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.

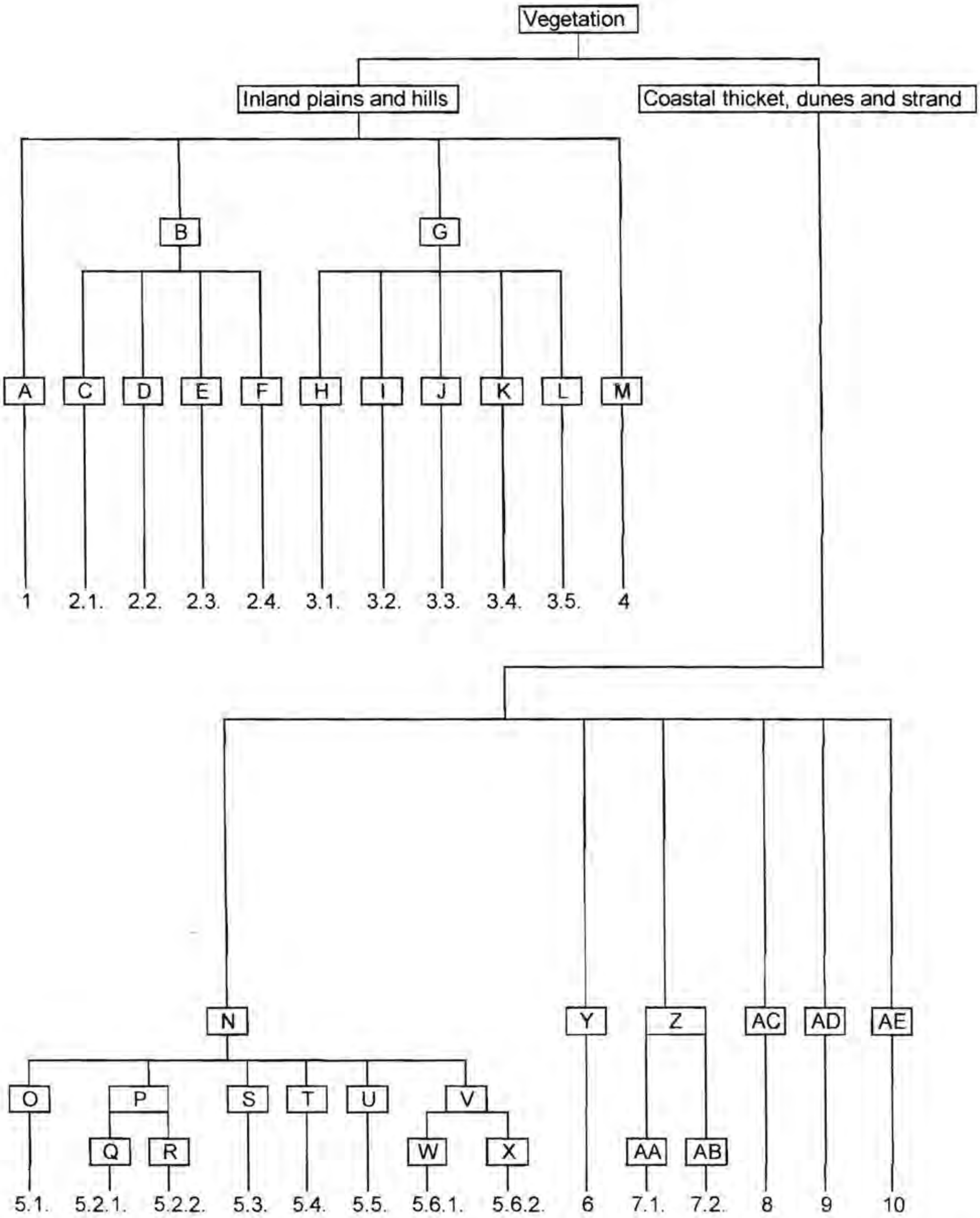

Figure 11. Summary of the total hierarchical classification and associated environmental characteristics of the vegetation of Andrew's Field and Tsaba-Tsaba nature reserve.

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.

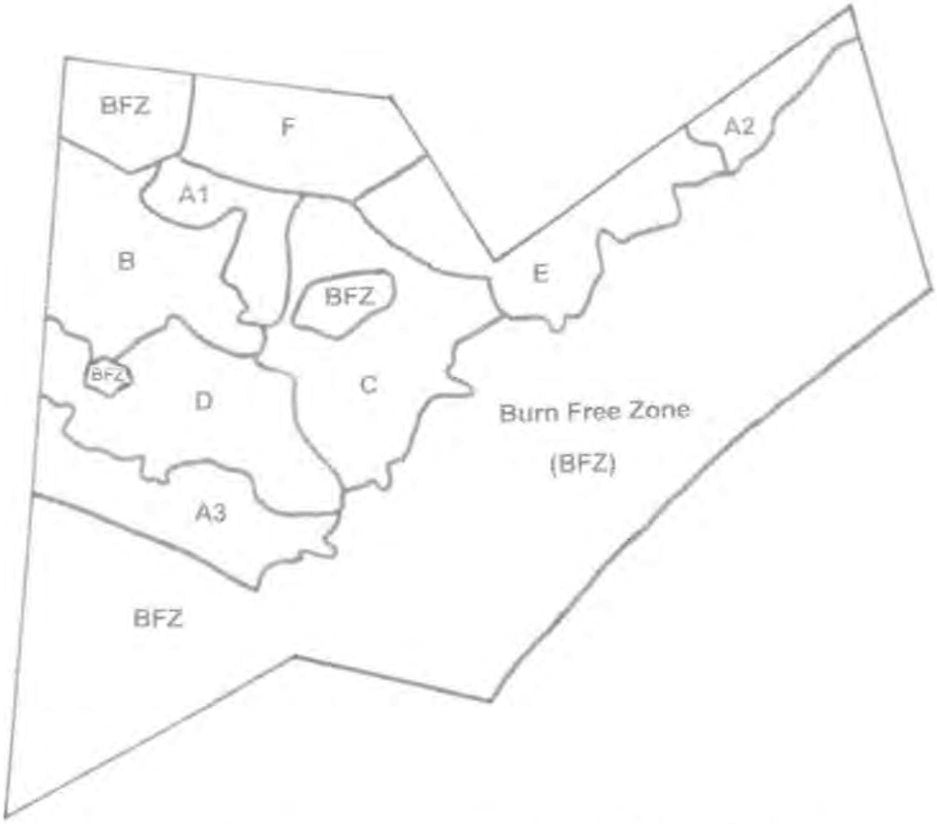

Figure 12. A map shows the proposed burning blocks of the study area.

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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.