Vegetation of Makana

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Executive Summary

The Makana District has diverse and unique vegetation, comprising ten vegetation types, representing all of the major southern African biomes. It is this diversity which makes it essential that the efforts to conserve and manage this natural resource for the benefit of all the people of Makana be coordinated within a single authority. The district contains 136 red data book (higher plant) taxa, and is an important centre of endemism in southern Africa (2548 native plant taxa). There are 27 endemics of which 17 are vulnerable, 5 are endangered and 5 are critical.

The biodiversity of the thicket within Makana is threatened by four major driving variables, namely overgrazing by domestic livestock, development of new lands for arable crop production, collection of native species for medicinal purposes and encroachment of invasive alien plants.

Initiatives to reverse these trends should be driven by LEAP and Makana Municipality. These include the effective implementation of the Conservation of Agricultural Resources Act 43 of 1983, which provides for i) setting carrying capacity norms for farms in the district; ii) the control of invasive plants and, iii) the cultivation of new lands. The Cape Provincial Conservation Ordinance should be applied rigorously to control the harvesting of plants for medicinal purposes, and the monitoring and protection of rare and endangered taxa. This will be achieved by the appointment of a permanent conservation officer within Makana. This officer should address the wider environmental issues within the district, focusing on effective implementation of all environmental legislation.

Introduction

The vegetation of Makana is internationally unique and comprises ten different vegetation types. These types have recently been re-defined following the work of the Vegmap project of the National Botanical Institute (Anonymous 2004), which developed a new vegetation map and associated descriptions for the whole of South Africa. This map, which now contains over 450 vegetation classes, is the latest approach to describing and mapping the unique flora of South Africa, and to providing detailed information on species composition and structure. The new map replaces Acocks (1953) as the definitive description of the vegetation of South Africa. Makana contains vegetation representative of five different biomes, namely the Thicket, Nama-Karoo, Grasslands, Forest and Fynbos. The Albany Thicket, comprising Great Fish Thicket, Great Fish Noorsveld, Kowie Thicket, Eastern Cape Thornveld and Albany Broken Veld, is the most important vegetation unit in Makana. The grassland (Bedford Dry Grassland), fynbos (Suurberg Quartzite Fynbos, Suurberg Shale Fynbos), forest (Southern Mistbelt Forest) and Nama-karoo (Southern Karoo Riviere) are also represented within Makana.

The Albany Thicket

This structurally unusual vegetation of the steeply sloping, semi-arid, river valleys was first described as Valley Bushveld (Acocks 1953). This nomenclature probably followed the colloquial term used by the colonial pastoralists who found it a largely impenetrable bush of the valleys which needed to be "opened-up" to allow access to domestic livestock (cattle and goats). In Acocks's own words, the Valley Bushveld was "an extremely dense, semi- succulent thorny scrub 2 metres high". Martin and Noel (1960) in their description of the Flora of Albany and Bathurst went on to describe it as a Succulent Woodland Formation, with two sub-formations, the taller "sub-succulent woodland" and the "low succulent scrub". This lack of clear nomenclature began causing confusion early on. In an effort to relate the vegetation relative to its origin, White and Moll (1978) included it in the Tongaland-Pondoland Regional Mosaic, as it showed strong tropical affinity, attributable to the presence of genera such as *Pappea, Carissa, Euclea, Brachylaena, Grewia, Rhoichissus, Ziziphus, Acacia* and *Ptaeroxylon* which were able to extend down the coast due to the ameliorating influence of the warm Aghulas Current. This led to the incorporation of the sub-tropical origin of the flora into the nomenclature. Cowling (1983) recognized the floristic uniqueness of the regional vegetation and coined the term Subtropical Transitional Thicket, which had two formations, the mesic "Kaffrarian Thicket" and the xeric "Kaffrarian Succulent Thicket". This terminology was not be well-received, and the development of appropriate nomenclature continued. During floristic research in the Subtropical Transitional Thicket, Everard (1987) described the Albany region as comprising two formations, the "xeric succulent thicket" formation which could be distinguished from the "mesic succulent thicket" because of its higher proportion of succulents (29,3% as opposed to 24.1% for mesic succulent thicket) and lower proportion of woody taxa (39.3 as opposed to 48.3%).

The lack of certainty about the affinity of this vegetation to the other biomes of South Africa was further exacerbated when Rutherford & Westfall (1986) described the south eastern Cape as part of the savanna biome. Following White & Moll (1978) and Cowling (1983), evidence for its classification as a distinct structural and floristic unit was presented, and this provided justification for the formation of the thicket biome (Low & Rebelo 1996). Scholes (1997) continued with the earlier approach and referred to it as part of the broad leaved savanna. Recent analyses and the STEP project have confirmed that the climatic uniqueness (Robertson & Palmer 2002) and floristic diversity justify its recognition as a biome. The complex topography of the region (coastal mountain ranges, steep river valleys, proximity to both cold and warm ocean currents) has resulted in a diverse climate, and although it is difficult to describe a single suite of macro-climatic factors which characterises the biome, the regional climate does contain unusual attributes. Mean annual precipitation (MAP) varies from 350-550mm, co-efficient of variation in MAP is 28-32%, elevation varies from sea-level to 500m, rainfall is bi-modal with peaks in October-November and then March-April, mean monthly maximum temperatures is 29-32^{o}C and mean monthly minimum is 4-6^{o}C. An important determinant is the underlying geology, which is predominantly the high base status, nutrient rich mudstones of the Ecca Series. The clumpiness of the vegetation is also a distinguishing feature, and appears to be strongly facilitated by zoogenic activity (termites, mole rat, aardvark, earthworms). The clumps show elevated levels of C, Ca, K, organics and moisture content when compared with the adjacent off-clump soils (Palmer et al 1988). All these factors contribute towards this distinct vegetation type restricted to the semi-arid valleys of the Eastern Cape Province, South Africa.

There are a wide range of growth forms, including leaf and stem succulents, deciduous and semi-deciduous woody shrubs and dwarf shrubs, geophytes, annuals, C3 and C4 grasses, and a high diversity of plant species (Cowling 1983). The high number of the local endemics has been recognized for some time (Cowling & Holmes 1991) and Cowling & Hilton-Taylor (1993) reported 51 red data book taxa, 10 endemics and 2000 taxa in the Albany hot-spot. The Makana LEAP has expanded this to 136 red data book taxa, 27 endemics (17 vulnerable, 5 endangered and 5 critical) and a total of 2548 native taxa.

With its high standing biomass of woody and succulent shrubs (Aucamp et al 1982) Albany Thicket shows little annual fluctuation in perennial cover or biomass, irrespective of the high (30-35%) co-efficient of variation in mean annual precipitation. This general resistance to drought most likely involves several co-occurring mechanisms such as below-ground storage organs, sclerophyly, CAM photosynthesis and succulence. Unlike other semi-arid ecosystems such as savannas and certain mediterranean-type shrublands (renosterveld, chaparral, tomillar, phrygana and mallee) intact Albany thicket does not support any regular or widespread fire regime (Kerley et al. 1999). This is due to a combination of the low availability of fuel and the high degree of succulence.

With its high standing biomass of woody and succulent shrubs (Aucamp et al 1982) Albany Thicket show little annual fluctuation in perennial cover or biomass, irrespective of droughts that may last months or even years (Aucamp et al 1982). The reasons for the general resistance of many species to drought remains unresolved, although it is likely to involve several co-occurring mechanisms such as below-ground storage organs, sclerophyly, CAM photosynthesis and succulence. Unlike other semi-arid ecosystems such as savannas and certain mediterranean-type shrublands (renosterveld, chaparral, tomillar, phrygana and mallee) intact Albany thicket does not appear to support any regular or widespread fire regime (Kerley et al. 1999) due to its succulent nature.

The understorey typically hosts a relatively high diversity of dwarf succulent shrubs and forbs (mainly Crassulaceae, Aizoaceae), many of which are locally endemic and rare (Cowling 1983, Johnson et al. 1999, Vlok & Euston-Brown 2002, Vlok et al. 2003), but few perennial grasses. The wide range of growth forms and taxa typical of Albany Thicket is a reflection of the transitional nature of thicket vegetation; being an interface between indigenous forests, Fynbos, Nama-Karoo and Grassland Biomes (Cowling 1983, Everard 1987, Palmer 1990, Kerley et al. 1995, Vlok & Euston-Brown 2002).

Vegetation Patterns and Diversity

Albany Thickets comprise of broad spectrum of physiognomic types reflecting gradients in climate, geology, soil and herbivory. Although there is no complete flora treatment for the region, van Wyk & Smith (2001) report that the region is floristically rich (2400 vascular plants), of which about 200 are endemic (Cowling & Hilton-Taylor 1994). Twelve families are particularly rich in endemics (van Wyk & Smith 2001) and are dominated by succulent genera.

The understorey typically hosts a relatively high diversity of dwarf succulent shrubs and forbs (mainly Crassulaceae, Mesembryanthemaceae and Aizoaceae), many of which are locally endemic and rare (Cowling 1983, Johnson et al. 1999, Vlok & Euston-Brown 2002). Perennial grasses are prevalent inside the clumps, with Panicum maximum, P. deustum and Setaria sphacellata being found. The wide range of growth forms and taxa typical of Albany Thicket is a reflection of the transitional nature of thicket vegetation; being an interface between forest, fynbos, Nama-Karoo and grassland biomes (Cowling 1984, Everard 1987, Palmer 1990, Kerley et al. 1995, Vlok & Euston-Brown 2002).

Floristic data collected at a local scale in the Great Fish River Valley (Palmer 1982, Palmer et al 1988) identified gradients in species composition and structure. These were further elaborated upon by Evans et al (1997), providing landscape scale descriptions of the vegetation units. The Medium Succulent Thicket of the Great Fish River Valley (Evans et al 1997), which is dominated by the leaf succulent Portulacaria afra, comprised the most extensive version of the xeric forms of the thicket, and is synonymous with sub-succulent woodland of Martin & Noel (1960). This is now called the **Great Fish Thicket**. The Short Succulent Thicket (SST), with *Euphorbia bothae* as the diagnostic species, is structurally similar to the noorsveld, being shorter (1-2m) and having a lower standing biomass then the MST. This is now termed **Great Fish Noorsveld**. The Tall Succulent Thicket, which is associated with cooler, moisture southern aspects, comprises taller emergent Euphorbia species, and has a greater standing biomass than either the MST or the SST. Within the medium succulent thicket (Birch et al 1999), the alpha diversity in the clumps is highest (28.4 taxa per releve, range 15-44, n=58), but the changes in diversity between clumps is low (total number of species in 58 releves is 195). Clump diversity in the short succulent thicket is lowest (25 taxa per releve (n=95). Tall succulent thicket contains 30 taxa per 100m2 sample (n=5).

The mesic forms of Albany Thicket (Kowie Thicket) are dominated by woody taxa (*Hippobromus pauciflorus, Olea europea, Buddleja saligna, Ptaeroxylon obliquum, Diospyros dichrophylla, Scutia myrtina*), but still contain the emergent stem succulents (*Euphorbia triangularis, E. tetragona*). The diversity of taxa is higher than the succulent forms (43 taxa per 100m^2 releve, range 35-54, n=14)(data from Everard, 1987).

Ecology: Climate, Geology, Soils and Natural Disturbance

Albany Thicket is typically found in semi-arid areas of the Eastern Cape, with between 200 mm and 950 mm mean annual rainfall (Vlok & Euston-Brown 2002). Two prevailing climate systems (winter rainfall to the southwest and summer rainfall to the northeast) converge in the region, resulting in all-year rainfall with spring and autumn maxima (Aucamp et al 1982). Rainfall reliability is poor, with an coefficient of variation of 32%, and droughts of several months are common. There is a 25% chance of not receiving 80% of the mean rainfall in any given year (Aucamp et al 1982). In addition to this unpredictable rainfall regime, the inland region experiences hot temperatures during summer (exceeding 40^{o}C on occasion) and close to freezing in winter. The physiology of the dominant plants reflects this harsh climate, with a high degree of succulence and leaf sclerophylly. Limited studies have shown that the larger shrubs and trees are deep rooted, and plants with storage organs are common. Studies on the production of thicket have shown that the life-strategy of most species appears to be one of slow growth (Aucamp et al 1982), possibly due to the high investment of resources into surviving the climate.

Geologically, much of the Eastern Cape is underlain by Karoo Sequence rocks, consisting primarily of shales and sandstones of the Ecca and Beaufort series laid down during the Permian and Triassic periods about c. 200 MYA. In the south-east, outcrops of Witteberg Quartzite and Table mountain Sandstone from the Cape Supergroup (laid down during the Devonian and Carboniferous c. 350 Mya) sink beneath the Karoo System rocks and are biogeographically important (Gibbs Russell & Robinson 1981) in that they typically support outlier populations of fynbos and renosterveld within a matrix of thicket. Tertiary planation of this system has resulted in a fairly level basin that is dissected by a series of large river valleys such as the Fish, Sundays and Gamtoos. It is these large valleys that gave rise to the name Valley Bushveld, as the thicket vegetation was restricted to their slopes and floors. The soils derived from these rocks vary considerably over a variety of scales, closely tracking the underlying geology and topography. The fine-textured rocks of the Karoo System typically give rise to deep, well-structured soils. A repeated catena pattern of shallow rocky soils on the upper slopes and deep fine-textured soils in the valley floors is evident in the series of river valleys through the Eastern Cape. The more coarse-textured rocks of the Witteberg and Table Mountain series are typically found in sharply folded mountain systems, and the combination of steep slopes and high percent of quartz sand gives rise to coarse, unstructured soils that are shallow and nutrient-poor. Much of the fine-scale pattern in the vegetation is likely to be attributable to the interaction of climate and pedology (e.g. Palmer et al. 1988)

The combination of the low availability of fuel and the high degree of succulence has largely excluded fire from Albany Thicket (Kerley et al. 1995). However, the occurrence of fire may be increasing in degraded areas due to the replacement of the non-flammable succulent component with a potentially flammable field layer (Vlok & Euston-Brown 2002).

Albany thicket has historically supported a high diversity and density of indigenous herbivores, ranging in size from duiker to elephants (Skead 1987). Early accounts from the travellers and explorers in the region report high numbers of elephants (Stuart-Hill 1991). The high nutrient status of the vegetation and proximity of many perennial rivers suggests that these large herbivores would have been permanent residents (Stuart-Hill 1991) and supports the hypothesis that herbivory has played an important role in shaping vegetation and ecosystem properties (Kerley et al. 1995). The impact of indigenous herbivory has been reflected in the evolution of the plant species, many of which are well defended (Everard 1987, Haschick 2001). Stuart-Hill (1991) describes the potential impacts of large herbivores through herbivory, trampling and dunging, and suggest that large mammals were the primary patch disturbance agents in Albany thicket prior to their extirpation in the 1800s.

The combination of browse pressure and the unreliable arid climate of the region have probably been the driving forces in the evolution of Albany thicket since the Last Glacial Maximum - 18 000 BP (Palmer 1990). Yet, in the face of this impressive array of indigenous herbivores (not even considering arthropods), Albany thicket appears to show little fluctuation in standing biomass (Aucamp et al 1982). This feature sets it apart from most of the other herbivore driven systems, such as savannas (Scholes & Walker 1993) and grasslands (O'Connor & Bredenkamp 1997), where the herbivores (Owen-Smith & Danckwerts 1997) fire and climate (Schulze 1997) are primary determinants of plant biomass. In the Albany Thickets, indigenous herbivores do reduce plant biomass, but the overall patch structure is retained (Cowling & Kerley 2002). In spite of the widespread and varied defences employed by plants, and their apparent resistance to herbivory, the onset of domestic herbivory was the catalyst to degradation of the Albany thicket ecosystem. The conundrum that has dogged Albany thicket ecology is that, in spite of the fact that the Albany thicket appears to be relatively resistant to drought and herbivory, the ecosystem collapses rapidly in the face of domestic herbivory.

Biogeography, Origins and Long-term Dynamics

The Eastern Cape flora arises from the convergence of four phytochoria (Cowling 1983, Cowling & Campbell 1983). As a result, the flora has been described as complex and transitional, with relatively low levels of endemism in comparison to the rich centres of endemism in Southern Africa (Cowling 1983, Gibbs Russell & Robinson 1981). Despite this, the region represents a centre of endemism for karroid succulents (Hoffman & Cowling 1991). Many of the species in the Albany Thicket Biome have their centres of distribution elsewhere and the region does not have a well developed flora (Gibbs-Russell & Robinson 1981, Hoffman & Cowling 1991). The convergence of these phytochoria in the Eastern Cape has led to a huge tension zone (Cowling 1983) where subtropical Tongaland-Pondoland forests entered from the north-east along the coast and penetrated up the river valleys after the establishment of warmer wetter conditions following the Last Glacial Maximum (18 000 BP) (Palmer 1990). The succulent and dwarf shrublands of the Karoo-Namib phytochorion extended down the river valleys from the arid interior and graded into the forest and thicket. Afromontane forest elements are found from the sea-level forests into the forest pockets in the interior mountains, possibly as refugia from the Last Glacial Maximum. Cape fynbos elements are well represented on the infertile soils derived from the Cape System rocks (Cowling 1983), representing a significant outlier of the Cape Floral Kingdom. The relative distributions of these phytochoria are held in balance by environmental drivers such as climate and, more recently, land-use. The result is a mosaic of plant communities with different or mixed chorological affinities (Cowling 1983). The current vegetation is believed to be a relict of the previous warmer wetter climate.

The region contains a wide range of taxa which use different photosynthetic pathways, and may have the highest diversity of different types in the world (S. Wand pers. comm.). Examples of locally occurring species include facultative CAM (*Portulacaria afra*, numerous species in genera *Mesembryanthemum* and *Tylecodon*), CAM (many species in the genera *Crassula*, *Euphorbia*, *Aloe*), C3 (most woody shrubs, *Merxmulellera disticha*), C4-NADPme (*Themeda triandra*), C4-NADme. This pattern suggests that the Albany Thicket is likely to show shifts in species distribution patterns under conditions of elevated CO_2. In an effort to assess the possible nature and extent of changes in global climate on the distribution of *Portulacaria afra*, Robertson & Palmer (2002) demonstrated that portions of the biome are likely to become less suited to *P. afra*, however these changes are not likely to lead to extinction in the short term.

Landuse History

Prior to the arrival of colonial settlers in the early 1800s, the area around the study sites was sparsely populated by humans. Most human activity was concentrated along the Sundays River Valley, the principle source of perennial water in the area. Early travellers describe the area as an unbroken expanse of dense thicket north of Uitenhage (Skead 1987): an area now dominated by grasses and ephemeral forbs, with remnant trees and pockets of thicket. Colonial pastoralists initiated commercial agriculture with domestic animals. Initially the domestic stock populations were restricted by the high densities of ticks (which carry the fatal heartwater disease), restricted access for the stock associated with the very dense bush, and the limited perennial water (A. Rudman, pers. comm.). Later, the use of dips and boreholes allowed farmers to increase their stock densities and enter into new areas of thicket. This trend resulted in the opening up of large areas of thicket. More recently, an increasing number of farmers are switching from stock to game farming (Smith & Wilson 2002) as reduced forage availability and increased variability in forage production make stock farming less profitable and sustainable.

With the arrival of the first European settlers in the early 1800s began the extirpation of mega-herbivores (elephant and black rhino) and significant reductions in the populations of small-sized (e.g. duiker) and medium-sized (e.g. bushbuck and kudu) herbivores (Kerley et al. 1999). The high quality forage available in intact Albany thicket has been used to support extensive pastoralism for almost two centuries. Goats, in particular, were the most successful domestic species in the region, being able to make use of the high biomass of browse. Despite its long history of herbivory, Albany thicket has not displayed any resilience to domestic herbivory, and there is much evidence to show that commercial pastoralism has led to ecosystem level degradation (Aucamp et al 1982, Hoffman & Cowling 1990, Moolman & Cowling 1994, Kerley et al. 1999). Approximately 92% (approx. 7500 km2) of Albany thicket in the Eastern Cape has been degraded to some degree during the past 200 years (Lloyd et al. 2002). Much of this degradation occurred decades ago when there was little understanding of sustainable stocking levels in Albany thicket. Anecdotal accounts suggest that government recommended stocking rates during the 1950s were at least twenty-fold those of today. Furthermore, it seems that some thicket farmers deliberately over-stocked goats to open up the dense bush, as much of the biomass was inaccessible to the stock, and high levels of tick-borne heart water disease were associated with dense bush (A. Rudman, pers. comm.). Thus, for a combination of reasons, much of the above-ground biomass of Albany thicket across the Eastern Cape has been consumed by domestic goats, and widespread degradation of the thicket landscape has ensued.

Recent Transformation, Current status and Threats

The current status of thicket vegetation is highly transformed. Lloyd et al (2002) describe how all units of thicket show high levels of degradation, ranging from 31 – 88%. More than 70% of all vegetation units are either moderately or severely degraded according to their classification. The factors responsible for degradation across the biome include cultivation in the moister regions; herbivory by livestock in the drier regions; and urban settlement along the coast (Lloyd et al. 2002).

Considering that thicket has historically been exposed to a range of indigenous herbivores, from duiker to elephants, sometimes in very dense numbers (Skead 1987), it is interesting why it collapses so rapidly in the face of domestic herbivory. The production potential of the Albany Thicket is easily destroyed by domestic herbivory due to a combination of the feeding behaviour of goats (Stuart-Hill & Danckwerts 1988) and the slow growth rates of the plants (Aucamp et al 1982). Stuart-Hill (1992) shows how goats feed into the sides of bush clumps, exposing the interior and reducing essential vegetative recruitment. In comparison, indigenous herbivores that browse from the top of the bush clumps, encourage vegetative recruitment. If damaged by over-utilisation, the woody component of the vegetation does not recover within management time frames (Stuart-Hill 1992). In comparison to other woody and herbaceous systems, such as savannas, removal of the woody component does not necessarily lead to a more productive grass understorey. The herbaceous layer is not a reliable source of forage as its production closely tracks rainfall (Stuart-Hill 1992). Furthermore, the grasses in the understorey are typically non-perennial and of low nutritional value to game or domestic stock.

It seems that it is not only the introduction of goats that is the problem, but also the removal of mega-herbivores. Elephants maintain vegetation structure and promote asexual recruitment of *P.*

afra in Albany thicket (Stuart-Hill 1992). Elephants encourage coppicing in woody shrubs and promote the development of a skirt around *P. afra* plants. Indigenous herbivores dispersed significantly more seeds than goats (Sigwela 1999). There have been several previous studies that examine the impact of goats and indigenous mega-herbivores on biodiversity and ecological processes. Most of the earlier work was done from an agricultural production basis, where the vegetation was viewed primarily as a resource for browsing animals (Aucamp et al 1982). There are two key vegetative traits that contribute to degradation of the Albany Thicket. Firstly, despite a high standing biomass, Albany thicket has a low annual production; thus giving a false impression of the amount of forage available for animal production (Aucamp et al 1982). Another is the very slow recovery periods of the main forage species such as P. afra, which can take up to 18 months to recover from 50% defoliation by goats (Aucamp et al 1982). Also, the feeding behaviour of goats, both as individuals and as herds, differs from indigenous herbivores (Danckwerts 1984, Stuart-Hill 1992). Goats are gregarious animals and tend to feed in groups around individual plants and vegetation patches, leading to very high localised impacts. They also damage the structure of bush clumps by browsing from the sides and exposing the interior to the forces of desiccating winds and erosion by water (Stuart-Hill 1992).

Vegetation Units in Makana

Great Fish Thicket

Synonyms: Fish River scrub variation of the Valley Bushveld (Acocks 1953), (Vlok & Euston-Brown 2002); Kaffrarian Succulent Thicket (Cowling 1984; Everard 1987).
Distribution: Eastern Cape Prov.:, restricted mostly to the lower Great Fish River and Keiskamma River valleys, between the Katberg Mountains in the north and the Suurberg range in the south. Extends in a narrow (20km) band in an east-west direction from the mouth of the Great Fish and Keiskamma rivers to Somerset East.

Vegetation Patterns: Fish Thicket comprises short, medium and tall thicket types (Palmer 1982, Palmer et al 1988, Evans et al 1997) where both the woody trees and shrubs and the succulent component are well developed, with many of the species spinescent. *Portulacaria afra* is locally dominant, and decreases in relative abundance and is replaced by *Euphorbia bothae*, with increasing aridity. With increasing moisture status on southern aspects and in the riparian zone, *P. afra* is replaced by woody elements and tall emergent *Euphorbia tetragona and E. triangularis*. There is a distinct clumpiness to the vegetation which is linked to zoogenic mounds, formed principally by termites (*Microhodotermes viator)*, earthworms (*Microchaetus sp)*, mole rats and aardvarks. These islands of concentrated nutrients and moisture have richer, deep soils. There is high heterogeneity within this vegetation unit, which have been divided into nine distinct subtypes (Vlok & Euston-Brown 2002).

Geology & Soils: Fish Thicket occurs mostly on shallow (<1m) clay soils derived from the Ecca formations (Ecca Group, Karoo System, c. 200 Mya)

Climate: mean annual rainfall ranging between 350 –550 mm; elevation ranges from sea level to 800m; rainfall is distributed unequally over the year, with 60% in summer and 40% in winter; mean maximum temperatures range between 29 – 32 ^{o}C, mean minimum temperatures range between 4 – 6 ^{o}C.
Important Taxa: Succulents: *Aloe ferox, Crassula ovata, Euphorbia tetragona, Euphorbia bothae, Portulacaria afra*
Shrubs: *Scutia myrtina, Rhus incisa,*

Trees: *Euclea undulata, Olea europaea, Pappea capensis*
Other: *Cadaba aphylla, Sansevieria hyacinthoides, Sarcostemma viminale.*
Endemic Taxa: *Euphorbia bothae*

Notes: There is a distinct clumpiness in parts of the Fish Thicket, where nutrient-rich termite mounds provide foci of activity for other zoogenic agents. These clumps are often occupied by long-lived woody shrubs and trees such as *Pappea capensis* and *Boscia oleoides* and provide deep soils for endemic geophytes. The closed canopy of the *Portulacaria afra* -dominated thicket is another distinctive feature of the Fish Thicket.

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Photo: WSW Trollope

Great Fish Noorsveld

Synonyms: Fish River scrub variation of the Valley Bushveld (Acocks 1953), (Vlok & Euston-Brown 2002); Kaffrarian Succulent Thicket (Cowling 1984; Everard 1987).
Distribution: Eastern Cape Prov.:, restricted mostly to the lower Great Fish River.
Vegetation Patterns: Comprises the short thicket type (Palmer 1982, Palmer et al 1988, Evans et al 1997) where *Portulacaria afra* is replaced by *Euphorbia bothae*, with increasing aridity.
Geology & Soils: Great Fish Noorsveld occurs on very shallow (<1m) clay soils derived from the Ecca formations (Ecca Group, Karoo System, c. 200 Mya)
Climate: mean annual rainfall ranging between 350–450 mm; elevation ranges from sea level to 350m; rainfall is distributed unequally over the year, with 60% in summer and 40% in winter; mean maximum temperatures range between 29 – 32 ^{o}C, mean minimum temperatures range between 4 – 6 ^{o}C.
Important Taxa: Succulents: *Aloe ferox, Euphorbia bothae, Portulacaria afra,*
Shrubs: *Rhigozum obovatum*
Trees: *Euclea undulate, Boscia oleoides, Pappea capensis*
Other: *Cadaba aphylla, Sansevieria hyacinthoides 3, Sarcostemma viminale 3.*

Endemic Taxa: *Pachypodium bispinosum. P. succulentum*
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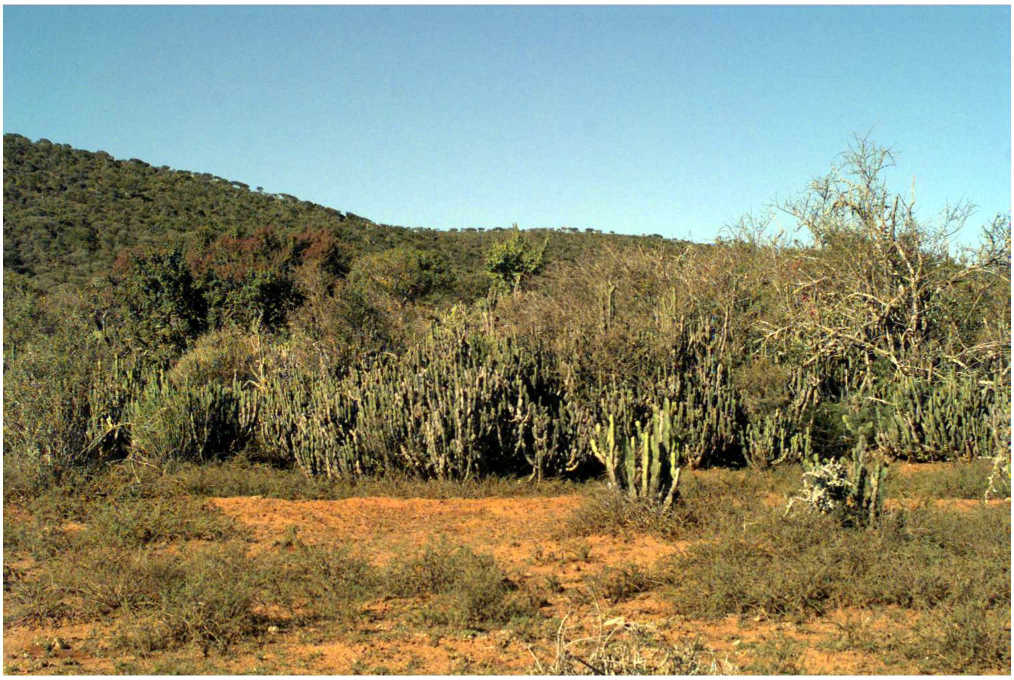

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Kowie Thicket

Synonyms: A23. Valley Bushveld p.p. (Acocks 1953); Albany Valley Thicket & Arid Thicket (of the Albany Spekboom Thicket (Vlok et al. 2003)

Distribution: Eastern Cape Province: River valleys of the Bushmans, Kariega, Assegaai, Blaaukrantz and Kowie rivers.

Vegetation Patterns: on prevalently steep and north-facing (dry) slopes: tall-grown thickets dominated by succulent Euphorbias and Aloes with thick understoprey composed of thorny shrubs, woody lianas (*Capparis, Secamone, Rhoicissus, Aloe*), and shrubby succulents (Crassulacae, Asphodelaceae); moister south-facing slopes support thorny thickets dominated by low-grown evergreen trees (*Euclea, Cussonia, Ptaeroxylon, Hippobromus, Schotia, Pappea*) and shrubs (*Gymnosporia, Carissa, Azima, Putterlickia*) with less pronounced participation of succulent shrubs and trees; due to low radiation intensity the herbaceous layer is poorly developed.

Important Taxa: *Euphorbia grandidens*, *E. triangularis*, *Aloe arborescens*, *Portulacaria afra* , *Sansevieria aethiopica*, *Aloe africana, A. speciosa, Cotyledon orbiculata, Crassula muscoides, C. perforata, Gasteria bicolor, Kalanchoe rotundifolia, Sarcostemma viminale, Senecio radicans*, *Euclea undulata*, *Pappea capensis*, *Schotia afra*, *Acacia natalitia*, *Commiphora harveyi*, *Cussonia spicata*, *Ptaeroxylon obliquum*, *Sideroxylon inerme*, *Brachylaenba ilicifolia*, *Encephalartos altensteinii*, *E. trispinosus*, *Gymnosporia polyacantha*, *Plumbago auriculata*, *Carissa haematocarpa*, *Azima tetracantha*, *Hippobromus pauciflorus*, *Putterlickia pyracantha*, *Pelargonium peltatum*, *Capparis sepiaria* var. *citrina*, *Secamone filiformis*, *Aloe ciliaris*, *Dalechampia capensis*, *Asparagus racemosus*, *Viscum rotundifolium*, *Dracaena alectroformis*, *Strelitzia reginae*, *Plectranthus madagascariensis*, *Stellarioides media*, *Panicum deustum*, *Ehrharta erecta*

References: Dyer (1937), Acocks (1953), Vlok et al. (2003)

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Eastern Cape Thornveld

AR Palmer

Albany Broken Veld

Synonyms: A37: False Karroid Broken Veld p.p. & A23: Valley Bushveld p.p. (Acocks 1953); 52: Eastern Mixed Nama Karoo, Xeric Succulent Thicket (Low & Rebelo 1996, 1998); Saltaire Karroid Thicket, Salem Karroid Thicket, Albany Bontveld, Beervlei Karroid Thicket (Vlok et al. 2002, Vlok et al. 2003).

Distribution: Eastern Cape Province: immediately to the north of the Zuurberg mountain range and south of Middlewater, Ripon and the area around the confluence of the Great and Little Fish

Rivers and extending eastwards, north of the mountain ridges around Riebeeck East to the Carlisle Bridge area and south of these ridges in the upper Bushmans River valley past Alicedale and up the New Years River Valley and including some irregular linear patches east of Riebeeck East; altitude varies mostly between 300 and 800 m.
Vegetation & Landscape Features: low mountain ridges and hills with an open grassy karoid dwarf shrubland with scattered low trees (*Euclea undulata*, *Boscia oleoides, Pappea capensis*, *Schotia afra* var. *afra)* with matrix of dwarf shrubs (*Becium burchellianum, Chrysocoma ciliata)* and grasses (*Eragrostis obtusa)*.
Geology & Soils: mainly shales of various stratigraphic units (Lake Mentz Subgroup of the Witteberg Group, Fort Brown Formation of the Ecca Group, Beaufort, Ecca and Dwyka Groups of the Karoo Supergroup); mainly Glenrosa and/or Mispah soils (Fc land type) with some red-yellow apedal drained soils, with high base status generally < 300 mm deep (Ag land type).
Climate: bimodal rainfall with main peak in March and secondary peak in November; some rain falls in the winter months; rainfall relatively high for the Nama-Karoo; incidence of frost is low with less than a tenth of the area experiencing more than 10 frost days per year; MAP ranges from about 290 mm in the west (in the rain shadow of the Zuurberg) to about 500 mm in the east.
Important Taxa: Succulent Tree: *Aloe ferox*; Small Trees: *Acacia natalitia*, *Euclea undulata*, *Pappea capensis*, *Schotia afra* var. *afra*, *Boscia oleoides*, *Cussonia spicata*; Tall Shrubs: *Grewia robusta*, *Lycium cinereum*, *Putterlickia pyracantha*, *Rhigozum obovatum*, *Rhus incisa* var. *effusa*; Low Shrubs: *Asparagus striatus*, *A. suaveolens*, *Becium burchellianum*, *Chrysocoma ciliata*, *Selago fruticosa*, *Asparagus acocksii*, *A. racemosus*, *Eriocephalus ericoides* subsp. *ericoides*, *Felicia filifolia*, *F. muricata*, *Gnidia cuneata*, *Helichrysum dregeanum*, *Hermannia linearifolia*, *Indigofera sessilifolia*, *Nenax microphylla*, *Pentzia incana*, *Polygala seminuda*, *Rosenia humilis*; Succulent Shrubs: *Cotyledon campanulata*, *Drosanthemum lique*, *Euphorbia meloformis*, *E. rectirama*, *Mestoklema tuberosum*; Herbs: *Bulbine frutescens*, *Drimia anomala*, *Eriospermum dregei*, *Gazania krebsiana*, *Hermannia pulverata*, *Hibiscus pusillus*, *Limeum aethiopicum*, *Ornithogalum dyeri*, *O. unifolium***,** *Senecio radicans*; Graminoids: *Aristida congesta*, *Eragrostis obtusa*, *Sporobolus fimbriatus*, *Tragus berteronianus*, *Cynodon incompletus*, *Digitaria eriantha*, *Ehrharta calycina*, *Eragrostis curvula*, *Setaria sphacelata* var. *sphacelata*, *Tragus koelerioides*
Biogeographically Important Taxa: *Sarcocaulon vanderietiae*
Endemic Taxa: *Brachystelma huttonii*, *Ceropegia cancellata*, *C. fimbriata* subsp. *fimbriata*, *Drimia acarophylla*, *Euphorbia inermis* var. *huttoniae*, *Gasteria baylissiana*, *Haworthia angustifolia* var. *baylissii*, *H. aristata*, *H. cymbiformis* var. *obtusa*, *Heterolepis mitis*, *Machairophyllum stayneri*, *Nerine huttoniae*, *Ornithogalum britteniae*, *O. perdurans*, *Rhombophyllum albanense*, *R. dyeri*, *Stapelia baylissii*
Notes: This vegetation type differs in a number of respects from those of the rest of the Nama-Karoo. Apart from climatic differences (highest rainfall, least frost), this type has a number of important species that are regarded as not important elsewhere in the Nama-Karoo. It is also the only vegetation type within the Nama-Karoo in which species such as *Enneapogon desvauxii* do not qualify as an important species.
References: Acocks (1953), Palmer (1982), Dold & Hammer (2003)
Authors: A.R. Palmer, D.B. Hoare, T. Dold & L. Mucina, M.C. Rutherford

AR Palmer

Bedford Dry Grassland

Synonyms: 68: Eastern Province Grassveld (Acocks 1953); 15: Subarid Thorn Bushveld (Low & Rebelo 1996, 1998); Dry Bedford Grassland (Martens & Morris 1993); *Cymbopogono excavati-Digitarietum argyrograptae* (Hoare 1997).

Distribution: On the gently undulating plains south of the Winterberg Mountains from Somerset East to Adelaide, at altitudes of 550-800 m.

Vegetation Patterns: A medium height open grassland interspersed with *Acacia karroo* woodland vegetation along the drainage lines; contains a dwarf shrubby component of karroid origin in the southern and south-western parts of its range.

Geology & Soils: loam or clay-loam soils on Beaufort Group (Karoo Sequence)

Climate: rainfall of 350-500 mm with a strong bimodal Spring-late and Summer pattern of occurrence

Important Taxa: *Digitaria argyrograpta*, *Tragus koelerioides*, *Eragrostis curvula*, *Eragrostis capensis*, *Cymbopogon excavatus*, *Eragrostis plana*, *Cyperus usitatus*, *Themeda triandra*, *Hermannia althaefolia*, *Helichrysum rugulosum*, *Tephrosia capensis*, *Gazania krebsiana*, *Pelargonium sidoides*, *Berkheya* species, *Lycium cinerium*, *Pentzia globosa*, *Melolobium burchelli*

Notes: Drainage lines within this unit contain an *Acacia karroo*-dominated woodland and the incised river valleys intruding from the south of this unit contain Great Fish Thicket or Albany Broken Veld. The grasslands of this unit furthest from the mountain range have a strong karroid element which enters from the dry Great Fish River Valley that marks the western boundary of this unit. This grassland unit falls within the Albany Centre of Endemism, which contains an extensive endemic flora, especially of succulents.

References: Acocks (1953), Martens & Morris (1993), Low & Rebelo (1996), Hoare (1997), Hoare & Bredenkamp (1999)

Author: D. Hoare

AR Palmer

Southern Karoo Riviere

This vegetation type occurs along the rivers of the semi-arid regions of the Nama-Karoo. It is dominated by *Acacia karroo*, and is tolerant of severe flooding. Associated species include *Diospyros dichrophylla*, *Lycium oxycarpum*, *Cenchrus ciliaris* and *Gymnosporia heterophylla*. It occurs in the deep Quaternary alluvium adjacent to the river.

Photograph: AR Palmer

Suurberg Quartzite Fynbos

Synonyms: False Fynbos (Acocks 1953), Dry Grassy Fynbos (Moll & Bossi 1983), Grassy Fynbos (Campbell, 6 Xeric Succulent Thicket (Low & Rebelo 1998), Zuurberg Grassy Fynbos,

Sundays Mesic Succulent Thicket (Cowling et al. 2003), Zuurberg Fynbos Thicket, Alicedale Fynbos Thicket, Farraway Fynbos Thicket
Distribution: Eastern Cape Province: Suurberg and Grahamstown hills from Baroe to Kidd's Beach.
Vegetation and Landscape Features: Grassy Fynbos, with localized patches of dense proteoid fynbos.
Geology & Soils: Sandy soils derived from Witteberg Group quartzites.
Climate: Summer rainfall, with autumn and spring peaks.
Important Taxa:
Seeps and water courses: Scrub Fynbos - *Cliffortia graminea, C. serpyllifolia, Berzelia commutata, Gnidia oppositifolia, Elegia asperiflora, Leptocarpus paniculatus*
Wetter, north slopes: Asteracous Fynbos - *Aloe ferox, Erica calycina, E. cerinthoides, E. glumiflora, Euphorbia polygona, Themeda triandra.*
Rocky ridges: *Cineraria saxifraga, Crassula cultrata, Diospyros scabrida, Euphorbia polygona, Grewia occidentalis, Lampranthus spectabilis, Loxostylis alata, Oldenburgia grandis, Othonna carnosa, Agapanthus africanus, Bulbine latifolia, Ficinia elongata.*
Plateau tops (incl. shale): *Erica adunca, E. demissa, E. pectinifolia, Gnidia coriacea, Leucadendron salignum, Linum thunbergii, Phylica axillaris, Diheteropogon filifolius, Eragrostis curvula, Themeda triandra, Tristachya leucothrix*
Shallow sandy soils, high rainfall: graminoid fynbos - *Erica simulans, Leucospermum cuneiforme, Passerina obtusifolia, Watsonia knysnana, Hypodiscus striatus*
Drier, deeper soils: graminoid fynbos - *Protea lorifolia, P. repens, Aspalathus teres, Disparago ericoides, Asclepias pubescens, Polygala microlopha, Muraltia squarrosa, Hyparrhenia hirta, Themeda triandra, Restio gaudichaudianus, R. triflorus, Tetraria cuspidata*
South hill slopes: Graminoid and ericaceous fynbos - *Acalypha peduncularis, Alepidea capensis, Alloteropsis semialata, Amellus strigosus, Anthospermum aethiopicum, Centella eriantha, Cliffortia linearifolia, Clutia heterophylla, Erica cerinthoides, E. chamissonis, E. copiosa, E. decipiens, E. demissa, Helichrysum anomalum, H. cymosum, H. felinum, H. nudiflorum, H. subglomeratum,, Leucadendron salignum, Phylica axillaris, Protea cynaroides, P. foliosa, Senecio othonniflorus, Sutera campanulata, Tephrosia capensis, Ursinia anethoides, Bobartia burchellii, Oxalis imbricata* var. *violacea, O. punctata, Pteridium aquilinum, Diheteropogon filifolius, Festuca costata, Poa binata, Restio sejunctus, R. triticeus, Schoenoxiphium sparteum, Tetraria capillacea, Themeda triandra*
Wet southern slopes. Grassy Fynbos – *Anthospermum spathulatum, Cliffortia burchellii, Clutia alaternoides, Erica chamissonis, E. deliciosa, E. simulans, Euryops latifolius, Helichrysum odoratissimum, Knowltonia cordata, Montinia caryophyllacea, Pelargonium reniforme, Pteronia teretifolia, Senecio axiifolius, Thesium strictum, Cannomois virgata, Festuca costata, Merxmuellera stricta, Miscanthus erectus, Pentaschistis eriostoma, Rhodocoma capensis*
Endemic Taxa: *Oldenburgia grandis*[R]
Notes: Untransformed (<0%), with 31% conserved – conservation target 18%. This transformation figure is certainly incorrect, as over-burning can convert Fynbos to grassland, which is not considered as transformed.
On drier, north-facing slopes grassland replaces this unit, however the south slopes are always fynbos unless converted to grassland by over burning, or to Thicket by over protection from fire. Historically, there has been no obvious attempt to separate fynbos on quartzite and shale in this region. Protea Atlas data suggest that there may be a separation, but the lack of references in the literature suggest that any such differences are not obvious.
Authors: A. Rebelo


AR Palmer

Suurberg Shale Fynbos
See Suurberg Quartzite Fynbos

Southern Mistbelt Forest


L. Mucina

Synonyms: Mist Belt Mixed Podocarpus Forests (Edwards 1967); Transkei and Natal Montane

Forests p.p. & Eastern Cape Montane Forests (Phillipson & Russell 1988); High Altitude Afrotemperate Forests, Middle Altitude Afrotemperate Forests, Mistbelt Afrotemperate Forests, Moist Afrotemperate Forests (Cawe 1996, Cawe & McKenzie 1989); Afromontane Forests p.p. (Low & Rebelo 1996, 1998); Amatole Forests Complex (Bailey et al. 1999)

Distribution: forest patches varying in size; located along the Great Escarpment, spanning a large area from Somerset East, the Amatole Mountains, scarps of Transkei to the KwaZulu-Natal Midlands as far east as Ulundi; occurring in fire-shadow habitats on south- and southeast-facing slopes at altitudes of 850–1 600 m; in KwaZulu-Natal these forest are found in a wide band sandwiched between the Drakensberg Montane Forests and Northern KwaZulu Natal Mistbelt Forests at higher altitudes and Eastern Scarp Forests at lower altitudes; belts of forest patches belonging to this unit occur in the Baviaanskloof Mountains, Zuurberg Mountains, and in the region spanning Grahamstown and King William's Town.

Vegetation Patterns: on the Great Escarpment (Amatole, Transkei Escarpment) and in the KwaZulu-Natal Midlands these forests are tall (15–20 m tall) and multilayered (having two layers of trees, a dense shrubby understorey and a well-developed herb layer); the forests found on low-altitude scarps are low (in places having the character of scrub forest), and although less structured into different tree layers, they are still species-rich; the tall forests show a mix of coarse-grained, canopy gap/disturbance-driven dynamics and fine-grained, regeneration characteristics; the Amatole mistbelt forests are dominated by emergent trees of Podocarpus falcatus and a range of deciduous and semideciduous species such as Celtis africana, Calodendrum capense, Vepris lanceolata and Zanthoxylum davyi; further east (Transkei, KwaZulu-Natal Midlands) Podocarpus henkelii becomes prominent in the canopy layer; deciduous elements play an important role.

Geology & Soils: some of the soils are well developed, deep, loamy and with a high nutrient status—developed on weathered dolerite intrusions or mudstones, shales and sandstones of the Balfour Formation (on the Great Escarpment); the soils supporting forests of low-lying scarps are shallower as they developed on quartzitic Witteberg Sandstones or various rocks of Karoo Sequence geology.

Important Taxa: Podocarpus falcatus, P. latifolius, Protorhus longifolia, Apodytes dimidiata, Celtis africana, Chionanthus foveolatus, C. peglerae, Cunonia capensis, Curtisia dentata, Olea capensis subsp. macrocarpa, Rapanea melanophloeos, Rhus chirindensis, Scolopia mundii, S. zeyheri, Vepris lanceolata, Xymalos monospora, Calodendrum capense, Combretum kraussii, Diospyros whyteana, Elaeodendron croceum, E. zeyheri, Halleria lucida, Kiggelaria africana, Maesa alnifolia, Mimusops obovata, Mystroxylon aethiopicum, Ochna arborea subsp. arborea, Ocotea bullata, Pleurostylia capensis, Psydrax obovata, Rinorea angustifolia, Zanthoxylum davyi, Burchellia bubalina, Canthium ciliatum, C. inerme, Clausena anisata, Eugenia capensis, Ptaeroxylon obliquum, Trimeria grandifolia, Azima tetracantha, Carissa bispinosa subsp. zambesiaca, Gymnosporia buxifolia, Maerua racemosa, Ochna serrulata, Grewia occidentalis, Scutia myrtina, Trichocladus ellipticus, Allophylus dregeanus, Hyperacanthus amoenus, Dietes iridioides, Dryopteris inaequalis, Hypoestes aristata, Isoglossa woodii, Polystichum pungens, Oplismenus hirtellus

Endemic Taxa: Bartramia compacta var. macowaniana, Eugenia zuluensis, Cassipourea flanaganii, Diospyros scabrida var. cordata, Orthotrichum armatum, Plectranthus elegantulus, *Podocarpus henkelii*

Notes: All mistbelt forests are species-rich afrotemperate forests containing an important share of

subtropical floral elements. *Podocarpus henkelii* is a near-endemic species for this vegetation unit, as it marginally occurs in the Northern Afrotemperate Forests as well.
Author: L. Mucina and C. Geldenhuis

Threats to the natural vegetation of Makana

The natural vegetation of Makana is threatened from a number of directions. These threats have been recently assessed (Lloyd et al 2002) as part of the Subtropical Thicket Ecosystem Planning Project (STEP), and provide a perspective on the nature and direction of threat. During the LEAP, a number of threats have been identified and include:

- excessive herbivory by domestic livestock
- clearing of land for cultivation
- alien plant invasions
- collection of plants for medicinal purposes.

Domestic livestock herbivory

The most serious threat to the vegetation of Makana arises from rangeland transformation by excessive herbivory by domestic livestock, or loosely covered by the term “over-grazing” (Lloyd et al 2002)(Figure 1 and 2). This excessive herbivory had its greatest impact during the 1980’s when the Angora goat market was at a peak and large numbers of Angora goats were farmed in the district. Examples of goat damage to the thicket were exemplified by the dramatic fence-line contrasts which arose between farmers with very different attitudes to the sustainability of the veld. Thicket was over-exploited, with large scale reductions in woody biomass, and extermination of important species such as *Portulacaria afra* on certain farms (, Tanser & Palmer 1999, Tanser & Palmer 2000). An example of a fence-line contrast can be seen in the photograph of Great Fish Thicket. The application of the regulations of Conservation of Agricultural Resources Act 43 of 1983 (CARA) will assist in remedying this situation, and its enforcement remains a priority within the district. The Eastern Cape Department of Agriculture should be strongly encouraged to establish carrying capacity norms for each of the properties in the district.

With major land-use changes in the late 1990’s and early 2000’s, when there has been a change from domestic herbivory to wild life, the application of CARA continues to remain an urgent priority. However the impact of the policies of the 1980’s will be observed for many years, as thicket recovers very slowly from disturbance.

Clearing of land for cultivation

The STEP project recognized that clearing of virgin thicket for the preparation of new cultivated dry lands remains an important threat to thicket (Lloyd et al 2002). There is a provision within CARA to control clearing of new lands and to prevent excessive bush clearing. This needs to be implemented and monitored by the LEAP.

Alien plant invasions

Invasive alien plants remain a serious threat to thicket (Figure 2). The LEAP has identified 121 invasive alien taxa within Makana (Appendix 2). Not all these species are of economic importance, but those that have been list in the regulations of CARA should be controlled. It is recommended that a project to clear jointed cactus (*Opuntia aurantiaca*) should be developed in co-operation with the National Department of Agriculture as an urgent priority of the LEAP. This project should follow the model of the highly successful “Working for Water” Programme of the Department of Water Affairs and Forestry, and involve private land-owners, Makana Municipality and the unemployed people of Grahamstown, Riebeek East and Alicedale. Private land-owners (e.g Kwandwe) have already indicated a willingness to co-operate in this project.

Collection of plants for medicinal purposes and for the construction of dwellings

The collection of plants for medicinal purposes is a recognized threat to many thicket species. Research has been conducted to show the extent of this threat in the Great Fish River Valley (Cocks & Wiersum 2003, Dold & Cocks 2000). Projects which encourage the cultivation of species in home gardens should be strongly encouraged. The thicket is a significant source of material for the construction of dwellings using traditional materials (Table 1). Collection should be encouraged to focus on cultivated plantations or alien infestations.

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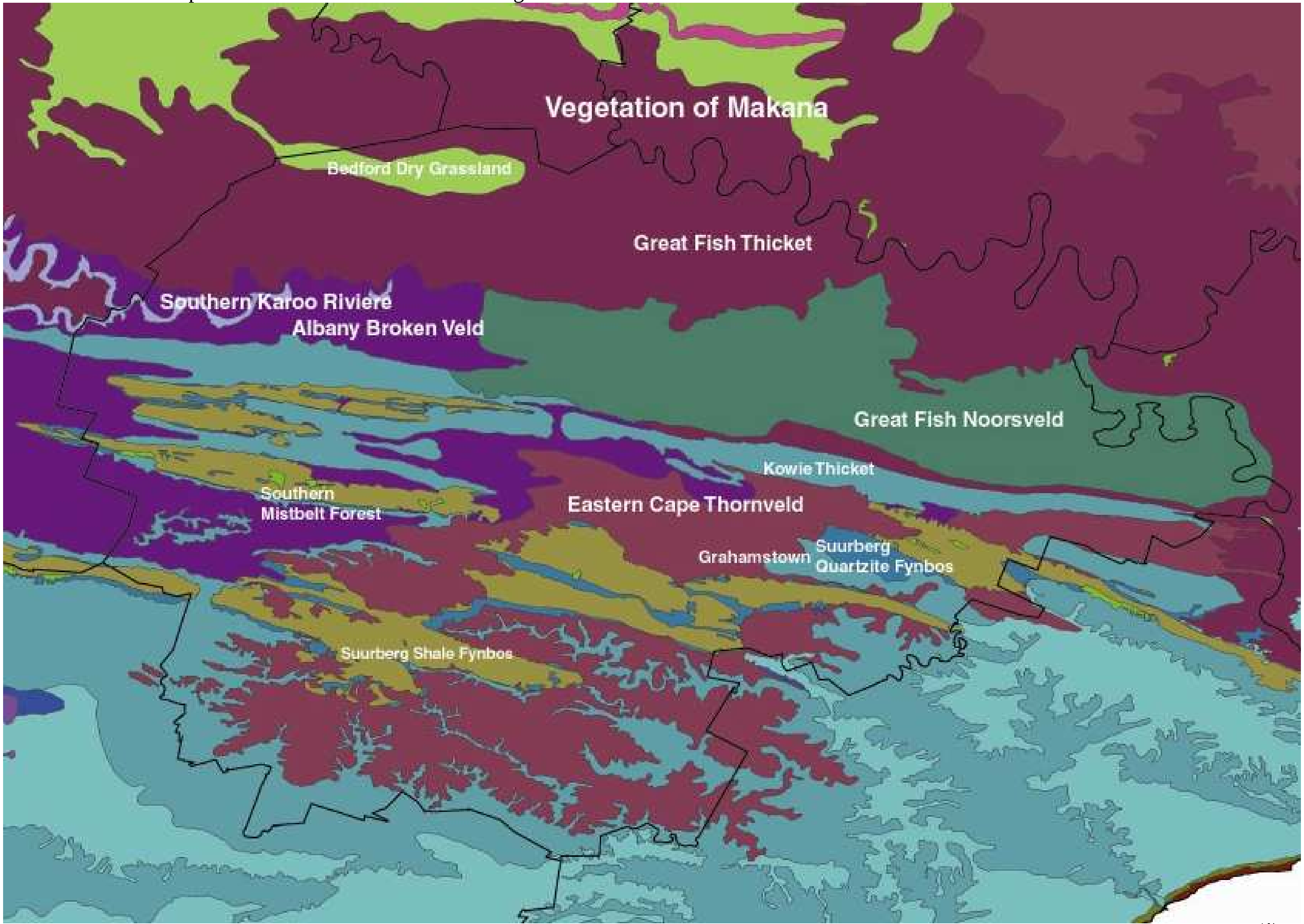
List of Tables and Figures

Table 1. Type of dwellings in Makana. 3112 dwellings rely on traditional material which is harvested from the thicket.

Type of dwelling	Number
House or brick structure on a separate stand or yard	10289
Traditional dwelling/hut/structure made of traditional materials	3112
Flat in block of flats	820
Town/cluster/semi-detached house (simplex; duplex; triplex)	297
House/flat/room in back yard	857
Informal dwelling/shack in back yard	746
Informal dwelling/shack NOT in back yard	1551
Room/flatlet not in back yard but on shared property	63
Caravan or tent	60
Private ship/boat	-
Not applicable (living quarters is not housing unit)	357
	18152


Vegetation of Makana
Bedford Dry Grassland
Great Fish Thicket
Southern Karoo Riviere
Albany Broken Veld
Great Fish Noorsveld
Kowie Thicket
Southern
Mistbelt Forest
Eastern Cape Thornveld
Grahamstown
Suurberg
Quartzite Fynbos
Suurberg Shale Fynbos

Portion of the new national vegetation map of South Africa, showing the distribution of vegetation types in Makana. The new vegetation types defined within Makana include: Bedford Dry Grassland, Great Fish Thicket, Great Fish Noorsveld, Kowie Thicket, Eastern Cape Thornveld, Albany Broken Veld, Southern Karoo Riviere, Suurberg Quartzite Fynbos, Suurberg Shale Fynbos and Southern Mistbelt Forest.

Figure 2. Severe degradation of succulent thicket in Makana (Lloyd et al 2002).

Figure 3. The extent of moderately degraded thicket in Makana (Lloyd et al 2002)

Figure 4. The distribution of commercial plantations in Makana (Lloyd et al 2002). These can be used as surrogate for woody aliens infestations.

Appendix 1. Red data list of plant

Threatened and endemic plant taxa (136) that occur in Makana (Dold & Victor 2002). The status of these taxa, following the IUCN list of threatened taxa version 3.1, is provided. (DD=Data deficient, R=Rare, EN=Endangered, VU=Vulnerable, NT=Near threatened, LC=Least Concern, CR=Critically threatened). A comprehensive data base of localities for these taxa has been established, but to avoid further exploitation of these taxa is not presented here.

Status	Taxon
CR	Encephalartos latifrons Lehm.59
CR	Isoetes wormaldii Sim
CR	Lachenalia convallarioides Baker
CR	Lobelia zwartkopensis F.Wimmer
CR	Rhus albomarginata Sond.
EN	Brachystelma comptum N.E.Br.
EN	Encephalartos arenarius R.A.Dyer59
EN	Encephalartos horridus (Jacq.) Lehm.59
EN	Faucaria gratiae L.Bol.
EN	Faucaria tigrina (Haw.) Schwantes var. tigrina
NT	Aloe longistyla Baker
NT	Aloe micracantha Haw.
NT	Aloe pratensis Baker
NT	Argyrolobium barbatum Walp.
NT	Bobartia gracilis Baker
NT	Bowiea volubilis Harv. ex Hook.f.
NT	Brachystelma campanulatum N.E.Br.
NT	Brachystelma delicatum R.A. Dyer
NT	Crassula latibracteata Toelken
NT	Crassula socialis Schönland
NT	Crinum campanulatum Herb.
NT	Cyrtanthus smithiae Watt ex Harv.
NT	Dioscorea elephantipes (L'Hér.) Engl.
NT	Disa lugens Bolus var. lugens
NT	Encephalartos caffer (Thunb.) Lehm.59
NT	Encephalartos longifolius (Jacq.) Lehm.59
NT	Eriospermum bracteatum Archibald
NT	Euphorbia bupleurifolia Jacq.
NT	Euphorbia meloformis Aiton subsp. valida (N.E.Br.) Rowley
NT	Euryops polytrichoides (Harv.) B.Nord.
NT	Gasteria bicolor Haw. var. liliputana (Poelln.) Van Jaarsv.
NT	Mestoklema albanicum N.E.Br. ex Glen
NT	Pelargonium exhibens Vorster
NT	Stangeria eriopus (Kunze) Baill.
NT	Tetradenia barberae (N.E.Br.) Codd
NT	Wahlenbergia kowiensis R.A.Dyer
R	Acrolophia micrantha (Lindl.) Schltr. & Bolus
R	Anacampseros rufescens (Haw.) Sweet
R	Asclepias expansa (E.Mey.) Schltr.
R	Atalaya capensis R.A.Dyer
R	Brachycorythis macowaniana Rchb.f.
R	Brachystelma minimum R.A.Dyer
R	Ceropegia cancellata Rchb.
R	Cyrtanthus helictus Lehm.
R	Dietes bicolor (Steud.) Sweet ex Klatt
R	Eugenia zeyheri Harv.
R	Euphorbia ornithopus Jacq.
R	Gladiolus huttonii (N.E.Br.) Goldblatt & M.P.de Vos
R	Holothrix macowaniana Rchb. f.
R	Homalium rufescens Benth.
R	Kniphofia citrina Baker
R	Neopatersonia uitenhagensis Schönland
R	Nerine bowdenii Watson subsp. bowdenii
R	Oldenburgia grandis (Thunb.) Baill.
R	Ophioglossum nudicaule L.f.
R	Otholobium polyphyllum (Eckl. & Zeyh.) C.H.Stirt.
R	Parapodium crispum N.E.Br.
R	Podalyria velutina Burch. ex Benth.
R	Polygala levynsiana Paiva
R	Polygala serpentaria Eckl. & Zeyh.

R	Psoralea ensifolia (Houtt.) Merr.
R	Psoralea repens L.
R	Selaginella pygmaea (Kaulf.) Alston
R	Woodia mucronata (Thunb.) N.E.Br. var. mucronata
VU	Albuca crudenii Archibald
VU	Apodolirion macowanii Baker
VU	Asclepias rara N.E.Br.
VU	Brachystelma luteum Peckover
VU	Ceropegia fimbriata E.Mey. subsp. fimbriata
VU	Clivia nobilis Lindl.
VU	Crinum lineare L.f.
VU	Encephalartos altensteinii Lehm.59
VU	Encephalartos trispinosus (Hook.) R.A.Dyer59
VU	Euphorbia meloformis Aiton subsp. meloformis forma meloformis
VU	Faucaria nemorosa L.Bol. ex L.E.Groen
VU	Nerine huttoniae Schönland
VU	Ornithogalum britteniae Leight.
VU	Ornithogalum perdurans Dold & Hammer
VU	Peucedanum typicum (Eckl. & Zeyh.) B.L.Burtt
VU	Raphionacme lobulata Venter & R.L.Verh.
VU	Sutera racemosa (Benth.) Kuntze
DD	Adromischus cristatus (Haw.) Lem. var. clavifolius (Haw.) Toelken
DD	Cyrtanthus clavatus (L'Hér.) R.A.Dyer
DD	Euphorbia ledienii A.Berger var. dregeiN.E.Br.
DD	Merxmuellera papposa (Nees) Conert
DD	Polygala bowkerae Harv.
DD	Senecio puberulus DC.
LC	Acrolophia capensis (Berg.) Fourc.
LC	Adenocline pauciflora Turcz.
LC	Agathosma ovata (Thunb.) Pillans
LC	Agathosma serpyllacea Licht. ex Roem. & Schult.
LC	Aloe ecklonis Salm-Dyck
LC	Bonatea speciosa (L.f.) Willd. var. speciosa
LC	Brownleea recurvata Sond.
LC	Carpobrotus deliciosus (L.Bol.) L.Bolus
LC	Commiphora harveyi (Engl.) Engl.
LC	Corymbium glabrum L. var. glabrum

LC	Cotyledon orbiculata L. var. oblonga(Haw.) DC.
LC	Cotyledon velutina Hook.f.
LC	Cyathea capensis (L.f.) Sm.
LC	Cyrtanthus brachyscyphus Bak.
LC	Disperis tysonii Bolus
LC	Drimia capensis (Burm.f.) Wijnands
LC	Elaeodendron zeyheri Spreng. ex Turcz.
LC	Encephalartos villosus Lem.59
LC	Eulophia speciosa (R.Br. ex Lindl.) Bolus
LC	Faucaria felina (L.) Schwantes subsp. felina
LC	Freesia corymbosa (Burm.f.) N.E.Br.
LC	Gardenia thunbergia L.f.
LC	Gethyllis spiralis (Thunb.) Thunb.
LC	Gladiolus gueinzii Kunze
LC	Gladiolus maculatus Sweet
LC	Gonioma kamassi E.Mey.
LC	Harveya pumila Schltr.
LC	Helichrysum rutilans (L.) D.Don
LC	Huernia barbata (Masson) Haw.
LC	Juncus kraussii Hochst. subsp. kraussii
LC	Justicia orchioides L.f. subsp. glabrataImmelman
LC	Kniphofia rooperi (T.Moore) Lem.
LC	Lobelia erinus L.
LC	Nemesia fruticans (Thunb.) Benth.
LC	Noltea africana (L.) Rchb.f.
LC	Ocotea bullata (Burch.) Baill.
LC	Pentaschistis pallida (Thunb.) H.P.Linder
LC	Podalyria burchellii DC.
LC	Prionium serratum (L.f.) Drège ex E.Mey.
LC	Rhus gueinzii Sond.
LC	Schoenoxiphium lehmannii (Nees) Steud.
LC	Stapelia macowanii N.E.Br. var. conformis(N.E.Br.) L.C.Leach
LC	Strelitzia reginae Aiton
LC	Sutera campanulata (Benth.) Kuntze
LC	Sutera polyantha (Benth.) Kuntze
LC	Trichocladus ellipticus Eckl. & Zeyh. subsp. ellipticus
LC	Tristicha trifaria (Bory ex Willd.) Spreng. subsp. trifaria

LC	Ursinia chrysanthemoides (Less.) Harv.
LC	Wahlenbergia androsacea A.DC.

Appendix 2. List of invader plants.

List of alien plant taxa recorded in Makana. The taxa are arranged in order of greatest threat following Robertson et al (2003). Category 1 (Act 43 of 1983) are weeds of economic importance and they should be controlled as a matter of urgency[2]. Makana contains over 90% of the serious problem plants listed by Robertson et al (2003). This list does not claim any degree of completeness, but serves to demonstrate the severity of the alien weed problem in Makana.

Taxon	**Common name**	**Rank of threat in Makana. ( ) = Rank of Robertson et al (2003)**	**Location in Makana**	**Category (Act 43 of 1983)**
Lantana camara L.	Lantana	1 (1)	Throughout Makana, Gardens in Grahamstown (3326DA, BC BD CA)	1
Opuntia ficus-indica	Sweet prickly pear	2 (3)	Throughout Makana	1
Acacia saligna (Labill.) H.L.Wendl.	Port Jackson willow	3 (4)	Hills around Grahamstown	2
Cestrum laevigatum Schltdl.	Inkberry	4 (5)	Gardens in Grahamstown	1
Hakea suaveolens R.Br.	Sweet hakea	5 (6)	Hills south west of Grahamstown	1
Tamarix usneoides E.Mey. ex Bunge x T. ramosissima Ledeb.	Chinese & pink tamarisks	6 (7)	River beds, Gardens in Grahamstown	1
Tamarix chinensis Lour.	Chinese & pink tamarisks	7 (8)	River beds, Gardens in Grahamstown	1
Acacia mearnsii De Wild.	Black wattle	8 (9)	Hills around Grahamstown	2
Azolla filiculoides Lam.	Red water fern	9 (10)	Blaauwkrantz Stream, (3326AC, 3326BC, 3326DA)	1
Solanum mauritianum Scop.	Bugweed	10 (11)	Gardens in Grahamstown	1
Myriophyllum aquaticum (Vell.) Verdc.	Parrot's feather	11 (12)	Rivers and streams. (3326AD, BC)	1
Acacia cyclops A.Cunn. ex G.Don	Red eye	12 (13)	Hills south west of Grahamstown	2
Salvinia molesta D.S.Mitch.	Kariba weed	13 (15)	Rivers and streams	1
Pereskia aculeata Mill.	Pereskia, Barbados gooseberry	14 (17)	Gardens in Grahamstown	1
Datura stramonium L.	Common thorn apple	15 (20)	River beds	1
Arundo donax L.	Giant reed	16 (21)	River beds	1
Leptospermum laevigatum (Gaertn.) F.Muell.	Australian myrtle	17 (22)	3325BD	1
Eichhornia crassipes (Mart.) Solms	Water hyacinth	18 (23)	New Years River dam	1
Ricinus communis L. var. communis	Castor-oil plant	19 (24)	Throughout Makana	2
Acacia baileyana F.Muell.	Bailey's wattle	20 (25)	Hills around Grahamstown	3
Acacia dealbata Link	Silver wattle	21 (27)	Hills around Grahamstown	1

Melia azedarach L.	Seringa	22 (28)	Gardens in Grahamstown	3
Acacia decurrens (J.C.Wendl.) Willd.	Green wattle	23 (30)	Hills around Grahamstown	2
Cirsium vulgare (Savi) Ten.	Spear or Scotch thistle	24 (35)	Throughout Makana	1
Paraserianthes lophantha (Willd.) I.C.Nielsen subsp. lophantha	Stink bean	25 (40)	Throughout Makana	1
Schinus molle L.	Pepper tree	26 (42)	Throughout Makana	
Opuntia aurantiaca Lindl.	Jointed cactus	27 (43)	Widespread throughout Makana	1
Hakea sericea Schrad. & J.C.Wendl.	Silky hakea	28 (44)	Hills south west of Grahamstown	1
Acacia longifolia (Andrews) Willd.	Long-leaved wattle	29 (45)	Hills around Grahamstown	1
Solanum sisymbriifolium Lam.	Dense-thorned bitter apple	30 (54)	Throughout Makana	1
Jacaranda mimosifolia	Jacaranda	31 (57)		3
Acacia fimbriata A.Cunn. ex G.Don				
Acacia terminalis (Salisb.) J.F.Macbr.				
Achyranthes aspera L. var. sicula L.				1
Agave americana				
Ageratum conyzoides L.				1
Agrimonia procera Wallr.				
Anredera baselloides (Humb., Bonpl. & Kunth) Baill.				1
Araujia sericifera Brot.				1
Argemone mexicana L. forma mexicana				1
Argemone ochroleuca Sweet subsp. ochroleuca				1
Atriplex lindleyi Moq. subsp. inflata (F.Muell.) Paul G.Wilson				3
Atriplex nummularia subsp nummularia				2
Callistemon rigidus R.Br.				
Canna edulis				
Cardiospermum grandiflorum Sw.				1
Casuarina cunninghamiana Miq.				2
Convolvulus arvensis L.				1
Cortaderia jubata				1
Crotalaria agatiflora Schweinf. subsp. agatiflora				
Cuscuta campestris Yunck.				1
Duranta erecta L.				
Echium plantagineum L.				1
Eragrostis tef (Zuccagni) Trotter				
Ilex mitis (L.) Radlk. var. mitis				
Jasminum abyssinicum Hochst. ex DC.				
Juniperus bermudiana L.				
Lavatera arborea L.				

Lavatera trimestris L.				
Lolium multiflorum Lam.				
Lolium perenne L.				
Lythrum hyssopifolia L.				
Macadamia ternifolia F.Muell.				
Mirabilis jalapa L.				
Nassella neesiana (Trin. & Rupr.) Barkworth				
Nasturtium officinale R.Br.				
Nerium oleander				1
Nicotiana glauca Graham				1
Nicotiana tabacum L.				
Oenothera glazioviana Micheli				
Oenothera indecora Cambess. subsp. indecora				
Oenothera parodiana Munz subsp. parodiana				
Oenothera rosea L'Hér. ex Aiton				
Oenothera stricta Ledeb. ex Link subsp. stricta				
Oenothera tetraptera Cav.				
Opuntia stricta Haw.				
Parkinsonia aculeata L.				
Pennisetum setaceum (Forssk.) Chiov.				1
Phytolacca americana L.				
Phytolacca dioica L.				3
Phytolacca octandra L.				
Pinus halepensis Mill. var. halepensis				2
Pinus pinaster Aiton				2
Plectranthus barbatus Andrews				3
Polypodium polypodioides (L.) Hitchc. subsp. ecklonii (Kunze) Schelpe				
Richardia brasiliensis Gomes				
Salsola kali L.				
Schinus terebinthifolius Raddi var. acutifolius Engl.				1
Senna didymobotrya (Fresen.) Irwin & Barneby				3
Senna multiglandulosa (Jacq.) Irwin & Barneby				
Senna pendula (Willd.) Irwin & Barneby var. glabrata (Vogel) Irwin & Barneby				3
Senna septemtrionalis (Viv.) Irwin & Barneby x S. multiglandulosa (Jacq.) Irwin				
Sesbania punicea (Cav.) Benth.				1
Solanum pseudocapsicum L.				

Sorghum halepense (L.) Pers.				2
Spartium junceum L.				1
Tribulus terrestris L.				
Ulmus parvifolia Jacq.				
Vinca major L.				
Xanthium spinosum L.				
Xanthium strumarium L.				1

Appendix 3. Extract from Regulations governing the control of invader plants.

Combating of category 1 plants

15A. (1) Category 1 plants may not occur on any land or inland water surface other than in biological control reserves.

(2) A land user shall control any category 1 plants that occur on any land or inland water surface in contravention of the provisions of sub-regulation (1) by means of the methods prescribed in regulation 15E.

(3) No person shall, except in or for purposes of a biological control reserve –

(a) establish, plant, maintain, multiply or propagate category 1 plants;

(b) import or sell propagating material of category 1 plants or any category 1 plants;

(c) acquire propagating material of category 1 plants or any category 1 plants.

(4) The executive officer may, on good cause shown in writing by the land user, grant written exemption from compliance with the requirements of sub-regulation (1) on such conditions as the executive officer may determine in each case.

Combating of category 2 plants

15B. (1) Category 2 plants may not occur on any land or inland water surface other than a demarcated area or a biological control reserve.

(2) (a) The executive officer may on application in writing demarcate an area as an area where category 2 plants may occur, be established and be maintained.

(b) An area in respect of which a water use license for stream flow reduction activities has been issued in terms of section 36 of the National Water Act, 1998 (Act No. 36 of 1998) shall be deemed to be a demarcated area.

(3) The executive officer shall demarcate an area for the occurrence, establishment and maintenance of category 2 plants only if –

(a) the category 2 plants in the area are cultivated under controlled circumstances; and

(b) the land user concerned has been authorised to use water in terms of the National Water Act, 1998 (Act No. 36 of 1998); and

(c) the category 2 plants or products of category 2 plants in the area are demonstrated to primarily serve a commercial purpose, use as a woodlot, shelter belt, building material, animal fodder, soil stabilisation, medicinal or other beneficial function that the executive officer may approve; and

all reasonable steps are taken to curtail the spreading of propagating material of the category 2 plants outside the demarcated areas.

(4) When an area is demarcated for the occurrence, establishment and maintenance of category 2 plants the executive officer may impose such additional conditions as may reasonably be deemed necessary to keep the category 2 plants in the area in check.

(5) No person shall sell propagating material of category 2 plants or any category 2

plants to another person unless such other person is a land user of a demarcated area or of a biological control reserve.

(6) No person shall acquire propagating material of category 2 plants or any category 2 plants unless such material or such plants are intended for use in a demarcated area or in a biological control reserve.

(7) Propagating material of category 2 plants or category 2 plants shall only be imported or sold in accordance with the provisions of the Plant Improvement Act, 1976 (Act No. 53 of 1976), the Agricultural Pests Act, 1983 (Act No. 36 of 1983) and the environment conservation regulations.

(8) A land user shall control any category 2 plants that occur on any land or inland water surface in contravention of the provisions of sub-regulation (1) by means of the methods prescribed in regulation 15E.

(9) Unless authorised thereto in terms of the National Water Act, 1998 (Act No. 36 of 1998), no land user shall allow category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland.

(10) The executive officer may, on good cause shown in writing by the land user, grant written exemption from compliance with one or more of the requirements of sub-regulations (1), (3), (5), (6), (8) and (9) on such conditions as the executive officer may determine in each case.

Combating of category 3 plants

15C. (1) Category 3 plants shall not occur on any land or inland water surface other than in a biological control reserve.

(2) Subject to the provisions of sub-regulation (3), the provisions of sub-regulation (1) shall not apply in respect of category 3 plants already in existence at the time of the commencement of these regulations.

(3) (a) No land user shall allow category 3 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland.

(b) The executive officer may impose such additional conditions as may reasonably be deemed necessary with regard to category 3 plants already in existence at the time of the commencement of these regulations.

(c) A land user must take all reasonable steps to curtail the spreading of propagating material of category 3 plants.

The executive officer may, after consultation with the land user, issue a direction in terms of section 7 of the Act that category 3 plants in existence at the time of the commencement of these regulations must be controlled by means of the measures prescribed in regulation 15F.

(4) No person shall, except in or for purposes of a biological control reserve –

(a) plant, establish, maintain, multiply or propagate category 3 plants;

(b) import or sell propagating material of category 3 plants or any category 3 plants;

(c) acquire propagating material of category 3 plants or any category 3 plants.

(5) The executive officer may, on good cause shown in writing by the land user, grant written exemption from compliance with one or more of the requirements of sub-regulations (1), (3) and (4) on such conditions as the executive officer may determine in each case.