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# Distribution and classification of swamp forests in the Lake St. Lucia area

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The distribution of swamp forests between Sodwana Bay and the Msunduze river was mapped. Selected swamp forests were classified using two-way indicator species analysis (TWINSpan). Two major communities, namely *Phoenix reclinata* - *Microsorium punctatum* - *Protosparagus falcatus* forests and *Barringtonia racemosa* - *Nephrolepis bisserata* forests were identified.

Moeraswoude tussen Sodwana Baai en die Msunduze rivier is gekarteer. Geselekteerde woude is deur middel van tweerigting indikatorspesie-analise (TWINSpan) geklassifiseer. Twee gemeenskappe, naamlik *Phoenix reclinata* - *Microsorium punctatum* - *Protosparagus falcatus* woude en *Barringtonia racemosa* - *Nephrolepis biserrata* woude is geïdentifiseer.

**Keywords:** Swamp forest, classification, TWINSpan

## SAMEVATTING

Baie min is oor Suid-Afrikaanse moeraswoude bekend. Beskikbare literatuur is byna totaal beskrywend en gebiedsgebonde van aard (Henkel et al. 1936; Huntley 1965; Kriel et al. 1966; Tinley 1976; Begg 1980; Bruton 1980; Moll 1980; Cooper 1985). Moeraswoude is die tweede skaarsste bostipe in Suid-Afrika, en beslaan 'n area van slegs 4 843 ha (Cooper 1985). Groot gebiede van hierdie bostipe word bedreig deur -landbou- en bosboubedrywighe, en waarskynlik ook deur die beoogde duinmynboubedrywighe aan die oostelike oewers van die St Lucia-strandmeer. Cooper (1985) het dus streng bewaringstatus vir die oorblywende bosse aangevra.

Cooper (1985) glo dat Suid-Afrikaanse moeraswoude 'n belangrike sedimentfiltrasierol vervul.

Geen ander waarde word aan Suid-Afrikaanse moeraswoude toegedig nie. Ondersoeke in Amerikaanse laaglandse hardehoutbosse (verwant aan moeraswoude in Afrika) het aangedui dat hierdie bosse talle gebruikseenskappe het. Hulle ondersteun ho omgewingsvogtigheid en 'n verskeidenheid flora en fauna, help om die gehalte van water en habitate in stroomafstelsels te beskerm, en dien as berggebiede vir vloedwater (Gosselink en Lee 1989). In die Verenigde State is die houtopbrengs die opvallendste oesbare hulpbron in die laaglandse hardehoutbosse (Turner et al. 1981). In Florida word sipresmoerasse sedert 1973 aangewend as tersire behandelingsentrums vir huishoudelike afloopwater, en is hulle 60% meer kostedoeltreffend as konvensionele fisiese behandelingsaanle (Maltby 1986). 'n Studie is in die moeraswoude tussen Sodwanabaai en die Msunduze-rivier in Zoeloeland uitgevoer om noodsaaklike basislyndata oor die verspreiding, samestelling en dinamiek van die Suid-Afrikaanse moeraswoude in te win. Hierdie referaat doen verslag oor die kartering van die verspreiding van die moeraswoude, en gee ook 'n hiërgiesse floristiese klassifikasie van geselekteerde woude aan. Ander referate sal die plant-terreinverwantskappe en bevolkingsdemografie en -dinamika behandel.

## INTRODUCTION

Very little is known about South African swamp forests. Available literature is almost entirely descriptive and regional in nature (Henkel *et al.* 1936; Huntley 1965; Kriel *et al.* 1966; Tinley 1976; Begg 1980; Bruton 1980; Moll 1980; Cooper 1985). Swamp forest is the second rarest forest type in South Africa, having a total area of only 4843 hectares (Cooper 1985). Large areas of this forest type are threatened by agriculture and forestry, and possibly by the proposed dune mining on Eastern Shores of the Lake St. Lucia estuary. Cooper (1985) has therefore called for strict conservation status of the remaining forests.

Cooper (1985) suggests that South African swamp forests may perform an important sediment filtering role. No other values have been attributed to South African swamp forests. Studies in American bottomland hardwood forests (akin to African swamp forests) have indicated that these forests have many useful attributes. They support a high density and diversity of flora and fauna, help to protect the quality of water and habitat in downstream systems, and serve as flood water storage areas (Gosselink & Lee 1989). In the United States the most obvious harvestable resource in bottomland hardwood forests is the timber crop (Turner *et al.* 1981). In Florida, cypress swamps have been used as tertiary treatment centres for domestic waste waters since 1973 and are 60% more cost effective than conventional physical treatment plants (Maltby 1986).

A study was initiated in the swamp forests between Sodwana Bay and the Msunduze river in Zululand to provide much needed baseline data on the distribution, composition and dynamics of South African swamp forests. This paper reports on the mapping of the distribution of the swamp forests, as well as a hierarchical floristic classification of selected forests. Further papers will deal with plant-site relationships and population demography and dynamics.

## STUDY AREA

The study area covers approximately 2960 km<sup>2</sup>, from Sodwana Bay in the north to the Msunduze river in the south, and from the N2 Highway in the west to the coastal dunes in the east (between 27° 33' and 28° 30' South latitude and 32° 17' and 32° 41' East longitude). The detailed studies were confined to the swamp forests occurring along the streams meandering through the coastal plains on Eastern Shores, Nyalazi and Dukuduku State Forests (Figure 1).

The study area forms part of the Mozambique Coastal Plain which extends from Mtunzini in the south and broadens northward into Mozambique. The coastal plain is characterized by high dunes along the coast giving way inland to a series of lower dune ridges and slacks (Hobday 1965). The geology of the area has not been mapped in detail, but Lindley & Scott (1987) extrapolated the geology from geological sections at Richards Bay. The underlying formation is comprised of low permeability Cretaceous siltstones. The overlying formations are comprised of unconsolidated Pleistocene fine sand, with silt, clay and organic material of alluvial estuarine and aeolian origin. The Pleistocene deposits are covered by shallow Holocene sands (Hobday 1976).

Impeded drainage and poor aeration characterize the Sterkspruit, Valsrivier and Katspruit soil forms of the depressions and pans of the Nyalazi area (Jacobs *et al.* 1989). Fernwood (Warrington and Shasha series) or Champagne soil forms dominate the pans and depressions on Eastern Shores and have a relatively low organic carbon content (Schafer & Van Wyk 1988). Water tables were found to fluctuate to the surface of these soils and were recorded at depths of between 200 mm and 600 mm at the time of the survey. South of the Bhangazi pan an irregular sequence of fine sands, sandy loams and fine silty sands occur with discontinuous bands of peat and clay (Reid 1969). These layers may form impermeable layers resulting in perched water tables. An electrical sounding profile on Eastern Shores showed that immediately beneath the surface layer of dry sand, a water-bearing layer of sand overlies a clayey bedrock (Van Zijl 1971).

The area is part of the coastal lowland bioclimatic subregion (Phillips 1973; Taylor 1982) and transitional between the tropical and sub-tropical climatic regions (Stuckenburg 1969). The anti-cyclonic or orographic rainfall is influenced by the proximity of the sea and the topography of the land. It occurs in longitudinal zones with the highest isohyets along the coastal dunes, with a mean annual rainfall of 1157 mm at the estuary mouth and a decrease in a north-westerly direction to 623 mm in the northern section of False Bay (Venter 1979; Taylor 1980). The wettest months are January to April and the driest months July to September (Venter 1979; Jacobs *et al.* 1989).

At Charter's Creek weather station, the mean annual temperature to the west of the lake is 21.5° C. The highest monthly mean is 35.3° C in January and the lowest monthly mean 5.5° C in July (Taylor 1982; Jacobs *et al.* 1989). East of the lake, mean monthly maximum temperatures recorded at Cape St. Lucia range from 21.3° C to 28.5° C with extremes being moderated to some extent by the proximity of the sea and the

warm Mozambique current (Taylor 1980).

## METHODS

A stereoscope was used to map all swamp forests occurring between Sodwana Bay and the Msunduze river on 1:50000 aerial photographs. Units were verified in the field as far as possible and their boundaries then copied onto 1:50000 topocadastral maps. ARC/INFO GIS software (1990) was used to map swamp forest localities and to calculate their individual areas.

Only the swamp forests occurring on the Dukuduku, Nyalazi and Eastern Shores State Forests were sampled. These were randomly sampled to determine a broad classification of the different swamp forest communities. Twenty three circular plots of 400 m<sup>2</sup> were initially sampled. All plant species were recorded and three strata were recognized, a canopy layer, a shrub layer and a herbaceous layer.

Trees and shrubs of > 5.0 metres height, ie. the canopy stratum, were recorded by DBH and species. True shrubs and saplings of canopy tree species between 0.4 m and 5.0 m high, the shrub stratum, were recorded by number of plants (frequency). The herbaceous component (less than 0.4 m) was evaluated on a presence/absence basis. Nomenclature follows Gibbs-Russell *et al.* (1985 & 1987). It was possible for a particular tree or shrub species, depending on its structural attributes, to be present in all three layers.

A standardized method was developed to enumerate *Ficus trichopoda*. This species has a peculiar growth form in that main branches have the tendency to grow horizontally and are supported by stilt-roots. These stilt-roots eventually develop into separate trees, and as such it is difficult to identify the parent tree. For the purposes of this study, each vertical stem > 5 m height was considered to be a separate tree. Horizontal stems were disregarded. A number of other tree species occasionally develop multi-stems. Stems (> 5 m) of trees that were multi-stemmed below breast height (1.3 m), were measured and recorded separately.

The data set was classified using two-way indicator species analysis (TWINSPAN; Hill 1979). The number of stems per plot (canopy and shrub layers) and the presence or absence of species in the herbaceous component was used for the input matrix. TWINSPAN is a computer program developed essentially for analyzing data sets in which the frequencies of species have been recorded for a set of samples. The program splits the samples into groups through a series of successive divisions. Using the groups of samples as a basis,

the species are then classified according to their preferentiality to either side of a division. Several species may be identified as being particularly diagnostic of each division in the classification. The output is in the form of a two-way table that clearly demonstrates the association between species and samples (Hill 1979).

For the purposes of this study seven pseudospecies cut levels (levels of species' abundance) were used for the TWINSpan classification, that is, 0-2, 2-5, 5-10, 10-20, 20-40, 40-80 and > 80. In this instance, pseudospecies 1 was a species occurring once in a plot, pseudospecies 2 had 2 to 4 stems in a plot, and pseudospecies 7 had 80 or more stems in a plot. Because the species in the herbaceous component were evaluated on a presence/absence basis, those present in a plot were assigned a value of 1.

On the basis of the preliminary classification, swamp forests representing four broad community types were randomly selected for sampling. Forty (400 m<sup>2</sup>) circular plots were sampled along transects. These transects were placed across the main water-drainage channels in the most representative parts of the selected forests. Two transects were sampled per broad forest type. In order to monitor transitions in floristic composition across drainage lines, plots were sampled in floristically distinct parts of the forests. Three to eight plots were sampled per transect, depending on the variability and size of a forest.

The final data set (63 plots) was classified using TWINSpan. Species occurring less than three times in the data set were omitted. Sample plots 10, 17 and 27 were omitted due to alien infestation and recent human disturbance. The two-way table for this final classification was re-arranged so that species preferential to the same plots were grouped in descending order of abundance.

## RESULTS

### Distribution

Figure 1 indicates the distribution of the swamp forests in the study area. The swamp forests occurring between Sodwana Bay and the Msunduze river can easily be recognized on aerial photographs of the area. They occur mainly in drainage lines and are differentiated from other forest types as physiognomically homogeneous units. The units on the Dukuduku, Nyalazi and Eastern Shores State Forests were visited. All were verified as swamp forests. Units north of Lake Bhangazi were not visited because of time constraints and inaccessibility. The total area of swamp forest in the study area is 3095 ha. The largest swamp forest occurs adjacent to the Mfabeni swamp on Eastern Shores. It covers an area of 352 ha.

## Composition

Eighty nine plant species were recorded in the sampled forests. Trees are the most abundant life form making up 42.7% of the flora (38 species), followed by creepers (15.7 %) and ferns (10.1%). All species, except those occurring less than three times, are listed in Table 1.

## Classification

The classification of 60 sample plots is presented in a two-way phytosociological table (Table 1). The classifications of the plots and of the species are indicated along the bottom and right margins respectively. Plots with similar species composition have been grouped into communities and sub-communities. The divisions are indicated by the vertical separations. The values for each species denote categories of abundance defined by the 7 pseudospecies cut levels.

The first division split the swamp forests into two communities: a community in which *Phoenix reclinata*, *Microsorium punctatum* and *Protosparagus falcatus* are diagnostic (Community 1), and a *Barringtonia racemosa* - *Nephrolepis biserrata* community (Community 2).

Community 1 was split into two sub-communities: one with *Phoenix reclinata* as the diagnostic species, and one which has no indicator species. Community 2 was split into two sub-communities. *Barringtonia racemosa* and *Tarenna pavettoides* are indicator species of the first sub-community, and the second has no diagnostic species. Further levels of division were ignored because only Community 1, and Community 2 and its two sub-communities, can be recognised in the field.

Five species groups were identified. The species in group A are preferential to Community 1. Species in group B are preferential to Community 1 and the *Barringtonia racemosa* - *Tarenna pavettoides* sub-community. Group C is comprised of species which are non-preferential. The species of group D are preferential to the *Barringtonia racemosa* - *Tarenna pavettoides* sub-community. Although the species in group E are widely distributed they appear to be more preferential to sub-community 2.2.

## Description of the communities

### 1. The *Phoenix reclinata* - *Microsorium punctatum* - *Protosparagus falcatus* community

The indicator species for this community are *Phoenix reclinata*, *Microsorium punctatum* and *Protosparagus*

*falcatus*. However in the field this community can more easily be recognized by a well developed canopy dominated by *Ficus trichopoda*. There is also a greater diversity of species in this community than in Community 2. The species in species group A are preferential to this community. The understorey usually consists of a dense entanglement of *F. trichopoda* horizontal branches and stilt roots, *Phoenix reclinata* shrubs, ferns and creepers.

Apart from the diagnostic *Phoenix reclinata*, other preferential tree species include *Schefflera umbellifera*, *Scolopia zeyheri*, *Ilex mitis* and *Trichilia dregeana*. *Voacanga thouarsii* and *Bridelia micrantha* are also common components of the canopy.

The fern *Microsorium punctatum* is a diagnostic species in the shrub layer of this community. True shrub species that are preferential are *Kraussia floribunda* and *Bersama lucens*. The understorey shrub layer is, however, dominated by *Tarenna pavettoides*. *Psychotria capensis* is also abundant in most of the plots.

*Protosparagus falcatus*, a creeper, is another diagnostic species for this community. There are three other preferential creeper species, *Mikania natalensis*, *Rhus nebulosa* and *Urera cameroonensis*.

The herbaceous layer is poorly developed but is represented by a greater number of species than in Community 2. *Crassocephalum crepidioides* and a species of *Plectranthus* were found only in this community. The herbaceous layer consists mainly of the seedlings of *V. thouarsii*, *B. micrantha* and *T. pavettoides*. Two orchids, *Cyrtorchus arcuata* and *Eulophia horsfallia* were recorded only in this community. The two sub-communities cannot be differentiated in the field and have therefore not been discussed.

## 2. The *Barringtonia racemosa* - *Nephrolepis biserrata* community

The two indicators for this community are *Barringtonia racemosa* and the fern *Nephrolepis biserrata*. This community-comprising 37 plots has been split into two sub-communities: a *Barringtonia racemosa* - *Tarenna pavettoides* sub-community comprising 26 plots, and a sub-community (the *Syzygium cordatum* sub-community) comprising 11 plots. Although *Barringtonia racemosa* is an indicator species for Community 2, it does not occur at all in the *Syzygium cordatum* sub-community. In the field the two sub-communities appear to be very dissimilar. It was therefore decided not to discuss Community 2 as a whole, but rather to address the two sub-communities separately.

### 2.1 The *Barringtonia racemosa* - *Tarenna pavettoides* sub-community

The most distinctive feature of this sub-community is the open understorey which lacks the *F. trichopoda* entanglement of Community 1 and the dense fern undergrowth of sub-community 2.2. Also characteristic is the complete dominance of *Barringtonia racemosa*. The species in Species Group D show preference to this sub-community.

The indicator tree species for this sub-community are *B. racemosa* and *Tarenna pavettoides*. The other preferential tree species are *Cussonia sphaerocephala*, *Ficus sur*, *Bridelia micrantha* and *Mimusops obovata*. *Voacanga thouarsii* occurs abundantly and *Cassipourea gummiflua* and *Bridelia micrantha* are fairly common. Although fairly abundant, *Ficus trichopoda* occurs primarily as single-stemmed specimens along the banks of the main drainage channel. Less common components of the canopy are *Sapium ellipticum* and *Syzygium cordatum*. *Macaranga capensis* is generally confined to the peripheries.

Indicator species for the shrub layer are again *B. racemosa* and *Tarenna pavettoides*, which are also dominant at this level. *B. Racemosa* saplings grow in gaps in dense clusters. Preferential species are *Burchellia bubalina*, *Ficus sur*, *Mimusops obovata* and *Allophylus dregeanus*. *Voacanga thouarsii* also usually occurs in high frequencies in this layer. *Scleria angusta* is quite abundant and can be seen growing mainly in canopy gaps where surface water is present. The ferns *Stenoclaena tenuifolia* and *Nephrolepis biserrata* are abundant. The creepers *Mikania natalensis* and *Canavallia rosea* are preferential to this sub-community.

The herbaceous layer is very impoverished. Very few true herbs were recorded and it is basically tree and shrub seedlings that constitute this layer. Near the banks of streamlets, where flood waters have presumably deposited the buoyant fruit, the seedlings of *B. racemosa* grow profusely. Even when floating in isolated pools or behind obstructions in the watercourse, *B. racemosa* seeds germinate freely. *V. thouarsii*, *Psychotria capensis* and *Tarenna pavettoides* seedlings occur as scattered individuals throughout.

### 2.2 The *Syzygium cordatum* sub-community

This sub-community is characterized by a poorly developed canopy comprised mainly of large but widely spaced *Syzygium cordatum* trees of up to 30 metres and more in height. The most distinctive feature of this community however, is the abundance of the ferns *Nephrolepis biserrata* and *Stenoclaena tenuifolia*. The species of Species Group E show preferentiality towards this sub-community.

Although there are no indicator species for this sub-community it may be recognised by the dominance of *Syzygium cordatum* and the relatively high frequencies of *Rapanea melanophloeos* and *Myrica serrata*. *R. melanophloeos* does not appear to be a peripheral species and may occur in clustered stands throughout the forest. *Voacanga thouarsii* is again a common component of the canopy. *Cassipourea gummiflua* and *Macaranga capensis* occur as scattered individuals.

Apart from the dense thickets of *Nephrolepis biserrata* the shrub stratum is poorly developed. Saplings of *Syzygium cordatum*, *Rapanea melanophloeos* and *Voacanga thouarsii* occur in moderate abundance. The only true shrub that occurs in any abundance is *Psychotria capensis*. *Myrica serrata* although occurring primarily on the peripheries may occur erratically throughout the community. *Nephrolepis biserrata* dominates the shrub layer and forms dense impenetrable thickets over two metres high. *Stenoclaena tenuifolia* is abundant and climbs up tree stems into the canopy. *Scleria angusta* occurs in open areas where surface water is present.

The herbaceous layer is negligible, smothered almost entirely by *Nephrolepis biserrata*. Very few seedlings are present. In open patches of surface water *Nymphaea capensis* and a species of *Sphagnum* moss were recorded.

## DISCUSSION

The swamp forests west of Lake St. Lucia are generally smaller and more scattered than those in the east. Most of the swamp forests on the Dukuduku and Nyalazi State forests are *Phoenix reclinata* - *Microsorium punctatum* - *Protosparagus falcatus* communities. A few isolated *Barringtonia racemosa* - *Nephrolepis biserrata* communities are present. The swamp forests in this area grow along narrow drainage lines 20 to 100 metres wide. They have relatively low canopies of approximately 12 m.

Two sub-communities can be differentiated in the swamp forest adjacent to the Mfabeni swamps (on Eastern Shores State forest). The southern part of this forest is a *Barringtonia racemosa* - *Tarenna pavettoides* sub-community, and the northern part is a *Syzygium cordatum* sub-community. The transition between the two sub-communities is abrupt. The southern part is completely dominated by *B. racemosa*. The canopy is approximately 15 m high. The northern part of the forest is almost a kilometre wide at its broadest. Here the canopy is poorly developed. *Syzygium cordatum* dominates as large (up to 30 m), but widely spaced,

individuals.

Although the swamp forests of the study area show considerable variation in composition, there are numerous species which are widely distributed. The most common tree species is *Voacanga thouarsii* which is abundant in almost all the forests sampled. It flourishes across the entire flood plain, from the "dry" peripheries to the permanently inundated zones. *Syzygium cordatum* and *Ficus trichopoda* also occur in most of the sampled forests but are less abundant. *Macaranga capensis*, *Rapanea melanophloeos* and *Myrica serrata* would appear to be peripheral species but individuals may occur sporadically throughout the flood plain. *Ficus trichopoda* tends to grow along the main drainage channels, spreading outwards on horizontal branches supported by stilt roots.

The most commonly occurring shrub is *Psychotria capensis*. *Tarenna pavettoides* is abundant in most plots except in those in which *Syzygium cordatum* is very abundant. Ferns make an important contribution to the shrub layer throughout the swamp forests. Nine species, including the rare *Psilotum nudum*, were recorded. The most widespread species is *Stenoclaena tenuifolia*. *Nephrolepis biserrata* is abundant in most of the Eastern Shores plots but is rarely found in the Dukuduku swamp forests. In the northern part of the Mfabeni swamp forest *N. biserrata* forms impenetrable thickets, excluding to a large extent any regeneration. *Scleria angusta* (a Cyperaceae), is fairly common and occurs in canopy gaps where surface water is present.

Creepers are an important constituent of the swamp forests, although only *Keetia gueinzii*, *Rhoicissus rhomboidea* and *Smilax kraussiana* occur throughout. In all the forests the herbaceous layer is poorly developed, but is especially so in those in which *Barringtonia racemosa* and *Syzygium cordatum* are abundant. The herb layer is confined to the drier peripheries and islands. The herb layer is made up primarily by tree and shrub seedlings. The most commonly occurring seedlings are those of *Voacanga thouarsii*, *Tarenna pavettoides* and *Psychotria capensis*. The few true herbs that do occur are found only on Dukuduku in those forests where *Ficus trichopoda* grows abundantly.

## CONCLUSION

The map of swamp forest distribution between Sodwana Bay and the Msunduze river serves to illustrate the rarity of swamp forests in the study area. It should therefore also serve as a basis for the conservation of the remaining forests. The swamp forests of the Lake St. Lucia environs represent 64% (3095 ha of the total

4843 ha) of all South African swamp forests. The Mfabeni swamp forest is the largest individual swamp forest in South Africa and yet it only covers an area of 352 hectares. Many of the forests are very small and isolated (< 5 ha).

The hierarchical classification and description of some swamp forest communities in the Lake St. Lucia area has contributed significantly to our knowledge of this rare forest type. A follow-up study has been conducted to relate the floristic composition of the communities to environmental variables.

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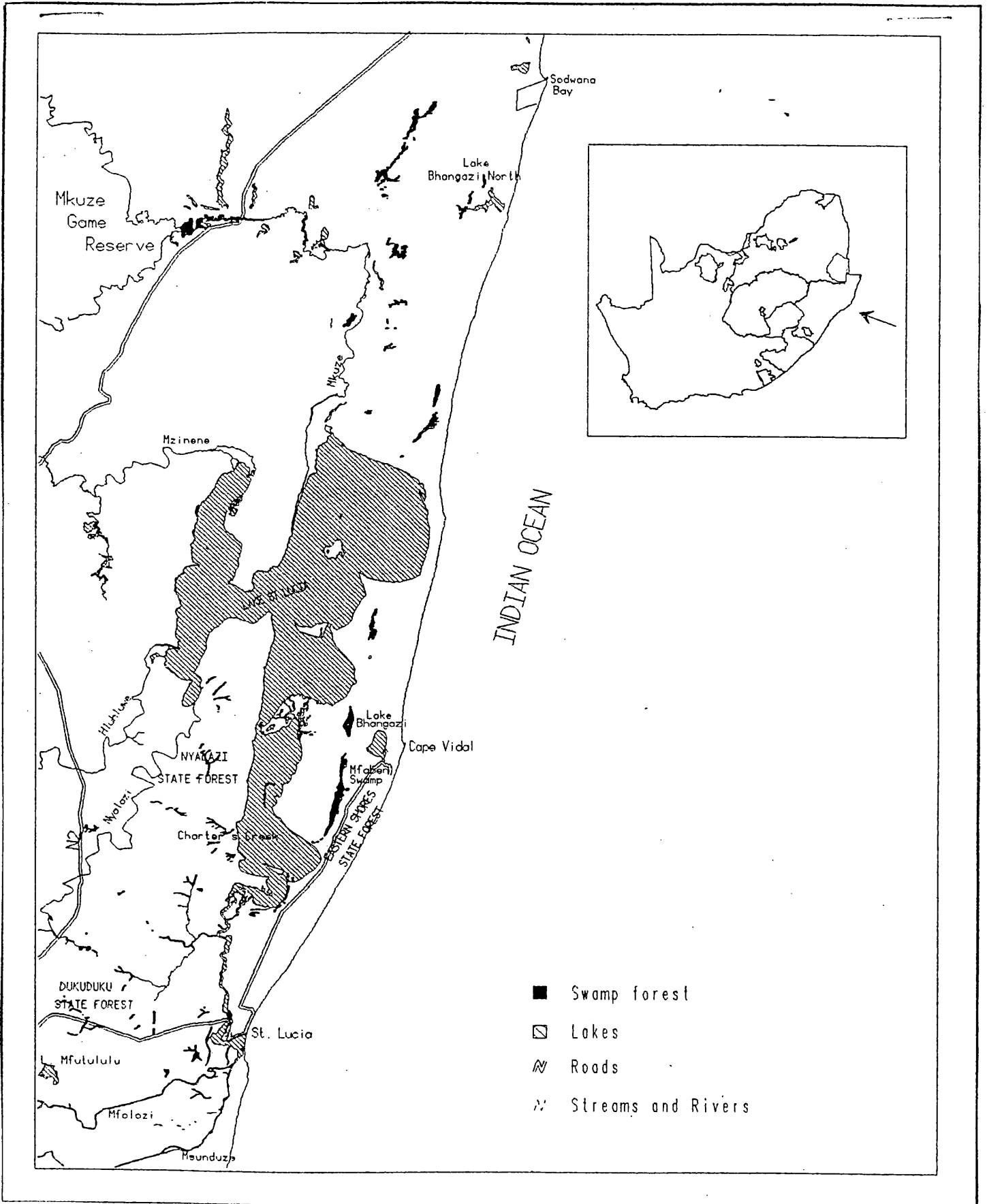
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Figure 1.



**Table 1.** A two-way phytosociological table produced by TWINSpan showing the classification of the swamp forest communities. In the list of species, "c" denotes tree and shrub species over 5 m in height, "j" denotes true saplings and shrubs between 0.4 m and 5 m, "r" denotes seedlings, "s" denotes true shrubs, "v" denotes vines, "h" denotes herbs, "o" denotes orchids, and "f" denotes ferns. For the localities of plots, D denotes Dukuduku, N = Nyalazi and E = Eastern Shores State Forest. Plots are indicated by the transect number and "#" indicates an outlier plot. Values for each species denote categories of abundance defined by the 7 pseudospecies cut levels: 1 = 0-1; 2 = 2-4; 3 = 5-9; 4 = 10-19; 5 = 20-39; 6 = 40-79; 7 = > 80. "-" indicates the absence of a species.

Plots	22233 1333 123333	11111222444444445345256	25556566555
	56345680117942582393467	81265890140123457890968290	31232413567
Locality	DDDDDDDDDDDDDDDDDDDDDD	NNENNEEEEEEEEEEEEEEEEEEE	EEEEEEEEEE
Transect	###222111###3441313344	#####5#####555556666567877	86887877888

SPECIES GROUP A	Community 1		Community 2		
			Sub-com 2.1	Sub-com 2.2	
Phoenix reclinata (c)	-----126-2-2---	5434345	-----	-----3-	0001
Phoenix reclinata (j)	-----45465246265355433		-----	-----1--2-	0001
Microsorium punctatum (f)	1-11-1-111111-111111111		11-----	-----11	0010
Protasparagus falcatus (v)	11111111-1111111-1-1211		111-1----	-----11	0010
Kraussia floribunda (j)	--2--2443221121515-2--		-----	-----1-----1	0001
Mikania natalensis (v)	11111-11111111-11111111		1111--1--	-----1-1-----11-1-	0010
Rhus nebulosa (v)	-11-1-11111111111111--		-----	-----1-----11	0010
Urera cameroonensis (v)	--1111-----11-1--111111		-----	-----1-----1-----1-	0010
Trichilia dregeana (c)	1--213--1-----1--11--		-----	-----1-----	0000
Trichilia dregeana (j)	2-5356-213--1-----1--		-----	-----1-----	0000
Schefflera umbellifera (j)	---21---32-24-1512---22		-2--1-----	-----	0001
Schefflera umbellifera (c)	---24---21---21522---22		-----	-----3-----	0001
Crassocephalum crepidioides (h)	-11-1-1111111-1---11-1-		-----	-----	0001
Phoenix reclinata (r)	--1--11-1-111111111--		-----	-----11-----11	0010
Allophylus dregeanus (r)	--11--11-1---1111--1-1-		-----	-----1-1--11-----1-	0010
Scolopia zeyheri (j)	---12---2--1-14-2-1--1		-----	-----	0001
Bersama lucens (j)	--2--1-334---1121-2-2		-----	-----1--1-----2	0001
Ilex mitis (c)	---2--22---1--14-11--2		-----	-----	0001
Bridelia micrantha (j)	-3-32--122-2142---		1-----	-----12-----	0011
Cussonia sphaerocephala (j)	---333--22--2---41-1---		---21---	-----1--2-----	0011
Apodytes dimidiata (j)	--3-2---321---1---1		-----	-----12---	0011
Flagellaria guinensis (v)	11111-----1-----		-----	-----	0000
Plectranthus spp. (h)	1--11-111-----1-1---		-----	-----	0000
Phragmites australis (h)	-1-----1-----1-----		-----	-----	0000
Eulophia horsfallia (o)	--111--1-----1---11-		-----	-----	0000
Rhus chirindensis (j)	---11-----1-----		-----	-----	0000
Harpephyllum caffrum (j)	---2--1-----1-----		-----	-----	0000
Bersama lucens (r)	--11--11-----1---1-1		-----	-----1-----	0000
Ficus natalensis (j)	2111-----12-----1-2--2-		-----	-----1-----	0001
Apodytes dimidiata (c)	-2---2112-----1--2		-----	-----1-----	0001
Scutia myrtina (r)	---1--1--11-1-11-1-1---		-----	-----	0001
Argyrollobium rupestra (h)	11-111--1-1-1-1-----		1-----	-----11-----	0011
Halleria lucida (j)	---111---11-1-----2-		-----	-----1--	0001
Cyrtorchus arcuata (o)	---1--11-----11-1--1		-1--1--1--1-----	-----	0010
Ilex mitis (j)	---2--24---1--2---1-		-----	-----1-	0001
Kraussia floribunda (c)	-----1-32-----1-2---		-----	-----	0001
Scolopia zeyheri (c)	-----1-----2--2---		-----	-----	0001
Bersama lucens (c)	-----11-----1-1--1-1		-----	-----	0001
Scutia myrtina (s)	-----1-21-2-----1-		-----	-----	0001
Canthium inerme (j)	2-----1-----2--		-----	-----	0001
Scadoxys multiflorus (o)	---1---11-----1-----		-----	-----	0001
Trichilia dregeana (j)	---1--2---1-----		-----	-----	0001
Schefflera umbellifera (r)	---1--1--1-1--1--11		-----	-----	0001
Kraussia floribunda (r)	-----11-1--1-1-		-----	-----1-----	0001
Myrica serrata (r)	-----1-1-----1-----		-----	-----	0001
Allophylus dregeanus (c)	-----1-1-----2--11--1		-----	-----1-1-----1	0010
Macaranga capensis (r)	---1---1---1---1---1---		---1---	-----1-----	0010
Burchellia bubalina (r)	---1-----1-----		-----	-----1-----	0011

## SPECIES GROUP B

Tarenna pavettoides (c)	4-654552342-55563442434	234-544125365556-323534434	---2-----	1000
Tarenna pavettoides (j)	62674653462264555554445	245-4452255554662432545354	211---41--1	1000
Bridelia micrantha (c)	432-2233143-34332111-2-	33-3132--1222221---224--3	-112-----2	1000
Allophyllus dregeanus (j)	--1-1-5-64-154255254322	----221132333-2----43--25	-1--1-----	0101
Cussonia sphaerocephala (c)	--4444-123---1-212-1-22	--3123----31321-----11-	-----1----	0100
Ficus sur (c)	-23--3---33-23122-1-12-	1---32---32221-----12-12	-----1-----	0100
Tarenna pavettoides (r)	111111--1-111--1111-111	1111111-11111111--1-1-1111	-1--1-----	1000
Bridelia micrantha (r)	2-111---111111-111--1-	11-1-11---1111-----1-1--	-----11-1--	0100
Ficus sur (j)	1--1131-23312--12---2-	1---32---1-11-----3112	-----1-----	0100
Oplis minus (h)	11--1--1--1-----1-----	---1---1---1-----1-----	-----1-----	0100
Rhoicissus tomentosa (v)	111-11--1-1-----1-----	-1--1--1--111-----1-----	-----1-----	0100
Peddiea africana (j)	43--121-----1-----	3-11-----1-----2--	-----1-----	0100
Thelypteris interruptus (f)	11-11--1-111111-----1-----	1-11-----11-----1---	-1-----11-1-	0110
Cyperus spp. (h)	--1-----1-11-----1-----	---1-----1-----1-1--	-----1-1--	0111
Rauvolfia caffra (c)	-3-----1-----1-----	1-----2-1-22-----1-----	-----1-----	1001
Burchellia bubalina (c)	--2--1-----1-----	-----12--11-----1-----1	-----1-----	1001
Halleria lucida (c)	---2-----1-----1-----	-----2---3-----1-----	-----1-----	1001
Asplenium prionitis (f)	-----1-----1-----	-----1-1-----1-----	-----1-----	1001
Ficus sur (r)	-----1-----1-----	-----1-----1-----	-----1-----	1001
Psychotria capensis (c)	-----1-----22-----	-----1-----3-----1--1-1	--1-----	1000
Rauvolfia caffra (j)	-2-----1-----1-----	--1-----2-----1-----	-----1-----	1000
Sapium ellipticum (j)	2-11-----1-----	-1-----2-----	-----1--	1000
Peddiea africana (r)	1--1-----1-----	1-1-----1-----	-----1-----	1000
Dalbergia amata (v)	-1-----1-----	1-1-----1-----	-----1-----	1001

## SPECIES GROUP C

Voacanga thouarsii (c)	5524--21341261324254554	32221444523443344435555254	224456551-2	1000
Voacanga thouarsii (j)	6666223336232542314122-	-525413442314--34343234132	225344564-3	1000
Ficus trichopoda (c)	354-41-43-563464-3-4655	12--21233241213-4442222-41	-3-----651-2	0110
Psychotria capensis (j)	--433536542435424655531	-14-3653354666662545662556	262-23551-1	1000
Keetia gueinzii (f)	11-1111-1111111111-1111	11111111111111111111111111	-11111-11-1	1000
Cassipourea gummiflua (j)	--45553-2---2--2313---	114-31-12-1322113442121112	12212322-1	1000
Rhoicissus rhomboidea (v)	1-11111111--11-1-111---	-1---11111-11111-11111-111	111-1111--	1000
Stenoclaena tenuifolia (f)	111111--11-1-1-1-----	1111-111111-11111111111-1	11111111111	1100
Microsorium scolopendrium (f)	---111-11-1111-111111111	11-----11--1-11--11-1-1--	-1-111111-1	0111
Psychotria capensis (r)	--111111-1-1112-111-11-	-11--1--11-1-111-1-11-1111	-1--11--1-	1000
Syzygium cordatum (r)	-1-1111-211-----1-----	1111-1-----1-----1--1-	--1-1-----	1000
Smilax kraussiana (v)	---111111-11-11--1--1--	1-111-111---11-1--1-11-1	111111-111-	1011
Macaranga capensis (c)	414-3443--4--3-1-----	342-4---2-12122-22-465424	3442212----	1001
Cassipourea gummiflua (c)	--15432-1-----12----	-----1212---1-22222-4-323	-23-1522----	1001
Macaranga capensis (j)	2-2132212-----2-----	-----22-4-1--1244---	-5-1-1-1--	1001
Voacanga thouarsii (r)	111111--111111111-1111	11111-11-----1-----111	--1-11-1--	0110
Rapanea melanophloeos (r)	-----11--111-1-1-1-1	-----1--1--1-1-1--	1-1--11111	1010
Scleria angusta (h)	1-1-----111-----1-1---	11111-111--111111-1111-11	-1--1-111-1	1100
Landolphia petersiana (v)	1--1-1111-1111111-11-	-11-----1-----111-1-1	11-1-11--	0110
Ipomoea spp. (v)	11-----1-11-----	-11-1--11--1-1--1111-1	111111-----	1100
Ficus trichopoda (j)	-52-----1---1--13-222-	-----2---1-1--1-3-2-	-11--1--2	0110
Antidesma venosum (c)	---2-----1-----	-----3---1-----2-----	-1-----	1100
Lindsaea ensifolia (f)	---1---1-----1-----	-----11-1-----	---1-11--	1100
Ptilotum nudum (f)	-----1-----1-----	-----1-1--1-----	-----1-----	1110

## SPECIES GROUP D

Barringtonia racemosa (c)	-----1-----	7657566675676656655671----	-----	1111
Barringtonia racemosa (j)	-----1-----	77776767777767677775----	-----	1111
Barringtonia racemosa (r)	-----1-----	111111-11-111--11111111	-----	1111
Nephrolepis biserrata (f)	-----1-----1-----	-1--11-11--11111111-11111	1-11111--	1110
Burchellia bubalina (j)	---12-1-21-----31-21-	----343323332-3211424--13	-1-----2----	1110
Sapium ellipticum (c)	--1-1-----1-----	-1-----1---232--22131-2	212-2-----2	1110
Canavallia rosea (v)	-----1-----11-1-11--111-1	-----1---11-1-11--111-1	-1-----	1111
Mimusops obovata (c)	-----1-----	-----121--2-123-1-	-----1-1--	1111
Mimusops obovata (j)	-----1-----	-----21-1--342--322234--3	-----1-1--	1111
Lygodium microphyllum (f)	-----1-----1-----	---1---1-1-1-----1-1-	-----11--	1110
Ficus natalensis (c)	-----1-----1-----	-1-----11-----	-----	1111
Cassipourea gummiflua (r)	-----1-----1-----	-----11--1-----	--1--1--	1110
Sphagnum spp. (h)	-----1-----1-----	-----111-----	-----111	1101
Nymphaea capensis (h)	-----1-----1-----	1-----1-----	---1-11--1	1101

SPECIES GROUP E

Syzygium cordatum (c)	21-2---3433-23--4241121	11-222224-1--2124122335434	33465545777	1101
Syzygium cordatum (j)	23-322144-1211-21-311-1	-4252-----1-2--212-2245-23	-26-4443774	1010
Rapanea melanophloeos (c)	----1-1521---31---2-111	-----2--1-----2-1--14132--	162621226-5	1101
Rapanea melanophloeos (j)	-----3544--1243-1--12-	-----11-----1---1-1--3442-1-	-6222332254	1010
Myrica serrata (c)	-----241-----	-----	1----1142-5	1010
Myrica serrata (j)	-----564-----	-----1-1--	-----235535	1010
	000000000000000000000000	11111111111111111111111111111111	111111111111	
	0000001111111111111111111111	000000000000000000000000000000	111111111111	

**CAPTIONS FOR FIGURES**

**Figure 1.** The distribution of swamp forests in the Lake St. Lucia area