld as badly managed on the basis of grass species, due to the fact that grasses occur in such low quantities in fynbos. Renosterveld has more grass, but there were only small patches of Renosterveld present in the study area. The values and diagnosis indicated by the grass species should only be seen as an indication of the current influence of the grazer species on the vegetation of the study area. It can clearly be seen that certain habitat types are preferred by the grazing animals, probably due to the amount of shelter or habitat preferences of the animals. No large grazers are present in the study area. Four relatively small, grass-eating herbivores are found in the study area: Steenbok (mixed-feeder), Cape Grysbok (mixed-feeder), Grey Rhebok (grazer, occasionally browsing), Common Duiker (browser, but also eating grass). In conclusion can be said that the grass-eating animals, of the study area, are not having such a pronounced negative influence on the study area (in the overgrazed areas), that would justify population control measures at this stage. The areas that contain grass that indicates under-grazing, would have been able to support more grazers, but due to the absence of suitable habitat types (open plains), additional grazing species will in all probability not make use of the under-grazed areas, but also of the already overgrazed areas. A list of animals found in the study area can be seen in Appendices I and II. It is also recommended not to try and introduce any more medium or large grazer species in the study area, due to a lack of suitable habitat and food.

In addition to the Red data species and limestone endemic plants, found in the ten plant communities of the study area, 27 of the plants found in the study area, are known to have medicinal value (Schwegler 2003, Van Wyk, Van Oudtshoorn & Gericke 1997). A list of the medicinal plants, and their occurrence in the vegetation units, can be seen in Appendix V. The number of medicinal plants, found in each vegetation unit, can be seen in Table 7. The presence of medicinal plants in an area increases the need to conserve an area. According to Van Wyk, Van Oudtshoorn & Gericke (1997) medicinal plants have played a very important role in the history of medicine, for example Quinine, used in the treatment of malaria, is obtained form the quinine tree (*Chichona pubescens).*

Medicinal plants must however not be considered as something of the past only. Recent important anti-cancer drugs such as taxol, obtained form *Taxus brevifolius*, and vincristine, obtained from *Catharanthus roseus*, have been developed (Van Wyk, Van Oudtshoorn & Gericke 1997).

Table 7. The number of known medicinal plant species in each vegetation unit.

Vegetation unit	Number of medicinal plant species.
1	1
2.1	8
2.2	10
2.3	8
2.4	11
3.1	9
3.2	16
3.3	18
3.4	6
3.5	8
4	8
5.1	3
5.2.1	8
5.2.2	4
5.3	2
5.4	3
5.5	4
5.6.1	8
5.6.2	6
6	0
7.1	3
7.2	2
8	0
9	1
10	0

The protection and conservation management of all vegetation units, will largely be met by following the alien plant control guidelines (Chapter 6), the burning program guidelines (Chapter 7), and the general management recommendations (Chapter 8). Due to the fact that most of the plants with known medicinal value are found in small quantities, they should not be exploited for medicinal use at this stage. As can clearly be seen, the vegetation units with the highest number of plants with medicinal value, are mostly also those with high conservation priority, due to the occurrence of Red data species and/or limestone endemic species. The protection of medicinal plants can be included in the protection of the vegetation units in which they occur. The study area should also be protected from the possible poaching of medicinal plants.

CONCLUSION

The description and classification of the plant communities of the study area, are a contribution to an improved understanding of the vegetation of the area.

The resulting classification should provide a useful tool, not only for the management of the plant communities of Andrew's Field and Tsaba-Tsaba nature reserve, but also for similar vegetation areas, found in the surrounding region.

Andrew's Field and Tsaba-Tsaba nature reserve are areas of great conservation significance. These areas comprise an important part of the natural heritage found at the southern tip of Africa, and should be protected and conserved for future generations.

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CHAPTER 6: ALIEN PLANT CONTROL

INTRODUCTION

Invasive plants are a major problem in the Fynbos biome, and controlling them (invasive shrubs and trees) is the largest single task of managers of most natural areas in the biome (Cowling 1992).

Invasive plants can be controlled using three types of methods (Cowling 1992) namely:

- Biological control
- Mechanical control
- Chemical control.

Acacia cyclops (Rooikrans) the dominant alien invader in the study area, was introduced form South Western Australia (Striton 1987). *Acacia cyclops* was cultivated and planted as a sand binder (Henderson *et al.* 1987), and cultivated for dune reclamation, shelter and firewood (Henderson 2001). According to Dey *et al.* (1978) the reason for the widespread adoption of the introduction of invasive weeds was mainly because of providing fast-growing sources of firewood and for drift sand control.

Acacia cyclops is the most widespread Australian wattle in all the provinces of the Cape, and favours calcareous dune-sands and rainfall of at least 250 mm per annum (Striton 1987). *Acacia cyclops* forms dense, impenetrable stands of tall shrubs or short trees with interlocking crowns (Striton 1987). *Acacia cyclops* is a serious problem in the Lowland Fynbos and coastal dunes, where it completely replaces indigenous vegetation (Henderson *et al.* 1987). According to Striton (1987) Rooikrans suppresses the germination and growth of indigenous vegetation, resulting in the disappearance of the natural flora.

The extent of weed invasion and the reduced state of the fynbos have led to great concern (Richardson *et al.* 1989). Today natural fynbos exists in isolated patches and often, narrow mountain corridors (Richardson *et al.* 1989). About 24% of the remaining Fynbos area has been estimated to carry light to heavy infestations of invasive weeds (Richardson *et al.* 1989).

According to Richardson *et al.* (1989) one of the major problems associated with the presence of dense stands of invasive alien trees and shrubs in the Fynbos Biome is the reduction of species richness of indigenous plants. Fynbos plant communities can be considered as the plant communities that have been changed most by introduced plants, in the whole world (Richardson *et al.* 1989).

Dense stands of *Acacia* species bring about significant reductions in the richness of indigenous species (Richardson *et al.* 1989). A decline in species richness with increase in alien plant cover was noted under stands of *Acacia cyclops* at the Good Hope Nature Reserve (Turpey 1986). Areas cleared of dense stands of alien invaders recover more slowly that those cleared from light infestation (Richardson *et al.* 1989).

METHODS OF CONTROLLING *ACACIA CYCLOPS*

<u>Biological control</u>

According to Dey *et al.* (1979) the insects' *Zulubius acaciophagus* and *Remiptevans sp.*, indigenous in Africa, have been found to be causing considerable damage to *Acacia cyclops* seeds. *Zulubius acaciophagus* destroys up to 84% of the seed crop (Cowling 1992).

<u>Mechanical control</u>

Cowling (1992) names the following methods of mechanical control:

- cut-and-leave
- cut-and-burn
- burn standing

Acacia cyclops does not resprout after being cut and has relatively short-lived seed banks stored in soil, and the seeds are not stimulated to germinate by fire (Cowling 1992). All three, or a combination of the above methods of mechanical control can thus be used.

Chemical control

Chemical control focuses chiefly on seedling mortality (Cowling 1992). The disadvantage of chemical control is that non-target species are adversely affected (Cowling 1992).

For long term control Cowling (1992) advised to use cut-and-leave or cut-and-burn or burn standing in combination with chemical control.

CURRENT CONTROLL METHOD FOR *ACACIA CYCLOPS*

Acacia cyclops is currently being controlled mechanically, by allowing an independent group to cut and sell the Rooikrans as firewood. This is a long-term project. The removal of *Acacia cyclops* using a prolonged method might present a threat to the conservation of the natural vegetation of the study area. It is advisable to use a faster method of removal, to ensure the conservation of the indigenous vegetation. If it should be decided to allow the worker group to continue their long-term removal project (because of work provision), the group should be advised to start removing *Acacia cyclops* in areas most threatened by alien invasion. A priority removal plan should be followed, according to conservation priorities. It is also advised that should the current removal method be continued, biological control agents (as mentioned above) should be used simultaneously with this method, to ensure a reduction in seed predation, while Rooikrans is not yet eradicated.

Conservation priorities:

1. Limestone Fynbos and Renosterveld: Plant communities 2, 3 and 4, and sub-communities 5.1, 5.2, 5.4, 5.5 and variant 5.6.1 (Figure 10).
2. Wetland area: Plant community 1, (Figure 10).
3. Dune Forest: Mosaic of sub- community 2.3 and variant 5.2.2 patch in area adjacent to biggest Renosterveld area, (Figure10).
4. Other plant communities.

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CHAPTER 7: BURNING PROGRAM

INTRODUCTION

According to Cowling & Richardson (1995) fire is a natural and normal process in fynbos. The role of fire in fynbos was not appreciated until after the mid 1970's, when a great deal of fire-related research on fynbos made a wealth of information available, that could be assimilated into wise fynbos management (Cowling & Richardson 1995).

FIRE AS A MANAGEMENT TOOL:

According to Cowling (1992) the use of fire is the major management practice in fynbos biome ecosystems. Fire regime is an important factor in mediating coexistence, and hence maintaining alpha richness in Gondwanan shrublands (Cowling 1987). According to Cowling (1992) to manage for the most important goals (nature conservation, water conservation, fire management, flower harvesting, grazing, recreation and tourism) centres largely on the application (or exclusion) of fire, and the control of alien invasive plants.

According to Cowling & Richardson (1995) if fire could be excluded from fynbos for a century or two, many of the landscapes would become densely infested with just a few dozen species of forest and thicket shrubs and trees.

Fire regime

Burning operations are prescribed in terms of the fire regime (frequency, season, intensity at which fire occur) and are based on a knowledge of the influence of these three components on the vegetation (Cowling 1992).

Frequency of fire

Fires in fynbos can burn at any time between four and 45 years, but to ensure that many component species survive repeated fire, a narrower range of fire frequencies would be needed (Cowling 1992).

According to Cowling & Richardson (1995) fire should only take place when half the population of the slowest-maturing species in an area have flowered for three successive seasons. In most fynbos areas the slowest maturing species in an area would have flowered for three successive seasons within the time limit of eight to 12 years (Cowling & Richardson 1995). Fire frequencies greater than 25 to 30 years are seldom recommended due to senescence in the Proteaceae, lower vegetation cover and greater patchiness in regeneration following fire in old fynbos, leading to increased erosion, and the suppression of understory species with long fire intervals (Cowling 1992). In vegetation which experience long fire-free intervals, post fire reproduction may be delayed for many years and proportionally more resources allocated to structural growth and maintenance (Cowling 1987). Under short intervals (e.g. < 10 year) fire regimes, there is a strong selective pressure for reduction in the juvenile period, increased allocation to reproduction and early senescence (Cowling 1987).

According to Van Wilgen *et al.* (1990a) fire frequencies should be between 10 and 25 years to maintain species richness. In some cases the shorter fire frequencies are needed, for example firebreaks are burned frequently to reduce biomass (Van Wilgen 1982).

According to Van Wilgen (1981) short rotational burning (four years) in an area resulted in the almost total elimination of larger seed-reproducing shrubs in that area. In mature (21-year old) vegetation the larger-seed reproducing shrubs survive and assume great importance while in older vegetation they decrease in importance, owing to mortality among over-mature adult shrubs (Van Wilgen 1981). Because of the high mortality rate of over-mature adult shrubs there is no significant difference in the canopy cover of vegetation managed on a short burning rotation on the same aspect (Van Wilgen 1981).

A study on *Protea neriifolia* in Jonkershoek, showed that in senescent stands seed germination occurred on a very limited scale, while fire in mature stands of *Protea neriifolia* resulted in mortality of adults, bur a large scale germination of seed (Van Wilgen 1981). According to Bond (1980) burns in senescent stands of vegetation (45 to 50 years old) dominated by Proteaceae, resulted in very poor seed germination, when compared to burnt mature (18 to 20 years old) vegetation. Bond (1980) postulates that the very poor seed germination in senescent stands of vegetation is due to a reduction in viability and canopy and soil stored seed, a decline in seed production and continual seed predation. Although species richness is lower in mature (21 year old vegetation), due to the fact that mature vegetation is dominated by large shrubs, all species vanishing in mature vegetation, reappear again after a burn in mature fynbos (Van Wilgen 1981). According to Kruger (1977) species which seem to be absent from the flora in a stand of mature fynbos may be present in the form of underground organs or soil-stored dormant seeds. According to Van Wilgen (1981) not burning (for > 30 years) in the Jonkershoek area resulted in senescence of the vegetation, as well as a reduction in total live biomass and an enormous build-up of litter. When a high build-up of fuel is allowed (in very old vegetation), high intensity burns may result, causing higher mortality among certain resprouting species (Van Wilgen 1981). According to Van Wilgen (1981) the fire frequency required to maintain vigorous fynbos (at Jonkershoek) appears to be 15 to 20 years.

Fire season

Climate, seasonal variations in moisture content, the variations, and the availability of ignition sources, determine which time of the year fires burn (Cowling & Richardson 1995). According to Cowling & Richardson (1995) lightning is the principal natural source of ignition, throughout the fynbos region, and is most likely in late summer and early autumn, when thunderstorm weather moves down from the Northeast. Ignition can also be caused by rock-falls (Cowling & Richardson 1995). Because seasonal curing of the vegetation is not a feature of fynbos vegetation, fire season therefore depends largely on climatic factors (Van Wilgen 1984).

According to Cowling (1992) fires occurring in different seasons can have marked effects on elements of the vegetation, nearly as pronounced as frequency effects.
Serotinous Proteacene shrubs that are killed by fire show maximum seedling recruitment after summer and early autumn fires (Cowling 1992). According to Bond *et al.* (1984) regular prescribed burning outside the late summer - early autumn period could result in the local extinction of species. Where species conservation is an objective, regular prescribed burning outside the late summer-early autumn period is not usually applied (Cowling 1992). The maximum flowering activity of most fynbos plants occurs in late winter and spring (Kruger 1981), implying that the maximum seed loads will be available after fires in late summer or early autumn

(Cowling 1992). According to Le Maitre (1988) Proteaceae with soil-stored seeds show the greatest recruitment following autumn burns, after the current seed crop has matured and been released.

Cowling *et al.* (1986) recommends autumn burns (Feb - Apr) in South Coast Renoster shrubland, if it should be desired to promote grasses at the expense of shrubs, like required in areas housing important grazers like Bontebok National Park. By using frequent burning to which the grasses are very resistant, the shrubs could be eliminated (Cowling 1992).

According to Cowling & Richardson (1995) fire in the autumn months (March and April) would be after the peak season for fire hazard but still within the safe zone for fynbos regeneration.

Fire intensity

Fire intensity depends on the fuel load of the burning vegetation and the rate of combustion (Cowling & Richardson 1995). On a hot and windy day very old veld (with a lot of dead vegetation and dense layer of fire litter) will support an intense burn, while a fire in young veld on a cool calm day will be much less intense (Cowling & Richardson 1995). Fynbos fires are more intense than those occurring in grassland or savanna (Cowling & Richardson 1995).

According to Cowling (1992) high intensity fires can have adverse effects on sprouting species. Late summer - early autumn fires are usually fires of high intensity, and indications are that at least some elements of the fynbos biota require high intensity fires for survival (Cowling 1992). Fire intensity may affect the relative abundance of species that generate from soil-stored seed banks after fire (Cowling 1992). Low fire intensities may favour species with shallow seed banks (e.g. the Asteraceae) above those with deeper seed banks (e.g. the Proteaceae) (Cowling 1992).

In areas where the felling of alien trees leads to accumulations of dead fuel, abnormally intense fires results, which have severe adverse effects on soil, vegetation, and fauna, and steps need to be taken to reduce fire intensities (Cowling 1992). Fire intensities can be reduced by selecting conditions that will lead to acceptable intensities (increased dead fuel moisture) or by dispersing or physically removing fuel loads (Cowling 1992).

Fire and Flower harvesting

It is not possible to sustain flower harvesting without fire (Cowling 1992). Many species require fire as a direct or indirect cue for seed germination and even the longer lived Proteaceae senescence and die after 30 to 50 years without fire (Bond 1980, Van Wilgen 1981). In practice, most veld is burnt after 12 to 15 years when the vigour of *Protea* shrubs declines and stem lengths become too short for the trade (Cowling 1992).

Fire and Alien Plant control

According to Cowling (1992) *Acacia cyclops* (Rooikrans), the dominant alien invader in the study area, seeds are not stimulated to germinate by fire. Fire would destroy the seeds near the soil surface (Cowling 1992). Cowling (1992) names cut-and-burn and burn standing as methods of controlling *Acacia cyclops*, using fire.

Influence of fire on mammals, birds and reptiles

According to McMahon & Frazer (1992) studies involving mice in the southern Cape indicated that less than expected mice were killed or injured during fire, presumably because such small animals are able to seek refuge under boulders and in burrows. Some mice species are apparently sensitive to the age of the vegetation (McMahon & Frazer 1992). Little seems to be known about the effects of fire on large mammals in the Fynbos Biome, but it is considered safe to assume that both browsing and grazing species of buck and antelope would be attracted to the proliferation of fresh growth following burn. (McMahon & Frazer 1992).

According to McMahon & Frazer (1992) veld burning influences the composition of bird communities and bird densities in the various fynbos vegetation types, although mortality during a fire is probably limited to eggs and unfledged young. Destruction of food plants by fire results in the disappearance of the nectarivous species (sugar-birds and sun-birds, until the Proteas and Ericas have matured and flowered again after the fire (McMahon & Frazer 1992).

Snakes and lizards are able to survive fire by sheltering under rocks, but large numbers of dead tortoises, are a feature of many fynbos fires (McMahon & Frazer 1992). If fire occurs in the autumn, buried clutches of tortoise eggs (e.g. Geometric Tortoises eggs generally laid in spring) would not be endangered by fire, and the tortoises may survive through their offspring. Emergent hatchlings would also benefit from the regenerating and relatively lush vegetation (McMahon & Frazer 1992).

Burning recommendations

It is therefore recommended that selected parts of the study area should be burned on a regular 15 to 18 year cycle. The South and South -west coast Renosterveld area could be included in the 15 to 18 year cycle, as there is no urgent need to promote grasses above shrubs, as required for important grazers. (When grazers needs to be favoured, the Renosterveld area should be burned every two to four years (Cowling 1992), to promote grass growth above shrub growth).

If however the forming of dune Thickets, possibly developing to dune forests is desired in certain areas of the study area, fire should be kept out of those specific areas. These areas will then however become useless for flower harvesting with time. Currently 14.49% of Dune Thicket in South Africa is being conserved, while only 1.42% of South & South -west Coast Renosterveld, 0.42% of Laterite Fynbos and 13.84% of Limestone Fynbos are conserved (Low & Rebelo 1996). The area in which Dune Thicket occurs in South Africa (3660 km^2) is however larger that the area in which Limestone Fynbos occur in South Africa (2148 km^2) (Low & Rebelo 1998). Thus the conservation of Limestone Fynbos, and naturally South and Southwest Coast Renosterveld and Laterite Fynbos, should still receive preference above the conservation of Dune Thicket.

It is recommended that the existing Dune Forest (in the mosaic of sub-community 2.3 and 5.2.2 area, Figure 6) in the study area should be conserved, due to the value thereof concerning recreation and habitat diversity for animals (especially birds). The further development of thicket forming should however not be favoured above the protection of the other vegetation types.

According to Tinley (1985) The ability of *Acacia cyclops* to invade natural vegetation is increased in areas that has been burnt, probably due to the fact that *Acacia cyclops* is a legume plant. An association is found between nitrogen fixing bacteria and the roots of many legume species, making nitrogen available to the legume plants (Tootill 1984). Because of this fact, it is very important that the proposed burning program should only start being implemented once *Acacia cyclops* is well under control.

According to Tinley (1985) the fact that the Cape Dune Mole-rat grazes on roots, would lead to an increase in burrowing, to obtain sufficient food, if fire would be allowed in an area infested with Dune Mole-rats. It is therefore advised that, as Dune Mole-rat burrowing is already very pronounced in some areas, fire should be kept out of those areas at any cost.

It is recommended that the study area should be burned in blocks, to ensure that adequate large areas of every different vegetation type remains, to sustain dependent animal populations, as well as sustaining flower harvesting and thatch reed cutting. A proposed burning plan can be seen in Figure 12. A few "Burn Free Zones" are marked on the map. The areas included in the burn free zones includes: housing developments areas, areas of high fire risk, (chalets, offices, aeroplane hangers), areas with high Dune-Mole rat infestation, the marsh area, the Dune forest area, and the dune areas, (where fire might cause an increase in sand instability). The whole of Andrew's Field is included in the "Burn Free Zone" because of high fire risk areas in the northern part of Andrew's Field, and a very high Dune Mole-rat infestation in a big part of the southern part of Andrew's Field. Flower harvesting would not be influenced by excluding Andrew's Field form the burning cycle, as Andrew's Field is not currently being utilised for flower harvesting, due to the absence of desired flowers.

The burning blocks should be burned in the following way:

1. Year one: burn blocks A1, A2 and A3.
2. Year three: burn block B
3. Year six: burn block C
4. Year nine: burn block D
5. Year twelve: burn block E
6. Year fifteen: burn block F

7. Year eighteen: restart cycle.

Burning in this way ensures that every block will be burned every 18 years.

Burning blocks are designed in such a way that an area burned in the current year, would have at least 6 years to recover, before an area, with very similar habitat types, would be burned. Burning blocks are also designed to ensure that only a portion of the area used for flower harvesting would be burned at a time.

Sufficient firebreaks should be made and maintained to keep fire from entering areas not included in the burn.

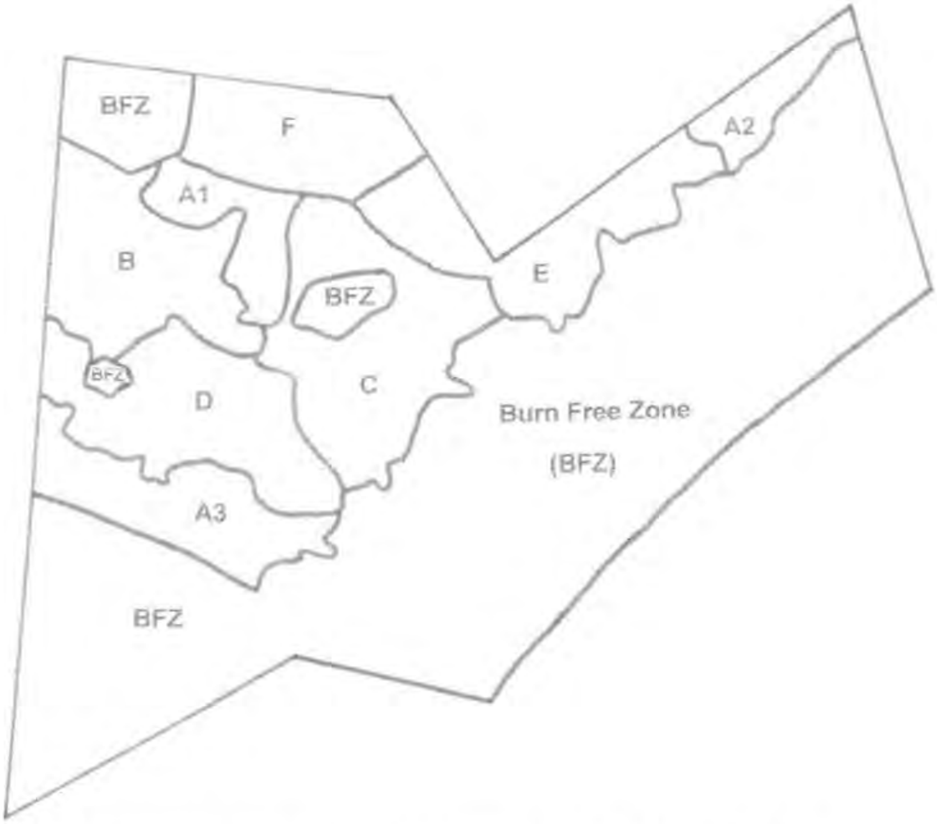

Figure 12. A map shows the proposed burning blocks of the study area.

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CHAPTER 8: GENERAL MANAGEMENT RECOMMENDATIONS

FLOWER HARVESTING

According to Cowling (1992) cutting methods in the field can have a substantial effect on the ability of a plant to produce subsequent harvestable flowers. The cutting of wood older than two years in the Proteaceae results in reduced shoot formation or the death of the branch, and incorrect pruning can lead to unproductive shrubs, which are more susceptible to disease (Brits *et al.* 1986). Long stems are required in the flower harvesting trade, and poor management of harvesting operations can lead to a decline in flower production.

The removal of flower heads or fruiting structures for the dried flower trade can influence the regeneration capacity or the veld (Cowling 1992). For veld-harvested Proteaceae, harvesting can be limited to some fraction of the available flowers to ensure adequate seed reserves (Cowling 1992).

It is recommended that the flower harvester, currently harvesting in Andrew's Field would be allowed to continue harvesting, since he is conducting harvesting operations in the desired manner, promoting maintenance of healthy plants.

THATCH REED HARVESTING

The management of Thatch reed (*Thamnocortus insignus)* is based on cutting good quality culms at a frequency (two to five years) and season (early winter) which will ensure continued productivity of the plants (Cowling 1992).

Thatch-reed (*Thamnocortus insignis)* is currently being cut in the study area, on a four-year rotational basis, during the summer months. It is recommended that this should be changed to early winter, to ensure that the thatch-reed is utilised in a sustainable way.

CONSERVATION OF LIMESTONE FYNBOS

Limestone Fynbos is found in the whole of Communities 2 and 3, and in sub-communities 5.1, 5.2, 5.4, and 5.5, on Andrew's Field and Tsaba-Tsaba nature reserve. According to Heydenrych (1994), due to the restricted distribution of Limestone Fynbos, and rarity of many species, all limestone sites are important and should receive as much conservation attention as possible. There are many factors threatening Limestone Fynbos vegetation, and invasive alien plants seem to be the biggest (Heydenrych 1994). Other threats to the Limestone Fynbos are agricultural land clearing, resort development, bad fire management and over-harvesting of flowers (Heydenrych 1994). Although Limestone Fynbos includes approximately 110 species endemic to limestone outcrops (Heydenrych 1994), only 13,84% of Limestone Fynbos are currently being conserved (Low & Rebelo 1998).

The conservation of Limestone Fynbos areas on Andrew's Field and Tsaba-Tsaba nature reserve should therefore enjoy high conservation priority.

ANIMAL POPULATIONS

A number of different animals are found in the study area (Appendix I, II).
As both herbivores and carnivores are present, it appears that no drastic management of the large herbivore animal populations is necessary at present, as the visible influence of the animals on the vegetation does not seem to be detrimental to the health of the plants. If it is ever considered to change the emphasis of the conservation area from a fynbos plant reserve to a game reserve, further studies on both the vegetation and the animal populations will be necessary.

DUNE MOLE-RAT POPULATION

The Cape Dune Mole-rat *Batyergus suillus* is found in abundance in a large part of the deeper sandy Dune Asteraceous Fynbos. *Batyergus suillus* digs extensive burrow systems, which are indicated on the surface by large moulds of earth (Stuart & Stuart 1996). The burrow system in some parts of the study area is to such an extent that it is close to impossible to walk safely, in the heavily infested areas. The reason for the high infestation of certain areas is due to the fact that those specific areas were used for agricultural purposes in former times. The addition of fertilisers to the soil seemingly continues to have an adverse effect on the soil, leading to an absence of a lot of the fynbos species in the area, with the exception of the geophytes. Under normal fynbos circumstances *Batyergus suillus* plays an important role in the dispersal of geophytes away from parent plants (Cowling &

Richardson 1995). It might however be possible that the high numbers of *Batyergus suillus* might have a detrimental effect on the indigenous vegetation. As *Batyergus suillus* feeds on roots, bulbs and tubers (Stuart & Stuart 1996), rare endemic bulbous plants as well as others might be adversely affected by the high Mole-rat infestation.

A high Cape Dune Mole-rat infestation is also found in an area adjacent to the Dune Asteraceous Fynbos. In this area, possibly due to the existence of shallow limestone rocks, the burrow-systems are however much closer to the surface, than the burrow systems of the Cape Dune Mole-rat, in the deep sand of the Dune Asteraceous Fynbos. The vegetation of the area consists of scattered low shrubs, and low grass and herbs (Photo 16). It is possible that the shallow burrow-systems resulted in the forming of the very short vegetation, as only plants with very shallow roots, like *Cynodon dactylon* and small herbs, are able to grow in the area. Due to the fact that this specific habitat is in all probability highly made use of by the small antelope species present in the study area (Grey Rhebok, Steenbok, Cape Grysbok, Common Duiker), drastic controlling of the Dune Mole-rat population might lead to the destroying of the habitat. *Raphicerus campestris* (Steenbok) and *Raphicerus melanotis* (Cape Grysbok) are both mixed feeders, *Pelea capreolus* (Grey rhebok) a grazer that occasionally browse, and *Sylvicapra grimmia* (Common Duiker) is a principal browser, also eating grass (Stuart & Stuart 1996). The destroying of the habitat would be very detrimental to Grey rhebok, as there is very little grazing available in the study area. As Steenbok also likes open areas with some cover (Stuart & Stuart 1996), changing the vegetation of this area would imply the destroying of a favourite habitat of the Steenbok as well.

It is advised that possible natural predators of the Cape Dune Mole-rat, like Black-backed jackal, Caracal, Small-spotted genet, Small grey mongoose, Striped polecat, Bat-eared fox as well as predator birds, currently found in the study area, should be promoted, but no other drastic control methods should be implemented at present.

The Cape golden mole (*Chrysochloris asiatica),* is also found in the study area. The Cape golden mole's excavations can be distinguished from those of the Cape Dune Mole-rat. The Cape golden mole excavate long, meandering tunnels that show as rounded ridges on the surface, while Cape Dune Mole-rats pushes up large mounds of earth on the surface, where they burrow (Stuart & Stuart 1996). As Golden Moles

Photo 16. *Ehrharta calycina - Leucadendron meridianum* sub-community, showing a shallow-soil limestone plain highly infested with Dune Mole-rats, and showing the resulting "lawn-mower" effect on the vegetation, probably due to root-pruning by the Mole-rats.

feed on a wide variety of insects, earthworms and small subterranean reptiles (Stuart & Stuart 1996), they would not present a threat to the vegetation.

MANAGEMENT OF SHIFTING SAND DUNE AREA

According to Tinley (1985) the type of dunes found in the study area are Transverse Barchanoid dunes. The crests and slipfaces of transverse dunes are orientated transversely to the wind direction, the concave curve of the leeward slipfaces facing downwind (Tinley 1985). Barchan dunes are isolated, crescent shaped dunes, with their axes at right angles to the wind (Tinley 1985). The leeward avalanching slipface of a Barchan dune tapers towards the sides where two streamers of sand form wings or horns which advance downwind faster than the higher central body of the crescent (Tinley 1985). A Barchanoid dune consists of parallel rows of linked or coalesced barchans with a single slipface on each arc. They are referred to as transverse dunes if the ridges are straight (Tinley 1985).

According to Klijn (1990b) the landward migration of dunes is considered to be primarily triggered by coastal erosion.

According to Tinley (1985) in areas where mobile dunes pose little or no threat either to natural resources (productive soils, forests, wetlands and estuaries) or to material developments, the dunes only need to be protected from extraneous disturbances such as trampling and vehicle traffic or from expensive stabilising schemes. Bare dunes, left alone, may remain essentially the same over many decades or centuries if of the transverse type (Tinley 1985).

It is therefore recommended that no development at all (houses or any other infrastructure) should be allowed on the dune area. No tracks for vehicles (4x4's) should be allowed either. Due to the fact that the coast of the study area is closed to vehicles, according to current legislation, there is little threat to the dunes concerning vehicle traffic from the coastal side. For owners of the houses inside the Reserve, limited entrance by foot could be allowed, on a nature trail footpath. Large scale trampling should be avoided at all times.

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CHAPTER 9: PLANT SPECIES LIST OF ANDREW'S FIELD AND TSABA-TASABA NATURE RESERVE

A species list of the species recorded during the plant survey is presented. To ensure easy locating of species, the families and species are arranged alphabetically (Paleodicotyledons, Monocotyledons and Dicotyledons). The taxon names in the list are followed by author names. Species endemic to the Cape are indicated with an at sign (@). Exotic taxa are marked with a star (*), species occurring on the Southern African Plant Red Data list, are marked with the Red data symbol, as applicable, (VU) = Vulnerable, (LC) = Least concern and (DD) = Data deficient. Limestone endemic species are indicated with a hash (#).

The list contains a total of 285 species, recorded during the survey. The relationship between the number of families, genera and species of Paleodicotyledons, Monocotyledons and Dicotyledons is given in Table 8. The most prominent families and genera are given in Table 9 and 10 respectively. A list of exotic plant species is given in Table 11.

Table 8. The relationship between the number of families, genera and species.

	Families		Genera		Species	
	No.	%	No.	%	No.	%
Paleodicotyledons	1	1.6	1	0.6	1	0.4
Monocotyledons	14	23	60	34	75	26
Dicotyledons	47	76	118	66	209	73
TOTAL	62		179		285	

Table 9. Most prominent families (families represented by seven or more species)

Family	**Number of species**
Asteraceae	56
Poaceae	24
Fabaceaea	14
Iridaceae	12
Scrophulareaceae	11
Aizoaceae	8
Rutaceae	8
Crassulaceae	7
Proteaceae	7
Thymelaeaceae	7

Table 10. Most prominent genera (represented by five or more species).

Genus	**Number of species**
Helichrysum	7
Metalasia	7
Crassula	6
Erica	6
Indigofera	5
Pelargonium	5
Rhus	5
Senecio	5

Table 11. List of exotic species.

Acacia cyclops
Ammophila arenaria
Anagallis arvensis
Bromus diandrus
Foenicum vulgare
Hordium murinum ssp. *murinum*
Orobanche minor
Tragus berteronianus

PLANT SPECIES LIST

PALEODICOTYLEDONS

Lauraceae

Cassytha ciliolata Nees

MONOCOTYLEDONS

Amaryllidaceae

Boophane disticha (L.f.) Herb.
Brunsvigia orientalis (L.) Aiton ex Eckl.
Gethyllis villosa (Thunb.) Thunb.

Asparagaceae

Asparagus capensis L.
Asparagus lignosus Burm.f. @
Asparagus setaceus (Kunth) Jessop

Asphodelaceae

Aloe brevifolia Mill. (VU) @
Bulbine lagopus (Thunb.) N.E.Br.
Trachyandra divaricata (Jacq.) Kunth
Trachyandra revoluta (L.) Kunth

Cyperaceae

Ficinia nigrescens (Schrad.) J.Raynal
Ficinia praemorsa Nees @
Ficinia secunda (Vahl) Kunth @
Ficinia truncata (Thunb.) Schrad. #
Isolepis antarctica (L.) Roem. & Schult. @
Tetraria cuspidata (Rottb.) C.B.Clarke

Haemodoraceae

Wachendorfia paniculata Burm. @

Hyacinthaceae

Albuca cooperi Baker
Drimia elata Jacq.
Lachenalia bulbifera (Cirillo) Engl. @
Lachenalia muirii W.F.Barker # @
Massonia pustulata Jacq.

Hypoxidaceae

Empodium gloriosum (Nel) B.L.Burtt

Iridaceae

Aristea glauca Klatt @
Babiana montana G.J.Lewis @
Bobartia longicyma J.B.Gillett ssp. *magna* J.B.Gillett ex Strid @
Chasmanthe aethiopica (L.) N.E.Br.
Freesia caryophyllacea (Burm.f.) N.E.Br. @
Geissorhiza heterostyla L.Bolus
Geissorhiza inflexa (D.Delaroche) Ker Gawl. @
Gladiolus gracilis Jacq. @
Gladiolus vaginatus F.Bolus @
Ixia orientalis L.Bolus
Moraea tripetala (L.f.) Ker Gawl.
Tritonia deusta (Aiton) Ker Gawl. @

Juncaceae

Juncus kraussii Hochst.

Orchidaceae

Bartholina burmanniana (L.) Ker Gawl.
Satyrium carneum (Dryand.) Sims (LC) @
Satyrium coriifolium Sw. @

Poaceae

**Ammophila arenaria* (L.) Link
Andropogon appendiculatus Nees
Aristida junciformis Trin. & Rupr. ssp. *junciformis*
**Bromus diandrus* Roth
Cymbopogon plurinodis (Stapf) Stapf ex Burtt Davy
Cynodon dactylon (L.) Pers.
Ehrharta calycina Sm.
Ehrharta villosa Schult.f. var. *maxima* Stapf @
Eragrostis sarmentosa (Thunb.) Trin.
Eustachys paspaloides (Vahl) Lanza & Mattei
Festuca scabra Vahl
**Hordeum murinum* L. ssp. *murinum*
Koeleria capensis (Steud.) Nees
Panicum deustum Thunb.
Pentaschistis airoides (Nees) Stapf
Pentaschistis calcicola H.P.Linder # @
Phragmites australis (Cav.) Steud.
Pseudopentameris macrantha (Schrad.) Conert @
Setaria sphacelata (Schumach.) Moss var. *sphacelata*

Stipagrostis zeyheri (Nees) De Winter ssp. *sericans* (Hack.) De Winter
Themeda triandra Forssk.
Thinopyrum distichum (Thunb.) A.Löve
**Tragus berteronianus* Schult.
Tribolium echinatum (Thunb.) Renvoize @

Restionaceae

Calopsis fruticosa (Mast.) H.P.Linder @
Calopsis viminea (Rottb.) H.P.Linder
Chondropetalum microcarpum (Kunth) Pillans @
Elegia stipularis Mast. @
Hypodiscus willdenowia (Nees) Mast. @
Ischyrolepis eleocharis (Nees ex Mast.) H.P.Linder @
Ischyrolepis triflora (Rottb.)H.P.Linder
Thamnochortus guthrieae Pillans @
Thamnochortus insignis Mast. @
Willdenowia glomerata (Thunb.) H.P.Linder @

Tecophyllaceae

Cyanella lutea L.f.

Typhaceae

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

DICOTYLEDONS

Aizoaceae

Aizoon rigidum L.f. var. *angustifolium* Sond.
Carpobrotus acinaciformis (L.) L.Bolus @
Carpobrotus edulis (L.) L.Bolus
Conicosia pugioniformis (L.) N.E.Br. ssp. *muirii* (N.E.Br.) Ihlenf. & Gerbaulet
Delosperma litorale (Kensit) L.Bolus @
Dorotheanthus bellidiformis (Burm.f.) N.E.Br.
Glottiphyllum depressum (Haw.) N.E.Br.
Ruschia calcicola (L.Bolus) L. Bolus # @

Anacardiaceae

Rhus crenata Thunb.
Rhus glauca Thunb.
Rhus laevigata L. var. *laevigata* fo. *cangoana* Moffett
Rhus laevigata L. var. *villosa* (L.f.) R.Fern.
Rhus lucida L.

Apiaceae

Arctopus echinatus L.
**Foeniculum vulgare* Mill.
Torilis arvensis (Huds.) Link

Apocynaceae

Astephanus triflorus (L.f.) Schult.
Carissa bispinosa (L.) Desf. ex Brenan
Cynanchum obtusifolium L.f.
Cynanchum zeyheri Schltr. @
Microloma sagittatum (L.) R.Br.

Araliaceae

Centella triloba (Thunb.) Drude @

Asteraceae

Arctotheca calendula (L.) Levyns
Arctotheca populifolia (P.J.Bergius) Norl.
Arctotis acaulis L.
Arctotis hirsuta (Harv.) P.Beauv. @
Athanasia dentata (L.) L. @
Berkheya coriacea Harv. # @
Chrysanthemoides monilifera (L.) Norl.
Cineraria species
Cineraria geifolia (L.) L.
Cotula turbinata L. @
Dimorphotheca nudicaulis (L.) DC. @
Dimorphotheca pluvialis (L.) Moench
Disparago anomala Schltr. ex Levyns @
Elytropappus rhinocerotis (L.f.) Less.
Eriocephalus kingesii Merxm. & Eberle
Eriocephalus sericeus Gaudich.
Euryops ericoides (L.f.) B.Nord.@
Euryops hebecarpus (DC.) B.Nord. # @
Euryops linearis Harv. # @
Felicia amoena (Sch.Bip.) Levyns ssp. *amoena*
Felicia aculeata Grau @
Felicia nordenstamii Grau (VU) # @
Gazania pectinata (Thunb.) Spreng. @
Gymnodiscus capillaris (L.f.) DC.
Helichrysum dasyanthum (Willd.) Sweet
Helichrysum litorale Bolus
Helichrysum patulum (L.) D.Don @
Helichrysum plebeium DC. (LC) @
Helichrysum pulchellum DC. (LC)
Helichrysum retortum (L.) Willd. @

Helichrysum teretifolium (L.) D.Don
Heterolepis peduncularis D.C. @
Metalasia acuta P.O.Karis
Metalasia brevifolia (Lam.) Levyns
Metalasia calcicola P.O.Karis # @
Metalasia densa (Lam.) P.O.Karis
Metalasia erectifolia Pillans # @
Metalasia muricata (L.) D.Don
Metalasia pungens D.Don
Oedera capensis (L.) Druce @
Oedera imbricata Lam.
Oedera uniflora (L.f.) Anderb. & K.Bremer @
Osteospermum subulatum DC. # @
Othonna dentata L. @
Othonna filicaulis Jacq.
Plecostachys serpyllifolia (P.J.Bergius) Hilliard & B.L.Burtt
Pteronia uncinata DC. @
Senecio arenarius Thunb. @
Senecio burchellii DC.
Senecio hastifolius (L.f.) Less. @
Senecio elegans L. @
Senecio burchellii DC.
Stoebe cinerea (L.) Thunb. @
Syncarpha argyropsis (DC.) B.Nord. @
Syncarpha canescens (L.) B.Nord.
Trichogyne repens (L.) Anderb. @

Boraginaceae

Lobostemon curvifolius H.Buek @
Lobostemon trigonus (Thunb.) H.Buek @

Brassicaceae

Heliophila linearis (Thunb.) DC.
Heliophila macra Schltr. @
Heliophila pusilla L.f. @
Heliophila refracta Sond. @

Campanulaceae

Lobelia setacea Thunb. @
Wahlenbergia calcarea (Adamson) Lammers # @
Wahlenbergia microphylla Lammers (VU) # @

Caryophyllaceae

Cerastium capense Sond.
Dianthus albens Aiton
Silene mundiana Eckl. & Zeyh. @

Celastraceae

Cassine peragua L.
Gymnosporia buxifolia (L.) Szyszyl
Maytenus procumbens (L.f.) Loes.
Pterocelastrus tricuspidatus (Lam.) Sond.
Robsonodendron maritimum (Bolus) R.H.Archer

Convolvulaceae

Falckia repens L.f.

Crassulaceae

Adromischus caryophyllaceus (Burm.f.) Lem. @
Crassula expansa Dryand.
Crassula fallax Friedrich @
Crassula glomerata P.J.Bergius @
Crassula nudicaulis L. var. *nudicaulis*
Crassula pellucida L.
Crassula subulata L. var. *subulata*

Ebenaceae

Euclea racemosa Murray

Ericaceae

Erica abietina L. var. *abietina* @
Erica propinqua Guthrie & Bolus # @
Erica lineata Benth. @
Erica longifolia Aiton @
Erica sessiliflora L.f. @
Erica spectabilis Klotzsch ex Benth. @

Euphorbiaceae

Adenocline pauciflora Turcz.
Clutia daphnoides Lam.
Euphorbia foliosa N.E. Br

Fabaceae

*Acacia cyclops A.Cunn. ex G.Don
Amphithalea alba Granby @
Aspalathus calcarea R.Dahlgren @
Aspalathus globulosa E.Mey. @
Aspalathus hispida Thunb.
Aspalathus pycnantha R.Dahlgren @

Indigofera brachystachya (DC.) E.Mey. @
Indigofera filicaulus Eckl. & Zeyh. @
Indigofera glomerata E.Mey. @
Indigofera incana Thunb. @
Indigofera meyeriana Eckl. & Zeyh.
Lessertia frutescens (L.) Goldblatt & J.C.Manning
Otholobium bracteolatum (Eckl. & Zeyh.) C.H.Stirt @
Tephrosia capensis (Jacq.) Pers.

Gentianaceae

Chironia baccifera L.
Chironia tetragona L.f.
Sebaea albens (L.f.) Roem. & Schult. @
Sebaea aurea (L.f.) Roem. & Schult. @

Geraniaceae

Pelargonium betulinum (L.) L'Hér. @
Pelargonium capitatum (L.) L'Hér.
Pelargonium myrrhifolium (L.) L'Hér.
Pelargonium suburbanum Clifford ex C.Boucher @
Pelargonium triste (L.) L'Hér.

Lamiaceae

Salvia africana-lutea L.

Linaceae

Linum africanum L. @

Malvaceae

Anisodontea scabrosa (L.) Bates
Hermannia althaeifolia L.
Hermannia concinnifolia I.Verd. # @
Hermannia ternifolia C.Presl ex Harv. @
Hermannia trifoliata L. # @

Menispermaceae

Cissampelos capensis L.f.

Myricaceae

Morella cordifolia (L.) Killick
Morella quercifolia (L.) Killick

Myrcinaceae

Myrsine africana L.

Oleaceae

Olea exasperata Jacq.

Orobanchaceae

**Orobanche minor* Sm.

Oxalidaceae

Oxalis obtusa Jacq.

Plumbaginaceae

Limonium scabrum (Thunb.) Kuntze var. *scabrum*

Polygalaceae

Muraltia ericoides (Burm.f.) Steud. @
Muraltia satureioides DC. var. *satureioides* @
Nylandtia spinosa (L.) Dumort.
Polygala peduncularis Burch. ex DC. @
Polygala umbellata L. @

Polygonaceae

Rumex lativalvis Meisn. @

Primulaceae

**Anagallis arvensis* L.

Proteaceae

Leucadendron coniferum (L.) Meisn. @
Leucadendron linifolium (Jacq.) R.Br. @
Leucadendron meridianum I.Williams # @
Leucadendron muirii E.Phillips # @
Leucospermum truncatum (H.Buek ex Meisn.) Rourke # @
Protea obtusifolia H.Buek ex Meisn. # @
Protea susannae E.Phillips @

Ranunculaceae

Knowltonia vesicatoria (L.f.) Sims

Rhamnaceae

Phylica dodii N.E.Br. @
Phylica ericoides L. @
Phylica pubescens Aiton @
Phylica stipularis L.

Rosaceae

Cliffortia falcata L.f. @

Rubiaceae

Anthospermum aethiopicum L.
Galium tomentosum Thunb.

Rutaceae

Acmadenia obtusata (Thunb.) Bartl. & H.L.Wendl.
Adenandra obtusata Sond. @
Agathosma collina Eckl. & Zeyh. (VU) @
Agathosma dielsiana Schltr. ex Dummer (LC) @
Agathosma serpyllacea Licht. ex Roem. & Schult. (LC) @
Diosma guthriei P.E.Glover (DD) # @
Diosma oppositifolia L. @
Euchaetis meridionalis I.Williams (LR) # @

Santalaceae

Osyrus compressa (P.J.Bergius) A.DC.
Thesidium fragile (Thunb.) Sond.

Sapotaceae

Sideroxylon inerme L.

Scrophulariaceae

Dischisma ciliatum (P.J.Bergius) Choisy @
Hemimeris racemosa (Houtt.) Merr.
Jamesbrittenia albomarginata Hilliard @
Jamesbrittenia calciphila Hilliard @
Selago aspera Choisy @
Selago fruticosa L. @
Sutera calciphila Hilliard # @
Sutera campanulata (Benth.) Kuntze
Zaluzianskya gracilis Hilliard @
Zaluzianskya muirii Hilliard & B.L.Burtt @
Zaluzianskya villosa (Thunb.) F.W.Schmidt @

Solanaceae

Lycium afrum L. @
Lycium cinereum Thunb. sensu lato
Solanum africanum Mill. (LC)

Thymelaeaeceae

Gnidia oppositifolia L.
Lachnaea densiflora Meisn. (VU) @
Passerina corymbosa Eckl. Ex C.H.Wright
Passerina galpinii C.H.Wright @
Passerina paleacea Wikstr. @
Passerina rigida Wikstr.
Struthiola argentea Lehm.

Verbenaceae

Chascanum cernuum (L.) E.Mey.

Viscaceae

Viscum capense L.f.

Zygophyllaceae

Zygophyllum flexuosum Eckl. & Zeyh. @
Zygophyllum uitenhagense Sond.

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SUMMARY

Phytosociological study of Andrew's field and Tsaba-Tsaba nature reserve, Bredasdorp district, Western Cape.

by

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MAGISTER SCIENTIAE

The aims of this study were to identify, describe and classify plant communities, and to interpret them ecologically, to delineate management units, identify ecological sensitive areas, to identify bush encroached areas or areas infested with alien plants or degraded areas, all in need of rehabilitation measures, identify the habitats of rare or endangered plant species, identify the habitats of specific animals.

Sample plots were placed in a stratified random way in the study area, within the different homogenous vegetation units, as recognized using orthographic photos of the study area. Sample plots were placed in such a way to ensure that they were both representative of the vegetation as well as homogenous. A total of 171 sample plots, of 10 x 10 m, were used to survey the vegetation of the study area of approximately 979 ha. A floristic survey, according to Braun-Blanquet method was carried out. The resulting data were classified using TWINSPAN, and Braun-Blanquet procedures for refinement.

The classification of the floristic data resulted in the identification of two main vegetation groups, ten plant communities, 17 sub-communities, and four variants. All identified communities, sub-communities and variants were classified, described and ecologically interpreted.

The study area is situated within the Fynbos Biome, but elements of the Thicket Biome are also present, forming a mosaic of the Fynbos and Thicket Biomes along the coastline. Various vegetation units and areas of high conservation priority, due to the presence of Red Data List species and limestone endemic species, were identified. The entire study area was identified as an area of high conservation priority, due to an exceptional high percentage of species endemic to the Cape Floristic Region.

OPSOMMING

Fitososiologiese studie van Andrew's field en Tsaba-Tsaba natuurreservaat, Bredasdorp distrik, Wes-Kaap.

deur

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Studieleier: Prof. dr. G.J. Bredenkamp

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MAGISTER SCIENTIAE

Die doel van die studie was om plantgemeenskappe te identifiseer, beskryf, klassifiseer en ekologies te interpreteer, om bestuurseenhede te begrens, om ekologies sensitiewe gebiede te identifiseer, om gebiede met bosindringing of gebiede geïnfesteer met uitheemse indringerplante, of gebiede wat agteruitgang toon, wat almal rehabilitasie stappe benodig, te identifiseer, om die habitatte van skaars of bedreigde spesies te identifiseer en om die habitatte van spesifieke diere te identifiseer.

Monsterpersele is indie studiegebied uitgeplaas op 'n gestratifiseerd-ewekansige wyse, binne die verskillende homogene plantegroei-eenhede, soos geïdentifiseer met behulp van ortofotos van die studiegebied. Plasing van monsterpersele is so gedoen dat die persele beide verteenwoordigend van die plantegroei is, en homogeen is. 'n Totaal van 171 monsterpersele, van 10 x 10 m, is gebruik om die plantegroei-opnames te doen, in die studiegebied van ongeveer 979 ha. 'n Floristiese opname is uitgevoer volgens die Braun-Blanquet metode. Die data is geklassifiseer met behulp van TWINSPAN, en verfyn met behulp van Braun-Blanquet prosedures.

Die klassifisering van die floristiese data het gelei tot die identifisering van twee hoof plantegroei groepe, tien plantgemeenskappe, 17 subgemeenskappe en vier variante. Al die geïdentifiseerde gemeenskappe, subgemeenskappe en variante is geklassifiseer, beskryf en ekologies geïnterpreteer.

Die studiegebied is geleë in die Fynbos Bioom, alhoewel elemente van die Ruigte Bioom ook teenwoordig is, en 'n mosaïk met die Fynbos Bioom langs die kus vorm. Verskeie plantegroei-eenhede en gebiede met hoë bewaringsprioriteit, as gevolg van die teenwoordigheid van Rooi Data gelysde spesies en kalksteen-endemiese spesies, is geïdentifiseer. Die hele studiegebied is geidentifiseer as 'n hoë bewaringsprioriteit-gebied, as gevolg van die buitegewone hoë persentasie spesies wat endemies tot die Kaapse Floristiese Ryk is.

APPENDIX I

MAMMALS

Amblysomus hottentotus (Hottentot golden mole)
Bathyergus suillus (Cape dune molerat)
Canis mesomelas (Black-backed jackal)
Felis caracal (Caracal)
Genetta genetta (Small-spotted genet)
Galerella pulverulenta (Small grey mongoose)
Hystrix africaeaustralis (Porcupine)
Ictonyx striatus (Striped polecat)
Mellivora capensis (Honey badger)
Otocyon megalotis (Bat-eared fox)
Pelea capreolus (Grey rhebok)
Raphicerus campestris (Steenbok)
Raphicerus melanotis (Cape Grysbok)
Rhabdomys pumilio (Striped mouse)
Sylvicapra grimmia (Common Duiker)
Tragelaphus strepsiceros (Kudu)

REPTILES

Homopus areolatus (Southern Padloper)
Agama agama (Southern rock agama)
Bitis arietans (Puff adder)
Dispholidus typus typus (Tree snake)
Naja nivea (Cape Cobra)
Psammophylax rhombeatus rhombeatus (Spotted skaapsteker)
Pseudaspis cana (Mole snake)

APPENDIX II

BIRDS

Anthropoides paradiseus (Blue Crane)
Apus caffer (White-rumped Swift)
Arenaria interpres (Ruddy Turnstone)
Ardea cinerea (Grey Heron)
Ardea melanocephala (Black-headed Heron)
Bostrychia hagedash (Hadeda Ibis)
Bubo capensis (Cape Eagle Owl)
Bubulcus ibis (Cattle Egret)
Burhinus capensis (Spotted Dikkop)
Buteo buteo (Steppe Buzzard)
Buteo trizonatus (Forest Buzzard)
Calidris canutus (Red Knot)
Calidris alba (Sanderling)
Charadrius hiaticula (Common Ringed Plover)
Charadrius pallidus (Chestnutbanded Plover)
Charadrius marginatus (Whitefronted Plover)
Ciconia ciconia (White Stork)
Cisticola fulvicapilla (Neddicky)
Colius striatus (Speckled Mousebird)
Colius colius (White backed Mousebird)
Columbia guinea (Rock Pigeon)
Corvus capensis (Black Crow)
Corvus albus (Pied Crow)
Cossypha caffra (Cape Robin)
Dicrurus adsimilis (Forktailed Drongo)
Egretta garzetta (Little Egret)
Elanus caeruleus (Black-shouldered Kite)
Emberiza capensis (Cape Bunting)
Euplectes afer (Golden Bishop)
Euplectes capensis (Yellowrumped Widow)
Eupodotis afra (Southern Black Korhaan)
Falco tinnunculus (Rock Kestrel)
Francolinus capensis (Cape Francolin)
Haematopus moquini (African Black Oystercatcher)
Hirundu rustica (European Swallow)
Hirundu dimidiata (Pearlbreasted Swallow)
Hirundu abyssinica (Lesserstriped Swallow)
Lanius collaris (Common Fiscal Shrike)
Laniarius ferrugineus (Southern Boubou)
Larus dominicanus (Kelp Gull)
Milvus aegyptius (Yellow-billed Kite)
Motacilla capensis (Cape Wagtail)
Nectarinia chalybea (Lesser Doublecollard sunbird)
Neotis denhami (Stanley's Bustard)
Numenius phaeopus (Whimbrel)
Numida meleagris (Helmeted Guinea-fowl)
Onychognathus morio (Redwinged starling)
Passer melanurus (Cape sparrow)
Pelecanus onocrotalus (Eastern White Pelican)

Phalacrocorax carbo (Whitebreasted Cormorant)
Phalacrocorax capensis (Cape Cormorant)
Ploceus capensis (Cape Weaver)
Pluvialis squatarola (Grey Plover)
Prinia maculosa (Spotted Prinia)
Promerops cafer (Cape Sugarbird)
Pycnonotus capensis (Cape Bulbul)
Sarothrura affinis (Striped Flufftail)
Serinus sulphuratus (Bully Canary)
Serinus flaviventris (Yellow Canary)
Serinus albogularis (Whitethroated Canary)
Spreo bicolor (African Pied starling)
Sterna bergii (Swift Tern)
Sterna sandvicensus (Sandwich Tern)
Sterna hirundu (Common Tern)
Sterna balaenarum (Damara Tern)
Streptopelia capicola (Cape Turtle Dove)
Streptopelia senegalensis (Laughing Dove)
Sturnus vulgaris (European Starling)
Telophorus zeylonus (Bokmakierie)
Tchagra tchagra (Southern Tchagra)
Upupa africana (African Hoopoe)
Vanellus coronatus (Crowned Plover)

APPENDIX III

Table 2: Rares

Species	Relevé	Community/sub-community/variant.
Adenocline pauciflora	9, 23, 30, 102	2.2, 2.3, 2.4, 3.3
Aizoon rigidu v. angus	35, 158	2.1, 2.2
Albuca cooperi	110	3.3
Aloe brevifolia	156	4
Anisodontea scabrosa	53	3.2
Arctotheca calendula	40, 55, 102, 156	2.4, 3.3, 4
Arctotis hirsuta	67, 73	3.2, 3.3
Asparagus setaceus	104, 106, 159	3.2, 3.3, 4
Astephanus triflorus	16, 107, 112	2.1, 3.2, 3.3
Athanasia dentata	151, 152	3.2, 3.3
Babiana montana	50, 55	2.4, 3.5
Bartholina burmanniana	136	3.2
Bulbine lagopus	20	2.1
Brunsvigia orientalis	18, 53	2.1, 3.2
Carpobrotus edulis	15, 24	2.2
Cassytha ciliolata	36, 58, 98	3.1, 3.2, 3.3
Chascanum cernuum	22, 23	2.2, 2.3
Cissampelos capensis	35	3.2
Cliffortia falcata	12, 21	2.2, 2.4
Conicosa pugioniformis s. muiri	70	3.2
Cotula turbinata	43, 53, 54, 56, 67	2.2, 3.2, 3.3
Crassula expansa	136	3.2
Crassula fallax	6, 38	2.1, 2.3
Crassu nudica v. nudic	5, 15	2.1, 2.2
Cyanella lutea	52	3.2
Cynanchum obtusifolium	50, 60	3.5
Dimorphothec pluvialis	108, 113	3.1, 4
Dischisma ciliatum	55, 98, 102, 156	2.4, 3.3, 4
Drimia elata	104	4
Elegia stipularis	96	3.2
Eriocephalus sericeus	23, 66,118,156,160	2.3, 3.4, 3.5, 4
Euphorbia foliosa	70	3.2
Euryops ericoides	6	2.1
Euryops linearis	50, 158	2.2, 3.5
Eustachys paspaloides	114	3.3
Felici amoena s. amoen	36, 60	3.1, 3.2
Felicia nordenstamii	36	3.1
Ficinia nigrescens	50, 53, 61	2.2, 3.2, 3.5
Ficinia secunda	50, 52, 70	3.2, 3.5
**Foeniculum vulgare*	45	3.3
Geissorhiza heterostyla	52, 68, 97	2.2, 3.2, 3.3
Geissorhiza inflexa	67	3.3
Gethyllis villosa	32, 67, 114	2.1, 3.3

Gladiolus vaginatus	4, 16, 19	2.1, 2.4
Glottiphyllum depressum	158	2.2
Helichrysum pulchellum	24, 55, 56, 97	2.2, 2.4, 3.3
Heliophila linearis	112, 136, 137, 152	3.2, 3.3
Heliophila macra	13, 23, 31, 47, 50, 56, 151	2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 3.5
Hermannia ternifolia	59, 110, 114	3.2, 3.3
**Hordeum murinum*	102, 107	3.3
Indigofera filicaulus	26, 31	2.4
Ixia orientalis	136	3.2
Jamesbrittenia albomarginata	2, 3, 16, 98, 108	2.1, 2.3, 3.1, 3.3
Jamesbrittenia calciphila	44, 47	2.3, 3.2
Lachenalia muirii	30, 136	2.2, 3.2
Lachnaea densiflora	35, 96	3.2
Lampranthus reptans	136	3.2
Lessertia frutescens	24, 32	2.1, 2.2
Leucadendron linifolium	72	3.2
Linum africanum	151	3.3
Lycium afrum	156	4
Massonia pustulata	46, 56, 67, 108	2.2, 2.4, 3.1, 3.3
Metalasia acuta	102	3.3
Muraltia ericoides	156	4
Nylandtia spinosa	26, 28	2.1, 2.4
Oedera imbricata	36	3.1
**Orobanche minor*	38, 55,110,114	2.3, 2.4, 3.2
Othonna filicaulis	107, 108, 112	3.1, 3.3
Panicum deustum	50	3.5
Pelargonium betulinum	5, 7, 39	2.1, 2.3, 2.4
Pelargonium capitatum	32	2.1
Pelargonium suburbanum	31, 32	2.1, 2.4
Pelargonium triste	55, 65, 70, 73	2.4, 3.2, 3.3
Pentaschistis airoides	96	3.2
Polygala peduncularis	43, 61	2.2
Polygala umbellata	69, 155	3.1, 3.4
Rhus crenata	170	3.4
Rumex lativalvis	54, 56, 67	2.2, 3.3
Satyrium coriifolium	67, 136, 151, 154	2.3, 3.2, 3.3
Selago aspera	96	3.2
Senecio burchellii	68	2.2
Senecio elegans	48, 50, 56, 67, 96	2.2, 3.2, 3.3, 3.5
Senecio hastifolius	108	3.1
Sideroxylon inerme	112	3.3
Silene mundiana	110, 136, 151	3.2, 3.3
Solanum africanum	102	3.3
Struthiola argentea	40	2
Sutera campanulata	19, 23	2.1, 2.3
Syncarpha argyropsis	152	3.2
Tephrosia capensis	32, 151	2.1, 3.3
Thamnochortu guthrieae	56, 70	2.2, 3.2
Trachyandra divaricata	55, 59	2.4, 3.2
Trachyandra revoluta	107, 110	3.3

**Tragus berteronianus*	158	2.2
Typha capensis	106, 156	3.3, 4
Viscum capense	114, 152	3.2, 3.3
Wahlenbergia calcarea	151	3.3
Wahlenbergia microphylla	35	2.1
Willdenowia glomerata	113	4
Zaluzianskya muirii	65, 107	3.3

APPENDIX IV

Table 3: Rares

Species	Relevés	Community/sub-community/variant.
Asparagus setaceus	37	5.2.2
Astephanus triflorus	33, 37, 103	5.2.2, 5.6.1, 5.6.2
Aristea glauca	49	5.6.1
Aristida junciformes s. junci	115	5.6.1
Berkheya coriacea	33	5.6.1
Carpobrotus edulis	57	5.2.1
Cerastium capense	119	5.6.1
Chasmanthe aethiopica	57	5.2.1
Cineraria geifolia	101, 120, 125	5.3, 7.1, 7.2
Crassula fallax	33	5.6.1
Crassula glomerata	57, 101, 103, 117	5.2.1, 5.3, 5.6.1, 5.6.2
Cynanchum zeyheri	33	5.6.1
Cynodon dactylon	37	5.2.2
Disparago anomala	49	5.6.1
Ehrharta calycina	119	5.6.1
Falckia repens	33	5.6.1
Ficinia truncata	119	5.6.1
**Foeniculum vulgare*	57	5.2.1
Helichrysum litorale	139	7.2
Helichrysum pulchellum	101, 119	5.3, 5.6.1
Hemimeris racemosa	49, 51, 57	5.2.1, 5.6.1, 5.6.2
Hermannia ternifolia	119	5.6.1
Hermannia trifoliata	119	5.6.1
Lachenalia bulbifera	33, 57	5.2.1, 5.6.1
Lobostemon curvifolius	49, 57	5.2.1, 5.6.1
Metalasia erectifolia	119	5.6.1
Morella quercifolia	115	5.6.1
Nylandtia spinosa	33	5.6.1
Pelargonium capitatum	33	5.6.1
Pteronia uncinata	115	5.6.1
Selago fruticosa	33	5.6.1
Senecio burchellii	124	7.2
Stipag zeyher s. seric	119	5.6.1
Thamnochortus guthrieae	116	5.6.1
Trachyandra divaricata	57	5.2.1
Zaluzianskya gracilis	51, 57	5.2.1, 5.6.2

APPENDIX V

Medicinal plants and their occurrence in the vegetation units.

Species	Vegetation units
Arctopus echinatus	2.2, 2.3, 2.4, 3.2, 3.3, 5.3
Bulbine lagopis	2.1
Carissa bispinosa	5.2, 5.6.1
Carpobrotus acinaciformes	2.1-3.3, 4, 5.5, 5.6.1, 7.1
Carpobrotus edulis	5.2.1
Chironia baccifera	2.2-3.5
Chrysanthemoides monilifera	2.2, 4
Cyanella lutea	3.2
Elytropappus rhinocerotus	2.2, 3.3, 3.4, 5.6.1
Helichrysum patulum	2.1-4
Lessertia frutescens	2.1, 2.2, 5.6.2, 7, 9
Lycium afrum	4, 5.6.1
Nylandtia spinosa	2.1, 2.4, 5.6.1
Olea exasperata	3.2-3.5, 4, 5.2, 5.6
Osyris compressa	5.2, 5.4, 5.5
Pelargonium triste	2.4, 3.2, 3.3
Phragmites australis	1
Rhus glauca	2.1-5.6, 7.1
Rhus laevigata	2.1-3.3, 3.5, 5.1, 5.2, 5.4, 5.5, 5.6.1, 7.2
Salvia africana-lutea	2.1, 2.3, 2.4, 3.1-3.4
Senecio elegans	2.2, 3.2, 3.3, 3.5
Sideroxylon inerme	3.3, 5.2.2
Trachyandra divaricata	2.4, 3.2
Viscum capense	3.2, 3.3, 5.6.2

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