THE CONSERVATION STATUS OF SOME UNIQUE PLANT COMMUNITIES IN THE EASTERN CAPE

Thesis submitted in fulfilment of the requirements
for the Degree of
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by

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". . . we don't ruin things. We shake down acorns and pinenuts. But the White people plow up the ground, pull down the trees, kill everything . . . They blast rocks and scatter them on the ground . . . How can the spirit of the earth like the White man? . . . Everywhere the White man has touched it, it is sore."

An old holy Wintu woman (North American Indian) speaks sadly about the needless destruction of the land in which she lived (McLuhan 1972).

CONTENTS

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ABSTRACT

In response to a growing concern over the rising rates of extinction of the world's plants and of habitat destruction, studies of Southern African threatened plants were initiated in the 1970's. These studies, which have largely concentrated on Western Cape flora, led to the publication of "Threatened Plants of Southern Africa" by Hall *et al.*, 1980, which attempted to list as many threatened or possibly threatened species as possible. It was however marred by a lack of recent herbarium records and detailed studies from many parts of the region, the Eastern Cape being one of these. In order to extend these detailed studies to gain a clearer picture of the numbers of threatened species in the Eastern Cape and evaluate the conservation status of Eastern Cape vegetation this project was initiated.

Initially lists of possibly threatened and endemic taxa of the Eastern Cape were compiled from various sources. These listed taxa were then checked against herbarium records, all available information being filled onto index cards for filing purposes. This paper-based filing system was then transferred into a computer-based data bank to facilitate the efficient storage and retrieval of information. Results from this data bank show that there are 662 variously threatened plant taxa in the Eastern Cape, many of which fall into temporary categories which need to be clarified by investigation in the field.

Primarily based on the above results, a table ranking the various

vegetation types into an order of priority for investigations about conservation requirement was developed. Subtropical Thicket was found to be the vegetation type in most need of investigation and so an extensive phytosociological survey was carried out in the Valley Bushveld which forms the major portion of Subtropical Thicket in the Eastern Cape. Twelve sites were sampled for floristic and environmental variables along a rainfall gradient of between 300 mm yr^{-1} and 1 000 mm yr^{-1} and along a longitudinal gradient from the Buffalo River in the east to the Gamtoos-Kromme complex in the west. Floristic data were analysed using multivariate techniques of classification and ordination. A classification by two-way species indicator analysis revealed the Valley Bushveld to consist of two orders of thicket, the Kaffrarian Succulent Thicket containing the two suborders, Inland Succulent Thicket and the Coastal Succulent Thicket and the Kaffrarian Thicket containing Coastal Kaffrarian Thicket and Inland Kaffrarian Thicket. Ordination by detrended correspondence analysis also grouped sites according to these vegetation categories in a sequence along one axis, to which the rainfall gradient could be related.

Variables such as diversity indices, numbers of endemics, numbers of threatened taxa and structural features were also extracted from the data and these were correlated with environmental variables by multiple regression analysis. Species richness and the percent woody component were positively correlated with rainfall while endemism and percent succulent component were

strongly negatively correlated with rainfall. Most of the other relationships were explained by interrelationships with rainfall.

Finally the sites were evaluated according to floristic criteria indicative of conservation value. The Coastal Succulent Thicket appeared to have the highest conservation value mainly owing to high endemism, while Inland Kaffrarian Thicket was also important as it supports a high number of species.

The thickets with high conservation value are therefore the thickets of coastal areas in the western parts of the Eastern Cape which receive a low rainfall and the thickets which receive a rainfall in excess of 800 mm.

CHAPTER 1

INTRODUCTION

Evidence of increasing concern over the rising rates of extinction amongst the world's plants is apparent from the number of books recently published on the subject of rare and threatened plant conservation (Simmons *et al.*, 1976; Prance and Elias, 1977; Soule & Wilcox, 1980; Synge, 1980; Morse and Henifin, 1981; Warren and Goldsmith, 1983 and Hall *et al.*,1984). Once extinct the complexity of a species, its potential for enriching the lives of other plants and animals and humanity cannot be recreated and is lost for all time. Habitats are shrinking drastically and is the chief cause of many previously widespread plants becoming rare, and those already rare, being threatened with extinction. Projections by Raven (1976) estimate that about 30% (50 000 species), of the world's tropical flowering plants will reach endangered or extinct status by the end of the century. Southern Africa with one of the highest population growth rates in the world (Talbot, 1978) is also losing many of its natural habitats at an alarming rate (Milewski, 1977; 1978a & b; Huntley, 1978; Boucher, 1981; Hall, 1982; Jarman, 1982 and Taylor & Edwards, 1972). In response to this situation, especially in the unique Cape Floral Kingdom, surveys of threatened plant taxa first began in 1974 (Hall, 1978) and culminated with the publishing of "Threatened Plants of Southern Africa" by Hall *et. al.*, 1980. This publication emphasised the lack of up-to-date information available on many plant taxa and the need for more detailed studies in all parts of Southern

Africa, the Eastern Cape with its great floral diversity and complexity of vegetation types being a priority.

Effective plant population conservation requires geographical data specifying where threatened plants grow. A lack of this information is especially apparent in the Eastern Cape where there is a lack of recent collection records (Hall *et. al.*, 1980). In response to these findings and to the concern of the present conservation status of vegetation types (Edwards, 1974) the Nature Conservation Research Section of the National Programme for Environmental Sciences (F.R.D - CSIR) was approached for funds to undertake this project to clarify the conservation status of plant communities in the Eastern Cape.

1.1 OBJECTIVES

The proposed aims and objectives of this study are therefore:-

1) To produce an updated list of threatened plant taxa in the Eastern Cape and to enter this information into a computer based data bank,
2) To identify those plant communities most threatened by land use practices,
3) To identify areas of high conservation value in selected vegetation types,
4) To correlate areas of high conservation value to environmental factors,
5) To identify future research priorities and make recommendations

on the possible approaches for this research.

1.1.1 Research Approach

In order to assess the conservation status of Eastern Cape plant communities and vegetation types, criteria for this assessment needed to be established. Margules and Usher (1981) in a review of methods for assessing wildlife conservation potential, point out that a plethora of criteria, concepts and values have been used in assessment schemes, many of which are complex and difficult to compare. They suggest that only criteria which can be scientifically measured rather than subjective estimates should be used, as such results can be directly compared. Most of the scientific criteria suggested by Margules and Usher can only be applied to the assessment of a defined area (eg. nature reserve) or require extensive and time- consuming surveys, so none of these could be used in this study for the assessment of vegetation types.

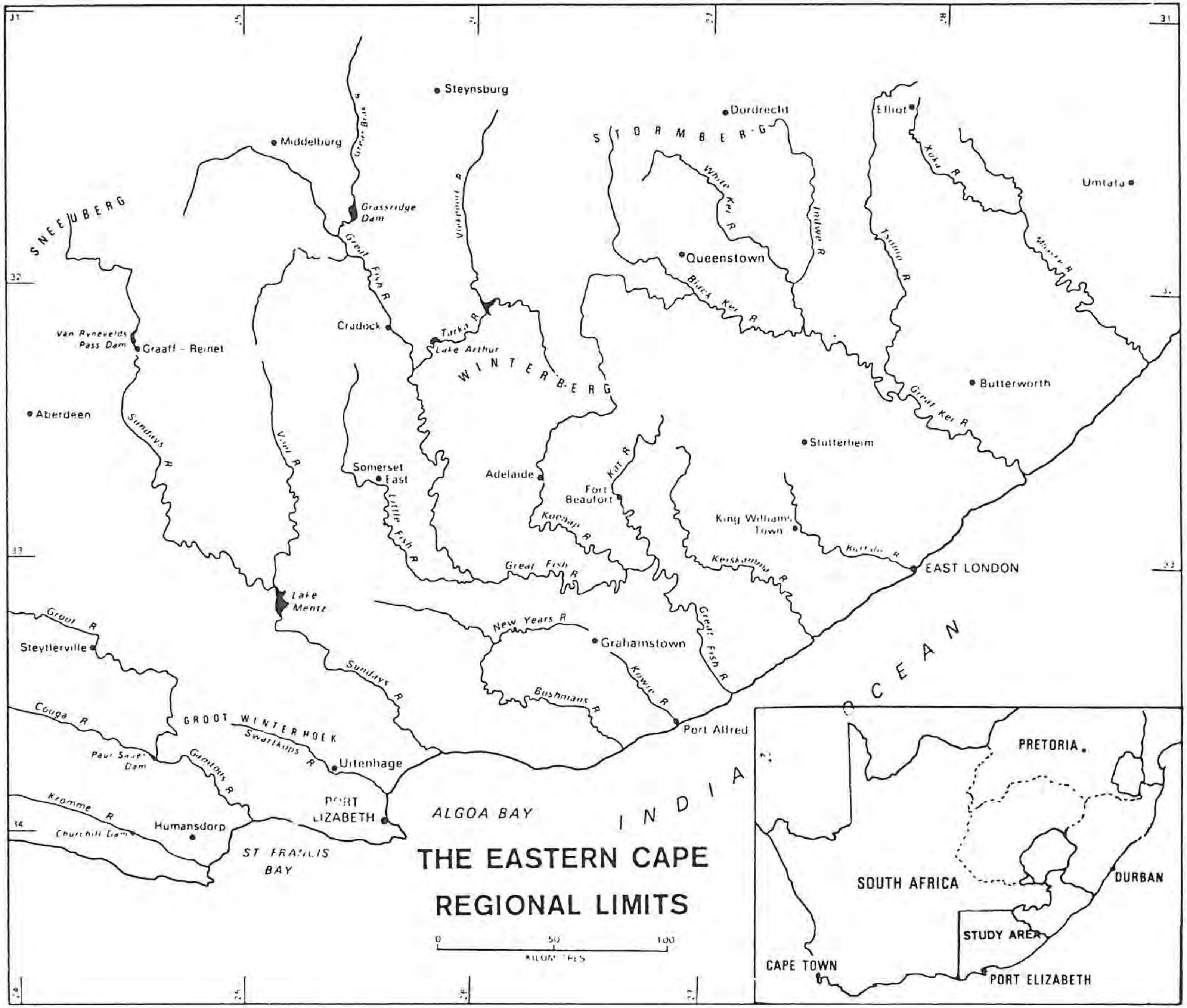
In an attempt to keep this assessment as objective as possible and to facilitate comparisons, floristic criteria such as total numbers of threatened plant taxa; numbers of endemic taxa in each vegetation type, and information on the present areas of each vegetation type under conservation management, were chosen as criteria for evaluating the vegetation types of the Eastern Cape. Data on endemic and threatened species in the Eastern Cape were far from complete (Hall *et.al.,* 1980), so the first step of this study was to review and update this information. Relevant literature and herbarium records were used to identify possible threatened plant taxa. This information was then used to identify the most threatened vegetation types. As time and financial constraints would not allow field surveys of individual threatened plant species in the most seriously threatened vegetation type to be undertaken, it was decided to conduct a broad survey of these vegetation types to identify possible areas of high conservation value. The approach adopted for this survey was to identify a number of sites along rainfall and longitudinal gradients, sample them and correlate measured floristic variables to measured environmental parameters. The critical environmental components which are responsible for floristic features important to conservation can then be identified. By extrapolating these findings to other regions it is hoped that areas of high conservation value can be identified, simply by examining the prevailing environmental conditions at that area.

1.2 THE STUDY AREA

1.2.1 Location

The Eastern Cape has never been regarded as a clearly demarcated natural area (Rennie 1945 and Bruton & Gess, 1986) and has been variously defined by different government departments, planners and developers, and the scientific community. For the purpose of this study the boundaries of the Eastern Cape have been defined as the area south of 32°S and between 24°E and 29°E and thus has the natural boundaries of the Sneeuberg-Winterberg-Stormberg escarpment in the north, the Great Kei River in the east and the Kromme-Gamtoos Rivers in the west (Fig 1). These limits were defined for a symposium entitled, "Towards an enviromental plan for the Eastern Cape" which was held at Rhodes University in July 1983 and have become widely adopted (Gibbs Russell & Robinson, 1981 and Cowling, 1983b). This area has long been known as a region of immense transition and complexity (Rennie, 1945; Cowling, 1983b and Lubke *et al.*, 1986). It forms a major climatic, topographic and geological transition zone and is consequently a focus of convergence for four phytochoria (Goldblatt, 1978; Werger, 1978b; Werger & Coetzee, 1978; Gibbs Russell & Robinson, 1981; White, 1982; Cowling, 1983b and Lubke *et al.*, 1984). This is therefore an area rich in species and communities and probably provides the greatest biological diversity of any equivalent region in South Africa (Bruton & Gess, 1986).

FIGURE 1. Location and regional limits of the Eastern Cape.


THE EASTERN CAPE
REGIONAL LIMITS
Steynsburg
Middelburg
Dordrecht
STORMBERG
Elliot
Umtata
SNEEUBERG
Grassridge Dam
Great Fish R
Vlekpoort R
White Kei R
Indwe R
Queenstown
Tsomo R
Black Kei R
Cradock
Tarka R
Lake Arthur
Van Ryneveld's Pass Dam
Graaff - Reinet
WINTERBERG
Butterworth
Great Kei R
Aberdeen
Sundays R
Stutterheim
Somerset East
Adelaide
Kat R
Fort Beaufort
Koonap R
King William's Town
Little Fish R
Great Fish R
Keiskamma R
EAST LONDON
Lake Mentz
Groot R
New Years R
Steytlerville
Grahamstown
Great Fish R
Kowie R
Sundays R
Bushmans R
Couga R
GROOT WINTERHOEK
Swartkops R
Port Alfred
Gamtoos R
Uitenhage
Kromme R
Humansdorp
PORT ELIZABETH
ALGOA BAY
ST FRANCIS BAY
INDIAN OCEAN
0
50
100
PRETORIA
SOUTH AFRICA
DURBAN
STUDY AREA
CAPE TOWN
PORT ELIZABETH

1.2.2 Geology

(i) Rock formations:

There are five major units making up the stratigraphic column in the Eastern Cape. Most of the formations are sedimentary, therefore sandstones, mudstones, limestones, conglomerate and tillite are relatively common. Dolerite and basalt occur in the northern parts of the Eastern Cape while granite, which is a common igneous rock, is absent. Table 1. shows the simplified stratigraghic column and Figure 2. shows the surface distribution of the various units. A full description of these formations is presented by Rust (1986).

(ii) Structure:

The geological structure of the Eastern Cape can be separated into two major areas, namely the Cape Fold Belt in the south and the Karoo basin in the north.

(a) Cape Fold Belt:

Folding occurred during the Triassic when the crust of Southern Africa was compressed horizontally from the south. The crest lines strike more or less east-west, the various hard and soft formations so folded, causing a distinctive valley and ridge topography. During the early Cretaceous Period when Gondwanaland broke up, the Fold Belt developed some very large faults which control the linear coastline near East London and define the margin of the continental shelf and the Agulhas Bank (Rust, 1986).

(b) Karoo Basin:

TABLE 1: Simplified stratigraphic column for the Eastern Cape (after Rust, 1986).

UNIT	SUBUNIT	ROCK TYPE	AGE & THICKNESS
Alexandria form & younger sediments	-	Limestone, Sandstone and Dune sand	Tertiary to Recent (100m)
Uitenhage group	-	Sandstone, Shale and Conglomerate	Jurassic to Cretaceous (4 300m)
Karoo sequence	Drakensberg	Basalt	Jurassic (1000m)
	Clarens	Sandstone	" (250m)
	Elliot	Siltstone, Mudstone	Late Triassic (500m)
	Molteno	Sandstone, Shale	" " (700m)
Beaufort	Burgersdorp	Mudstone and Sandstones	Triassic (1000m)
	Katberg		" (900m)
	Balfour		" (2150m)
	Middleton		" (1500m)
	Koonap		" (1300m)
Ecca	Waterford	Mudstone & Sandstone	Permian (800m)
	Fort Brown		" (1500m)
	Ripon		" (1000m)
	Collingham		" (30m)
	Whitehill		" (50m)
	Prince Albert		" (100m)
	Dwyka	Tillite	Carboniferous (1000m)
Cape Supergroup	Witteberg group Bokkeveld group Table Mountain	Quartz, Sandstone, Shale & Siltstone	Ordovician to Devonian (+8700m)
Gamtoos formation		Limestone, Quartzite	Namibian (several hundred)

FIGURE 2. Simplified geological map of the Eastern Cape (after Rust, 1986)

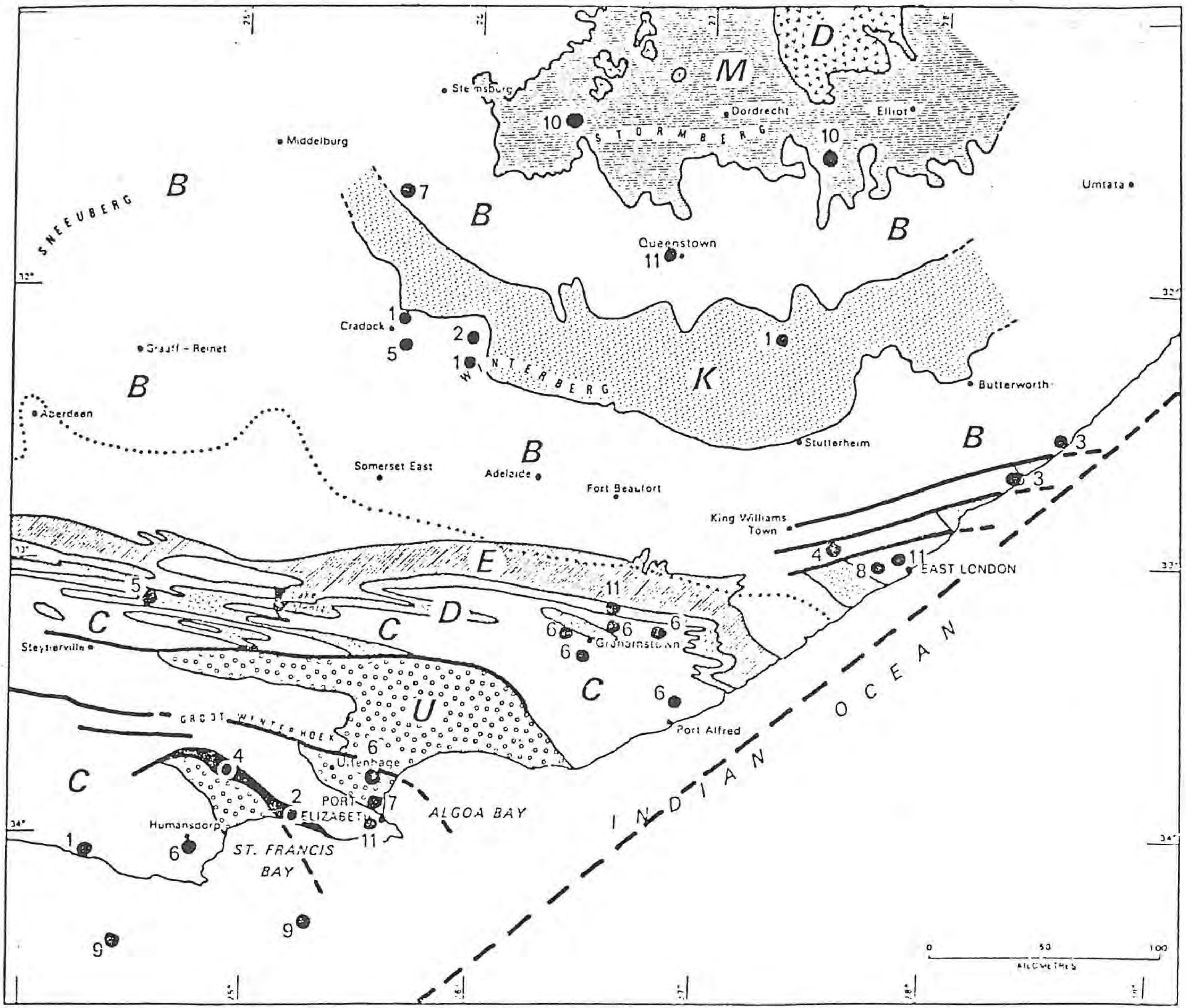
The main geological units are indicated as follows:-
C - Cape Supergroup
D - Dwyka formation
E - Ecca group
B - Beaufort group
K - Katberg formation
M - combined outcrop of Molteno, Elliot and Clarens formations
D - Drakensberg Formation
U - Uitenhage group

Gamtoos formation

Southern limit of Karoo dolerite

Faults

Ore deposits are numbered:-
1 - gold
2 - lead, silver, copper, zinc
3 - black sands with titanium, zirconium, thorium & rare earth elements
4 - limestone
5 - gypsum
6 - kaolin & brick clay
7 - salt pans
8 - barite
9 - phosphorite
10 - coal
11 - crushed rock



D
M
Steynsburg
Dordrecht
Elliot
STORMBERG
10
10
Middelburg
7
B
SNEEUBERG
B
B
Umtata
Queenstown
11
1
Cradock
2
5
1
Graaff - Reinet
WINTERBERG
K
1
Butterworth
B
Aberdeen
Stutterheim
B
B
3
3
Somerset East
Adelaide
Fort Beaufort
King Williams Town
4
8
11
EAST LONDON
E
5
11
C
D
C
6
6
6
6
Steytlerville
Grahamstown
C
6
U
GROOT WINTERHOEK
Port Alfred
O C E A N
6
C
4
Uitenhage
2
PORT ELIZABETH
7
ALGOA BAY
I N D I A N
Humansdorp
1
6
11
ST. FRANCIS BAY
9
9
0
50
100
KILOMETRES

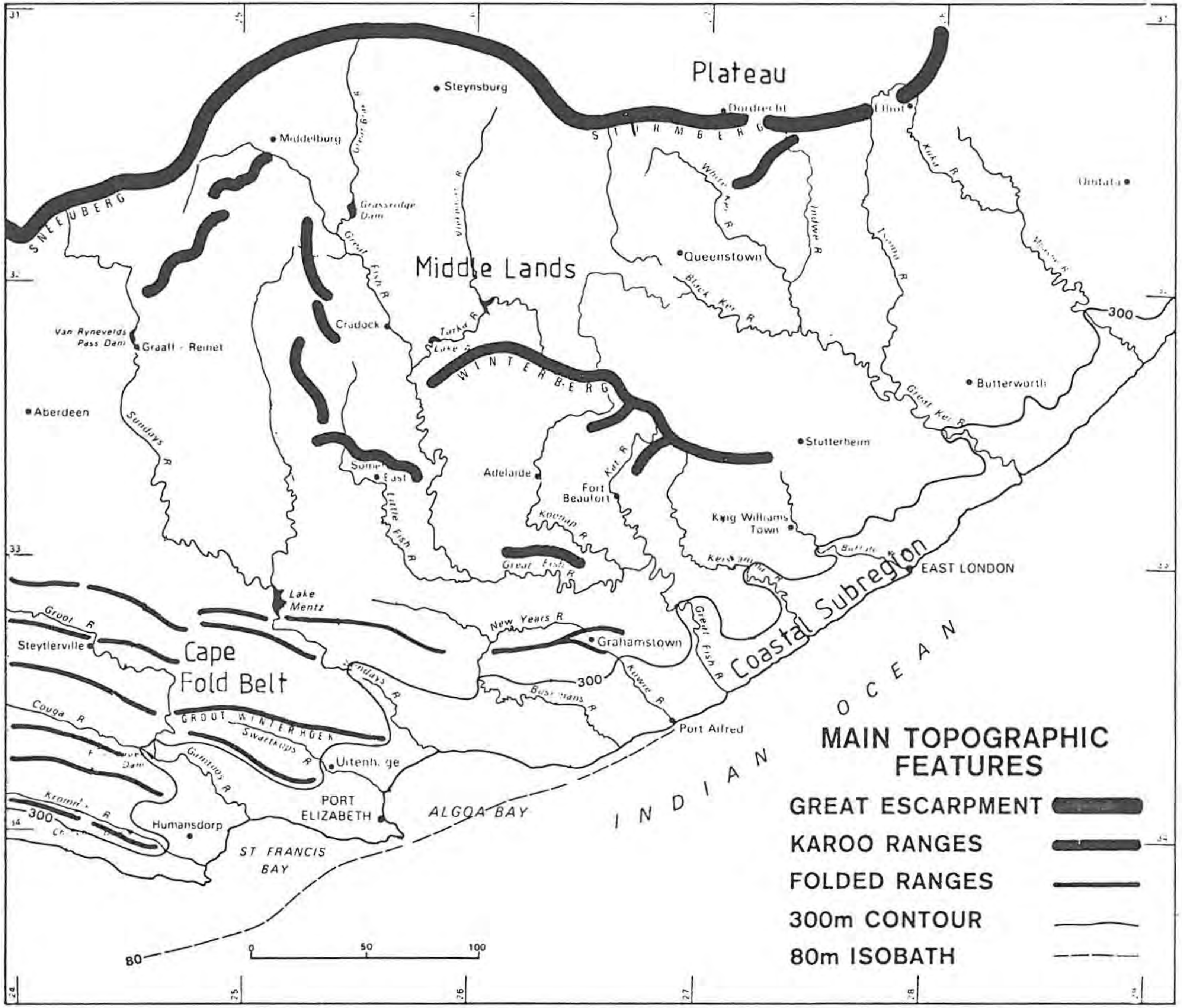
The rocks of the Karoo basin lie more or less horizontal and only appear tilted where distributed locally by dolerite dykes and sheets. The dykes are subvertical intrusive bodies which extend along crack systems, this structure controlling the distinctive mesa, butte and ridge topography of the Karoo basin (Rust, 1986).

Mining potential is very limited in the Eastern Cape and thus future mining operations are unlikely to pose a threat to the environment. The most geologically sensitive areas are estuaries, coastal dune fields, beaches, salt pans and ground water, these being particularly vulnerable to disturbance by human activity.

1.2.3 Geomorphology

After the eruptions bringing the Stormberg lavas to the surface ceased to operate at about the time of the break up of Gondwanaland (late Jurassic), the main geomorphic processes that have influenced the present geomorphology in the Eastern Cape came into action. Headward erosion from the coastline, which was positioned with the breakup of Gondwanaland, is responsible for the formation of the 3 physiographic zones, recognised by Wellington (1928), which now occur in the Eastern Cape. These zones consist of the Plateau, the Southern Folded Belt, and the Middlelands. Nicol (1986) recognises a fourth, the Coastal Subregion (Fig 3.).

FIGURE 3 Main Topographic features and Physiographic Zones (after Nicol, 1986).


Plateau
Middle Lands
Cape Fold Belt
Coastal Subregion
SNEEUBERG
STORMBERG
WINTERBERG
GROOT WINTERHOEK
Steynsburg
Middelburg
Dordrecht
Elliot
Umtata
Grassridge Dam
Queenstown
Cradock
Van Ryneveld's Pass Dam
Graaff - Reinet
Aberdeen
Tarka R
Lake
Great Fish R
Sundays R
Little Fish R
Somerset East
Adelaide
Fort Beaufort
Kat R
Koonap R
King Williams Town
Stutterheim
Butterworth
Great Kei R
Black Kei R
White Kei R
Indwe R
Tsomo R
Xuka R
Mbashe R
Buffalo R
Keiskamma R
EAST LONDON
Lake Mentz
Groot R
Steytlerville
New Years R
Grahamstown
Great Fish R
Kowie R
Bushmans R
Port Alfred
Couga R
Swartkops R
Gamtoos R
Uitenhage
PORT ELIZABETH
ALGOA BAY
Kromme R
Humansdorp
ST FRANCIS BAY
INDIAN OCEAN
300
80
0
50
100
MAIN TOPOGRAPHIC FEATURES
GREAT ESCARPMENT
KAROO RANGES
FOLDED RANGES
300m CONTOUR
80m ISOBATH

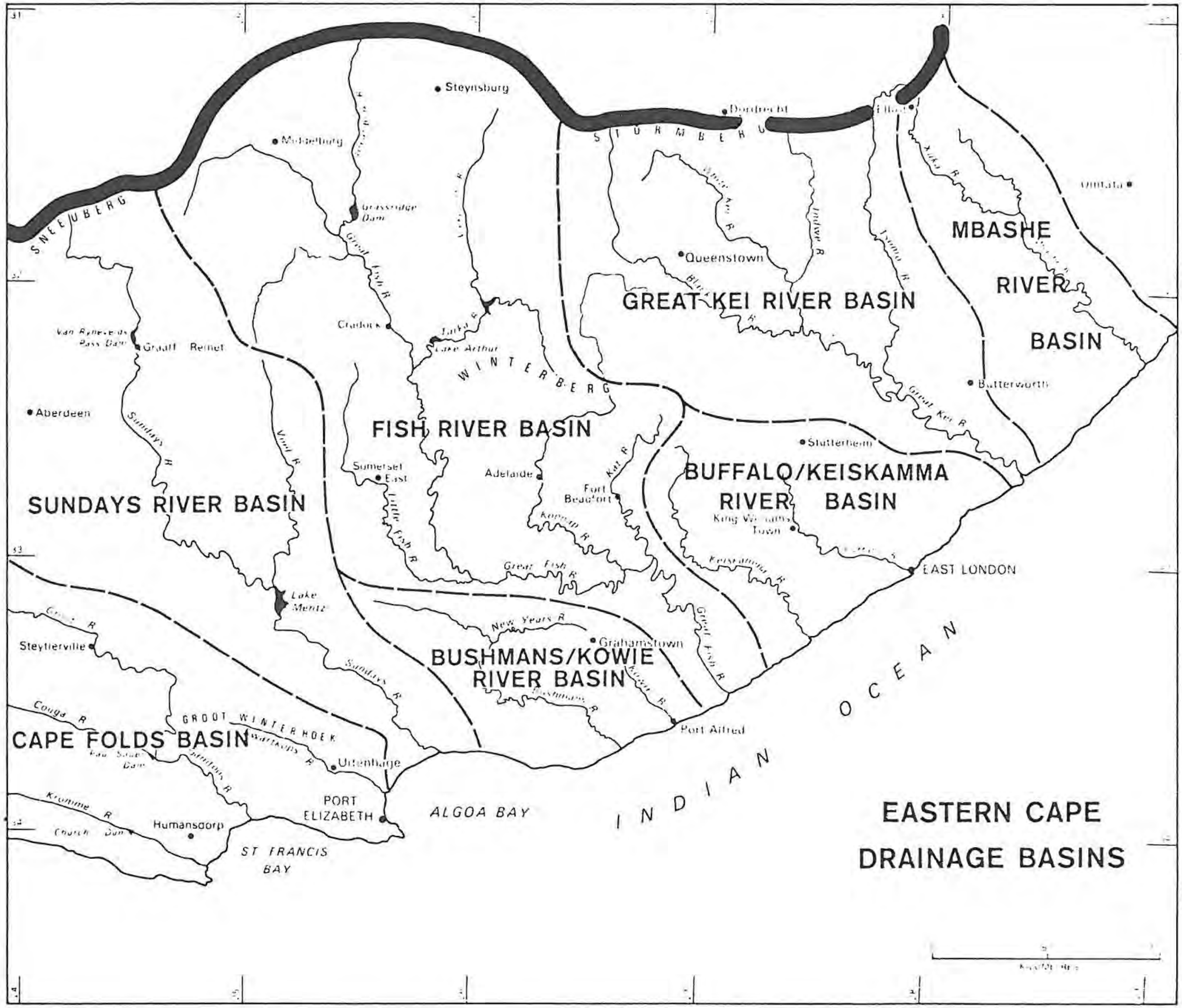
(a) The Plateau

The Plateau which is bounded by the Great Escarpment (Fig 3.), has retreated under the attack of the headward erosion from the main river systems in the Eastern Cape. This has resulted in an irregular escarpment with a large embayment at the headwaters of the Great Fish River, (north of Middleburg and Steynsburg), and a smaller one at the headwaters of the Sundays River (Fig 4.).

(b) The Middlelands

The removal of the Stormberg lavas has exposed the Beaufort Group in this zone which covers the greater part of the surface area of the Eastern Cape (Fig 3.). The presence of thick formations of relatively homogeneous sedimentary rocks with nearly horizontal, cap-rock sills of hard resistant dolerite resulted in the development of extensive pediplains. These resistant dolerites protect the softer strata below, exposing the edges to back wearing which results in the development of the classic four-element hill slope features which are so common in the Karoo (Nicol, 1986). The continuing undercutting of the supporting sandstones below the dolerites and the removal of talus by surface weathering and sheetwash , results in the pediment spreading outwards from the flattopped Karoo hills or koppies. The 3 major river basins which have played a significant role in shaping the physiographic character of this region are shown in Fig 4. They include the Great Kei River basin, the Great Fish River basin and the Sundays River basin, each being bounded by the watershed of the Great Escarpment to the North.

FIGURE 4. Drainage basins of the main rivers of the Eastern Cape (after Nicol, 1986).


EASTERN CAPE
DRAINAGE BASINS
SUNDAYS RIVER BASIN
FISH RIVER BASIN
GREAT KEI RIVER BASIN
MBASHE RIVER BASIN
BUFFALO/KEISKAMMA RIVER BASIN
BUSHMANS/KOWIE RIVER BASIN
CAPE FOLDS BASIN
SNEEUBERG
STORMBERG
WINTERBERG
GROOT WINTERHOEK
INDIAN OCEAN
ALGOA BAY
ST FRANCIS BAY
Steynsburg
Queenstown
Butterworth
Stutterheim
Adelaide
Aberdeen
Graaff Reinet
Cradock
Lake Arthur
Somerset East
Fort Beaufort
King William's Town
EAST LONDON
Grahamstown
Port Alfred
Lake Mentz
Steytlerville
Uitenhage
PORT ELIZABETH
Humansdorp
Sundays R
Vaal R
Great Fish R
Little Fish R
Kat R
Koonap R
New Years R
Bushmans R
Kowie R
Keiskamma R
Great Kei R
Black Kei R
White Kei R
Indwe R
Tsomo R
Xuka R
Tarka R
Kouga R
Kromme R
Groot R
Swartkops R
Elands R

(c) The Southern Folded Belt

The folded belt of the Cape Super Group enters the Eastern Cape from the west, finally folding in the area of Grahamstown andthe Fish River Mouth (Fig 3.). Quartzites, sandstones and shales of the Table Mountain, Bokkeveld and Witteberg Groups were subjected to folding before the Karoo rocks were laid down. These folds were buried by the Karoo Super Group and have since been exposed.

(d) The Coastal Subregion

This region extends from the shoreline, inland to about the 300 metre contour (Fig 3.), most of it lying within 40km of the coast. A strong up-arching of the interior of the subcontinent during the late Pliocene and early Pleistocene (King, 1957) caused an altitude increase of up to 350 metres along the present line of the Great Escarpment. This together with a seaward tilting of the outer margins lifted the areas immediately inland of the coast by about 250 - 300 metres which caused the energy levels of all the rivers to increase sharply, causing them to incise their beds deeply, resulting in the impressive river gorges separated by interfluves of low relief that are typical of this zone (Nicol, 1986).

Quarternary Influences:

Climatic changes on a world wide scale during the quarternary caused fluctuations of sea level resulting in a number of raised beaches which are especially well developed in the Alexandria district where limestones are found up to 20km inland. A stepped topography has developed with eight identifiable raised beaches in the Port Elizabeth and Alexandria areas (Nicol, 1986).

The effect of recent human occupation and that associated with cultivation has had a marked accelerative effect on the geomorphic processes of denudation. Removal of the vegetation cover has resulted in a chronic increase in soil erosion, with the associated increase in sediment loads in rivers causing the silting up of dams and estuaries. Nicol (1986) feels this process has reached alarming proportions in some areas of the Eastern Cape.

1.2.4 Soils

Based on the soil map of the Republic of South Africa compiled by the Soil and Irrigation Research Institute (Soil Survey Staff, 1973), Hartmann (1986) mapped and described the soils of the Eastern Cape. The distributions of the various soil types appear in Fig 5. The south-western, western and north-western parts of the Eastern Cape are dominated by rocky land, lithosols and weakly developed lime rich soils (map unit 1,Fig 5.) while in the east, solonetzic and red clay soils predominate (unit 2). The above groups of soil collectively account for approximately 68% of the soils of the Eastern Cape. Latosols (unit 3) also occur in the east but are limited to isolated high precipitation mountainous areas. The central parts of the Eastern Cape are dominated by lithosols with much rocky land (unit 5). Weakly developed soils interspersed with black clays (unit 4) dominate

FIGURE 5. Soils of the Eastern Cape (after Hartmann, 1986).

1 Weakly developed lime rich soils.

2 Weakly developed and solonetzic soils interspersed with red clays.

3 Deep red and yellow latosolic clays with varying amounts of rock and lithosols.

4 Weakly developed soils on rock interspersed in parts with black and brownish black clays and clay loams.

5 Weakly developed soils with much rocky land.

6 Black and red clays and solonetzic soils.

7 Relatively deep, red, lime rich sandy clay loams.

8 Weakly developed soils interspersed with red sandy clays.

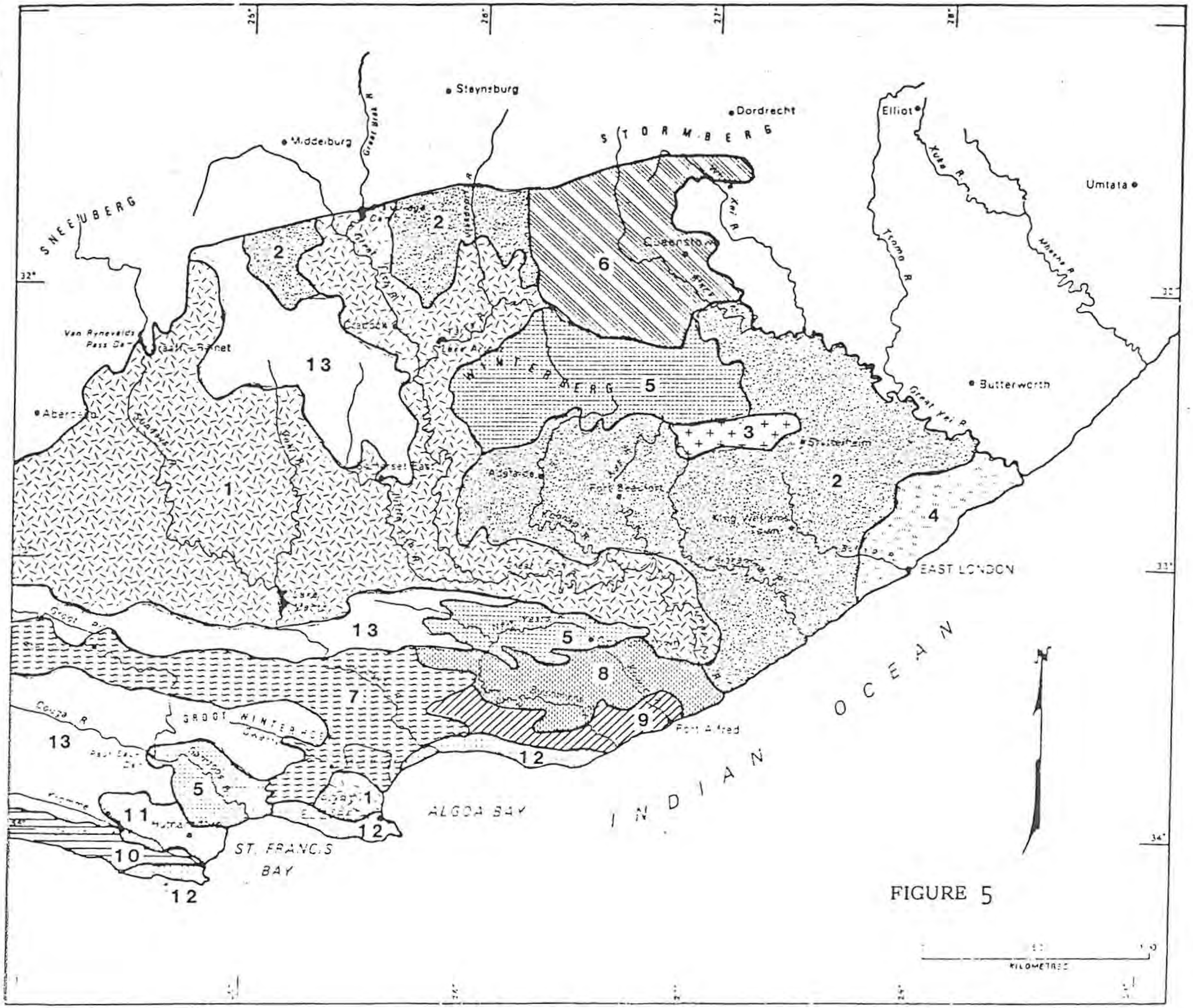
9 Red porous sandy clay loams and lithosols on lime.

10 Acid loamy sands.

11 Weakly developed stony soils.

12 Coastal sands and sandy soils.

13 Rock and lithosols.


Steynsburg
Dordrecht
Elliot
Middelburg
S T O R M B E R G
Umtata
S N E E U B E R G
Butterworth
Great Kei R
EAST LONDON
INDIAN OCEAN
ALGOA BAY
ST. FRANCIS BAY
Port Alfred
GROOT WINTERHOEK
Couga R
1
2
3
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12
13
KILOMETRES

FIGURE 5

the eastern coastal belt, while in the south-eastern coastal region sandy soils with variable depth and deep red sandy clay loams (unit 9) overlying limestone, are common. The southern coastal belt is characterised by coastal sands, and sandy soils (unit 12), lime containing lithosols and weakly developed soils on rock (unit 13).

1.2.5 Climate

i) Climatic types:

Based on the modified Koppen system Schulze (1947) consider the Eastern Cape to have the following seven climatic types; Cfbl, Cfwb, Cfw'b, Bskw, BSha, BSka and BWhw' (Fig 6.). An explanation of these symbols appears in the Legend to Fig 6. Rainfall is usually a major criterion in climatic classification, however in the Eastern Cape temperature often appears to be more important.

ii) Temperature:

Kopke (1986) recognises four distinctive temperature regimes in the Eastern Cape. These include:

1) the interior above the escarpment which is characterised by hot summers, and cold winters with widespread frosts occurring at night;
2) the coastal zone which is mild in both winter and summer, wind reducing heat and humidity in summer;
3) the mountainous escarpment zone which has temperatures modified by altitude, winters being cool with periodical

FIGURE 6 The climate of the Eastern Cape according to Koppen's classification and the mean monthly rainfall for selected stations (after Kopke, 1986).

KEY TO SYMBOLS

Cfbl - subtropical, all months between 10-22,2°C, all months at least 60mm of rain.

Cfwb - subtropical, all months between 10-22,2°C, summer maximum of rainfall.

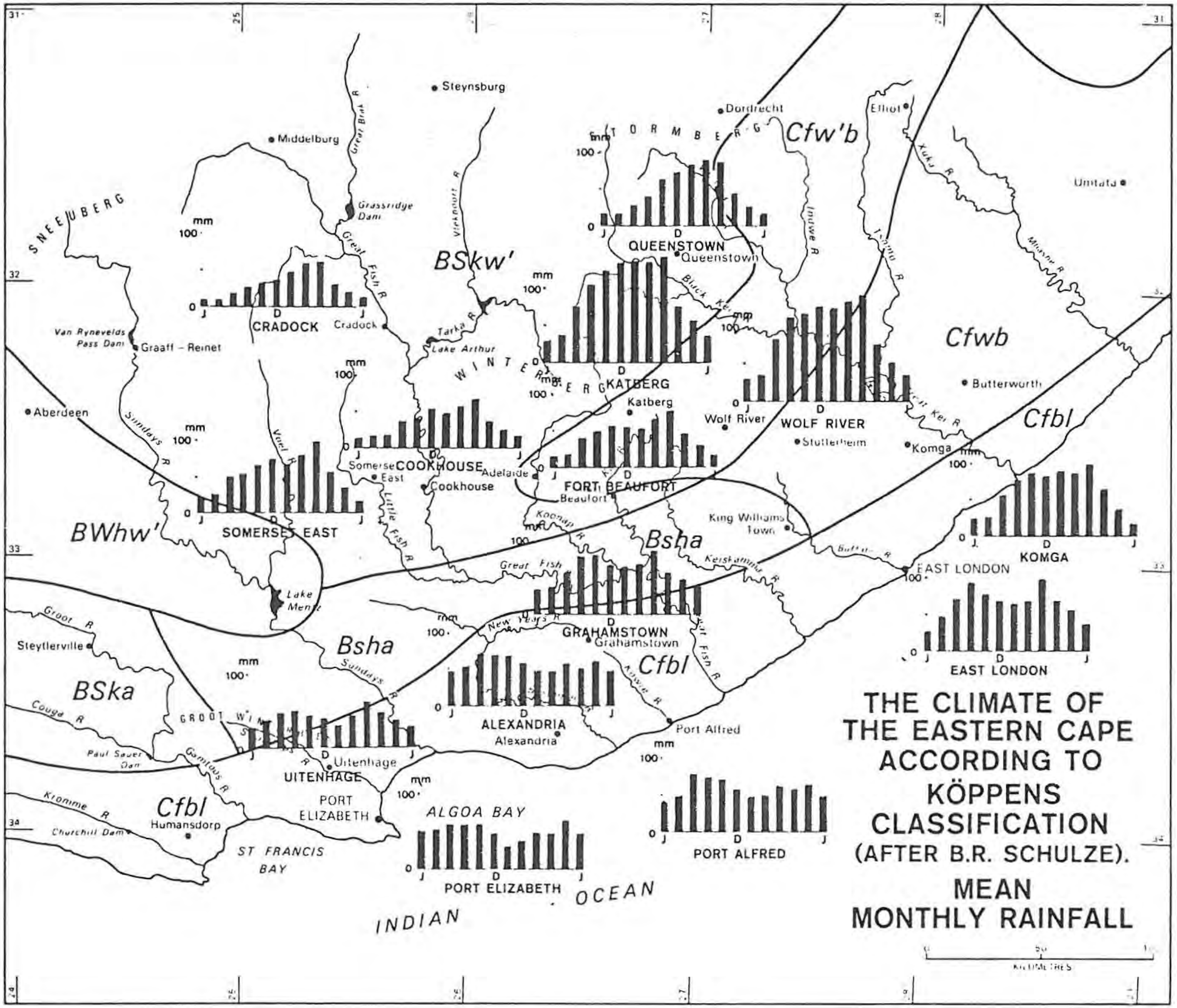
Cfw'b - subtropical, all months between 10-22,2°C, autumn maximum of rainfall.

BSkw'- Steppe, less than 8 months over 10°C, winter dry with at least 2 months below 60mm rainfall.

BSha - Steppe, 8 months & more over 10°C with warmest month over 22,2°C.

BSka- Steppe, less than 8 months over 10°C with hottest below 22,2°C.

BWhw' - Desert, 8 months and more over 10°C with autumn maximum of rainfall.


THE CLIMATE OF
THE EASTERN CAPE
ACCORDING TO
KÖPPENS
CLASSIFICATION
(AFTER B.R. SCHULZE).
MEAN
MONTHLY RAINFALL
CRADOCK
QUEENSTOWN
KATBERG
WOLF RIVER
COOKHOUSE
FORT BEAUFORT
SOMERSET EAST
KOMGA
GRAHAMSTOWN
EAST LONDON
ALEXANDRIA
UITENHAGE
PORT ELIZABETH
PORT ALFRED
BSkw'
Cfw'b
Cfwb
Cfbl
BWhw'
Bsha
BSka
Steynsburg
Middelburg
Dordrecht
Elliot
Umtata
Grassridge Dam
Great Fish R
Great Brak R
Vlekpoort R
Cradock
Graaff - Reinet
Van Ryneveld's Pass Dam
Aberdeen
Sundays R
Voel R
Tarka R
Lake Arthur
Queenstown
Black Kei R
Indwe R
Xuka R
Mbashe R
Butterworth
Katberg
Wolf River
Stutterheim
Komga
Somerset East
Cookhouse
Adelaide
Fort Beaufort
Little Fish R
Koonap R
King Williams Town
Keiskamma R
Buffalo R
East London
Lake Mentz
Groot R
Steytlerville
New Years R
Grahamstown
Kowie R
Port Alfred
Alexandria
Couga R
Paul Sauer Dam
Gamtoos R
Uitenhage
Kromme R
Churchill Dam
Humansdorp
PORT ELIZABETH
ALGOA BAY
ST FRANCIS BAY
INDIAN OCEAN
SNEEUBERG
STORMBERG
WINTERBERG
GROOT WINTERHOEK
KILOMETRES
mm
100
0
J
D

'cold snaps' and;

4) the remaining greater proportion of the Eastern Cape region which experiences mild winters with occassional frost and warm summers. Hot days with temperatures of 40^{o}C and above do occur occasionally and are usually associated with "Berg Wind" conditions.

Temperature regimes for a number of selected stations are shown in Fig 7.

iii) Rainfall:

The topography of the Eastern Cape has a very marked influence on rainfall totals and thus these vary considerably throughout the region. However, based on seasonal distribution the Eastern Cape can be divided into four subregions (Fig 7.):

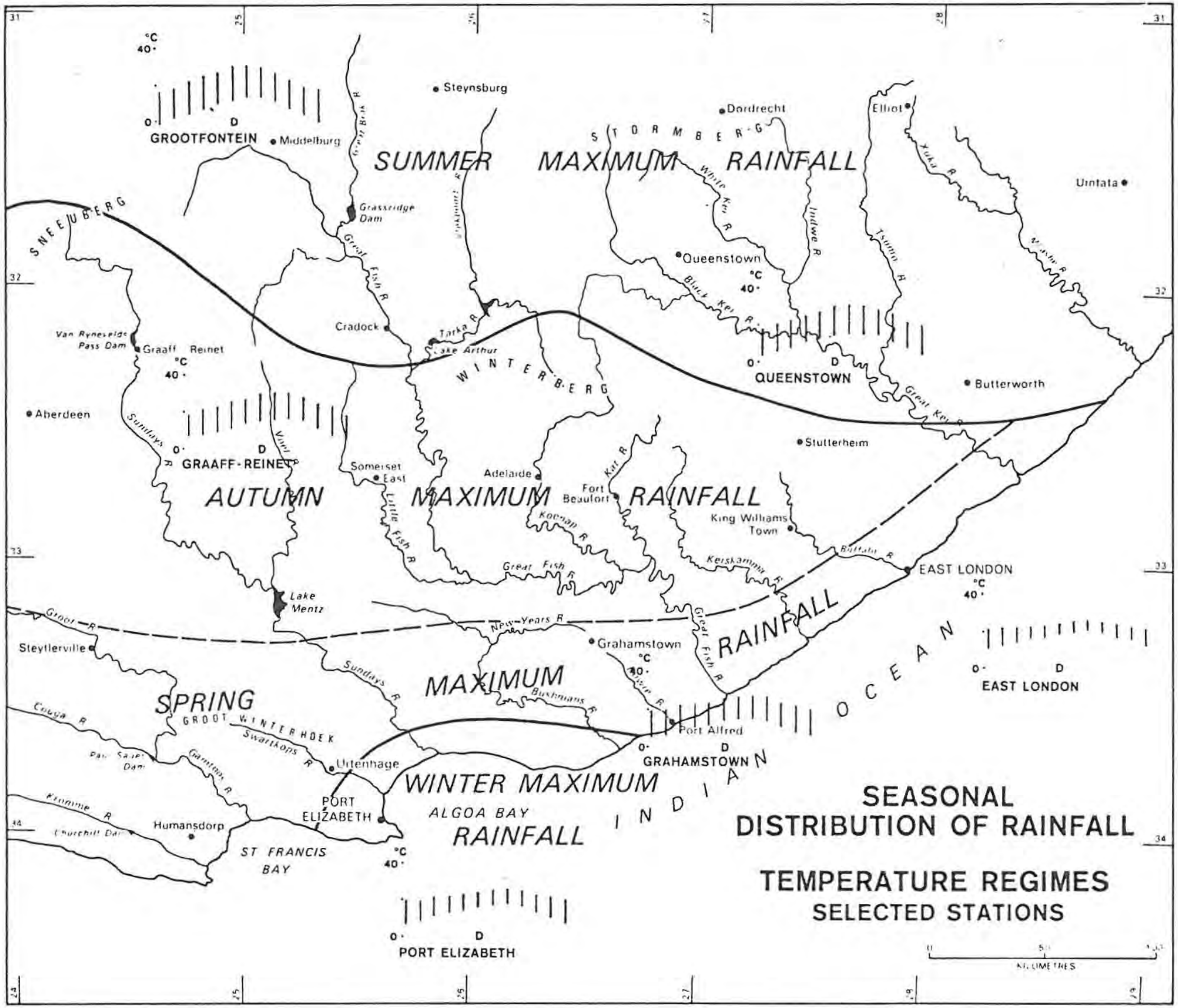
1) summer maximum rainfall occurs in the region north of the Great Escarpment;
2) autumn maximum rainfall occurs in the areas below the Escarpment extending down the valleys of the main rivers;
3) spring maximum rainfall occurs in the coastal region while
4) winter maximum rainfall occurs along the coast from Port Elizabeth to Port Alfred (Fig 7.).

Mean monthly rainfall for a number of stations throughout the Eastern Cape is given in Figure 6. The 500mm and 1000mm isohyets are shown in Figure 8.

iv) Wind:

The Eastern Cape coast is considered to be one of the windiest parts of Southern Africa (Kopke, 1986). The interior of the

FIGURE 7 Seasonal distribution of rainfall and temperature regimes of a number of selected stations in the Eastern Cape (after Kopke, 1986).


SEASONAL
DISTRIBUTION OF RAINFALL
TEMPERATURE REGIMES
SELECTED STATIONS
SUMMER MAXIMUM RAINFALL
AUTUMN MAXIMUM RAINFALL
SPRING MAXIMUM RAINFALL
WINTER MAXIMUM RAINFALL
INDIAN OCEAN
ALGOA BAY
ST FRANCIS BAY
GROOTFONTEIN
GRAAFF-REINET
QUEENSTOWN
EAST LONDON
GRAHAMSTOWN
PORT ELIZABETH
°C
40
0
D
Steynsburg
Dordrecht
Elliot
Umtata
Middelburg
Grassridge Dam
Queenstown
Cradock
Lake Arthur
Van Ryneveld's Pass Dam
Graaff Reinet
Aberdeen
Butterworth
Stutterheim
Somerset East
Adelaide
Fort Beaufort
King Williams Town
EAST LONDON
Lake Mentz
Steytlerville
Grahamstown
Port Alfred
Uitenhage
PORT ELIZABETH
Humansdorp
SNEEUBERG
STORMBERG
WINTERBERG
GROOT WINTERHOEK
Great Fish R
Tarka R
White Kei R
Indwe R
Black Kei R
Great Kei R
Sundays R
Little Fish R
Great Fish R
Koonap R
Kat R
Keiskamma R
Buffalo R
New Years R
Groot R
Sundays R
Bushmans R
Kouga R
Swartkops R
Gamtoos R
Kromme R
KILOMETRES

Eastern Cape is also surprisingly windy owing to the topographic effects of the escarpment. Winds in both the coastal and inland areas are experienced frequently, calms being a rarity. Figure 8. gives windspeed and direction for four selected stations in the Eastern Cape.

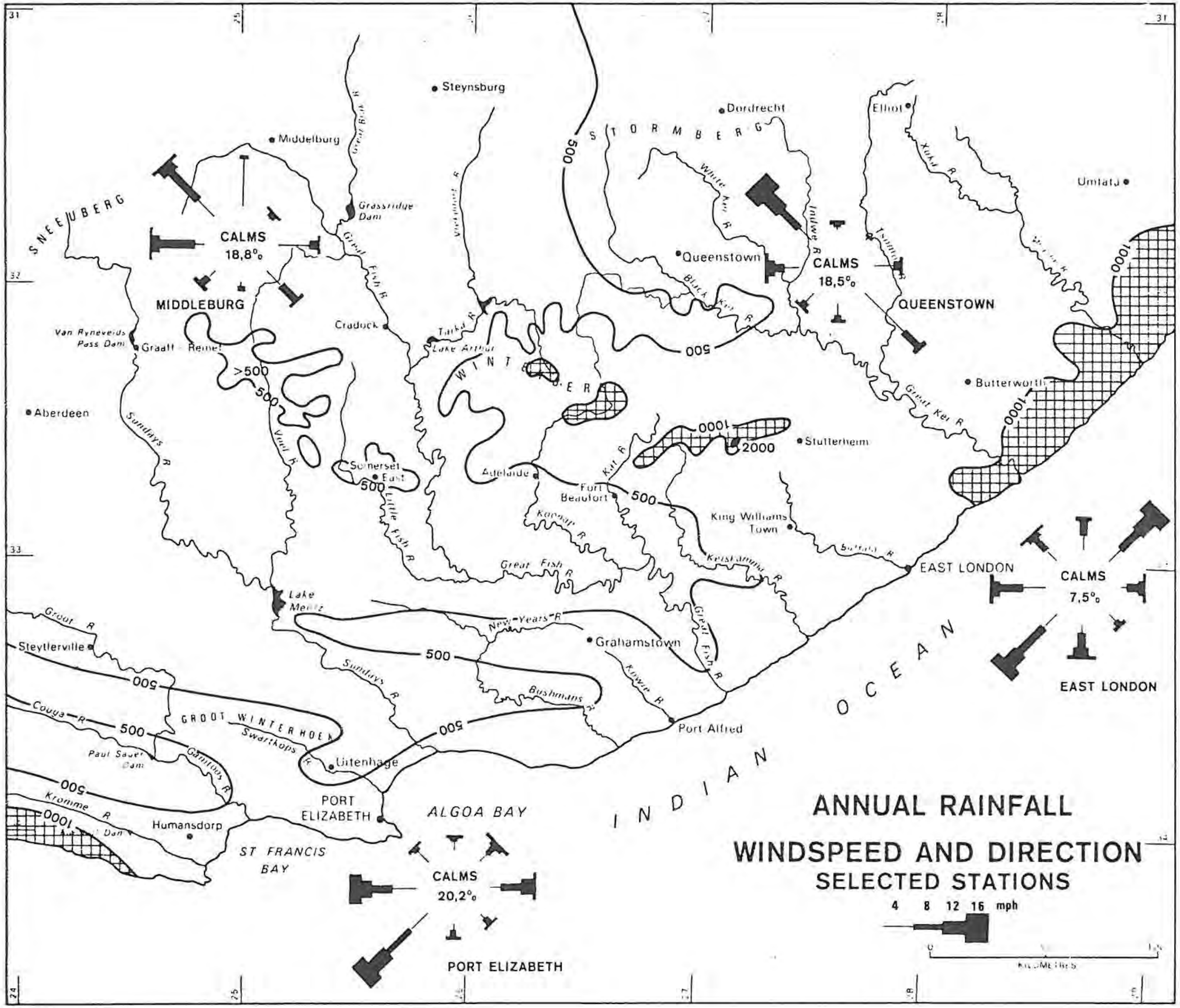
Notable features of the climate of the Eastern Cape are the occurrence of low pressure systems which move eastwards past the coast of the Eastern Cape with their associated "cold fronts". They are more frequent in the winter months and are responsible for extremes in weather conditions, warm "berg winds" followed by huge drops in temperature, strong winds and sometimes rain and even snow on the highlying ground. Heavy rainfalls are caused by either outbreaks of polar air, cut-off lows, or by a high pressure system to the south feeding in moist cool air over the Eastern Cape. When these systems coincide devastating floods can occur in the coastal areas.

1.2.6 Vegetation

(i) Review

The earliest studies of the vegetation in the Eastern Cape failed to recognise the complexity and diversity of the vegetation types and floristic regions. Black (1901) described the "river bush" of the Fish River valley to be of a different nature to that covering the rest of the country. Schonland (1919) described nine vegetation formations in the Uitenhage and Port Elizabeth areas while Pole-Evans (1936) classified the vegetation in the

FIGURE 8 Average annual rainfall as shown by the 500mm and the 1000mm isohyets. Windspeads and directions are also shown for 4 selected stations (after Kopke, 1986).


ANNUAL RAINFALL
WINDSPEED AND DIRECTION
SELECTED STATIONS
4 8 12 16 mph
CALMS 18,8%
MIDDLEBURG
CALMS 18,5%
QUEENSTOWN
CALMS 7,5%
EAST LONDON
CALMS 20,2%
PORT ELIZABETH
Steynsburg
Middelburg
Dordrecht
Elliot
Umtata
STORMBERG
SNEEUBERG
WINTERBERG
GROOT WINTERHOEK
Grassridge Dam
Queenstown
Cradock
Van Ryneveld's Pass Dam
Graaff-Reinet
Lake Arthur
Butterworth
Aberdeen
Stutterheim
Somerset East
Adelaide
Fort Beaufort
King Williams Town
EAST LONDON
Lake Mentz
Grahamstown
Steytlerville
Port Alfred
Uitenhage
Paul Sauer Dam
PORT ELIZABETH
Humansdorp
ALGOA BAY
ST FRANCIS BAY
INDIAN OCEAN
Great Fish R
Sundays R
Vogel R
Little Fish R
Great Kei R
White Kei R
Black Kei R
Indwe R
Tarka R
Koonap R
Kat R
Keiskamma R
New Years R
Bushmans R
Kowie R
Groot R
Couga R
Swartkops R
Gamtoos R
Kromme R
500
>500
1000
2000

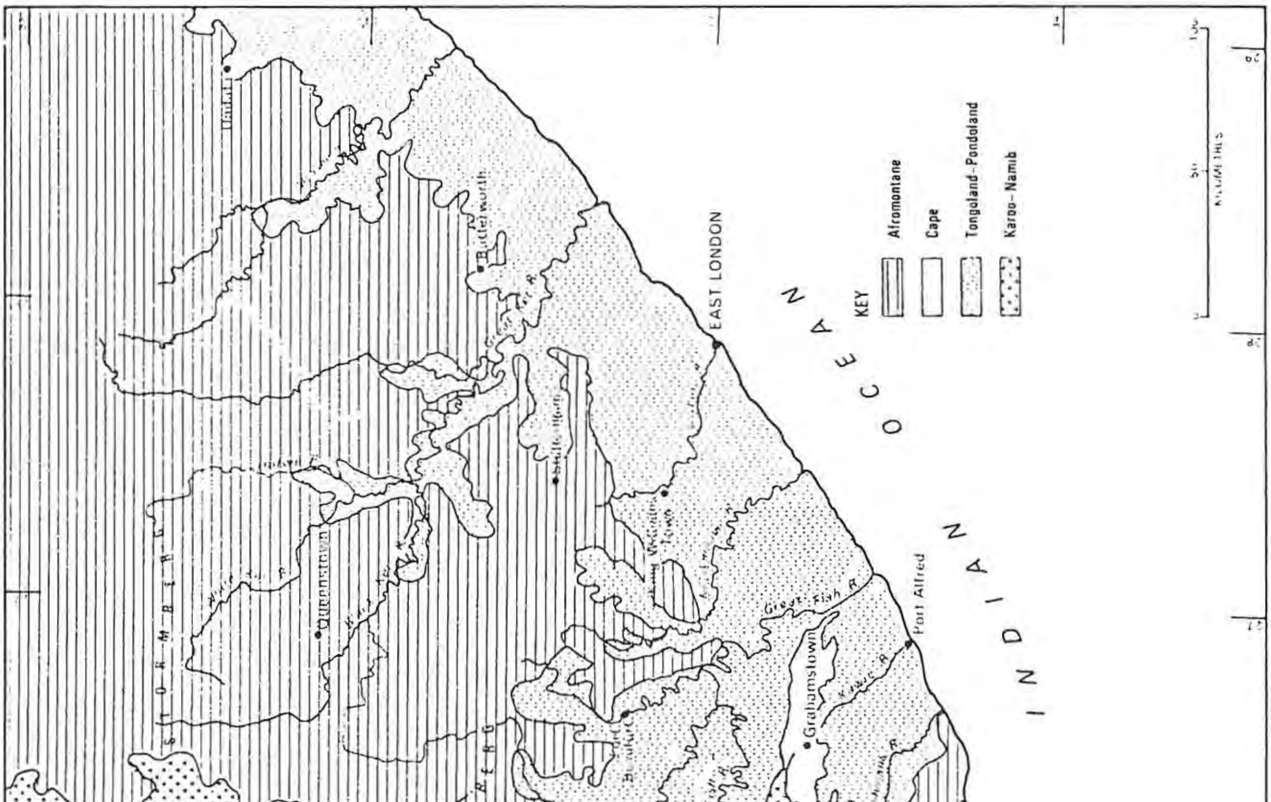
Eastern Cape to consist of Tall grass, Desert scrub, Evergreen and Deciduous bush and Subtropical forest, and patches of Temperate forest. Dyer (1937) was one of the first to show how the "South-Eastern Flora, Karoo Flora, and the Subtropical Flora" all entered the Albany and Bathurst divisions which are centrally situated in the Eastern Cape. Adamson (1938) was superficial in his description of the Eastern Cape while Story (1952) recognised nine vegetation types when he described in detail the vegetation of the Keiskammahoek district. Acocks (1953) was the first worker to draw attention to the complexity of the vegetation in the Eastern Cape when he produced "Veld Types of South Africa" which has since become a standard guide for vegetation study in South Africa. His vegetation map based on a very thorough knowledge of the distribution and abundance of species has brought clarity to the classification of South African vegetation, though a number of authors, notably those working in the Eastern Cape, have criticized aspects of his work. Acocks's concept of veld type, which is an agro-ecological unit of vegetation with a vague definition based on untestable statements on history, past utilization and dynamics of the vegetation, was criticized by Martin and Noel (1960). Martin and Noel (1960) and a number of other authors (Heydorn & Tinley, 1980; Cowling, 1982 and Lubke *et al.*, 1986) also criticize Acocks for the way he grouped unrelated types into a single veld type and for his classification above the level of veld types.

Since Acocks (1953) clarified the vegetation types a number of surveys of aspects of Eastern Cape vegetation have been produced. Martin and Noel (1960) published the Flora of Albany and Bathurst which is the only comprehensive list of the area produced to date. This list revealed the diversity of species occurring in the Eastern Cape and Gibbs Russell and Robinson (1981) have combined this with extrapolations from a preliminary list (in preparation) to come up with a figure of 3600 to 4000 vascular plant species occurring in the Eastern Cape. Comins (1962) produced a survey of the East London and King Williams Town districts but owing to the extent of the area covered the survey was confined to a broad rather than an intensive study of the vegetation. Van der Walt (1968) conducted a plant ecological survey of the Noorsveld which was the first study in this region to consider a "veld type" recognised by Acocks (1953) rather than to study the vegetation of a district or division. Palmer (1981) applied phytosociological techniques to a study conducted in the Andries Vosloo Kudu Reserve in the Great Fish River Valley and has identified and classified communities in the valley bushveld in great detail. Gibbs Russell and Robinson (1981) discussed the vegetation in a broader biogeographical context. They point out that although there is great diversity in the Eastern Cape, (21 or 30% of the 70 veld types recognised by Acocks (1975) occurring in the Eastern Cape which is more than in any other comparable region in Southern Africa), there are relatively few endemics. They suggest two possible reasons for this. Firstly selection pressures, particularly climatic instability, have acted to produce a flora in which "generalist" genotypes predominate; and secondly, that the close proximity of phytochoria of different evolutionary histories ensures that somewhere there is a species already present that can fill, by migration, any new niche which may result from environmental change. Cowling (1982a, 1982b, 1983a&b, 1984) studied various aspects of the vegetation in the Humansdorp region and described the Eastern Cape as a huge tension zone where four major phytochoria converge and showed the vegetation to be transitional between a typical Cape flora and a subtropical flora. The result of this chorological complexity is a mosaic of communities each with a different chorological affinity or communities with a chorologically mixed flora. Lubke *et al.*, (1986) recognised the need for a new vegetation classification which fitted an "international" framework (Martin and Noel, 1960), related to the biome concept (Heydorn & Tinley, 1980). A syntaxonomic hierarchy of vegetation units (Cowling, 1984) was used in producing the new vegetation map. It is these units and this classification of the vegetation, described fully below, that are used in this study.

(ii) Phytochorological Regions

The relationship between the four phytochorological regions and the physiographical nature of the Eastern Cape is shown in Figure 9. Dwarf forest or thicket, described as being of Tongaland-Pondoland affinity (Moll & White, 1978) enters the region along the east coast and penetrates up the river valleys. Succulent and dwarf shrublands of the Karoo-Namib region (Werger, 1978a) extend down the dry river valleys from the arid interior. Afromontane elements (White, 1978) extend down the mountains to

FIGURE 9 Distribution of the phytochorological regions within the Eastern Cape (after Lubke *et al.*, 1986).


KEY
Afromontane
Cape
Tongoland-Pondoland
Karoo-Namib
INDIAN OCEAN
EAST LONDON
Port Alfred
Grahamstown
ALGOA BAY
PORT ELIZABETH
Uitenhage
ST FRANCIS BAY
Humansdorp
GROOT WINTERHOEK
Great Fish R
Queenstown
Butterworth
Steytlerville
Aberdeen
Graaff-Reinet

reach sea level in the south-western region of the Eastern Cape. Fynbos taxa of the Cape region (Taylor, 1978) which enter from the west are strongly associated with infertile sandy soils derived from Cape Super Group rocks (Lubke *et al.*, 1986).

(iii) Vegetation

The new vegetation map produced by Lubke *et al.*, (1986) is shown in figure 10. The recognition of major classes and orders of vegetation categories is based on the concepts of Cowling (1984) and the veld types of Acocks (1975), in order to clarify the classification of the vegetation and yet maintain many of the recognised and accepted veld types or vegetation categories. The most notable features of the map are:

1) the majority of the biomes of Southern Africa extend into the Eastern Cape yet none are confined to the area.
2) The prominent biomes are: a) the karroid subdesert which extends from the north west, where it predominates, into the centre and south-eastwards almost to Grahamstown; b) the Subtropical Thicket which extends down the coast from the east, up the river valleys and into the dry mountainous areas of the south west; c) the Sourgrassveld which extends down the eastern side from the higher altitudes and is interdispersed with; d) Temperate Forest which extends into the coastal forest in the south-west; e) the Fynbos of the Cape region which has its eastern most limit just past Grahamstown and; f) the Acacia savanna which extends down the coast and replaces grasslands in the interior of the Eastern Cape.

The vegetation classes and orders are described in general terms by Lubke *et al.*, (1986) and are only listed here. The numbers after each category refer to Acocks' (1975) veld type numbers. The classes and orders of vegetation in the Eastern Cape are:

1) Cape Fynbos Shrublands which includes, a) Mountain Fynbos (A70), b) Grassy Fynbos (A70) and c) Dune Fynbos (A47);
2) Cape Transitional Shrublands consisting of the Renosterveld (A46);
3) Subtropical Thicket which includes a) Dune Thicket (A1(d)), b) Valley Bushveld or Succulent Thicket (A23), c) Noorsveld (A24), and d) Spekboomveld or Succulent Mountain Thicket (A25);
4) Karroid Subdesert (A26-31 & A42). This class has not been divided into orders or veldtypes;
5) Acacia Savanna which includes a) Coastal Acacia Savanna (A7) and b) Upland Acacia Savanna (A21, A22, A68);
6) Afromontane Forest which is made up of a) Montane Forests (A44 in part), b) Alexandria Forest (A2) and c) Knysna Forest (A4);
7) Grasslands which consist of a) Sour Grassveld including i) Dohne Sourveld or Moist Montane Grassland (A44) and ii) Coastal Sour Grassveld (A1 in part), b) Sweet Grassveld (A48 & A50) which includes i) Highland Sweet Grassveld and ii) False Thornveld Grasslands (A21, A22 & A68) and c) Mixed Grassveld including i) Coastal Mixed Grassveld (A1), ii) Mountain Mixed Grassveld (A58 & A59); and
8) Littoral Strand Vegetation:

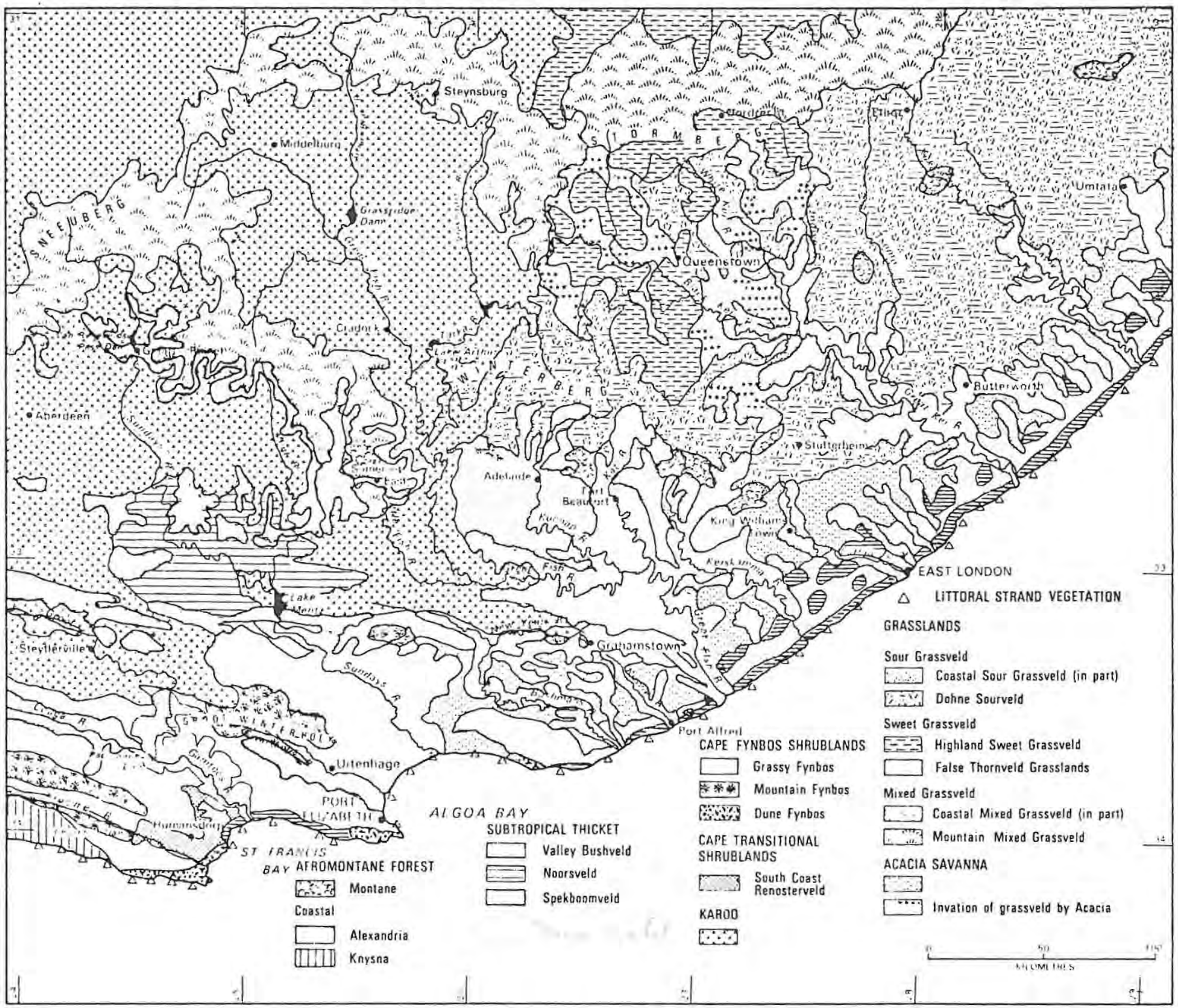
The following reasons have been proposed to explain this great diversity of vegetation types in the Eastern Cape (Lubke *et al.*, 1986):

a) earth history or changes in paleoclimate and paleoecology resulting in mixing, extinction and speciation and so changes in flora;

b) the close or tight juxtaposition of contrasting modern landforms which provide a multiplicity of aspect and substrate differences under extreme contrasts of rainfall or moisture conditions.

The result is a plethora of ecotonal combinations (Heydorn and Tinley, 1980). This is evident when comparing rainfall patterns (Figs 6&7) the geomorphology (Fig 3), geology (Fig 2) and the soils (Fig 5) with the vegetation patterns (Fig 10). It is this great diversity in vegetation types that makes Eastern Cape vegetation important when considering conservation.

FIGURE 10 Vegetation map of the Eastern Cape (after Lubke *et al.*, 1986).


Steynsburg
Middelburg
STORMBERG
Elliot
Umtata
SNEEUBERG
Queenstown
Cradock
WINTERBERG
Aberdeen
Butterworth
Stutterheim
Adelaide
Fort Beaufort
King William's Town
EAST LONDON
Lake Mentz
Steytlerville
Grahamstown
Sundays R.
Port Alfred
Uitenhage
PORT ELIZABETH
ALGOA BAY
ST FRANCIS BAY
LITTORAL STRAND VEGETATION
GRASSLANDS
Sour Grassveld
Coastal Sour Grassveld (in part)
Dohne Sourveld
Sweet Grassveld
Highland Sweet Grassveld
False Thornveld Grasslands
Mixed Grassveld
Coastal Mixed Grassveld (in part)
Mountain Mixed Grassveld
ACACIA SAVANNA
Invation of grassveld by Acacia
CAPE FYNBOS SHRUBLANDS
Grassy Fynbos
Mountain Fynbos
Dune Fynbos
CAPE TRANSITIONAL SHRUBLANDS
South Coast Renosterveld
KAROO
SUBTROPICAL THICKET
Valley Bushveld
Noorsveld
Spekboomveld
AFROMONTANE FOREST
Montane
Coastal
Alexandria
Knysna

CHAPTER 2

THREATENED PLANTS OF THE EASTERN CAPE: A SYNTHESIS OF DISTRIBUTION RECORDS

2.1 INTRODUCTION

The first survey of Southern Africa's rare and endangered species was set in motion in February 1974, when Dr. Melville and his co-workers of the Threatened Plants Committee of the International Union for Conservation of Nature and Natural Resources (IUCN) realised that numbers of endangered species would be found in South Africa, especially in the south-western Cape Province (Hall, 1981). Through the National Programme for Environmental Sciences, Cape botanists were asked what species might be threatened or endangered in their area. The task proved larger than expected, so proposals were made to the National Programme for Environmental Sciences for funds, guidance and assistance to set up a survey in the south-western Cape. This survey was extended to other parts of the country and in 1980 Hall *et al.*, published a preliminary list of threatened plant species in South Africa and neighbouring territories. It lists 1 915 vascular plant taxa, however a large number of these taxa fall into the "Indeterminate" (I) and "Uncertain whether safe or not" (U) categories. Reasons given for this are, 1) the lack of recent herbarium collecting, resulting in an out-of-date image of the present state of rare plants and, 2) the immature state of the taxonomy. Most of the records in the extinct (X), endangered (E), vulnerable (V) and rare (R) categories were backed by recent field knowledge, especially in the south-western Cape. Intensive studies of threatened plants (Mc Coy, 1981 and Day, 1983) and their habitats (Cholewa & Henderson, 1984; Foxx & Tierney, 1980; Milewski, 1977; 1978 a&b and Wright, 1983) are helping to give an understanding of the strategies needed for their conservation, but in Southern Africa many of these studies have been concentrated in specific regions and it was felt that this work needed to be started on a wide scale in all regions (Hall *et al.*, 1980). This section is therefore an analysis, update and extention of the work carried out by Hall *et al.*,(1980) with the aim of gaining a clearer picture of the conservation status of the vegetation in the Eastern Cape and the threat to and pressures on rare species.

2.2 METHODS

The preliminary list of rare, endangered and endemic plant taxa in the Eastern Cape, was established using: literature sources, including Weimark (1941), Hall *et al.*, (1980), Court (1981), Palmer (1981), von Breitenbach (1982) and Cowling (1982a); lists and records from both the National Herbarium (PRE) and the Albany Herbarium (GRA); and field records from Lubke (pers. comm.), Tinley (pers. comm.), Jacot Guillarmod (pers. comm.) and the Fynbos Working Group (Cowling pers. comm.). Information on these species was then obtained by checking them with herbarium records in the Albany and Rhodes University (RUH) herbaria. Additional information was also obtained from various checklists (Jessop & Jacot Guillarmod, 1969; Penzhorn & Olivier, 1974; Pennefather & Parsons, 1976; Olivier, 1977; Palmer, 1981; Olivier, 1981 and 1983) This information was filled onto index cards (Fig 11) based on forms which were developed by the Botanical Research Institute for plant collecting (Magill *et al.*, 1983). This paper-based data bank proved to be too large and cumbersome for the effective extraction of information and as Crovello (1976) points out, one of the important problems facing government and other decision makers is access to the vast amounts of information acquired about threatened species. Thus a more efficient system of record data storage was required. A number of authors (Hall, 1972a, b & 1974; Crovello, 1976; Morris & Glen, 1978 and Magill *et al.*, 1983) suggested computer based data banking systems were the most effective. No readily available and adaptable programme was found, primarily because different computers have different

FIGURE 11 Index card developed by the BRI for plant collecting (Magill *et. al.*, 1983). Herbarium records of threatened species were checked and all available information was filled onto these cards, the cards were then filed to form the paper based data bank.

BOTANICAL RESEARCH INSTITUTE, PRETORIA 'PRECIS', DAT 3-1 Specimen form [ ] Locality form [ ] Update form [ ]

A. Name of collector .... Name of plant ....

Registered No. of collector | Locality No. | Specimen No. | y y y y m m d d | Grid ref. | Region

4 6 8 1 0 [ ]* [ ]* [ ]* Date *[ ] *[ ] [ ]

Major location *[ ]

Minor location *[ ]

1 Botswana 2 Cape Prov 3 Lesotho 4 Natal 5 O.F.S. 6 S.W.A. 7 Swaziland 8 Transvaal 9 Other

Precise location

4 6 8 1 1 [ ]

4 6 8 1 2 [ ]

B. Notes

4 6 8 1 3 [ ]

4 6 8 1 4 [ ]

4 6 8 1 5 [ ]

4 6 8 1 6 [ ]

4 6 8 1 7 [ ]

4 6 8 1 8 [ ]

C. 4 6 8 1 9

Height [ ] m

Alt. [ ] m

Aspect [ ]*

N S E W
NE SW SE NW

Biotic Effects [ ]
- 01 Abandoned land
- 02 Cultivated land
- 03 Planted pasture
- 04 Plantation
- 05 Garden
- 06 Road/railwayside
- 07 Grazed heavily
- 08 Burned recently
- 09 Disturbed—other
- 10 No effect seen

Vegetation Type [ ]
- 01 Desert
- 02 Karoo
- 03 Grassland
- 04 Open shrubland
- 05 Closed shrubland
- 06 Open woodland
- 07 Closed woodland
- 08 Forest
- 09 Fynbos
- 10 Afroalpine

Substrate [ ]
- 01 Soil
- 02 Stony soil/rocky
- 03 Bare rock
- 04 Talus
- 05 Cliff face
- 06 Termite mound
- 07 Dune-beach
- 08 Dune-desert
- 09 In water
- 10 Trunk
- 11 Branch
- 12 Leaf
- 13 Other

Moisture Regime [ ]
- 01 Poorly-drained
- 02 Well-drained
- 03 Pan/depression
- 04 Seepage area
- 05 Marsh/swamp
- 06 Floodplain
- 07 Bank river/stream
- 08 River/stream
- 09 Dry river/stream bed
- 10 Ditch/donga
- 11 Lake/dam
- 12 Sea/estuary/lagoon

Soil Type [ ]
- 01 Gravel
- 02 Sand
- 03 Loam
- 04 Clay
- 05 Black turf
- 06 Humus rich
- 07 Salt/brack
- 08 Calcrete
- 09 Laterite
- 10 Disturbed
- 11 Grey mottles
- 12 Other

Life form [ ]
- 01 Tree
- 02 Shrub
- 03 Dwarf shrub
- 04 Herb
- 05 Graminoid
- 06 Geophyte
- 07 Epiphyte
- 08 Climber
- 09 Parasite
- 10 Succulent
- 11 Hydrophyte
- 12 Bryophyte
- 13 Lichen

D. HERBARIUM USE ONLY

Name of plant ....

Genspec [ ] — [ ] Det. by *[ ] Date *[ ]

Herbarium Code [ ] Type [ ] Flower [ ] Fruit [ ] Labels needed [ ]* storage and memory capacities. Hall (1981) points out that although tempting, it is unnecessary to load data banks with all available information as they become too vast for efficient maintainence and updating. Computer-based data banks are most effective when functioning as a cross-indexing system with only essential information backing up a larger paper-based data bank. Considering this, it was decided to adapt a filing programme for use on a microcomputer. PFS (Personal Filing System), a programme for use on an Apple II or equivalent microcomputer proved to be ideal. Information was stored on a "form" designed on the screen especially for the particular requirements of the project (Figs 12 & 13). This information can be quickly retrieved by searching on any of the stored information and printed out or displayed on the screen. By using PFS Report, an associated programme, information can be summarised into table form, only the information required being printed out as a report (Fig 14). Data are stored on diskettes, each diskette storing approximately 1000 forms. The chief limitation of the system is that one is restricted to only 40 columns per line, and printed reports are restricted to 80 columns per line which restricts the number of headings per report. The advantages of the system are 1) its simplicity of use, 2) its adaptiveness to particular requirements, and 3) its rapid search and retrieval of required information.

Information was thus entered into the data bank which now contains in the region of 2000 records, with a total of 774 taxa listed. This information must be regarded as preliminary and

```
NO:
SPECIES:

FAMILY:
STATUS:                  SOURCE:
LOCALITY:


GRID REFERENCE:
DATE:                    HERBARIUM:
VEG TYPE:

LIFE FORM:
CONSERVED:

NOTES:
```

FIGURE 12: A blank form designed on the computer screen onto which information is entered for storage.

```
NO: 4498
SPECIES: EUPHORBIA OBESA HOOK.F.

FAMILY: EUPHORBIACEAE
STATUS: E-ENDEMIC     SOURCE: COURT
LOCALITY: ON SMALL KOPJE  AMONGST SAND-
STONE BOULDERS AND ON LEDGES. KENDREW,
RAAFF-REINET.
GRID REFERENCE: 3224DA
DATE: 031929          HERBARIUM: GRA
VEG TYPE: KARROID

LIFE FORM: DW.SUCCULENT
CONSERVED: NIL

NOTES:
```

FIGURE 13: A completed form showing stored information.

FIGURE 14: A report generated by P.F.S. Report. All the threatened plant records from grid reference 3426 BC are shown together with their status and the vegetation type in which they were collected.

3426 BC

SPECIES	STATUS	VEG TYPE
EUPHORBIA MICRACANTHA AIT.	U-ENDEMIC	V.BUSHVELD
EUPHORBIA ORNITHAPUS JACQ.	U-ENDEMIC	V.BUSHVELD
EUPHORBIA PENTAGONA HAW.	ENCEMIC	V.BUSHVELD
	ENDEMIC	V.BUSHVELD
		V.BUSHVELD
EUPHORBIA POLYGONA HAW.	ENDEMIC	V.BUSHVELD
		V.BUSHVELD
EUPHORBIA SQUARROSA HAW.	ENDEMIC	V.BUSHVELD
		V.BUSHVELD
		V.BUSHVELD
EUPHORBIA STELLATA WILLD.	U-ENDEMIC	V.BUSHVELD
EUPHORBIA STRIATA THUNB. VAR. CUSPIDATA (BOISS.)N.E.BR.	U	V.BUSHVELD
EUPHORBIA STRIATA THUNB. VAR. CUSPIDATA (BOISS.)N.E.BR.	U	V.BUSHVELD
EUPHORBIA VALIDA N.E.BR.	I-ENDEMIC	VAL.BUSHVELD
		VALLEY BUSHVELD
GREYIA FLANAGANII H.BOL.	R	GRASSVELD
		GRASSVELD
		GRASSVELD
		GRASSVELD
HERMANNIA SACCIFERA (TURCZ.) K. SHUM.	U	DRY GRASSVELD
POLYGALA BOWKERAE HARV.	I	GRASSVELD
POLYGALA ERICAEFOLIA D.C.	ENDEMIC	DRY GRASSVELD
		DRY GRASSVELD
RHUS FRASERI SCHONL.	U	GRASSVELD
		GRASSVELD

requires re-evaluation and continual updating as field surveys investigating these species are undertaken.

2.3 RESULTS

2.3.1 List of Threatened taxa

A list of endemic, threatened and rare plants occurring in the Eastern Cape was prepared using the computer data bank described above and is presented in appendix 1. Only the conservation status category of each plant species is presented although other information including locality, grid reference, date of collection, vegetation type and life form of the plant and nature reserves in which it has been recorded is stored in the data bank and is readily available.

Definitions of Conservation Status Categories and other terms used

The various states of threat and rarity used in this study are the same as those used by Hall *et al.*, (1980) which follow the standards of the IUCN. Hall *et al.*, (1980) changed two of the code letters for easier use (X=Ex; U=K), these changes are also used in this study. The term threatened is used in a general way to include all of the categories, Extinct, Endangered, Vulnerable and Rare. The definitions of the conservation status categories are as follows:-

X: EXTINCT No longer known to exist in the wild, after repeated searches of all former and other possible localities. This category is also used for species that have vanished in the wild but survive in at least some form in cultivation.

E: ENDANGERED In immediate danger of extinction if the causal factors continue operating. Included are taxa whose populations are so critically reduced, that a breeding collapse due to a lack of genetic diversity becomespossible, whether or not they are threatened by human activity.

V: VULNERABLE AND DECLINING Used for a plant that was recently more widespread, but is on the decline, and is likely to become endangered if the causal factors for its decline continue operating.

R: RARE Used for a plant with a relatively small world population that is not declining and is under no known immediate threat. Because of its rarity, the plant should be checked regulary for a decline due to some unexpected pressure.

I: INDETERMINATE A temporary category for plants that are known to be either endangered, vulnerable or rare, but due to lack of study, cannot yet be placed convincingly in one category in preference to another.

U: UNCERTAIN WHETHER SAFE OR NOT A temporary category for plants that are so little known that there is an even chance that they could prove to be safe.

e: ENDEMIC Used to show whether a plant is confined to the area in question in that list. In this case endemism refers to the Eastern Cape.

Appendix 1 lists a total of 1 extinct taxon, 3 endangered taxa, 15 vulnerable taxa,14 rare taxa, 117 indeterminate taxa and 485 uncertain taxa. In addition, 112 endemics which do not appear to be in any sort of hazard are also listed making a total of 205 endemics for the Eastern Cape. Table 2 compares these findings with those of Hall *et al.*, (1980) who have a total of 147 threatened taxa listed as occurring in the Eastern Cape.

Table 2: Comparison of results with those of Hall *et al.*,1980

	X	E	V	R	I	U	TOTAL
This survey	1	3	15	41	117	485	662
E.C. (Hall *et al.*)	1	3	18	36	35	52	147
Cape (Hall *et al.*)	36	96	125	336	237	672	1502
S.A. (Hall *et al.*)	39	105	166	537	261	807	1915

The addition of 627 taxa in this list is a large increase, however most of these additional taxa are in the I and U categories. The Eastern Cape however compares favourably with the Cape as a whole, especially in the X, E, V and R categories.

2.3.2 Taxonomic analysis

A taxonomic analysis of the more threatened families (Table 3) shows predictably, that the larger families have the greatest number of threatened species. The most serious threat is to the Cycads (family Zamiaceae), where of the 12 species that occur in the Eastern Cape, 5 of which are endemic, all are threatened in some way (Table 3).

2.3.3 Distribution of threatened taxa per quarter degree square

Lists of the threatened taxa occurring in each quarter degree square of the Eastern Cape have not been produced as many of the herbarium records lacked this information and distributions of many of the taxa are not known making such lists incomplete and

TABLE 3. Taxonomic analysis of the more threatened families

FAMILY		X	E	V	R	I	U	TOT	e	GTOT
ASTERACEAE	Endemic						8	8	12	20
	Total			1	1	12	54	68		80
LILIACEAE	Endemic						13	13	11	24
	Total			2	1	15	42	60		71
FABACEAE	Endemic						8	8	6	14
	Total				1	11	41	53		59
ASCLEPIADACEAE	Endemic									
	Total				2	6	45	53		53
MESEMBRYANTHEMACEAE	Endemic						8	8	12	20
	Total					6	30	36		48
EUPHORBIACEAE	Endemic		1			1	6	8	12	20
	Total		1		2	5	16	24		36
ORCHIDACEAE	Endemic								2	2
	Total		1	1	3	14	13	32		34
IRIDACEAE	Endemic				1		2	3	7	10
	Total	1		1	4	7	12	25		32
CYPERACEAE	Endemic								1	
	Total			1		6	23	30		31
AMARYLLIDACEAE	Endemic						1	1	2	3
	Total			1	9	2	9	21		23
CRASSULACEAE	Endemic				1		10	11	3	14
	Total				2	1	17	20		23
PROTEACEAE	Endemic								6	6
	Total					2	7	9		15
ERICACEAE	Endemic					1	5	6	6	12
	Total					1	6	7		13

TABLE 3. cont.

FAMILY		X	E	V	R	I	U	TOT	e	GTOT
GERANIACEAE	Endemic						1	1	2	3
	Total					4	7	11		13
ZAMIACEAE	Endemic		1	3				4		4
	Total		1	7	4			12		12
APIACEAE	Endemic					1				1
	Total					2	9	11		11
SANTALACEAE	Endemic						1	1	3	3
	Total					1	6	8		11
RUTACEAE	Endemic						3	3	4	7
	Total				1	1	4	6		10
THYMELAEACEAE	Endemic						3	3	1	4
	Total					1	8	9		10

unreliable. The data bank does however contain all the available grid references of localities where collections were made. This information is easily retrievable. When more of the taxa have been investigated in the field such information will be more complete and useful.

2.3.4 Distribution of threatened taxa within vegetation types

A synthesis of the distribution of threatened taxa amongst the various vegetation types in the Eastern Cape (Table 4) reveals that the greatest number of taxa fall into the "others" vegetation category. Taxa were classified as "others" if they could not be satisfactorily placed in any of the main vegetation types. These taxa would include species that are widespread and occur in a number of vegetation types; species that occur in specific habitats such as ponds, streams, vleis, marshes, estuaries, salt marshes and strand areas; and species for which no information about favoured habitats or vegetation types, is available. Many of these specific habitats are small and isolated with very specific environmental parameters making them sensitive to pressures which in turn render plants vulnerable.

Excluding the "others" category, Subtropical Thicket has the greatest total number of threatened species (125). This either indicates that it is the most threatened vegetation type in the Eastern Cape or that it has been the most neglected from a collecting point of view. Grasslands and Savanna have 83 threatened taxa and appear to be the next most critical

TABLE 4. Distribution of threatened and endemic plant taxa amongst the various vegetation types of the Eastern Cape

		X	E	V	R	I	U	TOT	e	GTOT
THICKET	Endemic		1	4	2	1	21	31	30	61
	Total		1	5	12	14	93	125		155
FYNBOS	Endemic				1	1	20	22	37	59
	Total		1	1	1	8	58	69		106
FOREST	Endemic				1		2	3	4	7
	Total				5	5	30	40		44
GRASSLAND SAVANNA	Endemic						3	3	7	10
	Total			3	11	14	55	83		90
KAROO	Endemic		1				7	8	7	15
	Total		1	1	4	9	41	56		63
OTHERS*	Endemic	1				1	27	29	27	56
	Total	1		5	8	67	208	289		316
TOTALS	Endemic	1	2	4	4	3	80	93	112	205
	Total	1	3	15	41	117	485	662		774

* Others include wide spread species, and those which occur in specific habitats such as ponds, vleis and marches, strand areas, etc, as well as unclassified species.

vegetation type. However, Fynbos has many more endemics (90 as opposed to 10) and so it may be considered to be far more important from a conservation point of view. Forest is the least threatened with a total of 41 taxa in some sort of danger. The number of threatened taxa in the various vegetation types cannot be regarded as a direct indication of the severity of threat to these vegetation types as these results must be seen in the context of the phytochorological associations of the vegetation types. None of the 4 phytochoria which occur in the Eastern Cape (Fig 3) are confined to this region, many of the species having distributions which extend beyond the regional limits of the Eastern Cape, which is only on the edge of major distribution patterns (Gibbs Russell and Robinson, 1981). Plants may therefore be threatened in the Eastern Cape but safe in other areas and so were not recorded as threatened in this study. Vegetation types with high endemism levels record the most threatened species and it is for this reason that all known endemics have been included in the list (Appendix 1).

Traditionally the Eastern Cape has been considered to show low levels of endemism when compared with the richly endemic areas in Southern Africa such as the South Western Cape (Gibbs Russell and Robinson, 1981 and Cowling,1982b). However Cowling (1983b)has recognised two endem centres in the South East Cape with relatively high levels of endemics amongst some genera. The results of this study show that the highest levels of endemics occur in the Thicket (61) and Fynbos (59) vegetation types (Table 4), which substantiate the findings of Cowling (1983b). These two vegetation types are therefore regarded as having characteristics peculiar to the Eastern Cape and therefore are important from a conservation point of view.

3.2.5 Distribution of threatened taxa within nature reserves

An important criterion that should be considered when investigating threatened plants is whether they occur within any conservation area or not. There are 90 conservation areas in the Eastern Cape (Fig 15) which cover a total area of 471 940ha or 3,04% of the Eastern Cape (Grahamstown Centre, in press). The total area covered by each vegetation type was obtained from the revised vegetation map (Figure 10) and using the areas of each vegetation type in the conserved regions (Anon, 1981), the percentage of each vegetation type conserved, was calculated (Table 5). All the vegetation types except for forests appear to be rather poorly conserved. Two of the vegetation types (Noorsveld and Coastal Mixed and Sour Grassveld) are not included in any conservation areas at all and 11 of the 18 have less than 1% under conservation. This indicates that although 90 conservation areas appears to be a lot for the Eastern Cape, most of them are very small and most of the vegetation types are inadequately conserved.

Checklists of the Flora of conservation areas prove invaluable when investigating distributions, and conservation status of taxa. Checklists were only available for 10 of the 90 reserves, Table 6 showing the number of threatened species occurring in these

FIGURE 15. Conservation areas of the Eastern Cape (after Grahamstown Centre, Wildlife Society, in press).

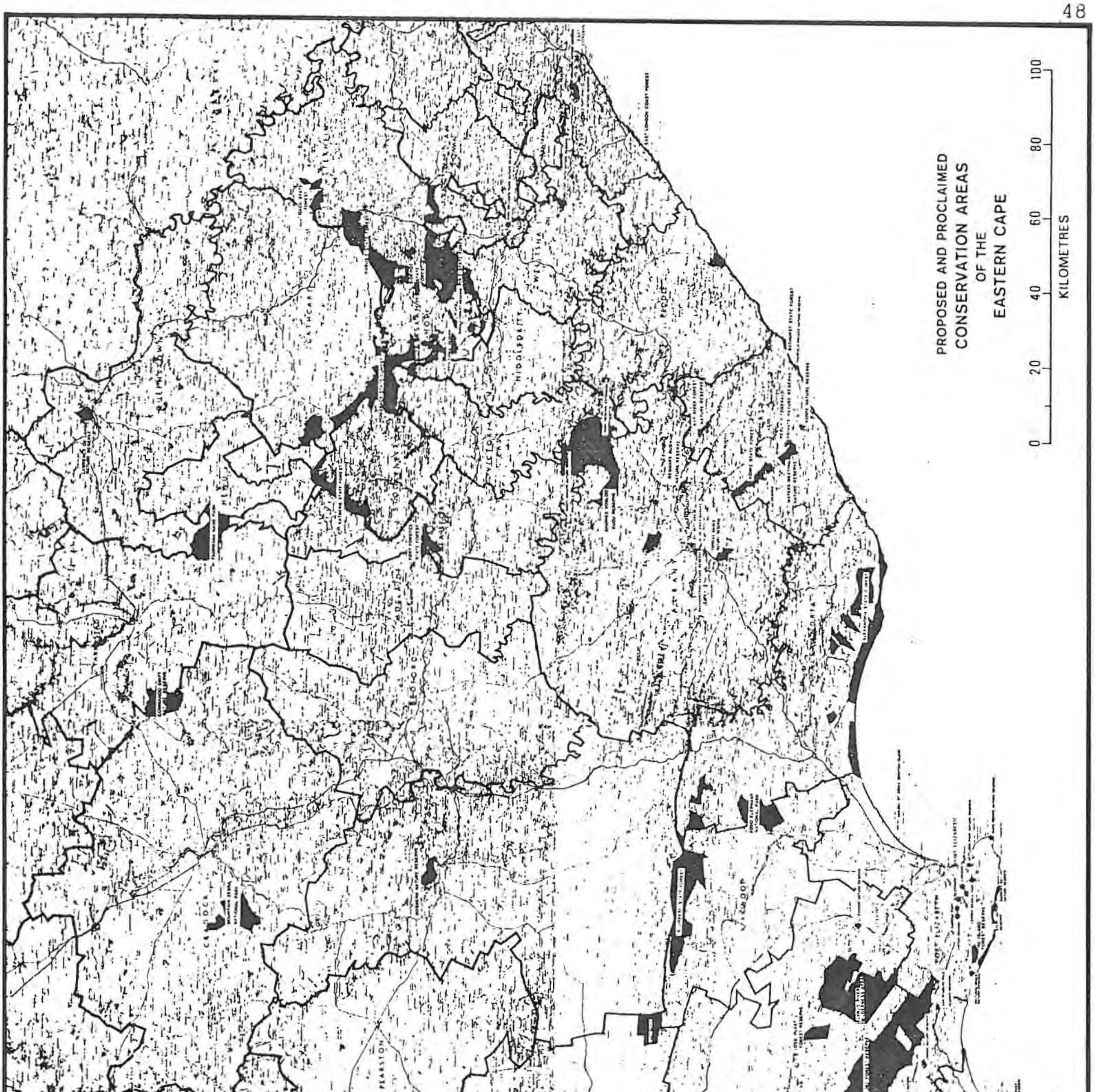

PROPOSED AND PROCLAIMED
CONSERVATION AREAS
OF THE
EASTERN CAPE
0 20 40 60 80 100
KILOMETRES

TABLE 5: Vegetation types of the Eastern Cape and the percentage of each conserved.

VEGETATION TYPE	Total Area in E.C.	Area Conserved	% Conserved
Afromontane Forest	135 606 ha	27 123 ha	+ 50%
Valley Bushveld	1991 730 ha	24 146 ha	1,21%
Noorsveld	414 779 ha	0	0
Spekboomveld	573 593 ha	10 370 ha	1,81%
Dune Thicket	200 963 ha	2 800 ha	1,39%
Grassy Fynbos	658 672 ha	12 530 ha	1,90%
Mountain Fynbos	213 920 ha	9 250 ha	4,32%
Dune Fynbos	54,013 ha	611 ha	1,13%
Renosterveld	66 684 ha	411 ha	0,62%
Karoo	4370 426 ha	15 921 ha	0,36%
Coastal Sour & Mixed Grassveld	199 298 ha	0	0
Dohne Sourveld	1054 301 ha	1 503 ha	0,14%
Highland Sweet Grassveld	736 153 ha	800 ha	0,11%
False Thornveld Grassveld	526 812 ha	35 ha	0,01%
Mountain Mixed Grassveld	1459 100 ha	1 249 ha	0,09%
Acacia Savanna	1073 919 ha	3 200 ha	0,30%

TABLE 6. Numbers of variously threatened taxa occurring in the 10 nature reserves in the Eastern Cape for which check lists of the flora is available.

	E	V	R	I	U	e	TOT
Addo Elephant National Park (A.E.N.P.)*					4	9	13
Barkens River Valley Port Elizabeth (B.R.V.P.E.)	1		2	1	4	19	27
Cape Recief Nature Reserve (C.R.N.R.)					5	16	22
Springs Reserve Uitenhage (S.R.U.)			1		3	17	21
Thomas Baines Nature Reserve (T.B.N.R.)			2		4	7	13
Mountain Zebra National Park (M.Z.N.P.)		1	2		13	1	17
Karroo Nature Reserve (K.N.R.)					2	2	4
Seekooi Rivier Nature Reserve (S.R.N.R.)		1	1		1	4	7
Commando Drift Nature Reserve (C.D.N.R)					1		1
Andries Vosloo Kudu Reserve (A.V.K.R.)		1	2		8	12	23

* Abbreviations as they appear in the data bank.

reserves. This low number of checklists is indicative of the lack of knowledge on the Eastern Cape Flora. The Directorate of Forestry control a large proportion of the area under conservation in the Eastern Cape yet they do not have checklists of species for any of the areas under their control. Controlling bodies should encourage people to sample their areas and compile checklists. Such surveys would also make useful projects for students.

2.4 DISCUSSION

2.4.1 Collecting intensity

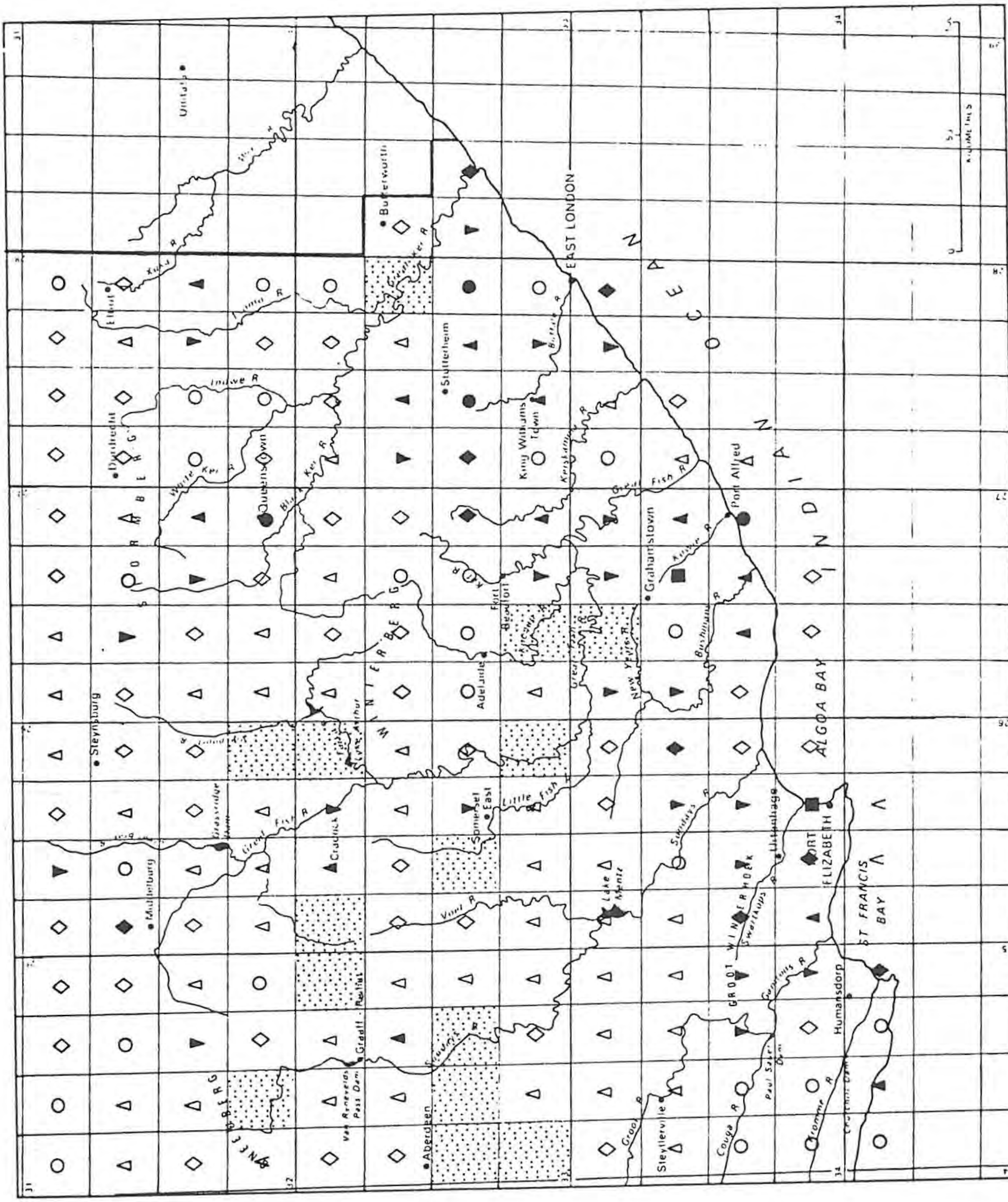
The list of threatened taxa (Appendix 1) should be regarded as a preliminary list of all the species that are possibly threatened in the Eastern Cape. The large number of Uncertain (U) and Indeterminate (I) cases reflects a number of short-comings in the available information of the Eastern Cape Flora. Even though collecting intensities appear to be relatively high in the Eastern Cape (Gibbs Russell *et al.*, 1984a), with few of the quarter degree squares (14) having no collection records (Fig 16), the chief contributor to the high number of I and U cases is an out-of-date image caused by a lack of recent herbarium collecting. Other contributing factors are the immature state of the taxonomy and the lack of field survey records and checklists from localities in the Eastern Cape. Most of these I and U cases therefore need to be investigated in the field and a number of taxonomic problems need to be resolved.

A possible remedy for this lack of recent collections could be to involve students in an investigation of these taxa, this forming part of the formal collections they are required to make for the second year plant science course. A list of the I and U taxa could be provided and students could be required to locate populations of some of these selected taxa, and make one collection of the threatened species. Detailed information such as size of population, localities of population and other

FIGURE 16 Collecting intensity for the Flora of the Eastern Cape, based on the number of specimens perquarter degree square, as reported by PRECIS (from Gibbs Russell *et al.*, 1984a).

KEY

		0	
1	-	10	△
11	-	50	◇
51	-	100	○
101	-	200	▼
201	-	500	▲
501	-	1000	◆
1001	-	2000	●
2001	-	16000	■


EAST LONDON
Butterworth
Stutterheim
King Williams Town
Queenstown
Dordrecht
Elliot
Grahamstown
Port Alfred
Fort Beaufort
Adelaide
Somerset East
Cradock
Middelburg
Steynsburg
Aberdeen
Steytlerville
Humansdorp
PORT ELIZABETH
ALGOA BAY
ST FRANCIS BAY
INDIAN OCEAN
WINTERBERG
GROOT WINTERHOEK
Great Fish R
Kei R
Little Fish R
Sundays R
Gamtoos R
Kouga R

valuable information could be gathered. Similarly the third year course requires collections to be made from a particular genus and possibly genera containing a number of species in the I and U categories could be considered. In this way records of the Uncertain and Indeterminate cases could be built up and this could be used to place taxa in the correct conservation status categories. Effective conservation legislation and the optimum siting of future reserves depends upon adequate up-to-date information on threatened species, especially as pressures on the vegetation increase. A long term method of monitoring these species must thus be formulated.

2.4.2 Monitoring Programmes

As stated earlier it is not necessary to include all information onto the computer-based data bank, as this should only function as a cross-indexing system backing up a larger paper based data bank. For the long term monitoring of threatened species a file should be made for each rare, vulnerable and endangered species based on the system as described by Hall *et al.*, (1980). The file should hold notes, maps and an A4 sized data card that can be taken into the field in a transparent folder. The card should carry an illustration of the plant, a description, notes for distinguishing similar species and statements on ecology, localities and dates of former collections. Field surveys of threatened plants would be aided by this data card and should follow a standard checklist of items to be examined. Taylor and Edwards (1972) point out that if we are to succeed in conserving these species, standardized data will have to be sent to a central coordinating authority who will compile and distribute the information. Henifin *et al.*, (1981) developed a detailed checklist from which Hall *et al.*, (1980) adapted one for use in the Western Cape survey. This standard checklist is shown in Table 7 and should be used to standardize information obtained in field surveys in the Eastern Cape.

Rates of extinction must also be monitored, but at present we are aware of only one case, that of *Gladiolus alatus* L. var. *algoensis* Herb., which was last recorded over a hundred years ago. Hall *et al.*, (1980) show that extinction rates have increased during the past twenty years although this finding has been strongly affected by varying collecting intensities over the years.

2.4.3 Conservation

The knowledge of whether the species is adequately conserved in a conservation area will alter the number of threatened species and this information would add value and importance to these areas as nature reserves. The International Convention on International Trade in Endangered Species of Wild Animals and Plants which is administered by the IUCN states that "wild fauna and flora, in their many beautiful and varied forms, are an irreplaceable part of the natural systems of the earth which must be protected for this and the generations to come," (Anon, 1973). Lucas (1976) points out that the evergrowing value of wild fauna and flora

TABLE 7: Standard checklist of items investigated for each report on a threatened or rare plant species, (after Henifin *et al.*, (1981).

SCIENTIFIC NAME, STATUS, ACTION PRIORITY

NOMENCLATURE

Family: scientific name, synonyms, common names

Species: scientific name, synonyms, common names

LEGAL STATUS FOR PROTECTION

National

Provincial

Other

DESCRIPTION

Field characters

Brief diagnostic description

Look-alikes, if any, with distinctive features

TAXONOMIC PROBLEMS, IF ANY

GEOGRAPHICAL DISTRIBUTION

Historical

Present known distribution

Other possible natural sites

HABITAT DESCRIPTION

Community structure

List of associated plants

Altitude ranges

Exposure, slope and aspect ranges

Edaphic factors including soil moisture

Habitat dynamics

Other habitat features of special interest

POPULATION BIOLOGY

Number of known populations

Numbers of individuals in each population

Types of reproduction

Age-class structure

Flowering and fruiting periods

Dispersal mechanisms

Pollinators

Other biological factors

Vigour,trendsand statusof known populations

RECOMMENDED ESSENTIAL HABITATS

Geographical boundaries essential to the survival of the taxon, including buffer zones and areas for required associates (such as pollinators and dispersers of seed) and areas through which associated animals migrate

THREATS TO SURVIVAL

Existing threats, with an indication of the destructive strength of each

Potential threats that may develop in the future

LAND OWNERSHIP AND STATUS

Owners and lessees of land bearing essential habitats

Legal status of this land

MANAGEMENT TO PROMOTE SURVIVAL OF THE TAXON

Action already taken

Suggestions for optimal action

Suggestions for alternative actions

CULTIVATION, SEED-STORAGE

Likelihood of present or potential maintenance of the taxon in cultivation

Locations, sizes, conditions and purposes of populations at present in cultivation

Arrangements, if any, made for seed storage and known or potential conservation value

SIGNIFICANCE OF TAXON

Evolutionary and ecological significance

Aesthetic, horticultural, agricultural, sylvicultural, medicinal, economic, recreational and scientific significance

SPECIALISTS

Names and addresses of those knowledgeable about the taxon

REFERENCES

List of published and unpublished references

APPENDICES

Copies of distribution maps, illustrations, original descriptions, floristic or monographic distributions, and if possible, popular literature

List of herbarium specimens giving label data and herbarium location

Map showing known distribution of populations and the boundaries of essential habitats and recommended buffer zones

AUTHOR OF REPORT AND DATE

Name and address of author, and date

OTHER SOURCES USED

Sources of information if other than any individual or reference cited above

ACTION REQUIRED BY FUTURE SURVEY TEAMS

Suggested interval for successive visits

Persons being informed of the need for conservation action, as expressed in this report

Other action

RECOMMENDED STATUS

World status in terms of IUCN definitions

URGENCY FOR CONSERVATION

Statement of whether priority is maximum, high, medium or low, or whether monitoring alone is required from aesthetic, scientific, cultural, recreational and economic points of view is being noted by many countries. Hall *et al.*, (1980) present many convincing reasons for conserving rare species and hence maintaining natural diversity.

Conservation strategies are discussed in detail by Hall *et al.*, (1980). They note that re-establishing populations at new sites or protecting them in Botanical gardens should be last resort actions as plants are often put under many adverse pressures such as alien selective pressures and hybridization pressures in these situations. Seed banks for storing seeds are also a useful method of saving species from extinction, although many factors such as gene pool sizes need to be considered when establishing seed banks. The best insurance against extinction is the conservation of natural habitats (Raven, 1976; Hall *et al.*, 1980). With the present land use requirements many of these habitats will have to be conserved in the form of sanctuaries or conservation areas. This may not be ideal but appears to be the only remaining practical option for conserving many species.

When planning these sanctuaries many authors (MacArthur and Wilson, 1963; Diamond, 1975; Diamond & May, 1976; Game, 1980; Gilpin & Diamond, 1980 and Poynton & Roberts, 1985) advocate that island biogeographical theory should be incorporated into the geometric design. Despite the occasional dissenters (Simberloff and Abele, 1975) who feel that the application of the theory to conservate practice is premature, the overwhelming consensus is that the theory's tenets need to be considered in the context of reserve planning. It has generally been proposed that reserves should be large, clumped, roundish and connected by corridors. Such recommendations are usually based on the notion that any geometrical consideration that increases immigration rates and/or decreases extinction rates or minimises the perimeter to area ratio is useful.

2.4.4 Threat factors

No studies have been carried out to show which or even how many species are threatened by the various threat factors in the Eastern Cape. There are three major forms of threat on natural habitats in this region. They are direct human impacts, indirect human impacts and natural pressures.

a) Direct human impacts
Direct human impacts consist of two major land use practices: agriculture and development.

i) Agriculture
In the Eastern Cape agriculture appears to be affecting the flora most seriously. Bad grazing methods have been responsible for the reduction of cover in all the vegetation types and has reached alarming proportions in the more arid areas of the Eastern Cape. Many species have been eliminated , species compositions changed and loss of soil has occurred in large areas of the Eastern Cape owing to overgrazing (Plate 1a &b). Aucamp (pers. comm.) estimates that approximately 150 000ha of thicket

PLATE 1a. The result of overgrazing. A denuded hillside north of Waterford, Eastern Cape.

PLATE 1b. A fence-line illustrating the effect of overgrazing on the vegetation cover. Rossouw's Port, north of Waterford.

in the Uitenhage district is so badly overgrazed that it will never recover. Overgrazing is possibly the major threat to Eastern Cape Flora.

Bushclearing for ploughing and crop cultivation has also been responsible for major reductions in certain species, especially in the higher rainfall areas of the Eastern Cape (Plate 2a & b). The department of Agriculture (Aucamp pers. comm.) has found that illplanned bushclearing can cause upto 34,8 tons of soil to be lost per ha per year. The natural rate of soil regeneration is only approximately 1 ton/ha $yr.^{-1}$

Although burning is a useful tool in veld management (Trollope, 1973 & 1974), the frequency of fires is critical. Excessive and uncontrolled burning especially in the Fynbos and the Grassland veld types can lead to undesirable changes in species composition.

ii) Development

Development of urban areas for industry and residential purposes is also responsible for increased pressure on plant communities. Some important and species-rich communities notably in the East London(Potters Pass) and Port Elizabeth areas (Swartkops region) are being directly threatened. Road building, mining and quarrying are minor threats to vegetation in the Eastern Cape, however care should be taken to minimise their impact on the surrounding vegetation. Exploitation such as flower picking,

PLATE 2a. Bushclearing for the establishment of pastures for grazing, Addo Heights, Eastern Cape.

PLATE 2b. Removal of Thicket for the establishment of wheatlands in the Alexandria district, Eastern Cape.

wood collecting and plant collecting (for growing purposes) is having devastating effects on certain species. Cycads (*Encephalartos* spp.) are indiscriminately collected by many people in spite of restrictions, and in certain areas (e.g. the national road through the the Fish River valley) are sold to passing motorists (Plate 3a & b). Other species that are threatened by collectors include many of the Family Liliaceae , Orchidaceae and succulents such as some Euphorbia species and Mesembryanthemaceae species.

b) Indirect human impacts

Indirect human impacts include pressures from alien plant invasion, erosion and possibly pollution.

i) Alien plant invasion

The exotic plant species which menace natural vegetation in the Eastern Cape include four Australian acacias: *Acacia cyclops* A.Cunn. ex G.Don, (Plate 4a),*A.longifolia* (Andr.)Wild., *A.mearnsii* De.Wild. and *A.saligna* (Labill.)Wendl. (Stirton, 1978); the pine tree - *Pinus pinaster* Ait. (Jacot Guillarmod, 1980); *Hakea sericea* Schrad. (Jacot Guillarmod, 1984); three species of cacti - *Opuntia aurantiaca* Lindl, *O. ficus-indica* (L.) Mill. (Plate 4b) and *O. imbricata* (Haw.) DC, (Schonland, 1924); nassella tussock - *Stipa trichotoma* Nees (Steinke, 1965); water hyacinth - *Eichhornisa crassipes* (Mort.) Solms. (Jacot Guillarmod, 1979); water fern - *Azolla filiculoides* Lam. (Jacot Guillarmod, 1984) and *Sesbania punicea* (Cav.) Benth. (Pienaar, 1977). There are several other exotic species present in the

PLATE 4a. A stand of *Acacia cyclops* on the dunes at the Sundays River Mouth.

PLATE 4b. An infestation of *Opuntia ficus-indica* in Succulent Thicket north of Uitenhage.

Eastern Cape that are not yet fully invasive but are dangerous. Among these are *Lantana camara* L, *Solanum mauritinum* Scop, *Salvinia molesta* Mitchell and possibly some *Eucalyptus* species. These weeds are generally a menace to natural vegetation because by not having natural enemies they outgrow and smother the natural vegetation causing many adverse pressures on natural ecosystems. Many rare indigenous species are threatened by these spreading exotics, a good example being *Oldenburgia arbuscula* DC which is threatened by spreading *Pinus pinaster*, *Hakea sericea* and *Acacia mearnsii*.

ii) Erosion

Erosion especially in areas where grazing pressures have been heavy is also a threat to the natural vegetation. Sheet erosion in the Karroo areas with the associated loss of top soil and the exposure of roots of many woody species is causing a reduction in the number of woody species in these areas (Hobson, B pers.comms.) (Plate 5a). Areas of the Ciskei are also very badly affected (Plate 5b).

iii) Pollution

Pollution is also a threat to certain habitats especially aquatic habitats. The extent of this threat is not clear at this stage; however there is a danger that the situation could deteriorate rapidly especially in habitats close to urban areas, e.g. Swartkops Estuary near Port Elizabeth.

PLATE 5a. Sheet erosion exposing the roots of woody trees and shrubs in the Kendrew district of the Karoo.

PLATE 5b. Severe erosion in the Keiskamma River Valley, Ciskei.

PLATE 3a & b. *Encephalartos altensteinii* for sale to passing motorists on the Ciskei side of the Fish River. Prices range from R2 for small plants to R10 for large plants.

c) Natural Pressures

Natural threats include pathogens, natural fires and genetic factors and only become a real threat when populations have been drastically reduced in size.

Studies to show the chief patterns of threat factors have been conducted for species in various areas in the Western Cape, however these will only become clear in the Eastern Cape when the threatened plants are investigated and monitored in the field using the standard checklist of items to be examined (Table 7).

2.5 CONCLUSIONS

The most important finding to come from the synthesis of the distribution records of threatened taxa, is the realisation of the lack of knowledge and information on the Flora of the Eastern Cape. Of the 662 threatened taxa 73,3% are classified as 'U' and another 17,7% as I (Appendix 1). This gives a total of 91% of the listed threatened taxa, classified in Uncertain and Indeterminate conservation status categories. It is thus very difficult to assign a value indicative of its conservation status to the various vegetation types in the Eastern Cape based on these results alone. Two possible approaches to acquire the necessary information are available, both of which should be adapted and used in the Eastern Cape.

The first approach is to investigate each of the threatened species in the field to obtain updated distribution records and information such as population size and present protection of these species. This would be an ongoing project which would require extensive manpower, research and a monitoring programme. Methods of employing this approach have been discussed above. The second approach is a phytosociological one where vegetation types are sampled in order to identify communities which can then be investigated for floristic factors indicative of conservation value. These factors may then be correlated with environmental factors, making it possible to predict where areas of high conservation value exist in a certain vegetation type purely from analysing existing environmental factors.

The latter approach has been used in this project to investigate the Valley Bushveld in the Eastern Cape. The choice of Valley Bushveld as the vegetation type to be investigated in more detail was made as objectively as possible. An assessment and scoring system for ranking the various vegetation types for conservation priority and for the need of further study was developed along the lines of those used by Tansely (1982). Each vegetation type was given a score for a number of criteria which contribute to the importance of the vegetation type for its conservation value. The rationale behind the choice of contributing factors and how they were interpreted is presented in Appendix 2. Table 8 presents the results of this ranking system, giving the scores for each contributing factor as well as the total scores for each vegetation type. The vegetation type with the highest score has the highest conservation priority and was therefore chosen to be investigated in more detail. Subtropical Thicket with a value of 35 out of a possible maximum of 46 is ranked highest and it was therefore decided to investigate the Valley Bushveld as it forms the major proportion of Subtropical Thicket in the Eastern Cape. Time constraints did not allow an investigation of all Subtropical Thicket in the Eastern Cape.

	Endangered (E)	Vulnerable (V)	Rare (R)	Indeterminate (I)	Uncertain (U)	Endemic (e)	THREAT	UNIQUE	% CONS	PAST STUDY	TOTAL
Subtropical Thicket	1	3	5	4	5	5	4	3	2	3	35
Fynbos	1	1	1	3	5	5	4	1	2	1	24
Forest			3	2	5	3	2	2	1	3	21
Grassland & Savanna		2	5	4	5	3	1	1	1	2	24
Karroo	1	1	3	3	5	4	2	1	4	2	26

TABLE 8: Priority table for the main vegetation types of the Eastern Cape. Values represent categories of the numbers of taxa in the various conservation status categories.

CHAPTER 3

SURVEY OF THE VALLEY BUSHVELD IN THE EASTERN CAPE

3.1 OBJECTIVES

1. To obtain a broad floristic classification of the various subunits within the Valley Bushveld.
2. To identify areas of high endemism and species diversity and identify those areas with high numbers of threatened taxa.
3. To relate the subunits or communities within the Valley Bushveld to environmental factors and to determine whether community attributes of high conservation status (eg. threatened taxa) can be predicted using environmental variables.
4. Identify the areas most vulnerable to disturbance and identify the effects these disturbances have on the floristics of the communities.
5. Produce an updated map showing the present extent of Valley Bushveld in the Eastern Cape along with features such ascentresofhighendemism, species diversity and seriously threatened areas.

3.2 METHODS

3.2.1 Mapping:

The extent of Valley Bushveld in the Eastern Cape was accurately mapped by Acocks (1953). His map was also used by Lubke *et al.*, (1986) when they produced their revised vegetation map of the Eastern Cape. Valley Bushveld has however been subjected to extensive 'bush clearing' in the recent past (Palmer, 1986 and Olivier, 1986) and as Acocks did not exclude areas where natural vegetation had been cleared, his map and that produced by Lubke *et al.*, (1986), were found to be unsuitable for identifying the remaining natural Valley Bushveld. A new map had to be drawn.

Visual interpretation techniques (Moll & Bossi, 1984) were used on Landsat satellite imagery of the Eastern Cape (Plate 6) to map the present extent of Valley Bushveld. The difference between the Valley Bushveld and other vegetation types was generally easily recognised. However in transitional zones especially those between Inland Succulent Thicket and Karroid scrub, aerial photography was used to assist in identifying boundaries. Five systematically corrected, edge enhanced, Landsat 2 images were used to cover the Valley Bushveld in the Eastern Cape (Table 9).

False - colour composite transparencies (wavebands 4,5,&7) at a scale of 1:1 000 000 were used, the images of the colour transparencies being interpreted by using a hand lens. The vegetation boundaries thus identified were then traced. A map

PLATE 6. A photographic print of a Landsat 2 false-colour composite transparency (wavebands 4, 5 & 7), depicting part of the Eastern Cape.

TABLE 9: Listing of the 5 Landsat images which cover the Valley Bushveld in the Eastern Cape. Scene I.D. uniquely identifies a particular Landsat scene. The form of the I.D. is SDDDD-HHMMS where S= Spacecraft No., DDDD= days since launch for that spacecraft; & HHMMS= Greenwich Meantime (GMT) of scene centre in hours, minutes & tens of seconds. WRS is the Worldwide Reference System, Track & Frame.

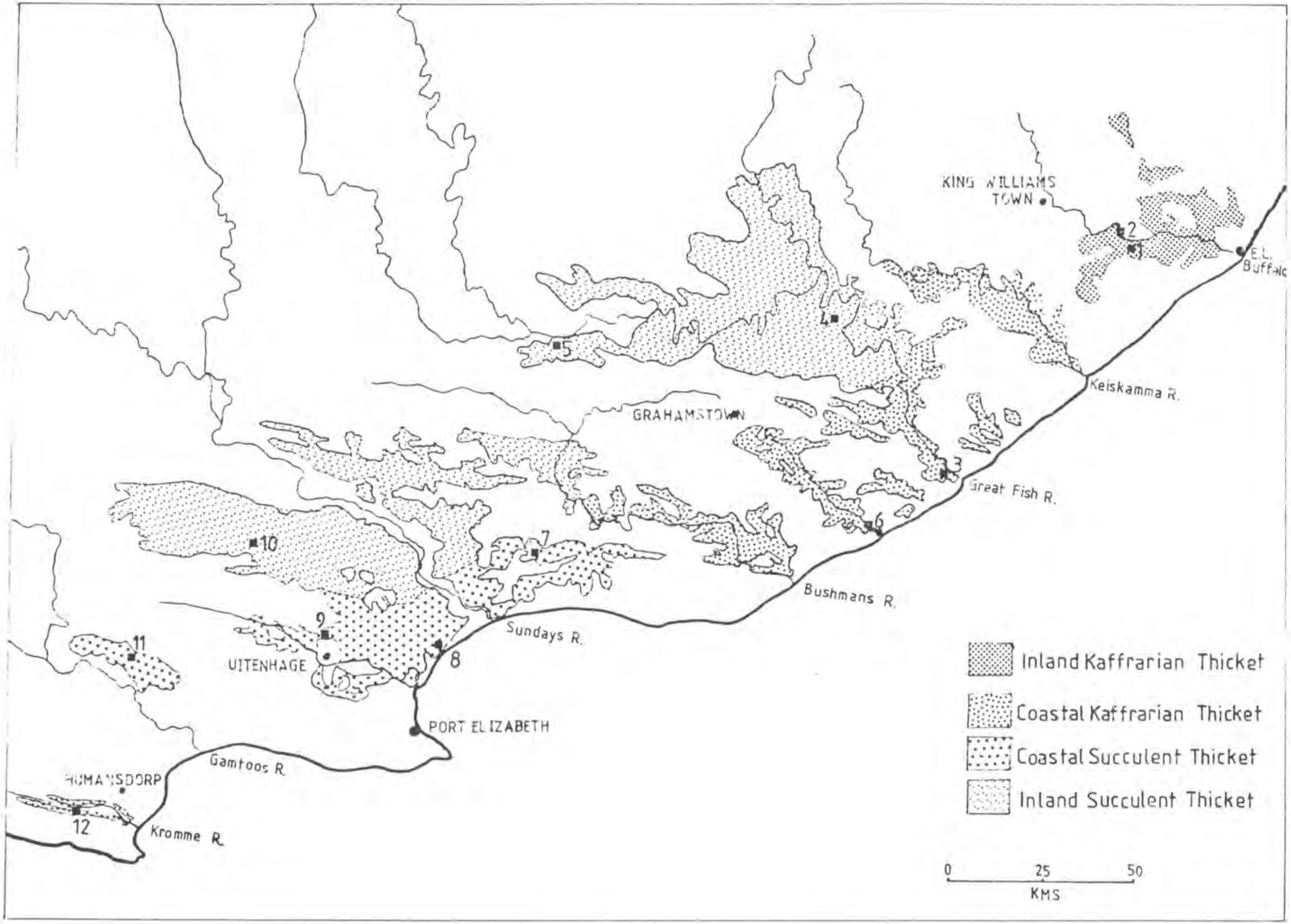
SCENE I.D.	W.R.S.	DATE	TIME	CENTRE
22314-07241	183-83	24/5/81	09H24	33°14'S 25°12'E
22169-07200	182-83/84	30/12/80	09H00	33°54'S 26°46'E
22169-07195	182-83	30/12/80	09H20	33°19'S 26°58'E
22456-07105	181-83	13/10/81	09H11	33°07'S 27°56'E
22456-07103	181-82	13/10/81	09H10	31°40'S 28°24'E

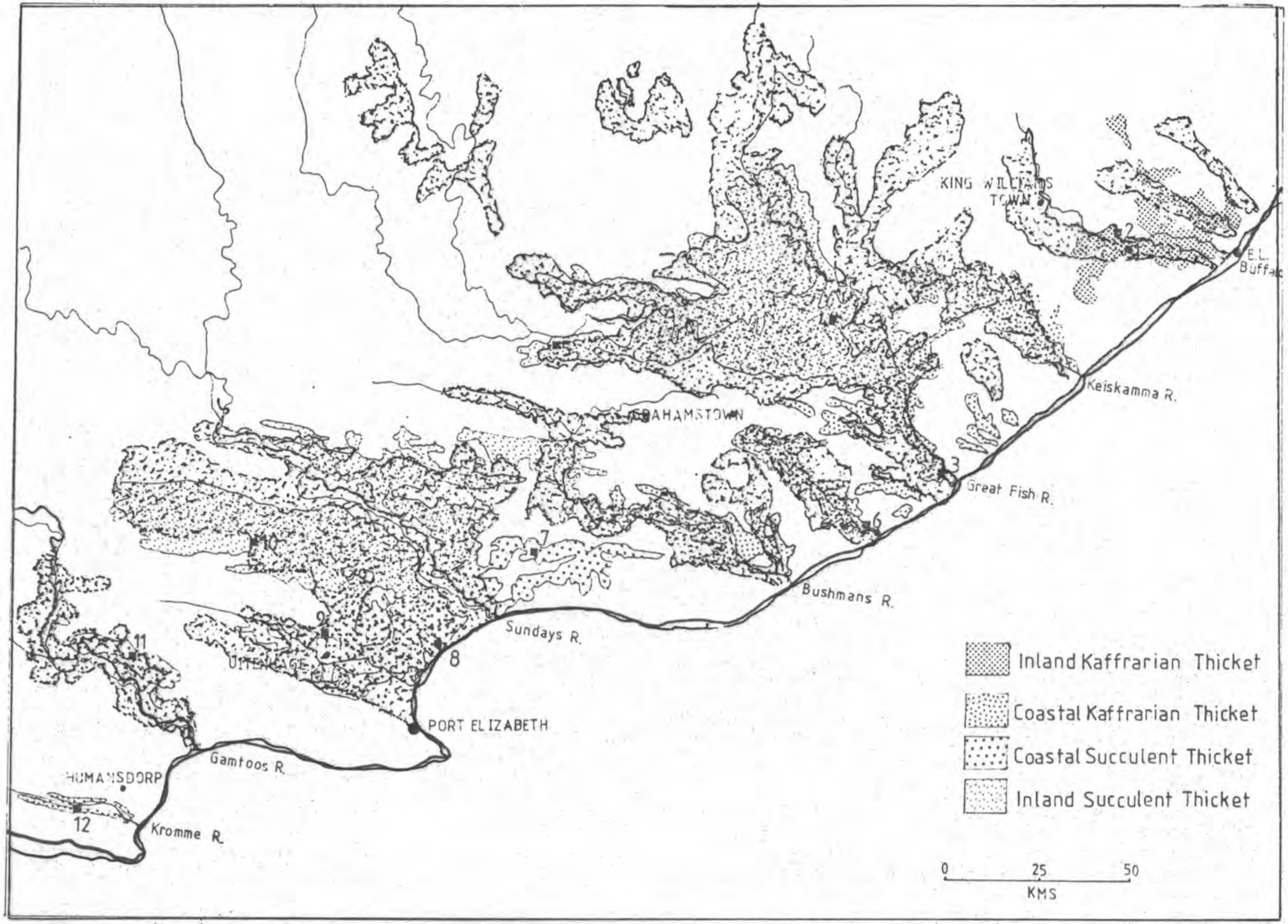
was compiled in this manner and photographically enlarged to a scale of 1:250 000. Figure 17 is a photostatically reduced version of this map. The transparent overlay was produced from Acocks (1975) and compares the present extent of the Valley Bushveld to what he mapped as Valley Bushveld. An attempt was made to map only areas of natural vegetation but it is recognised that some areas infested with alien vegetation may have been included as natural.

3.2.2 Data Collection

i) Site selection & sampling strategy:

The choice of sites was made along rainfall and longitudinal gradients in an attempt to get the largest variation in Valley Bushveld between sites, the assumption being that rainfall is the chief factor affecting the composition of the Valley Bushveld. Longitude is also assumed to cause a large variation in environmental factors, such as temperature and influences from other phytochoria. The rainfall gradients were identified using 1:250 000 rainfall maps. Twelve preliminary sites were identified in this manner, stretching from the Inland Kaffrarian in the east to the Gamtoos River in the west. As comparisons were to be drawn between the sites, care had to be taken to choose sites containing relatively undisturbed veld. Much of the thicket on privately owned land shows some degree of degradation, so as far as possible, veld in conservation areas was sampled. The actual choice of sites therefore deviate to some extent from


KING WILLIAMS TOWN
E.L.
Buffalo
Keiskamma R.
GRAHAMSTOWN
Great Fish R.
Bushmans R.
Sundays R.
UITENHAGE
PORT ELIZABETH
Gamtoos R.
HUMANSDORP
Kromme R.
1
2
3
4
5
6
7
8
9
10
11
12
Inland Kaffrarian Thicket
Coastal Kaffrarian Thicket
Coastal Succulent Thicket
Inland Succulent Thicket
0
25
50
KMS



KING WILLIAMS TOWN
E.L.
GRAHAMSTOWN
Keiskamma R.
Great Fish R.
Bushmans R.
Sundays R.
UITENHAGE
PORT ELIZABETH
Gamtoos R.
HUMANSDORP
Kromme R.
2
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Inland Kaffrarian Thicket
Coastal Kaffrarian Thicket
Coastal Succulent Thicket
Inland Succulent Thicket
0
25
50
KMS

FIGURE 17. Extent of Valley Bushveld in the Eastern Cape as mapped from Landsat 2 imagery. Locations of the sites sampled are also indicated. The overlay is a map of Acock's, (1975) Valley Bushveld in the Eastern Cape.

the sites identified strictly according to the gradients. The actual sites that were sampled are listed in Table 10 which gives the location and grid reference of each. Their locations are also shown on Figure 17.

ii) Sampling intensity and plot size:

Sampling intensity was largely governed by the aims of this study and was limited by logistic and time constraints. This study was not concerned with obtaining an accurate classification at the level of the association (sensu Westhoff and van der Maarel, 1973), but rather with the identification of communities which expressed and characterized the floristic variation and integrity of higher syntaxonomic units. However, the degree of variation that can be intergrated into a meaningful expression of a vegetation unit is still a matter of judgement (Mueller - Dombois & Ellenberg, 1974). Nine sites were sampled and data from three other sites were included, two sampled by Cowling (1982) and one sampled by Palmer (1981), giving a total of 120 plots and 503 species (Appendix 3).

Werger (1972) defines optimal plot size as that size nearest to the minimal area giving the best compromise between information obtained and effort expended. In this study it was necessary to have a fixed plot size to facilitate comparisons. Cowling (1984), using the approach of Werger (1972), sampled nested quadrats containing plot sizes 1,5,10,100 & 1000m^2, in a wide range of vegetation types and found that with a few exceptions, 10 x 10 m plots retrieved the desired level of information (ie.

TABLE 10. Location and grid-references of the 12 sample sites.

SITE	LOCATION	GRID REFERENCE
1	Fort Pato Nature Reserve, Buffalo River Valley	3227DC
2	Potsdam, Buffalo River Valley	3227DC
3	Fish River Mouth	3327AC
4	Andries Vosloo Kudu Reserve, Fish River Valley	3326BB
5	Carlisle Bridge, Fish River Valley	3326AB
6	Kariega River Mouth	3326DA
7	Wavey Ridge Farm, Kenkelbos, Sundays River Complex	3325DC
8	St. Georges Strand	3325DC
9	Springs Reserve, Uitenhage	3325CB
10	Colesgrove Farm, Kirkwood area	3325AD
11	Lower Gamtoos Valley	3324DD
12	Humansdorp area	3424BA

50% of the number of species in a hectare). He considered this size as optimal for all vegetation types in his study area, which included Kaffrarian Thicket. Palmer (1981) also adopted a 10 x 10 m plot size for his study of the Valley Bushveld in the Andries Vosloo Kudu Reserve. As data from both Cowling (1982a) and Palmer (1981) were used in this study, and on the strength of the findings of Cowling (1984), a 100 m^2 plot size was chosen for this study. This size is also in agreement with the findings of other researchers in southern Africa (Werger, 1972 and McKenzie *et al.*, 1977.

iii) Sampling procedure:

Plots measuring 10m x 10m were demarcated using a 50 metre measuring tape. A total floristic list was drawn up for each plot and the percentage projected canopy cover was subjectively estimated for each species. Specimens of most species were collected and pressed for identification. Initial identifications were made in the Rhodes University Herbarium (RUH). Uncertain cases and the remaining unidentified species were subsequently identified in the Albany Museum Herbarium (G.R.A., Botanical Research Institute). Nomenclature follows that of Gibbs Russell *et al.*, (1984b). Environmental variables recorded in each plot included grazing intensity categorised in the following classes, ungrazed=1, light=2, moderate=3, heavy=4 and overgrazed=5; percentage rock cover; percentage litter cover; aspect (degrees); and slope categorized in the following classes, flat=1, gentle=2, moderate=3, steep=4 and very steep=5 (Table

11). This information was recorded on Field Data Sheet designed by the Botanical Research Institute, Department of Agriculture and Water Supply, Pretoria.

A total of 20 soil samples were collected, with at least one from each site. The sample was collected by sinking a hand-held auger down to the C horizon, the extracted soil was mixed and a sample was collected and sealed in a plastic packet. Where soils appeared to differ with-in the sites, soil samples were collected for each soil type observed. The soil type of each plot was recorded. Other environmental variables recorded for each site included: mean annual rainfall from 1:250 000 isohyet maps, and altitudes and grid references from 1:50 000 topographic sheets.

3.2.3 Data analysis

i) Soil analysis

The soil samples were analysed for pH, Cl (ppm), P (mg/kg), K (ppm),Ca (ppm), Mg(ppm) and Na (ppm) by the Plant Nutrition Research Unit, Department of Plant Sciences, Rhodes University. Soil pH was measured in a 1:2,5 1 N KCl solution. The analysis for Cl was done by extraction in H_2O and titration against $AgNO_3$. Phosphorus was measured using the Bray 1 extraction method (Bray & Kurtz 1945) & K, Ca, Mg and Na were extracted using Cation extraction in 1 M ammonium acetate, colour was developed by using a Molybdenum blue colour development method and read on an atomic absorption spectrophotometer.

TABLE 11. Floristic and environmental variables recorded per site.

VARIABLE	ABB	CLASSES OF VARIABLE & METHOD
FLORISTIC VARIABLES		
Species Richness	S	Total number of species per site
Shannon diversity index	H'	Calculated per $100m^2$ plot
Simpson dominance	l	Calculated per $100m^2$ plot
Number Woody species	WOO	Calculated as a percentage of total per site
Number Succulent species	SUC	Calculated as a percentage of total per site
Number Endemic species	END	Calculated as a percentage of total per site
Number Threatened species	THR	Calculated as a percentage of total per site
INDEPENDENT VARIABLES		
Degrees Longitude	LON	From 1:50 000 topographic sheets
Mean annual rainfall	RAI	Data from 1:250 000 Isohyet maps
Grazing intensity	GRZ	Classes: ungrazed=1, light=2, moderate=3,heavy=4, overgrazed=5. Scale based on stocking rates and field observations.
Litter cover (%)	LIT	Subjective estimate
Rock cover (%)	ROC	Subjective estimate
Soil depth (cm)	SDE	Estimated from augerings at each sit
Exchangeable Cl (ppm)	CHL	H_2O extraction, $AgNO_3$ titration
Available P (ppm)	PHO	Bray No.1
Exchangeable K (ppm)	POT	
Exchangeable Ca (ppm)	CAL	Ammonium acetate extraction, Mo blue colour development - Atomic
Exchangeable Mg (ppm)	MAG	absorption spectro-photometer
Exchangeable Na (ppm)	SOD	
Soil pH	PHH	1 N KCl 1:2,5 solution

ii) Vegetation classification

Classification of the vegetation was carried out by using the multi-variate techniques of classification and ordination. Sites were initially ordinated using detrended correspondence analysis - D.C.A. (DECORANA; Hill, 1979a). D.C.A. is an improved eigenvector ordination technique based on reciprocal averaging but corrects reciprocal averaging faults by detrending and rescaling (Hill, 1979a; Hill & Gauch, 1980 and Gauch, 1982). Detrending is implemented to replace the arch distortion of reciprocal averaging which arises when second and higher axes are derived (see Gauch, 1982). The second fault of reciprocal averaging is compression of the first axis ends relative to the axis middle and is corrected by rescaling in DCA which expand or contract small segments along the species ordination axis such that species turnover occurs at a uniform rate along the species ordination axis and , consequently, that equal distances in the ordination correspond to equal differences in species composition (Hill, 1979a and Gauch, 1982). The end product is a two-dimensional scatter diagram with similar samples located together and dissimilar entities far apart. Environmental gradients can usually be associated with the axes.

Classification of plots was achieved using two-way indicator species analysis (TWINSPAN; Hill, 1979b), which is a polythetic, divisive classificatory technique (Hill, 1979b and Gauch, 1982). TWINSPAN produces a classification of stands by the progressive splitting of ordinations (reciprocal averaging; Hill, 1973) at their centres of gravity. At each split, indicator (diagnostic) species are chosen to define the two groups of data. TWINSPAN produces a classification of species as well as samples in the form of an ordered two-way table which approximates the tabular matrix arrangement of the Zurich-Montpellier School (Gauch & Whittaker, 1981). These techniques have been used successfully in many vegetation types (Bond, 1981; Cowling, 1984; Cooper, 1984 and Everard, 1986).

iii) Syntaxonomic ranking:

Owing to the low intensity of sampling which aimed at identifying the floristic variation of higher syntaxonomic units, no attempt was made at identifying communities. The ultimate units identified in the TWINSPAN classifications and depicted in a two-way phytosociological table (Appendix 4) were ranked at the suborder level. The hierarchical system presented (Table 12) follows that of Cowling (1984) which is an attempt to meet the guidelines proposed by the Botanical Research Institute (BRI). The suborder category forms the unit of mapping (Figure 17) and can be regarded as roughly equivalent to an Acocks (1953) veld type. A class comprises a group of related orders.

vi) Community nomenclature

The same approach as Cowling (1984) was adopted, where the nomenclature of the suborders is a locality - structured term e.g. Kaffrarian Coastal Thicket.

v) Species Diversity

Species richness values (S) defined simply as the number of species per site (Whittaker, 1972 and Cowling, 1983c) were obtained by totalling the number of species recorded per site. Alpha diversity is defined as within-habitat or intra-community diversity (Whittaker, 1972) with diversity measures incorporating both species richness and species evenness (Peet, 1974 and Brower & Zar, 1984). As comparisons between sites were made, the sample area for which species diversity indices were calculated had to be constant. The mean number of species per plot for each site was therefore calculated. The species diversity indices were calculated for the 100m^2 plot that had the same or closest number of species to the mean number of species per plot for that site. The diversity indices were thus calculated for plots of constant area and so can be compared. The data formed random samples of species abundances from a larger community making the Shannon diversity index (H') the most useful (Brower & Zar, 1984). As a community with high diversity has a low dominance and vice versa, (Brower & Zar, 1984) Simpsons dominance (l) was also used to compare sites. Both these indices (H' & l) were calculated using a microcomputer programme published by Brower & Zar (1984). Percentage canopy cover was used to assign importance values to the species.

vi) Regression analysis

Simple correlations between the independent factors and floristic variables, summarized in Table 11, were obtained by using the multiple regression analysis option of the Statistical Package for the Social Sciences (SPSS) (Nie *et al.*, 1975). The sample consisted of 12 sites as most of the environmental variables were only measured per site.

3.3 RESULTS

3.3.1 Classification

The classification of the plots by TWINSPAN is presented in the form of a two-way phytosociological table (Appendix 4). Plots with similar species compositions are grouped, and as plots sampled at each site generally had similar species compositions they have remained grouped within sites or groups of sites. The classification therefore groups similar sites into clusters. A summary of the classification is presented in Table 12, and is described below.

Subclass: Valley Bushveld:

The classification obtained in this study divides Valley Bushveld into two orders which closely resemble the orders of Subtropical Thicket obtained by Cowling (1984), who classified Subtropical Thicket as a class of vegetation. Valley Bushveld is therefore described as a subclass in this study. It consists of an impenetrable tangle of spinescent shrubs, low trees and vines. Structurally the communities are dominated by evergreen sclerophyllous shrubs and succulents. Endemics are few, most being succulents (*Euphorbia, Crassula, Delosperma, Aloe*) of karroid affinity. Ecologically, Valley Bushveld is restricted to deepish, well drained fertile soils (Cowling, 1984). Common wide spread species include *Puttelickia pyracantha, Rhoicissus tridentata, Grewia occidentalis, Phylanthus verrucosus* and the grass *Panicum maximum*. Valley Bushveld is divided into two orders

TABLE12: Syntaxonomic and synecological relationships of higher vegetation units of Subtropical Thicket in the Eastern Cape.

RANK	NAME	STRUCTURAL CHARACTERIZATION	DISTRIBUTION	RAINFALL	SOIL
Class	Subtropical Thicket	Closed dense sclerophyllous (succulent) shrubland	Kei to Gouritz Rivers	300 - 850	Deep fertile soils; also deep calcareous coastal dune sands
Subclass	ValleyBushveld	Closed - semiclosed (succulent) shrubland	River basins of the Eastern Cape	300 - 850	Deep fertile soils
Order	Kaffrarian Succulent Thicket	Closed dense large-leaved and succulent shrubland	Dry river valleys Kei to Gouritz	300 - 450	Deep fertile soils
Suborder	Inland Succulent Thicket	Semiclosed sclerophyllous succulent shrubland	Hot dry inland river basins	300 - 400	Deep fertile soils
Suborder	Coastal Succulent Thicket	Closed very dense sclerophyllous succulent shrubland	Coastal areas - Sundays to Gouritz Rivers	400 - 450	Deep calcareous coastal dune sands and fertile soils
Order	Kaffrarian Thicket	Closed dense large-leaved tall shrubland to low forest	Kei to Gouritz in wetter river valleys	550 - 850	Deep fertile soils and dune sands
Suborder	Coastal Kaffrarian Thicket	Closed dense large-leaved low forest	Wetter coastal regions of the Eastern Cape	550 - 700	Deep fertile soils and consolidated dunes
Suborder	Inland Kaffrarian Thicket	Closed-semiclosed tall shrubland	Kei to Buffalo River valleys - Moist	700 - 850	Deep fertile Doleritic soils

viz: Kaffrarian Succulent Thicket and Kaffrarian Thicket (Table 12).

1) Kaffrarian Succulent Thicket:

Kaffrarian Succulent Thicket occurs in dry areas and is recognised by a high proportion of succulents (Figure 18). Growth forms are diverse and include leaf and stem succulent shrubs, trees and vines, arborescent rosette succulents, succulent herbs, large and small-leaved sclerophyllous and orthophyllous shrubs, low trees and vines, grasses, forbs, annuals and geophytes. Differential species include *Portulacaria afra, Schotia afra, Pappea capensis* and *Crassula perforata* (Appendix 4). Two suborders of Kaffrarian Succulent Thicket have been recognised in this study: Inland Succulent Thicket and Coastal Succulent Thicket.

i) Inland Succulent Thicket:

The Inland Succulent Thicket of the Fish and Sundays Rivers (sites 4, 5 & 10; Fig 17) is a low relatively sparse thicket (Plate 7a & b) with the shrub canopy ranging between 2 and 2,5 m in height and having an average total cover of approximately 73% (Figure 19). It has a large number of succulents (29,3%) and is also relatively high in endemics (7,3%; Figure 19). Species richness is relatively low although diversity compares favourably with other thicket types in the Eastern Cape. The most abundant differential species types include *Grewia robusta, Protasparagus striatus* and associated species (Appendix 4). It predominates in

PLATE 7a & b. Inland Succulent Thicket in the Fish River Valley at Trumpetters Drift. Species include *Euphorbia bothea, Portulacaria afra, Pappea capensis, Grewia robusta, Euclea undulata* and *Helichrysum rosum.*

the hot dry river basins where average annual rainfall ranges from 300 mm to 450 mm.

ii) Coastal Succulent Thicket:

Coastal Succulent Thicket is an exceptionally dense, impenetrable thicket occurring in the coastal areas from roughly the Sundays River mouth to the Humansdorp district (Fig 17). With a mean total cover of 89,8% and an average canopy height of 2,5 m (Figure 19) this thicket forms some of the most dense thicket in the Eastern Cape (Plate 8a & b). It is characterised by a high proportion of spinescent shrubs and woody creepers but also has many succulents which form between 19,4 and 32,1 percent of the flora(Fig 18). Diversity is high (H'=1,301) but more important, this thicket suborder has the highest percent of endemism (9,2%; Figure 19) of all the thicket types recognised. The highest number of threatened species was also recorded in this thicket type during sampling. Differential species common to this thicket type only, are shown in Appendix 4.

2) Kaffrarian Thicket:

Kaffrarian Thicket consists of non-succulent thicket communities where although Tongaland-Pondoland affiliated species dominate, it also has strong affinities to the Afromontane flora. Structurally the thicket is a closed shrubland to low forest dominated by evergreen, sclerophyllous trees and shrubs with a high cover of stem spines and vines. Appendix 4 lists differential species, *Euphorbia triangularis* being a characteristic dominant species. Two suborders of Kaffrarian

Thicket were identified: Coastal Kaffrarian Thicket and Inland Kaffrarian Thicket.

i) Coastal Kaffrarian Thicket:

The Coastal Kaffrarian Thicket was found associated with the estuaries of the Fish; Kariega and Gamtoos/Kabeljous Rivers (Fig 17). It forms a closed low forest with a high proportion of trees forming a closed canopy at between 4 and 6 m in height (Plate 9a & b). Floristic variables are given in Figure 18 which shows that succulents form a small proportion of the flora with most species being woody (61,7%). Endemism is low (4,0%) however species richness (37,3) and diversity (1,194) are high (Fig 19). Differential species are shown in Appendix 4.

ii) Inland Kaffrarian Thicket:

The Inland Kaffrarian Thicket forms a very dense thicket of mainly woody shrubs and trees (Plate 10a & b). It occurs in the river valleys which receive an annual average rainfall of above 800mm and was identified in the Buffalo River area during this study (Fig 17). It has a very low compliment of succulents, only 2,4%, and is highest in forbs (18,3%) and Graminoids (9,8%; Figure 18). It also forms the most species rich (49,1 species/plot) and diverse (1,409) thicket that was sampled in the Eastern Cape. However, it had the lowest number of endemics (1,1%; Figure 19). Appendix 4 presents the common differential species for this thicket type.

PLATE 9a. Coastal Kaffrarian Thicket in the Keiskamma River Valley. Important species include *Euphorbia triangularis*, *Rhus dentata*, *Maytenus heterophylla*, *Olea capensis*, *Cassine crocea* and *Panicum maximum*.

PLATE 9b. Coastal Kaffrarian Thicket at Waters Meeting Nature Reserve, near Bathurst. Dominant species are as listed for plate 9a.

PLATE 10a & b. Inland Kaffrarian Thicket in the Buffalo River Valley at Fort Pato Nature Reserve (site 1). Dominant species include *Burchellia bubalina*, *Scutiamyrtina*, *Diospyros dichrophylla*, *Carissa bispinosa*, *Rhus lucida*, *Maytenus heterophylla* and *Hippobromus pauciflorus*

PLATE 8a. Coastal Succulent Thicket at St. Georges Strand near Port Elizabeth, (site 8). Species include *Aloe africana*, *Schotia afra*, *Zygophyllum uitenhagensis*, *Maytenus procumbens* and *Euphorbia ledienii*.

PLATE 8b. Coastal Succulent Thicket in the Springs Reserve north of Uitenhage, (site 9). Dominant species include *Cappris sepiaria*, *Euclea undulata*, *Sarcostemma viminale*, *Aloe ferox*, *Putterlickia pyracantha* and *Plectranthus hirtus*.

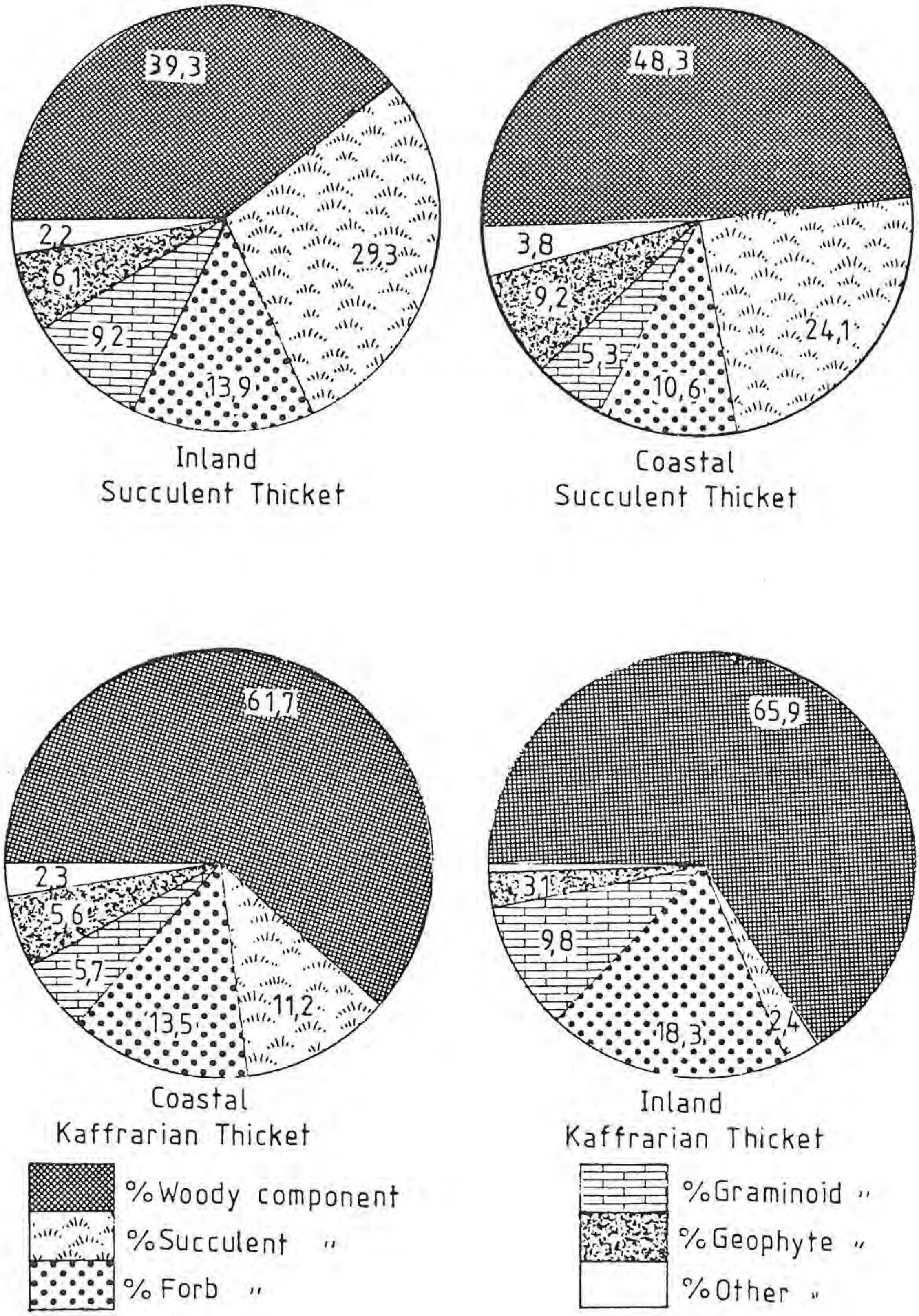
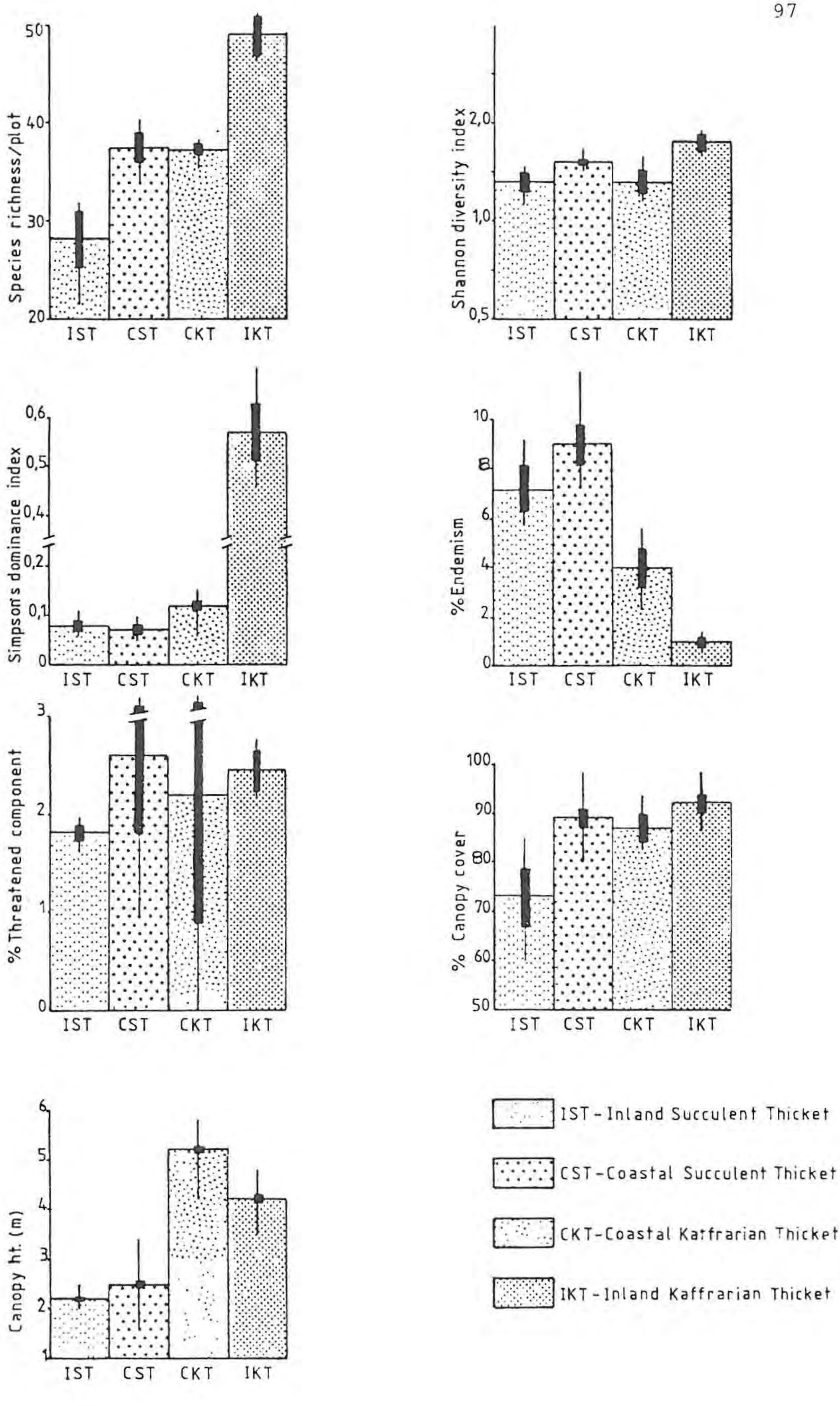


FIGURE 18. Percentages of various life forms in the 4 suborders of Valley Bushveld in the Eastern Cape.

FIGURE 19. Structural and floristic comparisons between the 4 suborders of Valley Bushveld in the Eastern Cape.


Species richness/plot
50
40
30
20
IST CST CKT IKT
Shannon diversity index
2,0
1,0
0,5
IST CST CKT IKT
Simpson's dominance index
0,6
0,5
0,4
0,2
0,1
0
IST CST CKT IKT
% Endemism
10
8
6
4
2
0
IST CST CKT IKT
% Threatened component
3
2
1
0
IST CST CKT IKT
% Canopy cover
100
90
80
70
60
50
IST CST CKT IKT
Canopy ht. (m)
6
5
4
3
2
1
IST CST CKT IKT
IST - Inland Succulent Thicket
CST - Coastal Succulent Thicket
CKT - Coastal Kaffrarian Thicket
IKT - Inland Kaffrarian Thicket

3.3.2 Environmental Variables:

A dendrogram (Figure 20) was constructed from TWINSPAN to illustrate the classification, and includes the results of the soil analysis and the environmental variables that were measured at each site. Similar environmental factors (eg. soil pH) will be grouped into the same group of sites if similar readings were obtained for the environmental factor at only those sites clustered into that particular group. In this way attempts can be made to identify which environmental factors, if any, control the species compositions of communities.

Rainfall appears to be the most influential environmental factor, with the Inland Succulent Thicket (Sites 4,5&10) having an average of between 300 to 450 mm yr^{-1}, Coastal Succulent Thicket from 450 to 500 mm yr^{-1}, Coastal Kaffrarian Thicket from 550 to 700 mm yr^{-1} and Inland Kaffrarian Thicket above 800 mm yr^{-1}. Litter appears to be generally higher in the Kaffrarian Thicket but this is obviously a result of the vegetation rather than a cause for the vegetation in that area. Magnesium levels also seems to be generally higher in the Kaffrarian Thicket than in the Succulent Thicket communities but as the variation of Magnesium in both these vegetation orders is large and overlapping no conclusion can be drawn from this. Calcium and Sodium levels are much higher in the dune thicket areas as a result of their proximity to the sea and many of the species common to these two communities (Appendix 4) have high Na and Ca tolerances. No further explanation of the grouping of sites can be explained by the environmental factors.

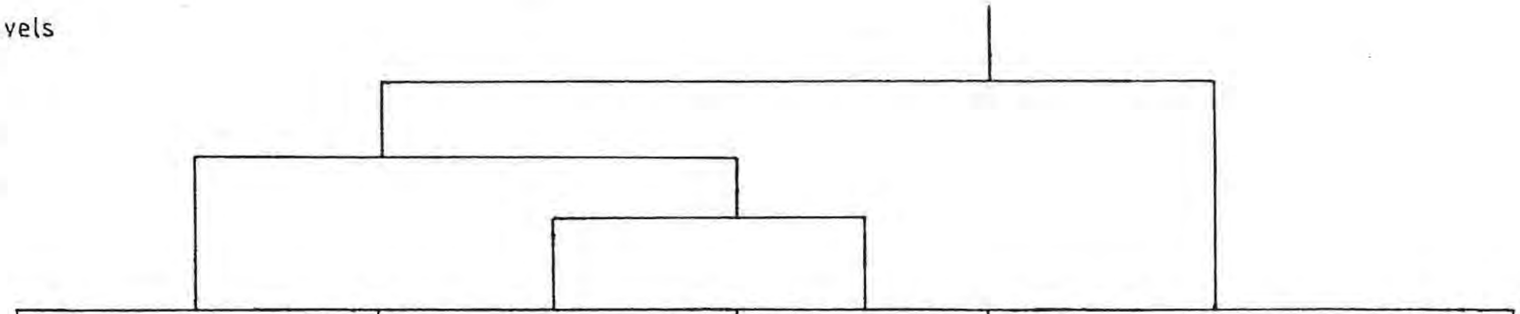
FIGURE 20. Dendrogram showing the classification of the sites by TWINSPAN. Environmental and floristic variables recorded at each site are tabulated below each site.

Division Levels

1

2

3



SITE	4	5	10	7	8	9	11	12	1	2	3	6
Species richness	31,7	31,10	21,7	39,9	35,0	40,3	34,9	38,4	51,8	46,3	35,3	38,1
Shannon diversity	1,231	1,275	1,089	1,335	1,274	1,264	1,31	1,327	1,474	1,343	1,095	1,159
Simpson dominance	0,074	0,063	0,106	0,06	0,076	0,100	0,055	0,058	0,460	0,670	0,149	0,142
% woody species	39,0	40,6	38,9	49,0	44,4	52,2	47,5	54,0	65,0	66,7	65,1	65,9
% succulents	21,1	29,7	37,0	19,6	32,1	25,2	19,4	16,6	0,7	4,1	7,7	9,4
% endemics	5,69	6,93	9,26	6,86	11,11	9,56	9,35	5,76	1,46	0,68	3,88	2,35
% threatened	1,63	1,98	1,85	0,98	2,47	2,61	4,32	5,04	2,19	2,72	1,55	0,0
Longitude	26°44'	26°15'	25°22'	25°53'	25°39'	25°25'	25°03'	24°45'	27°40'	27°38'	27°08'	26° 40'
Rainfall (mm yr^{-1})	450	350	300	500	550	450	450	550	850	800	700	700
Grazing[1]	1	4	4	3	2	1	1	1	1	1	1	2
Litter %	20	10	10	25	25	20	70	80	50	50	40	40
Rock %	15	5	12	2	5	10	30	35	2	2	7	2
Soil depth (mm)	100	150	150	1 000	250	150	1 000	500	250	200	200	200
Cl (ppm)		75	46	48	124	44			51		102	99
P (ppm)		15,0	13,5	5,5	1,0	4,0	10,0	5,4	¾1	2,0	5,6	5,5
K (ppm)	20	208	92	94	68	118	256	642	31	84	116	214
Ca (ppm)	73	1 000	850	500	2 650	2 000	2 490	1 656	1 020	500	2 130	2 150
Mg (ppm)	25	147	130	74	145	278	341	801	425	215	520	510
Na (ppm)	10	51	63	37	130	14	151	308	72	26	245	200
pH	6,10	4,62	4,71	5,43	7,52	7,32	5,20	6,30	4,46	5,00	6,50	6,80

[1] see table 4.

3.3.3 ORDINATION

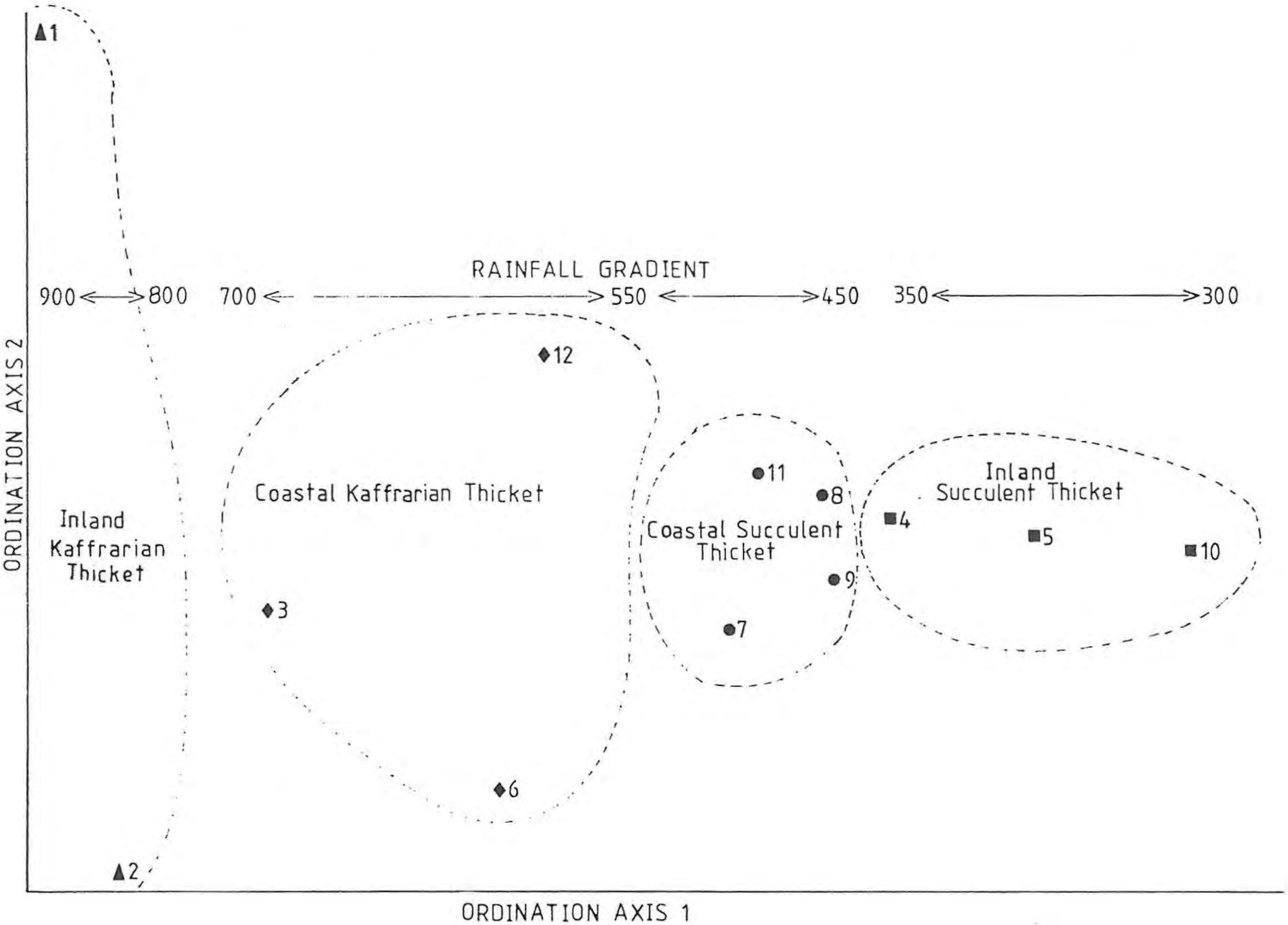
Plots were initially ordinated, but as plots within sites were closely clustered it was decided to lump the plot data for each site and obtain an ordination of the sites. This ordination by DECORANA is presented in the form of a scatterdiagram (Figure 21). Ordination axis 1 is clearly related to a rainfall gradient, the sites receiving high average annual rainfalls (sites 1 and 2) being distributed towards the origin of axis 1 and those receiving the lowest average annual rainfall situated furthest from the origin. It is not clear which environmental factors are related to Axis 2, if any, although it is apparent that the Inland Kaffrarian Thicket which is the most species rich community is distributed along the entire length of Axis 2. Conversely, the Inland Succulent Thicket, which is the most species poor community, shows little variation along Axis 2.

3.3.4 REGRESSION ANALYSIS

The floristic variables (Figure 18) were subjected to multiple regression analysis in relation to the environmental variables presented in Figure 20. A matrix of simple correlation coefficients between all variables is given in table 13.

There are two major pairs of intercorrelated floristic variables. Species richness (S) is positively intercorrelated with diversity (H) (r=0,5; p¾0,01) and the woody component (WOO) is strongly negatively intercorrelated with the succulent component (SUC)

FIGURE 21. A scatterdiagram showing the ordination of the sites by DECORANA.


RAINFALL GRADIENT
900 800 700 550 450 350 300
Inland Kaffrarian Thicket
Coastal Kaffrarian Thicket
Coastal Succulent Thicket
Inland Succulent Thicket
1 2 3 4 5 6 7 8 9 10 11 12
ORDINATION AXIS 1
ORDINATION AXIS 2

(r=-0,90; p¾0,001).

Predictably S shows strong positive relationships with average annual rainfall (RAI) (r=0,82; p¾0,001) and a negative relationship to grazing intensity (GRZ; Table 13). S also shows a positive relationship to WOO and hence a negative relationship to SUC and negative relationships to the number of endemics (END) and the available Phosphorus (PHO). Dominance (l) is positively correlated to WOO, Longitude (LON) and RAI are negatively correlated to SUC and END. WOO is positively correlated to LON and exchangeable Magnesium (MAG), and negatively correlated to END and PHO. SUC shows a positive relationship to GRZ and a negative relationship to Litter cover (LIT), however, LIT is more likely to be a result of a high woody component and not a cause of a small succulent component. END are strongly positively correlated to SUC indicating that the endemics are mostly succulents or succulent associated species. END have a negative relationship to LON and RAI. The number of threatened species (THR) show positive relationships to LIT and rock cover (ROC) but is not negatively correlated to any of the variables (Table 13).

A number of the environmental and soil variables show interrelationships (Table 13), however these do not appear to be important factors affecting the floristic variables of the sites.

TABLE 13. Correlation matrix of all recorded variables.

	S	H'	1	WOO	SUC	END	THR	LON	RAI	GRZ	LIT	ROC	SDE	Cl	P	K	Ca	Mg	Na
Species richness	1,00																		
Shannon diversity	0,75**	1,00																	
Simpson dominance	0,67*	0,41	1,00																
% Woody species	0,74**	0,17	0,65*	1,00															
% Succulents	-0,79**	-0,37	-0,67*	-0,90***	1,00														
% Endemics	-0,61*	-0,20	-0,73**	-0,78**	0,89***	1.00													
% Threatened	0,08	0,42	-0,02	-0,12	0,06	0,27	1.00												
Longitude	0,46	0,08	0,72**	0,58*	-0,68*	-0,79**	-0,49	1,00											
Annual rainfall	0,82***	0,36	0,75**	0,91***	-0,91***	-0,80**	-0,12	0,70*	1,00										
Grazing	-0,59*	-0,32	-0,33	-0,54	0,64*	0,33	-0,38	-0,22	-0,59*	1,00									
Litter cover	0,48	0,43	0,24	0,51	-0,59*	-0,33	0,65*	-0,09	0,48	-0,65*	1,00								
Rock cover	-0,24	0,08	-0,39	-0,27	0,16	0,32	0,82**	-0,65*	-0,34	-0,31	0,61*	1,00							
Soil depth	0,11	0,38	-0,26	-0,08	-0,03	0,23	0.31	-0,44	-0,12	-0.03	0,44	0,38	1,00						
Available Chlorine	-0,11	-0,031	-0,21	0,19	-0,06	-0,01	-0,17	0,19	0,29	-0,19	0,24	-0,30	-0,26	1,00					
Available Phosphorus	-0,79**	-0,44	-0,49	-0,65*	0,57	0,36	-0,01	-0,34	-0,78**	0,70*	-0,33	0,25	0,07	-0,24	1,00				
Exchangeable Potassium	-0,08	0,08	-0,31	0,05	-0,01	0,04	0,63*	-0,57	-0,12	-0,11	0,64*	0.74**	0,29	0,23	0,19	1,00			
Exchangeable Calcium	-0,02	-0,17	-0,33	0,19	0,07	0.36	0,24	-0,34	-0,06	-0,25	0,32	0,23	0,13	0,77**	-0,15	0,30	1,00		
Exchangeable Magnesium	0,32	0,05	0,04	0,60*	-0,50	-0,35	0,39	-0,09	0,44	-0,46	0,76**	0,45	0,05	0,30	-0,23	0,74**	0,48	1,00	
Exchangeable Sodium	-0,03	-0,21	-0,26	0,35	-0,24	-0,10	0,31	-0,24	0,23	-0,27	0,65*	0,48	0,16	0,77**	-0,06	0,72**	0,60*	0,86***	1,00
Soil pH	-0,03	-0,22	-0,38	0,07	0,13	0,30	-0,06	-0,28	0,03	-0,36	-0,02	0,04	-0,17	0,56	-0,43	0,11	0,59*	0,21	0,33

* p 0,05

** p 0,01

*** p 0,001

3.4 DISCUSSION

3.4.1 Syntaxonomy

The Subtropical Thicket, which is similar in structure and generic composition to communities that are found throughout tropical and subtropical Africa (White, 1982 and Cowling, 1984), penetrates the Eastern Cape from the east and extends along the west coast as far as Lamberts Bay. Cowling (1984) identifies the thicket in the Eastern Cape as Subtropical Transitional Thicket which has a distribution from the Kei River to the south-western Cape. The Valley Bushveld recognised in this study forms a major portion of the Subtropical Thicket in the Eastern Cape and includes thicket in Acock's (1975) Southern Variation of the Valley Bushveld (23b), Fish River Scrub (23c), Addo Bush (23d(i)), Sundays River Scrub (23d(ii)) and Gouritz River Scrub (23e).

Structurally the Subtropical Thicket is distinguished from other African thicket types by a predominance of evergreen sclerophyllous leaves and a high cover of succulent shrubs of karroid affinity (Figure 18). In contrast, thickets to the north have a strong component of orthophyllous deciduous species (Wild, 1952; Edwards,1967 and Cowling,1984). Rainfall distribution is highly erratic in the Eastern Cape (Gibbs Russell & Robinson,1981) and so plants must be capable of utilizing soil moisture whenever available. Many Subtropical Thicket species are drought deciduous.

The distribution of thicket communities is determined by a complex of interrelated factors. Fire is cited as a factor limiting the distribution of thicket in the Eastern Cape (Du Toit, 1972 and Trollope, 1974). Tinley in (Heydorn & Tinley, 1980) stressed edaphic controls on thicket distribution, development of thicket often being restricted to deep, well drained soils. Cowling (1984) found that the densest thicket occurred on deep apedal sandy loams to sandy clay loams (Hutton and Clovelly Forms) in the south-eastern Cape. In this study all the Valley Bushveld sample sites had deep, well drained soils.

Very little is know about post-disturbance dynamics and recovery of Subtropical Thicket communities. However, Cowling (1984) considers Subtropical Thicket to be stable but with a low resilience. Thicket communities are vulnerable to overstocking and are slow to recover after disturbances (Aucamp & Barnard, 1980).

Owing to the low sampling intensity of the Valley Bushveld during this study, classification could only be made to the level of suborder. Four suborders in two orders were identified these being the Kaffrarian Thicket and the Kaffrarian Succulent Thicket (Table 12). The Kaffrarian Succulent Thicket identified in this study corresponds to the Kaffrarian Succulent Thicket of Cowling (1984) and includes Acocks's (1975) Southern Variation of the Valley Bushveld (23b), Fish River Scrub (23c), Addo Bush (23d(ii), Sundays River Scrub (23d(i)) and Gouritz River Scrub

(23e). Similarily the Kaffrarian Thicket identified here includes Cowling's (1984) Kaffrarian Thicket which also includes parts of Acocks's (1975), Eastern Province Thornveld (7b), some of the Alexandria Forest (2) and parts of the False Thornveld of the Eastern Province (21). As it was not one of the fundamental aims of the Thicket survey to produce a comprehensive phytosociological classification of the Valley Bushveld, phytosociology will not be discussed any further.

3.4.2 Environmental and Floristic Relationships:

The main aim of the thicket survey was to identify which environmental factors are responsible for floristic variables which contribute to conservation values of communities. Rainfall appears to be the dominating environmental factor responsible for the distribution and composition of the various communities (Fig. 21). In high rainfall areas species richness is highest, dominance is stronger and the vegetation has a high woody and low succulent component. The number of endemics however appear to decrease with an increase in rainfall, which substantiates the finding of Cowling (1983 b & c) that most Subtropical Thicket endemics are of Karroo affinity and predominate in dry areas. Rainfall is positively intercorrelatd with longitude, but since it is generally wetter in the eastern parts of the Eastern Cape most of the correlations between longitude and floristic variables are more the effect of rainfall than of the change in longitude. Grazing and Phosphorous levels are both negatively correlated to rainfall, however the variations in grazing intensity are more likely to be influenced by site choice than by rainfall. Leaching of Phosphorous in high rainfall areas possibly explains the negative relationship of phosphorous levels to rainfall. The importance of rainfall when evaluating Valley Bushveld communities is therefore two-fold. Valley Bushveld in high rainfall areas tends to have a higher species richness but a lower number of endemics than thicket in low rainfall areas. Thus in both high and low rainfall areas there are important floristic features (species richness and endemism) which would enhance the value of the thicket types for conservation.

The effects of grazing cannot be analysed in detail as sites were chosen where grazing was minimal. It does however show that where grazing intensity was high (site 10) species richness was low (21,7 species per $100m^2$ Figure 19). High grazing intensity therefore appears to eliminate species and thus has an effect on the conservation status of thicket communities. Sites in dry areas, where the succulent component was high, were generally more heavily grazed than in higher rainfall areas where conserved, ungrazed veld could be sampled. This explains the correlation obtained between grazing and the succulent component. This would also explain why there is a negative relationship between litter cover and grazing (ie. more litter in woody, high rainfall areas) and between available phosphorous and grazing.

The negative relationship between succulents and litter cover is expected as few succulent plants are deciduous. There is a positive correlation between litter and the number of threatened species but as only very few threatened species were sampled no conclusions can be drawn from this correlation. The fact that there is a negative correlation between grazing and litter is again probably the effect of rainfall, where in wet areas where grazing intensity of the sites was low, more species are leafy and deciduous and therefore there is a higher litter cover. The positive interrelationships between litter and rock cover, exchangeable Potassium, Calcium and Magnesium do not have any important significance to the conservation status of any community.

The strong positive correlation between rock cover and the number of threatened plants recorded, suggests that in rocky terrain a higher number of threatened plants is expected. However, owing to the very low frequency of threatened plants in the sample data, it is more likely that this relationship is coincidental.

Soil factors appear to have very little effect on the floristic variables of each site. Phosphorous is negatively correlated to rainfall, species richness and woody component. The interrelationships of many of the soil factors do not appear to affect the floristic variables.

3.4.3 Conservation:

The evaluation of nature or "wildlife" ("wildlife" includes all macroscopic organisms other than those which have been domesticated, introduced, or bred) is a complex process.

Complexity arises from the multiplicity of functions which "wildlife" may perform and hence both the consequent range of criteria for evaluation and the different relative weights those criteria may be given by different evaluators (Margules and Usher, 1984).

There are a number of techniques available for evaluating "wildlife" which are appropriate for different purposes. Tubbs and Blackwood (1971) used the simple, rapid approach of using aerial photography and field work to evaluate land in terms of relative rarity and species diversity of the habitat's present and produced `ecological zones' of standard value. In terms of time and manpower this method is very efficient. Ratcliff (1971), Tansley(1982) and many other workers adopted the approach of giving values to various criteria and then by either adding or multiplying them , assigning a conservation value to the area and its wildlife. Helliwell (1973) took this approach a step further by giving value to habitats and components of habitats eg. trees, woods or individual species, based on a number of criteria. These were then converted into arbitary monetary values. The values of trees, for example, were based on crown area, useful life expectancy, importance of position in the landscape, presence of other trees, form, species and special or historical value. His system for valuing habitats was based on seven factors: direct return (capital value), genetic reserve, ecological balance, educational value, research value, natural history interest, and local character. Evaluating these criteria is largely based on subjective judgements.

The use of ecological criteria has been critically evaluated by various workers such as Spellerberg (1981) Goldsmith (1983) Margules & Usher (1984) and Margules (1984). The main criticism is that they contain a mixture of ecological criteria (such as size, diversity or richness) which can be more or less precisely measured, and rarity and conservation criteria which are value judgements of ecological or social and aesthetic criteria (Goldsmith, 1983). Examples of the latter categorising are potential value and intrinsic appeal, eg. the intrinsic appeal of impenetrable succulent thicket may well depend on whether one was brought up in Uitenhage or Johannesburg.

Although a standard approach and technique for evaluating "nature" is desirable for making comparisons, Margules and Usher (1984) showed that when a panel of assessors evaluated a number of natural areas in different habitats according to a set of 18 criteria, no simple set of criteria weights could be found to account satisfactorily for the variance of all assessors` site scores, and therefore no general model could be derived. They did however find that there was a general agreement on the relative importance of each criterion to the evaluation of each site.

Using the same methods as Margules and Usher (1984), Margules (1984) found that similar results were obtained when similar habitats were evaluated, however he was able to derive a workable framework for the evaluation and comparison of potential conservation sites in areas where sites are generally small (see Margules, 1984).

Having briefly explored the philosophical background of `nature' evaluation and considered some techniques, it is evident that evaluating the Valley Bushveld is a complex and involved process. The need for the conservation of Valley Bushveld has already been emphasised: only 1,21% of the total extent of Subtropical Thicket occurs in the Eastern Cape in conservation areas (Table 5). Subtropical Thicket also came out on top of a table ranking the vegetation types in the Eastern Cape according to conservation priorities (Table 8). This evaluation used the same approach as Ratcliffe (1971) Helliwell (1973) Tansely (1980) and Margules (1984) in that ecological and social criteria were weighted to give each vegetation type a value. It is not possible at this stage to evaluate potential nature reserves within the Valley Bushveld, however using the floristic information obtained at each site (Fig 20), sites could be evaluated using the approach of Margules (1984).

Margules (1984) used a panel of assessors from a variety of disciplines (planning, engineering, conservation etc.) to assess a number of sites according to eleven criteria. In this study the sites to be evaluated are not units (reserves or potential reserves) and so many of the social criteria (representativeness, naturalness, threat of human interference, ecological fragility, scientific value, position in ecological/geological unit and wildlife reservoir potential) cannot be used. The sites can only be evaluated for ecological criteria for which accurate measurements have been made. Table 14 shows scores for these criteria for each site. The scores have been multiplied to give each site a value. The interdependent variables are normally multiplied and independent variables added (Helliwell, 1973).

The results of this evaluation show that site 12 scored highest and so has the greatest floristic value to conservation. Site 9 is ranked second and site 11 third, however they do not allfall into the same orders of vegetation. Kaffrarian Thicket in the Humansdorp region scored highest however the Kaffrarian Thicket at the Fish River Mouth (site 3) and the Kariega River Mouth (site 6) are amongst the lowest and so are not floristically important to conservation. Conservation values therefore vary considerably within vegetation types and communities.

Environmental factors responsible for the criteria considered to be important to conservation can thus be identified from the regression analysis (Table 13). Endemism shows strong negative relationships to rainfall and longitude, so the drier western areas of thicket could be predictably high in endemics and thus be important to conservation. Conversely, species richness is strongly positively correlated to rainfall and so in wet areas the vegetation can be presumed to be rich in species and so important to conservation. Diversity shows no relationships to environmental factors and so no predictions of high or low diversity can be made according to environmental factors. The environmental factors important to the conservation values of Valley Bushveld from a floristic point of view are therefore low and high rainfall and longitude.

TABLE 14.Thecalculation of the conservation indexfor each site. The scores assigned to each criterion are explained in the key.

	1	2	3	4	5	6	7	8	9	10	11	12
No. Endemics	2	1	3	4	4	2	4	4	5	3	5	4
Threatened Species	3	3	2	2	2	1	1	2	3	1	4	4
Species Richness	5	4	3	2	2	3	3	2	4	1	2	3
Diversity	4	4	1	3	3	2	4	3	3	1	4	4
Conservation Index	120	48	18	48	48	12	48	48	180	3	160	192

KEY

Endemics & Threatened Species	Species Richness	Diversity
1 = 0- 2 species	1 = 20-22 sp./plot	1 = 1,080-1,090
2 = 3- 5 "	2 = 23-25 "	2 = 1,091-1,100
3 = 6-10 "	3 = 26-30 "	3 = 1,110-1,200
4 = 11-20 "	4 = 31-40 "	4 = 1,201-1,500
	5 = 40-100 "	5 = 1,501-2,000

CHAPTER 4

CONCLUSIONS

4.1 Threatened plant taxa of the Eastern Cape

Herbarium records indicate that the Eastern Cape has 662 vascular plant taxa in the following categories:

1 recently extinct

3 endangered

15 vulnerable and declining

41 rare

117 indeterminate, but in one of the above categories

485 uncertain whether safe or not

Of these 662 threatened taxa 93 are endemic to the Eastern Cape. There are also an additional 112 endemic taxa that do not appear to be in any sort of danger, giving the Eastern Cape atotal of 205 endemics. This list together with distribution and other information is stored in a computer based data bank and is therefore easily retrievable and readily available to interested people and organizations. Field surveys and increased collecting are required to investigate the high number of I and U cases. A paper based back-up data bank is also suggested in order to monitor the seriously threatened taxa. This data bank should follow the guidelines as proposed by the IUCN(Table 7).

The distribution of threatened taxa in the vegetation types of the Eastern Cape shows that many taxa from specific habitats, such as aquatic and marshy areas are threatened, possibly owing to the greater sensitivity of these habitats to disturbance. Thicket vegetation also shows a high number of threatened taxa and thus it warranted further investigation as a vegetation type.

Distribution records of the threatened taxa are inadequate and so it was not possible to list the threatened taxa by quarter degree squares. Grid references for some of the taxa are stored in the data bank and are easily retrievable.

Of the 90 conservation areas in the Eastern Cape checklists of the flora were available for only 10 ,indicating a lack of knowledge of threatened taxa within these areas . The Directorate of Forestry controls a large proportion of these areas yet no checklists are available for any of the areas under their control.

The best method of conserving threatened taxa is by conserving viable populations in their natural habitats. As these will inevitably be in the form of small reserves or sanctuaries they should as far as possible follow Island Biogeographic theory in geometric design. Other methods of conserving threatened taxa include relocation and establishment of alternative "natural" populations, development of seedbanks and protection and cultivation of taxa within Botanical Gardens.

The major threats to the vegetation and thus to many taxa in the Eastern Cape include grazing, bush clearing, burning, exploitation, alien invasion, erosion and possibly natural factors. It is not clear at this stage which of the threats are responsible for the greatest pressures on the taxa, however this should become evident after field surveys have been conducted.

General and specific field studies in the Eastern Cape are urgently required to provide more information on the present status of the vegetation in the Eastern Cape and to gain more information on the possibly threatened taxa.

4.2 Identification of threatened plant communities

As it was not feasible to conduct intensive field studies on individual threatened plant taxa, nor was it practical to investigate all the vegetation types, the most threatened vegetation type was identified. Criteria used to evaluate the vegetation types were based on the findings of the survey of threatened plants. A table (Table 9) ranking the vegetation types in a conservation priority order indicates the Subtropical Thicket as the most threatened vegetation type in the Eastern Cape. Valley Bushveld a major component of Subtropical Thicket in the Eastern Cape was therefore chosen to be investigated for conservation requirements.

4.3 Evaluation of Valley Bushveld

The classification of the Valley Bushveld is summarized in Table 12. Floristically the Inland Kaffrarian Thicket is the most species rich and diverse thicket type while Inland Succulent

Thicket is the most species poor thicket type in the Eastern Cape. Diversity is also lowest in the latter thicket type. Conversely, numbers of endemic species are highest in the Kaffrarian Succulent Thickets. The occurrance and numbers of threatened plants were more-or-less constant throughout the sampled sites, thus it was not possible to identify the most threatened areas from the information obtained.

Correlations between floristic variables and environmental variables are summarized in Table 15. Predictably the most significant environmental factor responsible for many of the floristic variables is rainfall. Rainfall is positively correlated to species richness, Simpsons dominance and percent woody component and negatively correlated to percent succulent component and percent endemic component. The relationships of longitude to floristic variables are probably explained by an interrelationship between longitude and rainfall. Most of the other relationships are also explained by interrelationships or are spurious.

4.4 Conservation

Conservation values for the sites evaluated on ecological criteria only, show that the Humansdorp Site (site 12) scored highest. The St. Georges Strand and Lower Gamtoos Sites (sites 9 & 11) also scored highly indicating that the Coastal Thickets from the western regions of the Eastern Cape (P.E. westwards) have highest conservation values for Subtropical Thicket

TABLE 15. Summary of correlations between independant and dependant variables recorded at each site

	LONGITUDE	RAINFALL	GRAZING	LITTER COVER	ROCK COVER	P	K	Mg
SPECIES RICHNESS		+++	-			--		
SIMPSONS DOMINANCE	++	++						
% WOODY COMPONENT	+	+++				-		+
% SUCULENTS	-	---	+	-				
% ENDEMICS	--	--						
% THREATENED TAXA				+	++		+	

\+ p 0,05
++ p 0,01
+++ p 0,001

vegetation. The Fort Pato site (site 1) also has a high conservation value, mainly owing to its species richness and high diversity of plants.

The most important environmental factor associated with conservation value is rainfall. Regions receiving high annual rainfalls (above 800 mm. yr^{-1}) can be expected to be species rich and diverse and therefore of high value for conservation. Low rainfall areas have higher numbers of endemic species which are mainly succulents of karroid affinity. Thickets in these areas, especially succulent thickets of the coastal areas which are slightly more moist and so have a higher diversity, are also important to conservation.

The criteria used to evaluate the sites for conservation purposes possibly pose the most controversial aspect of the project. Criteria such as species diversity, endemism and numbers of threatened taxa have many arguments for and against their use (Margules & Usher 1981) however it is essential to note that they are useful only when comparing sites of similar vegetation types. They cannot be used to identify "healthy" or relativily undisturbed areas. The identification of "healthy" areas should be based on the identification of as many functioning natural biological processes (pollination, dispersal, germination, recruitment, predation and natural disturbances etc.) as possible. As many of these processes have not yet been identified or understood in thicket vegetation, research investigating them should be initiated. Understanding of biological processes is essential if we are to successfully conserve natural habitats and thus individual plant species.

4.5 Research requirements

1) A long term and ongoing monitoring programme based on the guidelines of the ICUN is required to investigate the bulk of the taxa listed as threatened in the Eastern Cape.As a clearer picture of the exact numbers of seriously threatened plants and moreup-to-date information about them are obtained, strategies need to be devised to conserve these plants.
2) Detailed investigations need to be extended to other vegetation types in the Eastern Cape.
3) If we are ultimately to succeed in the long term conservation of communities, projects investigating natural processes in Thicket and other vegetation types in the Eastern Cape need to be initiated to obtain a clear picture of how these communities function under various management strategies .
4) Specific sites requiring conservation need to be identified within areas of high conservation value and these sites should then be evaluated along the lines suggested by Margules (1984).

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APPENDIX 1

List of threatened and endemic plant taxa of the Eastern Cape. Nomenclature is that of Gibbs Russell *et al.*,(1984). The conservation status codes are as follows; X = Extinct, E = Endangered, V = Vulnerable, R = Rare, I = Indeterminate, U = Uncertain whether safe or not and e = Endemic. Definitions of the conservation status categories appear on page 39.

	Conservation status
ZAMIACEAE	
Encephalartos altensteinii Lehm.	R
E. arenarius R.A. Dyer	Ve
E. caffer (Thunb.) Lehm.	V
E. cycadifolius (Jacq.) Lehm.	V
E. friderici-guiliemi Lehm.	R
E. horridus (Jacq.) Lehm.	Ve
E. latifrons Lehm.	Ee
E. lehmannii Lehm.	R
E. longifolius (Jacq.) Lehm.	V
E. princeps R.A. Dyer	V
E. trispinosus (Hook.) R.A. Dyer	Ve
E. villosus Lehm.	R
CUPRESSACEAE	
Widdringtonia schwarzii (Marloth) Mast.	Ue
ISOETACEAE	
Isoetes wormaldii Sim.	U
CYATHEACEAE	
Cyathea capensis (L.F.) J.E. Sm.	U
C. dregei Kunze	R

MARSILEACEAE

Marsilea schelpeana Launert	V

CYPERACEAE

Carex ecklonii Nees	U
Cyperus brevis Boeck.	V
C. rupestris Kunth	U
C. semitrifidus Schrad.	U
Eleocharis palustris R.Br.	U
Ficinia capillifolia (Schrad.) C.B.Cl.	U
F. dasystachys C.B.Cl.	I
F. laciniata (Thunb.) Nees	U
F. ramosissima Kunth	U
F. trichodes (Schrad.) Benth. & Hook.F.	U
Fuirena microlepis Kunth	I
Kyllinga alba Nees	U
Mariscus breviradius Vorster Ms.	U
M. dubius (Rottb.) Kuekenth. ex G.E.C. Fischer	I
M. longicarpus	I
M. macrocarpus Kunth	U
M. solidus subsp. solidus var. solidus	U
M. solidus (C.B.Cl.) Vorster subsp. solidus var. involutus	U
M. sumatrensis (Retz.) J.Raynal	U
M. tabularis (Schrad.) C.B.Cl.	U
M. uitenhagensis Steud.	U
Pycreus polystachyos (Rottb.) Beauv.	I
Rhynchospora rugosa (Vahl.) S.Gale	U

Schoenoxiphium caricoides C.B.Cl.	U
S. ecklonii Nees	U
S. filiforme Kuekenth	U
S. lanceum (Thunb.) Kuekenth.	U
S. rufum Nees	U
Tetraria compar (L.) Lestib.	U
T. galpinii Schonl. & Turrill	I
T. robusta (Kunth) C.B.Cl.	e
RESTIONACEAE	
Elegia compensis (Burm.F.) Schelpe	I
E. spathacea Mast. var. spathecea	I
E. thyrsoidea (Mast.) Pillans	Ue
Hypodiscus synchroolepis (Steud.) Mast.	e
Restio aspericaykus Pillans	U
R. fourcadei Pillans	Ue
R. giganteus (Kunth) N.E.Br.	e
R. sejunctus Mast.	e
Thamnochortus glaber Pillans	e
COMMELINACEAE	
Commelina undulata R.Br.	U
LILIACEAE	
Albuca aurea Jacq.	U
A. caudata Jacq.	U
A. crudenii Archib.	U
A. juncifolia Bak.	U
A. microcantha	Ue
A. polyphylla Bak.	U
A. rogersii Schonl.	U

Aloe africana Mill.	e
A. bainesii T.Dyer	U
A. bowiea Roem. & Schult.	Ue
A. humilis (L.) Mill. var.enchinata (Willd.) Bak.	I
A. reynoldsii Letty	V
A. striatula Haw. var. caesia Reynolds	U
A. striatula Haw. var. striatula	U
A. tenuior Haw. var. densiflora Reynolds	U
A. tidmarshii (Schonl.) Muller ex. R.A. Dyer	e
Androcymbium albanense Schonl.	e
Asparagus crassicladus Jessop	e
Astroloba congesta (Salm-Dyck) Uitew.	Ue
Bulbine caulescens L.	e
Drimia haworthioides Bak.	Ue
D. sphaerocephala Bak.	U
Eriospermum brevipes Bak.	Ue
E. cordiforme Salter	Ue
E. dissitiflorum Schltr.	U
E. dregei Schonl.	e
E. dyeri Archib.	Ue
E. porphyrium Archib.	Ue
Eucomis autumnalis (Mill.) Chitt Subsp. amaryllidifolia (Bak.) Reyneke	U
E. autumnalis (Mill.) Chitt Subsp. autumnalis	U
E. comosa (Houtt.) Wehrh. var. comosa	U
Gasteria acinacifolia (Jacq.) Haw.	U

G. armstrongii Schonl.	Ue
G. baylissiana Rauh	e
G. beckeri Schonl.	Ue
G. croucheri (Hook. F.) Bak.	e
G. liliputana V.Poelln.	Ue
G. variolosa Bak.	U
Haworthia attenuata Haw.	U
H. fasciata (Willd.) Haw.	e
H. fulva G.G.Sm.	U
H. glauca Bak.	U
H. greenii Bak.	U
H. incurvula V.Poelln	U
H. lepida G.G.Sm.	U
H. longiana V.Poelln	U
H. monticola (Bak.) Fourc.	U
H. radula (Jacq.) Haw.	e
H. ramosa G.G.Sm.	I
H. springbokvlakensis C.L.Scott	I
H. translucens Haw.	U
Kniphofia acraea Codd	I
K. citrina Bak.	I
K. fibrosa Bak.	I
K. praecox Bak. subsp. bruceae Codd	R
K. rooperi (Moore) Lem.	V
Lachenalia algoensis Schonl.	Ue
L. campanulata Bak.	I
L. convallarioides Bak.	I
L. rhodantha Bak.	I

L. socialis Bak.	Ue
Ledebouria concolor (Bak.) Jessop	I
L. hypoxidioides (Schonl.) Jessop	I
L. ovalifolia (Schrad.) Jessop	I
Massonia grandiflora Lindl.	U
Neopatersonia uitenhagensis Schonl.	I
Ornithogalum anguinum Leighton	U
O. fimbrimarginatum Leighton	U
Scilla rigidifolium Kunth	e
Trachyandra giffenii (Leighton) Oberm.	I
T. capillata (V. Poelln.) Oberm.	I
AMARYLLIDACEAE	
Brunsvigia gregaria R.A. Dyer	e
B. litoralis R.A. Dyer	e
Clivia nobilis Lindl.	R
C. miniata Regel	I
Crinum campanulatum Herb.	R
C. lineare L.F.	R
C. variabile (Jacq.) Herb.	R
Cyrtanthus affinis R.A. Dyer	Ue
C. clavatus (L'Herit) R.A. Dyer	R
C. flavus Barnes	U
C. helictus Lehm.	R
C. huttonii Bak.	R
C. macowani Bak.	U
C. smithiae Watt ex Harv.	R
C. spiralis Burch. ex Ker-Gawl.	R

C. staadensis Schonl.	V
C. suaveolens Schonl.	U
C. tuckii Bak.	U
Haemanthus carneus Ker-Gawl.	U
Klingia namaqualia	U
Nerine bowdenii Watson	I
N. huttoniae Schonl.	U
Strumaria undulata Jacq.	U
HYPOXIDACEAE	
Empodium plicatum (Thunb.) Garside	U
Hypoxis kraussiana Buchinger	I
H. ludwigii Bak.	I
H. stellipilis Ker-Gawl.	e
H. zeyheri Bak.	e
Spiłoxene minuta (L.) Fourc.	U
DIOSCOREACEAE	
Dioscorea stipulose Uline ex Kunth.	U
IRIDACEAE	
Anapalina caffra (Ker-Gawl. ex Bak.) G.J. Lewis	e
A. intermedia (Bak.) G.J. Lewis	e
Anomatheca laxa (Thunb.) Goldbl.	I
Babiana disticha Ker-Gawl.	U
Bobartia orientalis J.B. Gillet	Re
Dierama medium N.E.Br.	U
D. pulcherrimum (Hook. F.) Bak.	V
Dietes bicolor (Steud.) Sweet ex Klatt	R
Geissorhiza bracteata Klatt	U
G. foliosa Klatt	I

G. setacea (Thunb.) Ker-Gawl.	I
Gladiolus alatus L. var. algoensis Herb.	X
G. floribundus Jacq.	U
G. gueinzii Kunze	R
G. oppositiflorus Herb. subsp. salmoneus (Bak.) Oberm.	R
G. permeabilis Delaroche	e
Homeria britteniae L. Bol.	U
Homoglossum huttonii N.E. Br.	e
Ixia orientalis L.Bol.	Ue
Moraea algoensis Goldbl.	Ue
M. reticulata Goldbl.	U
M. viscaria (L.F.) Ker-Gawl.	U
Romulea atrandra G.J. Lewis var. esterhuyseniae de Vos	I
R. gigantea Beg.	U
R. longipes Schltr.	e
Syringodea bicolor Bak.	U
S. flanaganii Bak.	U
Tritonia atrorubens (N.E.Br.) L. Bol.	I
T. securigera (Ait.) Ker-Gawl.	e
Tritoniopsis ramosa (Eckl. ex Klatt.)G.J. Lewis var. ramosa	I
Watsonia gladioloides Schltr.	I
W. longifolia Matthews & L. Bol.	e
STRELITZIACEAE	
Strelitzia alba (L.F.) Skeels	e
S. juncea Link	R
S. reginae Ait.	e

ORCHIDACEAE

Acrolophia micrantha (Lindl.) Schltr. & H.Bol	R
Angraecum sacciferum Lindl.	U
Anochilus flanaganii (H.Bol.) Rolfe	R
Bonatea densiflora	U
Brachycorythis macowaniana Reichb. F.	U
Calanthe natalensis	I
Corycium dracomontanum Parkman & Schelpe	I
C. tricuspidatum H. Bol.	I
Diaphananthe xanthopollinia (Reichb. F.) Summerh.	U
Disa tysonii H. Bol.	R
Disperis macowanii H. Bol.	U
D. wealii Reichb.F.	I
Eulophia meleagris Reichb. F.	I
E. platypetala Lindl.	V
E. speciosa (R.Br.ex Lindl.) H. Bol.	U
Habenaria anguiceps H.Bol.	I
H. falcicornis (Burch. ex Lindl.) H.Bol. var. caffra (Schltr.) Renz & Schelpe	I
H. lithophila Schltr.	I
H. tridens Lindl.	U
Herschelia lugens (H.Bol.) Kraenzl. var. nigrescens Linder	E
Holothrix cernua (Burm.F.) Schelpe	U
H. longicornu G.J. Lewis	U
H. macowaniana Reichb. F.	U
H. pilosa (Burch. ex Lindl.) Reichb. F.	I

H. villosa Lindl.	U
Mystacidium aliceae H.Bol.	U
Pterygodium newdigateae H.Bol.	I
Satyrium acuminatum Lindl.	U
S. bicorne (L.) Thunb.	I
S. hallackii H. Bol.	I
S. ligulatum Lindl.	I
S. membranaceum Swartz	e
S. princeps H. Bol.	e
S. trinerve Lindl.	I
POACEAE/GRAMINEAE	
Anthoxanthum brevifolium Stapf	U
Arundinaria tessellata (Nees) Munro	V
Catapodium rigidum (L) C.E. Hubb	U
Chloris pycnothrix Trin.	U
Cymbopogon proxilus (Stapf) Phill.	U
Digitaria setifolia Stapf	U
Panicum heptariera	e
P. obumbratum Stapf	e
Pennisetum sphacelatum (Nees) Dur. & Schinz	U
Pentaschistis heptamera (Nees) Stapf	e
SALICACEAE	
Salix mucronata Thunb.	U
MORACEAE	
Ficus polita Vahl	U
PROTEACEAE	
Leucadendron conicum (Lam) I. Williams	e
L. ericifolium R. Br.	U

L. loeriense I. Williams	e
L. nobile I. Williams	e
L. orientale I. Williams	I
L. uliginosum R. Br. subsp. glabratum I. Williams	U
Leucospermum cuneiforme (Burm.F) Rourke	U
Paranomus reflexus (Phill.& Hutch) N.E.Br.	e
Protea foliosa Rourke	e
P. macrocaphala	U
P. punctata Meisn.	U
P. rupicola Mund ex Meisn.	U
P. subvestita N.E.Br.	U
P. tenax (Salisb.) R.Br.	e
P. vogtsiae Rourke	I
LORANTHACEAE	
Tapinanthus kraussianus (Meisn)	U
SANTALACEAE	
Rhoiacarpos capensis (Harv.) DC.	e
Thesium congestum R.A. Dyer	U
T. disciflorum A.W. Hill	I
T. flexuosum DC.	e
T. leptocaule Sond.	Ue
T. lisae-mariae Stauffer	U
T. orientale A.W. Hill	U
T. pallidum DC.	I
T. quinqueflorum Sond.	U
T. scandens E. Mey	e
T. sonderianum Schltr.	U

POLYGONACEAE

Rumex obtusifolius L. subsp.agrestis (Fr.) Dans.	I
CHENOPODIACEAE	
Atriplex rosea L.	I
Rhagodia nutans R.Br.	U
AMARANTHACEAE	
Amaranthus deflexus L.	U
A. lybridus L.	U
AIZOACEAE	
Limeum pauciflorum Moq.	U
L. viscosum (Gay) Fenzl	I
Psammotropha marginata (Thunb.) Druce	U
MESEMBRYANTHEMACEAE	
Bergeranthus addoensis L.Bol.	Ue
B. katbergensis L. Bol.	Ue
B. multiceps (Salm-Dyck) Schwant.	I
B. respertinus (Berg) Schwartz	U
B. scapiger (Haw.) N.E.Br.	U
B. vespertinus (Bgr.) Schwant.	U
Delosperma acuminatum L. Bol.	U
D. britteniae L. Bol.	U
D. echinatum (Ait.) Schwant.	e
D. ecklonis (Salm-Dyck) Schwant.	e
D. frutescens L. Bol.	I
D. laxipetalum L. Bol.	U
D. lehmannii (Eckl. and Zeyh.) Schwant	U
D. rogersii (Schoenl. & Bgr.) L. Bol. var. rogersii	U
D. vinaceum (L. Bol.) L. Bol.	U

Disphyma crassifolium (L.) L. Bol.	U
Drosanthemum candens (Haw.) Schwant.	U
D. gracillimum L. Bol.	Ue
D. intermedium (L. Bol.) L. Bol.	e
D. lique (N.E.Br.) Schwant.	e
D. parvifolium (Haw.) Schwant.	U
Faucaria britteniae L. Bol.	Ue
Glottiphyllum longum (Haw.) N.E.Br.	e
Hereroa dyeri L. Bol.	I
Lampranthus dependens (L. Bol.) L.Bol.	U
L. elegans (Jacq.) Schwant.	U
L. formosus (Haw.) N.E.Br.	U
L. pauciflorus (L. Bol.) N.E.Br.	Ue
L. productus (Haw.) N.E.Br.	e
L. scaber (L.) N.E.Br.	U
L. spectabilis (Haw.) N.E.Br.	e
Malephora verruculoides (Sond.) Schwant.	I
Mestoklema albanicum N.E.Br. ex Glen	Ue
Micropterum (Genus) Schwant	e
Orthopterum (Genus) L. Bol.	e
Platythyra haeckeliana (Berger) N.E.Br.	e
Pleiospilos bolusii (Hook. F.) N.E.Br.	U
Psilocaulon simile (Sond.) Schwant.	U
Rabiea albinota (Haw.) N.E.Br.	I
Rhombophyllum dolabriforme (L.) Schwant.	U
R. rhomboideum (Salm-Dyck) var. rhomboideum Schwant.	Ue
Ruschia congesta (Salm-Dyck) L. Bol.	U

R. dyeri	e
R. tenella (Haw.) Schwant.	U
R. uncinata (L.) Schwant.	e
Sceletium crassicaule (Haw.) L. Bol.	U
Trichodiadema barbatum (L.) Schwant.	I
T. decorum (N.E.Br) Stearn	Ue
PORTULACACEAE	
Anacampseros albidiflora V. Poelln	U
A. arachnoides (Harv.) Sims	U
A. filamentosa (Harv) Sims	U
Talinum paniculatum (Jaqu) Gaertn.	U
CARYOPHYLLACEAE	
Cerastium glomeratum Thuill	U
Dianthus holopetalus Turcz.	U
Silene primuliflora Eckl. & Zeyh.	e
Spergularia rubra (L.) J. & C. Presl	U
ANNONACEAE	
Monanthotaxis caffra (Sond) Verdc	U
LAURACEAE	
Cryptocarya myrtifolia Stapf	U
FUMARIACEAE	
Fumaria muralis Sond. ex Koch	U
BRASSICACEAE	
Bachmannia woodii (Oliv.) Gilg.	U
Heliophila macrosperma Burch. ex DC.	U
H. ramosissima O.E. Schulz	U
Lepidium africanum (Burm. F.) DC.	U
L. africanum (Burm.F.) subsp. *divaricatum* DC. (Ait.)	U

Jonsell	
<u>L. bipinnatum</u> Thunb.	U
<u>Matthiola torulosa</u> (Thunb) DC.	U
CRASSULACEAE	
<u>Adromischus bicolor</u> P.C.Hutch	Ue
<u>A. cooperi</u> (Bak.) Berger	Ue
<u>A. cristatus</u> (Haw.) Lem.	Ue
<u>A. fallax</u> Toelken	Ue
<u>A. inamoenus</u> Toelken	Ue
<u>A. rhombifolius</u> (Haw.) Lem. ex Berger	U
<u>A. sphenophyllus</u> C.A.Sm.	Ue
<u>Cotyledon campanulata</u> Marloth	e
<u>C. velutina</u> Hook F.	Ue
<u>Crassula arata</u> (Mill.) Druce	U
<u>C. arborescens</u> (Mill.) Willd. subsp. <u>undulatifolia</u> Toelken	R
<u>C. decidua</u> Schonl.	e
<u>C. intermedia</u> Schonl.	Ue
<u>C. lanuginosa</u> Harv.	Ue
<u>C. latibracteata</u> Toelken	Ue
<u>C. mesembryanthoides</u> (Haw.) Dietr.	e
<u>C. multicava</u> Lem.	U
<u>C. planifolia</u> Schonl.	U
<u>C. sediflora</u> (Eckl. & Zeyh.) Walp var. <u>amatolica</u> (Schonl.) Toelken	I
<u>C. sericea</u> Schonl.	U
<u>C. socialis</u> Schonl.	Re

C. southii Schonl. subsp. sphaerocephala Toelken	U
C. southii Schonl. subsp. southii	U
MONTINIACEAE	
Montinia coryophyllacea Thunb.	U
PITTOSPORACEAE	
Pittosporum crassifolium Banks ex Soland. ex Cunn.	U
BRUNIACEAE	
Berzelia burchellii Duemmer	U
ROSACEAE	
Cliffortia dregeana Presl.	U
C. drepanoides Eckl. & Zeyh.	Ue
C. graminea L.F. var. elegans Weim.	U
C. ilicifolia L. var. incisa Harv.	U
C. montana Weim.	U
Prunus africana (Hoek.F.) Kalkm.	I
Rubus fruticosus L.	U
FABACEAE	
Argyrolobiumn barbatum Walp.	U
A. crassifolium Eckl. & Zeyh.	Ue
A. nivea	Ue
A. sericeum Eckl. & Zeyh.	Ue
A. setaceae	Ue
Aspalathus biflora E. Mey	U
A. biflora E. Mey. subsp longicarpa Dahlg.	U
A. cliffortiifolia Dahlg.	I
A. fourcadei L. Bol.	U
A. marginalis Eckl. & Zeyh.	I
A. nivea Thunb.	e

A. simii H.Bol. subsp. simii	U
A. simii L. Bol. subsp. katbergensis Dahlg.	U
A. teres Eckl. & Zeyh.	U
A. teres Eckl. & Zeyh. subsp. thodei Dahlg.	U
Bauhinia bowkeri Harv.	U
Buchenroedera meyeri Presl.	I
B. umbellata Harv.	I
Calpurnia floribunda Harv.	U
Cassia bicapsularis L.	U
Cyclopia aurescens Kies	Ue
Dolichos peglerae L. Bol.	I
Elephantorrrhiza sp.	R
Eriosema salignum E. Mey.	I
Erythrina humeana Spreng.	U
Indigofera complicata Eckl. & Zeyh.	U
I. declinata E. Mey	U
I. disticha Eckl. & Zeyh.	e
I. glaucescens Eckl. & Zeyh.	Ue
I. stenophylla Eckl. & Zeyh.	e
I. sulcata DC.	e
Lebeckia microphylla E. Mey	U
Lessertia carnosa Eckl. & Zeyh.	I
L. flexuosa E. Mey	U
Lotononis microphylla Harv.	I
L. pumila Eckl. & Zeyh.	U
L. pungens Eckl. & Zeyh.	e
L. sericophylla Benth	U

L. versicolor Benth.	U
Medicago nigra (L.) Krocker	I
Melolobium pegleri Duemmer	I
Millettia sutherlandii Harv.	U
Mundulea pondoensis Codd	U
M. sericea (Willd.) A. Chev	U
Podalyria burchellii DC.	Ue
P. velutina Burch.	U
Psoralea axillaris L.	U
P. pinnata L.	U
P. polyphylla Eckl. & Zeyh.	e
Rhynchosia effusa (E. Mey.) Druce	U
R. grandiflora Steud.	U
R. leucoscias Benth.	U
R. peglerae Bak. F.	I
Tephrosia capensis (Jacq.) Pers. var. *longipetiolata* H.M. Forbes	U
T. polystachya E. Mey var. *longidens* H.M. Forbes	U
Trifolium burchellianum Ser. var. *johnstonii* (Oliv.) J.B.Gillett	U
T. campestre Schreb.	U
T. stipulaceum Thunb.	U
Umtiza listerana Sim.	Ue
GERANIACEAE	
Erodium malachoides (L.) Willd.	U
Geranium flanaganii Schltr.	I
G. harveyi Briq.	U
G. schlechteri Kunth	I

Monsonia galpinii Schltr. ex Kunth	U
Pelargonium campestre (Eckl. & Zeyh.) Harv.	U
P. frutetorum R.A.Dyer	U
P. leucophyllum Turcz.	I
P. ovale (Burm. F.) L' Hèrit.	e
P. parvirostre R.A. Dyer	U
P. ranunculophyllum (Eckl. & Zeyh.) Bak.	I
P. schizopetalum Sweet	e
P. urbanum (Eckl. & Zeyh.) Harv.	Ue
OXALIDACEAE	
Oxalis bifurca Lodd. var. *bifurca*	U
O. psilopoda Turcz.	U
O. stenorrhyncha Salter	e
O. tragopoda Salter	U
O. tysonii Phill.	I
ERYTHROXYLACEAE	
Erythroxylum pictum E. Mey ex Sond.	U
Nectaropetalum capense (H. Bol.) Stapf & Boodle	U
ZYGOPHYLLACEAE	
Zygophyllum uitenhagense Sond.	e
RUTACEAE	
Acmadenia densifolia Sond.	I
A. kiwanensis I. Williams	Ue
Agathosma acutissima Duemmer.	Ue
A. gonaquensis Eckl. & Zeyh.	e
A. hirta (Lam.) Bartl. & Wendl.	Ue
A. pilifera Schlechtd.	e

A. *puberula* (Steud.) Fourc.	e
A. *stenopetala* (Steud.) Steud.	e
A. *unicarpellata* (Fourc) Pillans	U
Diosma passerinoides Steud.	R
BURSERACEAE	
Commiphora harveyi (Engl.) Engl.	R
C. *woodii* Engl.	I
POLYGALACEAE	
Muraltia squarrosa (L.F.) DC.	e
Polygala bowkeriae Harv.	I
P. *ericifolia* DC.	e
P. *hamata*	Ue
EUPHORBIACEAE	
Acalypha zeyheri Baill.	I
Clutia africana Poir.	U
C. *alpina* Prain	I
C. *pulchella* L. var. *obtusata* Sond.	U
C. *rubicaulis* Eckl. ex Sond. var. *grandifolia* Prain	U
Euphorbia albanica N.E. Br.	U
E. *bothae* Lotsy and Goddijn	e
E. *coerulescens* Haw.	e
E. *cumulata* R.A. Dyer	e
E. *curvirama* R.A. Dyer	e
E. *ernesti* N.E. Br.	U
E. *ferox* Marloth	Ue
E. *fimbriata* Scop.	e
E. *flanaganii* N.E. Br.	U
E. *franckiana* Berger	I

E. globosa (Haw.) Sims.	e
E. gorgonis Berger	e
E. horrida Boiss.	I
E. jansenvillensis Nel	R
E. ledienii Berger var. *dregei* N.E. Br.	R
E. ledienii Berger	e
E. meloformis Ait.	e
E. micracantha Boiss.	Ue
E. obesa Hook. F.	Ee
E. ornithopus Jacq.	Ue
E. pentagona Haw.	e
E. polycephala Marloth	Ue
E. polygona Haw.	e
E. squarrosa Haw.	e
E. stellata Willd.	Ue
E. striata Thunb. var. *cuspidata* (Boiss) N.E. Br.	U
E. submammillaris (Berger) Berger	Ue
E. symmetrica Whyte, Dyer & Sloane	U
E. valida N.E. Br.	Ie
Micrococca capensis (Baill.) Prain	U
Tragia collina Prain	U
CALLITRICHACEAE	
Callitriche bolusii Schonl. & Pax	I
BUXACEAE	
Buxus natalensis (Oliv.) Hutchinson	U
B. macowanii Oliv.	U

ANACARDIACEAE

Rhus fraseri Schonl.	U
R. krebsiana Presl. ex Engl.	U

CELASTRACEAE

Cassine eucleiformis (Eckl. & Zeyh.ij) Kuntze	U
C. reticulata (Eckl. & Zeyh.) Codd	e
Hartogellaia schinoides (Spreng.) Codd	U

SAPINDACEAE

Atalaya capensis R.A. Dyer	U
Smelophyllum capense Radlk.	e

MELIANTHACEAE

Bersama stayneri Phill.	U

GREYIACEAE

Greyia flanaganii H.Bol.	R

RHAMNACEAE

Noltia africana (L.) Reichb. F.	U
Phylica abietina Eckl. & Zeyh.	e
P. debilis Eckl. & Zeyh. var. debilis	I
P. galpinii Pillans	U
P. gnidioides Eckl. & Zeyh.	e
P. litoralis D. Dietr.	e
P. purpurea Sond.	U
P. simii Pillans	I
P. tysoni Pillans var. brevifolia Pillans	I

VITACEAE

Cissus quadrangularis L.	U

MALVACEAE

Hibiscus aethiopicus L.	U
H. aridus R.A. Dyer	U
Malva sylvestris L.	U
STERCULIACEAE	
Dombeya tiliacea (Endl.) Planch.	U
Hermannia mucronulata Turcz.	U
H. relutina DC.	U
H. saccifera (Turcz.) K. Schum.	U
H. salviifolia L.F. var grandistipula Harv.	I
H. sulcata Harv.	e
H. velutina DC.	U
H. violacea K.Schum.	U
Sterculia alexandri Harv.	R
FLACOURTIACEAE	
Douvyalis lucida Sim.	U
Gerrardina foliosa Oliv.	U
Homalium rufescens Benth.	U
CACTACEAE	
Rhipsalis baccifera (J. Mill.) Stearn.	I
THYMELAEACEAE	
Englerodaphne subcordata (Meisn.) Engl.	U
Gnidia cariaceae Meisn.	Ue
G. fastigiata Rendle	U
G. meisneriana Phillips.	U
G. pulchella Meisn.	U
Lachnaea glomerata Fourc.	I
Lasiosiphon anthylloides var. glabrescens	U

Passerina falcifolia C.H.Wr.	Ue
P. pendula Eckl. & Zeyh.	Ue
Struthiola argentea Lehm.	e
RHIZOPHORACEAE	
Cassipourea flanaganii (Schinz) Alston	R
COMBRETACEAE	
Combretum bracteosum (Hochst.) Brandis	U
MYRTACEAE	
Syzygium pondoense Engl.	U
ONAGRACEAE	
Oenothera drummondii Hook.	U
ARALIACEAE	
Cussonia gamtoosensis Strey	Re
APIACEAE	
Alepida cirsiifolia Schltr. & Wolff	I
A. macowani Duemmer	U
A. setifera N.E.Br.	U
Bupleurum rotundifolium L.	U
Caucalis platycarpos L.	U
Centella graminifolia Adamson	U
C. hermanniifolia (Eckl. & Zeyh.) Domin	Ie
C. virgata (L.F.) Drude.	U
Lichtensteinia interrupta (Thunb.) E. Mey.	U
L. kolbeana H. Bol.	U
Peucedanum hypoleucum Benth. & Hook.	U
ERICACEAE	
Coilostigma tenuifolium Klotzsch	Ie

C. zeyherianum Klotzsch	Ue
Erica chamissonis Klotzsch ex Benth.	e
E. chloroloma Lindl.	e
E. glumiflora Klotsch ex Benth.	e
E. harvieana Guth. & Bol.	Ue
E. humansdorpensis Compton	Ue
E. inconstans Zahlbr.	U
E. pectinifolia Salisb.	e
E. sparrmannii L.F.	e
E. unilateralis Klotzsch ex Benth.	Ue
Simocheilus barbiger Klotzsch	e
Thamnus multiflorus Klotzsch	Ue
MYRSINACEAE	
Embelia ruminata (E. Mey. ex. A.DC.) Mez	U
Myrsine pillansii Adamson	R
Rapanea gilliana (Sond.) Mez	e
PLUMBAGINACEAE	
Limonium linifolium (L.F.) Kuntze var. linifolium	U
L. scabrum (Thunb.) Kuntze var. corymbulosum (Bois.) R.A. Dyer	U
EBENACEAE	
Diospyros simii (Kuntze) de Winter	U
OLEACEAE	
Chionanthus foveolata (E. Mey.) Stearn subsp. tomentellus (Verdoorn) Stearn	U
LOGANIACEAE	
Buddleja auriculata Benth.	U
B. dysophylla (Benth.) Radlk.	U

B. glomerata Wendl. F.	U
GENTIANACEAE	
Sebaea crassulifolia Cham. & Schlectd.	U
APOCYNACEAE	
Pachypodium bispinosum (L.F.) A.DC.	e
ASCLEPIADACEAE	
Asclepias navicularis (E.Mey.) Schltr. var. compressidens Schltr.	U
A. peltigera (E. Mey.) Schltr.	I
Brachystelma comptum N.E.Br.	U
B. elongatum (Schltr.) N.E.Br.	U
B. huttonii (Harv.) N.E.Br.	U
B. meyerianum Schltr.	R
B. pygmaeum (Schltr.) N.E.Br.	I
B. schizoglossoides (Schltr.) N.E.Br.	U
Ceropegia estelleana R.A.Dyer	U
C. filiformis (Burch.) Schltr.	U
C. radicans Schltr.	I
C. woodii Schltr.	U
Cynanchum intermedium N.E.Br.	U
Duvalia elegans (Mass.) Haw. var. elegans	U
D. maculata N.E.Br.	U
D. modesta N.E.Br.	U
Huernia brevirostris N.E.Br.	U
H. primulina N.E.Br. var. rugosa N.E.Br.	U
H. thureti Cels	U
Pachycarpus linearis N.E.Br.	I

P. reflectens E. Mey.	U
Parapodium crispum N.E.Br.	U
Piaranthus foetidus N.E.Br. var. diversus N.E.Br.	U
P. pillansii N.E.Br. var. pillansii	U
Riocreuxia flanaganii Schltr.	I
Schizoglossum addoense N.E.Br.	U
S. biflorum (E. Mey.) Schltr. var. intergrum N.E.Br.	U
S. bowkeriae N.E.Br.	U
S. consimile N.E.Br.	U
S. cordifolium E. Mey var. centralis N.E.Br.	U
S. dissimile N.E.Br.	I
S. flanagani Schltr.	U
S. hamatum E. Mey.	U
S. heterophyllum (E. Mey.) Schltr. var. majus N.E.Br.	U
S. heterophyllum (E.Mey.) Schltr.	U
S. linifolium Schltr. var. centrirostratum N.E.Br.	U
S. macowanii N.E.Br.	U
S. ovalifolium Schltr.	U
S. parvulum Schltr. var. parvulum	U
S. pulchellum Schltr.	U
S. robustum Schltr. var. robustum	U
S. truncatum Schltr.	U
S. verticullare Schltr.	U
S. virens E.Mey	U
S. virgatum (E. Mey.) Schltr.	U
Sisyranthus barbatus (Turcz.) N.E.Br.	U
Stapelia desmetiana N.E.Br var. fergusoniae R.A. Dyer	U
S. pachyrrhiza Dinter	U

S. peglerae N.E.Br.	U
S. pulchella Mass.	U
S. verrucosa var. *conspicula*	U
Trichocaulon annulatum N.E.Br.	R
Xysmalobium winterbergense N.E.Br.	U
CONVOLVULACEAE	
Convolvulus galpinii C.H.Wr.	U
C. sagittatus Thunb.	U
Cuscuta bifurcata Yunck.	I
C. suaveolens Ser.	I
BORAGINACEAE	
Myosotis semiamblexicaulus DC.	I
VERBENACEAE	
Vitex obovata E. Mey.	U
LABIATAE	
Iboza barberae N.E.Br.	R
Leonotis galpinii Skan	U
Salvia obtusata Thunb.	U
S. triangularis Thunb.	U
Stachys arvensis L.	U
S. bolusii Skan	U
S. bowsii Skan	U
S. rudatisii Skan	U
SOLANACEAE	
Solanum aggregatum Jacq.	U
S. burbankii Bitter	U
S. giganteum Jacq.	U

SCROPHULARIACEAE

Polycarena cuneifolia (Benth.) Levyns.	e
Sutera cordata (Thunb.) Kuntze	U
S. roseoflava Hiern	Ue
SELAGINACEAE	
Dischisma ciliatum (Berg.) Choisy subsp. orinoides (L.F.) Roessl.	U
Walafrida nitida E. Mey.	e
W. macowani Rolfe	I
SCROPHULARIACEAE	
Harveya scarlatina Hook. ex Steud.	U
Melasma scabrum Berg.	U
GESNERIACEAE	
Streptocarpus kentaniensis Britten & Story	R
LENTIBULARIACEAE	
Utricularia gibba L.	I
ACANTHACEAE	
Asystasia stenosiphon C.B.Cl.	U
Blepharis dilatata C.B.Cl.	U
B. procumbens (L.F.) Pers.	e
B. sinuata (Nees) C.B.Cl.	U
Duvernoia adhatodoides E. Mey.ex Nees	U
Isoglossa densa N.E.Br.	U
I. stipitata C.B.Cl.	U
Justicia acuta C.B.Cl.	Ue
Mackaya bella Harv.	U
Monechma acutum C.B.Cl.	Ue

PLANTAGINACEAE

Plantago remota Lam.	I
P. rhodosperma Decne.	U
RUBIACEAE	
Alberta magna E. Mey.	U
Galium capense Thunb. subsp. garipense (Sond.) Puff var. garipense	U
G. scabrelloides Puff	U
G. spurium L. subsp. africanum Verdc.	U
G. thunbergianum Eckl. & Zeyh. var. hirsutum	I
Gardenia thunbergii L.F.	R
Pachystigma macrocalyx (Sond.) Robyns	U
Pavetta kotzei Brem.	U
P. mbumbulensis Brem.	I
CAMPANULACEAE	
Lightfootia divaricata Buek. var. filifolia Adamson	U
Wahlenbergia bowkeri Sond.	I
W. galpiniae Schltr.	U
W. kowiensis R.A. Dyer	U
W. macra Schltr. & V. Brehm.	I
LOBELIACEAE	
Cyphia heterophylla Presl	U
Grammatotheca bergiana (Cham.) Presl var. bergiana	U
Laurentia hederacea Sond.	I
Lobelia flaccida (Presl.) A.DC.	U
ASTERACEAE	
Amphiglossa callunoides DC.	I

Anisocheata mikanioides DC.	I
Arctotis candida Thunb.	U
A. elongata Thunb.	U
Athanasia indivisa (Drege) Harv.	U
Berkheya cardopatifolia (DC.) Roessl.	U
B. speciosa (DC.) O. Hoffm.	U
Brachylaena glabra (L.F.) Druce.	U
Corymbium fourcadei	Ue
Diplopappus laevigatus	Ue
Eriocephalus tenuifolius DC.	U
E. xerophilus Schltr.	U
Eroeda intermedia DC.	U
Euryops ciliatus B. Nord.	I
E. gracilipes B. Nord.	U
E. hypnoides B. Nord.	e
E. intermedia	Ue
E. latifolius B. Nord.	R
E. lateriflorus (L.F.) DC.	U
E. munitus (L.F.) B. Nord.	e
E. polytrichoides (Harv.) B. Nord.	I
E. ursinoides B.Nord.	e
Felicia echinata (Thunb.) Nees	e
F. zeyheri (Less.) Nees	Ue
Garuleum bipinnatum (Thunb.) Less.	Ue
G. tanacetifolium (Macowan)T. Norl.	U
Gazania caespitosa H. Bol.	U
G. gerrardii	U

Gerbera cordata	e
Gnaphalium acilepis DC.	I
Haplocarpha lyrata Harv.	e
Hedypnois polymorpha DC.	U
Helichrysum alticolum H. Bol.	I
H. asperum (Thunb.) Hilliard & Burtt.	U
H. drakensbergense Killick	I
H. isolepis H. Bol.	U
H. litorale H. Bol.	U
H. mimetes S. Moore	U
H. recurvatum (L.F.) Thunb.	V
H. rosum (Berg.) Less. var. *concolorum* (DC.) Moeser.	U
H. striatum Thunb.	e
H. subglomeratum Less.	e
H. umbraculigerum Less.	U
H. vellereum R.A. Dyer	e
Heterolepis mitis DC.	I
Matricaria nigellaefolia DC.	U
Metalasia aurea D. Don	Ue
Oldenburgia arbuscula DC.	U
Osteospermum microphyllum DC.	U
O. pterigoideum Klatt	I
O. spathulatum (DC.)T. Norl.	U
O. spinigerum T. Norl.	I
Othonna membranifolia DC.	U
O. rufibarbis Harv.	e
Pteronia bolusii Phill.	U

P. quinqueflora DC.	I
P. teretifolia (Thunb.) Fourc.	e
Relhania calycina (L.F.) L`Herit. subsp. lanceolata Bremer	e
R. pungens L`Herit. subsp. angustifolia (DC.) Bremer	U
R. pungens L`Herit. subsp. trinervis (Thunb.) Bremer	U
Rosenia oppositifolia (DC.) Bremer	U
Senecio bupleuroides DC.	U
S. carnosus Thunb.	U
S. crenulatus DC. var. crenulatus	U
S. crenatus Thunb.	Ue
S. erubescens Ait. var. erubescens	U
S. mimetes Hutch. & R.A. Dyer	I
S. monticola DC.	U
S. multibracteatus Harv.	U
S. napifolius Macowan	U
S. pellucidus DC.	U
S. pyramidatus DC.	Ue
S. reclinatus L.F.	U
S. serrulatus DC.	U
S. thyrsoideus	U
S. tropaeofolius Macowan	U
Sonchus integrifolius Harv.	U
Stoebe bruniades (Riechb.) Levyns	U
S. leucocephala DC.	U
Venidium perfoliatum Less.	U

APPENDIX 2

The formulation of the scoring to develop the ranking system presented in Table 11.

Of the many criteria available for conservation evaluation (Margules & Usher 1981) only those based on the floristic information obtained in the first part of this study, were chosen for the evaluation of the vegetation types. Area bound criteria (diversity, area, shape, proximity ratings and aesthetic ratings) could not be used as these apply to the evaluation of a site rather than a vegetation type. The factors that were chosen and the scoring of these factors is presented below.

a) Endangered, Vulnerable and Rare plant taxa

The numbers of Endangered, Vulnerable and Rare plants in the Eastern Cape are relatively low, however theiroccurrence is considered to be an important motivation for conservation. Each vegetation type was assigned a score according to the numbers of E, V or R plant taxa present, the score being given according to categories of numbers of E, V or R plant taxa.

Table for E, V or R plant numbers.

No. of E/V or R. taxa	Score
0 - 1	1
2 - 3	2
4 - 5	3
6 - 10	4
> 10	5

b) Indeterminate, Uncertain and Endemic taxa

The occurrence of I and e taxa within vegetation types adds to their conservation value, while the occurence of U cases is added motivation for the requirement of further study. I cases also add to the requirements for further study. The numbers of I, U and e cases are relatively high in the Eastern Cape and so the categories of numbers given scores are as follows:

Table for I, U or e plant species

No. of I,U or e taxa	Score
0 - 1	1
2 - 5	2
6 - 10	3
10 - 20	4
> 20	5

c) Percent of the vegetation type conserved

The percentage of a vegetation type situated within a formal conservation area is an important criterion indicative of its conservation status. The greater the amount a vegetation type is conserved the lower it will be ranked on a conservation priority table.

The formulation of conservation ratings table.

% of veg type conserved	Score
> 3,0%	0
2,1% - 3,0%	1
1,1% - 2,0%	2
0,6% - 1,0%	3
0 - 0,5%	4

APPENDIX 3

Check list of the Subtropical Thicket sample flora with associated species codes which appear in Appendix 4. Nomenclature is that of Gibbs Russell et al., (1984).

PTERIDOPHYTA

ADIANTACEAE

Adiantum capillus-veneris L.	Adia cap
Cheilanthes bergiana Schlechtd.ex Kunze	Chei ber
C. hirta Swartz	Chei hir
C. viridis (Forssk.)Swartz	Chei vir
POLYPODIACEAE	
Polypodium vulgare L.	Poly vul
ASPLENIACEAE	
Asplenium rutifolium (Berg.)Kunze var. rutifolium	Aspl rut
Ceterach cordatum (Thunb.)Desv.	Cete cor
ASPIDIACEAE	
Dryopteris inaequalis (Schlechtd.)Kuntze	Dryo ina
GYMNOSPERMAE	
ZAMIACEAE	
Encephalartos altensteinii Lehm.	Ence alt
PODOCARPACEAE	
Podocarpus falcatus (Thunb.)R.Br. ex Mirb.	Podo ful
ANGIOSPERMAE MONOCOTYLEDONAE	
JUNCAGINACEAE	
Triglochin striata Ruiz & Pav.	Trig str

POACEAE

Cymbopogon marginatus (Steud.) Stapf ex Brutt Davy	Cymb mar
Heteropogon contortus (L.)Roem.& Schult.	Hete con
Diheteropogon amplectens (Nees)Clayton	Dihe amp
Themeda triandra Forssk.	Them tri
Digitaria eriantha Steud.	Digi eri
Paspalum urvillei Steud. *	Pasp urv
Panicum aequinerve Nees	Pani aeq
P. deustum Thunb.	Pani deu
P. maximum Jacq.	Pani max
P. obumbratum Stapf	Pani obu
Setaria chevalieri Stapf ex Stapf & C.E. Hubb.	Seta che
S. flabellata Stapf	Seta fla
S. sphacelata (Schumach.)Moss var. *sphacelata*	Seta sph
S. sphacelata (Schumach.)Moss var. *torta* (Stapf)Clayton	Seta tor
S. verticillata (L.)Beauv.	Seta ver
Rhynchelytrum repens (Willd.)C.E.Hubb	Rhyn rep
Ehrhartia calycina J.E.Sm. var. *calycina*	Ehrh cal
Helictotrichon turgidulum (Stapf.)Schweick.	Heli tur
Pentaschistis airoides (Nees)Stapf	Pent air
P. angustifolia (Nees)Stapf	Pent ang
Aristida congesta Roem.& Schult. subsp. *congesta*	Aris con
Stipa dregeana Steud. var. *dregeana*	Stip dre
Tragus berteronianus Schult.	Trag ber

T. koeleroides Aschers.	Trag koe
Sporobolus capensis (Willd.)Kunth	Spor cap
S. nitens Stent	Spor nit
Eragrostis capensis (Thunb.)Trin.	Erag cap
E. curvula (Schrad.)Nees	Erag cur
E. lehmanniana Nees var. *lehmanniana*	Erag leh
E. obtusa Munro ex Fical.& Hiern	Erag obt
Cynodon dactylon (L.)Pers.	Cyno dac
Koeleria capensis (Steud.)Nees	Koel cap
Lasiochloa longifolia (Schrad.)Kunth	Lasi lon
CYPERACEAE	
Cyperus albostriatus Schrad.	Cype alb
C. textilis Thunb.	Cype tex
Mariscus congestus (Vahl.)C.B.Cl.	Mari con
Ficinia sp.	Fici spp
Schoenoxiphium caricoides C.B.Cl.	Scho car
ARECACEAE	
Phoenix reclinata Jacq.	Phoe rec
COMMELINACEAE	
Commelina africana L. var. *africana*	Comm afr
C. benghalensis L. *	Comm ben
Cyanotis speciosa (L.f.)Hassk.	Cyan spe
LILIACEAE	
Bulbine alooides (L.)Willd.	Bulb alo
B. caulescens L.	Bulb cau
B. frutescens (L.)Willd.	Bulb fru
Chlorophytum cordatum (Thunb.)Bak.	Chlo cor

C. comosum (Thunb.)Jacq.	Chlo com
Aloe africana Mill.	Aloe afr
A. arborescens Mill.	Aloe arb
A. ciliaris Haw.	Aloe cil
A. ferox Mill.	Aloe fer
A. pluridens Haw.	Aloe plu
A. speciosa Bak.	Aloe spe
A. striata Haw.	Aloe str
Gasteria sp. cf. G. beckeri Schonl.	Gast bec
G. nigricans (Haw.)Haw.	Gast nig
G. pulchra (Ait.)Haw.	Gast pul
G. sp.	Gast spp
Haworthia sordida Haw.	Hawo sor
Urginea altissima (L.f.)Bak.	Urgi alt
Drimia haworthioides Bak.	Drim haw
Scilla sp.1	Scil sp1
Scilla sp.2	Scil sp2
Ornithogalum longibracteatum Jacq.	Orni lon
O. sp.	Orni spp
Ledebouria revoluta (L.f.)Jessop	Lede rev
L. socialis (Bak.)Jessop	Lede soc
L. undulata (Jacq.)Jessop	Lede und
L. sp.1	Lede sp1
L. sp.2	Lede sp2
Lachenalia orchioides (L.)Ait.	Lach orc
Massonia huttonii Bak.	Mass hut
Dracaena hookerana K.Koch	Drac hoo
Sansevieria aethiopica Thunb.	Sans aet

S. hyacinthoides (L.)Druce	Sans hya
Protasparagus acocksii Jessop	Prot aco
P. africanus Lam.	Prot afr
P. aethiopicus L. var. *aethiopicus*	Prot aet
P. asparagoides (L.)Wight	Prot asp
P. capensis L.	Prot cap
P. crassicladus Jessop	Prot cra
P. densiflorus (Kunth)Jessop	Prot den
P. denudatus (Kunth)Bak.	Prot ded
P. macowanii Bak.	Prot mac
P. oxyacanthus Bak.	Prot oxy
P. plumossus Bak.	Prot plu
P. racemosus Willd.	Prot rac
P. setaceus (Kunth)Jessop	Prot set
P. striatus (L.f.)Thunb.	Prot str
P. suaveolens Burch.	Prot sua
P. subulatus Thunb.	Prot sub
Behnia reticulata (Thunb.)Didr.	Behn ret
AMARYLLIDACEAE	
Haemanthus albiflos Jacq.	Haem alb
H. cf. *incarnatus*	Haem inc
Scadoxus puniceus (L.)Friis & Nordal	Scad pun
Boophane disticha (L.f.)Herb.	Boop dis
Brunsvigia gregaria R.A.Dyer	Brun gre
HYPOXIDACEAE	
Hypoxis stellipilis Ker-Gawl.	Hypo ste
H. zeyheri Bak.	Hypo zey

H. sp.1	Hypo sp1
H. sp.2	Hypo sp2
DIOSCOREACEAE	
Dioscorea cotinifolia Kunth	Dios cot
D. sylvatica (Kunth) Eckl. var. sylvatica	Dios syl
IRIDACEAE	
Dietes iridioides (L.)Sweet ex Klatt	Diet iri
D. vegeta	Diet veg
Tritonia dubia Eckl. ex Klatt	Trit dub
T. securigera (Ait.)Ker-Gawl.	Trit sec
Watsonia meriana (L.)Mill.	Wats mer
W. longifolia Mathews & L.Bol.	Wats lon
W. sp	Wats spp
STRELITZIACEAE	
Strelitzia reginae Ait.	Stre reg
ORCHIDACEAE	
Bonatea speciosa (L.f.)Willd. var. speciosa	Bona spe
Holothrix cf. lindleyana Reichb.f.	Holo lin
DICOTYLEDONAE	
ULMACEAE	
Chaetachme aristata Planch.	Chae ari
LORANTHACEAE	
Tieghemia quinquenervia (Hochst.)Balle	Tieg qui
Moquiniella rubra (Spreng.F.)Balle	Moqu rub
Erianthemum dregei (Eckl.& Zeyh.)V.Tieghem	Eria dre
VISCACEAE	
Viscum capense L.f. subsp. capense	Visc cap
V. crassulae Eckl. & Zeyh.	Visc cra

V. obscurum Thunb.	Visc obs
V. rotundifolium L.f.	Visc rot
SANTALACEAE	
Colpoon compressum Berg.	Colp com
Rhoiacarpos capensis (Harv.)DC.	Rhoi cap
Osyridicarpos schimperianus (Hochst.ex A.Rich.)DC.	Osyr sch
Thesium galioides DC.	Thes gal
CHENOPODIACEAE	
Chenopodium album L. *	Chen alb
AIZOACEAE	
Limeum telephioides E.Mey.ex Fenzl var. telephioides	Lime tel
Aizoon glinoides L.f.	Aizo gli
A. rigidum L.f.	Aizo rig
Tetragonia fruticosa L.	Tetr fru
MESEMBRYANTHEMACEAE	
Carpobrotus edulis (L.)L.Bol.	Carp edu
Delosperma calycinum L.Bol.	Delo cal
D. echinatum (Ait.)Schwant.	Delo ech
D. ecklonis (Salm-Dyck)Schwant. var. ecklonis	Delo eck
D. prasinum L. Bol.	Delo pra
D. sp.1	Delo sp1
D. sp.2	Delo sp2
Drosanthemum lique (N.E.Br.)Schwant.	Dros liq
D. parvifolium (Haw.)Schwant.	Dros par

D. sp.	Dros spp
Hereroa albanensis L.Bol.	Here alb
Lampranthus dependens (L.Bol.)L.Bol.	Lamp dep
L. elegans (Jacq.)Schwant.	Lamp ele
L. sp.	Lamp spp
Mesembryanthemum sp.	Mese spp
Mestoklema albanicum N.E.Br.ex Glen	Mest alb
M. sp.	Mest spp
Ruschia uncinata (L.)Schwant.	Rusc uni
R. sp.	Rusc spp
PORTULACACEAE	
Portulacaria afra Jacq.	Port afr
RANUNCULACEAE	
Clematis brachiata Thunb.	Clem bra
BRASSICACEAE	
Heliophila suavissima Burch. ex DC.	Heli sua
Lepidium divaricatum Ait. subsp. *divaricatum*	Lepi div
L. ecklonii Schrad.	Lepi eck
MENISPERMACEAE	
Cissampelos torulosa E.Mey.ex Harv.	Ciss tor
CAPPARACEAE	
Capparis sepiaria L. var. *citrifolia* (Lam.)Toelken	Capp sep
Boscia oleoides(Burch.ex DC.)Toelken	Bosc ole
Maerua cafra (DC.)Pax	Maer caf
M. racemulosa (DC.)Glig & Ben.	Maer rac
CRASSULACEAE	
Cotyledon orbiculata L.	Coty orb

C. velutina Hook.f.	Coty vel
C. sp.	Coty spp
Tylecodon sp.	Tyle spp
Kalanchoe rotundifolia (Haw.)Haw.	Kala rot
Crassula cultrata L.	Cras cul
C. ericoides Haw. subsp. ericoides	Cras eri
C. expansa Dryand. subsp. expansa	Cras exp
C. falcata Wendl.	Cras fal
C. mesembryanthoides(Haw.)Dieter subsp. mesembryanthoides	Cras mes
C. mollis Thunb.	Cras mol
C. muscosa L. var. muscosa	Cras mus
C. orbicularis L.	Cras orb
C. ovata (Mill.)Druce	Cras ova
C. pellucida L. subsp. alsinoides (Hook.f.) Toelken	Cras pel
C. pellucida L. subsp. marginalis (Dryand. In Ait.)Toelken	Cras mar
C. perfoliata L. var. perfoliata	Cras per
C. perforata Thunb.	Cras for
C. rogersii Schonl.	Cras rog
C. socialis Schonl.	Cras soc
C. spathulata Thunb.	Cras spa
C. tetragona L.	Cras tet
C. sp.1	Cras sp1
C. sp.2	Cras sp2
Adromischus rhombifolius (Haw.)Lem.ex Berger	Adro rho

PITTOSPORACEAE

Pittosporum viridiflorum Sims	Pitt vir

HAMAMELIDACEAE

Trichocladus ellipticus Eckl.& Zeyh. ex Walp.	Tric ell

ROSACEAE

Rubus sp. *	Rubu spp

FABACEAE

Acacia caffra (Thunb.)Willd.	Acac caf
A. karroo Hayne	Acac kar
A. mearnsii De Wild *	Acac mea
Schotia afra (L.)Thunb. var. angustifolia (E.Mey.)Harv.	Scho afr
S. latifolia Jacq.	Scho lat
Calpurnia aurea (Ait.)Benth. subsp. aurea	Calp aur
Crotalaria capensis Jacq.	Crot cap
Indigofera stenophylla Eckl.& Zeyh.	Indi ste
Tephrosia capensis (Jacq.)Pers. var. angustifolia E.Mey.	Teph cap
T. grandiflora (Ait.)Pers.	Teph gra
Lessertia annularis Burch.	Less ann
Dalbergia obovata E.Mey	Dalb obo
Erythrina caffra Thunb.	Eryt caf
Rhynchosia hirsuta Eckl.& Zeyh.	Rhyn hir
Dipogon lignosus (L.)Verdc.	Dipo lig
Dolichos hastaeformis E.Mey.	Doli has
D. gibbosus Thunb.	Doli gib

GERANIACEAE

Geranium incanum Burm.F. var. incanum	Gera inc

Monsonia ovata Cav.	Mons ova
Sarcocaulon vanderietiae L.Bol.	Sarc van
Pelargonium frutetorum R.A.Dyer	Pela fru
P. peltatum (L.)L'Herit.	Pela pel
P. reniforme Curtis	Pela ren
P. sp.	Pela spp
OXALIDACEAE	
Oxalis bowiei Lindl.	Oxal bow
O. obtusa Jacq.	Oxal obt
O. psilopoda Turcz.	Oxal psi
O. stenorrhyncha Salter	Oxal ste
O. stellata Eckl.& Zeyh. var. stellata	Oxal stl
O. sp.	Oxal spp
ZYGOPHYLLACEAE	
Zygophyllum lichtensteinianum Cham.& Schlechtd.	Zygo lic
Z. uitenhagense Sond.	Zygo uit
RUTACEAE	
Zanthoxylum capense (Thunb.)Harv.	Zant cap
Agathosma ovata (Thunb.)Pillans	Agat ova
Vepris lanceolata (Lam.)G.Don	Vepr lan
Teclea natalensis (Sond.)Engl.	Tecl nat
Clausena anisata (Willd.)Hook.F.ex Benth.	Clau ani
BURSERACEAE	
Commiphora harveyi (Engl.)Engl.	Comm har
PTAEROXYLACEAE	
Ptaeroxylon obliquum (Thunb.)Radlk.	Ptae obl

POLYGALACEAE

Polygala asbestina Burch.	Poly asb
P. leptophylla Burch.	Poly lep
P. myrtifolia L.	Poly myr
P. virgata Thunb. var. *virgata*	Poly vir

EUPHORBIACEAE

Lachnostylis hirta (L.f.)Muell.Arg.	Lach hir
Phyllanthus verrucosus Thunb.	Phyl ver
Croton rivularis Muell.Arg.	Crot riv
Leidesia obtusa (Thunb.)Muell.Arg.	Leid obt
Acalypha glabrata Thunb.	Acal gla
Ctenomeria capensis (Thunb.)Harv.ex Sond.	Cten cap
Jatropha capensis (L.f.)Sond.	Jatr cap
Clutia affinis Sond.	Clut aff
C. daphnoides Lam.	Clut dap
C. pulchella L.	Clut pul
Suregada africana (Sond.)Kuntze	Sure afr
Euphorbia bothae Lotsy & Goddijn	Euph bot
E. clava Jacq.	Euph cla
E. coerulescens Haw.	Euph coe
E. cumulata R.A.Dyer	Euph cum
E. fimbriata Scop.	Euph fim
E. grandidens Haw.	Euph gra
E. ledienii Berger	Euph led
E. mauritanica L. var. *mauritanica*	Euph mau
E. pentagona Haw.	Euph pen
E. tetragona Haw.	Euph tet
E. triangularis Desf.	Euph tri

E. sp.1	Euph sp1
E. sp.2	Euph sp2
ANACARDIACEAE	
Harpephyllum caffrum Bernh.	Harp caf
Protorhus longifolia (Bernh.)Engl.	Prot lon
Ozoroa mucronata (Bernh.ex Krauss) R.& A. Fernandes	Ozor muc
Rhus carnosula Schonl.	Rhus car
R. chirindensis Bak. F.Forma Legatii (Schonl.)R.& A.Fernandes	Rhus chi
R. dentata Thunb.	Rhus den
R. fastigiata Eckl.& Zeyh.	Rhus fas
R. glauca Thunb.	Rhus gla
R. incisa L.f.	Rhus inc
R. longispina Eckl.& Zeyh.	Rhus lon
R. lucida L.	Rhus luc
R. pyroides Burch.	Rhus pyr
R. refracta Eckl.& Zeyh.	Rhus ref
CELASTRACEAE	
Maytenus acuminata (L.f.)Loes. var. acuminata	Mayt acu
M. capitata (E.Mey.ex. Sond.)Marais	Mayt cap
M. linearis (L.f.)Marais	Mayt lin
M. nemorosa (Eckl.& Zeyh.)Marais	Mayt nem
M. heterophylla (Eckl.& Zeyh.)N.K.B.Robson	Mayt het
M. peduncularis (Sond.)Loes.	Mayt ped
M. polyacantha (Sond.)Marais	Mayt pol

M. procumbens (L.f.)Loes.	Mayt pro
M. undata (Thunb.)Blakelock	Mayt und
Putterlickia pyracantha (L.)Szyszyl.	Putt pyr
Pterocelastrus tricuspidatus (Lam.)Sond.	Pter tri
Cassine aethiopica Thunb.	Cass aet
C. crocea (Thunb.)Kuntze	Cass cro
C. papillosa (Hochst.)Kuntze	Cass pap
C. peragua L.	Cass per
C. reticulata (Eckl.& Zeyh.)Codd	Cass ret
C. tetragona (L.f.)Loes.	Cass tet
Pleurostylia capensis (Turcz.)Oliv.	Pleu cap
ICACINACEAE	
Cassinopsis ilicifolia (Hochst.)Kuntze	Cass ili
Apodytes dimidiata E.Mey.ex Arn. subsp *dimidiata*	Apod dim
SAPINDACEAE	
Allophylus decipiens(Sond.)Radlk.	Allo dec
A. natalensis (Sond.)De Winter	Allo nat
Smelophyllum capense Radlk.	Smel cap
Pappea capensis Eckl.& Zeyh.	Papp cap
Hippobromus pauciflorus (L.f.)Radlk.	Hipp pau
RHAMNACEAE	
Ziziphus mucronata Willd. subsp. *mucronata*	Zizi muc
Scutia myrtina (Burm.F.)Kurz	Scut myr
VITACEAE	
Rhoicissus digitata (L.f.)Gilg & Brandt	Rhoi dig
R. tomentosa (Lam.)Wild & Drum.	Rhoi tor
R. tridentata (L.f.)Wild & Drum.	Rhoi tri

Cyphostemma cirrhosum (Thunb.)Desc. ex Wild & Drum. subsp. cirrhosum	Cyph cir
C. quinatum (Dryand.)Desc.ex Wild & Drum.	Cyph qui
TILIACEAE	
Grewia occidentalis L.	Grew occ
G. robusta Burch.	Grew rob
MALVACEAE	
Abutilon sonneratianum (Cav.)Sweet	Abut son
Sida ternata L.f.	Sida ter
Hibiscus aethiopicus L. var. aethiopicus	Hibi aet
H. pedunculatus L.f.	Hibi ped
H. pusillus Thunb.	Hibi pus
STERCULIACEAE	
Melhania didyma Eckl.& Zeyh.	Melh did
Dombeya tiliacea (Endl.)Planch.	Domb til
Hermannia althaeoides Link.	Herm alt
H. candicans Ait.	Herm can
H. cuneifolia Jacq.	Herm cun
H. gracilis Eckl.& Zeyh.	Herm gra
H. velutina DC.	Herm vel
OCHNACEAE	
Ochna arborea Burch. ex DC. var. arborea	Ochn arb
O. natalitia (Meisn.)Walp.	Ochn nat
O. serrulata (Hochst.)Walp.	Ochn ser
FLACOURTIACEAE	
Scolopia mundii (Eckl.& Zeyh.)Warb.	Scol mun

S. zeyheri (Nees)Harv.	Scol zey
Trimeria grandifolia (Hochst.)Warb.	Trim gra
Dovyalis caffra (Hook.F.& Harv.)Hook.F.	Dovy caf
D. rhamnoides (Burch.ex DC.)Harv.	Dovy rha
D. rotundifolia (Thunb.)Thunb.& Harv.	Dovy rot
PASSIFLORACEAE	
Passiflora sp.	Pass spp
CACTACEAE	
Opuntia aurantiaca Lindl. *	Opun aur
O. ficus-indica (L.)Mill. *	Opun fic
THYMELAECEAE	
Passerina filiformis L.	Pass fil
MYRTACEAE	
Eugenia capensis (Eckl.& Zeyh.)Harv.ex Sond.	Euge cap
Syzygium cordatum Hochst.	Syzy cor
ARALIACEAE	
Cussonia gamtoosensis Strey	Cuss gam
C. spicata Thunb.	Cuss spi
C.thyrsiflora Thunb.	Cuss thr
APIACEAE	
Centella coriacea Nannf'd.	Cent cor
Heteromorpha arborescens (Spreng.)Cham. & Schlechtd.	Hete arb
CORNACEAE	
Curtisia dentata (Burm.F.)C.A.Sm.	Curt den
MYRSINACEAE	
Myrsine africana L.	Myrs afr
Rapanea melanophloeos (L.)Mez.	Rapa mel

PLUMBAGINACEAE

Plumbago auriculata Lam.	Plum aur
SAPOTACEAE	
Sideroxylon inerme L.	Side ine
EBENACEAE	
Euclea crispa (Thunb.)Guerke subsp. crispa	Eucl cri
E. natalensis A.DC. subsp. capensis F.White	Eucl nat
E. racemosa Murray	Eucl rac
E. schimperi (A.DC.)Dandy var. schimperi	Eucl sch
E. undulata Thunb. var. undulata	Eucl und
Diospyros dichrophylla (Gand.)De Winter	Dios dic
D. lycioides Desf.	Dios lyc
D. scabrida (Harv.ex Hiern)De Winter var. scabrida	Dios sca
D. simii (Kuntze)De Winter	Dios sim
D. villosa (L.)De Winter var. villosa	Dios vil
D. whyteana (Hiern)F. White	Dios why
OLEACEAE	
Chionanthus foveolata (E.Mey.)Stearn subsp. foveolata	Chio fov
Olea europaea L. subsp. africana (Mill.) P.S.Green	Olea eur
O. capensis L. subsp. capensis	Olea cap
O. woodiana Knobl.	Olea woo
Jasminum angulare Vahl	Jasm ang
J. multipartitum Hochst.	Jasm mul

SALVADORACEAE

Azima tetracantha Lam.	Azim tet
LOGANIACEAE	
Buddleja saligna Willd.	Budd sal
APOCYNACEAE	
Acokanthera oppositifolia (Lam.)Codd	Acok opp
Carissa bispinosa (L.)Desf.ex Brenan var. bispinosa	Cari bis
C. haematocarpa (Eckl.)A.DC.	Cari hae
Gonioma kamassi E.Mey.	Goni kam
Pachypodium bispinosum (L.f.)A.DC.	Pach bis
P. succulentum (L.f.)Sweet	Pach suc
ASCLEPIADACEAE	
Cynanchum ellipticum (Harv.)R.A.Dyer	Cyna ell
C. obtusifolium L.f.	Cyna obt
Sarcostemma viminale (L.)R.Br.	Sarc vim
Secamone alpinii Schultes	Seco alp
S. frutescens (E. Mey.)Decne.	Seco fru
Ceropegia carnosa E.Mey.	Cero car
Riocreuxia torulosa Decne.	Rioc tor
Fockea edulis (Thunb.)K.Schum.	Fock edu
CONVOLVULACEAE	
Convolvulus cf. capensis Burm.F.	Conv cap
BORAGINACEAE	
Cordia caffra Sond.	Cord caf
Ehretia rigida (Thunb.)Druce	Ehre rig
Euchium sp.	Euch spp
VERBENACEAE	
Lantana camara L. *	Lant cam

L. rugosa Thunb.	Lant rug
Lippia javanica (Burm.F.)Spreng.	Lipp jav
Chascanum dehiscens (L.f.)Moldenke	Chas deh
Priva meyeri Jaub.& Spach. var. *meyeri*	Priv mey
Clerodendrum glabrum E.Mey. var. *glabrum*	Cler gla
LABIATAE	
Leucas capensis (Benth.)Engl.	Leuc cap
Stachys aethiopica L.	Stac aet
Salvia repens Burch.ex Benth. var. *repens*	Salv rep
S. scabra L.f.	Salv sca
S. triangularis Thunb.	Salv tri
Plectranthus coloratus E.Mey.	Plec col
P. hirtus Benth.	Plec hir
P. madagascariensis (Pers.)Benth. var. *madagascariensis*	Plec mad
P. strigosus Benth.	Plec str
P. verticillatus (L.f.)Druce	Plec ver
P. sp.	Plec spp
Becium burchellianum (Benth.)N.E.Br.	Beci bur
SOLANACEAE	
Lycium afrum L.	Lyci afr
L. campanulatum E.Mey.	Lyci cam
L. oxycarpum Dun.	Lyci oxy
L. ferocissimum Miers	Lyci fer
Solanum coccineum Jacq.	Sola coc
S. sp.	Sola spp

SCROPHULARIACEAE

Halleria lucida L.	Hall luc
Sutera microphylla (L.f.)Hiern	Sute mic
S. mollis (Benth.)Hiern	Sute mol
S. pinnatifida Kuntze	Sute pin

SELAGINACEAE

Selago corymbosa L.	Sela cor
Walafrida geniculata (L.f.)Rolfe	Wala gen

SCROPHULARIACEAE (part b)

Veronica anagallis-aquatica L.	Vero ana

BIGNONIACEAE

Tecomaria capensis (Thunb.)Spach	Teco cap
Rhigozum obovatum Burch.	Rhig obo

ACANTHACEAE

Thunbergia capensis Retz.	Thun cap
Ruellia cordata Thunb.	Ruel cor
Barleria obtusa Nees	Barl obt
Blepharis capensis(L.f.)Pers. var. capensis	Blep cap
Asystasia stenosiphon C.B.Cl.	Asys ste
Hypoestes aristata R.Br.	Hypo ari
H. verticillaris (L.f.)R.Br.ex C.B.Cl.	Hypo ver
Isoglossa ciliata (Nees)Lindau	Isog cil
I. eckloniana (Nees)Lindau	Isog eck
I. macowanii C.B.Cl.	Isog mac
Justicia bowiei C.B.Cl.	Just bow
J. protracta (Nees)T.Anders.	Just pro

RUBIACEAE

Burchellia bubalina (L.f.)Sims	Burc bub

Coddia rudis (E.Mey. ex Harv.)Verdc.	Codd rud
Gardenia thunbergii L.f.	Gard thu
Tricalysia capensis (Meisn.)Sim	Tric cap
Pentanisia angustifolia (Hochst.)Hochst.	Pent ang
P. prunelloides (Eckl.& Zeyh.)Walp. subsp. prunelloides	Pent pru
Canthium ciliatum (Klotzsch)Kuntze	Cant cil
C. inerme (L.f.)Kuntze	Cant ine
C. mundianum Cham.& Schlechtd.	Cant mun
C. obovatum Klotzsch	Cant obo
C. pauciflorum (Klotzsch)Kuntze	Cant pau
C. spinosum (Klotzsch)Kuntze	Cant spi
Pavetta lanceolata Eckl.	Pave lan
P. revoluta Hochst.	Pave rev
Psychotria capensis (Eckl.)Vatke	Psyc cap
Galopina circaeoides Thunb.	Galo cir
Anthospermum aethiopicum L. var aethiopicum	Anth aet
A. herbaceum L.f. var. herbaceum	Anth her
Richardia humistrata (Cham.&Schlechtd.)Steud. *	Rich hum
Rubia petiolaris DC.	Rubi pet
CUCURBITACEAE	
Kedrostis africana (L.)Cogn.	Kedr afr
K. nana (Lam.)Cogn. var. nana	Kedr nan
Melothria cordata (Thunb.)Cogn.	Melo cor
LOBELIACEAE	
Cyphia volubilis (Thunb.)Willd.	Cyph vol
C. sp.	Cyph spp

Lobelia sp.	Lobe spp
ASTERACEAE	
Vernonia capensis (Houtt.)Druce	Vern cap
Pteronia incana (Burm.)DC.	Pter inc
P. paniculata Thunb.	Pter pan
Aster sp.	Aste spp
Felicia filifolia (Vent.)Burtt Davy subsp. filifolia	Feli fil
Chrysocoma tenuifolia Berg.	Chry ten
Brachylaena discolor DC. subsp. discolor var. discolor	Brac dis
B. elliptica (Thunb.)DC.	Brac ell
B. ilicifolia (Lam.)Phill.& Schweick.	Brac ili
Tarchonanthus camphoratus L.	Tarc cam
Helichrysum appendiculatum (L.f.)Less.	Heli app
H. capillaeum (Th.)Less	Heli cap
H. cymosum (L.)D.Don subsp. cymosum	Heli cym
H. nudifolium (L.)Less.	Heli nud
H. rosum (Berg.)Less. var. rosum	Heli ros
H. sp.1	Heli sp1
H. sp.2	Heli sp2
Elytropappus rhinocerotis (L.f.)Less.	Elyt rhi
Relhania genistifolia (L.)L'Herit.	Relh gen
Eriocephalus africanus L.	Erio afr
Sigesbeckia orientalis L. *	Sige ori
Pentzia incana (Thunb.)Hutch.	Pent inc
Senecio angulatus L.f.	Sene ang
S. coccinea DC.	Sene coc

S. deltoideus Less.	Sene del
S. ficoides (L.)Sch.Bip.	Sene fic
S. inaequidens DC.	Sene ina
S. littoreus Thunb.	Sene lit
S. longifolius L.	Sene lon
S. mikanioides Otto ex. Harv.	Sene mik
S. paniculatus Berg.	Sene pan
S. pterophorus DC.	Sene pte
S. pyramidatus DC.	Sene pyr
S. radicans (L.f.)Sch.Bip.	Sene rad
S. retrorsus DC.	Sene ret
S. sp.	Sene spp
Euryops algoensis DC.	Eury alg
E. brevipapposus M.D.Henderson	Eury bre
E. euryopoides (DC.)B.Nord.	Eury eur
Othonna carnosa Less. var. carnosa	Otho car
O. rufibarbis Harv.	Otho ruf
Gazania linearis (Thunb.)Druce var. linearis	Gaza lin
Berkheya carduoides (Less.)Hutch.	Berk car
B. heterophylla (Thunb.)O.Hoffm. var. heterophylla	Berk het
Gerbera piloselloides (L.)Cass.	Gerb pil

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