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VEGETATION AND FLORA OF THE KOSI BAY COASTAL FOREST RESERVE IN MAPUTALAND, NORTHERN KWAZULU-NATAL, SOUTH AFRICA

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Vegetation and flora of the Kosi Bay Coastal Forest Reserve in Maputaland, northern KwaZulu-Natal, South Africa.

by

Richard Andrew Lubbe

Submitted in fulfilment of the requirements for the degree

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Supervisor: Prof. Dr. A.E. van Wyk

Co-supervisor: Prof. Dr. N. van Rooyen

Project co-ordinator: Mr. W.S. Matthews

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'Fear not, O land; be glad and rejoice: for the LORD will do great things.
Be not afraid, ye beasts of the field: for the pastures of the wilderness do spring, for the tree beareth her fruit, the fig tree and the vine do yield their strength.' JOEL 3: 21,22.

ABSTRACT

Vegetation and flora of the Kosi Bay Coastal Forest Reserve in Maputaland, northern KwaZulu-Natal, South Africa.

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The vegetation of the Kosi Bay Coastal Forest Reserve was classified by means of Braun-Blanquet and TWINSPAN procedures. Twelve major plant communities were identified, occurring along a gradient from the inland fresh water habitats, to the beach with influences from strong winds and salt spray. Some of these communities were further divided into plant communities and sub-communities giving a total of 27 plant communities and three sub-communities. A vegetation map was compiled for the study area using Geographical Information System procedures. Veld condition was good and the grazing capacity high ranging between 2.9 and 5.6 ha/LSU (cattle). A checklist of 1 164 vascular plant species collected in the study area was compiled. The distribution of 71 plant species endemic to the Maputaland Centre of Endemism was related to plant communities. The coastal grassland communities were prioritized for conservation, as a large number of Maputaland Centre endemics are restricted to these communities.

Keywords: Classification, community, grazing capacity, endemism, grassland, forest, conservation, management, checklist, dune.

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CHECKLIST OF VASCULAR PLANTS RECORDED IN THE STUDY AREA

LIST OF ABBREVIATIONS

CFR = Kosi Bay Coastal Forest Reserve

CPD = Centre of Plant Diversity

GIS = Geographical Information System

GPS = Global Positioning System

KDNC = KwaZulu Department of Nature Conservation

LSU = Large Stock Units

MC = Maputaland Centre

MH = Maputaland Herbarium, Tembe Elephant Park

MPR = Maputaland-Pondoland Region

NH = Natal Herbarium, Durban

PC = Pondoland Centre

PRE = National Herbarium, Pretoria

PRÉCIS = Pretoria National Herbarium Computerised Information System

PRU = H.G.W.J. Schweickerdt Herbarium, University of Pretoria

TWINSPAN= Two-way Indicator Species Analysis

CHAPTER 1

INTRODUCTION

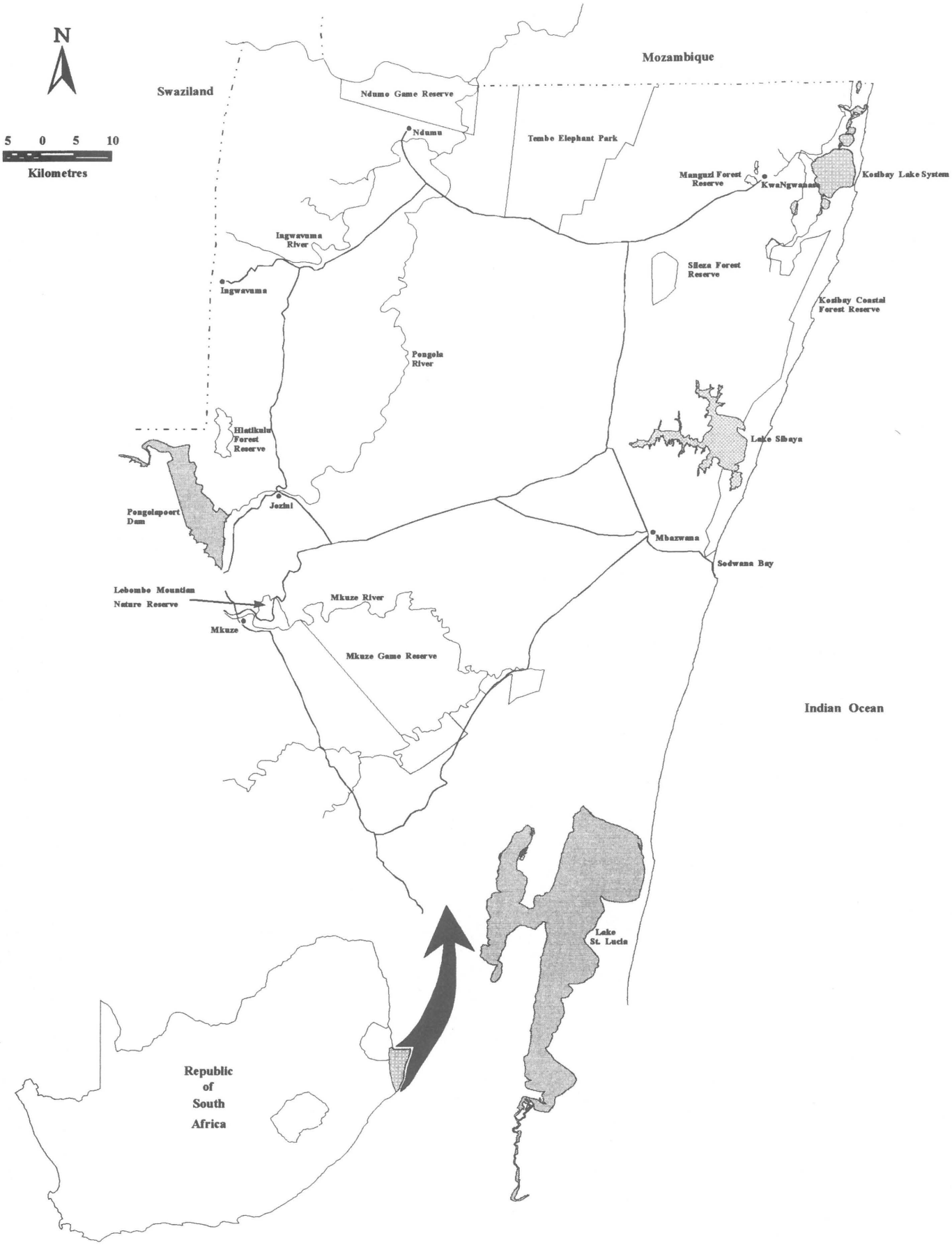
1.1 Maputaland

Maputaland (previously known as Tongaland) is located in the north-eastern corner of KwaZulu-Natal, bordered by Mozambique to the north, the Indian Ocean to the east, the Lebombo Mountains and Swaziland to the west, and the Mkuzi River and Lake St. Lucia to the south (Moll 1977). Maputaland lies at the southern end of the Mozambique coastal plain and comprises a broad, flat to undulating, cretaceously uplifted sandy region about 60 km in width (Figure 1). It can also be seen as the southern end of the tropics in Africa and many tropical plant and animal species reach their southernmost distribution limit here (Van Wyk 1994).

Phytogeographically, Maputaland is part of the Indian Ocean Coastal Belt (Moll & White 1978), which is both a Regional Transitional Zone and a Regional Mosaic (White 1976a), having a high proportion of endemics (Moll 1980). It forms part of the Tongaland-Pondoland Regional Mosaic (White 1983), a region which displays at least three foci of high floristic endemism, namely the Maputaland Centre [MC] in the north and the Pondoland Centre [PC] and Albany Centre to the south (Van Wyk 1994). Biogeographically the boundaries of the MC are clearly defined, except in the north, where the line is arbitrary (Van Wyk 1994).

For its size, which is approximately 26 734 km², the MC is one of the most remarkable areas of biodiversity in the world. Not only is the number of endemic species high, but they are spread over virtually the entire taxonomic spectrum. The total number of vascular plant species in the MC is at least 2 500, with 225 or more species or infraspecific taxa endemic or near-endemic to the centre. Of the more than 472 species of birds in the MC, 4 species and approximately 43 subspecies are endemic or near-endemic. Other endemic or near-endemic species and infraspecific taxa include 14 mammals, mainly of subspecific rank, 23 reptiles, 3 frogs and 8 freshwater fishes (Van Wyk 1996). Few other places in the world have so many

Figure 1. Map of Maputaland showing localities of game reserves, water bodies and major roads.



rare animals and plants concentrated in such a small area.

The vegetation of Maputaland is exceptionally diverse. It consists of a mosaic of forest, woodland, grassland and swamps. Moll (1980) classified the vegetation of Maputaland into fifteen major types, ranging from forest on the Lebombo Mountain Range through different types of bushveld, sandforest and swamps down to the coast with coastal grassland and dune forest.

1.2 Kosi Bay Coastal Forest Reserve

In January 1950 the Kosi Bay Nature Reserve, covering an area of 50 ha on the edge of Lake Nhlange, was proclaimed (Anonymous 1995). The proclamation aimed to conserve the unique vegetation and ecosystems occurring in the lake system and swamp areas and to create tourist facilities in the area. It was managed by the Natal Parks Board. In 1958 the Malangeni area and an area extending up to Kosi Mouth were added to the Reserve. The KwaZulu Department of Nature Conservation [KDNC] took over management from the Natal Parks Board in February 1984 (Anonymous 1995).

In the 1950s the coastal strip was proclaimed as the Coastal Forest Reserve under the State Forestry Act, in order to conserve and protect the indigenous forest vegetation as well as the habitats along the northern Zululand coast. In the late 1970s the KwaZulu Department of Forestry took over control of the Reserve, but in 1988 the KDNC took over the area from the Department of Forestry. The Kosi Bay Nature Reserve and the Coastal Forest Reserve were merged, re-surveyed and re-proclaimed by the KwaZulu Government as the Coastal Forest Reserve in 1992 (Republic of South Africa 1992). The area comprises some 21 772 ha. Although the area was proclaimed as the Coastal Forest Reserve, it is being referred to as the Kosi Bay Coastal Forest Reserve [CFR] to avoid confusion. In December 1993, Lake Sibaya, covering an area of about 6 500 ha, was proclaimed as a Freshwater Reserve. Lake Sibaya has been added to the CFR to ensure the correct and wise management and utilization of this unique freshwater system (Anonymous 1995).

Early management by the Forestry departments concentrated on planting and managing stands of the alien tree species, *Casuarina equisetifolia,* on bare sand areas along the coast. When the reserve was taken over by the KDNC, their intention was to manage it as a major conservation area. Fencing began in the northern area around Kosi Bay. The KDNC planned to develop ecotones on the landward side of the coastal dunes, remove cattle pressure from the dunes and remove *Casuarina equisetifolia* from the sand patches. The re-introduction of larger wild animals indigenous to the area was envisaged once fencing had progressed sufficiently (Ward 1991). Unfortunately only the Kosi Bay proclamation, about 55 km of the northern section down to Malangeni, just south of the Kosi Lake System, was fenced. The local communities opposed further fencing of the Reserve. In spite of addressing this problem at meetings with the local community, fencing has not been resumed since 1987 and more negotiations with the local communities are needed before the entire proclaimed Coastal Forest Reserve area can be fenced.

Some outstanding features of the CFR which have been identified as unique, valuable or sensitive areas, are the Kosi Lake System, which includes its different channels, the swamp forests, the mangrove community, Khalu inlet, Kosi Mouth and the various streams feeding the system. Further south, the cycad colonies, sand seas (bare dunefields), Black Rock, and the Sibaya dunes have been identified as important conservation areas. The whole foredune zone between the sea and the coastal dune forest has been identified as sensitive because it provides protection to the dune community and provides nesting sites for loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea)* turtles (Anonymous 1995).

Although the management of the area is extremely difficult, the KDNC has succeeded in maintaining and conserving the existing habitat diversity. Most of the vegetation in the area is still in a pristine state and almost untouched by human activity. With the development of infrastructures, the vegetation of the CFR is being put under a lot of pressure, which could have an irreversible impact on the area.

1.3 Motivation for study

The local people of Maputaland are noted for making wise use of the natural resources of the region. The vegetation provides fuel, building materials, household utensils, medicines and grazing for cattle and goats. Although the local people still use indigenous food resources, they also make use of the slash-and-burn type of shifting agriculture to plant crops such as maize, sweet potatoes, peanuts and bananas. It is clear that Maputaland cannot stand apart from a changing Africa however. Population pressures are increasing and people are depleting the available natural resources as they struggle to deal with their poverty. Already there are large parts of Maputaland which were formerly tree- or thicket-covered that are now laid bare. Not only will the local people suffer deprivation due to the need to buy expensive fuel and building materials, but age-old customs will fall away when the flora and fauna are depleted (Pooley 1980). If the conservation of the CFR as a selection of natural ecosystems and natural resources is to succeed, effective management must be applied, not only for the sake of the environment, but also for the people of Maputaland, because the unique richness of diversity of Maputaland can also be found in its people.

There is a worldwide concern today about the conservation of biodiversity. Solow (1993) states that biological diversity conservation promises to be among the premier environmental issues of this decade and beyond. It stands to reason that scarce funding resources for the conservation of biological diversity should be allocated according to a scientifically determined measure of biological diversity. Maputaland seems to be one of the richest areas of biodiversity in South Africa. Basic information of its plant species richness is essential for the effective conservation of the CFR in the future. At the same time, however, anxiety continues as to how the rapidly increasing population of the world is to be fed in the years to come. One of the greatest challenges facing humankind is to solve the problem of world hunger and malnutrition in ways that lessen our consumption of non-renewable energy resources. In the context of the CFR, management will have to permit the maximum sustainable utilization of natural resources if it is to be considered effective. Although resource utilization in the CFR is not a panacea for the regions malnutrition problems, household incomes and quality of life could be improved for people living around the reserve,

whilst still maintaining biodiversity.

For effective management a basic knowledge of the vegetation and the environmental and biotic factors that affect it, is essential. One of the Mission Statements adopted by the KDNC is "The implementation of applied research and the development of an adequate database so that decisions can be based on reliable and accurate information" (Anonymous 1995). Although a lot of work has already been done on the coastal vegetation of Maputaland (Tinley 1958 & 1976; Breen 1971; Venter 1974; Moll 1977 & 1980; Bruton & Cooper 1980; Weisser 1980 & 1989), the majority are broadscale studies. Weisser (1989) has done much detailed work on coastal dune vegetation dynamics, but a detailed plant ecological survey is required before the underlying ecological and phytogeographical factors can be fully understood (Moll 1977). Data on floristic diversity and detailed habitat correlations are lacking for the CFR and bordering areas. Lists of indicator species linked to habitats and localities are not available at this stage. The area has not yet been stratified into homogeneous management units, which would help in the conservation of species, control of grazing and the development of infrastructure and ecotourism. It is therefore important that such base work be carried out for the CFR.

1.4 Principal aims of study

- Compile a description and classification of the CFR's vegetation as it relate to environmental factors.
- Produce a detailed vegetation map that can be used in the management of the reserve.
- Determine the veld condition and grazing capacity of the reserve.
- Compile a species list of all the plant species that occur in the study area.
- Determine which plant species endemic to the MC occur in the CFR and map their distribution.

- Identify priority conservation areas based on the amount of MC endemic species.

- Propose management guidelines to ensure the wise utilization of resources and the preservation of floristic biodiversity in the CFR.

CHAPTER 2

STUDY AREA AND PHYSICAL ENVIRONMENT

2.1 Study area

The study area is located on the north coast of KwaZulu-Natal, north of Sodwana Bay and south of the Mozambique border. The area is situated between 26°51' and 27°31' S; 32°34' and 32°54' E, and covers an area of approximately 464 km². It consists of the Kosi Bay Coastal Forest Reserve [CFR], the Kosi Lake System, Lake Sibaya and some of its surrounding areas, as illustrated in the vegetation map (Figure 2a, b & c). The study area covers an area of 46 440.3 ha, which is about 1.7 % of the MC. The CFR (including Lake Sibaya and the Kosi Lake System) covers 33 341 ha, 72 % of the study area (Table 1). The area is known for its scenic landscape which is dominated by a high coastal dune barrier, partly interrupted to the west by the lakes of the Kosi Lake System and Lake Sibaya. The CFR's boundary stretches from about 3 km north of Sodwana Bay near Shazibe Pan, up to the Mozambique border in the north. The maximum width of the CFR is only about 7 km, with the largest part of the reserve consisting of a narrow stretch (about 3 km wide) of coastal dune forest bordered by coastal grassland.

The beaches of Maputaland, including those of the CFR, are one of the few places in the world where leatherback and loggerhead turtles can still breed without disturbance (Reardon & Reardon 1984). However, the CFR is much more than lonely golden beaches and sea turtles. It has pristine estuary and unpolluted lake systems as well as beautiful natural forests and grasslands rich in biodiversity. The Kosi Lake System in the north, which is about 18 km long, runs parallel to the coast. It consists of four interconnected lakes, each with its own ecological characteristics, opening into the sea in the north through an estuarine basin. It is one of the few pristine estuarine systems remaining in South Africa (Mountain 1990).

Key to vegetation map (Figure 2) according to plant communities from the phytosociological table (Table 3)

Disturbed Area

1. *Pinus elliottii-Chromolaena odorata* disturbed areas.

Beach/Open Sand

2. *Scaevola plumieri-Gazania rigens* var. *uniflora* dune pioneer community.

Coastal Dune Forest

3. *Eugenia capensis-Euclea natalensis* subsp. *natalensis* coastal scrub thicket.
4. *Peddiea africana-Diospyros inhacaensis* coastal dune forest.
   - 4.1 *Pavetta gerstneri-Apodytes dimidiata* subsp. *dimidiata* coastal dune forest.
   - 4.2 *Croton gratissimus* var. *gratissimus-Isoglossa woodii* coastal dune forest.

Inland Forest

5. *Tricalysia delagoensis-Dialium schlechteri* inland forest.
   - 5.1 *Artabotrys monteiroae-Hymenocardia ulmoides* inland forest.
   - 5.2 *Catunaregam spinosa* subsp. *spinosa-Tabernaemontana elegans* inland forest.

Large Thicket

6. *Syzygium cordatum-Canthium inerme* thicket.
   - 6.1 *Syzygium cordatum-Cymbopogon plurinodis* thicket.
   - 6.2 *Syzygium cordatum-Albertisia delagoensis* thicket.
   - 6.3 *Syzygium cordatum-Strelitzia nicolai* thicket.

Woodland

7. *Syzygium cordatum-Hyperthelia dissoluta* woodland.
   - 7.1 *Syzygium cordatum-Digitaria natalensis* woodland.
   - 7.2 *Syzygium cordatum-Wahlenbergia abyssinica* subsp. *abyssinica* woodland.**Coastal Grassland**

8. *Parinari capensis* subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland.
   - 8.1 *Helichrysum kraussii-Melinis repens* subsp. *repens* coastal grassland.
   - 8.2 *Vernonia natalensis-Polygala producta* coastal grassland.
   - 8.3 *Vernonia oligocephala-Diheteropogon amplectens* coastal grassland.
   - 8.4 *Cymbopogon plurinodis-Asclepias affinis* coastal grassland.

6. *Syzygium cordatum-Canthium inerme* thicket.
   - 6.1 *Syzygium cordatum-Cymbopogon plurinodis* thicket.
   - 6.2 *Syzygium cordatum-Albertisia delagoensis* thicket.
   - 6.3 *Syzygium cordatum-Strelitzia nicolai* thicket.

Hygrophilous grassland Low Water Table

- 9.1.1 *Themeda triandra-Monocymbium ceresiiforme* hygrophilous grassland.

Hygrophilous grassland High Water Table

- 9.1.2 *Ischaemum fasciculatum-Fuirena umbellata* hygrophilous grassland.
- 9.1.3 *Ischaemum fasciculatum-Hydrocotyle bonariensis* hygrophilous grassland.
- 9.2 *Brachiaria arrecta-Hemarthria altissima* hygrophilous grassland.

Swamp Forest

10. *Nephrolepis biserrata-Ficus trichopoda* swamp forest.

Mangroves

11. Mangrove community of the tidal basin of the Kosi Lake System.

Casuarina stands

12. *Casuarina equisetifolia* afforestation on drift sand areas near the coast.

Figure 2a. Vegetation map of study area Kosi Lake System section.

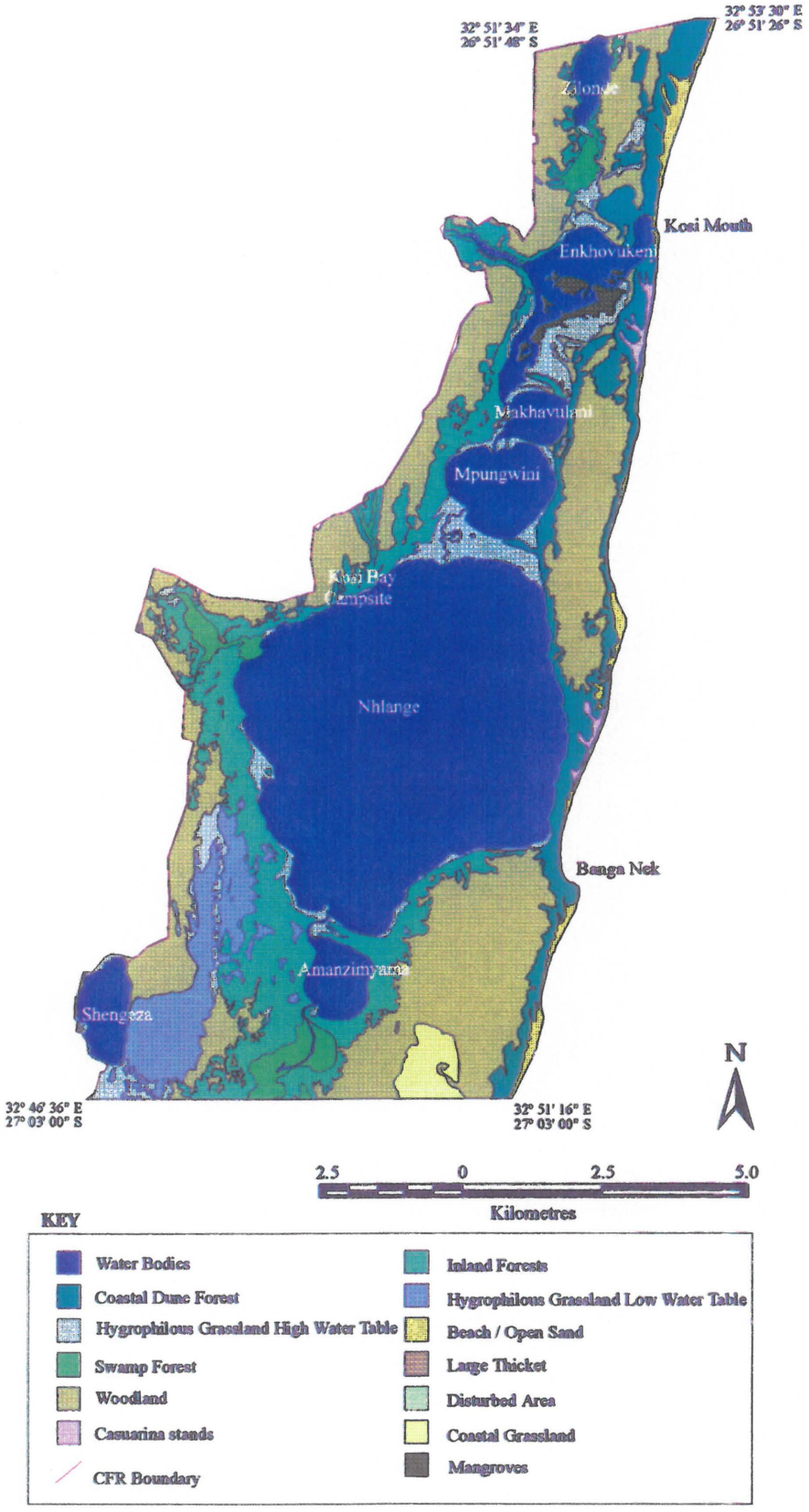


Figure 2b. Vegetation map of study area central section.

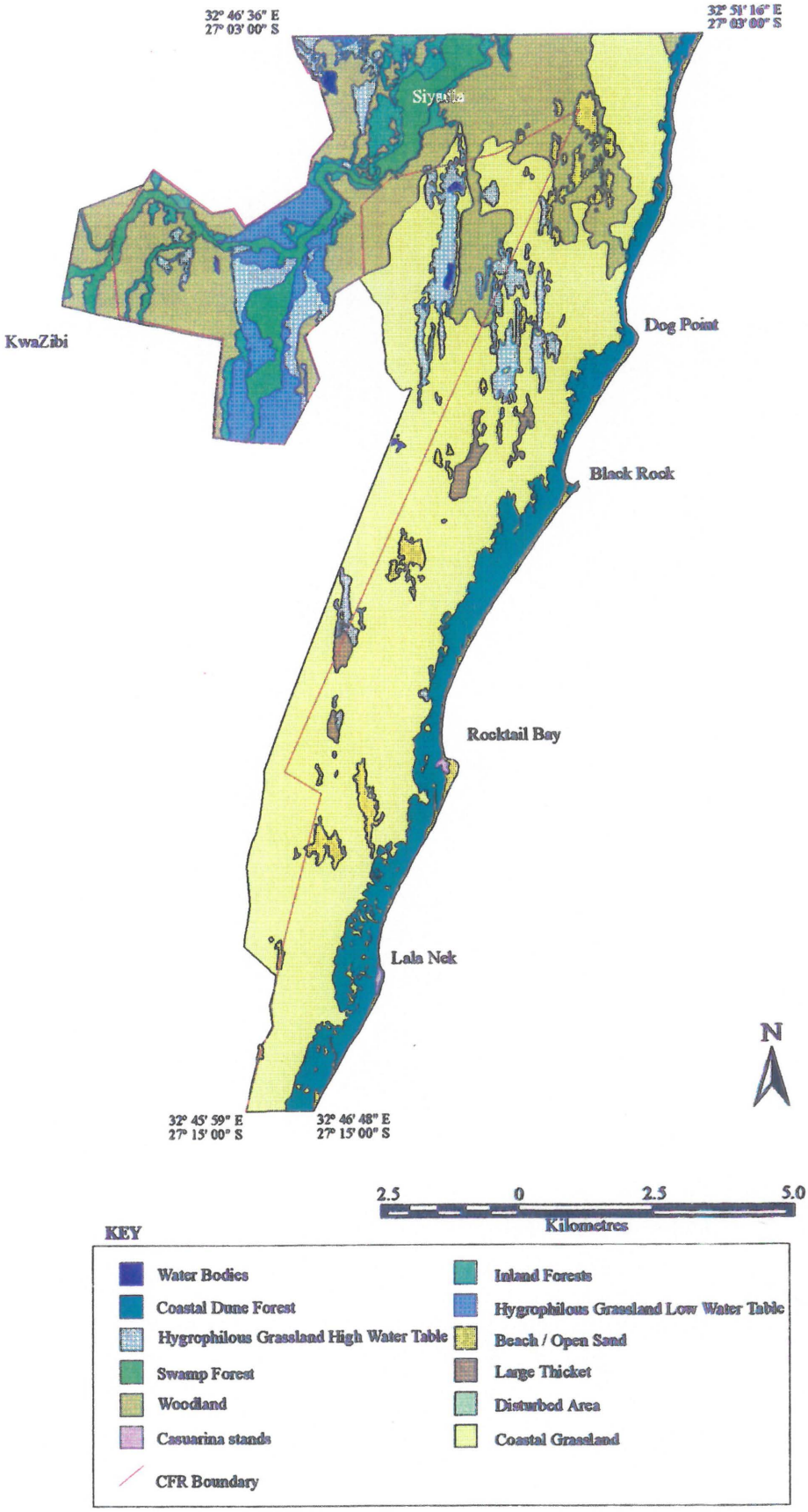


Figure 2c. Vegetation map of study area Lake Sibaya section.

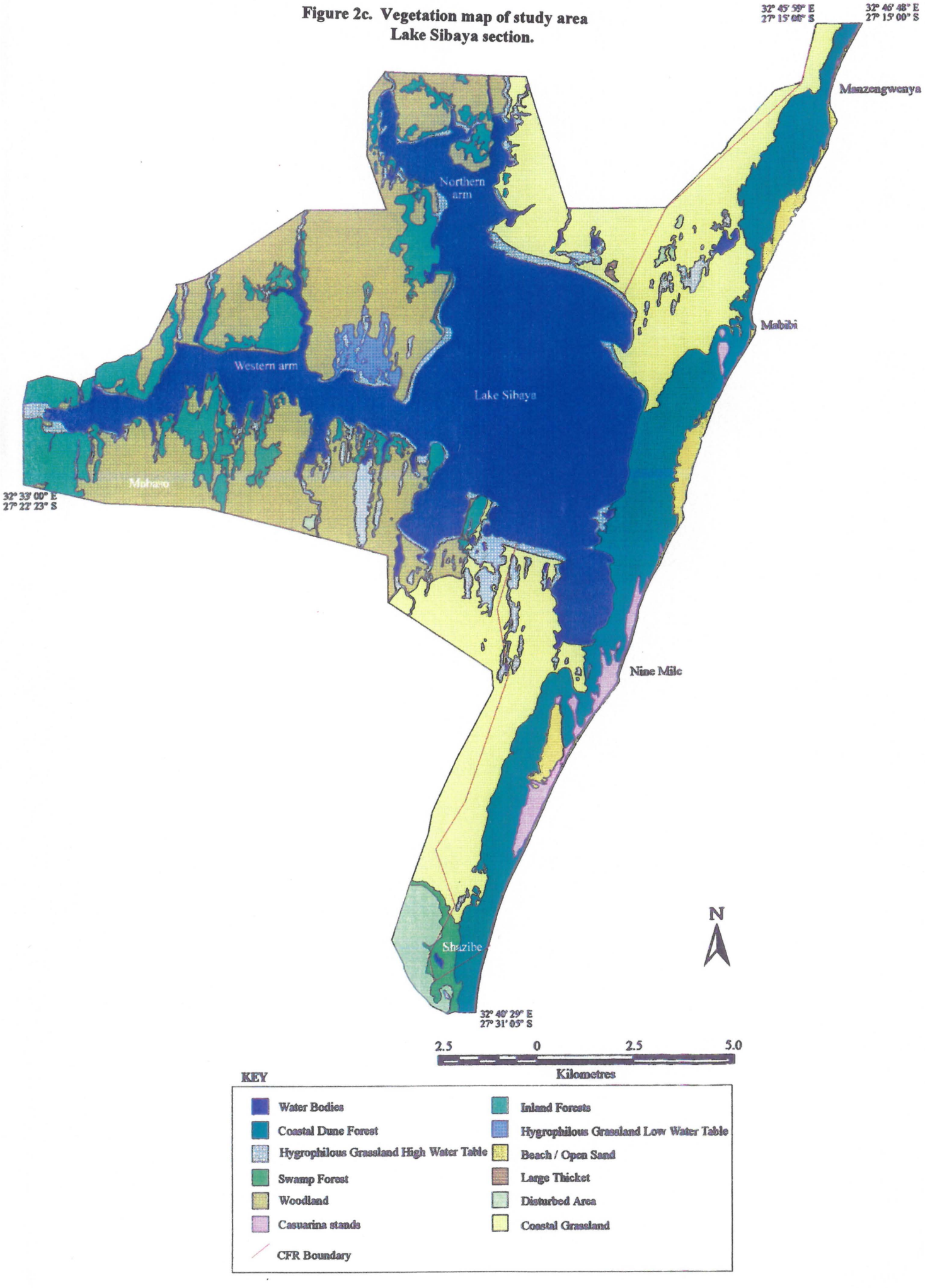


Table 1. Sizes of plant communities in the study area and the CFR taken from the vegetation map (Figure 2)

Community number	Study area (ha)	% of study area	CFR (ha)	% of CFR
2	979	2.1	950.5	2.9
3&4	4 656.6	10.1	4 559.6	13.7
5	3 776.1	8.1	1 873.5	5.6
6	93.5	0.2	77.2	0.2
7	10 377	22.3	4 815	14.4
6 & 8	9 826.2	21.2	6 276.4	18.8
9.1.1	1 081.2	2.3	876.8	2.6
9.1.2, 9.1.3 & 9.2	2 620.8	5.6	1 350.3	4.1
10	983.6	2.1	849.5	2.5
11	75.9	0.2	75.9	0.2
12	326.9	0.7	326.9	1
Disturbed Areas	361.2	0.8	26.2	0.1
Water Bodies	11 282.3	24.3	11 282.3	33.8
Total	**46 440.3**	**100**	**33 340.1**	**100**

Between Kosi Bay and Sodwana Bay lies Lake Sibaya, the largest freshwater lake in South Africa, rich in wildlife and bordered in the east by some of the highest vegetated dunes in the world (Moll 1977). The highest dune reaches 172 m above sea level. Many people are dependent on Lake Sibaya and the Kosi Lake System for fish, their main source of protein. The unique swamp forests around the lakes as well as the coastal dune forests of the CFR are also still in pristine state and almost untouched by humankind.

2.2 Physical environment

2.2.1 Topography and landscape

Maputaland is a predominantly flat, low-level coastal plain referred to as the Zululand or Mozambique Coastal Plain (Hobday 1979; Moll 1980). The Coastal Plain is about 60 km in width stretching from Mozambique in the north and ending near Mtunzini in the south. The Lebombo Range, which rises to an elevation of some 600 m, forms the western boundary of Maputaland (Hobday 1979). The Coastal Plain has a maximum elevation of about 150 m with a coastal dune ridge in the east which rises to 172 m above sea-level. The coastal dune ridge extends from Mtunzini northward well into Mozambique and constitutes one of the largest persistent coastal cordons in the world (Hobday 1979). It effectively separates the sea from the land (Moll 1977). The land immediately behind the coastal dune ridge is flat and it is here where the Kosi Lake System, Lake Sibaya and other minor lakes are found. Inland, more undulating, sandy country and landscapes are found.

Surveying Maputaland from the heights of the Lebombo Mountains, one sees flat bush country, stretching as far as the eye can see towards the east. On the way to the coast, one passes through areas of sand forest and the palm-belt zone, with scattered iLala palms (*Hyphaene coriacea)* interspersed with marshy areas. The undulating coastal grasslands lie just west of the coastal dune ridge, which mostly hides the sea from view. Numerous commercial plantations are distributed throughout the coastal grassland.

The CFR, stretching from Kosi Bay in the north, southward past Lake Sibaya, is blessed with a beautiful landscape which is popular with tourists. Looking out over Kosi

Mouth one can see the fish kraals of the Kosi Lake System, an intricate maze of structures first devised over 400 years ago (Mountain 1990). Down past Lake Amanzimnyama and the Sihadla River are the mysterious areas of swamp forest, with ferns covering the understorey of the forest. Further south, a road takes you through large vlei areas interspersed by small islands of trees, towards the evergreen coastal dune forest. You pass Black Rock where the strength and harshness of the connection between sea and land can be seen. A small road that winds between the dune forest and coastal grassland takes you further south past secluded bays and lonely beaches that seem to stretch forever, down to Lake Sibaya with its steep dune forest, where the road at places seems to go through a little tunnel of trees. A tourist can see the sun rise over the sea in the morning and watch it go down over lake Sibaya in the evening.

The importance of conserving landscapes was recognized by Franklin (1993). He emphasizes that by conserving the landscape the bulk of the existing biodiversity is also conserved.

2.2.2 Geology

The geology of Maputaland is perhaps one of the features which contributes most to the uniqueness of the area (Moll 1977). The Maputaland Coastal Plain consists mainly of Cretaceous to Recent marine sediments, with clayey alluvium occurring in the flood plains of some of the larger rivers (Bruton & Cooper 1980). Underlying sediments of marine origin are mostly covered with Quaternary aeolian sands (Weisser *et al.* 1989).

The coastal dunes are of late Pleistocene and Recent age and overlie coastal sandy limestone or Port Dunford Beds. The Port Dunford Beds comprises sand, clayey limestones and diatomite which were laid down under marine shallow-water, terrestrial and freshwater lacustrine conditions (Maud 1980). The vegetation covering these dunes are their only stabilizing factor.

At intervals along the coast, outcrops of calcarenites consisting of marine-cut platforms, sometimes overlain by younger deposits, are found. Black Rock is an example of

the oldest calcarenites of aeolian sandstone. The upper parts have been subjected to karst weathering forming solution pipes. Calcarinites extend from an unknown depth below sea-level to elevations of 25 m (Hobday 1979).

2.2.3 Soil

The soils of the study area are very sandy. They are characterized by adverse physical and chemical properties which make them infertile and of low agricultural potential. In combination with the relatively high rainfall, they are highly leached, making them poor in nutrients, especially in the dune areas. In the interdune depressions a higher water table is found and this leads to the soil being waterlogged, at least periodically. The high water table is due to the impermeable Port Dunford Beds (Maud 1980).

Dunes of the coastal areas consist mainly of a pure quartz sand with local concentrations of heavy minerals such as ilmenite, rutile, zircon and magnetite (Hobday 1979). Recent sands are whitish, whereas older sands are reddish to brownish with a higher clay content. On older dunes with closed woody vegetation, the soils are dark greyish-brown sand, with a relatively high humus content (Weisser & Cooper 1993). Watkeys *et al.* (1993) describe the soils of the area as poorly developed yellow to orange arenosols, with the dunes consisting of dystrophic pallid sands with a high relief and steep slopes, stabilized by vegetation. They state that leaching as a result of the high rainfall has lead to the development of impermeable horizons within the soil profile.

Local people in the coastal areas make use of the so-called slash-and-burn type of shifting agriculture. The poor fertility and the high leaching status of the soil has necessitated the adoption of this type of agriculture. While studying the dune forest structure, Breen (1979) did some observations on the soil and the impact of agriculture on the soils of the dune forest around Lake Sibaya in particular. He found that nitrogen, carbon and pH levels decrease during crop production, but are restored to their former levels fairly quickly when a field is abandoned and the natural vegetation left to regenerate. He observed that a comparison of aerial photographs before and after regeneration of cultivated fields, and taken 17 years

apart, shows a considerable amount of re-establishment, but that even at the end of this period some areas had not yet been re-colonized by trees. Breen's data shows that although nitrogen and carbon levels can be restored within a relatively short period, the effect on the composition and structure of the vegetation continues for a much longer time. This has also been noticed by the local people, who return to clear abandoned fields after regeneration has commenced, but before too much vegetation has been re-established. In this way a lot of work is saved but the continued pressure of human activity on certain areas leads to degradation of the system.

A comparative study of the soils around Lake Sibaya (Weisser 1989) shows that in relation to woodlands and previously cultivated land the dune forest has the highest K and Mg levels and the most acid soil, with a pH of 5.3. The woodland had the highest levels of P and Ca, as well as the most alkaline soil (pH 7.2). Cultivated land showed clear signs of nutrient depletion.

2.2.4 Climate

Climatically Maputaland forms the southern end of the tropical region. The limit of the tropics, as indicated by Poynton (1962), seems to be the 18°C midwinter month surface isotherm. It crosses the coastal plain in the region of Lake St. Lucia after skirting the western edge of the Mozambique plain. The climate is humid and warm to hot. No frost, not even light frost, occurs.

The average annual minimum and maximum temperature for Manzengwenya, which is situated almost halfway between Lake Sibaya and Kosi Bay, is 18.2 and 26 °C respectively. The correlation between temperature and rainfall is illustrated in Figure 3, with a higher rainfall in the warmer months and a low rainfall in the colder months. The average annual rainfall recorded at weather stations in the area are: Manzengwenya 981 mm; Kosi Bay 947.1 mm; and Mbazwana 934.8 mm. Using rainfall data for Manzengwenya, Kosi Bay and Mbazwana (Figure 3), the highest average rainfall was found to occur in February and March and the lowest in May and June. There does not seem to be a pronounced dry season, with

Figure 3a. Average temperature and rainfall for Manzengwenya.
(figure according to Larcher 1983)

Manzengwenya (60 m) 22.2 °C 945.3 mm
6 years

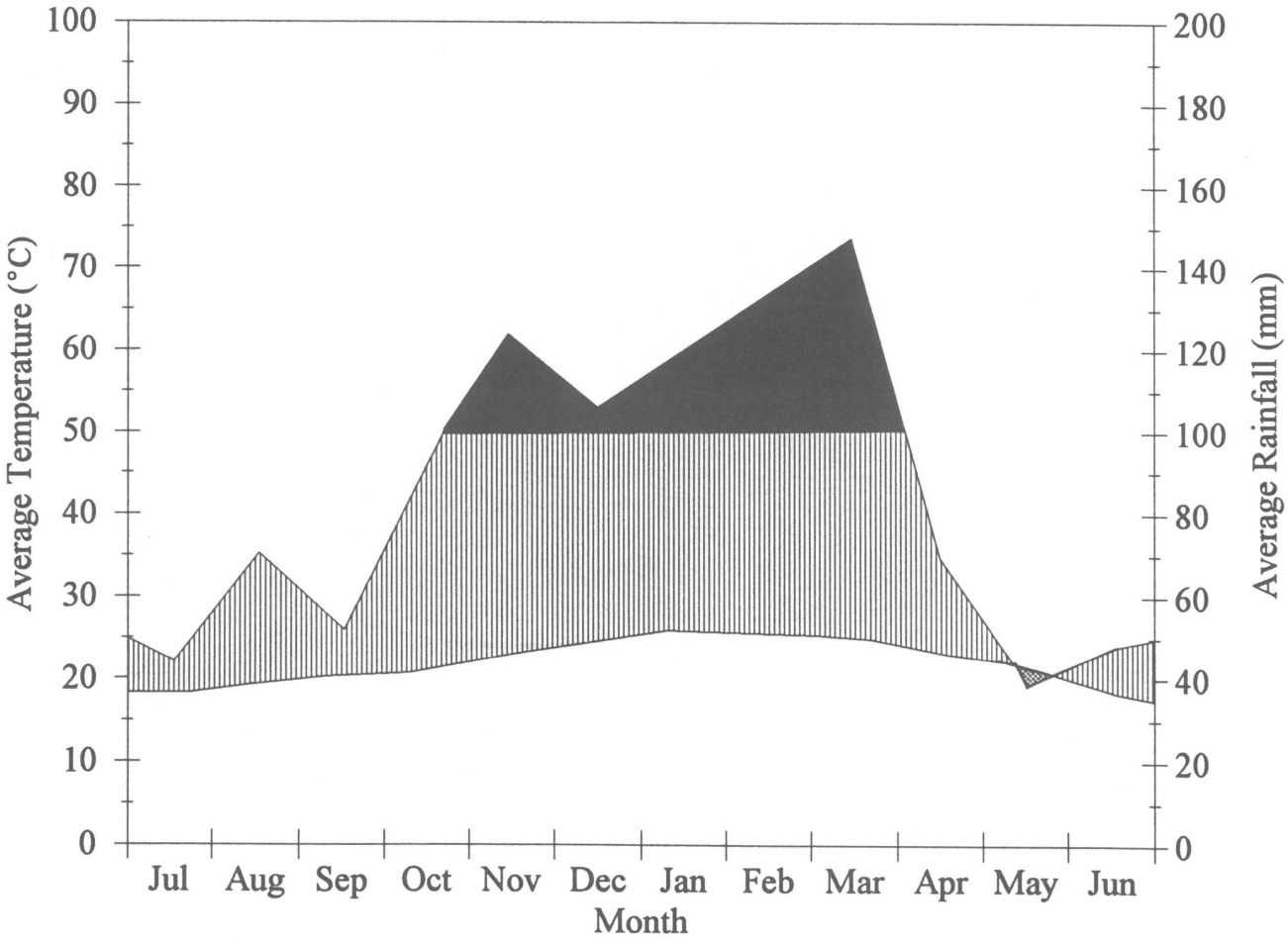
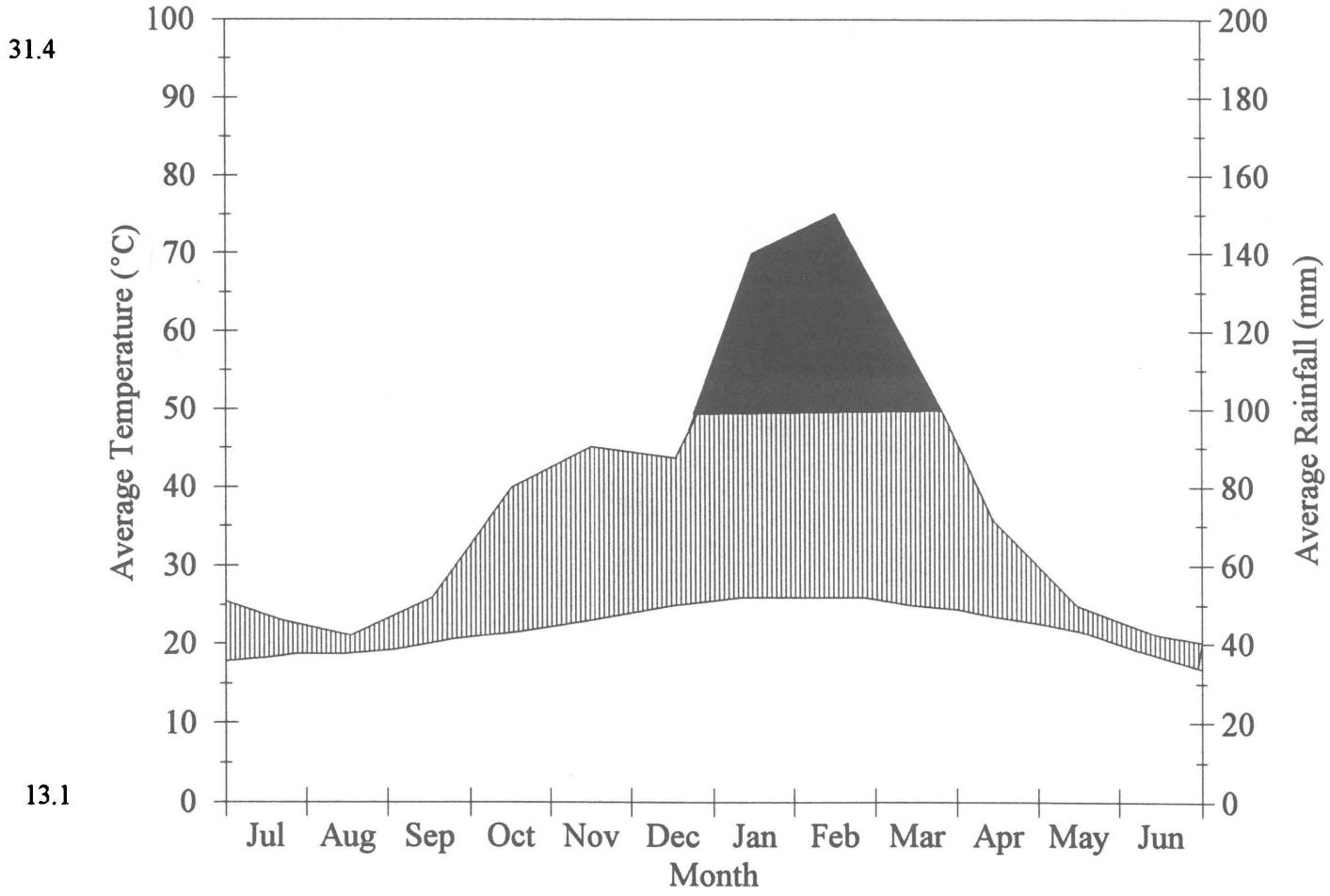


Figure 3b. Average temperature and rainfall for Kosi Bay.
(figure according to Larcher 1983)

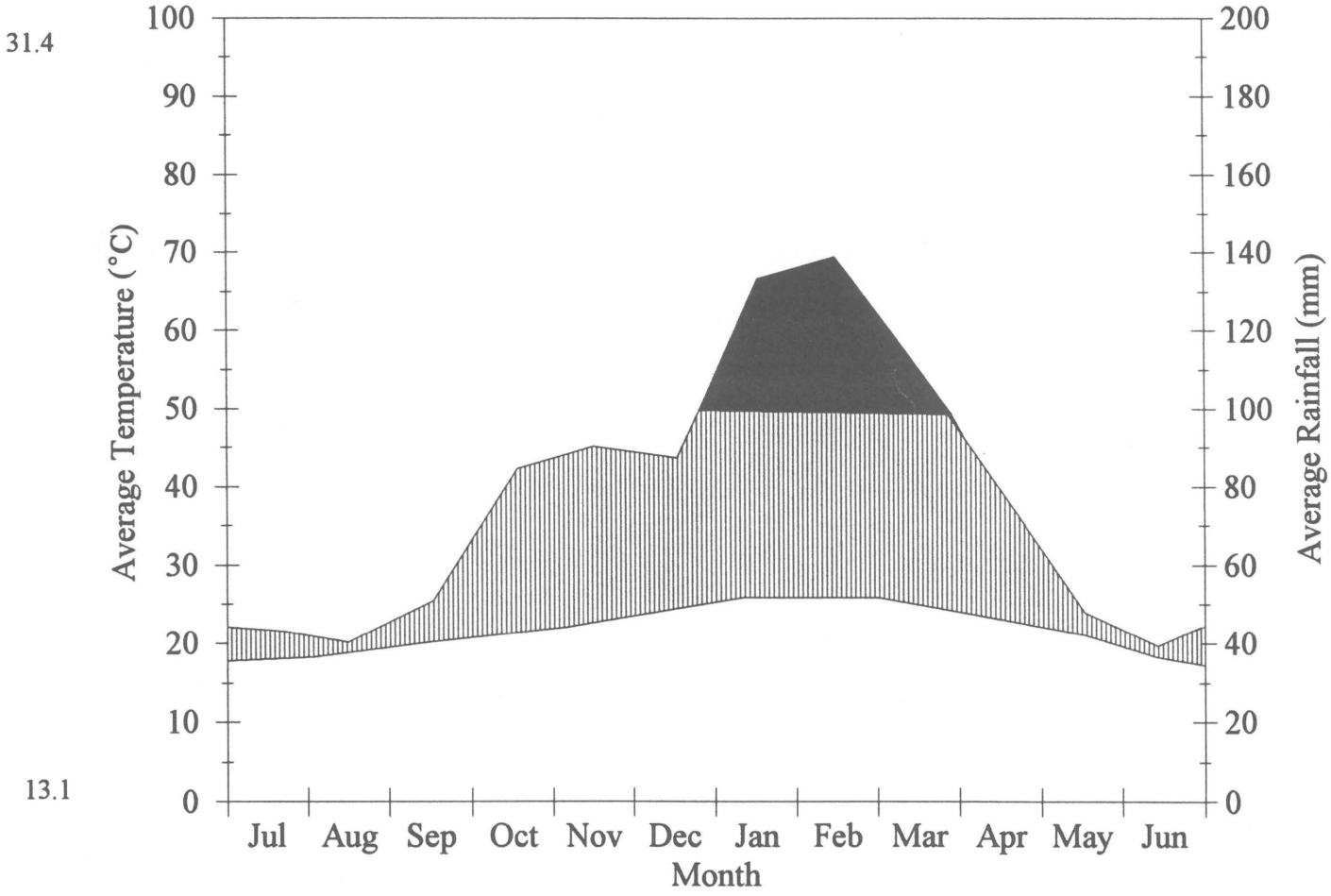
Kosi Bay (50 m) 22.2 °C 947.1 mm
42 years



No temperature data was available for Kosi Bay so the average temperature for Manzengwenya over 6 years was used.

Figure 3c. Average temperature and rainfall for Mbazwana.
(figure according to Larcher 1983)

Mbazwana (50 m) 22.2 °C 934.8 mm
43 years



No temperature data was available for Mbazwana so the average temperature for Manzengwenya over 6 years was used.

the lowest average monthly rainfall still exceeding 35 mm.

The coast is occasionally subjected to cyclonic rainfall from the Indian Ocean summer cyclones. The cyclone season is generally from January to March. This is caused by the ameliorating effect of the warm Mozambique current. This effect has a considerable influence on the vegetation of the region and is one of the reasons why so many tropical plant species occur in Maputaland.

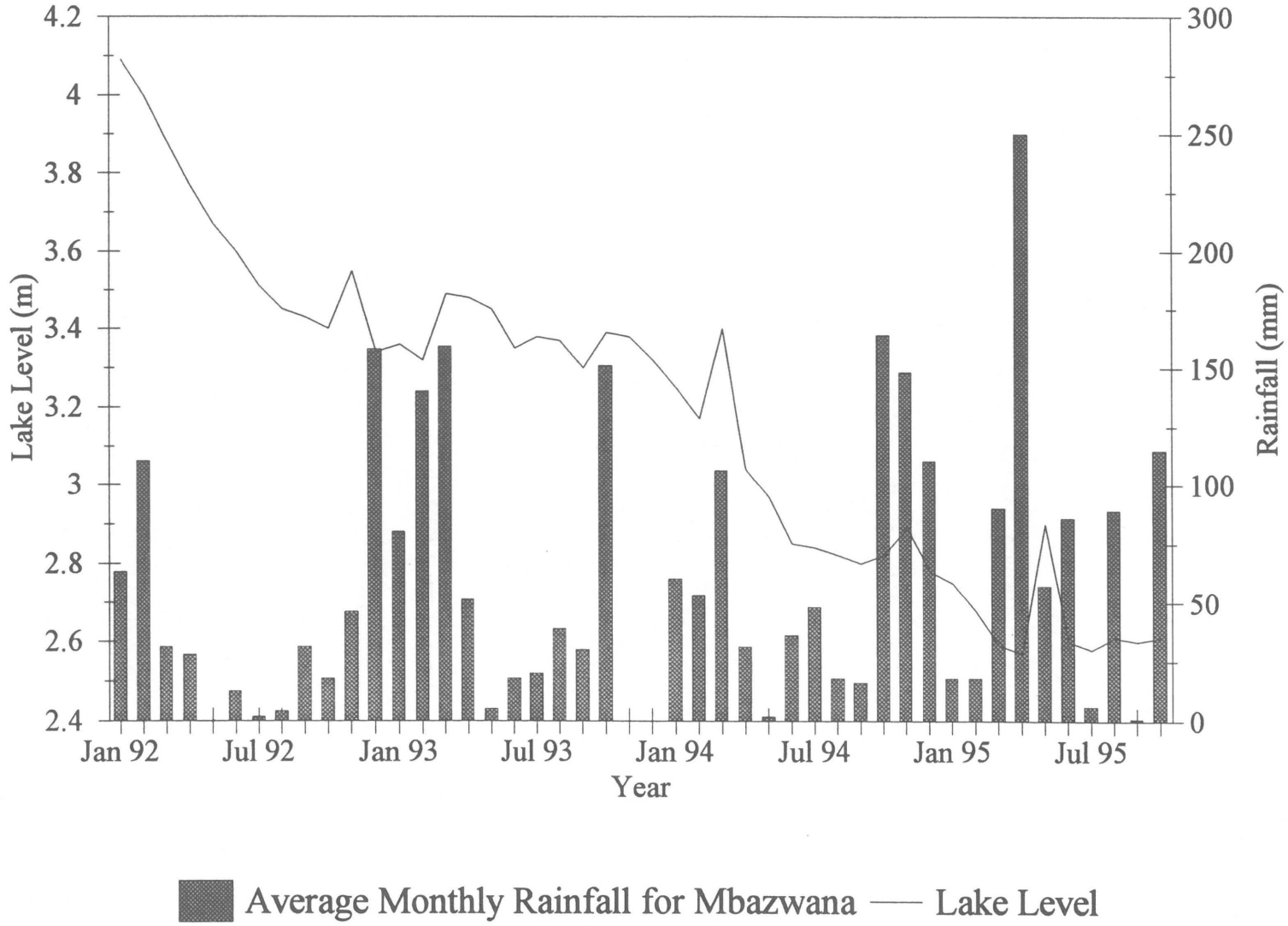
2.2.5 Fresh Water Systems

- Lake Sibaya

Lake Sibaya is the largest natural freshwater lake in South Africa and covers an area of between 6 500 and 7 000 ha. The lake is of estuarine origin, but is now completely sealed off from the sea by a range of dunes up to 172 m in height. The closure occurred at some time during the late Pleistocene. The Sibaya area is unique because of the well-developed submarine canyons offshore, a feature not as well developed elsewhere along the South African coastline (Maud 1968). The submarine canyons around Sibaya suggest a former extension of a large river, probably the Pongola, to an estuary at Sibaya, before the development of the river's more northerly inland course (Maud 1980).

The catchment area estimated by Pitman (1980) is about 53 000 ha, of which about 7 000 ha is taken up by the lake itself. The freshwater supply from the catchment reaches the lake by a few small streams. The lake level seems to fluctuate according to rainfall (Figure 4), with a rise in lake level recorded in or after a month when a high average rainfall was recorded. From 1992 to 1995 the annual rainfall was below average for the area, and this is reflected in the gradual drop in lake level recordings from about 4.3 to 2.6 m. The mean annual rainfall value for the lake is 1 030 mm, varying between 1 700 mm in wet and 600 mm in dry years (Pitman 1980). Evaporation is the main cause of water loss from the lake, but a small amount is lost through seepage to the sea. The water of the lake is alkaline, with a pH of 8.3 and has a high chloride concentration of 135 mg/1 Cl- (Allanson *et al.* 1974).

Figure 4. Lake Sibaya: water level compared to monthly rainfall



The estuarine origin of Lake Sibaya is supported by the presence of numerous estuarine and marine invertebrates and vertebrates. Primary production in the lake is very low and the water is clear. The lake is bedded on low nutrient sands and has no major inflow of nutrients. Aquatic macrophytes play only a minor role in reducing water turbulence or trapping organic matter and are negligible as nutrient reservoirs, and therefore do not form a major food source for any fish species (Howard-Williams 1980). Because of the low nutrient status of the water, fish species that inhabit the lake are much smaller than their counterparts in other water bodies.

Lake Sibaya's fish fauna consists of 18 species, five of which show a marine affinity. One endemic species, the Sibaya goby (*Silhouetta sibayi),* is only found in Lake Sibaya and the Kosi Lake System. At least 22 different species of frogs live in the reeds and vegetation surrounding the lake. Eight reptile species are closely associated with the lake and a further 59 species have been recorded in the adjacent areas. Of the 279 species of birds recorded in the area, 62 are closely associated with the lake through their breeding, feeding and roosting habits (Bruton 1980). Six mammal species are consistently associated with the lake, reedbuck and hippopotamus being the largest of these. The hippopotamus population has grown from 40 in 1958 (Tinley 1958) up to approximately 130 in 1995. The hippopotamus population seems to have stabilized either through movement into adjacent lakelets, or deaths occurring through fighting and poaching. Reedbuck are occasionally seen at the southern side of the western arm of Lake Sibaya.

In 1968 Professor B.R. Allanson of Rhodes University, Grahamstown, founded a permanent research station on the eastern shores of Lake Sibaya. This station basically consisted of a laboratory, a workshop, a weather station and living quarters. From this station various research projects were conducted including work on the bathometry of the Lake and the unique fish, plant and animal species of the Lake. In 1977 the station was flooded due to a rise in lake level, caused by heavy rains during February and March 1975 and a high average rainfall during the winter of 1976 (Bruton 1979). The station was subsequently abandoned. From 1968 to 1977 valuable knowledge were obtained from research conducted from this station, yet today little evidence of its existence remains on the eastern shores of Lake Sibaya.

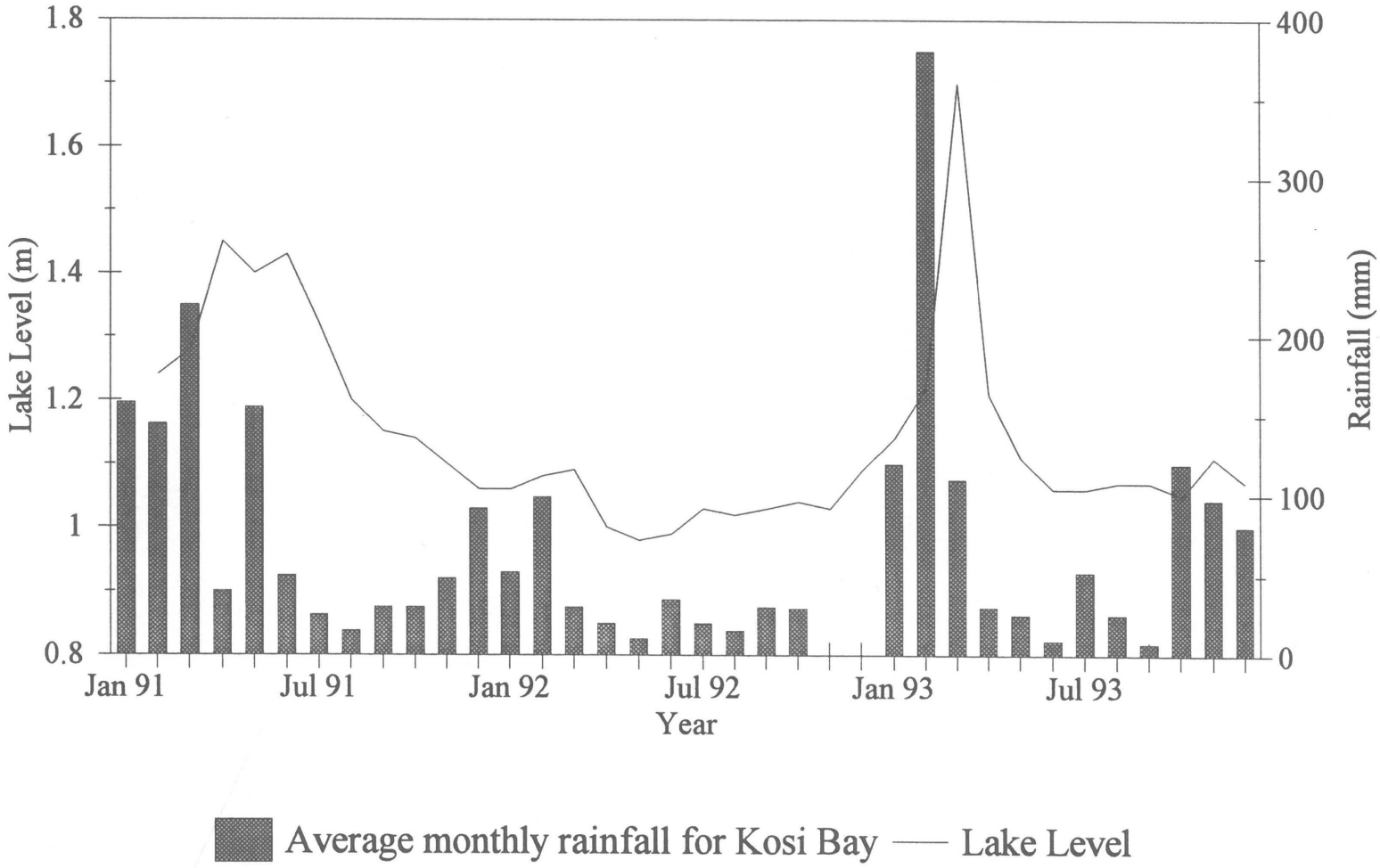
- Kosi Lake System

The Kosi Lake System is situated in the north eastern corner of Maputaland. It consists of four interconnected lakes with an estuary and stretches from north to south for about 18 km (Figure 2a). The northernmost part of the system, where it is connected to the sea, is approximately three kilometres from the Mozambique border. The estuary or Kosi Mouth, which is connected to the sea, is known locally as Enkhovukeni, a name which refers to the rising and falling of water caused by the tides. Connected to Enkhovukeni in the south, is First Lake or Lake Makawulani, referring to the axe-like shape of the lake. Below Makawulani is Second Lake or Lake Mpungwini, named after a custom of the Thonga people that is said to prevent larvae from eating the crops. Third Lake or Lake Nhlange is connected to Lake Mpungwini by a channel. Its name means, "the reedy place". Fourth Lake or Lake Amanzimnyama, meaning "black water", is the most southern lake of the system and its name is derived from the dark colour of the water caused by fragmented and decomposed plant material fed into the lake by the Sihadla River from the adjacent forests and swamps.

The Kosi Lake System is fed by two rivers, the Sihadla River, which is approximately 30 km long and enters Lake Amanzimnyama in the south, and the Nswamanzi River, which is approximately 15 km long and enters Lake Nhlange on its western shore. In the north a stream called the Sifazanene flows into the system from Lake Zilonde. The Kosi Lake Systems catchment area is estimated to be 50 000 ha and is surrounded by pans, swamps and marshes (Begg 1980). The salinity of the lakes ranges from a salinity close to sea water in the tidal basin (Enkhovukeni) to freshwater in Lake Amanzimnyama. Lake level recordings of Lake Nhlange show a correlation with average monthly rainfall (Figure 5). The lake level seems to be rather stable with recordings varying between about 1 and 1.7 m. A rise in water level can be detected in or after months with a high rainfall.

The bottom materials of the system consist of clean, white sands, particularly in the north where the tides have the biggest influence, while the only silt is found in deeper waters.

Figure 5. Lake Nhlange: water level compared to monthly rainfall



The sandy substrate lacks fine particles and is low in nutrients, but the bottom materials of the deeper parts are rich in nutrients (Hemens *et al.* 1971). These materials originate in the swamps and marshes alongside the system and gravitate towards the deeper areas. In general nutrient levels are low, although the reservoir of nutrients in the form of organic detritus is sufficient to feed the system (Blaber 1978).

Around the Kosi Lake System swamp forests, marshes, coastal dune forests and open grassland are found. One of the unique features of the area around Lake Amanzimnyama is the groves of the palm *Raphia australis* which grows in swamp forest. The largest concentration of this species in South Africa is found here. All six of the mangrove species that occur in South Africa are found in the Kosi Lake System (Steinke 1995). Two of these (*Lumnitzera racemosa* and *Ceriops tagal)* are at the southernmost limit of their distribution and do not occur elsewhere in South Africa.

The fauna of the Kosi Lake System is extremely rich, from the lower trophic levels and insect life up to fish, mammals, birds and reptiles. About 163 species of marine and estuarine fish occur in the system (Blaber & Cyrus 1981), while nine freshwater species have been recorded, mostly in Lake Nhlange and Amanzimnyama (Blaber 1978). Tinley (1976) listed 25 mammal species around Kosi Bay with hippopotamus being the largest of these. The number of hippopotamus has increased from 19 in 1958 (Tinley 1976) to about 54 at present. About 247 bird species are found around the Kosi Lake System with about 85 closely associated with the water. Of these several are at the most southerly limits of their distribution (Cooper 1976). The area is rich in reptiles and crocodiles occur in Lake Amanzimnyama, although these are uncommon in the other lakes of the system.

- Smaller lakes

Lake Shengeza is found to the south-west of the Kosi Lake System. This lake does not seem to have any direct influence on the Kosi Lake System, but might indirectly have an influence on it. A connection of scattered marshes and swamps east of Lake Shengeza leads into the Sihadla River that flows into Lake Amanzimnyama. Water is pumped from Lake Shengeza to

provide water for the town of Manguzi (KwaNgwanase). Lake Shengeza has a sandy bottom and the water colour is brown-stained. The average depth of Shengeza is 6 m (Appleton 1977).

Lake Zilonde is found to the north of the Kosi Lake System on the Mozambique border. It forms part of the Kosi Lake Systems catchment area and is connected to Lake Enkhovukeni (Kosi Mouth) by a small stream called the Sifazanene stream which flows through swamp forest and marsh areas. To the north of Lake Zilonde a series of marshes, swamps and a small stream feeds into Lake Zilonde from Mozambique (Tinley 1958). Lake Zilonde's bottom substrate consists of silt. The Lake is about 4 m deep and the water is brown-stained (Appleton 1977). Eleven freshwater fish species have been recorded from the Lake (Bruton & Kok 1980) and crocodiles are present. The Thonga people fish in the Lake and Pooley (1980) states that intensive fishing and trapping has depleted the crocodile population.

Lake Shazibe is found at the southernmost tip of the CFR and together with Lake Mgobezeleni (which lies outside the CFR) supplies fresh water to an estuary further south at Sodwana. The bottom of the Lake consists of white and grey sand, densely covered with macrophytic debris. Lake Shazibe receives water mainly through underground seepage. The Lake is connected by a stream to the rest of the Mgobezeleni Lake system. Nineteen species of fish have been recorded from Lake Shazibe and Mgobezeleni (Bruton 1980). Although Lake Shazibe partially falls under the management of the CFR, it would be more efficient if it falls under the management of Sodwana and the rest of the Mgobezeleni Lake System.

CHAPTER 3

METHODS

3.1 Introduction

Different sampling methods were used to compile a classification of the different vegetation types, determine the veld condition and grazing capacity and acquire knowledge on the endemic and rare species of the Kosi Bay Coastal Forest Reserve [CFR].

3.2 Vegetation Survey

3.2.1 Terrain reconnaissance

All the relevant environmental, vegetation and floristic information of the area that was available, was obtained. Stereo- and ortho-photographs of the CFR on a 1: 50 000 scale were studied together with geological maps, topo series maps on a 1:50 000 scale (26 32 DD, 27 32 BA, 27 32 BB, 27 32 BC & BD and 27 32 DA) and land type maps, to enable a sound stratification of the study area for efficient sampling of the representative vegetation types. The study area was traversed in order to get a basic idea of the variation in vegetation types, land use and species composition. Using this information as basis, the area was stratified into relatively homogeneous units on aerial photographs, using topography, physiognomy and dominant plant species as major attributes to delimit stratification units.

3.2.2 Number and distribution of sample plots

The number of sample plots required are influenced by various factors, including the scale of the survey, environmental heterogeneity (variation) in the study area, and the scale necessary for the classification (Bredenkamp 1982). In order to give a clear reflection of the variation of the vegetation, sample plots were, as far as possible, equally distributed within the different stratification units. A minimum of four sample plots were placed in each of the stratification

units recognized.

The exact position of each sample plot within the relevant stratification unit was chosen subjectively according to the methodology of the Zurich-Montpellier approach of phytosociology (Braun-Blanquet 1964). This survey technique is strongly recommended by Werger (1973) and Bredenkamp (1982), because it enables efficient sampling in heterogeneous vegetation (Braun-Blanquet 1964). It has been successfully applied in other phytosociological studies in South African grasslands (e.g. Bezuidenhout *et al.* 1988; Behr & Bredenkamp 1989; Bezuidenhout & Bredenkamp 1990; Bredenkamp & Bezuidenhout 1990; Kooij *et al.* 1990), and many other vegetation types. Weisser (1989) used the Braun-Blanquet technique when doing work on the dune forests in the same area as this study.

The size of each sample plot was approximately 10 m x 10 m, but varied in size and shape according to the unit being sampled. Areas like vleis or the crests of dunes were treated as single sampling units if the units were distinct. Sampling of the dune forest was done in the same way, but to get a perspective of the vegetation gradient, it was conducted in a transect from the beach inland, with plots distributed throughout all the homogeneous units.

Sampling was carried out from January to May 1994 and January to March 1995. A total of 200 sample plots were distributed throughout the study area. Most of the previous work done in the CFR by other botanists (Tinley 1976; Moll 1977; Bruton & Cooper 1980; Weisser 1989) has been confined to the dune forest and the grasslands did not receive that much attention. It was decided to sample the grasslands more intensively.

3.2.3 Data analysis

To save time and money travelling to different sample sites, sampling was done in such a way that all relevant data from a sample site could be collected. At each sample site all the floristic, grass production, grazing capacity and habitat data, were recorded. The exact position of each sample plot was obtained with a hand held Global Positioning System [GPS] (Trimble Ensign distributed by OPTRON, P.O. Box 1462, Rivonia, 2126) (see 3.5.1).

Herbarium specimens were also collected in each sample plot, in order to identify plant species and contribute to the floristic survey.

The Braun-Blanquet method was used, as it is considered to be a standardised method for phytosociological surveys in South Africa. The survey included a list of all the plant species present in a sample plot as well as a cover-abundance value for each of these species, according to the Braun-Blanquet cover-abundance scale (Mueller-Dombois & Ellenberg 1974):

r = one or a few individuals (rare) with less than 1 % cover of total sample plot area.
+ = infrequent with less than 1 % cover of total sample plot area.
1 = frequent with low cover, or infrequent but with higher cover; 1—5 % cover of total plot area.
2 = abundant with >5—25 % cover of total sample plot area.
A: >5—12 %
B: >12—25 %
3 = greater than 25—50 % cover of total sample plot area, irrespective of the number of individuals.
4 = greater than 50—75 % cover of total sample plot area, irrespective of the number of individuals.
5 = greater than 75 % cover of total sample plot area, irrespective of the number of individuals.

Taxon names conform to those of Arnold & De Wet (1993).

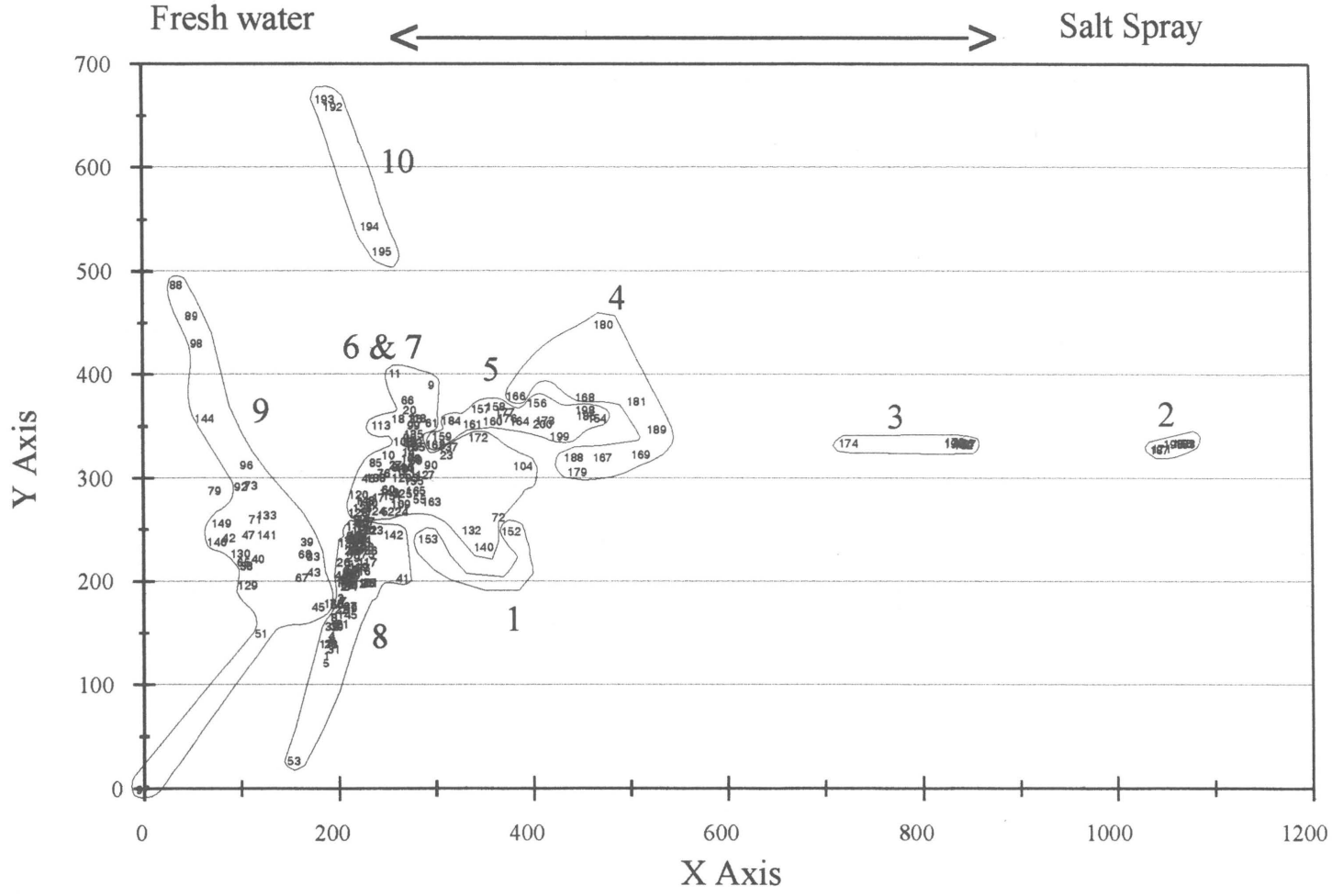
A relevé was compiled for each sample plot. A relevé is a list of all the observations made in a sample plot (Coetzee 1972). A Braun-Blanquet table was compiled and Two-way Indicator Species Analysis [TWINSPAN] (Hill 1979b) was applied to the basic phytosociological data set in order to derive a first approximation of the possible plant communities. Refinement of this classification was done by the application of Braun-Blanquet procedures. This was attained by using the computer programmes BBNEW, (available at the

Botany Department of the University of Pretoria) and Quatro Pro (a product of Borland International Inc., 100 Borland Way, P.O. Box 660001, Scotts Valley).

In analysing the data set, an ordination algorithm, Detrended Correspondence Analysis (DECORANA) (Hill 1979a) was applied to the phytosociological data set in order to determine possible vegetation and associated habitat gradients, as well as the floristic relationships among the plant communities (Figure 6).

Subjective estimates of the percentage cover of trees, shrubs, herbs and grasses were made in each sample plot. These estimates were done in such a way as to determine what percentage of the vegetation cover is made up of trees, shrubs, herbs and grasses. The sum of the percentages of trees, shrubs, herbs and grasses within a sample plot therefore always equals 100 %, although there might be some bare ground. The estimates are subjective because of the difficulty of distinguishing between small trees and shrubs, and herbs and shrubs. The criteria used to distinguish between trees, shrubs and herbs was chiefly plant height and growth form, similar to what has been proposed by Edwards (1983). A plant was classified as a grass if it belongs to either the Poaceae or Cyperaceae family. Trees were usually taller than 3 m (excluding climbers), while shrubs were anything between 1 m and 3 m in height (including small trees, but excluding species like *Isoglossa woodii*, which is usually shorter than a meter but can sometimes grow up to 2 m). Herbs were shorter than about 1 m with herbaceous stems (plants one can climb or step over). The coastal dune forest consists of three strata: canopy (tall trees), understorey (small trees and shrubs) and field layer (small shrubs and herbs). Although many authors use the term sub-canopy to refer to tall trees not reaching up to the canopy, this stratum was incorporated into the tree (canopy) stratum to simplify monitoring.

Figure 6. Distribution and ordination of sample plots along a gradient from the coast with high levels of salt spray, inland to fresh water habitats.



To avoid confusion or misinterpretation, some of the terminology used in the description of plant communities based on Whittaker (1980) are explained below:

Diagnostic species: A species whose distribution is confined to a specific community, and very seldom occurs in another community. Such a species can be used in the field to identify a plant community. A species is sometimes used diagnostically although it might not be present in more than 50 % of the relevés describing that community.

Prominent species: A species which distribution is not confined to a specific community but which is conspicuous or dominant in a specific community because of its size, cover, density or constancy. High cover or abundance values, or high constancy in the community make the species outstanding or prominent. Prominent species are always present in more than 50 % of the sample plots comprising the community, but could also be present in other communities.

3.2.4 Habitat analysis

The following habitat factors were recorded:

- Watertable depth

  The watertable depth was measured by means of a soil augar which reached down to 1.5 m. With the exception of some of the hygrophilous grassland communities, the water table in the majority of sample plots could not be reached (> 1.5 m). Estimates of the water table depth, based on topography, were made in the areas where it could not be reached by means of the soil auger. Other watertable data from water monitoring stations at Lake Sibaya and Kosi Bay were obtained from the Department of Water Affairs and Forestry (Durban).

- Topography

  The following criteria were used to describe the topographical position of each sample plot:

  a. Topographical position recorded in relation to the dune on which the sample plot was taken, divided into three categories:
     i) Dune crest
     ii) Dune slope
     iii) Dune bottom

     The topographical position was linked with the vegetation type, e.g. grassland, dune crest, or coastal forest dune slope.
  b. Gradient measured with a clinometer (degrees).
  c. Aspect measured with a compass.

3.2.5 General observations and notes

General observations included the degree of exposure, grazing, as well as signs of fire.

a. Exposure was evaluated in terms of the sample plots' exposure to sun and wind and expressed as either sheltered or exposed.

b. Notes, when available, on when the area was last burnt are based on personal observation.

c. The land type according to 1:250 000 Land Type maps as well as soil form (Land Type Survey Staff 1986, MacVicar *et al.* 1977) was also noted for each sample plot.

d. Rainfall figures were obtained from weather stations at Manzengwenya, Mbazwane and Kosi Bay.

3.2.6 Compilation of vegetation map

The vegetation of the study area was stratified into homogeneous units, using 1: 50 000 aerial photographs, after which sample plots were placed out at random in the different homogeneous vegetation units (see 3.2.1). The position of each sample plot was recorded with a GPS (see 3.4.1) and a relevé was compiled for each sample plot. During the phytosociological analysis the relevés were classified into communities. The position of each relevé was mapped using IDRISI (a product of Clark University, Graduate School of Geography, 950 Main Street, Worcester, MA 01610 USA)(see 3.5.2). The mapped distributions of relevés were compared to the homogeneous units mapped on aerial photographs, and the different plant communities were mapped on ortho-photographs. The plant communities were digitized from these ortho-photographs, using IDRISI (see 3.5.2).

The area covered by each plant community was calculated from the vegetation map (digitized from ortho-photographs) using the computer program IDRISI (see 3.5.2)(Figure 2a, b & c, Table 1). Only the sizes of communities that could be distinguished on ortho-photographs are given. The sizes of the study area and the CFR are given separately. Areas around Lake Sibaya have been included into the study area because of the unique inland forests that occur around it and because the water mass itself forms part of the CFR. The grazing capacity calculations are based on the entire study area, and not only the CFR.

3.2.7 Biomass measurement

Measurement of the biomass of the grasslands and the woodlands of the CFR was done with a disc pasture meter, developed by Bransby & Tainton (1977). This technique compares favourably with traditional methods of estimating the standing crop biomass of grass. Measurement of the amount of grass can be made rapidly, and it is a relatively non-destructive way of sampling (Danckwerts & Trollope 1980).

The disc pasture meter was calibrated by using the same procedure as Trollope & Potgieter (1986). It was not necessary to determine the botanical composition of the grass

sward in each quadrat, because the species composition had already been determined by means of the phytosociological survey. The sample sites were chosen randomly within the different grassland communities in areas where the grass sward had been lightly, moderately and heavily grazed. In addition, widely differing grassland communities were sampled as far as possible within each landscape.

At each of the floristic sample plots, 10 readings were taken with the disc pasture meter. The measurements were made at random by traversing the sample plot and taking a reading at every second step. The biomass of each of the different communities that can be distinguished in the coastal grassland and hygrophilous grassland communities were calculated.

Biomass measurements were made only in the coastal grassland and hygrophilous grassland communities. In the other communities the field-layer usually consisted of short shrubs with very little grass.

3.3 Veld condition and grazing capacity

In each floristic sample plot made in the woodland, coastal grassland and hygrophilous communities, the nearest plants were recorded at 100 points, in order to determine the percentage frequency of the different grass and forb species. This was done by traversing the sample plot and recording the nearest plant to the tip of the shoe at each step (step-point method) (Mentis 1981).

- Veld condition

The veld condition was determined, using indicator species classification (Increasers and Decreasers), based on the reaction of a plant to grazing and trampling pressures by herbivores (Danckwerts & Teague 1989). Indicator species were weighted according to values determined by Danckwerts & Teague (1989). Although these weighted values for grass were determined for the interior part of the country, it was assumed that the grasses' reaction to grazing and trampling pressures by herbivores would be the same at the coast. Some of the

grass species which were included in the analysis have not been categorized as to their precise ecological or grazing status (grazing gradient position) and subjective decisions about their status were made. These were based on experience of researchers from the area (Table 2).

The ecological index of the woodland (7), coastal grassland (8) and hygrophilous grassland (9) were determined according to Vorster (1982). The percentage Decreasers was multiplied by 10, the Increaser 1 percentage by 7, the Increaser 2a,b by 4, and the Increaser 2c by 1. By calculating the sum of these values the ecological index for these communities were determined. The potensial maximum would have been 1 000, if all plants were Decreasers.

- Grazing capacity

Average rainfall for the area in the year in which the recordings were made was taken into account when calculating grazing capacity, according to the methods used by Danckwerts & Teague (1989), using the computer program Quatro Pro.

3.4 Floristic survey

3.4.1 Floristic database

A database for the plant species that occur in and around the CFR was created with the database program PARADOX (a product of Borland International Inc., 100 Borland Way, P.O. Box 660001, Scotts Valley), using all the plant distribution data that were available. These distributions were mapped using the Geographical Information Systems [GIS] program IDRISI (see 3.5.2).

- **Sources of data**

Existing data on the presence and distribution of plant taxa in the area was obtained from the Pretoria National Herbarium Computerised Information System [PRÉCIS] and from a field herbarium used by the research staff of the CFR for identifying plants. Further information was obtained from extensive sampling and field work (see 3.4.2). This information was

Table 2. Grass species utilization classes

DECREASERS	INCREASER 1	INCREASER 2a & 2b	INCREASER 2c
Brachiaria arrecta	*Andropogon gayanus var. polycladus*	*Cynodon dactylon*	*Andropogon eucomus*
Cenchrus brownii	*Bewsia biflora*	*Dactyloctenium geminatum*	*Aristida congesta subsp. barbicollis*
Digitaria angolensis	*Cymbopogon excavatus*	*Eragrostis curvula*	*Aristida stipitata subsp. graciliflora*
Digitaria eriantha	*Cymbopogon plurinodes*	*Sporobolus subtilis*	*Eragrostis cilliaris*
Digitaria natalensis	*Hyperthelia dissoluta*	*Trichoneura grandiglumis var. minor*	*Eragrostis gummiflua*
Diheteropogon amplectens	*Sorghastrum stipoides*	*Triraphis schinzii*	*Imperata cylindrica*
Eragrostis capensis	*Trachypogon spicatus*		*Melinis repens subsp. repens*
Eragrostis inamoena	*Tristachya leucothrix*		*Perotis patens*
Eragrostis lappula var. lappula	*Urelytrum agropyroides*		*Sporobolus pyramidalis*
Eragrostis sclerantha subsp. sclerantha			
Eustachys paspaloides			
Hemarthria altissima			
Ishcaemum fasciculatum			
Monocymbium ceresiforme			
Panicum deustum			
Panicum genoflexum			
Panicum hymeniochilum			
Panicum maximum			
Themeda triandra			
Setaria sphacelata var. sphacelata			

verified and supplemented by a study of herbarium specimens in the Maputaland Herbarium [MH] Tembe Elephant Park; National Herbarium [PRE], Pretoria; the H.G.W.J. Schweickerdt Herbarium [PRU], University of Pretoria; the Natal Herbarium [NH], Durban (Holmgren *et al.* 1990), as well as relevant botanical literature.

- **Locality data**

Latitude and longitude were used in recording locality data. A special method was devised to determine the latitude and longitude for the distribution records obtained from the PRÉCIS Data Base and the different herbaria. A georeferenced grid with a matching code was developed to simplify the obtaining of a specific locality off a 1:50 000 topographical map. A half minute grid was drawn up for the area and codes representing the locality of the centre of each grid square created. This code system allows easy locality acquisition and quick data input. If the locality is determined by GPS, as was done for all the locality data from the field work that was conducted during this study (see 3.5.1), the data can be entered directly in decimal degree format.

A system to indicate the resolution of collectors' location data was developed, as some of the data was more accurate (and therefore more useful) than others. The accuracy of each location given by a collector was investigated and given a resolution. Resolution values ranged from 0—7, with a resolution of 0 indicating a location between 0 m and 50 m from the point indicated on a map (accuracy like this can only be obtained with the use of a GPS).

Resolution values

0	0—50 m (GPS)
1	1—100 m (Manual / Ortho-photo)
2	101—250 m
3	251—500 m
4	501—1 000 m
5	1 001—5 000 m
6	5 001—12 000 m
7	12 001—25 000 m

- **Species names**

Species names conform to those of Arnold & De Wet (1993). The species name was entered as a code using the first four letters of the genus name and the first three letters of the specific epithet. If it was a subspecies or a variety, the first letter of the subspecies or variety was also entered. For example *Chrysanthemoides monilifera* subsp. *rotundata* was entered as **chrymonr**. The use of a code system reduced data input time and prevented redundant data input. The main database was linked to a look up database that was based on the species code. The look up database contains all the valid species names linked to their codes, synonyms and families.

- **Other data**

Other data recorded included the locality, date of collection, altitude, substrate (e.g. sand), flower colour, status (e.g. flower, fruit or buds), height, source of data (e.g. herbarium sheet, PRÉCIS system etc.), the collector's number, abundance and any notes considered to be of importance. Once this data has been inputted, the user can run complex queries on the database. To simplify the entering of data and to reduce the chance of entering errors, customized abbreviations were used when entering the habitat, status, abundance and the source of the data.

- **Data entry**

The database containing plant species records consists of a series of interlinked databases. Using the code system, the data was transferred from a plant species record form into the database, through a visually appealing data input screen. Each record was given a unique reference number. A series of validity checks and the interlinked database system ensured that the data entered was not redundant, that the latest plant species names formed part of the database, and that error entries were reduced.

- **Database link with GIS**

Although data was entered in a coded format and was subjected to built-in validity checks, editing of the database was required to ensure that the data was correct. The advantages using a powerful database program such as PARADOX are that complex queries can be conducted. A single or series of queries can be run on the database, allowing the retrieval of information on specific issues as it is required.

Once a query has been run, an Answer database is produced, containing all the information requested. A text file was produced for all the plant species retrieved, and included their geographical localities. This text file was produced in the IDRISI format using of the report generation facility of PARADOX e.g:

48	1
32.252600	-26.678666
0	0

The 48 relates to the unique reference number given to each record in the plant record database. The one refers to the number of points in the feature. The longitude and latitude follow on the subsequent line, written in decimal degree format. The latitude is written as a negative value due to South Africa's position in the southern hemisphere. The report must end with two zeroes to signify the end of the file.

The DOS version of PARADOX, (PDOX40), was used to create this report because IDRISI is a DOS based program (a Windows version is now also available). This text file was saved with the extension VEC. Before IDRISI could read the data, however, a document file had to be produced in IDRISI. This document file contained data relating to the geographical position of the points as well as the type of reference system used.

IDRISI has the capability to manipulate the data to suit the needs of the researcher and can perform relatively complex mathematical and statistical calculations on georeferenced data. Presentation maps were produced with the export of the IDRISI vector files to the graphics program COREL DRAW (obtained from Corel, P.O. Box 39, Isando, 1600). From

the PRÉCIS list and the other data sources the plant name, collector, date of collection and the specific location was obtained.

3.4.2 Field work

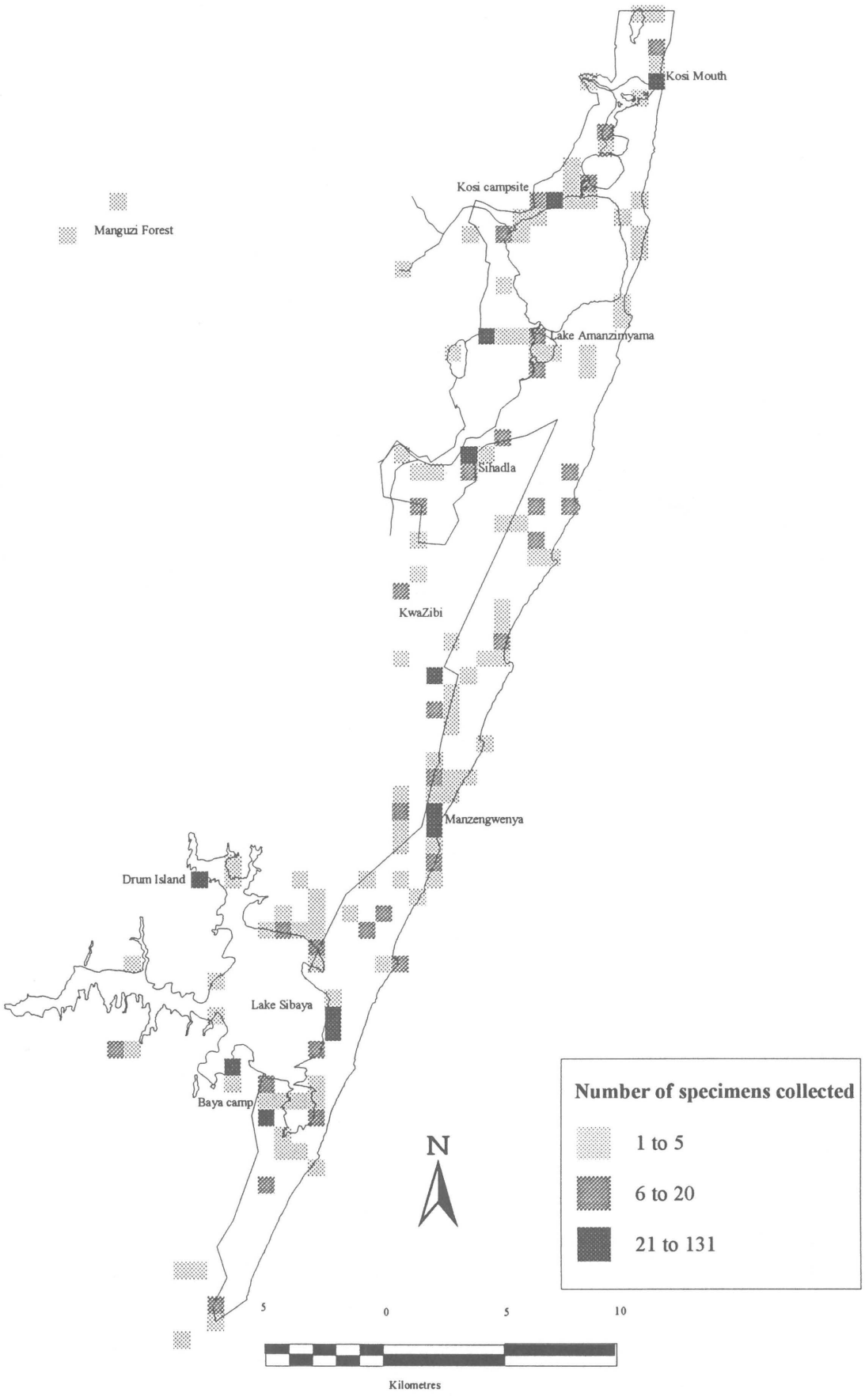
In addition to the phytosociological sampling, during which many herbarium specimens were collected, extensive fieldwork was conducted to collect herbarium specimens. Collections were made during all seasons over the two years in which this study was undertaken, in order to collect plants that might fruit or flower in different seasons. All the vegetation types were sampled, but more extensive sampling was done in areas that were not easy to reach and therefore likely to have escaped previous sampling by other botanists. To identify such areas, we used the information about existing herbarium collections from the study area, obtained from the PRÉCIS Data Base (Figure 7).

For each plant that was collected and preserved, a GPS reading was taken with a view to eventually map species distribution with the GIS computer program IDRISI. Distributional data was correlated with 1:250 000 scale geological maps (Geological Survey 1986) from the Geological Survey, Department of Mineral and Energy Affairs, Pretoria. Environmental information such as slope, aspect, water regime and exposure was recorded for each plant collected. To facilitate identification and for further reference, a short description of each plant was given, including plant height, flower or fruit colour and a description of the leaves. The local abundance was also recorded.

3.4.3 Checklist

A list of all the species collected during the survey was compiled, using the database program PARADOX. At least one voucher specimen from the study area is listed for each taxon collected. All the plant taxa previously collected in this area and taken up in PRE were included. This data was obtained from the PRÉCIS Data Base at PRE. Further information about species in this area was obtained from the MH, Tembe Elephant Park, KDNC and from the NH, Durban and the PRU, University of Pretoria. The checklist was compared and

Figure 7. Plant collecting sites and number of specimens collected



supplemented with information from literature such as the species list of vascular plants in the Sodwana-Kosi Bay area (Ward & Weisser 1991).

3.4.4 Endemic taxa

Recognition of endemic/near-endemic species from literature was based on the most recent list of species endemic to the Maputaland Centre [MC] proposed by Van Wyk (1996). This list of endemic species was compared to the species list that was compiled in PARADOX. All the Maputaland endemic species collected in the study area were recognized, and a checklist of the endemics in the CFR was compiled. The distribution of these endemic taxa was mapped using IDRISI in order to identify areas with high concentrations of endemic species (Figure 8).

3.5 Geographical Information System

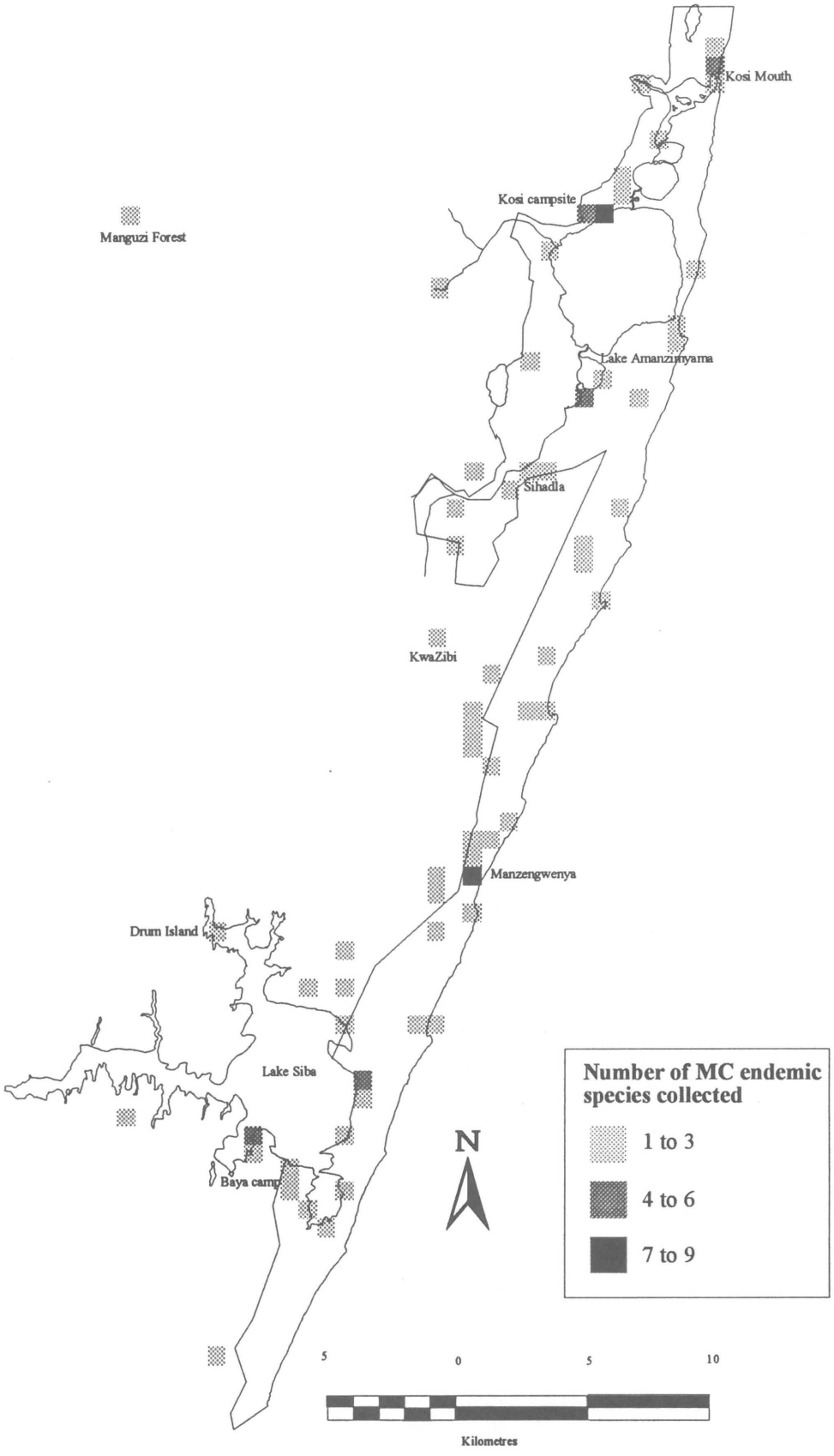
3.5.1 Global Positioning System

A hand held GPS instrument (Ensign model manufactured by Trimble) was used in recording the position of each sample plot. A GPS can record positional data directly in the field and when linked with GIS can be used to compile and generate maps and other data sets (Lass & Callihan 1993). The latitude and longitude GPS point data were recorded in degrees, minutes and seconds, and this format had to be converted to decimal degrees to enable its use with the GIS program IDRISI. This data allowed for the plotting of the distribution of relevés, which was used in the compilation of the vegetation map. For each plant specimen sampled during field work a GPS reading was also obtained. In this way plant distributional data was obtained with more accuracy than any conventional method. A GPS can record positional data with an error of less than 100 m. This was difficult with methods such as conventional mapping, and it was also much quicker.

3.5.2 IDRISI

IDRISI is a computer-based GIS which graphically positions map features in relation to

Figure 8. MC endemic plant collecting sites and number of endemic plants collected



known locations and relates these positions to other cartographic features. Maps can be digitized with IDRISI and positioned with known location data. The vegetation map of the CFR was digitized by using ortho-photographs from the 1992 Ortho-photo series (Figure 2a, b & c).

The plant distribution data from the database in PARADOX (see 3.4.1) was converted into a format that was compatible with IDRISI. This enabled mapping of the distribution of the previous plant collections that were made in the CFR (Figure 7). Areas where little or no sampling has been done were identified by looking at these maps. More extensive field work and sampling was carried out in these areas. IDRISI was also used to map the distribution of collection sites of MC endemics in the CFR (Figure 8).

CHAPTER 4

VEGETATION

4.1 Classification of vegetation

A classification of the vegetation of the study area is presented in a phytosociological table (Table 3). Twelve major plant communities were identified. The major communities that were easily distinguishable on ortho-photographs have been mapped (Figure 2), and a schematic representation indicating their distribution is given (Figure 9). The mangrove community and the *Casuarina equisetifolia* stands are not included in the phytosociological table. Much work has been done on the mangrove community at Kosi Bay and it is still regularly monitored (Cooper 1968; Breen & Hill 1969; Tinley 1976; Ward *et al.* 1986). Very few, if any, other plants grow within the *Casuarina equisetifolia* stands. The KwaZulu Department of Nature Conservation [KDNC] is busy with a program of gradually removing these monocultures to promote re-establishment of natural vegetation in these areas. It was therefore decided not to include these communities in the phytosociological table.

Plant communities recognized in the study area are classified as follows (Table 3):

1. *Pinus elliottii-Chromolaena odorata* disturbed areas outside the Reserve where a commercial plantation has been cut down about six years ago and not yet replanted.

2. *Scaevola plumieri-Gazania rigens* var. *uniflora* dune pioneer community on the beach above the high water mark.

3. *Eugenia capensis-Euclea natalensis* subsp. *natalensis* coastal scrub thicket on seaward slopes of coastal dunes, characterized by dense, stunted vegetation caused by exposure to salt-laden onshore winds.

4. *Peddiea africana-Diospyros inhacaensis* coastal dune forest on the landward side of the coastal dune barrier, sheltered from the pruning effect of the sea winds, with taller trees and a stratified community.

    4.1 *Pavetta gerstneri-Apodytes dimidiata* subsp. *dimidiata* coastal dune forest which is still in a developing stage, indicating a young forest. The percentage cover of the understorey exceeds that of the canopy.

4.2 *Croton gratissimus* var. *gratissimus-Isoglossa woodii* coastal dune forest where the percentage of cover of the canopy exceeds that of the understorey.

5. *Tricalysia delagoensis-Dialium schlechteri* inland forest found further from the coast around the inland water bodies and more sheltered from the wind.

5.1 *Artabotrys monteiroae-Hymenocardia ulmoides* inland forest with a high percentage of tree cover and usually situated on dunes with a gradual gradient.

5.2 *Catunaregam spinosa* subsp. *spinosa-Tabernaemontana elegans* inland forest with a high percentage of shrub cover and usually situated on dunes with a steep gradient.

6. *Syzygium cordatum-Canthium inerme* thicket forming an ecotone between coastal dune forest and coastal grassland. These thickets are scattered throughout the grassland. Confined to areas with a low water table, on dune crests or slopes.

6.1 *Syzygium cordatum-Cymbopogon plurinodis* thicket forming a transition between forest, thicket and woodland.

6.2 *Syzygium cordatum-Albertisia delagoensis* thicket usually found low on dune slopes, with signs of disturbance.

6.3 *Syzygium cordatum-Strelitzia nicolai* thicket usually found on dune crests or high on dune slopes.

7. *Syzygium cordatum-Hyperthelia dissoluta* woodland usually situated on dune crests or slopes, in areas which are not regularly burnt.

7.1 *Syzygium cordatum-Digitaria natalensis* woodland usually found on dune slopes.

7.2 *Syzygium cordatum-Wahlenbergia abyssinica* subsp. *abyssinica* woodland usually found on the crest of dunes.

8. *Parinari capensis* subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland situated on the inland (western) side of the coastal dune forest.

8.1 *Helichrysum kraussii-Melinis repens* subsp. *repens* coastal grassland on dune slopes with a relatively steep gradient, in areas where grazing by cattle was noted.

8.2 *Vernonia natalensis-Polygala producta* coastal grassland found low on the slopes of dunes, with a more gradual gradient.

8.3 *Vernonia oligocephala-Diheteropogon amplectens* coastal grassland found higher on the slopes of dunes, with quite a steep gradient.

8.4 *Cymbopogon plurinodis-Asclepias affinis* coastal grassland found on the crest of dunes.

9. *Ischaemum fasciculatum-Centella asiatica* hygrophilous grassland, occurring in low lying areas often close to lakes or pans, or in inter-dune depressions, where the water table level is high.

9.1 *Ischaemum fasciculatum-Sporobolus subtilis* hygrophilous grassland where the water table level is seldom higher than about 0.5 m or lower than an estimate of about 2 m.

9.1.1 *Themeda triandra-Monocymbium ceresiiforme* hygrophilous grassland with an estimated water table level of about 2 m.

9.1.2 *Ischaemum fasciculatum-Fuirena umbellata* hygrophilous grassland with an average water table level of 1.15 m.

9.1.3 *Ischaemum fasciculatum-Hydrocotyle bonariensis* hygrophilous grassland with an average water table level of 0.85 m.

9.2 *Brachiaria arrecta-Hemarthria altissima* hygrophilous grassland with an average water table level of 0.1 m, in close proximity to a water body.

10. *Nephrolepis biserrata-Ficus trichopoda* swamp forest found in close proximity to small rivers or streams.

11. Mangrove community of the tidal basin of the Kosi Lake System.

12. *Casuarina equisetifolia* afforestation on drift sand areas near the coast.

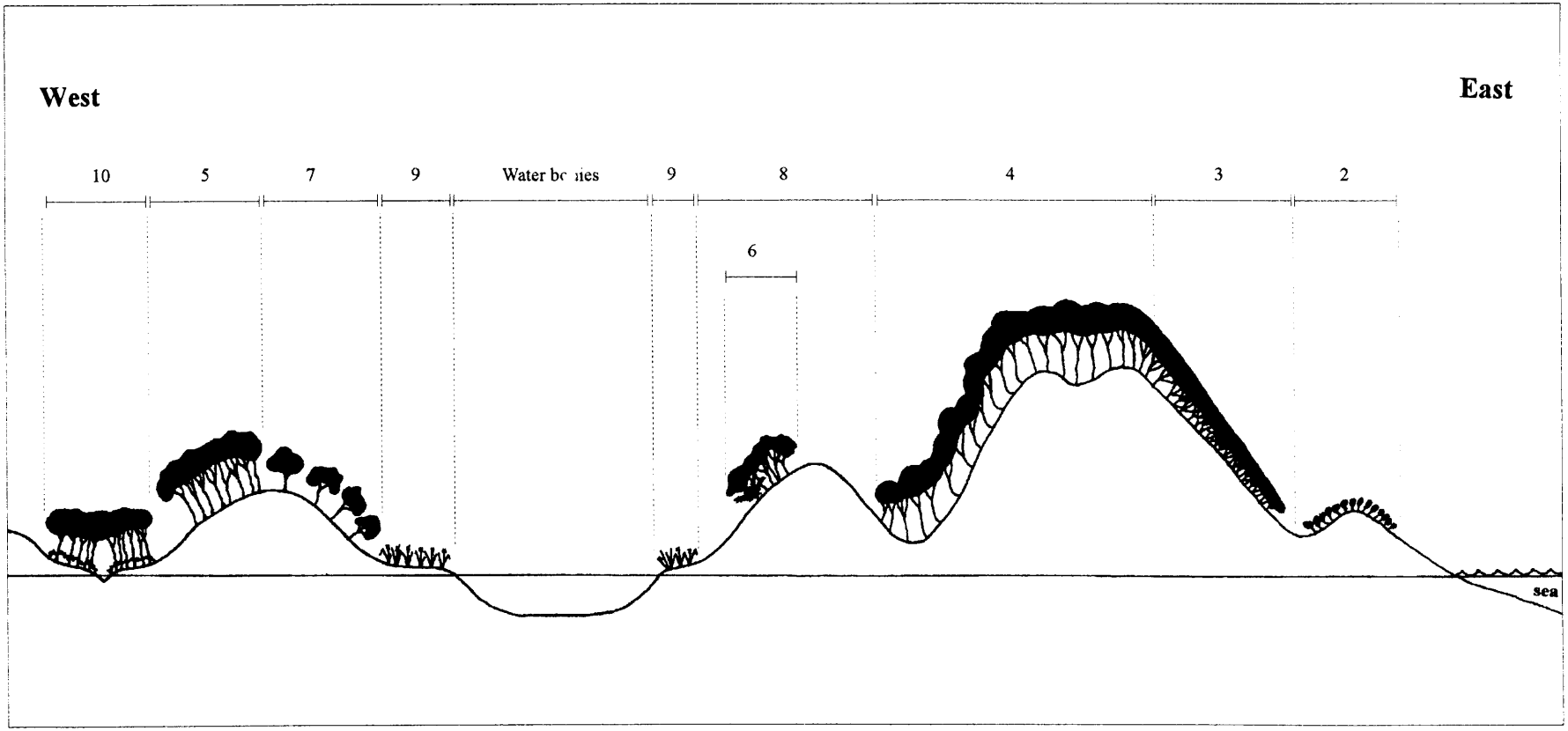


Figure 9. A schematical representation of the different habitat types. Broken lines indicate overlapping distributions. The disturbed area community is not included in this figure.

KEY

2. *Scaevola plumieri-Gazania rigens* var. *uniflora* dune pioneer community.
3. *Eugenia capensis-Euclea natalensis* coastal scrub thicket.
4. *Peddiea africana-Diospyros inhacaensis* coastal dune forest.
5. *Tricalysia delagoensis-Dialium schlechteri* inland forest.
6. *Syzygium cordatum-Canthium inerme* thicket.
7. *Syzygium cordatum-Hyperthelia dissoluta* woodland.
8. *Parinari capensis* subsp. *incohata-Diospyros lycioides* coastal grassland.
9. *Ischaemum fasciculatum-Centella asiatica* hygrophilous grassland.
10. *Nephrolepis biserrata-Ficus trichopoda* swamp forest.

Table 3

PHYTOSOCIOLOGICAL TABLE

PART 1 — PART 2

COMMUNITY NUMBER: 1; 2; 3; 4 (4.1, 4.2); 5 (5.1, 5.2); 6 (6.1, 6.2, 6.3); 7 (7.1, 7.2); 8 (8.1, 8.2, 8.3, 8.4); 9 (9.1 (9.1.1, 9.1.2, 9.1.3), 9.2); 10

RELEVE' NUMBER

SPECIES PER RELEVE'

Species	Number of relevés
SPECIES GROUP 1	
Pinus elliottii	4
Chromolaena odorata	3
Solanum rigescens	3
Hoslundia opposita	3
Xanthium strumarium	2
Asclepias burchellii	1
SPECIES GROUP 2	
Scaevola plumieri	6
Gazania rigens var. uniflora	4
Cyperus crassipes	4
Carpobrotus dimidiatus	4
Tephrosia purpurea subsp. canescens	6
Canavalia maritima	1
Arctotheca populifolia	1
Sophora inhambanensis	1
SPECIES GROUP 3	
Eugenia capensis	12
Euclea natalensis subsp. natalensis	24
Acokanthera oblongifolia	9
SPECIES GROUP 4	
Pavetta gerstneri	6
Sideroxylon inerme subsp. inerme	5
Plectroniella armata	4
Thespesia acutiloba	8
SPECIES GROUP 5	
Croton gratissimus var. gratissimus	6
Celtis africana	6
Diospyros natalensis subsp. natalensis	4
Ziziphus mucronata subsp. mucronata	2
SPECIES GROUP 6	
Peddiea africana	13
Diospyros inhacaensis	9
Drypetes natalensis var. natalensis	11
Deinbollia oblongifolia	10
Clausena anisata	8
Teclea gerrardii	6
Tragia glabrata var. glabrata	7
Acacia karroo	9
SPECIES GROUP 7	
Artabotrys monteiroae	4
Zamioculcas zamiifolia	5
Scadoxus puniceus	5
Cyrtorchis arcuata	3
Microgramma lycopodioides	3
Morus mesozygia	4
SPECIES GROUP 8	
Catunaregam spinosa subsp. spinosa	8
Crotalaria monteiroi var. galpinii	10
Xylotheca kraussiana	8
Maytenus heterophylla	2
Gloriosa superba	5
Barleria repens	3
SPECIES GROUP 9	
Dialium schlechteri	14
Tricalysia delagoensis	8
Landolphia kirkii	10
Manilkara discolor	6
Drimiopsis maculata	9
Protasparagus natalensis	2
SPECIES GROUP 10	
Microsorium scolopendrium	19
Commiphora neglecta	16
Psychotria capensis var. capensis	18
Isoglossa woodii	12
Vepris lanceolata	11
Grewia caffra	13
Acacia kraussiana	15
Pupalia lappacea var. lappacea	9
Sansevieria hyacinthoides	7
SPECIES GROUP 11	
Tecomaria capensis subsp. capensis	22
Bridelia cathartica	21
Hymenocardia ulmoides	21
Strelitzia nicolai	21
Psydrax locuples	22
Tricalysia sonderana	20
Carissa bispinosa subsp. zambesiensis	19
Albertisia delagoensis	21
Tabernaemontana elegans	15
Zanthoxylum capense	15
Tarenna littoralis	9
Allophylus natalensis	7
SPECIES GROUP 12	
Sapium integerrimum	50
Brachylaena discolor subsp. discolor var. discolor	48
Canthium inerme	51
Albizia adianthifolia	40
Mimusops caffra	40
Rhus natalensis	35
Cussonia arenicola	36
Rhus nebulosa forma nebulosa	33
Chrysanthemoides monilifera subsp. rotundata	24
Ximenia caffra var. natalensis	15
SPECIES GROUP 13	
Vernonia centaureoides	15
Hyperthelia dissoluta	14
SPECIES GROUP 14	
Lippia javanica	27
Berkheya bipinnatifida subsp. echinopsoides	19
[illegible]paragus natalensis	22
[illegible]	19
[illegible] gangetica	17
Annona senegalensis subsp. senegalensis	17
Secamone filiformis	11
Wahlenbergia abyssinica subsp. abyssinica	16
Ehretia rigida	12
Encephalartos ferox	11
Monulea parviflora var. parviflora	7
SPECIES GROUP 15	
Melinis repens subsp. repens	26
Eragrostis ciliaris	21
Triraphis schinzii	13
Vigna unguiculata subsp. stenophylla	13
Astripomoea malvaceae	10
Nidorella resedifolia subsp. resedifolia	9
Digitaria angolensis	6
SPECIES GROUP 16	
Psidium guajava	42
Polygala producta	25
Aristida stipitata subsp. graciliflora	26
Commelina africana var. africana	22
Triumfetta rhomboidea	24
Acalypha villicaulis	19
Indigofera vicioides var. rogersii	12
SPECIES GROUP 17	
Panicum maximum	83
Kraussia floribunda	74
Synaptolepis kirkii	61
Apodytes dimidiata subsp. dimidiata	57
Commelina erecta	56
Rhoicissus digitata	56
Ozoroa obovata var. obovata	50
Strychnos madagascariensis	40
Ochna natalitia	41
Vangueria infausta subsp. infausta	40
Sclerocarya birrea subsp. caffra	37
Trichilia emetica	33
Rhynchosia nervosa var. nervosa	22
SPECIES GROUP 18	
Asclepias affinis	16
Thesium polygaloides	9
Anthericum cooperi	13
Sonchus integrifolius var. integrifolius	6
SPECIES GROUP 19	
Vernonia oligocephala	50
Eustachys paspaloides	39
Raphionacme galpinii	36
Euphorbia epicyparissias var. epicyparissias	38
Hypoxis hemerocallidea	37
Eugenia albanensis	32
Scabiosa columbaria	30
Aloe cooperi subsp. pulchra	29
Tephrosia brummittii	27
Senecio glaberrimus	22
Crotalaria globifera	18
Helichrysum oxyphyllum	22
Hypoxis angustifolia var. angustifolia	17
Helichrysum nudifolium	11
Polygala fruticosa	8
Tricalysia capensis var. capensis	8
Dipcadi viride	5
SPECIES GROUP 20	
Strychnos spinosa	109
Salacia kraussii	109
Dalbergia obovata	93
Maytenus procumbens	79
Ancylobotrys petersiana	58
SPECIES GROUP 21	
Parinari capensis subsp. incohata	99
Diospyros lycioides subsp. sericea	70
Themeda triandra	69
Vernonia natalensis	63
Stylosanthes fruticosa	58
Cissampelos hirta	50
Oxygonum robustum	48
Abrus precatorius subsp. africanus	39
Helichrysum appendiculatum	11
SPECIES GROUP 22	
Cymbopogon plurinodis	116
Helichrysum kraussii	114
Dichrostachys cinerea subsp. nyassana	89
Setaria sphacelata var. sphacelata	85
Perotis patens	62
Urelytrum agropyroides	61
Diospyros galpinii	59
Diheteropogon amplectens	43
Trachypogon spicatus	43
Antidesma venosum	42
Panicum genuflexum	21
SPECIES GROUP 23	
Cassytha filiformis	65
Imperata cylindrica	66
Lobelia coronopifolia	49
Eragrostis capensis	41
Eriosema salignum	33
Chamaecrista mimosoides	34
Eragrostis inamoena	12
SPECIES GROUP 24	
Sporobolus subtilis	20
Hydrocotyle bonariensis	11
Sorghastrum stipoides	13
Eriosema parviflorum	9
Monocymbium ceresiiforme	14
SPECIES GROUP 25	
Brachiaria arrecta	10
Rhynchospora holoschoenoides	6
Scleria poiformis	5
Lobelia anceps	6
Pycreus nitides	8
Panicum hymeniochilum	2
Nymphaea nouchali var. caerulea	2
SPECIES GROUP 26	
Pentodon pentandrus var. minor	19
Hemarthria altissima	15
Fuirena umbellata	14
Juncus kraussii	14
Cyperus prolifer	16
Fimbristylis ferruginea	10
Xyris anceps	9
Phragmites australis	10
Persicaria serrulata	8
SPECIES GROUP 27	
Ischaemum fasciculatum	33
Centella asiatica	27
[illegible]pogon gayanus var. polycladus	19
SPECIES GROUP 28	
Cyperus obtusiflorus var. obtusiflorus	97
Bulbostylis contexta	97
Dactyloctenium geminatum	71
Tephrosia kraussiana	66
Desmodium dregeanum	61
Cyperus natalensis	48
Cyperus tenax	29
Helichrysum decorum	28
Merremia tridentata subsp. angustifolia var. angustifolia	27
SPECIES GROUP 29	
Nephrolepis biserrata	4
Keetia gueinzii	4
Rapanea melanophloeos	4
Voacanga thouarsii	4
Ficus trichopoda	3
Bridelia micrantha	4
Dracaena mannii	2
Myrica serrata	2
Hibiscus tiliaceus	2
Macaranga capensis	2
Podocarpus falcatus	2
Scleria angusta	2
Stenochlaena tenuifolia	2
Erythroxylum emarginatum	2
SPECIES GROUP 30	
Syzygium cordatum	127
Digitaria natalensis	114
Phoenix reclinata	90
Smilax anceps	90
Dianthus crenatus var. angicalyx	1
Phyllanthus sp.	4
Gladiolus crassifolius	5
Helichrysum longifolium	1
Nidorella resedifolia subsp. resedifolia	1
Hibiscus aethiopicus var. ovatus	3
Ledebouria ovatifolia	11
Macrotyloma axillare var. axillare	5
Melinis nerviglumis	1
Mundulea sericea	2
Pachycarpus concolor	4
Sporobolus pyramidalis	7
Tephrosia longipes subsp. longipes	4
Jasminum streptopus var. transvaalensis	1
Tristachya leucothrix	2
Tricliceras mossambicense	3
Galopina tomentosa	9
Aeschynomene micrantha	9
Alysicarpus rugosus subsp. rugosus	4
Catharanthus roseus	1
Crotalaria lanceolata subsp. lanceolata	1
Eragrostis gummiflua	2
Oldenlandia affinis subsp. fugax	4
Fimbristylis complanata	2
Fuirena pubescens	1
Helichrysum adenocarpum subsp. ammophilum	1
Helichrysum cephaloideum	8
Hibiscus schinzii	2
Kyllinga erecta	2
Pycreus polystachyos var. polystachyos	1
Sacciolepis curvata	1
Restio zuluensis	3
Zornia capensis	3
Dodonaea angustifolia	3
Euclea schimperi var. schimperi	1
Euphorbia grandidens	2
Lagynias lasiantha	2
Melanthera biflora	1
Sida cordifolia	7
Vitex amboniensis	5
Hyphaene coriacea	7
Terminalia sericea	5
Bidens pilosa	1
Bauhinia tomentosa	1
Spirostachys africana	1
Strychnos gerrardii	2
Sideroxylon inerme subsp. inerme	1
Ptaeroxylon obliquum	1
Pteleopsis myrtifolia	1
Tapinanthus gracilis	1
Tephrosia capensis var. capensis	1
Casuarina equisetifolia	1
Corchorus junodii	2
Polygala uncinata	1
Raphia australis	1
Rhus rehmanniana	1
Schrebera alata	1
Indigofera charlieriana var. scaberrima	1
Passiflora edulis	1
Pentarrhinum insipidum	1
Manilkara concolor	1
Mariscus dubius	1
Momordica balsamina	1
Cassipourea gerrardii	1
Cleome angustifolia subsp. petersiana	1
Combretum molle	1
Striga bilabiata	1
Dovyalis longispina	1
Ephippiocarpa orientalis	1
Acridocarpus natalitius var. linearifolius	3
Adenia gummifera var. gummifera	4
Albizia versicolor	1
Buchnera dura	3
Canthium setiflorum subsp. setiflorum	3
Crassula lanceolata subsp. transvaalensis	5
Crotalaria pallida var. pallida	1
Ekebergia capensis	2
Ficus burtt-davyi	2
Cissampelos hirta	1
Panicum hymeniochilum	3
Trema orientalis	2
Trimeria grandifolia	2
Turraea obtusifolia	2
Aristida congesta	1
Centella glabrata var. natalensis	1
Bewsia biflora	3
Diospyros rotundifolia	7
Stenochlaena secundatum	4
Tricalysia lanceolata	4

4.2 Description of plant communities

1. *Pinus elliottii-Chromolaena odorata* disturbed areas.

This community is found outside the reserve where a commercial plantation has been cut down about six years ago and not yet replanted. Pine and eucalypt plantations cover the most of the coastal grassland areas immediately west of the reserve boundary (not included in Figures 2 & 9). Where the plantation has been cut down and left for a few years before replanting, alien as well as some indigenous pioneer plant species establish themselves on the dunes. One MC endemic species was recorded in this community (Table 4). An average of 22 species per relevé was recorded.

The community is characterized by species group 1 (Table 3). Diagnostic species include the alien tree *Pinus elliotii*, the alien invasive shrub *Chromolaena odorata* and the alien forb *Solanum rigescens*. Prominent species include the small tree *Sapium integerrimum*, the shrub *Lippia javanica*, the suffrutex *Salacia kraussii*, the sedge *Bulbostylis contexta* and the grass *Dactyloctenium geminatum*. The majority of the other species found in this community are widespread throughout the grassland and woodland communities. Species group 29 (Table 3) contains species that are not only common for the disturbed area community but also for the thicket, woodland, grassland and hygrophilous communities.

2. *Scaevola plumieri-Gazania rigens var. uniflora* dune pioneer community.

This community is found on the beach above the high water mark. The foredune area just above the high water mark is subjected to harsh environmental conditions. Strong winds (north-easterly, easterly and south-easterly) result in high levels of salt spray. Loose wind-blown sand causes abrasion and physical damage to plant leaves and buries them in the process of dune formation. During cyclones or rough seas coinciding with spring tides, beaches are eroded and some pioneers destroyed. The size of the community could not be determined because it was difficult to recognize it from ortho-photographs. The community is located in the beach area on the vegetation map (Figure 2). One MC endemic species was recorded

Table 4. Maputaland Centre endemic species distribution in relation to plant communities

	Endemic or near-endemic species	Sample number	Growth Form	Family	1	2	3	4	5	6	7	8	9	10
1	*Asystasia pinguifolia*		Herb	Acanthaceae		X								
2	*Barleria prionitis subsp. delagoensis*		Herb	Acanthaceae							X			
3	*Sclerochiton apiculatus*	608	Small Tree	Acanthaceae							X			
4	*Ozoroa engleri*		Small Tree	Acanthaceae					X					
5	*Cussonia arenicola*	398	Shrub	Araliaceae				X	X	X	X			
6	*Raphia australis*		Palm	Arecaceae										X
7	*Aspidoglossum delagoense*	28, 682	Herb	Asclepiadaceae								X		
8	*Aloe parvibracteata*		Aloe	Asphodelaceae							X	X		
9	*Cineraria pinnata*		Herb	Asteraceae								X		
10	*Helichrysopsis septentrionale*	344, 542	Herb	Asteraceae							X	X	X	
11	*Helichrysum adenocarpum subsp. ammophilum*	120, 442	Herb	Asteraceae									X	
12	*Helichrysum tongense*		Herb	Asteraceae								X		
13	*Nidorella tongensis*	516	Herb	Asteraceae									X	
14	*Senecio ngoyanus*	278	Herb	Asteraceae									X	
15	*Vernonia centaureoides*	196	Herb	Asteraceae							X	X		
16	*Warburgia salutaris*		Small Tree	Canellaceae					X					
17	*Maerua nervosa*	315, 446	Small Tree	Capparaceae				X		X				
18	*Krausseola mosambicina*		Herb	Caryophilaceae				X	X					
19	*Hippocratea delagoensis*	400	Climber	Celastraceae				X	X					
20	*Maytenus heterophylla subsp. arenaria*		Small Tree	Celastraceae				X						
21	*Salacia kraussii*	318	Dwarf Shrub	Celastraceae	X			X	X	X	X	X	X	
22	*Parinari capensis subsp. incohata*	410	Dwarf Shrub	Chrysobolanaceae					X	X	X	X	X	
23	*Aneilema schlechteri*		Herb	Commelinaceae				X						
24	*Kalanchoe neglecta*	658	Herb	Crassulaceae							X			
25	*Diospyros inhacaensis*	490	Tree	Ebenaceae				X	X					
26	*Diospyros rotundifolia*	588	Small Tree	Ebenaceae			X	X		X				
27	*Euclea natalensis subsp. rotundifolia*	592	Small Tree	Ebenaceae				X		X				
28	*Erythroxylum delagoense*	182, 435	Small Tree	Erythroxylaceae							X			
29	*Acacia kraussiana*		Shrub	Fabaceae				X	X	X				
30	*Crotalaria monteiroi var. monteiroi*		Shrub	Fabaceae						X	X	X		
31	*Dialium schlechteri*	236, 335	Tree	Fabaceae					X	X				
32	*Erythrophleum lasianthum*	575	Tree	Fabaceae							X			
33	*Indigofera inhambanensis*	62, 556	Herb	Fabaceae								X		
34	*Tephrosia brummittii*	25	Herb	Fabaceae						X	X	X		
35	*Dovyalis longispina*	268	Small Tree	Flacourtiaceae				X	X					
36	*Anomatheca laxa*	256	Herb	Iridaceae				X	X	X				
37	*Gladiolus dalenii (tall form)*		Herb	Iridaceae								X		
38	*Gladiolus invenustus*		Herb	Iridaceae								X	X	
39	*Cassytha sp. nov.*		Twiner	Lauraceae								X		
40	*Wolffiella denticulata*		Herb	Lemnaceae									X	
41	*Acridocarpus natalitius var. linearifolius*	105	Shrub	Malpighiaceae						X	X			
42	*Thespesia acutiloba*	174, 178, 571	Small Tree	Malvaceae				X		X	X			
43	*Cissampelos hirta*	88, 276	Herb	Menispermaceae						X	X	X	X	
44	*Eugenia mossambicensis*	206	Small Tree	Myrtaceae							X			
45	*Syzygium cordatum (suffruticose form)*	442	Dwarf Shrub	Myrtaceae								X		
46	*Commicarpus chinensis subsp. natalensis*	368	Herb	Nyctaginaceae				X						

Table 4. Maputaland Centre endemic species distribution in relation to plant communities

	Endemic or near-endemic species	Sample number	Growth form	Family	1	2	3	4	5	6	7	8	9	10
47	*Ochna natalitia (suffruticose form)*		Dwarf Shrub	Ochnaceae								X		
48	*Bonatea lamprophylla*	376	Orchid	Orchidaceae					X					
49	*Podocarpus falcatus*		Tree	Podocarpaceae										X
50	*Oxygonum dregeanum subsp. streyi*		Herb	Polygonaceae								X		
51	*Oxygonum robustum*	24, 448	Herb	Polygonaceae						X	X	X	X	
52	*Restio zuluensis*	121, 190, 581	Herb	Restionaceae									X	
53	*Ancylanthos monteiroi*	249, 330, 427, 578	Small tree	Rubiaceae						X	X			
54	*Canthium setiflorum subsp. setiflorum*	187, 406, 426, 508, 591, 693	Small tree	Rubiaceae					X	X	X			
55	*Coffea racemosa*		Small tree	Rubiaceae				X						
56	*Gardenia volkensii subsp. volkensii var. saundersiae*		Small tree	Rubiaceae					X					
57	*Lagynias lasiantha*	470, 510	Small tree	Rubiaceae				X	X					
58	*Oxyanthus latifolius*	238	Small tree	Rubiaceae					X					
59	*Pavetta gerstneri*	486	Small tree	Rubiaceae				X						
60	*Plectroniella armata*	552	Small tree	Rubiaceae			X	X						
61	*Psydrax locuples*	395, 455, 511	Small tree	Rubiaceae				X	X	X	X			
62	*Tarenna junodii*	428, 502	Small tree	Rubiaceae				X			X			
63	*Tricalysia delagoensis*	142	Small tree	Rubiaceae				X	X	X				
64	*Tricalysia junodii var. junodii*		Small tree	Rubiaceae							X			
65	*Thesium vahrmeijeri*		Herb	Santalaceae								X		
66	*Striga junodii*	336	Herb	Scrophulariaceae									X	
67	*Corchorus junodii*	168, 447	Herb	Tiliaceae						X		X		
68	*Tricliceras mossambicense*	80	Herb	Turneraceae								X	X	
69	*Lapportea peduncularis subsp. latidens*		Herb	Urticaceae				X		X				
70	*Rhoicissus sessilifolia*		Climber	Vitaceae				X						
71	*Encephalartos ferox*		Cycad	Zamiaceae						X	X	X		
TOTAL					1	1	2	24	19	22	24	24	13	2
TOTAL	Number of endemic species restricted to plant community				0	1	0	6	5	0	7	11	6	2

(Table 4) together with an average number of six species per relevé.

This community is characterized by species group 2 (Table 3) and diagnostic species include the short robust shrub *Scaevola plumieri*, the robust forb *Gazania rigens* var. *uniflora*, the sedge *Cyperus crassipes* and the succulent *Carpobrotus dimidiatus*.

3. *Eugenia capensis-Euclea natalensis* subsp. *natalensis* coastal scrub thicket.

This community is found on the seaward slopes of coastal dunes. On the seaward side it borders the dune pioneers or the beach. On the landward side it extends into the dune forest (Figure 9). Although the foredune with its pioneer community provides a modicum of shelter (from wind blown sand in particular), the effect of wind and salt on the vegetation is clearly visible. Coastal scrub thicket consists of a dense, almost impenetrable layer of low-growing scrub with an uniform or "hedged" canopy. Close to the beach the scrub is usually short, but its height increases further inland, as the effects of salt spray and windblown sand decrease. The aspect is east towards the sea with an average slope of 9.7°. It is impossible to distinguish between coastal scrub thicket and coastal dune forest from 1:50 000 aerial or ortho-photographs and therefore the size of this community could not be calculated and is included in Figure 2 under coastal dune forest. Two MC endemic species were recorded in this community (Table 4). An average of six species per relevé was recorded.

The community is characterized by species group 3 (Table 3) with the shrub *Eugenia capensis* as diagnostic species. Prominent species include the shrub *Euclea natalensis* subsp. *natalensis*, the small tree *Mimusops caffra* and the woody climber *Rhoicissus digitata*. The shrub *Acokanthera oblongifolia* has also been recorded in 50 % of the sample plots. Sight records of species often found in this vegetation type that have not been recorded in the sample plots include the low shrubs *Chrysanthemoides monilifera* subsp. *rotundata*, *Ficus burtt-davyi* and the small tree *Brachylaena discolor* subsp. *discolor* var. *discolor*. This community is linked to the coastal dune forest community (4) through the presence of *Euclea natalensis* subsp. *natalensis*, *Acokanthera oblongifolia* and *Mimusops caffra*, which occur in both communities, suggesting a gradual change from coastal scrub thicket to coastal dune

forest.

4. *Peddiea africana-Diospyros inhacaensis* coastal dune forest.

This community is found on the landward dune areas of the high dune barrier that runs parallel to the coast from north to south (Figure 2 & 9). Sheltered from the pruning effect of the sea winds, trees grow taller and the community is stratified. To the east (seawards) it changes to coastal scrub thicket (3). Westwards (inland) it is bordered by the grassland communities, or by the inland lakes such as Lake Sibaya and Lake Nhlange (Kosi Lake System). The coastal dune forest (together with the coastal scrub thicket) covers 4 654.3 ha (10 % of the study area) (Table 1). Twenty four MC endemic species have been recorded in this community (Table 4). An average of 28 species was recorded per relevé.

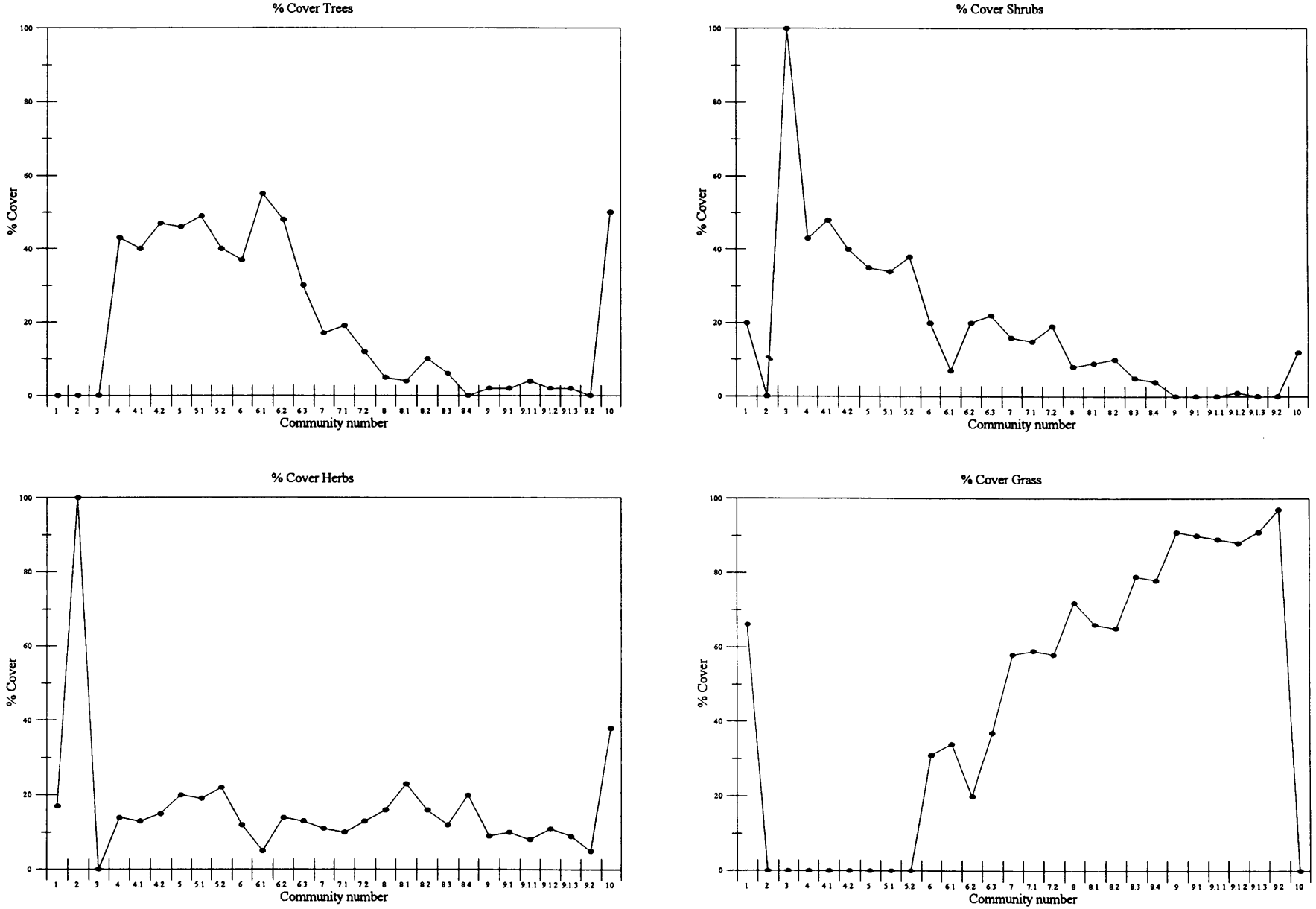
The community is characterized by species group 6 (Table 3), and diagnostic species include the tree *Diospyros inhacaensis*, the small trees *Peddiea africana, Drypetes natalensis* var. *natalensis, Deinbollia oblongifolia* and *Clausena anisata.*

This major community is further divided into two communities on the basis of structure and floristic composition.

4.1 *Pavetta gerstneri-Apodytes dimidiata subsp. dimidiata* coastal dune forest.

Usually situated on the crest and landward (western) slopes of the dune barrier, this forest has a lower canopy than the more mature coastal dune forest (4.2). Estimates of the percentage cover of trees (canopy) averaged 40 %, with shrubs and small trees (understorey) 47 % and herbs (field-layer) 13 % (Figure 10). This may indicate that the forest is still relatively young and is still developing. Recolonization of vegetation gaps usually results in a complex mosaic of vegetation patches of different ages (Weisser & Cooper 1993). Because of the lack of historical information on the area it is difficult to determine the causes of disturbances. It can be assumed that in these areas the

Figure 10. Estimated percentage cover of trees, shrubs, herbs and grasses



dune forest was disturbed either by the impact of man or fire, and that the forest is still in a recovery stage. The coastal dune forest in the Rocktail Bay area, where a fire had swept through the dune forest in 1992, is an example of such a fire-disturbed area which is now in a recovery stage. In the densely populated Mabibi area, the coastal dune forest also seems to be in a recovery stage, especially the landward sides. This could be attributed to the forest being under a lot of pressure through clearing of areas for cultivation or firewood collection. Conservation of this area has given the forest time to start recovering. An average of 31 species was recorded per relevé.

This community is characterized by species group 4 (Table 3). Diagnostic species include the small tree *Pavetta gerstneri* and the tree *Sideroxylon inerme* subsp. *inerme*. Prominent species include the canopy trees *Apodytes dimidiata* subsp. *dimidiata* and *Mimusops caffra*, the small tree *Deinbollia oblongifolia* in the understorey, with the tree *Vepris lanceolata* forming part of the canopy and the understorey. The fern *Microsorium scolopendrium* was prominent in the field-layer, with the creeper/climber *Tragia glabrata* var. *glabrata* regularly present.

4.2 *Croton gratissimus* var. *gratissimus-Isoglossa woodii* coastal dune forest.

This community is also situated on the crest and landward (western) slopes of the dune barrier, but is characterized by a high canopy of up to 20 m and a more extensive field layer. Estimates of the percentage cover of trees (canopy) averaged 46 %, with shrubs (understorey) 37 % and herbs (field-layer) 16 % (Figure 10). This could be interpreted as an indication of an older forest, in pristine condition. Examples of this type of coastal dune forest can be found in the Lake Sibaya, Manzengwenya and Lala Nek areas. An average of 25 species was recorded per relevé.

This community is characterized by species group 5 (Table 3), and diagnostic species include the trees *Croton gratissimus* var. *gratissimus* and

Celtis africana. The tree *Diospyros inhacaensis* were prominent in the canopy with the small tree *Drypetes natalensis* var. *natalensis* in the understorey and the shrubby forb *Isoglossa woodii* in the field layer.

5. *Tricalysia delagoensis-Dialium schlechteri* inland forest.

These inland forests occur further from the coast around the inland lakes (Kosi Lake System and Lake Sibaya), or close to small rivers (Figures 2 & 9). Further away from the coast, with its high dune barrier, the dunes tend to be much lower. Environmental influences as a result of the topography tend to be much less than along the coast. Factors such as strong winds with salt spray and tall dunes with steep slopes sheltering some of the vegetation do not play such a major role in the inland forests. These forests are mostly situated on the crest of dunes or dune slopes, where the water table is deeper. They seem to be dependent on the proximity to water in the form of lakes or small streams where the soil is usually moist and the humidity high. The Manguzi Forest, found near the small town of Manguzi (KwaNgwanase), is included under inland forests. As is the case with the Manguzi Forest, the inland forests are remnants of much larger forests that have shrunk as a result of human activities. Inland forests cover 3 776.1 ha (excluding Manguzi Forest, which is situated outside the study area), which is about 8 % of the study area (Table 1). Inland forests were subdivided into three strata, namely a canopy, understorey and field layer. Nineteen MC endemic species were recorded in this community (Table 4). An average of 37 species was recorded per relevé.

The community is characterized by species group 9 (Table 3), and diagnostic species include the trees *Dialium schlechteri, Tricalysia delagoensis* and the woody climber *Landolphia kirkii.* Prominent species include the bulbous forb *Drimiopsis maculata*, the trees *Albizia adianthifolia* and *Trichilia emetica,* and the climber *Dalbergia obovata.*

Species group 10 (Table 3) contains species that occur in both inland forests and the coastal dune forests. The inland forest major community can be subdivided into two communities on the basis of structure and floristic composition.

5.1 *Artabotrys monteiroae-Hymenocardia ulmoides* inland forests.

Estimates of the percentage of cover of trees (canopy) averaged 48.3 %, with shrubs (understorey) 33.3 % and herbs (field-layer) 18.3 % (Figure 10). Canopy trees are about 5 m tall, shorter than those found in the coastal dune forest, where some trees grow taller than 10 m (although some individual trees in the Manguzi Forest grow over 15 m tall). An average slope of 5.6° was recorded. An average of 32 species was recorded per relevé.

This community is characterized by species group 7 (Table 3), and diagnostic species include the scrambling shrub *Artabotrys monteiroae,* the robust forb *Zamioculcas zamiifolia,* and the tree *Manilkara discolor.* Prominent species include the tree *Hymenocardia ulmoides* and the small tree *Ochna natalitia.*

5.2 *Catunaregam spinosa* subsp. *spinosa-Tabernaemontana elegans* inland forests.

Estimates of the percentage of cover of trees (canopy) averaged 40 %, with shrubs (understorey) 38 % and herbs (field-layer) 22 % (Figure 10). In this type of inland forest the percentage of cover of canopy trees is much lower than in the *Artabotrys monteiroae-Hymenocardia ulmoides* inland forest (5.1) with a more pronounced shrub and herb layer (understorey and field-layer). An average slope of 9.4° indicates that these forests are also found on steeper dune slopes than the *Artabotrys monteiroae-Hymenocardia ulmoides* inland forest (5.1). An average of 43 species was recorded per relevé.

This community is characterized by species group 8 (Table 3), diagnostic species include the small trees *Catunaregam spinosa* subsp. *spinosa* and *Xylotheca kraussiana* and the shrub *Crotalaria monteiroi* var. *galpinii.* Prominent species include the small trees *Tabernaemontana elegans, Strychnos*

spinosa, Brachylaena discolor subsp. *discolor* var. *discolor* and the shrub *Synaptolepis kirkii.*

6. *Syzygium cordatum-Canthium inerme* thicket.

Thickets form an ecotone between coastal dune forest and coastal grassland, and are distributed throughout the coastal grassland areas. The thickets are confined to areas with a low water table, on dune crests or slopes. Estimates of the percentage cover of trees and grasses were higher and lower respectively (Figure 10), when compared with those of the woodland areas (7). In the thicket community trees were usually shorter (about 4 m) and the canopy more open (more variation in height) than in the forest communities. The field-layer of the thickets usually consists of small shrubs, herbs and some grasses, whereas grass is usually comparatively rare in the forests. The size of the thicket community in the study area could not be determined because small thickets are scattered throughout the grasslands and is impossible to map on the scale used. Some of the larger thickets occurring in the vicinity of Black Rock and Lake Sibaya were, however, mapped. These thickets cover 93.5 ha (0.2 %) of the study area, but this figure is an under-estimate for the thicket community, because the areas covered by the numerous small thickets were not taken into account (Table 1). Twenty two MC endemic species were recorded in this community (Table 4). An average of 43 species was recorded per relevé.

Lacking a diagnostic species group, this community is characterized by the absence of species group 10 and species group 13 (Table 3). Prominent species include the trees *Syzygium cordatum* and *Mimusops caffra* and the small trees *Canthium inerme, Cussonia arenicola* and *Strychnos spinosa.*

This major community is divided into three communities on the basis of structure and floristic composition.

6.1 *Syzygium cordatum-Cymbopogon plurinodis* thicket.

This community has affinities with forests, thickets and woodlands but is difficult to place in any of these, because of a lack in any diagnostic or prominent species. Topographically it is situated on dune crests and on dune sides, with a low water table. An average of 23 species was recorded per relevé.

Lacking a diagnostic species group this community is characterized by the absence of species groups 10 and 14 (Table 3). Species that are regularly present in this community include the tree *Syzygium cordatum,* the small trees *Strychnos spinosa* and *Maytenus procumbens* and the grasses *Cymbopogon plurinodis* and *Setaria sphacelata* var. *sphacelata.*

6.2 *Syzygium cordatum-Albertisia delagoensis* thicket.

Usually situated low on dune slopes, signs of trampling and grazing were recorded in 50 % of the sample plots within this community. Most of the sample plots were surveyed close to human settlements, which might explain the high frequency of trampling and grazing. From estimates of the percentage trees, shrubs, herbs and grasses, this community has the lowest percentage of grasses of all the woodland and thicket communities with quite a high percentage of trees (Figure 10). An average of 26 species was recorded per relevé.

Lacking a diagnostic species group, this community is characterized by the absence of species group 19 and the presence of species group 11 (Table 3). The creeper *Albertisia delagoensis* is diagnostic for this community to an extend, although it does occur sporadically in a few other communities. Prominent species include the trees *Syzygium cordatum* and *Albizia adianthifolia* and the small trees *Strychnos spinosa* and *Sapium integerrimum.*

6.3 *Syzygium cordatum-Strelitzia nicolai* thicket.

Predominately found on the crest or high on dune slopes the water table of this community has been estimated to be very low. Estimates of percentage cover of trees were lower than in community 6.2 with a higher estimated grass cover (Figure 10). An average of 49 species was recorded per relevé (the highest average of all the communities).

Lacking a diagnostic species group, this community is distinguished by the absence of species group 13 and the presence of species group 11 (Table 3). The palm-like plant *Strelitzia nicolai* is diagnostic for this community. Prominent species include the tree *Syzygium cordatum*, the shrubs *Synaptolepis kirkii* and *Dichrostachys cinerea* subsp. *nyassana*, the grasses *Panicum maximum* and *Eustachys paspaloides*, the climber *Dalbergia obovata* and the palm *Phoenix reclinata*.

7. *Syzygium cordatum-Hyperthelia dissoluta* woodland.

This major community is mainly found in the northern part of the study area, in a rather densely populated area. It is situated on dune crests or slopes, in areas which is not regularly burnt. Close proximity to the Kosi Lake System and the Sihadla River that feeds into the system, make this area popular for human settlement. Fresh water is available from the small rivers or pans in the area with plenty of fish to be caught in the sea and lakes. There is enough grass available for the grazing of cattle and small areas of land are cleared for agricultural purposes. The woodland community covers 4 815.9 ha inside the Kosi Bay Coastal Forest Reserve [CFR], and together with the woodland around Sibaya covers about 10 377 ha (22 %) of the study area (Figure 2, Table 1). The average grazing capacity for the woodland for an average year is 2.9 ha/LSU (cattle) (Table 5). The woodlands are usually situated on the crests or slopes of dunes where the water table level is low (Figure 9), with small marsh areas or grassy patches in the inter-dune depressions. Twenty four species endemic to the MC were recorded in the woodland areas (Table 4). An average of 38 species was recorded per relevé.

Table 5a. Grazing capacity of the study area (ha/LSU game)

Rainfall			Grazing capacity							
			12 months prior to survey		6 months prior to survey		Average per year		Worst Year	
Mean rainfall (mm/year)			776		480.5		981		612	
Community number	Community	Size (ha)	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU
7	Woodland	10 377	6	1 729	12.5	832	4.4	2 351	8.4	1 231
8	Coastal grassland	9 826.2	6	1 624	12.7	775	4.4	2 213	8.5	1 153
9	Hygrophilous grassland	3 702	6	619	12.4	299	4.4	841	8.4	441
Total		**23 905.2**		**3 972**		**1 906**		**5 405**		**2 825**

Table 5b. Grazing capacity of the study area (ha/LSU cattle)

Rainfall			Grazing capacity							
			12 months prior to survey		6 months prior to survey		Average per year		Worst Year	
Mean rainfall (mm/year)			776		480.5		981		612	
Community number	Community	Size (ha)	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU
7	Woodland	10 377	4	2 594	8.2	1 265	2.9	3 578	5.6	1 853
8	Coastal grassland	9 826.2	4	2 456	8.4	1 170	2.9	3 388	5.6	1 755
9	Hygrophilous grassland	3 702	3.9	949	8.2	451	2.9	1 277	5.5	673
Total		**23 905.2**		**5 999**		**2 886**		**8 243**		**4 281**

Table 5c. Grazing capacity of the CFR (ha/LSU game)

Rainfall Mean rainfall (mm/year)			Grazing capacity 12 months prior to survey 776		6 months prior to survey 480.5		Average per year 981		Worst Year 612	
Community number	Community	Size (ha)	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU
7	Woodland	4 815.9	6	803	12.5	385	4.4	1 095	8.4	573
8	Coastal grassland	6 276.4	6	1 046	12.7	494	4.4	1 426	8.5	738
9	Hygrophilous grassland	2 227.1	6	371	12.4	180	4.4	506	8.4	265
Total		**13 319.4**		**2 220**		**1 059**		**3 027**		**1 576**

Table 5d. Grazing capacity of the CFR (ha/LSU cattle)

Rainfall Mean rainfall (mm/year)			Grazing capacity 12 months prior to survey 776		6 months prior to survey 480.5		Average per year 981		Worst Year 612	
Community number	Community	Size (ha)	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU	ha/LSU	LSU
7	Woodland	4 815.9	4	1 204	8.2	587	2.9	1 661	5.6	860
8	Coastal grassland	6 276.4	4	1 569	8.4	747	2.9	2 164	5.6	1 121
9	Hygrophilous grassland	2 227.1	3.9	571	8.2	272	2.9	768	5.5	405
Total		**13 319.4**		**3 344**		**1 606**		**4 593**		**2 386**

This community is characterised by species group 14 (Table 3). The grass *Hyperthelia dissoluta* and the forb *Vernonia centaureoides* is diagnostic for this community. Prominent species include the tree *Syzygium cordatum,* the dwarf shrub *Salacia kraussii* and the grass *Cymbopogon plurinodis.*

This major community is divided into two communities on the basis of structure and floristic composition. The estimated percentage cover by trees is 6 % higher in community 7.1 than in community 7.2 (Figure 10).

7.1 *Syzygium cordatum-Digitaria natalensis* woodland.

Usually situated on dune slopes, the average water table level is estimated to be higher than in community 7.2, which is situated on the crest of dunes. An average of 40 species was recorded per relevé.

Lacking a diagnostic species group, this community is distinguished by the absence of species group 11 and the presence of species group 12 (Table 3). Prominent species include the tree *Syzygium cordatum,* the small trees *Rhus natalensis* and *Kraussia floribunda* and the grasses *Digitaria natalensis, Dactyloctenium geminatum* and *Panicum maximum.*

7.2 *Syzygium cordatum-Wahlenbergia abyssinica* subsp. *abyssinica* woodland.

Usually found on the crest of dunes, this community has a lower estimated water table level than community 7.1. An average number of 35 species was recorded per relevé.

Lacking a diagnostic species group, this community is distinguished by the absence of species group 12 and the presence of species group 14 (Table 3). The forb *Wahlenbergia abyssinica* subsp. *abyssinica* is diagnostic although it does occur sporadically in a few other communities. Prominent species

include the trees *Syzygium cordatum* and *Sclerocarya birrea* subsp. caffra, the small tree *Strychnos spinosa* and the palm *Phoenix reclinata.*

Another area where woodlands were distinguished from ortho-photographs and personal observation is on the western shores of Lake Sibaya, covering an area of 5 561.1 ha (12 % of the study area) (Figure 2). No sample plots were done in these woodlands because it falls far outside the boundaries of the CFR. These woodlands appear from visual observation (the tree *Terminalia sericea* appears to be prominent) to be different to the woodlands found in the north of the study area.

8. *Parinari capensis* subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland.

This community is situated on the inland (western) side of the coastal dune forest. The coastal grasslands are burnt annually by the local inhabitants in order to obtain better grazing for their livestock. Situated on the dune crests, dune slopes and dune bottoms (inter-dune depressions) (Figure 9), the water table is estimated to be low (presumably higher in the inter-dune depressions than on the dune crests). Small thickets or clumps of trees (community 6) are found throughout the coastal grassland. In the study area, the grasslands stretch from south of Lake Sibaya northwards to the Kosi Lake System, where woodlands are more dominant. The coastal grassland covers 9 826.2 ha (21 % of the study area) (Figure 2, Table 1). The average grazing capacity on an average year is 2.9 ha/LSU (cattle) (Table 5). The average biomass for the coastal grassland is 5 853.53 kg/ha (Table 6). Twenty four MC endemic species were recorded (Table 4). An average of 30 species was recorded per relevé.

Lacking a diagnostic species group this community is distinguished by the absence of species group 14 and the presence of species group 19 (Table 3). Prominent species include the dwarf shrubs *Parinari capensis* subsp. *incohata* and *Diospyros lycioides* subsp. *sericea,* the shrub *Helichrysum kraussii* and the sedge *Bulbostylis contexta.*

Species group 28 contains species that are distributed in the coastal grassland, hygrophilous

grassland and woodland communities. The coastal grassland moajor community is further divided into four communities on the basis of structure and floristic composition, as well as topographical position and grazing pressure.

8.1 *Helichrysum kraussii-Melinis repens* subsp. *repens* coastal grassland.

This community is usually found on dune slopes in proximity to human settlements. Trampling and grazing by cattle was recorded in some of the sample plots. The average gradient of the dune slopes is 9°, which is quite steep in relation to the average gradient of the other grassland plots on the side of dunes with a gradient ≤8°. The average biomass recorded was 5 570.56 kg/ha (Table 6). An average of 31 species was recorded per relevé.

Lacking a diagnostic species group, this community is distinguished by the absence of species group 13 and the presence of species group 15 (Table 3). Prominent species include the small shrub *Helichrysum kraussii,* the grasses *Melinis repens* subsp. *repens, Perotis patens* and *Dactyloctenium geminatum* and the dwarf shrub *Salacia kraussii.*

8.2 *Vernonia natalensis-Polygala producta* coastal grassland.

Occurring low on the slopes of dunes and sometimes in the inter-dune depressions, the estimated water table is quite high in this community (although it could not be reached with a 1.5 m soil auger). An average gradient of 7° was recorded on the dune slopes, which is quite gradual for the coastal grassland communities. The average biomass recorded was 5 757.99 kg/ha (Table 6). An average of 36 species was recorded per relevé.

Lacking a diagnostic species group this community is distinguished by the absence of species group 15, and the presence of species group 16 (Table 3). Prominent species include the forbs *Polygala producta, Vernonia*

Table 6. Biomass of the different plant communities

Community number (see text)	Average Biomass (kg/ha)
8	5 853.58
8.1	5 570.56
8.2	5 757.99
8.3	5 902.85
8.4	6 055.86
9	5 861.64
9.1	5 590.83
9.1.1	4 542.58
9.1.2	5 838.42
9.1.3	5 854.63
9.2	6 990.05

natalensis and *Stylosanthes fruticosa,* the grass *Digitaria natalensis* and the climber/creeper *Abrus precatorius* subsp. *africanus.*

8.3 *Vernonia oligocephala-Diheteropogon amplectens* coastal grassland.

Occurring high on the slopes of dunes, an average gradient of 8° was recorded in this community. This average gradient is steeper than that of community 8.2, but more gradual than the average gradient of community 8.4. The average biomass recorded was 5 902.85 kg/ha (Table 6). An average of 30 species was recorded per relevé.

Lacking a diagnostic species group, this community is distinguished by the absence of species group 16 and 18 and the presence of species group 17 (Table 3). Prominent species include the forbs *Vernonia oligocephala* and *Euphorbia epicyparissias* var. *epicyparissias* and the grasses *Diheteropogon amplectens, Themeda triandra* and *Trachypogon spicatus.*

8.4 *Cymbopogon plurinodis-Asclepias affinis* coastal grassland.

The estimated water table level is very low because of the topographical distribution of this community, which is usually found high on the crest of dunes. The average biomass recorded was 6 055.86 kg/ha (highest biomass recorded among coastal grassland communities) (Table 6). An average of 25 species was recorded per relevé.

This community is characterized by species group 18 (Table 3) and diagnostic species include the forbs *Asclepias affinis* and *Thesium polygaloides.* Prominent species include the dwarf shrub *Diospyros galpinii,* the forbs *Hypoxis hemerocallidea* and *Tephrosia kraussiana* and the grasses *Cymbopogon plurinodis, Urelytrum agropyroides* and *Setaria sphacelata* var. *sphacelata.*

9. *Ischaemum fasciculatum-Centella asiatica* hygrophilous grassland.

The hygrophilous grasslands are usually situated further inland from the coastal dune ridge. In the coastal grassland and woodland communities they are situated in low lying areas, or in close proximity to lakes or small pans (Figure 9). A very high water table level (average 0.8 m) distinguishes this community from the coastal grassland community. In 85 % of the sample plots made within this community the water table could be reached with a 1.5 m soil auger. In the other plots (15%) the water table depth is estimated to be very high, probably not much deeper than 2 m. Hygrophilous grassland covers about 3 702 ha (8 %) of the study area (Figure 2, Table 1). The grazing capacity for an average rainfall year was 2.9 ha/LSU (cattle) (Table 5). The average biomass recorded was 5 861.64 kg/ha (Table 6). Thirteen MC endemic species were recorded in this community (Table 4). An average of 19 species was recorded per relevé.

Characterized by species group 27 (Table 3), diagnostic species include the grasses *Ischaemum fasciculatum* and *Andropogon gayanus* var. *polycladus* and the forb *Centella asiatica*. Prominent species include the sedges *Cyperus obtusiflorus* var. *obtusiflorus*, *Cyperus natalensis* and *Cyperus tenax*.

This major community is divided into two communities determined by floristic composition and water table depth.

9.1 *Ischaemum fasciculatum-Sporobolus subtilis* hygrophilous grassland.

This community is usually found further away from open water, in areas where it might be inundated by water for short periods in extremely wet years. The water table level is seldom higher than about 0.5 m or lower than an estimated 2 m. The average biomass recorded for this community was 5 590.83 kg/ha (Table 6). An average of 20 species was recorded per relevé.

This community is characterized by species group 24 (Table 3) and

diagnostic species include the grass *Sporobolus subtilis.* Prominent species include the grasses *Ischaemum fasciculatum* and *Imperata cylindrica* and the creeper *Desmodium dregeanum.*

This community is further subdivided into three sub-communities determined by floristic composition and water table depth.

9.1.1 *Themeda triandra-Monocymbium ceresiiforme* hygrophilous grassland.

At the time of monitoring this sub-community, the water table could not be reached with a soil auger of 1.5 m. The water table depth is estimated to be about 2 m. In a year with a higher rainfall the water table depth would probably be higher. The average biomass recorded was 4 542.58 kg/ha (Table 6). An average of 22 species was recorded per relevé.

Lacking a diagnostic species group, this sub-community is distinguished by the absence of species group 20 and 26 and the presence of species group 21 (Table 3). Prominent species include the grasses *Themeda triandra, Monocymbium ceresiiforme* and *Diheteropogon amplectens* and the sedge *Bulbostylis contexta.*

9.1.2 *Ischaemum fasciculatum-Fuirena umbellata* hygrophilous grassland.

The average water table level recorded in this community was 1.15 m. The average biomass recorded was 5 838.42 kg/ha (Table 6). An average of 22 species was recorded per relevé.

Lacking a diagnostic species group, this sub-community is characterized by the absence of species group 21 and the

presence of species group 22 (Table 3). Prominent species include the grasses *Ischaemum fasciculatum* and *Andropogon gayanus* var. *polycladus* and the sedges *Fuirena umbellata, Juncus kraussii* and *Cyperus obtusiflorus* var. *obtusiflorus*.

9.1.3 *Ischaemum fasciculatum-Hydrocotyle bonariensis* hygrophilous grassland.

The average water table level recorded in this community was 0.85 m. The average biomass recorded was 5 854.63 kg/ha (Table 6). An average of 18 species was recorded per relevé.

Lacking a diagnostic species group, this sub-community is distinguished by the absence of species groups 22 and 25 and the presence of species group 23 (Table 3). Prominent species include the grasses *Ischaemum fasciculatum, Imperata cylindrica* and *Sporobolus subtilis,* the forb *Hydrocotyle bonariensis* and the sedge *Cyperus natalensis.*

9.2 *Brachiaria arrecta-Hemarthria altissima* hygrophilous grassland.

Usually found on the edges of lakes and pans, the water table is usually visible (average water table level is 0.1 m). The average biomass recorded was 6 990.05 kg/ha (highest biomass recorded in all the hygrophilous and coastal grassland communities) (Table 6). An average of 22 species was recorded per relevé.

This community is characterized by species group 25 (Table 3), and diagnostic species include the grass *Brachiaria arrecta* and the fern *Rhynchospora holoschoenoides.* Prominent species regularly present include the grass *Hemarthria altissima,* the sedge *Cyperus tenax* and the forb *Centella*

asiatica.

10. *Nephrolepis biserrata-Ficus trichopoda* swamp forest.

Usually found in close proximity to small rivers or water bodies (Figure 9), this community is confined mainly to the northern part of the study area around the little inlets running into the Kosi Lake System, and all along the Sihadla River. A very small piece of swamp forest is also found in the south of the study area in the region of the Shazibe Pan. In the study area this community covers 983.6 ha (2.1 %) (Figure 2; Table 1). The swamp forest is under a lot of pressure in the areas where it occurs outside the reserve. The soil is fertile and large pieces of swamp forest have been cleared to make way for small fields where mostly bananas are grown. Inside the study area these forests are usually characterized by a high canopy, a sparse understory consisting of shrubs and small trees with an extensive field-layer mainly consisting of ferns. Two MC endemic species were recorded in this plant community (Table 4). An average of 16 species was recorded per relevé.

This community is characterized by species group 29 (Table 3) and diagnostic species include the fern *Nephrolepis biserrata* which is dominant in the field layer, the scrambling shrub *Keetia gueinzii* and the smallish tree *Rapanea melanophloeos* (dominant in the understory), with the trees *Ficus trichopoda* and *Voacanga thouarsii* in the canopy. Prominent species regularly present include the tree *Syzygium cordatum* (canopy), the palm *Phoenix reclinata* (understory) and the climber *Smilax anceps* (field layer/understory).

4.3 Ordination

The distribution of the relevés along the first and second axes of ordination is indicated on a scatter diagram (Figure 6). A third axis of ordination contributes little to the interpretation of the communities and will therefore not be considered further.

The scatter diagram illustrates a gradient from fresh water habitats with a high water table (left) to habitats that are influenced by salt spray (right), along the horizontal axis. The

diagram might also reflect a gradient of distance away from the sea from the hygrophilous grassland communities further inland (left of diagram), to the beach pioneer community close to the sea (right of diagram).

All plant communities are more or less restricted to specific areas of the diagram. The thicket (6) and woodland (7) communities could not be separated from the diagram, probably because their species compositions are very similar. Distinct discontinuities exist between the dune pioneer and dune scrub thicket communities, and the dune scrub thicket and the coastal dune forest communities. The other communities show high similarities and exhibit a continuum pattern. This continuum pattern of one community gradually changing to another community can be observed in the field. The discontinuity between the dune pioneer community and the coastal scrub thicket is probably a result of the difference in the habitat, and reflects the change in exposure to salt spray and effects of wind and waves, from the fore dune and the beach to the more sheltered dune scrub community. This supports the belief that the fore dune with its dune pioneer community provides some protection to the dune scrub community against the effects of salt spray, wind and waves. The discontinuity between the dune scrub thicket community and the coastal dune forest community is probably caused by the sampling approach used in these communities. Sample plots were made in the dune scrub thicket community close to the beach, and in the coastal dune forest community on the crest of the dune. The ecotone area between these two communities was therefore not sampled, and the scatter diagram does not reflect the gradual change from coastal scrub thicket to coastal dune forest which is evident in the field.

4.4 Biomass

Biomass can play a role in assessing the grazing capacity and are very important in determining the fire regime of the Reserve. The regression equation, after calibration, which was used and can be used in the future for determining biomass in kg/ha is as follows (Trollope & Potgieter 1986):

y = 483.3x - 733.1

y = estimated fuel load (kg/ha)
x = mean disc height (cm)

Coefficient of determination (r^2) = 0.826
Standard error of y estimate = 246.791
Standard error of x coefficient = 483.212

The square root transformation of the independent variable, disc height, resulted in the best fit of the linear regression for which the correlation coefficient was highly significant (r = 0.909).

The biomass of the different coastal grassland and hygrophilous grassland communities has been calculated (Table 6; Figure 2). The highest average biomass recorded in all the coastal and hygrophilous grassland communities was in the *Brachiaria arrecta-Hemarthria altissima* hygrophilous grassland which is found on the edges of lakes and pans. *Hemarthria altissima* forms a thick grass carpet in this community which might account for the high average biomass. The lowest average biomass of all the coastal and hygrophilous grassland communities was recorded in the *Themeda triandra-Monocymbium ceresiiforme* hygrophilous grassland. The scant growth form of the grass and sedge species of this community together with the removal of grass material through grazing, could account for this low average biomass. The highest average biomass recorded in the coastal grassland community was recorded in the *Cymbopogon plurinodis-Asclepias affinis* coastal grassland community, which is situated on the crest of dunes. A high number of dwarf shrub species occurs in this community, which may account for the high average biomass found on the crest of dunes. The *Helichrysum kraussii-Melinis repens* subsp. *repens* coastal grassland community had the lowest average biomass of the coastal grassland communities, this is probably due to high grazing pressures.

Trollope & Potgieter (1985) have found in the Kruger National Park that fires will not spread readily when the average biomass is less than 1 500—2 000 kg/ha. To generate enough fire to control bush encroachment the average biomass should not be lower than 4 000 kg/ha. If these figures are applied to the grasslands of the study area, the fuel load in all the grassland communities is significant enough for the control of bush encroachment. Because of

the differences between the grasslands of the study area and those of the Kruger National Park, however, and together with the high humidity and the lack of a pronounced dry season in the study area, further research on the correlation of fire and fuel load in the study area is needed.

CHAPTER 5

FLORA

5.1 Introduction

In 1988 a project was started by the IUCN-WWF called "Centres of Plant Diversity: A Guide and Strategy for their Conservation". This project aimed at listing all the major botanical sites and vegetation types considered to be of international importance for the conservation of plant diversity. One of the 84 sites which has been identified in Africa as a Centre of Plant Diversity [CPD] and Endemism is the Maputaland-Pondoland Region [MPR]. The MPR is comprised of two clear foci of high endemism, namely the Maputaland Centre [MC] and the Pondoland Centre [PC]. The study area forms part of the MC of Endemism (Van Wyk 1994).

The MC is defined by Van Wyk (1996) as that part of southern Mozambique and north-eastern KwaZulu-Natal, bounded in the north by the Inkomati-Limpopo River, in the east by the Indian Ocean, in the west by the western foothills of the Lebombo Mountains and in the south by the St. Lucia Estuary, from where it extends further along the coast down to about Mtunzini. The MC covers an area of about 2 673 400 ha, of which about 257 600 ha (almost 10 %) is presently conserved in KwaZulu-Natal. For its size the MC is one of the most remarkable areas of biodiversity in the world, with a high number of endemic species spread over virtually the whole taxonomic spectrum (Van Wyk 1994). About 2 500 species (but probably more) of vascular plant species occur in the MC. Of these at least 225 species or infraspecific plant taxa and 3 genera (*Brachychloa, Galpinia, Helichrysopsis*) are endemic or near-endemic to the region (Van Wyk 1996).

The study area covers an area of 46 440.3 ha, which is about 1.7 % of the MC. The largest part of the study area (33 341 ha, 72 %) consists of the Kosi Bay Coastal Forest Reserve [CFR] which includes Lake Sibaya and the Kosi Lake System (Table 1). The vegetation of the study area is very diverse, with 12 major plant communities distinguished during the vegetation study (Table 3). Some of the more important plant communities

distinguished in the vegetation study include coastal dune forest, inland and swamp forest, mangroves, woodland and coastal and hygrophilous grassland. In the CFR these communities are still in an almost pristine state and rich in species.

The fauna of the CFR is also very diverse, with as many as 279 species of birds and 67 reptiles recorded around Lake Sibaya alone. The CFR is the only place in South Africa where stands of the large monocarpic palm *Raphia australis* occur naturally. The rare palm nut vulture (*Gyphierax angolensis)* only breed in the vicinity of these large palms, and they are often seen in the Kosi Bay area. The CFR is also one of the few places in South Africa where the pink throated longclaw (*Macronyx ameliae*) and the red squirrel (*Paraxerus palliatus*) occur. An endemic fresh water fish species, the Sibaya goby (*Silhouetta sibayi*) can be found in Lake Sibaya and the Kosi Lake System.

While the CFR is bounded in the east by the Indian Ocean, only a small part of the inland boundary of the CFR is fenced. To manage a reserve without a fence is very difficult and probably a unique situation in South Africa. There is still at least 200 homesteads within the boundaries of the Reserve. The livestock of people living in and around the CFR still graze within the CFR. The people of the area often clear small pieces of land for subsistence agriculture inside the boundaries of the CFR and make extensive use of the vegetation for food, building material and medicine. Although forest clearing in the CFR has been restricted by conservation efforts of the KwaZulu Department of Nature Conservation [KDNC], the ever increasing population of the area puts a lot of pressure on the forest areas in particular. The present study has shown, however, that over-grazing by domestic livestock does not pose a serious immediate threat to the vegetation of the CFR.

It has been suggested in the past that the coastal grasslands of the region constitute a secondary, fire-maintained vegetation type, created by extensive forest clearing (Moll & White 1978; White 1983; Conlong & Van Wyk 1991). It has therefore been considered as anthropogenic in origin. This view has contributed to the poor conservation status of the coastal grasslands of the MC. The fact that a large proportion of species endemic to Maputaland are confined to the grassland areas seems to contradict this view (Van Wyk

1994). From the vegetation study of the area the coastal grassland appears to be fire-maintained, and a large number of the plant species recorded in the coastal grassland areas shows adaptation to fire. The extent of the grassland in an area which in the past has been mostly unsuited for extensive human settlement seems to contradict the view that the grasslands have been created by forest clearing. The poor conservation status of the coastal grasslands in the past has resulted in the destruction of this vegetation type, which has been cleared and replaced with exotic Pine and Eucalypt plantations. Commercial afforestation is currently the most serious direct threat to the coastal grasslands of the area. Findings from the vegetation study have also recognized the indirect threat that extensive afforestation could have on the hygrophilous grassland community of the CFR through the depletion of the water table. Alien and invasive species are concentrated in plantation areas and this also poses a threat to the vegetation of the study area.

The floristic part of the present study aimed at establishing the conservation importance of the CFR as part of the MC. A checklist of plant species collected in the study area was compiled with the emphasis on determining the number of MC endemics that occur in the CFR. The known collection sites of MC plant endemics within the CFR were mapped to determine priority areas for conservation. The distribution of endemic species was related to plant communities. This will help in assessing the importance of the different plant communities for conservation and how they should be managed.

5.2 Checklist of vascular plants

From the plant database 1 164 plant species have been recorded in the CFR, the western side of Lake Sibaya and in the Manguzi Forest (see Appendix 1). The areas most intensively collected were identified using the distribution map of the localities where plants have been collected (Figure 7). Localities where a large number of plants have been collected (between 21 and 131 collections per locality) were Kosi Mouth; Kosi Bay campsite; about 3 km west of Lake Amanzimnyama; Sihadla River crossing; KwaZibi; Manzengwenya; Drum Island; the eastern side of Lake Sibaya; Baya Camp and just south of Lake Sibaya (Figure 7).

To get a better idea of the distribution of species richness in the study area, the presence of taxa was related to plant communities (see 5.4). The average number of taxa collected per sample plot during the phytosociological study was also calculated (Table 7). The thicket community has the highest average number of taxa collected per sample plot (43). High average numbers were also recorded in the coastal dune forest, inland forests, woodland and grassland communities.

5.3 Distribution of MC endemics

A checklist of the endemic plant species of Maputaland (Van Wyk 1996) was used to determine those taxa endemic to the study area. At least 71 (32 %) of the 225 plant species endemic to Maputaland have been recorded in the study area. Collecting sites with high numbers of endemic species could be identified from the distribution map showing all the localities where MC endemic species were collected (Figure 8). The highest number of MC endemic species (7—9) were collected at Kosi Bay campsite and Manzengwenya. Four to six MC endemic species were collected at Kosi Mouth; just west of Kosi Bay campsite; near Amanzimnyama trails camp; east of Lake Sibaya and at Baya Camp (Figure 8).

5.4 MC endemic species distribution in relation to plant communities

The distribution of MC endemics in the different plant communities was determined (Tables 1 & 5, Figure 2). The highest numbers of MC endemic species were recorded in the coastal dune forest (community 4), woodland (community 7) and coastal grassland (community 8) communities, which contain 24 endemic species each. Other communities which have high numbers of MC endemic species are the thickets (community 6) and the inland forests (community 5).

About 38 (52 %) of the MC endemics in the study area were recorded in one community only (restricted to the community), whereas the other endemics occur in more than one community (Table 4). Eleven MC endemics are found only in the coastal grassland community (community 8). This represent, the highest number of endemic species restricted

Table 7. Average number of plant species per sample plot

Community number (see text)	Average number of species per sample plot
1	22
2	6
3	6
4	28
5	37
6	43
7	38
8	30
9	19
10	16

to any single plant community. Although the hygrophilous grasslands have 13 MC endemic species only, 6 of these are unique to this community. By contrast, 22 MC endemic species found in the thicket community are also present in the forest and grassland communities.

CHAPTER 6

GENERAL DISCUSSION AND ADDITIONAL NOTES

6.1 Vegetation

1. *Pinus elliottii-Chromolaena odorata* disturbed areas.

Most of the coastal grassland, hygrophilous grassland, woodland and thicket areas outside the CFR boundary have been replaced with pine and eucalypt plantations. A high water table, together with a high average rainfall make the region ideally suited for afforestation. The *Pinus elliottii-Chromolaena odorata* community occurs in areas where pine plantations have been cleared and left undisturbed for some time before replanting. Although this community is linked to the grassland, forest, and woodland communities, the majority of species are early successional species. The small tree *Sapium integerrimum*, which is prominent, seems to be one of the first tree species (occurring naturally in forest and thicket areas), to colonize disturbed areas. Another small tree which often colonizes these areas (although not prominent in the phytosociological table) is *Brachylaena discolor* subsp. *discolor* var. *discolor* (Table 3). The area in which these sample plots were made was probably soon to be cleared and replanted with pine or eucalypt trees.

Forestry is a highly productive land-use system which produces large amounts of raw material for the water it consumes. Because of the unsuitability of the soils in the study area for agricultural purposes other than small subsistence farming, afforestation has provided a form of effective land use. Most of the wood grown in the area is presently used for paper pulp production, but at least two sawmills have been established in the area. The forestry industry provides work for many people and makes products used in the building of houses and the manufacturing of furniture and paper. Large forestry companies make substantial contributions to conservation initiatives and cultivate an environmentally conscious image. The fact remains, however that afforestation might be one of the biggest threats to the vegetation of the Kosi Bay Coastal Forest Reserve [CFR], not only through destruction of the natural

vegetation, but through the spreading of alien invasive species such as the shrub *Chromolaena odorata* (from the phytosociological table, Table 3). Alien and invasive species seem to be concentrated in forestry areas outside the CFR. Plantations could also have an effect on the hydrology of an area. In the St Lucia area the pine plantations have been said to transpire at a rate of up to 450 mm/year higher than the surrounding grasslands (Rawlins & Kelbe 1991). This influence on the hydrology of the area has a detrimental effect on the hygrophilous grassland community in particular.

The hygrophilous grassland seems to occur in a north-south line (Figure 2). The hygrophilous grassland runs from the Kosi Lake System southwards to Lake Sibaya, about eight kilometres inland from the coast. Small pans and marshes are scattered throughout the hygrophilous grassland, which forms part of the catchment areas of both the Kosi Lake System and Lake Sibaya. The Manzengwenya Plantation is situated outside the CFR's boundary between the Kosi Lake System and Lake Sibaya, and straddles the hygrophilous grassland line. Mbazwane Plantation is situated south of Lake Sibaya and is also situated on the hygrophilous grassland line. The effect of these two plantations on the hydrology of the area is difficult to determine. Nänni (1969), in a report done on the effect of afforestation in the area, states that it will only have a minor negative effect on the Kosi Lake System and Lake Sibaya, as the plantations are situated far enough away from the Lakes. Uncontrolled afforestation on private land closer to the Kosi Lake System (KwaZibi and KwaNkumende areas) does give cause for concern. Afforestation in these areas will most probably have a serious effect on the salinity levels of the Kosi Lake System and on the water table levels of the hygrophilous grassland and pans in the area. Careful monitoring and some means of control should be implemented in these areas. An investigation of the impact exotic trees have on local plant and animal communities together with an assessment of how afforestation affects the hydrology of the region will be some of the research requirements of the future.

2. *Scaevola plumieri-Gazania rigens* var. *uniflora* dune pioneer community.

This community is sometimes called the Strand Community, but the majority of authors refer to it as the Dune Pioneer community (Donnely & Pammenter 1983; Weisser & Backer 1983;

Weisser 1989; Weisser & Cooper 1993). Breen (1979) notes that it is unlikely that this community represents a stage in the succession of dune forest as there is no evidence that it gives way to a more complex or stable community. Barbour *et al.* (1980) states that the dune pioneer community forms part of a toposequence, where different distances from a stress, in this case salt spray, influence the topographical distribution of plants. In such a scenario, succession from dune pioneer to dune forest would only occur if the sea level were to drop considerably. It is therefore better to regard this community as one in which plants colonize sites as and when they become suitable.

Continual changes of tides, waves and wind make beaches an extreme habitat for plant colonization. Strong winds cause salt spray and form new dunes which expose or cover beach pioneer plants. Beach sand consists of silica quartz sands (Tinley 1985) and has a high salt content. The sand has a high infiltration rate and dries out rapidly after rain. The habitat is fully exposed to the sun and also experiences high extremes of temperatures.

The pioneer community is composed mainly of creeping herbaceous plants with upright branches. Studies done on Natal coastal sand dunes by Donnelly & Pammenter (1983) indicate that salt spray and short-term sand deposition are the major factors controlling the distribution of common beach pioneers. They reasoned that the pioneers do not extend further into the more sheltered areas of coastal scrub thicket because they thrive in unstable conditions, or are unable to compete with the species in the shrub thicket community. The beach pioneer plants are ideally suited for growth under the harsh environmental conditions that occur on the beaches. A rapid growth rate enable the pioneer species to grow faster than the sand can accumulate. The pioneers are also able to withdraw nutrients and water from leaves that become buried (Tinley 1985). Most of the pioneers are succulents which are adapted to survive in these extreme conditions (Larcher 1983).

The species composition recorded in the study area is similar to what was found in studies done on beach pioneer communities in the Mhlalazi-Richards Bay and Mtunzini areas to the south (Weisser & Müller 1983). *Scaevola plumieri* has also been found to be the main colonizer on foredunes in that area. *Scaevola plumieri* is said to be the most efficient sand

binder in these communities, but its efficiency and ability to colonize the beachfront seems to decline to the south of the Fish River Mouth in the Eastern Cape (Weisser & Cooper 1993).

Although the dune pioneer community is not very rich in species, it fulfils a very important function in the stabilizing and formation of dunes. It acts as a barrier providing some protection to the dune scrub community. Behind the foredune and dune pioneer community, the salt-spray and sand deposition decreases and it is in this area where there is a change in vegetation from dune pioneer to dune scrub (Donnelly & Pammenter 1983). Another important function of the dune pioneer community, through its stabilizing effect on the foredune areas, is the protection of sea turtle nests. The foredune area serves as a nesting site for giant leatherback and loggerhead turtles to lay their eggs. The stabilizing effect the pioneers have on the foredune gives some protection to the nests from being blown open by the wind or washed open by waves. These are some of the reasons why beach driving has been prohibited in large areas of the CFR, and these strict controls should be maintained in the future.

3. *Eugenia capensis-Euclea natalensis* subsp. *natalensis* coastal scrub thicket.

The findings of the study compare well with work done by Weisser (1989) in the same area. *Eugenia capensis* has also been found to be the most common species in the dune scrub community in work done at Mtunzini (Weisser & Backer 1983). The *Passerina* sp. scrub zone, which occurs between the coastal scrub thicket and the dune pioneer communities in the Mtunzini and Mlalazi-Richards Bay area (Weisser & Müller 1983; Weisser & Cooper 1993), seems to be absent in the sample plots made in the study area. The coastal scrub thicket borders directly on the pioneer community in most cases within the study area, and it might be that the *Passerina* sp. scrub community is absent because of lack of space or suitable habitat.

The dune scrub thicket consists of a single dense layer of vegetation, between 0 and 5 m high, which protects the coastal dune forest from the effects of wind and salt-spray. As the effects of the wind and salt-spray decrease further away from the sea, an ecotone is formed between coastal dune forest and dune scrub thicket. The transition from dune scrub thicket to

coastal dune forest is therefore more gradual than the vegetation change between dune pioneer and dune scrub thicket. Destruction of this community through the indiscriminate cutting of roads or even footpaths, especially in line with the prevailing and strongest winds, creates sand blows which could have a seriously detrimental effect on the coastal dune forest. This should be kept in mind when any new development is planned along the coast of the CFR.

4. *Peddiea africana-Diospyros inhacaensis* coastal dune forest.

Although the findings of this study show a great degree of similarity in species composition to work done in the coastal dune forests by other authors, it is a broad classification that should be used with the classifications of other authors (Breen 1971; Venter 1974; Breen 1979; Moll 1980; Weisser 1980; Tinley 1985; Weisser 1989; Weisser & Cooper 1993) . In the phytosociological study the dune forest was subdivided into two communities (Table 3) on the basis of chronological age. In communities that are still developing, the understorey has a higher estimated percentage cover than the canopy . In older communities the canopy has a higher estimated percentage cover than the understorey (Figure 10). The younger communities seem to be still in a developing stage because of human impact. Areas with young communities were encountered near Mbibi, Rocktail Bay and in the Black Rock and Dog Point areas. Fire and bush clearing seem to be the major disturbance factors in the destruction of the dune forest in these areas, resulting in it being in a successional stage. In the Dog Point area the palm-like plant *Strelitzia nicolai* occurs in large numbers on the seaward slopes of the coastal dune ridge. They are burnt by the people living in the area at intervals of about five years to obtain a durable cord for rope-making using the singed and now pliable leaf petioles. The burning of thickets and dune forest enhances the habitat for *Strelitzia nicolai* and for the large MC endemic cycad *Encephalartos ferox.* Tinley (1985) states that this phenomenon, where the burning of the dune climax vegetation has enhanced the habitat for the palm-like plant *Strelitzia nicolai* and the cycad *Encephalartos ferox*, is found only in two other small sites along the Mozambique Coast, and recommends the maintenance of this community by burning.

The coastal dune ridge faces south-south-east to east, and consists of bidirectional

parabolic dunes (Tinley 1985) (a parabolic dune is a U- or V-shaped blowout or tongue of advancing sand with its sides and leading slip faces partially stabilized by vegetation). Coastal dune sands are classified as littoral sands of the arenosol order of sands (MacVicar *et al.* 1977). Coastal dune sands have a high calcareous content from shell fragments and are therefore usually alkaline. Windblown sands are highly permeable to water, and as a result rain water is quickly absorbed with little opportunity for evaporation. The upper sand layers are usually loosely packed with intervening air spaces, resulting in a high infiltration rate. There is usually not much surface runoff and the sands collect all the rain that falls. The deeper soil moisture is protected from evaporation by the loose sand surface. Deep rooted woody plants therefore have an ample supply of water. Because of the permeability of the sand, nutrients are easily lost through leaching. Most of the nutrients are locked up in the vegetation itself, but a humus layer is usually formed in the topsoil of the forest floor (Tinley 1985).

The mature coastal forest is found on the land-facing slopes of the back dunes where salt spray and wind effect are least (Figure 9). Tinley (1985) noted that trees growing on the steeper slopes tend to be J-shaped. Stems bend in a downhill direction from the base and recurve to a vertical plane, because of the steep dunes being under constant gravity adjustments.

Weisser (1989) describes the dune forest as a complex formed by various floristically different communities covering a wide range of ecological situations. Breen (1979) studied the dune forest around Lake Sibaya and found that the trees were usually taller on the crest of the dune and where it merges with the coastal plain, while on the steep slopes trees tend to be shorter without a well developed field layer. In areas where the canopy is continuous he found that the herbaceous stratum is not well developed, but where the canopy had been broken, dense undergrowth (*Isoglossa woodii)* developed. Venter (1974), in his study of the Sibaya Dune Forest, distinguished a *Ziziphus mucronata* community at the base of the dune, a *Mimusops caffra* community on the slope of the dune and a *Ptaeroxylon obliquum* community on the crest of the dune, with *Acacia karroo* being dominant as a pioneer along the lake shore and on old fields.

Weisser & Cooper (1993) detected a change in the dune forest caused by distance away from the sea. As the distance from the sea increases, the wind and salt spray have less impact on the vegetation and trees seem to get taller and the field-layer more pronounced. Venter (1974) ascribed changes in dune forest to topography and slope. Moll (1980) remarked that where there is protection against the wind (from the topography as well as other vegetation), species richness as well as canopy height increases.

The destruction of dune forest caused by fire and humans results in areas of forest being in different successional stages. Lack of historical data on the history of the dune forest makes it difficult to distinguish between the primary forest and secondary forests in succession stages. As stated by Weisser (1989), topography, successional stage and other environmental conditions are responsible for variation of species composition in the dune forests. Separate sampling of primary and secondary communities would give a clearer reflection of environmental factors influencing species distribution.

A more intensive study of the dune forests in this area could lead to a better understanding of the environmental factors which influence it. Care should be taken to try and find out more about the history of specific areas, so that primary and secondary forests could be sampled separately. Studies done on dune forest succession could be of great value in distinguishing between a primary forest and a secondary forest in stages of succession (Weisser & Backer 1983; Weisser & Müller 1983).

Management of the coastal dune forest should concentrate on the prevention of forest destruction through practices such as clearing of the forest or the cutting of wood for building material. Sustainable utilization in the form of collecting plant material for traditional medicines, should be controlled.

5. *Tricalysia delagoensis-Dialium schlechteri* inland forest.

These inland forests are the last remaining patches of what in the past were probably much larger forests. A decrease in size of the Manguzi Forest is noticed when comparing recent

(1992) aerial photographs with photographs from the 1960's. The inland forests are situated further away from the coast, where there is little or no effect from strong winds, salt spray and sand movement. Although they are usually situated on the crest or slopes of dunes with a low water table, the forests always seem to be in close proximity to water (Figure 9). In the study area they are distributed along the shores of Lake Sibaya and around the Kosi Lake System. The Manguzi Forest, which falls outside the boundaries of the CFR, is situated next to a small stream which forms part of the catchment of the Kosi Lake System. Two types of inland forests, based on floristic composition, were distinguished from the phytosociological table (Table 3). A difference in the percentage cover of the canopy (Figure 9), and a difference in the average slope were noticed when comparing the two types of inland forests. Those forests that occurred on gradual slopes seem to have a better developed canopy than the forests on steeper slopes.

Cunningham (1983) classified the Manguzi Forest, as well as the forests around Sibaya and the forests around Lake Amanzimnyama, as moist evergreen forests. The term moist evergreen forest might be somewhat misleading, however. Further away from the coast rainfall declines, and these forests do not appear to be very moist, especially if it is taken into account that the estimated water table level is > 4 m. A comparison with work done by Matthews *et al.* (1996) on the sand forests in the Sileza Nature Reserve (about 20 km west of the CFR) indicates a high degree of similarity between sand forest and the inland forests of the study area (*Dialium schlechteri* was also found to be one of the most prominent species). From the phytosociological table (Table 3), however, inland forests also contain species which occur in the coastal dune forest. This is probably because of their proximity to the coast.

In the CFR the inland forests are mostly found around the Kosi Lake System. The majority of the inland forests on the northern and western side of Lake Sibaya fall outside the boundaries of the CFR and are therefore at the mercy of the local communities. The Mabaso Tribal Game Reserve was established a few years ago on the southern side of the western arm of Lake Sibaya (Figure 2). This Reserve has been established in response to requests from tribal communities and is presently under the control of the KwaZulu Department of Nature Conservation [KDNC]. No further development has taken place inside this Reserve and

although it was fenced when it was established, the fence was subsequently cut down by the local community. The forests on the northern side of the western arm of Sibaya and around the northern arm of Sibaya (Figure 2) are not being conserved at the moment. In the last few years (1994—1996) private tourism enterprises have been established on the shores of the northern arm of Lake Sibaya. The KDNC does not have any way to control these private enterprises because this land belongs to the local communities. The forests in this area are still in an almost pristine condition, but the impact from uncontrolled development by private enterprises, together with a growing human population could have a seriously detrimental impact. The inland forests are rich in biodiversity and contain many MC endemic species, but because of their small size they are very vulnerable. The conservation bodies should try and obtain some control of the area before it is too late.

6. *Syzygium cordatum-Canthium inerme* thicket.

The thicket community is distributed throughout the grassland areas and occurs as an ecotone between coastal dune forest and coastal grassland. Estimated water table depth is low because the thickets are either situated on the crests or slopes of dunes. Thickets are probably formed as a result of localized absence of fire (the coastal grassland is burned at least once a year by the local people). In grassland areas where there has not been a fire for a few years, more shrubs and small trees seem to occur. Absence of fire in a certain area could be a result of human disturbance. In areas where a homestead was situated in the past or in overgrazed areas grass cover would be insufficient for burning. Natural factors such as topography, which influence wind speed and direction, also have an influence on fire. Trampling by cattle could have an influence as well, especially on steep slopes, where trampling combined with slope results in a continual shifting of sand. Woody plant species are better adapted to such circumstances, because they have better developed underground root systems, and they soon become prominent in such areas (as is evident in community 8.1 where the shrub *Helichrysum krausii* is prominent on dunes with a steep slope). As soon as a small group of trees forms, the grass cover diminishes. This results in a less severe fire which would not have such a destructive effect on the woody vegetation, and the size of the thicket increases.

Species group 11 (Table 3) contains species distributed in the coastal dune forest and the thicket community. This might be an indication of the tendency of the grasslands to develop into forest. The distribution of the thicket community within the coastal grassland would result in the thicket community being managed in the same way as the coastal grassland community and this would include annual fires.

7. *Syzygium cordatum-Hyperthelia dissoluta* woodland.

From the vegetation map (Figure 2a, b and c) the woodland communities seem to be distributed north of Black Rock and around the Kosi Lake System, to the north of the study area. The area north of Black Rock towards Banga Nek is densely populated, and signs of trampling by cattle were noted in some of the sample plots. Tinley (1985) noted that in the Dog Point area the vegetation is usually burnt at five year intervals. The coastal grassland further south is usually burnt annually. Woodland formation could therefore be the result of irregular burning (five year intervals). In the woodland areas, trees seem to be more widely spaced than in the thickets, but while the thickets consists of small clumps of trees in the grassland areas, the woodland consists of more evenly distributed trees (Figure 10).

Although the woodland areas around Lake Sibaya (Figure 2c) were not surveyed and are not included in the phytosociological table, they seem to have a different species composition than those found to the north of the study area (the tree *Terminalia sericea* seems to be prominent). This difference could be ascribed to a difference in soil type. Comparing a map of the geology with a map of the vegetation (Figure 2c), the woodland around Lake Sibaya seems to be restricted to calcarenite soils. Fire does not seem to occur annually in these woodlands.

A large number of MC endemic species was recorded in the woodland community. Management and maintenance of the woodland community include burning at about five year intervals.

8. *Parinari capensis* subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland.

Topography, slope and water table depth are some of the environmental factors by which the coastal grassland was differentiated. The absence of trees and shrubs and the dominance of grasses distinguish the grasslands from the forests, thickets and woodlands (Figure 10). A low water table depth differentiates the coastal grasslands from the hygrophilous grasslands (which has a high water table).

In work done on the grasslands of the eastern Shores of Lake St Lucia, Conlong & Van Wyk (1991) designated three indicator species in the grassland that occurs on dune ridges, namely *Helichrysum kraussii, Parinari capensis* subsp. *incohata* (then referred to as *Parinari curatellifolia*) and *Salacia kraussii.* These species were also found to be prominent in the coastal grasslands of the study area. The grasslands of the study area show similarities to the grasslands of Sodwana State Forest (Conlong & Van Wyk 1991). Grasses such as *Trachypogon spicatus, Themeda triandra* and *Urelytrum agropyroides* were also found to be prominent on the dunes in the grasslands of Sodwana State Forest. On abandoned fields in the Sodwana State Forest area, the shrub *Helichrysum kraussii* and grasses such as *Imperata cylindrica, Dactyloctenium geminatum* and *Perotis patens* were found. This compares well with the *Helichrysum kraussii-Melinis repens* subsp. *repens* community (8.1) found in areas with a dense human population within the study area.

Communities distinguished in the coastal grasslands of southern Mozambique (Myre 1964) agree with those in the study area. He distinguished a *Themeda triandra- Salacia krausii* community with the herb *Vernonia natalensis* prominent, and another variation of this association with *Parinari capensis* subsp. *incohata* (then referred to as *Parinari latifolium*) where *Polygala producta* (then referred to as *Polygala hottentota*) is prominent. He also refers to another alliance in the grassland where species such as *Urelytrum agropyroides* (then referred to as *Urelytrum squarrosum*) and *Trachypogon spicatus* is prominent. Myre (1964) ascribed changes in grassland to factors such as agriculture, grazing and fire.

Moll & White (1978) and White (1983) distinguished two broad types of grassland in the Tongaland-Pondoland Regional Mosaic, namely edaphically controlled grassland associated with scattered palms on badly drained sandy soils and secondary fire-maintained grassland that has replaced anthropogenically destroyed coastal dune forest. There is a rather abrupt change from coastal dune forest to coastal grassland. No obvious environmental changes occur in this area and it is therefore difficult to explain this abrupt transition from forest to grassland. Tinley (1982) described the grasslands of the Mozambique plain as sour occurring on leached sands, in comparison to the calcicole trees and shrubs found in the coastal dune forest on calcareous sands. The difference in sand is probably caused by the different impact that grassland and forest have on the soil. Conlong & Van Wyk (1991) classified the grasslands of the dune system of the KwaZulu Natal north coast as secondary grasslands created by clearing of coastal dune forest and maintained as such by regular fires and grazing. Hall (1981) even went as far as postulating that the vegetation of the coastal dunes before the arrival of the Early Iron Age settlers was dense evergreen forest. Weisser (1978), in work on the grasslands on the dunes between Richards Bay and the Mfolozi River, states that the grasslands of that area seem to be secondary, originating from forest clearing by the local inhabitants. Although this could be true of the grasslands to the south, this is not so for the grasslands of the study area.

The grasslands of the CFR are maintained by fire, but to consider them solely as the result of forest clearing can not be supported. In the study area alone the grassland covers about 9 826.2 ha (21 %) (Table 1), stretching from north of Lake Sibaya up to the Kosi Lake System. Coastal grassland extends about 20 km further inland outside the CFR (Moll 1980). Although there are a few small pans and marshes (near Mbibi and Black Rock), most of the area does not have any open water available. It would therefore be most unlikely that any people could stay in the area for long periods of time.

The only reason why the local inhabitants would clear forest would be to prepare small areas for subsistence farming. This has been recorded by Breen (1979) in the coastal dune forest on the east side of Lake Sibaya. He noted that within 17 years of the fields being abandoned, they had already been re-colonized. In some areas, for example near Mbibi and in

the Black Rock, Dog Point and Banga Nek area, where there is enough fresh water available to support human settlements, some of the grasslands were probably formed by destruction of the dune forest.

Topography could play a major role in the origin and the maintenance of the grasslands. The high dune barrier which originated in the quaternary period and the influence of winds could be one of the reasons for the drastic change in vegetation from coastal dune forest to coastal grassland, from east to west. The prevailing winds are usually from the east (from the sea blowing inland), either the north-east or south-east. Wind was probably one of the most important factors in the formation of the coastal dune ridge. The high vegetated coastal dune ridge now acts as a barrier against the wind, creating an area just to the inland side of the dune ridge, where there is little or no wind. Further inland from the coastal dune ridge the wind speed usually picks up again. Fires follow the direction of the wind and therefore would usually move inland either from the south or the north, but very seldom towards the sea (eastward). If a fire were to start in the dune forest it would be blown inland by the prevailing winds, without causing extensive damage to the dune forest. Fires started in the grassland would usually move inland (westward) with the prevailing wind. Were the fire to move towards the coastal dune forest, the wind still area created by the high dune ridge on the landward side would act as a barrier, slowing the speed and reducing the effect of the fire. Together with the lack of a high amount of dry material in the field layer of the coastal dune forest (which is usually moist), this might be one of the reasons why the dune forest very rarely burns.

Although more than one factor was most probably involved in the formation of coastal grassland, fire has certainly played one of the major roles. Hall (1981) suggested that before Early Iron Age settlement the extent of marshlands and alluvial flats were less extensive, with larger expanses of open water. It could therefore be possible that as soon as the water table dropped, grasslands (or woodlands) formed and were maintained as such by fires either induced by man or lightning. Edwards (1967) states that it is unlikely that fire was a major limiting factor on the vegetation, because of the high rainfall and humid climate of the area, which lacks a pronounced dry season with large fuel load accumulation. If Edward's

statement is correct it would be difficult to explain the adaptations to fire that are displayed by the vegetation. *Syzygium cordatum*, one of the most common species throughout the study area is fire resistant and some common species (for instance the palm *Phoenix reclinata*) show quick recovery after fire (Table 3). Other fire-maintained woody plants include *Brachylaena discolor* subsp. *discolor* var. *discolor, Strychnos spinosa, Strychnos madagascariensis* and *Garcinia livingstonei*. The high occurrence of geoxylic suffrutices or dwarf shrubs in the coastal grassland also suggests a long period of exposure to fire. White (1976b) states that suffrutex plants are able to avoid fires by means of their extensive underground root system with only annual or short-lived shoots above ground. Suffrutices seem to be most abundant in areas with a high frequency of less intense fires. Further evidence that fires must have had a long history of occurrence in the coastal grasslands, is the presence of five endemic suffrutice species in the coastal grassland of the study area. This suggests that the grasslands of the study area have been subjected to frequent fires over a long period of time, enabling the development of taxa with the suffrutex habit.

Although the frequency of fire has obviously increased owing to the presence of man, floristic and morphological evidence are clearly in favour of these coastal grasslands being a long standing fire-maintained component of the vegetation of Maputaland.

Coastal grassland is one of the most threatened vegetation types in Maputaland. The destruction of coastal grassland, mainly through afforestation and other agricultural activities, has diminished coastal grassland considerably in Maputaland. In the Western Shores area of St Lucia a 56 % decrease in grassland has been estimated, from 1937 to 1975 (Conlong & Van Wyk 1991). This reduction in grassland due to indigenous bush encroachment is ascribed to changes in management. Weisser & Marques (1979) ascribe a 86 % decrease in grassland in the area between Richards Bay and the Mfolozi River from 1937 to 1974, as being due to afforestation, the protection of these grasslands against fire by conservation authorities and the departure of the local inhabitants.

The majority of the roads in the CFR traverse the grassland. The quality of these roads is very poor and they deteriorate quickly. New ways around bad road patches are often

created by motorists, especially during the tourist season. Some work has been done by the KDNC to try and upgrade bad patches in the roads. The poor quality of the roads has deterred large numbers of tourists from travelling through the Reserve and restricted access to the privileged few who own four-wheel drive vehicles. The roads in the Mbibi area, which are used by two-wheel drive vehicles as well, seem to change regularly and each time a larger area of coastal grassland is destroyed. The ruggedness of the roads seems to fit the remoteness of the area, and appeals to the more adventurous tourists and their present condition should be retained. Some way of upgrading the bad patches of these roads should be implemented however, in order to prevent further destruction of coastal grassland.

The coastal grassland of the CFR is rich in plant diversity and contains a large number of MC endemic species, it is also a rare community in South Africa. Although it has been considered to be secondary grassland by previous authors, this view is not supported here. The maintenance of coastal grasslands in the study area is crucial to the conservation of the biodiversity of the area. Conservation of the coastal grasslands of the study area depends on effective management by conservation bodies as well as strict control and monitoring of those agricultural practices such as afforestation which destroy grasslands. Effective management of the coastal grassland would include the continuation of annual burning.

9. *Ischaemum fasciculatum-Centella asiatica* hygrophilous grassland.

This community is distinguished from the coastal grassland community by its very high (≤ 2 m) water table. The water table fluctuates according to rainfall, which results in the soil being water-logged for different periods of time. Soils are sandy and rich in humus. Topographically this community occurs in low lying areas or inter-dune depressions with a low altitude. The water table level in the hygrophilous grassland communities should therefore always be lower than in the coastal grasslands. The hygrophilous community was differentiated into two communities, one of which has three sub-communities on the basis of water table depth and floristic composition (Table 3). Because of the influence of rainfall on the water table level, the hygrophilous grassland communities would vary according to rainfall. It should still be possible to distinguish the different hygrophilous communities by water table

level.

Myre (1964) distinguished a grassland type which occurs in depressions on the plains of southern Mozambique where rainwater is not retained for long periods on the soil surface and where the soil is humus rich and sandy. He states that *Themeda triandra* forms associations with *Ischaemum arcuatum* (*Ischaemum fasciculatum*), *Eragrostis capensis* or *Monocymbium ceresiiforme* in these habitats. This community is very similar to the *Themeda triandra -Monocymbium ceresiiforme* (9.1.1) community of the present study with an estimated water table level of about 2 m. On the margins of water courses, lakes and marshy depressions, Myre (1964) distinguished grasslands dominated by *Ischaemum fasciculatum* (then referred to as *Ischaemum arcuatum*) associated with various species of the Cyperaceae. The soil usually remains water-logged for long periods of time. This community is similar to the *Brachiaria arrecta-Hemarthria altissima* community (9.2) found in this study, with an average water table level of 0.1 m. On soils that are not water-logged for long periods of time he distinguished an association of *Ischaemum fasciculatum* (then referred to as *Ischaemum arcuatum*) with *Imperata cylindrica.* This community is similar to the *Ischaemum fasciculatum-Hydrocotyle bonariensis* community found in the study area with an average water table level of 0.85 m, where *Imperata cylindrica* has also been found to be prominent.

Work on the hygrophilous grasslands of the Eastern shores of Lake St Lucia (Conlong & Van Wyk 1991) also shows similarities with what was found in the study area. *Centella asiatica* was found to be the most common in dune slacks, with communities dominated by species such as *Ischaemum fasciculatum* and *Sporobolus subtilis*. Conlong & Van Wyk (1991) found that where depressions were only seasonally flooded the soil shows characteristics of partial gleying, and in depressions where the soil is permanently flooded it shows characteristics of complete gleying with a higher content of organic material. They ascribed species distribution and palatability to geomorphology and soil formation, which seem to be directly correlated with water table depth.

One of the biggest threats to the hygrophilous grassland of the study area would be a drop in the water table level. This could be caused by afforestation (as discussed under 1.

Pinus elliottii-Chromolaena odorata disturbed areas). Another threat lies in the planned extraction of peat for fuel production from specific hygrophilous communities (Grundling, P. 1996, Personal communication. Council of Geoscience. Private Bag X112, Pretoria). The hygrophilous grassland of the study area forms an important part of the wetland catchment areas of both the Kosi Lake System and Lake Sibaya. Reasons for the conservation of wetlands include maintenance of genetic and biodiversity, maintenance of life support systems (functions of wetlands as sponges, buffering floods, improving water quality) and maintenance for sustained utilization (high primary productivity) (Taylor & Cunningham 1983). Management of the hygrophilous grassland should be aimed at the prevention and close monitoring of practices which might influence the water table level.

10. *Nephrolepis biserrata-Ficus trichopoda* swamp forest.

Swamp forest is mostly restricted to the northern part of the study area around the small streams and rivers entering the Kosi Lake System, but it also occurs in the south of the study area close to Shazibe Pan. Swamp forest occurs only in isolated patches in the rest of the grassland and palm veld areas of Maputaland (Moll 1980). *Ficus trichopoda, Syzygium cordatum, Voacanga thouarsii* and *Podocarpus falcatus* were also found by Moll (1980) to be common and widespread in the swamp forest. A feature of the swamp forest in the CFR is the stands of the large monocarpic palm *Raphia australis* (also a MC endemic) around Lake Amanzimnyama.

Weisser (1989) rated swamp forest as one of the first priorities for conservation in the area because of its function in retaining banks along the water courses. Swamp forest could also be seen as part of the wetlands of the study area and probably plays a large role in the improvement of water quality by filtering out nutrients and sediments. Swamp forest has almost totally been destroyed on the outside of the Reserve by the local people, primarily for the small-scale cultivation of bananas. Management of the swamp forest should concentrate on the prevention of any further destruction of this rare community.

11. Mangrove community.

Six mangrove species occur in the tidal basin of the Kosi Lake System: *Acrostichum aureum, Avicennia marina, Bruguiera gymnorrhiza, Ceriops tagal, Lumnitzera racemosa* and *Rhizophora mucronata* (Steinke 1995). *Ceriops tagal* and *Lumnitzera racemosa* are at the southernmost limit of their distribution and Kosi Bay is therefore the only place in South Africa where they occur (Weisser 1989). The mangrove community of the Kosi Lake System is the third largest mangrove community in South Africa , covering an area in extent of 59 ha (Ward & Steinke 1982). From the vegetation map (Figure 2), the size of the mangrove community was calculated to be 75.9 ha. This difference in size may well be a result of the difficulty in distinguishing between the mangrove community and the communities that surrounds it, on ortho-photographs, but on the other hand it is possible that the mangrove community has increased in size since Ward & Steinke's (1982) work.

Mangroves fulfill important functions as breeding and feeding grounds for marine species and also protect shorelines against erosion. Mangroves provide a source of reduced carbon in the form of leaves, wood and other litter that falls from the trees and contributes to detritus-based food chains in estuaries (Steinke 1995). During 1965/1966 a mass mortality of the Kosi Bay mangrove community occurred. This was caused by a rise in lake levels, as a result of the closing of Kosi Mouth (Ward *et al.* 1986). The closing of Kosi Mouth was a natural occurrence, and conservation bodies should decide what to do if a similar situation occurs in the future. From the author's viewpoint the best action to take if Kosi Mouth is closed naturally is to let the natural processes take their course. Cooper (1968) states that the mangrove community is threatened by the cutting down of mangroves by the local people for making guide fences for their fish traps. Ward *et al.* (1986) suggested controlled utilization of mangroves in the Kosi Lake System, with a sanctuary set aside, where no undue human activity like the making of fires, cutting of plants and excavation of crabs is permitted. Management of the mangrove community would include controlled utilization as well as the maintenance of the natural hydrological processes that occur in the Kosi Lake System.

12. *Casuarina equisetifolia* afforestation on drift sand areas near the coast.

Casuarina equisetifolia afforestation was started by State Forestry, who controlled the study area in the 1950s. KwaZulu Forestry continued with the planting of casuarina on bare sand areas when they took over control of the area in the 1970s. The casuarina is a pine-like angiosperm with wind and water dispersed seeds and occurs naturally on Indo-Pacific Islands. It is not an aggressive invader, but its dense growth, shade and heavy leaf litter inhibits succession of natural forest (Tinley 1985). Very few other plants grow within the casuarina stands. In the study area bare sand patches or sand blows seem to occur naturally on the coastal dune ridge. The only reason why casuarina was planted in these areas was probably to prevent local destruction of coastal dune forest by being covered by sand. Removal of casuarina plants from the dunes has been taking place on a small, experimental scale in the Mbibi area. Management of the casuarina stands would include the harvesting of the plantations so that drift sand can re-assume their natural geomorphic functions or so that natural vegetation could become re-established in these areas. Ward (1989) mapped the casuarina areas in the CFR and compiled a report on how they should be managed. He provides excellent management recommendations and specify which areas are too sensitive to be cleared, and which areas can be cleared without any detrimental effect on the indigenous forests. Research in the re-establishment of natural forest within the areas where the casuarina forests are harvested is currently being undertaken by the terrestrial research staff of the KDNC.

6.2 Veld condition assessment and grazing capacity

Veld condition trends and grazing capacity were determined for the *Syzygium cordatum-Hyperthelia dissoluta* woodland, *Parinari capensis* subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland and *Ischaemum fasciculatum-Centella asiatica* hygrophilous grassland communities of the study area (Table 8; Figure 2). The grazing capacity of the smaller communities into which the woodland, coastal grassland and hygrophilous grassland communities have been divided could not be calculated because the areas that these smaller communities occupy could not be determined from the vegetation map (Figure 2; Table 1).

Table 8. Percentage distribution of Decreasers & Increasers in the different plant communities

Community number (see text)	Decreaser	Increaser 1	Increaser 2a,b	Increaser 2c	Ecological Index
7	21.2	22.8	47.9	8.1	571.3
7.1	32.97	7.9	49.47	9.67	592.6
7.2	11.4	29.1	40.17	19.33	497.7
8	21.3	16.9	56.1	5.7	561.4
8.1	16.39	14.52	57.59	11.5	507.4
8.2	23.42	8.84	58.96	8.77	540.7
8.3	25.53	19.54	51.52	3.41	601.6
8.4	19.34	23.08	57.45	0.13	584.9
9	30	3.7	61	5.3	575.2
9.1	32.54	4.61	55.84	6.99	588
9.1.1	52.14	4.64	33.94	9.28	698.9
9.1.2	34.4	7.6	54	4	617.2
9.1.3	25.4	3.61	63.76	7.23	541.5
9.2	22	1	77	0	535

The vegetation map was digitized from ortho-photographs and from these it was impossible to distinguish the areas occupied by the different communities within the woodland, coastal grassland and hygrophilous grassland communities.

The CFR must be seen as an open system because most of the area has not yet been fenced. In the northern part of the CFR around the Kosi Lake System, where a fence has been put up, uncontrolled grazing by cattle and goats is still allowed. Grazing by hippopotamus occurs in the areas surrounding Lake Sibaya and the Kosi Lake System. During aerial counts in 1995, 130 hippopotamus were counted at Lake Sibaya, and 54 at the Kosi Lake System. In some areas, usually in close proximity to human settlements, signs of trampling and grazing by cattle has been noticed.

6.2.1 Veld condition assessment

Veld condition assessment was done by comparing the relative dominance of Decreaser and Increaser grass species (Trollope *et al.* 1989) and calculating the ecological index of each community (Vorster 1982). The overall veld condition seems to be good with high ecological indexes calculated for the woodland (7), coastal grassland (8) and hygrophilous grassland (9) communities.

Syzygium cordatum-Hyperthelia dissoluta woodland (community 7, Table 3; Figure 2).

The ecological index of this community is 571.3, which is higher than that of the coastal grassland community, but lower than that of the hygrophilous grassland community. This community has a high average percentage of Increaser 1 species, which could indicate underutilisation or selective grazing. Grass species like *Hyperthelia dissoluta* become dominant as a result of underutilisation or selective grazing, which causes grasses to become unpalatable in the absence of regular burning (Trollope *et al.* 1989). This supports the view that the pattern of the woodland communities is probably the result of irregular burning frequencies. A difference in Increaser and Decreaser species composition and ecological index of the two types of woodlands distinguished from the phytosociological table (Table 3) is

apparent (Table 8). The *Syzygium cordatum-Digitaria natalensis* woodland (7.1), usually found on the slopes of dunes, has the highest ecological index of the woodland communities (592.6) which is probably the result of a high percentage of Decreaser species, which indicate good veld condition. The *Syzygium cordatum-Wahlenbergia abyssinica* subsp. *abyssinica* (7.2) woodland, which is usually situated on the crests of dunes, has a the lowest ecological index of the woodland communities (497.7) as a result of a high percentage of Increaser 1 species. This could be interpreted as an indication of underutilisation or selective grazing, probably a result of unpalatability caused by nutrient poor sandy soils or a very low water table. It could also be that the cattle prefer grazing on the slopes and bottom of dunes, because they have to expend too much energy to get to the crest of the dunes.

Parinari capensis subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland (community 8, Table 3; Figure 2).

The ecological index of this community is 561.4, which is lower than that of the woodland and hygrophilous grassland communities. This is probably the result of a high percentage of Increaser 2a and 2b species, which could indicate light to moderate over utilisation. A difference in Increaser and Decreaser species composition and ecological index (Table 8) is apparent in the four types of coastal grasslands distinguished from the phytosociological table (Table 3). The *Helichrysum kraussii-Melinis repens* subsp. *repens* (8.1) coastal grassland, which is found on the slopes of dunes with signs of grazing pressure, has the lowest ecological index of the coastal grassland communities (507.4) caused by a low percentage of Decreaser species and a high percentage of Increaser 2a and 2b species, which could be seen as a result of over utilisation in areas close to human settlements. The *Vernonia natalensis-Polygala producta* (8.2) coastal grassland, usually found low on the slopes of dunes with a more gradual gradient, has a relatively low ecological index if compared to the other coastal grassland communities (540.7) caused by a high percentage of Increaser 2a and 2b species, which could indicate light to moderate over utilisation. The *Vernonia oligocephala-Diheteropogon amplectens* (8.3) coastal grassland, found higher on the slopes of dunes, has the highest ecological index of the coastal grassland communities (601.6) caused by a high percentage of Decreaser species, indicating good veld condition. Although the *Cymbopogon*

plurinodis-Asclepias affinis (8.4) coastal grassland on the crests of dunes has a high ecological index if compared to the other coastal grassland communities (584.9) it has a high percentage of Increaser 1 species, which could indicate that although the veld condition is good the community is understocked or selectively grazed. This is probably the result of a very low estimated water table and high woody species composition.

In both the grassland and the woodland cluster of communities, the communities found on the crests of the dunes are underutilised or selectively grazed. Another possible explanation for the underutilisation and unpalatability of the grass on the dune crests, other than deep nutrient poor sandy soils with a high woody species content, could be fire intensity. It is possible that fires do not burn very intensely (and might even be absent in some circumstances) on the crest of dunes, possibly because winds are stronger at this level. A less intense fire or the absence of fire would result in the establishment of woody species and the grass species becoming unpalatable on the crests of dunes. This would support the deductions mentioned earlier on the formation of thicket areas. Thicket areas were found to be the result of localized absence of fire and are usually found on the crest or high on the sides of dunes.

Ischaemum fasciculatum-Centella asiatica hygrophilous grassland (community 9, Table 3; Figure 2).

The ecological index of this community is 575.2 which is higher than that of the coastal grassland and woodland communities. This is caused by a high average percentage of Decreaser species (Table 8), and indicates a relatively good veld condition, which is probably a result of the high water table level of this community. The *Themeda triandra-Monocymbium ceresiiforme* (9.1.1) hygrophilous grassland, with an estimated water table level of 2 m and the *Ischaemum fasciculatum-Fuirena umbellata* (9.1.2) hygrophilous grassland, with an average water table level of 1.15 m, if compared with the other hygrophilous grassland communities, have high ecological indexes of 698.9 and 617.2 respectively. This is a result of high percentages of Decreaser species and an indication of good veld condition. However the *Ischaemum fasciculatum-Hydrocotyle bonariensis* (9.1.3) hygrophilous grassland, with an average water table level of 0.85 m and the *Brachiaria arrecta-Hemarthria altissima* (9.2)

hygrophilous grassland, with an average water table level of 0.1 m, both have lower ecological indexes of 541.5 and 535 respectively. This is a result of high percentages of Increaser 2a,b species, which is usually seen as an indication of light to moderate over utilisation, but is probably caused by the regular inundation of this communities by water.

6.2.2 Grazing capacity

The mean grazing capacity for the woodland, coastal grassland and hygrophilous grassland communities of the study area, during an average rainfall year, was 2.9 ha/LSU (cattle) (Table 5). Because the CFR is an open system, cattle can still move in and out of the area in search of grazing. The number of cattle that graze within the CFR is therefore never stable, but is estimated to be in the region of about 3 500. Although signs of overgrazing and trampling were noted in some areas, the grazing capacity figures of the study area are very good. The grazing capacity of the study area is higher than what was recorded by Matthews *et al.* (1995) in the Malongane concession area in the coastal area of southern Mozambique. In the Malongane area human impact is low and grazing by cattle is absent. This could indicate that utilization and burning of the grassland and woodland areas of the study area improved veld condition and increased the grazing capacity. To facilitate future monitoring and photographing of veld condition trends, average biomass and grazing capacity, permanent points have been established in conjunction with research staff of the KDNC. These permanent points were established at selected sites in the different habitat and vegetation types and will be monitored annually by the research staff of the KDNC to detect and monitor any changes in habitat or vegetation. If negative trends in veld condition are noticed in future, some means of controlling the number of cattle should be implemented.

If the CFR is ever fully fenced, measures to control the movement of cattle in and out of the Reserve should be implemented. From the grazing capacity figures it has been calculated that if the CFR is fenced it could provide sustainable grazing for about 3 980 head of cattle and still be able to accommodate the current hippopotamus population. At the moment, the number of cattle that graze within the reserve seems to be well below the number the Reserve can sustain. Although some areas might show signs of over-utilization, it is

probably the result of close proximity to human settlements.

6.3 Flora

The study area is very rich in plant species diversity. The checklist of vascular plants of the study area contains 1 164 species, which is 47 % of the estimated 2 500 plant species that occur in the MC. As the study area only covers a small part (1.7 %) of the MC, the number of species recorded in the study area is highly significant.

Plant collection sites are distributed uniformly throughout the study area. Accessibility seems to be very important in the distribution of collection sites, as the majority of sampling has been done in areas that are easily accessible to vehicles. Sampling sites seem to follow the roads in the CFR, with at least 20 collections at most of the picnic spots or campsites (Figure 7). Another explanation for the distribution of collection sites could be that plant collectors sometimes do not give an accurate reference for a collection site. This is particularly the case in an area like the CFR, where most specific local place names may not have been known to visiting plant collectors. It could therefore be possible that although they might have indicated that they have sampled at a certain place, the actual sample site might be a few kilometres away from the place indicated. It is therefore difficult to identify small areas which are rich in species diversity. Reference to plant collection sites by means of latitude and longitude as recorded by means of a Global Positioning System [GPS] gives much more accurate positional data. A GPS was used in the recording of plant collection sites during this study and proved accurate and easy to use. Although this data has been included in maps of the distribution of collection sites, a lot more data will be needed for more accurate determining of areas that are rich in species.

MC endemic species collection sites are distributed uniformly throughout the study area. The distribution of collection sites of MC endemic species in the study area shows a clear correlation with number of plants collected at a collection site (Figures 7 & 8). Places where a lot of collecting has been done, as at Manzengwenya and Kosi Bay also boast a large number of MC endemics.

Based on distribution of MC endemics, the coastal dune forest (4), inland forests (5), thicket (6), woodland (7), coastal (8) and hygrophilous grassland (9) were identified as communities rich in endemic species (see 5.4). These communities should enjoy a high conservation priority. The importance of the conservation of the coastal grassland is reinforced by the high number of 12 MC endemic species that seems to be restricted to this community. A possible reason why such a high number of MC endemic species (24) was collected in the woodland areas could be because species endemic to both the forest and grassland communities occur in this community. Although a lot of MC endemics have been recorded in the coastal dune forest and inland forests, few of them seem to be restricted to these communities, and several can also be found in the thicket and woodland areas as well.

In the past the following communities in the CFR have been prioritized for conservation as unique and sensitive: swamp forest, mangrove community, *Encephalartos ferox* colonies, the dune pioneer community and the coastal dune forest on the eastern shores of Lake Sibaya (Anonymous 1995). Weisser (1989), in work done on the conservation priorities of the dune area between the Mozambique border and Sodwana, has distinguished and mapped areas with a first, second and third priority rating for conservation. His findings revealed that most of the area is covered by vegetation with a first priority for conservation. The majority of the coastal grassland areas of the area however, have been given second priority for conservation by Weisser (1989). In view of the findings of the present study, this view can no longer be maintained, and a first priority rating must be given to the coastal grassland.

The importance of the coastal grassland for conservation is proved by the large number of MC endemic species that are found in the grassland communities of the study area. Most of the plants that occur in the grassland areas show resistance to fire or recover quickly after fires, for example *Syzygium cordatum, Phoenix reclinata, Brachylaena discolor* subsp. *discolor* var. *discolor, Strychnos spinosa, Strychnos madagascariensis* and *Garcinia livingstonei.* The geoxylic suffrutex or dwarf shrub growth form may be considered an adaptation to avoid fires by having an extensive underground root system with only short-lived shoots above ground. The high number of geoxylic suffrutices in the coastal grasslands also

suggests an extended period of exposure to fire. Five of the MC endemics associated with coastal grassland are geoxylic suffrutices. Views of the past which considered the coastal grassland communities as anthropogenic, i.e. secondary communities which were established in areas where forests were cleared, and therefore worthy only of a low conservation priority, are contradicted by the evidence presented in this study. Future management of the CFR should include the coastal grasslands as one of the priority areas for conservation.

CHAPTER 7

CONCLUSIONS

Vegetation

- Vegetation of the study area can be divided into at least 12 major plant communities. Some of these communities were further divided into plant communities and sub-communities giving a total of 27 plant communities and 3 sub-communities (Table 3).
- Plant communities were classified according to species composition and relationships shown with topography, slope, water table level and human impact through forest clearing, fire and grazing and trampling by cattle.
- A georeferenced vegetation map, depicting the distribution of all the plant communities, has been produced. This can be used in the management of the Kosi Bay Coastal Forest Reserve [CFR].
- Plant communities have been found to occur along a gradient from the coast with its dune pioneer community, inland to hygrophilous grassland and swamp forest communities, associated with fresh water and a high water table level.
- Beach pioneer and dune scrub thicket communities that occur near the sea are influenced by strong winds and high levels of salt spray.
- Coastal dune forest occurs further away from the sea on the landward sides of dunes where there is less effect from strong winds and salt spray, on alkaline calcarenite sands which have unique water holding capabilities.
- Further inland from the coast, forests are found in the proximity of water bodies. Some of these forests seem to be the remaining patches of much larger forests which were reduced by human impact through forest clearing.
- Thicket areas are found inland from the coastal dune forest, and occur in patches throughout the coastal grassland community. Thickets seem to develop in the coastal grassland areas as a result of the localized absence or low frequency of fire. Woody plants establish themselves on the crests and slopes of dunes, which have a very low estimated water table level, in the absence of fire.

- Woodland communities occur in the north of the study area around the Kosi Lake System on the crests and slopes of dunes with a low water table level. The woodlands seem to have developed as a result of irregular burning (at about five year intervals), together with a high human impact.
- Coastal grassland is found inland from the coastal dune forest on the crests, slopes and bottom of dunes with a low estimated water table. Coastal grassland seems to be maintained by annual burning.
- Hygrophilous grassland occurs in low lying areas or inter dune depressions often close to lakes or pans with a high average water table level.
- Swamp forest communities occur in close proximity to small streams around the Kosi Lake System and near Shazibe Pan.
- A disturbed area community was distinguished outside the boundary of the CFR where the coastal grassland have been replaced by pine and eucalypt afforestation.

Veld condition and grazing capacity

- The majority of the woodland and grassland areas are in very good condition, with a few communities being underutilized and only a few places being overutilized.
- A high average grazing capacity of 2.9 ha/LSU (cattle) for an average rainfall year was calculated for the woodland and grassland communities.
- Present management and maintenance of the woodland and grassland communities of the study area, which includes grazing by cattle and burning by the local people, is effective in maintaining a good veld condition.

Flora

- A checklist of the plant species recorded in the study area was compiled. This contains 1 164 species and infra specific taxa. At least 71 of the 225 plant species endemic to the MC have been recorded in the study area. It is clear that the study area forms a unique part of the MC.
- High numbers of MC endemic plant species have been recorded in the woodland, inland forest and coastal dune forest and in the coastal grassland areas, emphasizing the importance of the conservation of these communities.

- The importance of the conservation of the coastal grassland communities of the study area, which in the past were treated as areas with a low conservation status, as they were believed to be secondary communities, has been demonstrated by the large number of MC endemic species restricted to them.

General

- The study area has high eco-tourism potential, offering excellent fishing in the Kosi Lake System and the sea, very good snorkelling at Kosi Mouth and the safe bays of Mbibi and LalaNek and superb bird watching.
- The beaches of the CFR are one of the few places in the world where the giant leatherback and loggerhead sea turtles can be observed, laying eggs on the beaches in the summer months.
- The local inhabitants of the area are dependent on their environment for survival. Their fish kraals in the Kosi Lake System not only ensure a consistent supply of fish, but also are tourist attractions which demonstrate the harmony between man and nature. Fish, crabs, red bait and mussels collected from the sea provide food for the people of the area.
- The people of the area are dependent on the vegetation for grazing for their cattle, food, building material and medicine.
- To maintain this unique area as a tourist destination with sustainable resources for the local inhabitants whilst still maintaining the present diversity in plant communities and plant species richness, effective management must be applied.

CHAPTER 8

MANAGEMENT RECOMMENDATIONS

- Management of the vegetation of the study area should be aimed at the maintenance of the present plant communities and species richness. The grassland and woodland communities seem to be in good condition, with very few signs of over-utilization.
- Although there is no burning policy for the Kosi Bay Coastal Forest Reserve [CFR] at the moment, the present application of burning of the grassland (which include the thickets distributed in the grasslands) and woodland areas by the local people of the area is effective enough to maintain present species diversity. Monitoring of the frequency of fires and the areas that are burned should be carried out. Information on the effects of fire on the grassland and woodland areas should contribute towards the development of a burning program for the CFR.
- Management of the forest areas (swamp, inland and coastal dune forest) should include the prevention of further forest destruction.
- If small scale sustainable utilization by the local people is allowed, it should be carefully monitored.
- Development of tourist facilities within the different natural plant communities should be minimized and preceded by proper environmental impact assessments.
- Areas which are already disturbed, for instance the *Casuarina equisetifolia* stands, should be used for the development of tourist facilities, if possible.
- In order to maintain the diversity in plant communities and plant species richness, the CFR should not be managed as a single homogeneous unit. Managers should note the differences in the specific plant communities of the area and their relation with environmental and biotic factors.
- The following recommendations are related to specific plant communities:

1. *Pinus elliottii-Chromolaena odorata* disturbed areas.

This community forms part of the afforested areas. Although all the plantations occur outside

the boundaries of the CFR, they could have serious long-term detrimental effects on the vegetation of the CFR through their impact on the water table level and through competition from alien/exotic plants. Careful monitoring of afforestation and some means of control should be implemented if necessary, in the KwaZibi and Nkumende areas in particular, where private land is being used for afforestation. Research requirements for the sound management of the area include an investigation of the effect that afforestation has on the surrounding natural vegetation through their impact on the hydrology of the area, as well as the dispersal of alien plants.

2. *Scaevola plumieri-Gazania rigens* var. *uniflora* dune pioneer community.

This community plays an important role in stabilizing the foredune areas and protects the dune scrub thicket community (3) to a certain extent against harsh environmental conditions. It also serves as a nesting site for leatherback and loggerhead turtles. Strict control should be kept over beach driving or other human activities on the beach.

3. *Eugenia capensis-Euclea natalensis* subsp. *natalensis* coastal scrub thicket.

Destruction of this community should be prevented, as it stabilizes the dune sand and provides shelter for the coastal dune forest against wind blown sand and salt spray. When roads or footpaths have to be made, care should be taken not to cut them in line with the prevailing winds as this would create sand blows which could have a seriously detrimental effect on the coastal dune forest.

4. *Peddia africana-Diospyros inhacaensis* coastal dune forest.

The importance of the conservation of the coastal dune forest of the study area, which is said to contain amongst the highest vegetated dunes in the world, has been emphasized by various authors in the past (Venter 1974; Breen 1971 & 1979; Moll 1980; Tinley 1985; Weisser 1980 & 1989; Weisser & Cooper 1993). A large number of plant species endemic to the MC have

been recorded in this community. Destruction of coastal dune forest should be prevented, especially the clearing of areas for agriculture.

5. *Tricalysia delagoensis-Dialium schlechteri* inland forest.

The inland forests of the area are very vulnerable to forest destruction. They are rich in species and contain a large number of species endemic to the MC. Conservation bodies should try to gain some control over the inland forests that occur outside the CFR, especially those that occur around Lake Sibaya, to prevent private tourism enterprises and the local community from damaging the forests.

6. *Syzygium cordatum-Canthium inerme* thicket.

Thickets should have a high conservation priority as they are rich in species and many MC endemic species, which usually occur in forest or grassland communities, have been recorded. As thickets are distributed throughout the coastal grassland areas it would be impossible to manage it in a different way than the coastal grasslands. Management of the coastal grassland includes annual burning by the people of the area, because thickets contain plant species that is fire resistant and do not contain a lot of dry material or grass, they usually survive the fires.

7. *Syzygium cordatum-Hyperthelia dissoluta* woodland.

The woodland is rich in species diversity and contains a high number of MC endemic species. Management of the woodland area should include an irregular frequency of burning (probably at about five year intervals). If the CFR is fenced the number of cattle or game should be kept below the grazing capacity (Table 5) of this community. The present veld condition of the woodlands is good and there is no specific need for a burning program at the moment.

8. *Parinari capensis* subsp. *incohata-Diospyros lycioides* subsp. *sericea* coastal grassland.

A high number of plant species endemic to the MC has been recorded in the coastal grassland community, of which nine occur there exclusively (the highest number for any community). The coastal grassland communities should therefore be given a high conservation priority. Management and maintenance of the coastal grassland include annual burning. If the CFR is fenced the number of cattle or game should be controlled according to the grazing capacity (Table 5) of this community, to ensure good veld condition. The present veld condition of the coastal grassland is very good, although some over-utilization is apparent in specific areas, usually in close proximity to human settlements. The coastal grassland is maintained at the moment by annual burning by the local people of the area, and there is no specific need for a burning program. Some way of upgrading the bad patches in the roads of the Reserve should be implemented in order to prevent further destruction of coastal grassland.

9. *Ischaemum fasciculatum-Centella asiatica* hygrophilous grassland.

A moderate number of MC endemic species has been recorded in this community and six species are restricted to it. The hygrophilous grassland communities form part of the catchment areas of the Kosi Lake System and Lake Sibaya and act as sponges, buffering floods and improving water quality. Management of this community should include regular monitoring of the water table and controlling afforestation that could result in a drop of the water table level. Practices that could destroy this community, like the extraction of peat for fuel production must be prevented. If the CFR is fenced the number of cattle or game should be kept below the grazing capacity (Table 5) of this community. The veld condition of this community is very good at the moment.

10. *Nephrolepis biserrata-Ficus trichopoda* swamp forest.

Only a small number of MC endemic species have been recorded in this community, but the reason could be because very little plant collection has been done in the swamp forest areas

because of their inaccessibility and remoteness. The swamp forest communities of the study area forms 75 % of all the swamp forest found in South Africa and fulfill an important role in the retention of the banks of small streams. Management of the swamp forest community should be aimed at the prevention of further destruction of swamp forest.

11. Mangrove community.

The mangrove community has been recognized as a unique and sensitive community and should be maintained as such. Management of the mangrove community would include controlled utilization, which should be carefully monitored. The hydrological processes that occur within the system should be maintained and monitored.

12. *Casuarina equisetifolia* afforestation.

Management of the casuarina stands would include the harvesting of the plantations so that drift sands can re-assume their natural geomorphic functions and so that natural vegetation can become re-established in these areas. Following the removal of the casuarina stands, replanting of the exposed bare sites with indigenous plant species might be advisable to speed up natural succession. When the development of tourist facilities is planned, the casuarina stands should be considered first, as the development of these areas would have a low impact on the natural vegetation.

SUMMARY

Vegetation and flora of the Kosi Bay Coastal Forest Reserve in Maputaland, northern KwaZulu-Natal, South Africa.

by

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for the degree

MAGISTER SCIENTIAE

The aims of this study were to classify and describe the vegetation of the study area, to compile a detailed vegetation map of the area, determine veld condition and grazing capacity, compile a checklist for the vascular plants of the area with emphasis on the distribution of species endemic to the Maputaland Centre of endemism [MC], determine priority conservation areas and propose management guidelines to ensure the preservation of the floristic diversity of the area.

The study area was stratified into relatively homogeneous vegetation units by using aerial photographs (1: 50 000). The position of sample plots was chosen subjectively within each of these stratification units. A total of 200 sample plots were surveyed over the area. A floristic survey according to the Braun-Blanquet methodology and a habitat survey was carried out. This data was classified by means of TWINSPAN and refined by Braun-Blanquet procedures.

The classification of the floristic data resulted in the identification of 12 major plant

communities distributed along a gradient from the inland communities associated with a high water table, to coastal communities adapted to survive under harsh conditions with strong winds and salt spray. Some of these communities were further divided into plant communities and sub-communities giving a total of 27 plant communities and 3 sub-communities, according to differences in species composition and habitat properties, such as topography, water table depth, slope, human impact through fire and grazing by cattle, as well as impact from the wind and salt spray. A vegetation map of the study area was compiled using a Geographical Information System [GIS].

Veld condition trends seem to indicate that the majority of grassland and woodland areas are in good condition. A high average grazing capacity of 2.9 ha/LSU (cattle) for an average rainfall year was calculated for the woodland and grassland communities. The present management and maintenance of the woodland and grassland communities of the study area, which include grazing by cattle and burning by the local people, is effective in maintaining the veld in good condition.

A plant species database was compiled for the study area using data from various herbarium collections. From this database a checklist of vascular plants of the Kosi Bay Coastal Forest Reserve [CFR] was compiled. This checklist contains 1 164 species, which is 47 % of the estimated 2 500 plant species that occur in Maputaland. This is highly significant as the study area only covers 1.7 % of the MC. Seventy one of these species are endemic to the MC. The distribution of these endemic species was mapped and related to the different plant communities of the area in order to determine priority conservation areas. The largest number of MC endemic plant species which only occurs in one community was found in the coastal grassland community. This reinforces the importance of the conservation of the coastal grassland. Guidelines for future conservation and management of the various vegetation types and species richness of the area were proposed.

OPSOMMING

Plantegroei en flora van die Kosi Bay Coastal Forest Reserve in Maputaland, noord Kwazulu-Natal, Suid-Afrika.

deur

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Voorgelê ter vervulling van die vereistes vir die graad

MAGISTER SCIENTIAE

Die doel van hierdie studie was om die plantegroei van die studiegebied te klassifiseer en te beskryf, om 'n gedetaileerde plantegroeikaart van die gebied op te stel, die veldtoestand en weidingskapasiteit vas te stel, 'n plantspesielys van die blomplante van die gebied op te stel, met klem op die plantspesies endemies tot die Maputaland Sentrum van endemisme [MS], om prioriteits bewaringsgebiede vas te stel en om bestuursriglyne voor te stel om die floristiese diversiteit van die gebied te verseker.

Die studiegebied is gestratifiseer in relatief homogene plantegroei-eenhede, met behulp van lugfoto's (1: 50 000). Monsterpersele is subjektief uitgeplaas in elk van die gestratifiseerde eenhede. In totaal is 200 monsterpersele oor die gebied uitgeplaas. 'n Floristiese opname volgens die Braun-Blanquetmetode en 'n habitatopname is uitgevoer. Hierdie data is met behulp van TWINSPAN geklassifiseer en die tabel is deur Braun-Blanquet prosedures verfyn.

Die resultaat van die klassifikasie van die floristiese data was die identifikasie van 12 hoof plantgemeenskappe, versprei oor 'n gradiënt vanaf die binnelandse plantgemeenskappe wat geassosieer is met 'n hoë watertafel, na die see met plantgemeenskappe wat aangepas is

vir oorlewing onder ekstreme toestande met sterk winde en soutsproei. Party van hierdie gemeenskappe is verder in plantgemeenskappe en subgemeenskappe verdeel om 'n totaal van 27 plantgemeenskappe en 3 subgemeenskappe te gee, na gelang van verskille in spesie samestelling en habitat eienskappe soos topografie, diepte van die watertafel, helling, impak van die mens deur vuur en weiding van beeste en impak van die wind en soutsproei. 'n Plantegroeikaart van die gebied is saamgestel deur gebruikmaking van 'n Geografiese Inligting Sisteem [GIS].

Uit die neiging van die veldtoestand blyk dit dat die meeste grasveld en boomveld gebiede in 'n goeie toestand is. 'n Hoë gemiddelde weidingskapasiteit van 2.9 ha/GVE (beeste) vir 'n gemiddelde reënval jaar is vasgestel vir die boomveld en grasveld-gemeenskappe. Die bestuur en bewaring van die boomveld en grasveld gemeenskappe van die studiegebied, wat die beweiding deur beeste en brande deur die mense van die gebied insluit, is tans effektief in die behoud van 'n goeie veldtoestand.

'n Plantspesiedatabank is saamgestel vir die studiegebied, deur middel van verskeie herbarium versamelings. Met behulp van hierdie databank is 'n spesielys van die blomplante van die Kosi Bay Coastal Forest Reserve [CFR] opgestel. Hierdie spesielys bevat 1164 spesies, wat 47 % van die geskatte 2 500 plant spesies wat in Maputaland voorkom is. Dit is hoogs betekenisvol omdat die studiegebied slegs 1.7 % van die oppervlakte van die MS beslaan. Een-en-sewentig van hierdie spesies is endemies tot die MS. Die verspreiding van hierdie endemiese spesies is gekoppel aan die verskillende plantgemeenskappe van die gebied, om prioriteits bewaringsgebiede vas te stel, daar is vasgestel dat die hoogste getal MS endemiese spesies beperk is tot die kusgrasveld gemeenskap. Dit ondersteun die belangrikheid van die bewaring van die kusgrasveld. Riglyne vir die toekomstige bewaring en bestuur van die unieke plantgemeenskappe en spesierykheid van die gebied is voorgestel.

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From 1994—1996 he conducted a vegetation and floristic study in the Kosi Bay Coastal Forest Reserve, Maputaland, in co-operation with the KwaZulu Department of Nature Conservation, this project was funded by the WWF and SAPPI.

APPENDIX 1

CHECKLIST OF VASCULAR PLANTS RECORDED IN THE STUDY AREA.

An asterisk denotes taxa endemic or near endemic to the MC. Plant collector and collection numbers are given. Material is housed in the Maputaland Herbarium (MH), Tembe Elephant Park, H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria and the National Herbarium (PRE), Pretoria. Taxa included in an earlier checklist of the area (Ward & Weisser 1991) but for which no voucher specimens have been given, are indicated as "Ward & Weisser (1991)".

ACANTHACEAE

Asystasia gangetica	R.A. Lubbe 138, 184, 412 (PRU)
**Asystasia pinguifolia*	M.C. Ward 2096 (MH)
Asystasia sp.	K. Balkwill 196 (MH)
Barleria obtusa	R.A. Lubbe 246 (PRU)
**Barleria prionitis*	M.C. Ward 1996 (MH)
Barleria repens	R.A. Lubbe 360 (PRU)
Chaetacanthus setiger	R.A. Lubbe 711 (PRU)
Crabbea hirsuta	R.A. Lubbe 352 (PRU)
**Crossandra fruticulosa*	R.A. Lubbe (sight record)
Dicliptera heterostegia	Vahrmeier & Tolken 872 (PRE)
Dicliptera zeylanica	M.C. Ward 421 (MH)
Ecbolium glabratum	G. Germishuizen 3159 (MH)
Hypoestes aristata	A.B. Cunningham 632 (MH)
Isoglossa ciliata	K. Balkwill 188 (MH)
Isoglossa woodii	M.C. Ward 2729 (MH)
Justicia betonica	M.C. Ward 273 (MH)
Justicia capensis	A. Abbott (MH)
Justicia flava	R.A. Lubbe 491 (PRU)
Phaulopsis imbricata	M.C. Ward 210 (MH)
Ruellia cordata	M.C. Ward 2094 (MH)
**Sclerochiton apiculatus*	R.A. Lubbe 608 (PRU)
Thunbergia atriplicifolia	R.A. Lubbe 136, 416 (PRU)
Thunbergia dregeana	R.A. Lubbe 361 (PRU)

ADIANTACEAE

Acrostichum aureum	C.J. Ward 8061 (PRE)
Adiantum capillus-veneris	Ward & Weisser (1991)
Cheilanthes viridis	R.J. Roden 4642 (PRE)
Cheilanthes viridis var. *glauca*	J.J.F. Stephen 476 (PRE)

AGAVACEAE

Sansevieria hyacinthoides	Ward & Weisser (1991)

AIZOACEAE

Corbichonia sp.	R.A. Lubbe 211 (PRU)

AMARANTHACEAE

Achyranthes aspera var. *aspera*	R.A. Lubbe 624(PRU)
Achyranthes aspera var. *sicula*	Ward & Weisser (1991)
Achyropsis avicularis	Ward & Weisser (1991)
Alternanthera sessilis	R.A. Lubbe 525 (PRU)
Amaranthus sp.	J. Vahrmeijer 1074 (PRE)
Amaranthus spinosus	M.C. Ward 457 (MH)
Hermbstaedtia caffra	R.A. Lubbe 29, 275 (PRU)
Hermbstaedtia odorata	M.C. Ward 278 (MH)
Kyphocarpa trichinoides	R.A. Lubbe 346 (PRU)
Psilotrichum scleranthum	R.A. Lubbe 463, 692 (PRU)
Pupalia lappacea var. *lappacea*	R.A. Lubbe 729 (PRU)

AMARYLLIDACEAE

Crinum bulbispermum	R.A. Lubbe 183 (PRU)
Crinum delagoense	Moll & Strey 3921 (PRE)
Cyrtanthus breviflorus	R.A. Lubbe 724 (PRU)
Cyrtanthus galpinii	M.C. Ward 783 (MH)
Scadoxus membranaceus	Guy & Ward 59 (MH)
Scadoxus multiflorus subsp. katharinae	R.A. Lubbe (sight record)
Scadoxus puniceus	M.C. Ward 1089 (MH)

AMBLYSTEGIACEAE

Leptodictyum riparium	Aitken & Gale 10283 (PRE)

ANACARDIACEAE

Harpephyllum caffrum	Ward & Weisser (1991)
Mangifera indica	Stephen & van Graan 1276 (PRE)
**Ozoroa engleri*	R.J. Rodin 4716 (PRE)
Ozoroa obovata var. *obovata*	E. Retief 865 (MH)
Ozoroa paniculosa	R.G. Strey 5047 (PRE)
Ozoroa paniculosa var. *paniculosa*	R.A. Lubbe 612 (PRU)
Rhus dentata	Ward & Weisser (1991)
Rhus fastigiata	Ward & Weisser (1991)
Rhus gueinzii	R.A. Lubbe 237, 616 (PRU)
Rhus microcarpa	A.J. Phelan 783 (MH)
Rhus natalensis	R.A. Lubbe 144, 498, 594 (PRU)
Rhus nebulosa forma *nebulosa*	R.A. Lubbe 201, 619 (PRU)
Rhus pyriodes var. *pyriodes*	R.J. Rodin 4699 (PRE)
Rhus rehmanniana	R.A. Lubbe 220 (PRU)
Rhus sp.	H.B. Nicholson (MH)
Rhus tomentosa	Ward & Weisser (1991)
Sclerocarya birrea subsp. *caffra*	M.C. Ward 2142 (MH)

ANNONACEAE

Annona senegalensis subsp. *senegalensis*	R.A. Lubbe 72 (PRU)

Artabotrys monteiroae	R.A. Lubbe 260, 396 (PRU)
Monanthotaxis caffra	R.A. Lubbe 506 (PRU)
Uvaria caffra	Ward & Weisser (1991)

APIACEAE

Centella asiatica	M.C. Ward 1803 (MH)
Centella glabrata var. *natalensis*	R.A. Lubbe 51 (PRU)
Hydrocotyle bonariensis	R.A. Lubbe 326 (PRU)

APOCYNACEAE

Acokanthera oblongifolia	R.A. Lubbe 23, 271, 501, 589 (PRU)
Acokanthera sp.	D.J. Botha 3440 (PRE)
Ancylobotrys petersiana	R.A. Lubbe 421 (PRU)
Carissa bispinosa subsp. *zambesiensis*	R.A. Lubbe 420 (PRU)
Carissa macrocarpa	Ward & Weisser (1991)
Catharanthus roseus	R.A. Lubbe 227, 694 (PRU)
Ephippiocarpa orientalis	R.A. Lubbe 141, 496, 606 (PRU)
Landolphia kirkii	R.A. Lubbe 22 (PRU)
Rauvolfia caffra	Ward & Weisser (1991)
Tabernaemontana elegans	R.A. Lubbe 221 (PRU)
Voacanga thouarsii	M.C. Ward 342 (MH)

AQUIFOLIACEAE

Ilex mitis var. *mitis*	Ward & Weisser (1991)

ARACEAE

Gonatopus angustus	K.L. Tinley 396 (PRE)
Pistia stratiotes	M. Bruton 161 (PRE)
Stylochiton natalensis	R.A. Lubbe 375 (PRU)
Zamioculcas zamiifolia	R.A. Lubbe (sight record)

ARALIACEAE

**Cussonia arenicola*	R.A. Lubbe 398 (PRU)
Cussonia sphaerocephala	Ward & Weisser (1991)
Cussonia zuluensis	Ward & Weisser (1991)
Schefflera umbellifera	P. van Wyk 751 (MH)

ARCHIDIACEAE

Archidium ohioense	P.H. Raven 262322 (PRE)

ARECACEAE

Hyphaene coriacea	J.J.F. Stephen 405 (PRE)
Phoenix reclinata	S. Venter 11544 (PRE)
**Raphia australis*	R.G. Strey 8200 (PRE)

ASCLEPIADACEAE

Asclepias affinis	R.A. Lubbe 33 (PRU)
Asclepias albens	E. Retief 858 (PRE)

Asclepias burchellii	M.C. Ward 396 (MH)
Asclepias fruticosa	Vahrmeiler & Tolken 879 (PRE)
Asclepias physocarpa	R.A. Lubbe 243 (PRU)
**Aspidoglossum delagoense*	R.A. Lubbe 28, 682, 712 (PRU)
Ceropegia conrathii	G. Rowley 84 (PRE)
Ceropegia sandersonii	D.S. Hardy 1781 (PRE)
Cynanchum ellipticum	K. Balkwill 178 (MH)
Cynanchum obtusifolium var. *pilosum*	R.J. Roden 4660 (PRE)
Pachycarpus concolor	R.A. Lubbe 81 (PRU)
Pentarrhinum insipidum	R.A. Lubbe 85 (PRU)
Pergularia daemia var. *daemia*	M.C. Ward 445 (MH)
Periglossum angustifolium	M.C. Ward 1830 (MH)
Sarcostemma viminale	M.C. Ward 425 (MH)
Schizoglossum cordifolium	R.A. Lubbe 669 (PRU)
Secamone alpini	Ward & Weisser (1991)
Secamone filiformis	R.A. Lubbe 91 (PRU)
Tylophora cordata	J. Vahrmeijer 575 (PRE)
Tylophora flanaganii	M.C. Ward 2537 (MH)

ASPARAGACEAE

Protasparagus buchananii	J. Vahrmeijer 515 (PRE)
Protasparagus cooperi	M.C. Ward 220 (MH)
Protasparagus densiflorus	R.A. Lubbe 96 (PRU)
Protasparagus falcatus	J. Vahrmeijer 494 (PRE)
Protasparagus natalensis	R.A. Lubbe 429 (PRU)
Protasparagus plumosus	C. Buthelezi 665 (PRE)
Protasparagus racemosus	R.A. Lubbe 277 (PRU)
Protasparagus setaceus	A.A. Balsinhas 3189 (PRE)
Protasparagus virgatus	M.C. Ward 1602 (MH)

ASPHODELACEAE

Albuca fastigiata	R.A. Lubbe 292 (PRU)
Albuca sp.	R.A. Lubbe 292 (PRU)
Aloe bainesii	Ward & Weisser (1991)
Aloe cooperi subsp. *pulchra*	A.E. van Wyk & M.J. Potgieter 12233 (MH)
Aloe ecklonis	R.A. Lubbe 348 (PRU)
Aloe kraussii	E.J. Moll 4733 (PRU)
Aloe linearifolia	M.C. Ward 1681 (MH)
Aloe minima	R.G. Strey 5100 (PRE)
**Aloe parvibracteata*	M.C. Ward 476 (MH)
Aloe umfoloziensis	R.P. Ellis 512 (PRE)
Anthericum cooperi	R.A. Lubbe 26 (PRU)
Anthericum fasciculatum	Stephen, van Graan & Schwabe 1143 (PRE)
Anthericum saundersiae	R.A. Lubbe 314 (PRU)
Chlorophytum comosum	J. Vahrmeijer 578 (PRE)
Dipcadi viride	R.A. Lubbe 130 (PRU)
Drimiopsis maculata	R.A. Lubbe 373 (PRU)
Gloriosa superba	R.A. Lubbe 11, 520 (PRU)
Ledebouria ovatifolia	R.A. Lubbe 99 (PRU)
Ornithogalum tenuifolium subsp. *tenuifolium*	M.C. Ward 548 (MH)
Scilla nervosa	R.A. Lubbe 353 (PRU)
Trachyandra gerrardii	Stephen, van Graan & Schwabe 1159 (PRE)
Trachyandra saltii var. *saltii*	R.A. Lubbe 683 (PRU)
Trachyandra saltii var. *secunda*	R.A. Lubbe 431 (PRU)

ASPLENIACEAE

Asplenium prionitis	Ward & Weisser (1991)

ASTERACEAE

Acanthospermum glabratum	M.C. Ward 889 (MH)
Achyrocline stenoptera	C.J. Ward 8468 (PRE)
Adenostemma viscosum	J. Vahrmeijer 8468 (PRE)
Ageratum conyzoides	R.A. Lubbe 371 (PRU)
Arctotheca populifolia	R.A. Lubbe 630 (PRU)
Arctotis adpressa	E. Retief 879 (PRE)
Aster squamatus	Vahrmeijer & Tolken 876 (PRE)
Berkheya bipinnatifida subsp. *echinopsoides*	R.A. Lubbe 425 (PRU)
Berkheya speciosa subsp. *lanceolata*	M.C. Ward 434 (MH)
Bidens pilosa	M.C. Ward 1988 (MH)
Blumea mollis	R.A. Lubbe 536 (PRU)
Brachylaena discolor subsp. *discolor* var. *discolor*	M.C. Ward 504 (MH)
Chromolaena odorata	M.C. Ward 989 (MH)
Chrysanthemoides monilifera subsp. *rotundata*	R.A. Lubbe 158 (PRU)
Chrysocoma ciliata	M.C. Ward 1599 (MH)
**Cineraria pinnata*	K. Balkwill 605 (MH)
Cineraria sp.	J. Vahrmeijer 1245 (PRE)
Conyza canadensis	R.A. Lubbe 638 (PRU)
Conyza ulmifolia	R.A. Lubbe 601 (PRU)
Crassocephalum crepidioides	R.A. Lubbe 482, 483 (PRU)
Crassocephalum picridifolium	R.A. Lubbe 529, 696 (PRU)
Ethulia conyzoides subsp. *conyzoides*	R.A. Lubbe 479, 544 (PRU)
Felicia muricata subsp. *muricata*	K. Balkwill 517 (MH)
Gazania krebsiana	M.C. Ward 461 (MH)
Gazania rigens var. *rigens*	R.A. Lubbe 4 (PRU)
Gazania rigens var. *uniflora*	R.A. Lubbe 584 (PRU)
Gerbera ambigua	R.A. Lubbe 697 (PRU)
Gerbera piloselloides	R.A. Lubbe 287 (PRU)
Gerbera viridifolia subsp. *viridifolia*	R.A. Lubbe 98 (PRU)
**Helichrysopsis septentrionale*	R.A. Lubbe 344, 542 (PRU)
**Helichrysum adenocarpum* subsp. *ammophilum*	R.A. Lubbe 120, 442 (PRU)
Helichrysum appendiculatum	R.A. Lubbe 83, 159, 670 (PRU)
Helichrysum asperum var. *asperum*	R.G. Strey 5187 (PRE)
Helichrysum asperum var. *comosum*	M.C. Ward 1722 (MH)
Helichrysum aureonitens	R.A. Lubbe 281 (PRU)
Helichrysum aureum var. *monocephalium*	B.D. Schrire 982 (PRE)
Helichrysum candolleanum	E. Retief 763 (MH)
Helichrysum cephaloideum	M.C. Ward 1750 (MH)
Helichrysum cooperi	Ward & Weisser (1991)
Helichrysum decorum	M.C. Ward 1121 (MH)
Helichrysum kraussii	K. Balkwill 492 (MH)
Helichrysum longifolium	R.A. Lubbe 60, 128, 457 (PRU)
Helichrysum nudifolium	R.A. Lubbe 45 (PRU)
Helichrysum oxyphyllum	R.A. Lubbe 307, 713 (PRU)
Helichrysum sp.	J. Vahrmeijer 677 (PRE)
Helichrysum spiralepis	R.A. Lubbe 443 (PRU)
**Helichrysum tongense*	M.C. Ward 380 (MH)
Launaea sarmentosa	R.A. Lubbe 9, 586 (PRU)
Melanthera biflora	R.A. Lubbe 629 (PRU)
Melanthera scandens subsp. *dregei*	R.A. Lubbe 515 (PRU)

Mikania natalensis	R.A. Lubbe 539 (PRU)
Nidorella resedifolia subsp. *resedefolia*	R.A. Lubbe 152 (PRU)
**Nidorella tongensis*	R.A. Lubbe 516 (PRU)
Nidorella auriculata	Ward & Weisser (1991)
Osteospermum grandidentatum	R.A. Lubbe 35, 298, 714 (PRU)
Othonna carnosa var. *discoidea*	R.A. Lubbe 328 (PRU)
Pseudognaphalium luteo-album	J. Vahrmeijer 1068 (PRE)
Senecio deltoideus	R.A. Lubbe 244 (PRU)
Senecio erubescens var. *erubescens*	R.A. Lubbe 411 (PRU)
Senecio glaberrimus	R.A. Lubbe 36 (PRU)
Senecio gregatus	R.A. Lubbe 688 (PRU)
Senecio inornatus	R.A. Lubbe 667 (PRU)
Senecio microglossus	R.A. Lubbe 705 (PRU)
Senecio madagascariensis	R.A. Lubbe 437, 738 (PRU)
**Senecio ngoyanus*	R.A. Lubbe 278 (PRU)
Senecio oxyodontus	R.A. Lubbe 241 (PRU)
Senecio polyanthemoides	R.A. Lubbe 324 (PRU)
Senecio sp.	R.A. Lubbe 698 (PRU)
Senecio speciosus	R.A. Lubbe 358 (PRU)
Senecio tamoides	Ward & Weisser (1991)
Senecio variabilis	R.A. Lubbe 721 (PRU)
Sonchus asper subsp. *asper*	J. Vahrmeijer 1072 (PRE)
Sonchus integrifolius var. *integrifolius*	R.A. Lubbe 37 (PRU)
Vernonia angulifolia	M.C. Ward 465 (MH)
Vernonia aurantiaca	R.A. Lubbe 253 (PRU)
**Vernonia centaureoides*	R.A. Lubbe 196 (PRU)
Vernonia natalensis	K. Balkwill 484 (MH)
Vernonia oligocephala	R.A. Lubbe 31, 557 (PRU)
Xanthium strumarium	R.A. Lubbe (sight record)

BALANITACEAE

Balanites maughamii	Strey & Moll 4002 (PRE)

BALANOPHORACEAE

Sarcophyte sanguinea	M.C. Ward 2198 (MH)

BIGNONIACEAE

Kigelia africana	Ward & Weisser (1991)
Tecomaria capensis subsp. *capensis*	M.C. Ward 204 (MH)

BLECHNACEAE

Stenochlaena secundatum	R.P. Ellis 3572 (PRE)
Stenochlaena tenuifolia	R.A. Lubbe 480 (PRU)

BORAGINACEAE

Cordia caffra	R.A. Lubbe 402 (PRU)
Ehretia rigida	R.A. Lubbe (sight record)

BRASSICACEAE

Heliophila scandens	M.C. Ward 507 (MH)

BRYACEAE	
Bryum canariense	Aitken & Gale 10 (PRE)
Bryum erythrocaulon	Moll & Cunningham 6009 (PRE)
BURMANNIACEAE	
Burmannia madagascariensis	R.A. Lubbe 288 (PRU)
BURSERACEAE	
Commiphora neglecta	R.A. Lubbe 19, 379, 452 (PRU)
Commiphora zanzibarica	F. White 10439 (PRE)
CACTACEAE	
Pereskia aculeata	M.C. Ward 1434 (MH)
Rhipsalis baccifera	M.C. Ward 1099 (MH)
CALYMPERACEAE	
Calymperes rabenhorstii	J. Vahrmeijer 12930 (PRE)
CAMPANULACEAE	
Wahlenbergia abyssinca subsp. *abyssinica*	R.A. Lubbe 222, 289, 413, 580 (PRU)
Wahlenbergia krebsii subsp. *krebsii*	D.J. Botha 322 (PRE)
Wahlenbergia sp.	J. Vahrmeijer 687 (PRE)
Wahlenbergia undulata	R.A. Lubbe 61 (PRU)
CANELLACEAE	
**Warburgia salutaris*	K.L. Tinley 197 (PRE)
CAPPARACEAE	
Bachmannia woodii	J. Vahrmeijer 732 (PRE)
Capparis brassii	R.A. Lubbe 258, 488 (PRU)
Capparis sepiaria var. *citrifolia*	R.A. Lubbe 487 (PRU)
Capparis tomentosa	Ward & Weisser (1991)
Cladostemon kirkii	J. Vahrmeijer 729 (PRE)
Cleome angustifolia subsp. *petersiana*	R.A. Lubbe 223, 671 (PRU)
**Maerua nervosa*	R.A. Lubbe 315, 446 (PRU)
Maerua racemulosa	J. Vahrmeijer 1082 (PRE)
CARYOPHYLLACEAE	
Dianthus crenatus var. *angicalyx*	M.C. Ward 280 (MH)
**Krauseola mosambicina*	M.C. Ward 1976 (MH)
Polycarpaea corymbosa	R.J. Rodin 4694 (PRE)
Silene burchelli var. *angustifolia*	R.A. Lubbe 273 (PRU)
Silene burchelli var. *burchelli*	Strey & Moll 3919 (PRE)
Silene burchellii var. *latifolia*	R.A. Lubbe 38, 567, 717 (PRU)
Silene primuliflora	R.A. Lubbe 687 (PRU)
CASUARINACEAE	

Casuarina equisetifolia	Ward & Weisser (1991)

CELASTRACEAE

Allocassine laurifolia	R.A. Lubbe 388 (PRU)
Cassine aethiopica	R.A. Lubbe 235 (PRU)
Cassine eucleiformis	R.A. Lubbe 704 (PRU)
Cassine papillosa	R.A. Lubbe 595 (PRU)
**Hippocratea delagoensis*	R.A. Lubbe 400 (PRU)
Maytenus heterophylla	M.C. Ward 1406 (MH)
**Maytenus heterophylla subsp. arenaria*	P. van Wyk 3001 (PRU)
Maytenus nemorosa	M.C. Ward 981 (MH)
Maytenus peduncularis	M.C. Ward 825 (MH)
Maytenus procumbens	P. Van Wyk 3019 (PRU)
Maytenus senegalensis	J. Vahrmeijer 1232 (PRE)
Maytenus undata	Ward & Weisser (1991)
Putterlickia sp.	R.A. Lubbe 500, 734 (PRU)
Putterlickia verrucosa	E.J. Moll 4851 (PRE)
Salacia gerrardii	J.J.F. Stephen 415 (PRE)
Salacia kraussii	R.A. Lubbe 318 (PRU)
Salacia sp.	Stephen & van Graan 1250 (PRE)

CERATOPHYLLACEAE

Ceratophyllum demersum var. *demersum*	Vahrmeijer & Tolken 885 (PRE)

CHRYSOBALANACEAE

Parinari capensis subsp. *capensis*	J.J. Gerstner 710 (PRE)
**Parinari capensis* subsp. *incohata*	R.A. Lubbe 410 (PRU)
Parinari curatellifolia	R.A. Lubbe 68 (PRU)

CLUSIACEAE

Garcinia livingstonei	K. Balkwill 525 (MH)
Hypericum lalandii	R.A. Lubbe 290 (PRU)

COMBRETACEAE

Combretum albopunctatum	J. Vahrmeijer 681 (PRE)
Combretum kraussii	F. White 10474 (PRE)
Combretum molle	R.A. Lubbe 614 (PRU)
Lumnitzera racemosa	M.C. Ward 1321 (MH)
Pteleopsis myrtifolia	H. Nicholson (MH)
Terminalia sericea	O. West 874 (PRE)

COMMELINACEAE

Aneilema aequinoctiale	R.A. Lubbe 367, 740 (PRU)
Aneilema dregeanum	R.A. Lubbe 177, 492, 546 (PRU)
Aneilema schlechteri	Ward & Weisser (1991)
Coleotrype natalensis	M.C. Ward 349 (MH)
Commelina africana var. *africana*	R.A. Lubbe 64, 408 (PRU)
Commelina africana var. *krebsiana*	Stephen, van Graan & Schwabe 1188 (PRE)
Commelina benghalensis	Ward & Weisser (1991)
Commelina diffusa subsp. *diffusa*	Ward & Weisser (1991)

Commelina eckloniana	R.G. Strey 4979 (PRE)
Commelina erecta	R.A. Lubbe 735 (PRU)
Commelina forskaolii	M.C. Ward 454 (MH)
Commelina subulata	Ward & Weisser (1991)
Cyanotis speciosa	R.A. Lubbe 299 (PRU)
Murdannia simplex	R.A. Lubbe 430 (PRU)

CONVOLVULACEAE

Astripomoea malvaceae	R.A. Lubbe 302 (PRU)
Hewittia sublobata	R.A. Lubbe 229, 597 (PRU)
Ipomoea bolusiana subsp. *pinnatipartita*	R.J. Rodin 4657 (PRE)
Ipomoea cairica	R.A. Lubbe 541 (PRU)
Ipomoea congesta	R.A. Lubbe 234 (PRU)
Ipomoea mauritiana	R.A. Lubbe 626 (PRU)
Ipomoea pes-caprae subsp. *brasiliensis*	R.A. Lubbe 631 (PRU)
Ipomoea urbaniana	Vahrmeijer & Tolken 866 (PRE)
Ipomoea wightii	Ward & Weisser (1991)
Jacquemontia tamnifolia	R.J. Rodin 4699 (PRE)
Merremia pterygocaulos	M.C. Ward 321 (MH)
Merremia tridentata subsp. *angustifolia* var. *angustifolia*	R.A. Lubbe 213 (PRU)
Turbina oblongata	R.A. Lubbe 333, 342 (PRU)

CRASSULACEAE

Crassula alba var. *alba*	R.A. Lubbe 272, 334 (PRU)
Crassula lanceolata subsp. *transvaalensis*	R.A. Lubbe 340 (PRU)
Crassula sp.	R.A. Lubbe 684 (PRU)
**Kalanchoe neglecta*	R.A. Lubbe 658 (PRU)
Kalanchoe rotundifolia	R.A. Lubbe 518 (PRU)

CUCURBITACEAE

Acanthosicyos naudinianus	J. Vahrmeijer 1118 (PRE)
Coccinia rehmannii	M.C. Ward 480 (MH)
Coccinia variifolia	M.C. Ward 1887 (MH)
Kedrostis foetidissima	R.G. Strey 4788 (PRE)
Momordica balsamina	R.A. Lubbe 40 (PRU)
Zehneria parvifolia	D. Edwards 2597 (PRE)

CYPERACEAE

Abildgaardia hygrophila	E.J. Moll 4765 (PRE)
Bulbostylis burchellii	G. Germishuizen 2036 (PRE)
Bulbostylis contexta	R.A. Lubbe 42 (PRU)
Bulbostylis sp.	C.F. Musil 141 (PRE)
Carex cognata var. *cognata*	C.J. Ward 10050 (MH)
Cladium mariscus subsp. *jamaicense*	M.C. Ward 853 (MH)
Cyperus albostriatus	R.A. Lubbe 67 (PRU)
Cyperus crassipes	R.A. Lubbe 587 (PRU)
Cyperus denudatus	M.C. Ward 240 (MH)
Cyperus distans	Ward & Weisser (1991)
Cyperus fastigiatus	R.A. Lubbe 718 (PRU)
Cyperus immensus	R.A. Lubbe 522 (PRU)
Cyperus laevigatus	Ward & Weisser (1991)
Cyperus latifolius	Ward & Weisser (1991)

Cyperus leptocladus	Ward & Weisser (1991)
Cyperus margaritaceus	R.A. Lubbe 317 (PRU)
Cyperus natalensis	M.C. Ward 1223 (MH)
Cyperus obtusiflorus var. *obtusiflorus*	M.C. Ward 1751 (MH)
Cyperus papyrus	Strey & Moll 3864 (PRE)
Cyperus pectinatus	M.C. Ward 1672 (MH)
Cyperus prolifer	R.A. Lubbe 107 (PRU)
Cyperus rotundus subsp. *rotundus* var. *rotundus*	Ward & Weisser (1991)
Cyperus sexangularis	M.C. Ward 2618 (MH)
Cyperus sphaerospermus	W.S. Matthews 1054 (MH)
Cyperus tenax	R.A. Lubbe 124 (PRU)
Eleocharis caduca	C.J. Ward 9969 (MH)
Eleocharis dulcis	R.G. Strey 8198 (PRE)
Eleocharis geniculata	Vahrmeijer & Hardy 1619 (PRE)
Eleocharis intricata	C.J. Ward 9083 (PRE)
Eleocharis limosa	R.A. Lubbe 523 (PRU)
Eleocharis palustris	Project Sibayi 279 (PRE)
Eleocharis intricata	R.A. Lubbe 551 (PRU)
Ficinia laciniata	D. Edwards 2568 (PRE)
Fimbristylis complanata	R.A. Lubbe 192 (PRU)
Fimbristylis ferruginea	R.A. Lubbe 110 (PRU)
Fimbristylis longiculmis	M.C. Ward 1850 (MH)
Fimbristylis obtusifolia	C.J. Ward 9079 (PRE)
Fuirena hirsuta	Ward & Weisser (1991)
Fuirena obcordata	M.C. Ward 268 (MH)
Fuirena pubescens	M.C. Ward 1673 (MH)
Fuirena umbellata	R.A. Lubbe 109 (PRU)
Isolepis fluitans	Ward & Weisser (1991)
Isolepis prolifer	Tinley & Ward 15 (PRE)
Kyllinga alata	R.A. Lubbe 58 (PRU)
Kyllinga erecta	R.A. Lubbe 247 (PRU)
Macrochaetium sp.	E.J. Moll 4789 (PRE)
Mariscus albomarginatus	P.J. Vorster 2707 (PRE)
Mariscus capensis	Ward & Weisser (1991)
Mariscus dregeanus	M.C. Ward 1839 (MH)
Mariscus dubius	M.C. Ward 1840 (MH)
Mariscus macrocarpus	M.C. Ward 1841 (MH)
Mariscus pseudo-vestitus	R.A. Lubbe 710 (PRU)
Mariscus solidus	K.L. Tinley 256 (PRE)
Mariscus vestitus	P.J. Vorster 2636 (PRE)
Pycreus macranthus	Ward & Weisser (1991)
Pycreus mundii	C.F. Musil 466 (PRE)
Pycreus nitidus	R.A. Lubbe 122 (PRU)
Pycreus polystachyos var. *polystachyos*	R.A. Lubbe 565 (PRU)
Rhynchospora barrosiana	E.J. Moll 4760 (PRE)
Rhynchospora brownii	E.J. Moll 4776 (PRE)
Rhynchospora corymbosa	D. Edwards 2555 (PRE)
Rhynchospora holoschoenoides	R.A. Lubbe 123 (PRU)
Rhynchospora rubra subsp. *africana*	C.J. Ward 9078 (PRE)
Schoenoplectus erectus	Ward & Weisser (1991)
Schoenoplectus littoralis	C.F. Musil 143 (PRE)
Scleria achtenii	M.C. Ward 860 (MH)
Scleria angusta	R.A. Lubbe 513 (PRU)
Scleria aterrima	E.J. Moll 4759 (PRE)
Scleria melanomphala	R.A. Lubbe 191 (PRU)

Scleria nutans	M.C. Ward 1680 (MH)
Scleria poiformis	R.A. Lubbe 242 (PRU)
Scleria sobolifer	C.J. Ward 9984 (MH)
Scleria welwitschii	Ward & Weisser (1991)

DAVALLIACEAE

Davallia chaerophylloides	J.B. Khoza 66 (MH)
Nephrolepis biserrata	M.C. Ward 474 (MH)
Nephrolepis exaltata	Ward & Weisser (1991)

DICHAPETALACEAE

Tapura fischeri	M.C. Ward 2534 (MH)

DIOSCOREACEAE

Dioscorea cotinifolia	E.J. Moll 4555 (PRE)
Dioscorea diversifolia	J. Vahrmeijer 540 (PRE)
Dioscorea sp.	R.A. Lubbe 625 (PRU)
Dioscorea sylvatica var. *sylvatica*	R.G. Strey 8231 (PRE)

DIPSACACEAE

Scabiosa columbaria	R.A. Lubbe 2 (PRU)

DRACAENACEAE

Dracaena hookeriana	Ward & Weisser (1991)
Dracaena mannii	R.A. Lubbe 465, 621 (PRU)
Sanseviera hyacinthoides	R.A. Lubbe 600 (PRU)

DROSERACEAE

Drosera madagascariensis	R.A. Lubbe 188 (PRU)
Drosera natalensis	R.A. Lubbe 279 (PRU)

EBENACEAE

Diospyros dichrophylla	Ward & Weisser (1991)
Diospyros galpinii	R.A. Lubbe 409 (PRU)
**Diospyros inhacaensis*	R.A. Lubbe 490 (PRU)
Diospyros lycioides subsp. *sericea*	R.A. Lubbe 303 (PRU)
Diospyros natalensis subsp. *natalensis*	R.A. Lubbe 393 (PRU)
**Diospyros rotundifolia*	R.A. Lubbe 588 (PRU)
Diospyros scabrida var. *scabrida*	Ward & Weisser (1991)
Diospyros sp.	De Winter & Vahrmeijer 8597 (PRE)
Diospyros villosa var. *villosa*	Ward & Weisser (1991)
Euclea natalensis subsp. *natalensis*	R.A. Lubbe 613 (PRU)
**Euclea natalensis* subsp. *rotundifolia*	R.A. Lubbe 592 (PRU)
Euclea polyandra	R.J. Rodin 4652 (PRE)
Euclea schimperi var. *schimperi*	C.J. Ward & M.C. Ward 103 (MH)

EQUISETACEAE

Equisetum ramosissimum	Ward & Weisser (1991)

ERYTHROXYLACEAE

**Erythroxylum delagoense*	R.A. Lubbe 182, 435 (PRU)
Erythroxylum emarginatum	R.A. Lubbe 135, 140, 356, 363, 604 (PRU)
Erythroxylum pictum	D.J. Botha 3434 (PRE)

EUPHORBIACEAE

Acalypha glabrata var. *glabrata*	R.A. Lubbe 504 (PRU)
Acalypha villicaulis	R.A. Lubbe 90, 164 (PRU)
Antidesma venosum	R.A. Lubbe 75, 149, 561 (PRU)
Bridelia cathartica	R.A. Lubbe 106 (PRU)
Bridelia micrantha	R.A. Lubbe 440, 477, 509 (PRU)
Chamaesyce hirta	M.C. Ward 1843 (MH)
Chamaesyce prostrata	M.C. Ward 1979 (MH)
Cleistanthus schlechteri var. *schlecteri*	Strey & Moll 3906 (PRE)
Clutia abyssinica var. *abyssinica*	R.A. Lubbe 703 (PRU)
Clutia natalensis	R.A. Lubbe 264 (PRU)
Clutia pulchella var. *pulchella*	M.C. Ward 873 (MH)
Croton gratissimus var. *gratissimus*	A. Abbott 2625 (MH)
Croton pseudopulchellus	R.A. Lubbe 310 (PRU)
**Croton steenkampianus*	P. van Wyk 370 (MH)
Croton sylvaticus	M.C. Ward 2207 (MH)
Dalechampia capensis	R.A. Lubbe 728 (PRU)
Dalechampia volubilis	M.C. Ward 1397 (MH)
Drypetes arguta	J. Vahrmeijer 733 (PRE)
Drypetes gerrardii	H.J.T. Venter 6260 (PRE)
Drypetes natalensis var. *natalensis*	R.A. Lubbe 389 (PRU)
Drypetes reticulata	R.A. Lubbe 464 (PRU)
Erythrococca berberidea	R.A. Lubbe 404 (PRU)
Euphorbia epicyparissias var. *epicyparissias*	R.A. Lubbe 52, 146 (PRU)
Euphorbia epicyparissias var. *wahlbergii*	C. Buthelezi 541 (PRE)
Euphorbia grandidens	R.A. Lubbe 453 (PRU)
Euphorbia ingens	Ward & Weisser (1991)
Euphorbia striata var. *striata*	Stephen, van Graan & Schwabe 1164 (PRE)
Euphorbia tirucalli	Ward & Weisser (1991)
Hymenocardia ulmoides	R.A. Lubbe 173, 535 (PRU)
Heywoodia lucens	H.J.T. Venter 448 (PRE)
Macaranga capensis	A.B. Cunningham 625 (MH)
Margaritaria discoidea var. *discoidea*	K. Balkwill 595 (MH)
Phyllanthus dinteri	K. Balkwill 595 (MH)
Phyllanthus incurvus	E.J. Moll 4720 (PRE)
Phyllanthus maderaspatensis	R.A. Lubbe 419 (PRU)
Phyllanthus nummulariifolius	K. Balkwill 501 (MH)
Phyllanthus reticulatus	R.A. Lubbe 239 (PRU)
Phyllanthus sp.	R.A. Lubbe 194 (PRU)
Ricinus communis	Ward & Weisser (1991)
Sapium ellipticum	K. Balkwill 185 (MH)
Sapium integerrimum	R.A. Lubbe 71, 321 (PRU)
Sapium sp.	J. Vahrmeijer 1090 (PRE)
Spirostachys africana	J.J.F. Stephen 399 (PRE)
Suregada africana	R.A. Lubbe 405 (PRU)
Suregada zanzibariensis	R.A. Lubbe 609, 707 (PRU)
Synadenium cupulare	M.C. Ward 714 (MH)
Tragia glabrata var. *glabrata*	R.J. Rodin 4664 (PRE)
Tragia meyeriana	M.C. Ward 1111 (MH)

Tragia rupestris	R.A. Lubbe 391 (PRU)

FABACEAE

Abrus laevigatus	R.A. Lubbe 305 (PRU)
Abrus precatorius subsp. *africanus*	R.A. Lubbe 49, 86, 554 (PRU)
Acacia burkei	Ward & Weisser (1991)
Acacia karroo	R.A. Lubbe 150 (PRU)
**Acacia kraussiana*	R.A. Lubbe (PRU)
Acacia nilotica subsp. *kraussiana*	Ward & Weisser (1991)
Acacia robusta subsp. *robusta*	Ward & Weisser (1991)
Acacia schweinfurthii var. *schweinfurthii*	Ward & Weisser (1991)
Adenopodia spicata	Ward & Weisser (1991)
Aeschynomene micrantha	R.A. Lubbe 79 (PRU)
Albizia adianthifolia	R.A. Lubbe 203 (PRU)
Albizia versicolor	R.A. Lubbe 467 (PRU)
Alysicarpus rugosus subsp. *rugosus*	R.A. Lubbe 126 (PRU)
Argyrolobium rupestre subsp. *rupestre*	M.C. Ward 546 (MH)
Bauhinia tomentosa	R.A. Lubbe 572 (PRU)
Caesalpinia bonduc	P. van Wyk 3014 (PRU)
Canavalia bonariensis	M.C. Ward 341 (MH)
Canavalia maritima	R.A. Lubbe 7, 632 (PRU)
Canavalia rosea	B.J. Pienaar 1413 (PRE)
Chamaecrista mimosoides	R.A. Lubbe 103 (PRU)
Chamaecrista plumosa var. *erecta*	K. Balkwill 554 (MH)
Cordyla africana	M.C. Ward 1620 (MH)
Craibia sp.	K.L. Tinley 164 (PRE)
Craibia zimmermannii	R.A. Lubbe 382 (PRU)
Crotalaria capensis	M.C. Ward 361 (MH)
Crotalaria distans subsp. *distans*	Ward & Weisser (1991)
Crotalaria globifera	R.A. Lubbe 59 (PRU)
Crotalaria lanceolata subsp. *lanceolata*	R.A. Lubbe 155 (PRU)
Crotalaria monteiroi var. *galpinii*	R.A. Lubbe 558, 559 (PRU)
**Crotalaria monteiroi* var. *monteiroi*	G. Germishuizen 3564 (PRE)
Crotalaria pallida var. *pallida*	R.A. Lubbe 208, 231 (PRU)
Crotalaria sp.	G. Germishuizen 2026 (PRE)
Crotalaria sphaerocarpa subsp. *sphaerocarpa*	R.A. Lubbe 233 (PRU)
Crotalaria vasculosa	R.A. Lubbe 240 (PRU)
Crotalaria virgulata subsp. *grantiana*	R.A. Lubbe 153 (PRU)
Dalbergia armata	R.A. Lubbe 311 (PRU)
Dalbergia obovata	R.A. Lubbe 18, 563 (PRU)
Derris trifoliata	R.A. Lubbe 583 (PRU)
Desmodium adscendens	M.C. Ward 854 (MH)
Desmodium adscendens var. *robustum*	R.A. Lubbe 161, 475, 674 (PRU)
Desmodium dregeanum	R.A. Lubbe 104, 459, 517 (PRU)
Desmodium salicifolium var. *salicifolium*	M.C. Ward 1435 (MH)
**Dialium schlechteri*	R.A. Lubbe 236, 335 (PRU)
Dichrostachys cinerea subsp. *africana* var. *africana*	Ward & Weisser (1991)
Dichrostachys cinerea subsp. *nyassana*	R.A. Lubbe 454 (PRU)
Dipogon lignosus	J. Vahrmeijer 569 (PRE)
Dolichos junodii	R.A. Lubbe 204 (PRU)
Dolichos trilobus subsp. *transvaalensis*	R.A. Lubbe 362, 549 (PRU)
Dumasia villosa var. *villosa*	M.C. Ward 1678 (MH)
Elephantorrhiza elephantina	R.A. Lubbe 341 (PRU)
Eriosema cordatum	R.A. Lubbe 366, 417, 716 (PRU)
Eriosema distinctum	Ward & Weisser (1991)

Eriosema kraussianum	Ward & Weisser (1991)
Eriosema parviflorum	R.A. Lubbe 119 (PRU)
Eriosema psoraleoides	M.C. Ward 318 (MH)
Eriosema salignum	R.A. Lubbe 32 (PRU)
Erythrina caffra	Ward & Weisser (1991)
Erythrina humeana	R.A. Lubbe 226 (PRU)
Erythrina lysistemon	Ward & Weisser (1991)
Erythrina sp.	E. Retief 852 (PRE)
**Erythrophleum lasianthum*	R.A. Lubbe 575 (PRU)
Galactia tenuiflora	M.C. Ward 1398 (MH)
Galactia tenuiflora var. *villosa*	R.A. Lubbe 350 (PRU)
Indigofera charlieriana var. *scaberrima*	R.A. Lubbe 194 (PRU)
**Indigofera delagoaensis*	C.H. Stirton 8872 (PRE)
Indigofera hedyantha	M.C. Ward 213 (MH)
**Indigofera inhambanensis*	R.A. Lubbe 62, 556 (PRU)
Indigofera laxeracemosa	R.A. Lubbe 127 (PRU)
Indigofera neglecta	G. Germishuizen 3599 (PRE)
Indigofera oxytropis	M.C. Ward 1677 (MH)
Indigofera sp.	R.A. Lubbe 323 (PRU)
Indigofera spicata	R.A. Lubbe 460 (PRU)
Indigofera tristis	R.A. Lubbe 82, 418 (PRU)
Indigofera vicioides var. *rogersii*	M.C. Ward 1998 (MH)
Indigofera williamsonii	R.A. Lubbe 579 (PRU)
Indigofera zeyheri	R.A. Lubbe 641 (PRU)
Lablab purpureus subsp. *purpureus* var. *purpureus*	M.C. Ward 1989 (MH)
Lotononis carinata	R.A. Lubbe 354 (PRU)
Macrotyloma axillare var. *axillare*	R.A. Lubbe 160, 170 (PRU)
Mucuna gigantea var. *quandrialata*	C.J. Ward & M.C. Ward 92 (MH)
Mundulia sericea	R.A. Lubbe 596 (PRU)
Neonotonia wightii	M.C. Ward 422 (MH)
Psoralea pinnata	M.C. Ward 281 (MH)
Rhynchosia caribaea	R.A. Lubbe 736 (PRU)
Rhynchosia confusa	R.A. Lubbe 212 (PRU)
Rhynchosia hirta	M.C. Ward 1981 (MH)
Rhynchosia minima var. *minima*	M.C. Ward 1718 (MH)
Rhynchosia nervosa var. *nervosa*	R.A. Lubbe 306 (PRU)
Rhynchosia pentheri var. *pentheri*	R.A. Lubbe 461, 474 (PRU)
Rhynchosia sp.	R.A. Lubbe 691 (PRU)
Rhynchosia totta var. *totta*	R.A. Lubbe 390, 550 (PRU)
Rhynchosia venulosa	G. Germishuizen 2034 (PRE)
Senna occidentalis	R.A. Lubbe 180 (PRU)
Sophora inhambanensis	R.A. Lubbe 6 (PRU)
Stylosanthes fruticosa	R.A. Lubbe 13 (PRU)
Tephrosia bachmannii	Ward & Weisser (1991)
**Tephrosia brummittii*	R.A. Lubbe 25 (PRU)
Tephrosia capensis var. *capensis*	E. Retief 845 (MH)
Tephrosia elongata	M.C. Ward 282 (MH)
Tephrosia forbesii subps. *interior*	A. Ngwenya 531 (PRE)
Tephrosia kraussiana	R.A. Lubbe 77 (PRU)
Tephrosia linearis var. *discolor*	M.C. Ward 385 (MH)
Tephrosia longipes subsp. *longipes*	R.A. Lubbe 131, 570 (PRU)
Tephrosia macropoda var. *macropoda*	C. Buthelezi 530 (PRE)
Tephrosia polystachya var. *latifolia*	M.C. Ward 459 (MH)
Tephrosia polystachya var. *polystachya*	M.C. Ward 368 (MH)
Tephrosia purpurea subsp. *purpurea*	M.C. Ward 289 (MH)

Tephrosia purpurea subsp. *canescens*	M.C. Ward 943 (MH)
Tephrosia purpurea subsp. *leptostachya*	R.A. Lubbe 47, 70 (PRU)
Tephrosia shiluwanensis	M.C. Ward 344 (MH)
Vigna frutescens subsp. *frutescens* var. *frutescens*	M.C. Ward 462 (MH)
Vigna luteola	R.A. Lubbe 377, 543 (PRU)
Vigna unguiculata subsp. *stenophylla*	R.A. Lubbe 347 (PRU)
Vigna unguiculata subsp. *unguiculata*	K. Balkwill 580 (MH)
Vigna vexillata var. *africana*	R.A. Lubbe 407 (PRU)
Vigna vexillata var. *vexillata*	R.A. Lubbe 407, 540, 548, 568, 680 (PRU)
Zornia capensis	R.A. Lubbe 63, 228, 301 (PRU)

FLACOURTIACEAE

Casearia gladiiformis	R.A. Lubbe 537 (PRU)
Dovyalis caffra	M.C. Ward 2189 (MH)
**Dovyalis longispina*	R.A. Lubbe 268 (PRU)
Dovyalis rhamnoides	Ward & Weisser (1991)
Dovyalis zeyheri	Ward & Weisser (1991)
Kiggelaria africana	Ward & Weisser (1991)
Rawsonia lucida	M.C. Ward 2165 (MH)
Scolopia stolzii	F. White 10473 (PRE)
Scolopia zeyheri	Stephen & Van Graan 1285 (PRE)
Trimeria grandifolia	R.A. Lubbe 145 (PRU)
Xylotheca kraussiana	R.A. Lubbe 66, 364 (PRU)

FLAGELLARIACEAE

Flagellaria guineensis	M.C. Ward 1090 (MH)

GENTIANACEAE

Chironia palustris subsp. *rosaceae*	M.C. Ward 284 (MH)
Neurotheca schlecteri	Vahrmeijer & Tolken 292 (PRE)
Sebaea sedoides var. *schoenlandii*	J. Vahrmeijer 550 (PRE)

GLEICHENIACEAE

Dicranopteris linearis	Ward & Weisser (1991)

GOODENIACEAE

Scaevola plumieri	M.C. Ward 1749 (MH)
Scaevola sericea	R.A. Lubbe 643 (PRU)
Scaevola sp.	D.J. Botha 3491 (PRE)

HALORAGACEAE

Laurembergia repens subsp. *brachypoda*	Vahrmeijer & Tolken 880 (PRE)
Myriophyllum spicatum	Vahrmeijer & Tolken 884 (PRE)

HYPOXIDACEAE

Hypoxis acuminata	Ward & Weisser (1991)
Hypoxis angustifolia var. *angustifolia*	R.A. Lubbe 137 (PRU)
Hypoxis argentea var. *argentea*	Vahrmeijer & Tolken 908 (PRE)
Hypoxis filiformis	R.A. Lubbe 415 (PRU)

Hypoxis hemerocallidea	R.A. Lubbe 44 (PRU)
Hypoxis longifolia	R.A. Lubbe 57 (PRU)
Hypoxis rigidula var. *rigidula*	R.A. Lubbe 285 (PRU)
Hypoxis sp.	E.J. Moll 4740 (PRE)

ICACINACEAE

Apodytes dimidiata subsp. *dimidiata*	R.A. Lubbe 17, 219 (PRU)
Cassinopsis tinifolia	R.G. Strey 8205 (PRE)
Pyrenacantha scandens	R.A. Lubbe 489 (PRU)

ILLECEBRACEAE

Dianthus zeyheri subsp. *natalensis*	Ward & Weisser (1991)
Pollichia campestris	R.A. Lubbe 65 (PRU)

IRIDACEAE

**Anomatheca laxa*	R.A. Lubbe 256 (PRU)
Aristea angolensis subsp. *angolensis*	R.A. Lubbe 338 (PRU)
Aristea cognata	R.A. Lubbe 296, 339 (PRU)
Aristea gerrardii	Moll & Strey 3819 (PRE)
Aristea woodii	M.C. Ward 270 (MH)
Crocosmia aurea var. *aurea*	M.C. Ward 1436 (MH)
Dietis grandiflora	R.A. Lubbe 135 (PRU)
Dietis iridioides	Ward & Weisser (1991)
Gladiolus crassifolius	R.A. Lubbe 54, 530 (PRU)
Gladiolus dalenii	R.A. Lubbe 466, 689 (PRU)
**Gladiolus dalenii* (tall form)	R.A. Lubbe (sight record)
**Gladiolus invenustus*	Ross & Moll 1840 (PRE)
Gladiolus papilio	M.C. Ward 250 (MH)
Hesperantha scopulosa	R.A. Lubbe 708 (PRU)

JUNCACEAE

Juncus kraussii	R.A. Lubbe 108 (PRU)
Juncus lomatophyllus	R.A. Lubbe 566 (PRU)

JUNCAGINACEAE

Triglochin striata	M.C. Ward 1992 (MH)

LAMIACEAE

Becium grandiflorum var. *obovatum*	R.A. Lubbe 433 (PRU)
Hoslundia opposita	M.C. Ward 552 (MH)
Leonotis ocymifolia var. *ocymifolia*	A.E. van Wyk 540 (PRE)
Leonotis ocymifolia var. *raineriana*	M.C. Ward 202 (MH)
Ocimum urticifolium subsp. *caryophylatum*	M.C. Ward 481 (MH)
Ocimum urticifolium subsp. *urticifolium*	M. Jordaan 491 (PRE)
Orthosiphon suffrutescens	Vahrmeijer & Hardy 1622 (PRE)
Plectranthus hadiensis var. *tomentosus*	M.C. Ward 2554 (MH)
Plectranthus petiolaris	M.C. Ward 363 (MH)
Plectranthus verticillatus	R.A. Lubbe 706 (PRU)
Pycnostachys reticulata	M.C. Ward 260 (MH)
Stachys natalensis var. *natalensis*	J. Vahrmeijer 1133 (PRE)

LAURACEAE	
Cassytha ciliolata	T.H. Arnold 1483 (PRE)
Cassytha filiformis	R.A. Lubbe 733 (PRU)
LECYTHIDACEAE	
Barringtonia racemosa	I. Jones 75 (PRE)
LEMNACEAE	
Lemna aequinoctialis	C.J. Ward 8510 (PRE)
Lemna minor	C.J. Ward 8976 (PRE)
Spirodela polyrrhiza	Strey & Moll 31711 (PRE)
Spirodela punctata	Strey & Moll 31709 (PRE)
Wolffia arrhiza	M.C. Ward 227 (MH)
**Wolffiella denticulata*	C.J. Ward 8978 (PRE)
LENTIBULARIACEAE	
Utricularia firmula	M.C. Ward 243 (MH)
Utricularia gibba	K.L. Tinley 305 (PRE)
Utricularia livida	M.C. Ward 207 (MH)
Utricularia prehensilis	R.A. Lubbe 545 (PRU)
Utricularia stellaris	M.C. Ward 713 (MH)
LINDSAEACEAE	
Lindsaea ensifolia	C.J. Ward 10054 (MH)
Schizoloma ensifolia	Tinley & Ward 14 (MH)
LOBELIALIACEAE	
Lobelia anceps	R.A. Lubbe 189, 355, 514, 720 (PRU)
Lobelia caerulea var. *caerulea*	K. Balkwill 619 (MH)
Lobelia coronopifolia	M.C. Ward 881 (MH)
Lobelia erinus	R.A. Lubbe 118, 282 (PRU)
Lobelia pinifolia var. *laricina*	M.C. Ward 230 (MH)
LOGANIACEAE	
Strychnos decussata	M.C. Ward 2164 (MH)
Strychnos gerrardii	M.C. Ward 2199 (MH)
Strychnos henningsii	M.C. Ward 2191 (MH)
Strychnos madagascariensis	M.C. Ward 2637 (MH)
Strychnos mitis	Ward & Weisser (1991)
Strychnos spinosa	De Winter & Vahrmeijer 8574 (PRE)
Strychnos usambarensis	D.J. Botha 3477 (PRE)
LORANTHACEAE	
Erianthemum dregei	R.A. Lubbe 21, 573 (PRU)
Tapinanthus gracilis	R.A. Lubbe 269, 493 (PRU)
Tapinanthus kraussianus subsp. *krausianus*	R.A. Lubbe 602 (PRU)
Tapinanthus kraussianus subsp. *transvaalensis*	R.A. Lubbe 14 (PRU)
Viscum obovatum	M.C. Ward 1671 (MH)

LYCOPODIACEAE

Lycopodium carolinianum	M.C. Ward 372 (MH)
Lycopodium carolinianum var. *carolinianum*	D.J. Botha 3474 (PRE)
Lycopodium cernuum	R.A. Lubbe 399 (PRU)

LYTHRACEAE

Nesaea crassicaulus	C.J. Ward 3713 (PRE)
Nesaea radicans var. *floribunda*	M. Bruton 16 (PRE)
Nesaea tolypobotrys	A.A. Balsinhas 3105 (PRE)

MALPIGHIACEAE

**Acridocarpus natalitius* var. *linearifolius*	R.A. Lubbe 105 (PRU)
Acridocarpus natalitius var. *natalitius*	H. Joffe 265 (PRE)
Sphedamnocarpus pruriens subsp. *pruriens*	R.A. Lubbe 198 (PRU)

MALVACEAE

Abutilon grandiflorum	R.A. Lubbe (sight record)
Abutilon grantii	R.A. Lubbe 370 (PRU)
Abutilon sonneratianum	Ward & Weisser (1991)
Gossypiodes kirkii	M.C. Ward 2289 (MH)
Hibiscus aethiopicus	R.A. Lubbe 97 (PRU)
Hibiscus aethiopicus var. *ovatus*	R.A. Lubbe 351, 569 (PRU)
Hibiscus altissimus	M.C. Ward 1216 (MH)
Hibiscus diversifolius subsp. *diversifolius*	R.A. Lubbe 325 (PRU)
Hibiscus schinzii	R.A. Lubbe 157 (PRU)
Hibiscus surattensis	R.A. Lubbe 230 (PRU)
Hibiscus tiliaceus	R.A. Lubbe 538 (PRU)
Pavonia leptocalyx	R.A. Lubbe 176 (PRU)
Sida cordifolia	R.A. Lubbe 197 (PRU)
Sida rhombifolia	R.A. Lubbe 369 (PRU)
**Thespesia acutiloba*	R.A. Lubbe 174, 178, 571, 727 (PRU)

MELASTOMATACEAE

Dissotis canescens	R.A. Lubbe 458, 699 (PRU)
Dissotis phaeotrichia var. *phaeotrichia*	R.A. Lubbe 434 (PRU)

MELIACEAE

Ekebergia capensis	R.A. Lubbe 148, 494 (PRU)
Melia azedarach	M.C. Ward 2140 (MH)
Trichilia dregeana	J. Vahrmeijer 1222 (PRE)
Trichilia emetica	M.C. Ward 473 (MH)
Turraea floribunda	R.A. Lubbe 250, 401, 505, 605 (PRU)
Turraea obtusifolia	M.C. Ward 896 (MH)

MELIANTHACEAE

Bersama lucens	R.A. Lubbe 610 (PRU)
Pseudobersama mossambicensis	Ward & Weisser (1991)

MENISPERMACEAE

Albertisia delagoensis	R.A. Lubbe (sight record)
**Cissampelos hirta*	R.A. Lubbe 88, 276 (PRU)
Cissampelos mucronata	E. Retief 831 (PRE)
Cissampelos torulosa	M.C. Ward 2197 (MH)
Tiliacora funifera	M.C. Ward 2203 (MH)
Tinospora caffra	M.C. Ward 1975 (MH)

MESEMBRYANTHEMACEAE

Carpobrotus dimidiatus	R.A. Lubbe 3, 628 (PRU)

MOLLUGINACEAE

Limeum viscosum subsp. *viscosum* var. *kraussii*	R.A. Lubbe 207, 636 (PRU)

MORACEAE

Ficus bubu	M.C. Ward 2536 (MH)
Ficus burtt-davyi	R.A. Lubbe 43, 179 (PRU)
Ficus craterostma	K.L. Tinley 130 (PRE)
Ficus lutea	J. Vahrmeijer 1212 (PRE)
Ficus natalensis subsp. *natalensis*	R.A. Lubbe 309, 644 (PRU)
Ficus polita var. *polita*	M.C. Ward 392 (MH)
Ficus sansibarica subsp. *sansibarica*	M.C. Ward 2536 (PRE)
Ficus stuhlmannii	R.A. Lubbe 614 (PRU)
Ficus sur	Ward & Weisser (1991)
Ficus tremula	M.C. Ward 423 (MH)
Ficus trichopoda	R.A. Lubbe 519 (PRU)
Ficus verruculosa	R.A. Lubbe 291, 725 (PRU)
Morus mesozygia	M.C. Ward 2192 (MH)

MYRICACEAE

Myrica serrata	R.A. Lubbe 263, 484 (PRU)

MYRSINACEAE

Embelia ruminata	Ward & Weisser (1991)
Maesa lanceolata	Ward & Weisser (1991)
Rapanea melanophloeos	R.A. Lubbe 261, 512 (PRU)

MYRTACEAE

Eugenia albanensis	M.C. Ward 348 (MH)
Eugenia capensis	R.A. Lubbe 593 (PRU)
**Eugenia mossambicensis*	R.A. Lubbe 206 (PRU)
Eugenia natalitia	De Winter & Vahrmeijer 8605 (PRE)
Eugenia woodii	R.A. Lubbe 534 (PRU)
Psidium guajava	R.A. Lubbe 56 (PRU)
Syzygium cordatum	J.B. Khoza 45 (MH)
**Syzygium cordatum* (suffruticose form)	R.A. Lubbe 422 (PRU)
Syzygium cuminii	M.C. Ward 1717 (MH)
Syzygium guineense	De Winter & Vahrmeijer 8578 (PRE)

NAJADACEAE

Najas horrida	C.J. Ward 8982 (PRE)
Najas marina subsp. *armata*	C.J. Ward 8953 (PRE)

NYCTAGINACEAE

**Commicarpus chinensis* subsp. *natalensis*	R.A. Lubbe 368, 642, 730 (PRU)
Commicarpus pentandrus	H.A. Junod 2171 (PRE)
Commicarpus plumbagineus	Ward & Weisser (1991)
Pisonia aculeata	M.C. Ward 393 (MH)

NYMPHAEACEAE

Nymphaea lotus	Strey & Moll 3925 (PRE)
Nymphaea nouchali var. *caerulea*	M.C. Ward 354 (MH)

OCHNACEAE

Ochna arborea var. *arborea*	Ward & Weisser (1991)
Ochna holstii	Ward & Weisser (1991)
Ochna natalitia	R.A. Lubbe 248 (PRU)
**Ochna natalitia* (suffruticose form)	M.C. Ward 224 (MH)
Ochna sp.	M.C. Ward 728 (MH)

OLACACEAE

Ximenia caffra var. *caffra*	R.A. Lubbe 1 (PRU)
Ximenia caffra var. *natalensis*	R.A. Lubbe 316, 577 (PRU)

OLEACEAE

Chionanthus battiscombei	Ward & Weisser (1991)
Chionanthus peglerae	Project Sibayi 334 (PRE)
Jasminum multipartitum	R.A. Lubbe 385 (PRU)
Jasminum streptopus var. *streptopus*	R.A. Lubbe 468, 423 (PRU)
Jasminum streptopus var. *transvaalensis*	R.A. Lubbe 174 (PRU)
Olea woodiana	M.C. Ward 2275 (MH)
Schrebera alata	R.A. Lubbe 265 (PRU)

OLINIACEAE

Olinia radiata	Project Sibayi 342 (PRE)

ONAGRACEAE

Ludwigia abyssinica	R.A. Lubbe 524 (PRU)
Ludwigia leptocarpa	M.C. Ward 456 (MH)

OPHIOGLOSSACEAE

Ophioglossum polyphyllum	M.C. Ward 1985 (MH)

ORCHIDACEAE

Acampe praemorsa	Vahrmeijer & Tolken 926 (PRE)
Acrolophia cochlearis	R.A. Lubbe 462 (PRU)
Aerangis mystacidii	R.A. Lubbe 139, 611 (PRU)

Aerangis sp.	R.G. Strey 8226 (PRE)
Angraecum cultriforme	K.L. Tinley 61 (PRE)
Ansellia africana	Ward & Weisser (1991)
**Bonatea lamprophylla*	R.A. Lubbe 376 (PRU)
Bonatea speciosa	R.A. Lubbe 327 (PRU)
Cheirostylis gymnochiloides	M.C. Ward 1018 (MH)
Cyrtorchis arcuata	R.A. Lubbe 599 (PRU)
Diaphananthe fragrantissima	R.A. Lubbe 623 (PRU)
Disa polygonoides	R.A. Lubbe 695 (PRU)
Disa similis	M.C. Ward 248 (MH)
Disa versicolor	J. Vahrmeijer 1064 (PRE)
Disa woodii	M.C. Ward 258 (MH)
Eulophia angolensis	R.A. Lubbe 115, 527 (PRU)
Eulophia clavicornis	A.J. Phelan 925 (MH)
Eulophia coeloglossa	M.C. Ward 1675 (MH)
Eulophia cucullata	R.A. Lubbe 283, 723 (PRU)
Eulophia ensata	R.A. Lubbe 284 (PRU)
Eulophia fridericii	K. Balkwill 643 (MH)
Eulophia horsfalli	A. Roberts 277 (PRE)
Eulophia longisepala	M.C. Ward 890 (PRE)
Eulophia milnei	E.J. Moll 4784 (PRE)
Eulophia odontoglossa	R.A. Lubbe 331 (PRU)
Eulophia speciosa	R.A. Lubbe 270, 476 (PRU)
Habernaria woodii	R.G. Strey 8189 (PRE)
Herschelianthe baurii	M.C. Ward 499 (MH)
Monodenia brevicornis	R.A. Lubbe 293 (PRU)
Platylepis glandulosa	J. Vahrmeijer 487 (PRE)
Polystachya sp.	R.G. Strey 8228 (PRE)
Satyrium hallackii subsp. *ocellatum*	Stephen, Van Graan & Schwabe 1180 (PRE)
Satyrium sphaerocarpum	R.A. Lubbe 332, 722 (PRU)
Satyrium trinerve	M.C. Ward 263 (MH)
Vanilla roscheri	M.C. Ward 338 (MH)

OXALIDACEAE

Oxalis semiloba	R.A. Lubbe 686 (PRU)

PASSIFLORACEAE

Adenia gummifera var. *gummifera*	R.A. Lubbe 169 (PRU)
Passiflora edulis	M.C. Ward 2732 (MH)
Schlechterina mitostemmatoides	M.C. Ward 1100 (MH)

PEDALIACEAE

Dicerocaryum eriocarpum	R.A. Lubbe 378 (PRU)
Dicerocaryum senecioides subsp. *senecioides*	R.G. Strey 4767 (PRE)
Sesamum alatum	M.C. Ward 547 (MH)
Sesamum triphyllum var. *triphyllum*	R.A. Lubbe 84 (PRU)

PERIPLOCACEAE

Cryptolepis capensis	J.J.F. Stephen 363 (PRE)
Cryptolepis obtusa	R.A. Lubbe 232 (PRU)
Raphionacme galpinii	R.A. Lubbe 200, 274 (PRU)
Tacazzea apiculata	R.A. Lubbe 526 (PRU)

PINACEAE	
Pinus elliottii	R.A. Lubbe (sight record)
PIPERACEAE	
Peperomia blanda var. *leptostachya*	J.D. Zwane (MH)
POACEAE	
Andropogon eucomus	De Winter & Vahrmeijer 8583 (PRE)
Andropogon gayanus var. *polycladus*	R.A. Lubbe 111 (PRU)
Andropogon huillensis	R.G. Strey 8250 (PRE)
Aristida congesta	R.A. Lubbe 296 (PRE)
Aristida congesta subsp. *barbicollis*	Project Sibayi 260 (PRE)
Aristida stipitata subsp. *graciliflora*	R.A. Lubbe 162 (PRU)
Bewsia biflora	R.A. Lubbe 166 (PRU)
Brachiaria arrecta	R.A. Lubbe 156 (PRU)
Brachiaria chusqueoides	R.A. Lubbe 495 (PRU)
Cenchrus brownii	R.P. Ellis 4059 (PRE)
Cymbopogon excavatus	G.J. du Toit 763 (PRE)
Cymbopogon plurinodis	M.C. Ward 369 (MH)
Cymbopogon validus	Ward & Weisser (1991)
Cynodon dactylon	Ward & Weisser (1991)
Dactyloctenium geminatum	M.C. Ward 935 (MH)
Dactylotenium australe	R.P. Ellis 3574 (PRE)
Digitaria angolensis	R.A. Lubbe 73 (PRU)
Digitaria eriantha	Tinley & Ward 11 (PRE)
Digitaria natalensis	M.C. Ward 370 (MH)
Digitaria rukwae	M.C. Ward 1404 (MH)
Digitaria scalarum	R.P. Ellis 4050 (PRE)
Diheteropogon amplectens	R.A. Lubbe 48 (PRU)
Elionurus muticus	Ward & Weisser (1991)
Eleusine coracana subsp. *africana*	M.C. Ward 1820 (MH)
Eragrostis capensis	R.A. Lubbe 10 (PRU)
Eragrostis ciliaris	R.A. Lubbe 74 (PRU)
Eragrostis curvula	R.P. Ellis 4050 (PRE)
Eragrostis glandulosipedata	C.J. Ward 10049 (MH)
Eragrostis gummiflua	R.A. Lubbe 214 (PRU)
Eragrostis inamoena	R.A. Lubbe 125, 143 (PRU)
Eragrostis lappula var. *lappula*	M.C. Ward 1834 (MH)
Eragrostis pallens	C.J. Ward 10041 (MH)
Eragrostis racemosa	Ward & Weisser (1991)
Eragrostis sarmentosa	De Winter & Vahrmeijer 8584 (PRE)
Eragrostis sclerantha subsp. *sclerantha*	R.A. Lubbe 654 (PRU)
Eragrostis superba	Ward & Weisser (1991)
Eulalia villosa	M.C. Ward 235 (MH)
Eustachys paspaloides	R.A. Lubbe 93 (PRU)
Hemarthria altissima	R.A. Lubbe 114 (PRU)
Hyparrhenia filipendula var. *filipendula*	R.A. Lubbe 151 (PRU)
Hyperthelia dissoluta	Ward & Weisser (1991)
Imperata cylindrica	R.A. Lubbe 92 (PRU)
Ischaemum fasciculatum	R.A. Lubbe 117 (PRU)
Leersia hexandra	R.A. Lubbe 622 (PRU)
Lepturus repens	K.L. Tinley 278 (PRE)
Megastachya mucronata	R.A. Lubbe 224 (PRU)

Melinis nerviglumis	R.A. Lubbe 709 (PRU)
Melinis repens subsp. *repens*	Ward & Weisser (1991)
Miscanthus capensis	Ward & Weisser (1991)
Monocymbium ceresiiforme	R.A. Lubbe 94 (PRU)
Oplismenus hirtellus	Ward & Weisser (1991)
Oryza sp.	H.H. Curson 33657 (PRE)
Panicum deustum	R.A. Lubbe 618 (PRU)
Panicum fluviicola	R.P. Ellis 4058 (PRE)
Panicum genuflexum	R.A. Lubbe 216 (PRU)
Panicum glandulopaniculatum	R.P. Ellis 4076 (PRE)
Panicum heterostachyum	M.C. Ward 1679 (PRE)
Panicum hymeniochilum	R.A. Lubbe 186 (PRU)
Panicum laticomum	M.C. Ward 1986 (MH)
Panicum maximum	A.J. Phelan 926 (MH)
Panicum parvifolium	C.J. Ward 10052 (MH)
Panicum repens	Vahrmeijer & Hardy 1621 (PRE)
Panicum sp.	Raven & Raven 26118 (PRE)
Panicum subalbidum	C.J. Ward 8822 (PRE)
Panicum subflabellatum	Ward & Weisser (1991)
Perotis patens	M.C. Ward 366 (MH)
Phragmites australis	R.A. Lubbe 225 (PRU)
Phragmites mauritianus	Ward & Weisser (1991)
Pogonarthria squarrosa	Ward & Weisser (1991)
Sacciolepis curvata	M.C. Ward 1851 (MH)
Setaria megaphylla	Ward & Weisser (1991)
Setaria sagittifolia	C.J. Ward 3227 (PRE)
Setaria sp.	A. Michelmore 29 (PRE)
Setaria sphacelata var. *sphacelata*	M.C. Ward 371 (MH)
Sorghastrum stipoides	R.A. Lubbe 102 (PRU)
Sporobolus africanus	Ward & Weisser (1991)
Sporobolus pyramidalis	M.C. Ward 934 (MH)
Sporobolus sp.	D. Edwards 2622 (PRE)
Sporobolus subtilis	R.A. Lubbe 101 (PRU)
Sporobolus subulatus	R.A. Lubbe 133 (PRU)
Sporobolus virginicus	R.A. Lubbe 627 (PRU)
Stenotaphrum dimidiatum	K.L. Tinley 436 (PRE)
Stenotaphrum secundatum	M.C. Ward 936 (MH)
Stipagrostis zeyheri subsp. *zeyheri*	Ward & Weisser (1991)
Themeda triandra	M.C. Ward 933 (MH)
Trachypogon spicatus	C.J. Ward 10047 (MH)
Trichoneura grandiglumis var. *minor*	R.G. Strey 5040 (PRE)
Trichoneura grandiglumis var. *grandiglumis*	R.A. Lubbe 167 (PRU)
Trichopteryx dregeana	J. Vahrmeijer 122 (PRE)
Triraphis andropogonoides	Ward & Weisser (1991)
Triraphis schinzii	R.A. Lubbe 89 (PRU)
Tristachya leucothrix	R.A. Lubbe 134 (PRU)
Urelytrum agropyroides	M.C. Ward 1844 (MH)

PODOCARPACEAE

**Podocarpus falcatus* (Maputaland Centre form)	M.C. Ward 2623 (MH)

POLYGALACEAE

Polygala capillaris	R.A. Lubbe 280 (PRU)
Polygala fruticosa	R.A. Lubbe 30, 715 (PRU)

Polygala gymnoclada	R.A. Lubbe 209 (PRU)
Polygala hottentotta	R.A. Lubbe 372, 685 (PRU)
Polygala producta	R.A. Lubbe 12 (PRU)
Polygala rehmannii	K. Balkwill 480 (MH)
Polygala sphenoptera	M.C. Ward 214 (MH)
Polygala uncinata	R.A. Lubbe 76 (PRU)

POLYGONACEAE

Oxygonum delagoense	G. Germishuizen 2024 (PRE)
Oxygonum dregeanum subsp. *dregeanum*	K. Balkwill 529 (MH)
**Oxygonum dregeanum* subsp. *streyi*	Vahrmeijer & Tolken 265 (PRE)
**Oxygonum robustum*	R.A. Lubbe 24, 448 (PRU)
Persicaria attenuata subsp. *africana*	M.C. Ward 223 (MH)
Persicaria lapathifolia	Ward & Weisser (1991)
Persicaria serrulata	R.A. Lubbe 112 (PRU)

POLYPODIACEAE

Microgramma lycopodioides	M.C. Ward 1096 (MH)
Microsorium punctatum	R.A. Lubbe 481 (PRU)
Microsorium scolopendrium	M.C. Ward 1440 (MH)
Polypodium lycopodioides	K.L. Tinley 169 (PRE)

PORTULACACEAE

Portulaca kermesina	R.A. Lubbe 547 (PRU)
Portulacaria afra	Ward & Weisser (1991)

POTAMOGETONACEAE

Potamogeton pectinatus	M.C. Ward 453 (MH)
Potamogeton schweinfurthii	M.C. Ward 452 (MH)

POTTIACEAE

Tortella humilis	S.E. Wood 40 (PRE)
Trichostomum brachydontium	Aitken & Gale 2 (PRE)

PSILOTACEAE

Psilotum nudum	Ross & Moll 1835 (PRE)

PTAEROXYLACEAE

Ptaeroxylon obliquum	R.J. Rodin 4692 (PRE)

RESTIONACEAE

Restio zuluensis	R.A. Lubbe 121, 190, 581 (PRU)

RHAMNACEAE

Berchemia discolor	Moll & Nel 5618 (PRE)
Lasiodiscus mildbraedii	R.A. Lubbe 384, 456 (PRU)
Scutia myrtina	R.A. Lubbe 576 (PRU)

Ziziphus mucronata subsp. *mucronata*	J.J.F. Stephen 35 (PRE)

RHIZOPHORACEAE

Bruguiera gymnorrhiza	M.C. Ward 1323 (MH)
Cassipourea gerrardii	C.J. Ward & M.C. Ward 93 (MH)
Cassipourea gummiflua var. *verticillata*	A.B. Cunningham 629 (MH)
Ceriops tagal	M.C. Ward 1322 (MH)
Rhizophora mucronata	M.C. Ward 1324 (MH)

RICCIACEAE

Riccia stricta	F. Eyles 1405 (PRE)

ROSACEAE

Rubus longepedicellatus	R.A. Lubbe 441 (PRU)
Rubus pinnatus	R.A. Lubbe 397 (PRU)
Rubus rigidus	M.C. Ward 265 (MH)

RUBIACEAE

Agathisanthemum bojeri subsp. *bojeri*	R.A. Lubbe 438 (PRU)
**Ancylanthos monteiroi*	R.A. Lubbe 249, 330, 427, 578 (PRU)
Anthospermum littoreum	Ward & Weisser (1991)
Anthospermum rigidum subsp. *pumilum*	R.A. Lubbe 349 (PRU)
Burchellia bubalina	R.A. Lubbe 449 (PRU)
Canthium ciliatum	Ward & Weisser (1991)
Canthium inerme	R.A. Lubbe 55, 394, 445 (PRU)
**Canthium setiflorum* subsp. *setiflorum*	R.A. Lubbe 187, 406, 426, 508, 591, 693 (PRU)
Catunaregam spinosa subsp. *spinosa*	R.A. Lubbe 320, 380, 403, 450, 451, 560 (PRU)
Coddia rudis	R.A. Lubbe 312 (PRU)
**Coffea racemosa*	M.C. Ward 2401 (MH)
Galopina tomentosa	R.A. Lubbe 69, 154, 163 (PRU)
Gardenia volkensii subsp. *volkensii* var. *volkensii*	P. van Wyk 1392 (PRU)
**Gardenia volkensii* subsp. *volkensii* var. *saundersiae*	De Winter & Vahrmeijer 8602 (PRE)
Guettarda spesiosa	R.A. Lubbe 259 (PRU)
Keetia gueinzii	M.C. Ward 1086 (MH)
Kohautia amatymbica	R.A. Lubbe 702 (PRU)
Kohautia caespitosa subsp. *brachyloba*	R.A. Lubbe 46 (PRU)
Kohautia virgata	R.A. Lubbe 215, 295, 436 (PRU)
Kraussia floribunda	R.A. Lubbe 15, 521 (PRU)
**Lagynias lasiantha*	R.A. Lubbe 470, 510 (PRU)
Oldenlandia affinis subsp. *fugax*	R.A. Lubbe 165, 414 (PRU)
**Oxyanthus latifolius*	R.A. Lubbe 238 (PRU)
Oxyanthus speciosus subsp. *gerrardii*	Ward & Weisser (1991)
Pavetta capensis subsp. *komghensis*	M.C. Ward 285 (MH)
Pavetta edentula	P. van Wyk 782 (MH)
**Pavetta gerstneri*	R.A. Lubbe 486, 739 (PRU)
Pavetta gracifolia	H.J.T. Venter 5635 (PRE)
Pavetta lanceolata	J.V. van Greuning 495 (PRE)
Pavetta revoluta	R.A. Lubbe 533 (PRU)
Pavetta sp.	P. van Wyk 7 (MH)
Pentanisia prunelloides subsp. *prunelloides*	M.C. Ward 216 (MH)
Pentarrhinum insipidum	R.A. Lubbe 85 (PRU)
Pentas micrantha subsp. *wyliei*	M.C. Ward 2731 (MH)

Pentodon pentandrus var. *minor*	R.A. Lubbe 116 (PRU)
Phylohydrax carnosa	R.A. Lubbe 585 (PRU)
**Plectroniella armata*	R.A. Lubbe 552 (PRU)
Psychotria capensis var. *capensis*	R.A. Lubbe 87, 444 (PRU)
**Psydrax fragrantissima*	M.C. Ward 1822 (MH)
**Psydrax locuples*	R.A. Lubbe 395, 455, 511 (PRU)
Psydrax obovata subsp. *obovata*	R.A. Lubbe 217 (PRU)
Rothmannia globosa	Ward & Weisser (1991)
Richardia brasiliensis	R.A. Lubbe 555 (PRU)
Spermacoce senensis	K. Balkwill 504 (MH)
Tapiphyllum sp.	H.J.T. Venter 6176 (PRE)
**Tarenna junodii*	R.A. Lubbe 428, 502 (PRU)
Tarenna littoralis	R.A. Lubbe 218, 254, 386, 617 (PRU)
Tarenna pavettoides subsp. *pavettoides*	D.J. Botha 3489 (PRE)
Tarenna sp.	Project Sibayi 294 (PRE)
Tarenna supra-axillaris subsp. *barbertonensis*	Ward & Weisser (1991)
Tricalysia capensis var. *capensis*	R.A. Lubbe 313, 381, 507, 532, 564 (PRU)
**Tricalysia delagoensis*	R.A. Lubbe 142 (PRU)
Tricalysia junodii var. *junodii*	Ward & Weisser (1991)
Tricalysia lanceolata	K.L. Tinley 112 (PRE)
Tricalysia sonderana	R.A. Lubbe 171, 255, 387 (PRU)
Tricalysia sp.	R.A. Lubbe 142 (PRU)
Vangueria infausta subsp. *infausta*	R.A. Lubbe 8 (PRU)
Vangueria randii subsp. *chartacea*	M.C. Ward 2652 (PRE)

RUTACEAE

Calodendrum capense	M.C. Ward 2200 (MH)
Clausena anisata	R.A. Lubbe 392, 737 (PRU)
Teclea gerrardii	M.C. Ward 2137 (MH)
Teclea natalensis	Ward & Weisser (1991)
Teclea nobilis	Vahrmeijer & Tolken 235 (PRE)
Vepris lanceolata	R.A. Lubbe 590 (PRU)
Vepris sp.	J.J.F. Stephen 428 (PRE)
Zanthoxylum capense	R.A. Lubbe 357 (PRU)

SANTALACEAE

Colpoon compressum	M.C. Ward 1721 (MH)
Osyridicarpos schimperianus	M. Jordaan 486 (PRE)
Thesium gypsophiloides	K. Balkwill 485 (MH)
Thesium polygaloides	M.C. Ward 503 (MH)
Thesium scirpioides	R.G. Strey 5116 (PRE)
Thesium triflorum	M.C. Ward 2684 (PRE)
**Thesium vahrmeijeri*	Brenan & Vahrmeijer 14221 (PRE)

SAPINDACEAE

Allophylus decipiens	J. Vahrmeijer 441 (PRE)
Allophylus dregeanus	R.A. Lubbe 620 (PRU)
Allophylus melanocarpus	J. Vahrmeijer 705 (PRE)
Allophylus natalensis	R.A. Lubbe 181 (PRU)
Atalaya natalensis	Ward & Weisser (1991)
Blighia sp.	J. Vahrmeijer 564 (PRE)
Blighia unijugata	R.A. Lubbe 485 (PRU)
Deinbollia oblongifolia	R.A. Lubbe 252 (PRU)

Dodonaea angustifolia	M.C. Ward 437 (MH)
Pancovia golungensis	R.A. Lubbe 471, 741 (PRU)

SAPOTACEAE

Bequaertiodendron natalense	Ward & Weisser (1991)
Chrysophyllum viridifolium	M.C. Ward 332 (MH)
Inhambanella henriquesii	D. Edwards 2547 (PRE)
Manilkara concolor	Project Sibayi 348 (PRE)
Manilkara discolor	R.A. Lubbe 469 (PRU)
Mimusops obovata	J. Vahrmeijer 1079 (PRE)
Mimusops caffra	R.A. Lubbe 199 (PRU)
Sideroxylon inerme subsp. *inerme*	R.A. Lubbe 607 (PRU)
Vitellariopsis marginata	Project Sibayi 370 (PRE)

SCHIZAEACEAE

Lygodium microphyllum	M.C. Ward 1845 (MH)

SCROPHULARIACEAE

Alectra sessiliflora var. *sessiliflora* forma *barbata*	R.A. Lubbe 294 (PRU)
Buchnera dura	R.A. Lubbe 50, 337 (PRU)
Buttonia natalensis	A.B. Cunningham 626 (MH)
Cycnium adonense subsp. *adonense*	M.C. Ward 254 (MH)
Cycnium racemosum	R.A. Lubbe 701 (PRU)
Halleria lucida	J. Vahrmeijer 1197 (PRE)
Manulea crassifolia subsp. *crassifolia*	E. Retief 833 (MH)
Manulea parviflora var. *parviflora*	M.C. Ward 241 (MH)
Manulea sp.	R.A. Lubbe 34 (PRU)
Nemesia caerulea	M.C. Ward 1020 (MH)
Nemesia denticulata	R.A. Lubbe 304 (PRU)
Sopubia simplex	R.A. Lubbe 432, 528, 700 (PRU)
Striga bilabiata	R.A. Lubbe 39 (PRU)
Striga elegans	R.A. Lubbe 319 (PRU)
Striga gesneriodes	R.A. Lubbe 205 (PRU)
**Striga junodii*	R.A. Lubbe 336 (PRU)
Zaluzianskya pachyrrhiza	R.A. Lubbe 297 (PRU)

SELAGINACEAE

Hebenstretia comosa	R.A. Lubbe 267, 650 (PRU)
Hebenstretia dentata	Ward & Weisser (1991)
Hebenstretia dura	K. Balkwill 573 (MH)

SMILACACEAE

Smilax anceps	R.A. Lubbe 147 (PRU)

SOLANACEAE

Cestrum laevigatum	R.A. Lubbe 257, 677 (PRU)
Lycium acutifolium	M.C. Ward 1601 (MH)
Solanum linnaeanum	P.E. Hulley 27 (PRE)
Solanum monotanthum	J. Vahrmeijer 739 (PRE)
Solanum nodiflorum	R.A. Lubbe 365 (PRU)

Solanum panduriforme	R.A. Lubbe 690 (PRU)
Solanum rigescens	R.A. Lubbe 424 (PRU)
Withania somnifera	R.A. Lubbe 245 (PRU)
SPHAGNACEAE	
Sphagnum truncatum	C.J. Ward 6568 (PRE)
STANGERIACEAE	
Stangeria eriopus	R.G. Strey 8182 (PRE)
STERCULIACEAE	
Cola greenwayi	R.A. Lubbe 383 (PRU)
Cola natalensis	Strey & Moll 3961 (PRE)
Dombeya tiliacea	Ward & Weisser (1991)
Hermannia spinosa	G. Germishuizen 2423 (PRE)
Waltheria indica	R.A. Lubbe 129 (PRU)
STRELITZIACEAE	
Strelitzia nicolai	J.J.F. Stephen 358 (PRE)
THELYPTERIDACEAE	
Thelypteris interrupta	M.C. Ward 848 (MH)
THYMELAEACEAE	
Dais cotinifolia	M.C. Ward 315 (MH)
Gnidia splendens	R.A. Lubbe 210, 343 (PRU)
Passerina rigida	M.C. Ward 2167 (MH)
Peddiea africana	R.A. Lubbe 473, 562 (PRU)
Synaptolepis kirkii	R.A. Lubbe 41 (PRU)
TILIACEAE	
**Corchorus junodii*	R.A. Lubbe 168, 447 (PRU)
Corchorus tridens	J. Vahrmeijer 581 (PRE)
Grewia bicolor	P. van Wyk 1398 (PRU)
Grewia caffra	R.A. Lubbe 175, 499, 603, 731 (PRU)
Grewia occidentalis	R.A. Lubbe 329, 732 (PRU)
Triumfetta rhomboidea	R.A. Lubbe 195 (PRU)
TURNERACEAE	
**Tricliceras mossambicense*	R.A. Lubbe 80 (PRU)
TYPHACEAE	
Typha capensis	Strey & Moll 3861 (PRE)
ULMACEAE	
Celtis africana	R.A. Lubbe 251 (PRU)

Chaetacme aristata	R.A. Lubbe 497 (PRU)
Trema orientalis	R.A. Lubbe 20, 472 (PRU)

URTICACEAE

Laportea peduncularis subsp. *latidens*	M.C. Ward 1982 (MH)
Laportea peduncularis subsp. *peduncularis*	Ward & Weisser (1991)

VERBENACEAE

Avicennia marina	P. van Wyk 3016 (PRU)
Clerodendrum glabrum var. *glabrum*	R.A. Lubbe 16, 503 (PRU)
Clerodendrum myricoides	M.C. Ward 1889 (MH)
Lantana camara	R.A. Lubbe 676 (PRU)
Lantana rugosa	R.A. Lubbe 95, 172 (PRU)
Lippia javanica	R.A. Lubbe 553 (PRU)
Phyla nodiflora var. *nodiflora*	M.C. Ward 292 (MH)
Priva cordifolia var. *abyssinica*	C.M. Breen 378 (PRE)
Priva meyeri	M.C. Ward 466 (MH)
Vitex amboniensis	R.A. Lubbe 478, 598 (PRU)

VITACEAE

Cissus quadrangularis	J. Vahrmeijer 1038 (PRE)
Cyphostemma cirrhosum	Ward & Weisser (1991)
Rhoicissus digitata	R.A. Lubbe 202 (PRU)
Rhoicissus revoilii	M.C. Ward 1407 (MH)
Rhoicissus rhomboidea	Ward & Weisser (1991)
**Rhoicissus sessilifolia*	Project Sibayi 293 (PRE)
Rhoicissus sp.	Stephen & Van Graan 1295 (PRE)
Rhoicissus tomentosa	J. Vahrmeijer 576 (PRE)

VITTARIACEAE

Vitaria isoetifolia	De Winter & Vahrmeijer 8607 (PRE)

XYRIDACEAE

Xyris anceps	R.A. Lubbe 113 (PRU)
Xyris congensis	R.A. Lubbe 719 (PRU)
Xyris natalensis	D. Edwards 2606 (PRE)

ZAMIACEAE

**Encephalartos ferox*	Ward & Weisser (1991)

ZANNICHELLIACEAE

Halodule uninervis	C.J. Ward 9974 (MH)
Thalassodendron ciliata	A.B. Cunningham (MH)

ZOSTERACEAE

Zostera capensis	C.J. Ward 9971 (MH)