ASPECTS OF THE ECOLOGY OF THE ELEPHANT

LOXODONTA AFRICANA (BLUMENBACH, 1797),

AND

A MANAGEMENT PLAN FOR THE TEMBE

ELEPHANT RESERVE IN TONGALAND, KWAZULU

by

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Submitted in partial fulfilment of the requirements
for the degree of

M.Sc. (WILDLIFE MANAGEMENT)

in the

Faculty of Science
University of Pretoria
PRETORIA

JANUARY 1987

Aspects of the ecology of the elephant Loxodonta africana (Blumenbach, 1797), and a management plan for the Tembe Elephant Reserve in Tongaland, KwaZulu.

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A B S T R A C T

The climate, surface water, soil nutrients, vegetation composition and the dependence of the local people within the study area on these environmental components and various aspects of the ecology of the Tongaland elephants, were examined. The objective was to provide a management plan for a future elephant reserve. It was established that a resident elephant population including breeding herds, existed in Tongaland. An attempt was made to explain the differences in local movement of the elephants during wet and dry seasons, and movement across the Mozambique-Natal border. It appears that the availability of surface water, food, and the presence of people determined elephant movement and distribution. After determining elephant habitat requirements and the dependence of the local people on the resources in the study area, boundary proposals for an elephant reserve were made, which should ensure the co-existence of the human and elephant population, in Tongaland, KwaZulu.

U I T T R E K S E L

Die klimaat, oppervlakwater, grondvoedingswaarde, die plantegroei-samestelling en die afhanklikheid van die plaaslike menslike bevolking van hierdie omgewingskomponente binne die studiegebied en verskeie aspekte van die ekologie van Tongaland se olifante is ondersoek. Die doel daarvan was om 'n bestuursplan op te stel vir 'n toekomstige olifantreservaat. Dit is vasgestel dat plaaslike olifanttroppe, waaronder ook teeltroppe, wel in Tongaland voorkom. Daar is gepoog om die verskille in die plaaslike bewegings van hierdie olifante gedurende die nat en droë seisoene, en die bewegings oor die Mosambiek-Natal grens te verduidelik. Dit wil voorkom asof die beskikbaarheid van oppervlakwater, voedsel en die teenwoordigheid van mense die olifante se bewegings en verspreiding bepaal. Nadat olifanthabitatvereistes en die afhanklikheid van die plaaslike mense op die hulpbronne van die studiegebied bepaal is, is grensvoorstelle vir 'n olifantreservaat gemaak, wat die mens en die olifant se voortbestaan in die noorde van Tongaland, KwaZulu, behoort te verseker.

ACKNOWLEDGEMENTS

The assistance of many people made this study possible and I gratefully acknowledge their co-operation.

This study was financed by the Eugène Marais Chair of Wildlife Management of the University of Pretoria and the Endangered Wildlife Trust, and was carried out under the auspices of the Eugène Marais Chair of Wildlife Management.

My appreciation is expressed to my supervisor Prof. J. du P. Bothma, who was always ready with advice, encouragement and interest shown in the study.

Thanks are also due to my co-supervisor Prof. G.K. Theron and Dr. N. van Rooyen for helpful advice and numerous suggestions during all stages of the investigation.

I would also like to acknowledge Mr. C. Walker, then Director of the Endangered Wildlife Trust, for having initiated this project, for his moral support, and for financial support from that Trust.

I would like to express my thanks to the Department of Constitutional Development and Planning for their permission to conduct this study in Tongaland, northern Natal.

I am deeply indebted to the Department of Agriculture and Forestry, KwaZulu Government, for all its assistance, the occasions too numerous to mention. Special thanks to the Senior Nature Conservation Officers, viz. Mr. H. Bourn, Mr. R. Langeveld, Mr. D.W. Freeman, and Mr. R. Selly for their help and warm hospitality.

I would like to thank the following Nature Conservation Officers for their help in one way or the other : Solomon nGubani, Eliakem Ndlovu, Joseph Ntuli, Sacharius Dhlamini and Robert Gumede.

To all those scouts who assisted me in various ways during my research, but who are not mentioned specifically, my gratitude is expressed. My thanks also go to Ennocent Mdletshe, Sotho Ndlovu, Sipo nGubani, Erik Tembe and December Kombebuse, for their invaluable field assistance and loyalty.

Mr. and Mrs. G. Jackson and staff of Ndumu Game Reserve of the Natal Parks Board, are thanked for many discussions and general assistance rendered by them. I am also grateful to Mr. and Mrs. D. Rutherford as well as Mrs. P. Freeman, for their kind hospitality.

I wish to express my sincere thanks to the South African Police and the South African Army, who were always willing to give a helping hand whenever needed.

Informative discussions were held with numerous people and apart from those already mentioned the following are specifically thanked: Mr. A. van Zyl (Magistrate of Ingwavuma), Dr. G.L. Smuts, Dr. K. Tinley, Prof. F.C. Eloff, Prof. W. van Hoven, Dr. A. Hall-Martin, Mr. E. Harris, Prof. R.H. Barnard, Mr. N. Swart, Mr. T.C. Cunningham and Mr. A.J. Buys.

To Chief Msimba Tembe, the Tribal Authorities, Indunas and local population I would like to convey my sincere appreciation for the manner in which I was made to feel at home in the Muzi-Sihangwana area.

Finally, this work is dedicated to my parents and my brother Thomas as a token for their unfailing encouragement, support and interest.

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C H A P T E R 1

INTRODUCTION

The position of the Muzi-Sihangwana area in Tongaland, KwaZulu, northern Natal, between the tropical and subtropical regions (Moll 1977), is rich in species diversity including many tropical elements and a wide range of different habitats. This makes the area an important and unique conservation area. The transitional vegetation types (Moll 1977) which occur in Tongaland, are of great botanical interest and value, because the area falls within the southern distribution of tropical species. The many new plant species and new records that have been recorded there since the early 1960's (Moll 1977) makes Tongaland a taxonomically important area. Northern Tongaland also supports the last free-roaming elephants Loxodonta africana of Natal, of which little is known concerning numbers and movements. Other rare and endangered ungulate species that occur in the area are the suni Neotragus moschatus and the red duiker Cephalophus natalensis.

Before the first settlers arrived in the Cape in 1652, elephants occurred throughout most of South Africa (Drummond 1875). With the greed for ivory and the increase in human settlements, the elephant distribution became restricted to reserves and national parks, except for the Knysna and Tongaland elephants, which are the last free-roaming elephants in South Africa.

The areas where elephants are found in South Africa today, include: 7 617 in the Kruger National Park (De Graaff, pers. comm.), 118 in the Addo Elephant National Park (De Graaff, pers. comm.), 3 in the Knysna Forest (Walker, pers. comm.), ca. 125 in the Timbavati Private Nature Reserve (Zimbatis, pers. comm.), ca. 100 in the Klaserie Private Nature Reserve (Zimbatis, pers. comm.) and ca. 75 in northern Tongaland. However, elephant numbers in the latter three areas fluctuate

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De Graaff, G. (1986): National Parks Board, P.O. Box 787, PRETORIA, 0002.

Walker, C. (1981): 66 Milford Avenue, Glendower, EDENVALE, 1610.

Zimbatis, N. (1986): Hans Hoheisen Research Station, P.O. Box 146, HOEDSPRUIT, 1380.

constantly. Elephants also move occasionally from the Tuli Block (Botswana) across the Limpopo River into northern Transvaal (De Beer, pers. comm.). Recent re-introduction of 18 elephants took place at Pilanesberg (Anderson, pers. comm.), 37 in the Sabie Sand Game Reserve (Fairall, pers. comm.), 23 in the Hluhluwe Game Reserve (Astrup, pers. comm.), and 22 in Umfolozi Game Reserve (Astrup, pers. comm.).

The elephants of Tongaland form a sub-population of those elephants found in southern Mozambique. The future of the elephants of southern Mozambique, however, seems to be in jeopardy. Since the independence of Mozambique in 1975, people were permitted to settle in the Maputo Elephant Reserve which is situated south of Maputo along the east coast. An estimated 5 000 - 10 000 people lived in that Reserve in 1980 (Hanlon 1980).

Illegal hunting and disturbance forced many elephant herds to leave the Maputo Elephant Reserve, which has decreased the elephant population of that Reserve from 269 in 1972 to 80 in 1979 (Tinley, pers. comm.). The elephants moved southwards, of which a number of the herds crossed the Mozambique-Natal border into Natal (Appendices 3 and 4).

The broad purpose of the present study was therefore to collect as much data on the Tongaland elephants as possible and to draw up management and boundary proposals for the future elephant reserve in Tongaland in which the future of elephants south of the Maputo River could be safeguarded.

De Beer, G.C.O. (1982): Division of Nature Conservation, P.O. Box 217, PIETERSBURG, 0700.

Anderson, J. (1982): Agriwane, Kangwane Agricultural Development Corporation Ltd., P.O. Box 1330, NELSPRUIT, 1200.

Fairall, N. (1981): Department of Zoology, University of Pretoria, PRETORIA, 0002.

Astrup, M. (1986): Natal Parks Board, P.O. Box 662, PIETERMARITZ-BURG, 3200.

Tinley, K.N. (1980): Department of Conservation and Environment, Mount Street 1, PERTH, 6000, WESTERN AUSTRALIA.

The main specific aims and objectives of the current research thus were:

- To determine the size and structure of the Tongaland elephant population and to establish if family units were present.

- To determine the range and extent of the movements, and the distribution of these elephants, and to establish how far, when, and why the elephants moved.

- To determine the extent of conflict between elephants and the local human population within and on the periphery of the Muzi-Sihangwana area.

- To provide a management plan for a future elephant reserve, which would be of benefit to both elephants and man.

As the research progressed, some attention was also paid to aspects such as a physiognomic vegetation classification, and soil and water analyses in the Sihangwana area. Thoughts on the re-introduction of other faunistic fauna into the proposed elephant reserve were also included.

C H A P T E R 2

TONGALAND

To obtain a better understanding of the history, physiography and climate of the study area, Tongaland will first be discussed in its entirety.

LOCALITY

Tongaland, an area of approximately 8 000 km^2, is situated in KwaZulu within the north-eastern part of Natal (Figure 1) which is bounded to the west by the Lebombo Mountains, to the south-west by the Ubombo Mountains, to the south by the Mkuze River, to the east by the Indian Ocean and to the north by the Mozambique-Natal border (Thorrington-Smith, Rosenberg and McCrystal 1978).

The study area (Figure 2), covering approximately 600 km^2, lies between 32°15'E and 32°36'E, and 26°51'S and 27°08'S. This includes the area from the Shilingi and Sihlenga Pans, northwards to the Mozambique-Natal border, between the Pongola River and 4 km east of Mozi Swamp North.

Fences in the area are : one in the north along the Mozambique-Natal border, and another in the south along the Makanes Drift-Sihangwana-Kwa Ngwanase road. The latter fence, also referred to as the 'red line', was constructed during the early 1930's (Potsamus, pers. comm.) to prevent foot-and-mouth disease carriers (wildlife and cattle) from moving southward.

Potsamus, P. (1985): Private Bag X 9005, PIETERMARITZBURG, 3201.

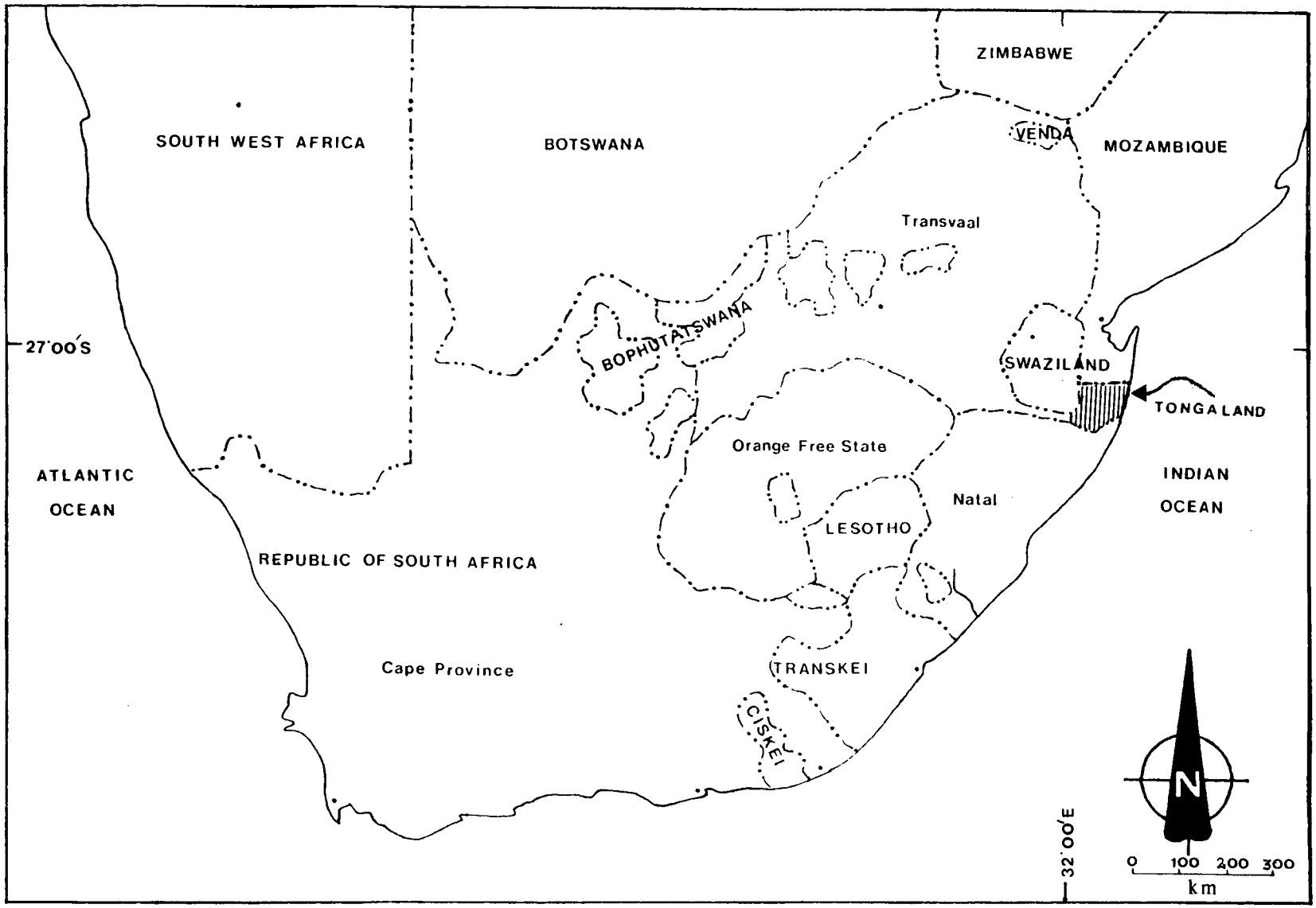

Figure 1 : Map showing Tongaland (shaded area) in northern Natal, Republic of South Africa.

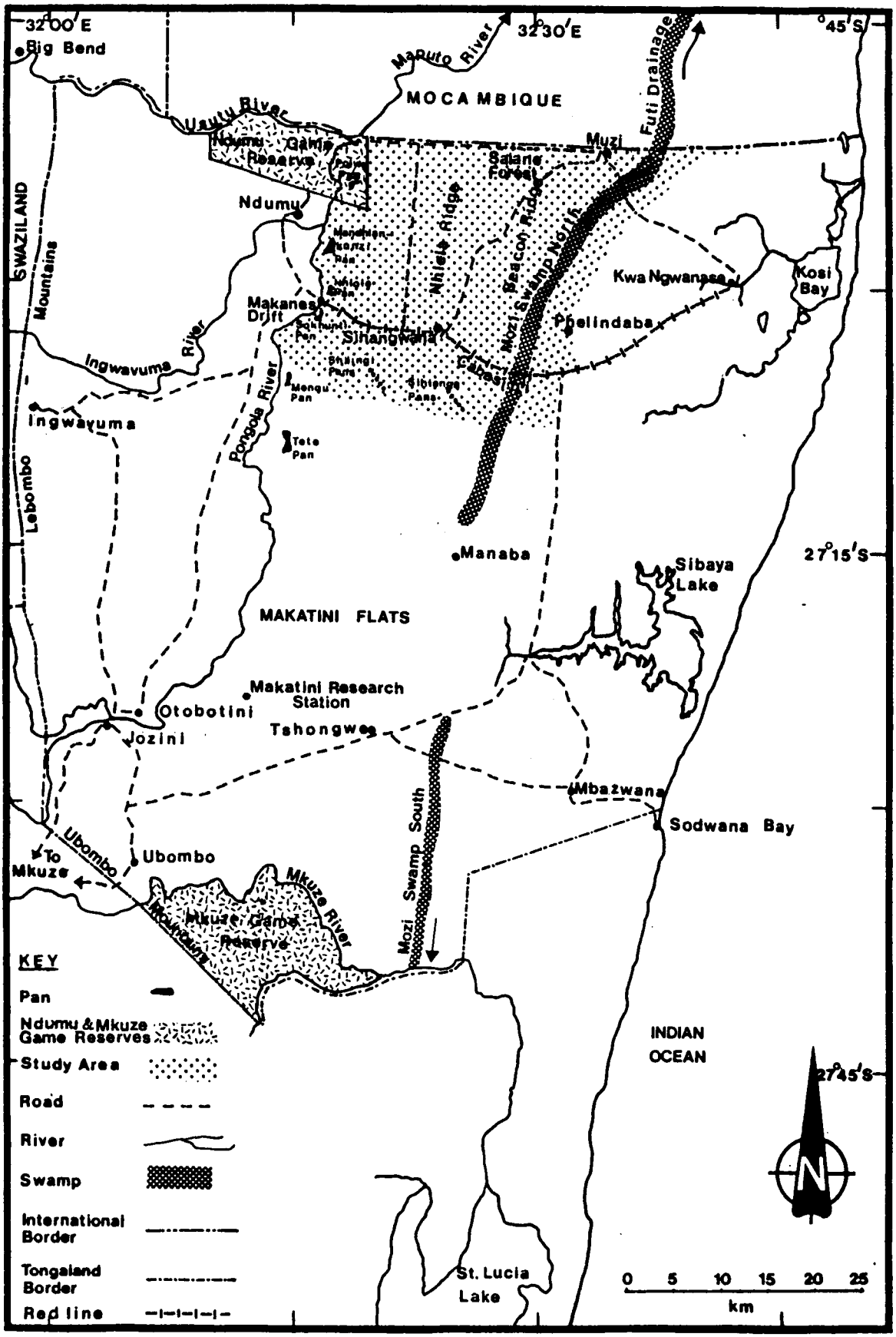

Figure 2 : Physiography and the existing infrastructure of Tongaland, northern Natal, modified after Thorrington-Smith, Rosenberg and Mc Crystal (1978) and Tinley and Van Riet (1981).

HISTORICAL REVIEW OF THE AMATONGA TRIBE AND THE ELEPHANTS OF NORTHERN NATAL

THE AMATONGA TRIBE

From early Portuguese sources, Junod (1927) cites accounts of Perestello (1554) as proof that at least 400 - 500 years ago the Tonga Chiefs Tembe, Mpfuma, Manhisa and Libombo, all of whom still have descendants in southern Mozambique, were already in the country around Delagoa Bay (now Maputo).

The Tongas lived undisturbed mainly as agricultural people possessing few, if any, cattle. Towards the first half of the 19th Century the Tongas were suddenly overwhelmed by displaced Nguni people from Zululand, fleeing from Shaka. These Zulu-speaking people were few in numbers but nevertheless succeeded in establishing the new kingdom of Gaza in Mozambique, over the Tonga tribe (Junod 1927).

As representative of the Tongas living in southern Mozambique, the Tribe of Chief Msimba Tembe is the only tribe living within the border of Natal. From 1840 onwards the Tembe tribe colonised areas at Kosi Bay, Sibaya Lake and along Mozi Swamp North and Pongola River in the District of Ingwavuma (Junod 1927).

The Mac Mahon Award of 1874, awarded all lands between Delagoa Bay and the present Natal-Mozambique border, to Portugal, and the Tonga tribe of the late Chief Ngwanase Tembe were thus effectively cut off from their brother tribes, Mpfuma, Manhisa and Libombo in southern Mozambique. The area north of the border became known as Portuguese Maputaland and that south of the border as British Maputaland (Bruton, Smith and Taylor 1980).

The Tongas were embittered by the boundary drawn through their country which now separated Mozambique from the British Colony of Natal.

In April 1888 the Tongas sent a deputation to Pietermaritzburg, and unsuccessfully appealed for redress as to the way in which their country had been divided and taken away from them and given to the Portuguese without the Chief's knowledge and consent. A similar deputation of protest sailed to Portugal in February 1889, but their appeal, made during May 1889 in Lisbon, also met with no success. In this appeal the Tonga Queen suggested that Portuguese Maputaland and British Maputaland be united, either under the Portuguese or the British flag, rather than have their country split in half with the Tongas under two powers instead of one. The Portuguese simply informed the Tonga Queen that the question was closed. British Tongaland was legally established as a Protectorate by an order in council, dated 29th June 1896. Since that day the Tonga Tribe has been cut in half officially (Bulpin 1969).

Today there still exists controversy as to whether the area in northern Natal should be called Tongaland or Maputaland. The name Maputaland is derived from that of the Maputa River, which flows northwards from the confluence of the Pongola and Usutu Rivers (Bruton et al. 1980).

Since the mid-19th Century the area has been referred to as AmaTongaland or Tongaland. It is understandable that the present Tongas in Tongaland, not only wish to call the area Maputaland, but also maintain that they are Zulus, because according to Junod (1927), the name Tonga is derogatory and is applied by the Zulus as a subject people. Throughout the text reference will be made to Tongaland and not Maputaland as suggested by certain circles, since Tongaland has not been officially named as Maputaland.

THE ELEPHANTS OF TONGALAND

The first known reports available on the elephants of Tongaland date from 1840. However, for the past century no scientific data are available on these elephants. Accounts of Tongaland and its elephants prior to 1900, include those written by Harris (1852), Drummond (1875), Baldwin (1863), Selous (1899), Bryden (1899) and more recently Bulpin (1969).

It was only from the early 1970's that more reliable accounts of elephant activity has been documented for Tongaland (Thomson 1974 and Hall-Martin 1976).

Bulpin (1969) mentions the first record of elephant hunting by a man called "Elephant White", accompanied by P. Hogg and W.Proudfoot during the 1840's. They mainly hunted in the area of the Pongola and Usutu Rivers and around St. Lucia Lake.

In 1854, Baldwin went on a hunting expedition into the AmaTonga country. He mentions crossing the Mkuze River (he does not state at which point) and after a two-day march from the river he sighted about 15 elephants near the Pongola River (specific location not given). This surprised him as he had not expected to encounter elephants in Tongaland. He fired some shots at them, only wounding a few, how many he could not determine. From the Pongola River he went to Maputa, and not far from there, in the vicinity of the Maputa Vlei, he sighted six elephants: a bull, four cows and a calf. He shot at the bull and a cow, again only wounding them. He continues stating that they fled and that he never came across them again (Baldwin 1863).

The report by Baldwin (1863), that George Shadwell shot about 150 elephants in one season in Tongaland during 1860, seems exaggerated.

Drummond (1875), mentions that elephant appeared to exist all over Africa and that in 1845 they were plentiful in the southern colonies, yet by 1875 they were then already almost extinct there. In 1875 elephants were only to be found in two jungles in the Cape Province: i.e. in the Knysna Forest and Addo Bushveld. In 1860 elephants were still common in Zululand but during his 1875 expedition they only occurred in a few places south of the Pongola River. The first elephant Drummond sighted was amongst the reeds where the White and Black Umfolozi Rivers meet (Figure 3). Further encounters with elephants were along the Lebombo Mountains, west of the Pongola River.

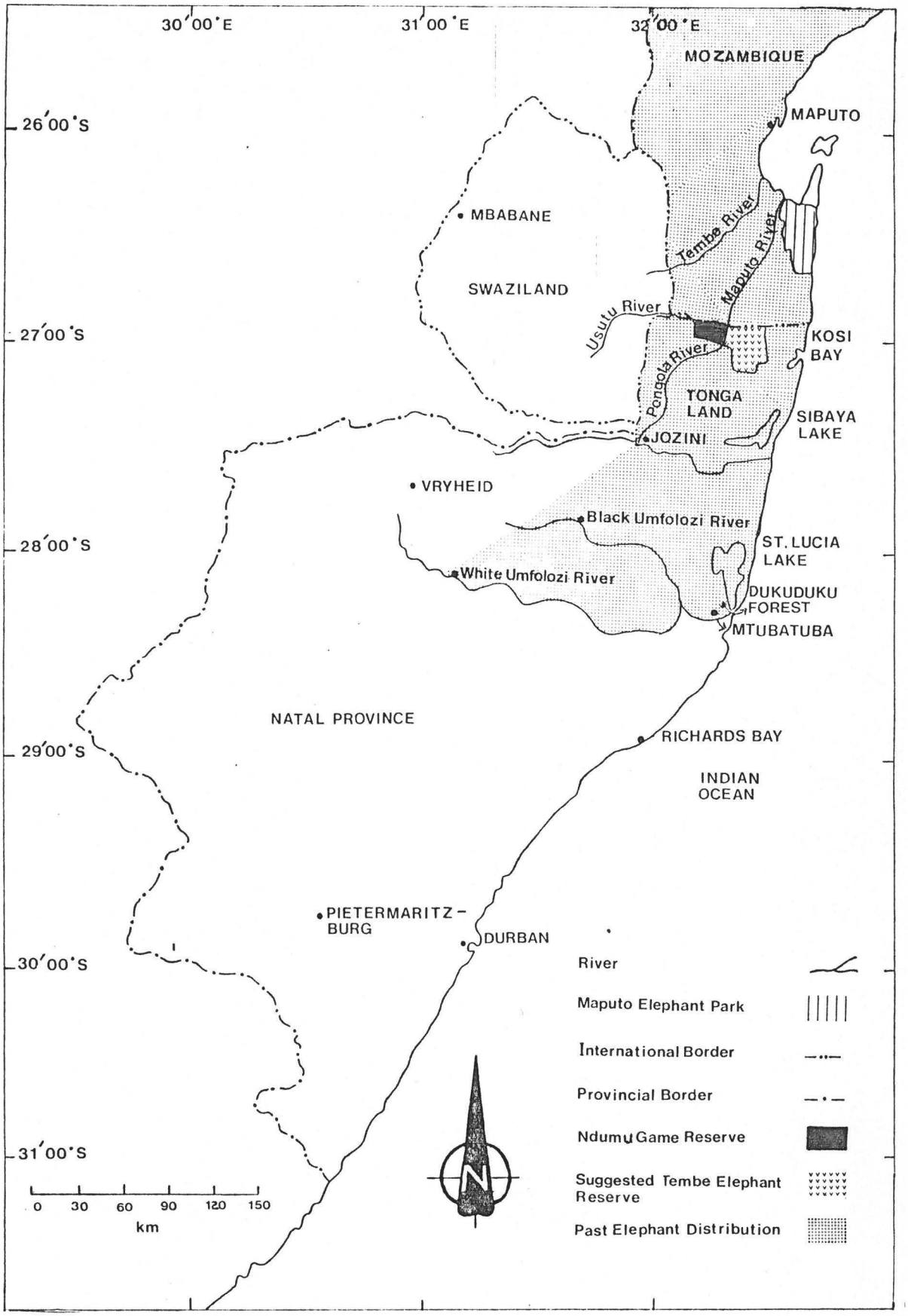

Figure 3 : Distribution of elephants from 1854-1955 in northern Natal and southern Mozambique.

1855

On one occasion Drummond sighted a herd of 23 elephants west of the Pongola River, most of which were cows, except for one bull with good tusks. Drummond shot the bull elephant and wounded five cow elephants. Drummond (1875) further reports that elephants were rare in the area west of the Pongola River, only frequenting this area during the hot, humid summer months, when there were no hunters left to take advantage of the opportunity. Near the Usutu River (Figures 2 and 3) Drummond encountered a few more elephants, of which he wounded a cow, before he entered Mozambique.

Selous, like his predecessors, shot every animal that came in sight of his rifle. He only mentions that in those times, elephants still maintained a precarious foothold in the Matutas area, which is the district between the Maputo and Tembe Rivers (Figure 3) in southern Mozambique (Selous 1899).

Leslie, (1875, In: Bulpin 1969) a young Englishman, secured sole hunting rights to an extensive tract of country along the Pongola River, the exact location of which is unknown. He and a partner employed about 50 Zulu elephant hunters to scour the bush in search of ivory and game. No mention is made of whether they ever got any ivory.

Roberts (1936) writes about elephant sightings along the Mozi Swamp North, but he does not mention any number of elephants sighted.

The last elephant shot in the Dukuduku Forest near Mtubatuba (Figure 3) was done so in 1916, while elephants were still recorded on the eastern shores of St. Lucia Lake in 1924 and 1937, Natal Parks Board (1979, In: Bruton et al. 1980).

During 1943, Ferraz (1947, In: Bruton et al. 1980) and Lugg (1970, In: Bruton et al. 1980), who were members of the first Tongaland expedition, reported herds of 30 and 40 elephants respectively from northern Tongaland, east of the Pongola River.

According to Kluge (pers. comm.) elephant bulls, cows and calves were sighted between Sihangwana and Maputa during the mid-1940's, the largest herd consisting of approximately 8 animals. He also mentioned that elephants were abundant across the border in the south of Mozambique during those years.

In the 1950's elephants were recorded once at Lake Nhlange in the Kosi Lake System, once in the northern margin of Sibaya Lake, twice in the southern Mozi drainage area close to Mkuze Game Reserve and more commonly at Tete Pan, Mengu Pan, Sokhunti Pan, Nhlole Pan, Mandhlan-kunzi Pan and Polwe Pan (Figure 2), (Tinley and Van Riet 1981). The latter authors also mention that all these occurrences were either of small family units or of bachelor groups.

It is only during the past 10 years that increasing attention has been focused on the Tongaland elephants. Thomson (1974), in his report on the elephants of the Muzi-Sihangwana area, gives a brief outline on:

- Movement and distribution of the elephants between 1973 and 1974.

- Vegetation of the Sihangwana area.

- Problems caused by the elephants to the local inhabitants.

- Elephant sightings.

Thomson (1974), was unable to give accurate figures on the number of elephants present during 1973 and 1974. However, he mentions that the elephant population was in excess of 20 with a possible maximum of 50. Thomson further theorised that there were perhaps three to four small mixed groups (i.e. with cows and calves) permanently resident in the thickly wooded areas between Beacon and Nhlela Ridges (Figure 2), whilst the remaining herds comprised only bulls.

Kluge, H. (1979): 503 Celieria, 79 Walker Street, Sunnyside, PRETORIA, 0002.

Hall-Martin (1976) on the other hand, in his report on the status of the Tongaland elephants, estimated the number of elephants at a maximum of 30 consisting of bulls only. He further mentions that the elephants confined themselves to an area between Nhlela Ridge and the Mozi Swamp North and that elephant impact on the vegetation was not noticeable at that time.

According to the Red Data Book on large mammals of South Africa (Skinner, Fairall and Bothma 1977), the number of elephants estimated for northern Tongaland were not more than 30, where no confirmed sightings of breeding herds were reported since 1946.

Mr. Paxton, who was the regional conservation officer in Tongaland working for the KwaZulu Government during 1977, was severely injured by a bull elephant whilst trying to take some photographs of a bachelor group (Ndlovo, pers. comm.).

Prior to the present study, scientific data regarding these elephants are scarce. The distribution of elephants in Tongaland and southern Mozambique, between 1854-1855, however, is represented in Figure 3.

PHYSIOGRAPHY

TOPOGRAPHY

Tongaland is hemmed in on the east by the Indian Ocean, on the west and on the north-west by the Lebombo Mountains reaching 730 m above sea-level at Ingwavuma, on the south west by the Ubombo Mountains (Bruton 1976) reaching 640 m above sea-level at Ubombo, and on the south by the Mkuze River.

The Tongaland plain, which is 60 km wide and 80 km long, between the Pongola River in the west and the coastal forest-covered sand dunes in the east, forms the southern limit of the Mozambique Coastal Plain (Moll 1977).

Ndlovo, E. (1979): P.O. Box 41, KWA NGWANASE, 3973.

According to Tinley and Van Riet (1981), Tongaland can be divided from west to east in six physiographic regions, which all run parallel to the present coastline. These regions are: the Lebombo Mountain Range along the Tongaland-Swaziland border, the Pongola Zone, the Sand Forest Zone in the central area between the northern Pongola River and Mozi Swamp North, the Mozi Drainage Zone, the Coastal Lakes (Kosi Bay and Sibaya Lake) and the coastline which consists of coastal forest-covered sand dunes and a series of shallow indented bays bounded by north-easterly facing reefs.

The study area which falls within the Tongaland Plain (Moll 1977) can be further subdivided into the following physiographic entities:

- The Pongola Zone:
  - Pongola River.
  - Pongola Floodplain with four pans on its east bank, namely Sokhunti, Nhlole, Mandhlankunzi and Polwe Pans.

- The Sand Forest Zone:
  - East to west-facing sand dunes that run parallel to the coastline, reaching a height of 129 m above sea-level on Nhlela and Beacon Ridges (Figure 2).
  - The remainder of the area between the Pongola River and the Mozi Swamp North, which is comprised of low-lying sandveld 75 m above sea-level.

- The northern Mozi Drainage Zone:
  - The Mozi Swamp North (50 m above sea-level) which is drained by a channel northwards into Mozambique.
  - Ilala palm-dambo catchment area east of Mozi Swamp North.

DRAINAGE

Tongaland is drained by four rivers and one swamp. The Pongola, Ingwavuma and Usutu Rivers break through the Lebombo Mountains at Jozini, Ingwavuma and Big Bend respectively (Figure 2). The Pongola River is joined by the Ingwavuma River near Ndumu and by the Usutu

River at the Mozambique-Natal border, to form the Maputo River, which flows in a north-easterly direction into the Mozambique Channel. The Mkuze River (Figure 2) first flows eastwards then southwards into St. Lucia Lake, while Mozi Swamp is drained by a channel in two opposite directions, i.e. north-easterly from Manaba into Mozambique where it forms the Futi-drainage (Figure 2) at the Mozambique-Natal border and southwards from near Tshongwe into the Mkuze River.

Mozi Swamp North (Figure 2) is fed by tributaries, coming from the eastern side. During dry conditions, Mozi Swamp North, from Manaba to Cabasini (Figure 2) hardly has any surface water. From Cabasini northwards, water surfaces and reaches a depth of up to 3 m near the Mozambique-Natal border, winding its way through massive beds of Phragmites australis and Typha littoralis.

During years of high rainfall, Mozi Swamp North south of Cabasini can be waterlogged to shallowly inundated, when a sheet of water 15 km wide can result, broken only by the islands of ilala palm / Hyphaene natalensis / and wooded sand ridges (Tinley and Van Riet 1981). This phenomenon is ascribed to the flat terrain of the southern sector of Mozi Swamp North, with its broad dambo type drainage lines. The northern sector of Mozi Swamp North on the other hand near the Mozambique-Natal border, narrows to a width of 50 m at places.

Mozi Swamp South, by contrast, is extremely narrow and incised along its entire course. It lacks the broad dambo catchment of the north-draining sector (Tinley and Van Riet 1981).

GEOLOGY

The geology of Tongaland (Figure 4) which has been described by Loxton, Hunting and Associates (1969) and Maud (1980), has been summarized as follows:

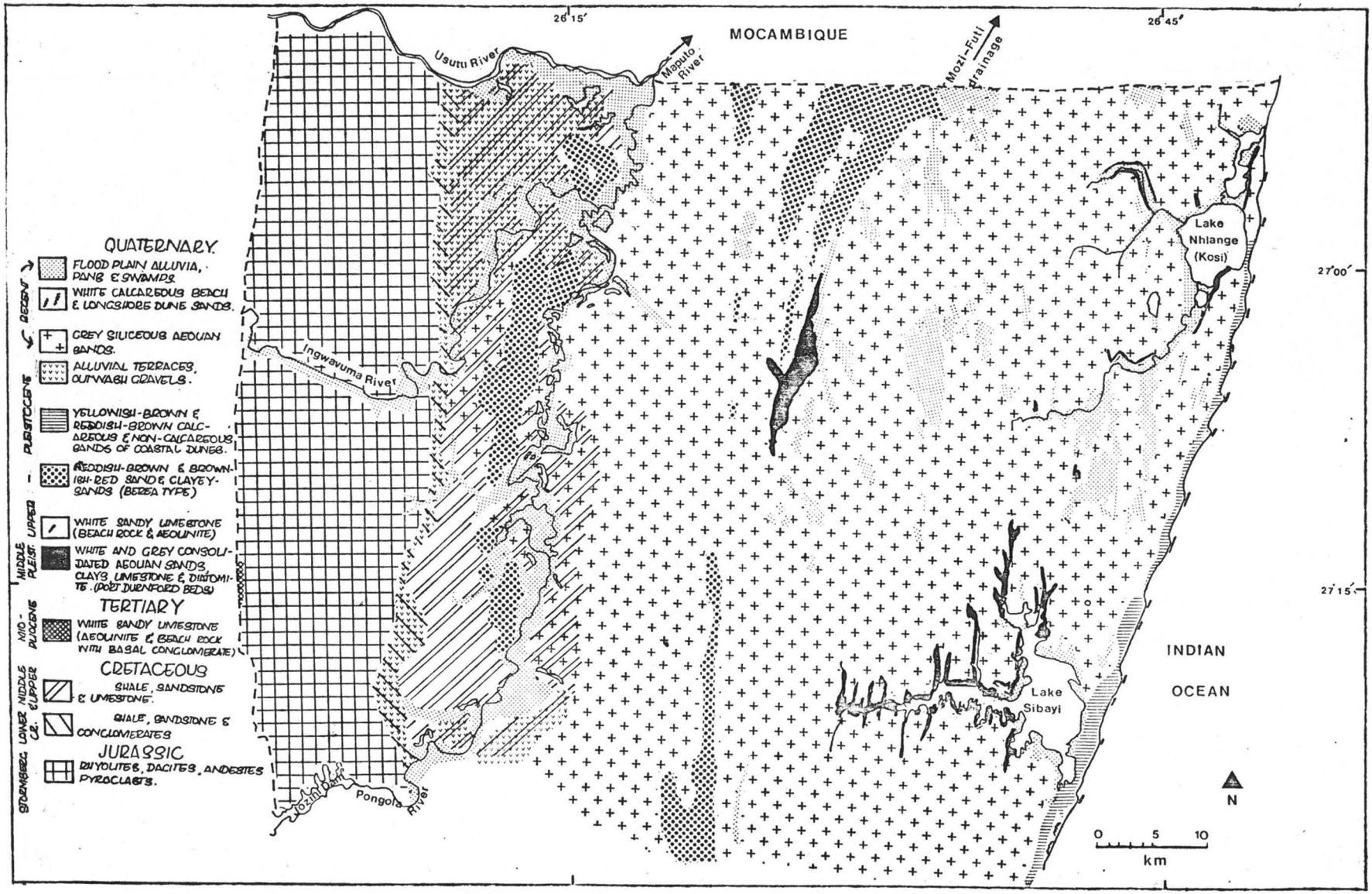

Figure 4 : Geological map of Tongaland, northern Natal, after Tinley and Van Riet (1981) and Loxton, Hunting and Associates (1969).

JURRASSIC PERIOD

West of the Pongola River, the Stormberg Rhyolites (Table 1) were exuded volcanically, during the Karoo (Jurassic) time period. This volcanic eruption occurred a relatively short time before the disruption of the old southern super-continent Gondwanaland (King 1953, Du Toit 1954 and Maud 1961, In: Maud 1980).

This disruption took place by a process of 'Rift Valley' formation and fracturing. At the time of fracturing, the Lebombo Rhyolites were tilted in a seaward direction.

The resistant volcanic rhyolitic lavas from the Lebombo Mountain Range, visibly extend as far as the western margin of the Tongaland coastal plain. Further eastwards (Maud 1980) the rhyolites occur beneath a covering of younger rocks at an ever-increasing depth in an easterly direction.

CRETACEOUS PERIOD

At the time of the Lower Cretaceous period, the Stormberg-Rhyolites, from the western margin of the Tongaland coastal plain to the coastal dunes in the east, were overlaid by a layer of lebombo-derived conglomerates (Maud 1980).

With the disruption of Gondwanaland and the formation of the east coast of Africa, the sea was able to enter the low-lying inland areas of the Tongaland coastal plain, and marine sediments were deposited in the process. There beds form a rock wedge that thickens in a seaward direction from a few centimetres at the edge of the eastern slope of the Lebombo Mountain Range to a thickness of 3 000 m at the coast (Maud 1980).

TERTIARY PERIOD

After the uplift of the sub-continent there followed a relatively long period of erosion. Shallow marine and terrestrial sediments were laid

Table 1 : The stratigraphic succession of the rocks and unconsolidated sediments of Tongaland, northern Natal (Maud 1980).

SOIL	EPOCH	PERIOD
Floodplain alluvium, pans and swamps	Recent	Quaternary
White calcareous beach and longshore dune sands	0-1 x 10^4 years	
Grey siliceous aeolian sands		
	Pleistocene	
Alluvial terraces and outwash gravels		
Yellowish-brown and reddish-brown calcareous and non-calcareous sands of coastal dunes		
Reddish-brown and brownish-red sands and clayey sand. (Berea red sands)		
White and grey sandy limestones	1 x 10^4 - 2 x 10^6 years	
Grey and white consolidated aeolian sands, clayey sands and lucustrine deposits (Port Durnford Beds)		Quaternary
White sandy limestone with basal conglomerate	Pliocene-Miocene 2-20 x 10^6 years	Tertiary
Yellowish-brown and grey siltstone, shale, sandstone and limestone	Upper and Middle Cretaceous - 50-100 x 10^6 years	Cretaceous
Yellowish-brown and grey siltstone, shale, sandstone and conglomerates	Lower Cretaceous 100-135 x 10^6 years	Cretaceous
Rhyolites, dacites, andesites and pyroclasts	Stormberg-Lebombo	Jurassic

down on the gently dipping seaward surface of the Cretaceous sediments at the time of the Tertiary period (Maud 1980).

The Tertiary sediments also comprise some Lebombo-derived conglomerates at the base, these being overlain by greyish-white sandy limestones.

The deposits of marine, terrestrial and conglomerate sediments are flatlying and relatively thin, the greatest known thickness being about 30 m (Maud 1980).

Along the banks of the Pongola River the Tertiary sediments and their contact with the underlying Cretaceous sediments are well-exposed (Maud 1968, In: Maud 1980).

QUATERNARY PERIOD

East of the Pongola River, the Tertiary formation is overlain by the flat-lying, partially consolidated sandy deposits of the Port Durnford beds. The Port Durnford beds were deposited after erosion of the underlying Tertiary sediments. The Port Durnford beds in Tongaland, first described by Anderson (1904, In: Maud 1980), comprise sands, clayey limestones and diatomites which were laid down under marine shallow-water, terrestrial and fresh-water lacustrine conditions. The Port Durnford beds are 50 m thick.

Reworking of the surface of the Port Durnford beds, later in the Pleistocene and Recent times, by wind-action has given rise to the extensive dune topography of grey sand which characterized most of Tongaland appearing as linear north-south tending dune ridges. Some of these ridges may, however, also represent former shore-lines of the retreat of the sea across the coastal plain after the deposition of the Port Durnford beds (Maud 1980). Due to more prolonged weathering, some of the more pronounced sand-dune ridges derived from the Port Durnford beds, such as Nhlela and Beacon Ridges (Figure 2), are reddish-brown in colour. These reddish-brown and red sands form the Berea red sand formation.

Sandy and clayey alluvium characterizes the floodplains of the Pongola and Mkuze Rivers as well as the Mozi Swamp, the upper terraces generally being more sandy than those close to the existing river bed level (Maud 1980).

CLIMATE

According to Watts (1971, In: Schulze and McGee 1978), restraints on the growth of land-based plant communities, are governed by climatic, topographic, edaphic and biotic restrictions. Of these, climatic restrictions are usually the most important, and according to Tivy (1971, In: Schulze and McGee 1978), light, temperature and moisture are of equal importance to the plant. However, different plant and animal species have different tolerances to climatic conditions which in turn will determine the place of existence for such species (Tivy 1971, In: Schulze and McGee 1978).

Tongaland lies within a transitional zone between tropical and sub-tropical regions, with hot summers and cool to warm winters, approximately 400 km south of the Tropic of Capricorn (Bruton 1976). These cool to warm winters and hot summers are due to the low relief of the area as well as the influence of the warm Mozambique current which passes south-eastwards close offshore.

According to Schulze and McGee (1978), Tongaland can be classified into the following four climatic zones:

Cwa
- warm temperate climate
- winter dry season
- warmest month above 22°C
- on top of the Lebombo Mountains

Cfa
- warm temperate climate
- sufficient precipitation during all months
- warmest month above 22°C
- along the coast from Mbazwana southwards

Aw - equatorial climate
- winter dry season
- warmest month above 22°C
- along the coast from Mbazwana northwards

Bsh - steppe climate; arid zone
- low rainfall throughout the year with winter dry season
- mean annual temperature above 18°C
- in the central area of Tongaland

Climatic records for Tongaland, obtained from the Weather Bureau, Pretoria, have been used in this study. The weather recording stations of Tongaland used in the present study are listed in Table 2 and their geographical positions in Figure 2.

Meteorological data for Tongaland were found to be incomplete and the only long-term weather records for the entire area are rainfall records.

RADIATION, SUNSHINE AND CLOUD COVER

According to Drummond and Von Winckel (1957, In: Schulze and McGee 1978), the main factor determining the radiation patterns of southern Africa in winter is the decrease in cloudiness south of 30° 00'S.

A mean of 7,6 hours of sunshine per day were recorded at Makatini Research Station over a six-year period (Maud 1980); at Ndumu Game Reserve over a three-year period it was 6,0 hours per day (Natal Parks Board 1981).

The mean cloud cover for Otobotini station in the south (n = 26 years) taken at 08h00 and using a scale of 0 (no cloud) to 10 (full cloud) (Maud 1980), was 3,5 for the dry period (1st April to 30th September) and 6,4 for the wet period (1st October to 31st March). Mean cloud cover for the months of January and February at Ndumu Game Reserve in the north, was 7,0 at 08h00 (Tinley 1964).

Table 2 : Weather recording stations in Tongaland, northern Natal, used in this study. Latitude, longitude and elevation in metres above sea-level are shown (Weather Bureau 1965).

WEATHER BUREAU NUMBER	RECORDING STATION	LATITUDE	LONGITUDE	ELEVATION
448/597	Kosi Bay	26°57'	32°50'	115
448/450	Kwa Ngwanase	27°00'	32°45'	46
411/723	Sihangwana	27°03'	32°25'	69
447/446	Ndumu	26°56'	32°15'	75
337/534	Ndumu Game Reserve	26°54'	32°18'	122
410/878	Ingwavuma	27°08'	32°00'	610
411/175	Otobotini	27°25'	32°06'	91
412/180	Mbazwana	27°30'	32°36'	68
411/323	Makatini Research Station	27°29'	32°21'	63

During the dry and wet season months incoming radiation for Tongaland is 14 x 10^6 Joules/day for both seasons (Schulze and McGee 1978).

In both the wet and dry season patterns of radiation, the relatively low values along the Natal and Mozambique coasts south of 20°00'S indicate that the high atmospheric water vapour content associated with the warm Mozambique current is the probable cause of radiation attenuation (Schulze and McGee 1978).

TEMPERATURE

The mean annual air temperature of Ndumu Game Reserve in the west (22,9 °C, n* = 7) and Kosi Bay in the east (21,3 °C, n* = 1) in northern Tongaland, and of Otobotini in the west (22,7 °C, n* = 25) and Sibaya Lake in the east (21,6 °C, n* = 1) in southern Tongaland (Maud 1980), indicates that mean annual air temperatures differ from north to south in Tongaland by only 0,2 °C and 0,3 °C, compared to 1,6 °C and 1,1 °C from west to east. This difference in temperature from west to east is due to Ndumu Game Reserve and Otobotini both being situated in the west approximately 60 km from the coast, compared to Kosi Bay and Sibaya Lake which both lie close to the coast in the east and at a lower altitude.

Humid, hot conditions are experienced towards the lower regions in the east during the wet season, whereas the Lebombo Mountains in the west have a stable climate throughout the year and the central area, between the Pongola River up to a point 15 km east of Mozi Swamp North has a hot, wet season and a cool, dry season (Bruton 1976).

WIND

Data on prevailing winds are only available for Ndumu Game Reserve (Tinley 1964) where the winds are predominantly north-east in the dry season and south to south-west during the wet season. During the wet season winds of high velocity but short duration are experienced

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n* = number of years.

during thunderstorms. On the flood plains, shallow-rooted tree are sometimes blown over when the soil is wet and soft (Natal Parks Board 1981).

The north-east winds are particularly desiccating, especially when blowing at midday or early afternoon.

During the wet season thunderstorms of short duration were experienced by the author in the proposed Tembe Elephant Reserve, and south-west winds, with high velocities, did considerable damage to the vegetation. A species uprooted by these winds during the study period was Acacia burkei, and species severely damaged were Albizia adianthifolia, Terminalia sericea, Albizia versicolor and Sclerocarya birrea.

RAINFALL

From as early as 1921, rainfall has been recorded at several stations in Tongaland (Weather Bureau 1965). However, for many years the only meteorological recording station in Tongaland was Otobotini (Weather Bureau 1965). Since 1974 this recording station has been superceded by one at the Makatini Research Station (Maud 1980).

Where available, mean monthly (Table 3) and annual (Table 4) rainfall figures were collected.

MEAN MONTHLY RAINFALL

Tongaland has a wet period from the beginning of October to the end of March, during which time 74,6 % of the year's annual rainfall falls (Table 3). Between April and September it is dry and 25,4 % of the year's annual rainfall is recorded then (Table 3).

Table 3 : Mean monthly rainfall (mm) for Ingwavuma, Otobotini, Ndumu, Sihangwana, Kwa Ngwanase, Mbazwana and Kosi Bay, Tongaland, northern Natal (Weather Bureau 1965).

MONTH	INGWAVUMA	OTOBOTINI	NDUMU	SIHANGWANA	KWA NGWANASE	MBAZWANA	KOSI BAY
January	126,2	92,8	102,7	141,0	138,2	134,2	147,2
February	109,7	101,0	86,7	142,0	129,0	139,2	139,2
March	106,5	87,5	98,7	66,0	149,0	98,7	107,9
April	54,4	37,9	37,4	89,0	71,2	40,8	52,0
May	28,5	22,0	23,9	47,0	43,5	36,1	45,4
June	17,3	12,6	12,7	31,0	39,7	19,2	32,5
July	16,8	10,6	14,9	32,0	40,1	36,8	30,7
August	18,6	10,6	7,9	23,0	36,2	39,3	39,3
September	47,6	34,3	29,9	15,0	47,2	74,1	62,6
October	70,6	54,2	48,8	48,0	67,0	105,1	106,5
November	106,5	95,8	81,8	80,0	86,7	108,8	120,9
December	124,2	97,9	96,4	54,0	108,8	116,6	95,8
Dry season total	192,9	128,0	126,6	235,0	278,8	253,6	262,5
Wet season total	643,7	529,2	515,1	531,0	678,7	702,6	717,5
Annual year total	836,6	657,2	641,7	766,0	957,5	956,2	980,0
Years recorded	47	39	37	13	44	7	6

Wet season : October to March

Dry season : April to September

Table 4: Annual rainfall (mm), standard deviation (SD) from the long-term mean and number of rainy days per year for Ingwavuma, Ndumu Game Reserve, Sihangwana, Kwa Ngwanase and Kosi Bay, Tongaland, northern Natal (Weather Bureau 1965 and 1981).

YEAR	INDGWAVUMA			NDUMU GAME RESERVE			SIHANGWANA			KWA NGWANASE			KOSI BAY			MEAN		
	Rainfall	Deviation	Days	Rainfall	Deviation	Days	Rainfall	Deviation	Days	Rainfall	Deviation	Days	Rainfall	Deviation	Days	Rainfall	Deviation	Days
1949	739,5	- 7,8	74	*	*	*	*	*	*	1175,0	+28,1	160	*	*	*	957,3	+20,7	117
1950	1106,0	+38,0	83	450,0	-30,2	35	*	*	*	950,0	+ 3,6	74	*	*	*	835,3	+ 5,4	64
1951	627,7	-21,7	61	455,0	-29,5	33	*	*	*	649,3	-29,2	79	642,1	-33,8	88	677,6	-14,5	65
1952	727,1	- 8,3	84	520,0	-19,4	40	*	*	*	043,7	+13,8	103	1183,0	+2,20	108	868,5	+ 9,6	84
1953	876,0	+ 9,3	68	799,5	+23,9	31	*	*	*	775,0	-16,5	70	772,0	-20,4	101	805,6	+ 1,6	68
1954	965,7	+20,5	93	583,0	- 9,6	25	*	*	*	797,8	-13,0	70	842,1	-13,1	87	797,1	+ 0,6	69
1955	1262,1	+57,6	119	979,5	+51,8	72	*	*	*	1239,9	+35,2	102	1211,4	+25,0	98	1173,2	+48,0	98
1956	694,5	-13,2	55	467,7	-27,5	35	*	*	*	804,6	-12,3	*	566,8	-41,5	50	633,4	-20,1	47
1957	1034,2	+29,0	66	659,5	+ 2,2	39	*	*	*	185,9	"29,3	*	1203,6	+24,1	39	1020,6	+28,7	48
1958	883,6	+10,2	56	695,7	+ 7,8	46	*	*	*	962,6	+ 4,9	*	874,0	- 9,2	53	854,0	+ 7,7	52
1959	894,0	+11,5	50	507,9	-21,3	36	415,0	-34,1	28	705,8	-23,1	*	502,6	-48,1	36	605,1	-23,7	38
1960	977,5	+21,9	51	670,0	+ 3,8	63	206,0	-67,3	17	986,4	+ 7,5	*	977,8	+ 0,9	52	763,5	- 3,7	46
1961	585,3	-27,0	44	527,1	-18,3	63	374,9	-40,5	38	941,3	+ 2,6	68	1008,3	+ 4,0	56	687,4	-13,5	67
1962	615,0	-32,3	65	569,9	-11,7	48	484,5	-23,1	38	564,6	-48,5	55	599,7	-38,1	44	566,7	-28,5	50
1962	750,3	- 6,5	57	514,0	-20,4	45	721,0	+14,4	42	967,5	+ 5,5	65	1093,0	+12,8	62	809,2	+ 2,1	54
1964	764,0	- 4,7	31	586,2	- 9,1	44	575,0	- 9,7	37	775,2	-15,5	46	510,6	-47,3	13	642,2	-19,0	34
1965	463,7	-42,2	26	450,9	-30,1	51	588,0	- 6,7	31	811,0	-11,6	79	775,8	-19,9	27	617,9	-22,1	43
1966	933,0	+16,4	*	871,0	-35,0	55	959,0	+52,2	29	1086,0	+18,4	63	868,3	-10,4	47	943,5	+19,0	49
1967	882,0	+10,0	40	613,8	- 4,9	53	768,5	+22,0	35	948,8	+ 3,4	64	1155,5	+10,2	83	873,7	+10,2	55
1968	432,5	-46,1	29	532,7	-17,4	65	454,8	-27,8	32	412,4	-55,0	62	608,0	-37,3	57	488,1	-38,5	49
1969	871,6	- 8,7	45	794,6	-23,3	74	856,1	+35,9	51	1320,3	+49,3	69	1452,0	+49,8	72	1058,9	+33,6	62
1970	539,7	-32,7	32	429,9	-33,4	43	428,6	-32,0	33	610,4	-33,4	43	638,8	-34,1	55	529,5	-33,2	41
1971	564,9	-29,5	34	605,1	- 6,2	84	434,1	-31,1	50	743,8	-18,9	72	791,4	-18,4	87	627,9	-20,8	65
1972	1058,4	+32,0	43	753,2	+16,7	116	712,0	+13,0	34	1252,4	+36,5	75	1315,9	+35,7	80	1018,4	+28,5	70
1973	651,0	-18,8	33	981,6	+52,1	85	643,0	+ 2,1	22	1036,5	+13,0	86	987,3	+ 1,8	69	859,9	+ 8,5	59
1974	991,1	+23,6	42	816,8	+26,6	34	1343,0	+113,1	27	1030,4	+12,3	55	976,3	+ 0,7	43	1031,5	+30,1	40
1975	*	*	*	806,9	+25,1	35	105,1	+75,4	51	988,9	+ 7,8	58	962,5	- 0,8	67	965,9	+21,8	53
1976	733,2	- 8,5	*	920,3	+42,6	65	*	*	*	*	*	*	1408,9	+45,3	41	1020,8	+28,8	53
1977	1023,0	-27,6	25	717,9	+11,3	56	*	*	*	*	*	*	1169,3	+20,6	52	970,6	+22,4	44
1978	*	*	*	989,3	+53,3	56	*	*	*	*	*	*	1455,4	+50,1	*	1222,4	+15,4	56
1979	575,7	-28,2	*	386,4	-40,1	*	417,1	-33,8	*	*	*	*	724,0	-25,3	*	382,4	-51,8	*
1980	827,8	+ 3,3	*	344,1	-46,7	*	485,6	-22,9	*	*	*	*	835,0	-13,9	*	623,2	-21,4	*
Mean	801,7			645,2			630,1			917,2			969,4			792,7		

+ : Standard deviation above the long-term mean

- : Standard deviation below the long-term mean

ANNUAL RAINFALL

There is a striking variation in rainfall across Tongaland from east to west (Figure 5). At the coast, in the east of the region, the average annual rainfall is close to 1 000 mm (Kosi Bay), but this figure declines progressively westwards and inland to a mean of 641,7 mm per annum in the west, at the foot of the Lebombo Mountain Range (Ndumu). On the crest of the Lebombo Mountain Range the annual rainfall has a mean of 836,6 mm (Ingwavuma).

Dry years experienced in Tongaland from 1949 to 1980, i.e. when the actual annual rainfall received was less than the long-term mean annual rainfall, are represented in Figures 6 and 7. Sihangwana and Ndumu Game Reserve suffer more than the adjacent areas because the annual rainfall for the above two stations drops to well below 500 mm in certain years (Table 4).

RELATIVE HUMIDITY

No long-term data on the percentage relative humidity of the air for Tongaland are available. The only existing long-term data for the area are those from the Mozambique side of the border (Tinley and Van Riet 1981).

The percentage relative humidity of the air on the Lebombo Mountains is highest during December to April when orographic fog is most frequent, and lowest during May to November (Table 5) (Tinley and Van Riet 1981).

The central dry zone, on the other hand, has the highest percentage relative air humidity from April to July when valley mist is most frequent. Along the coast relatively high air humidities occur throughout the year (Table 5).

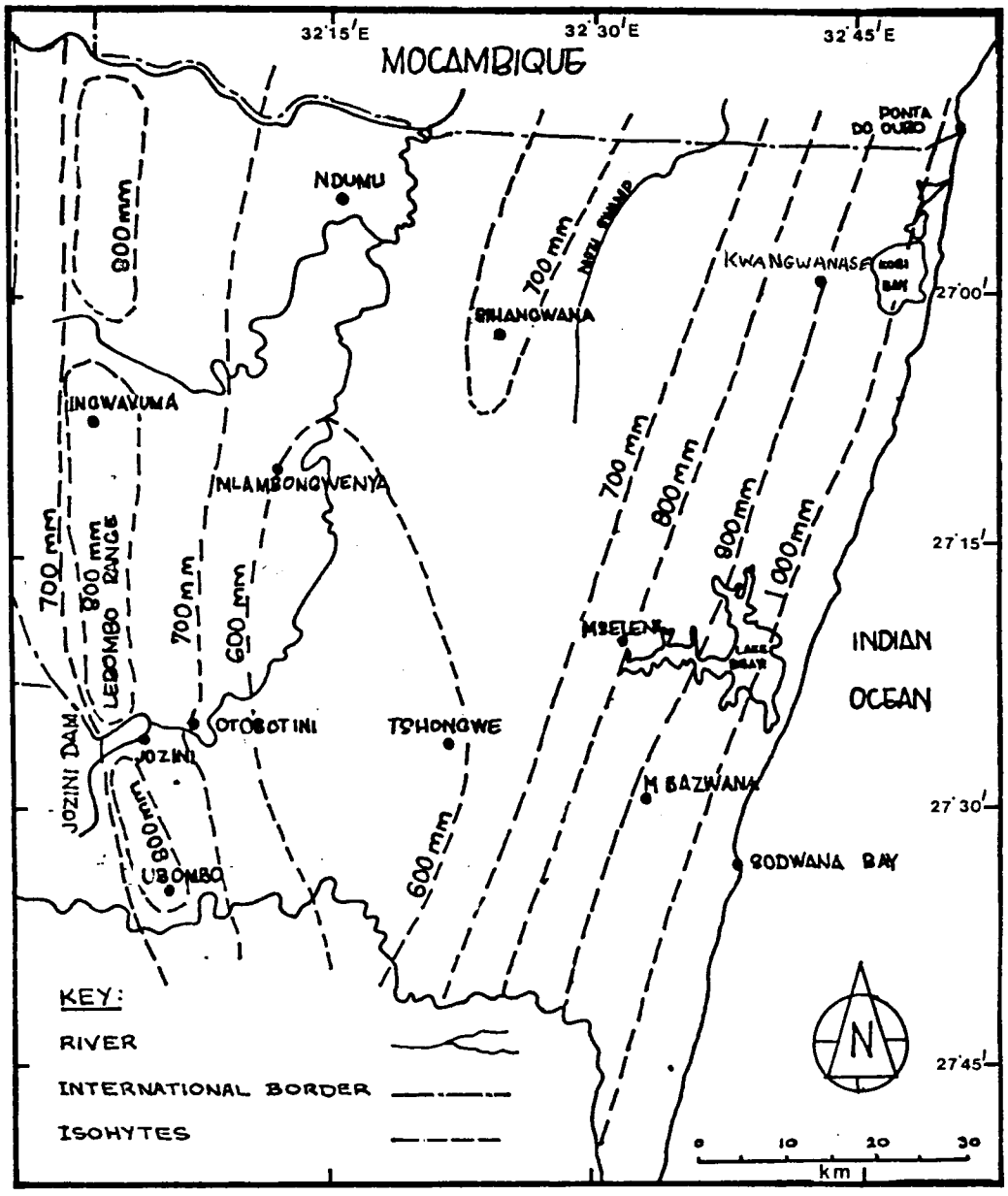
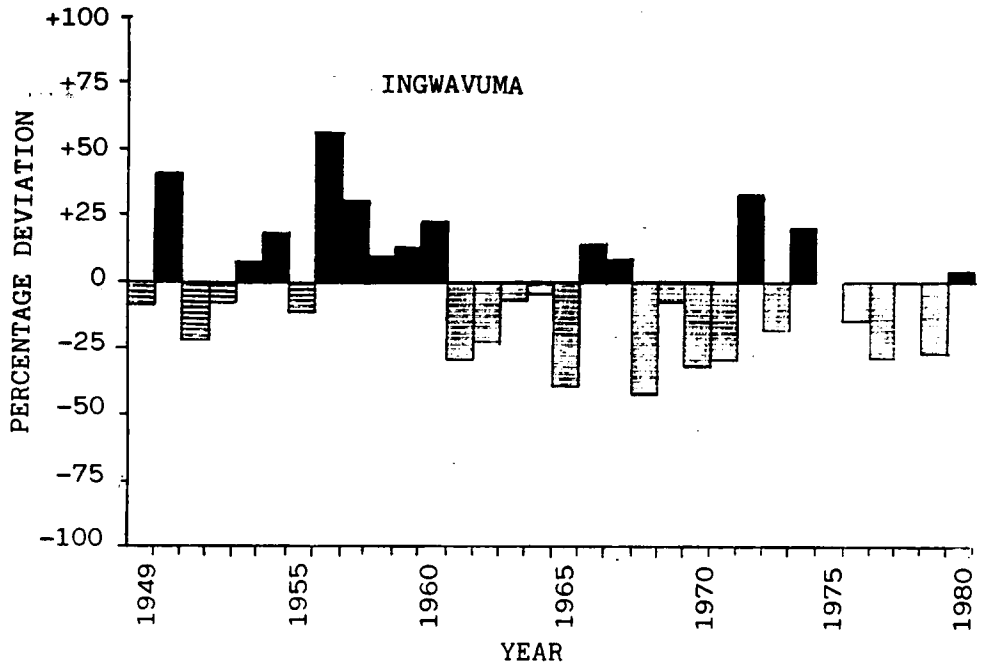


Figure 5 : Mean annual rainfall (mm) for Tongaland, northern Natal, (Maud 1981) and (Tinley and Van Riet 1981).



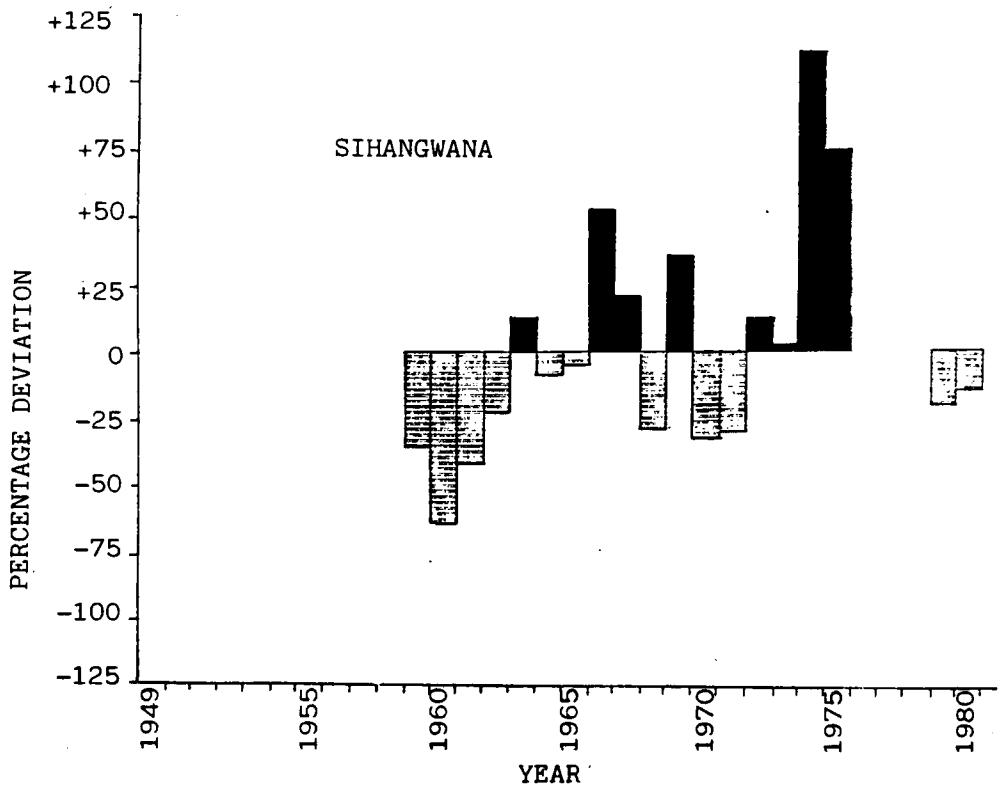


Figure 6 : Percentage deviation from the long-term mean of the annual rainfall (mm) for Ingwavuma and Sihangwana, Tongaland, northern Natal.

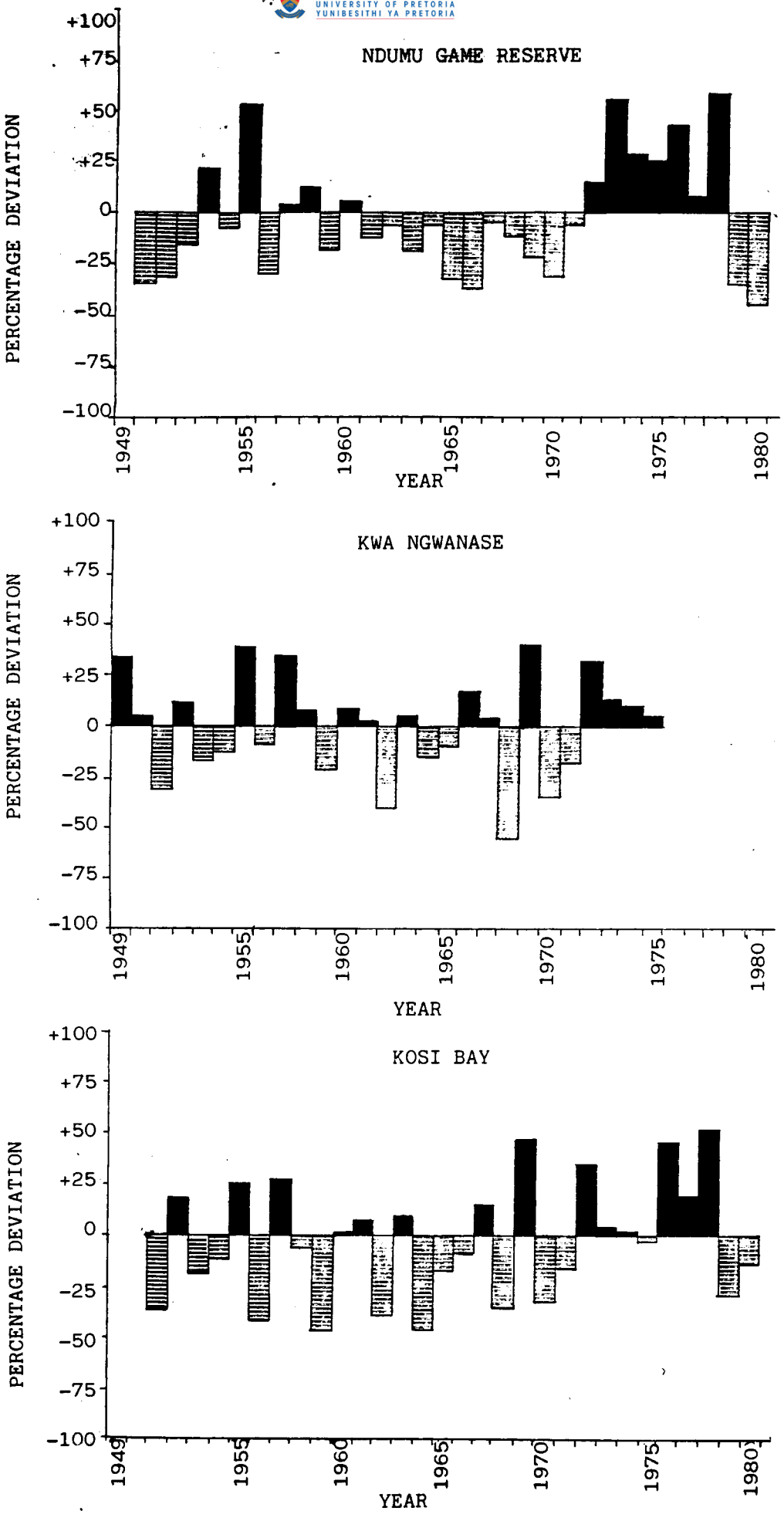


Figure 7 : Percentage deviation from the long-term mean of the annual rainfall (mm) for Ndumu Game Reserve, Kwa Ngwanase and Kosi Bay , Tongaland, northern Natal.

Table 5 : Expected percentage relative humidity of the air for the Lebombo Mountain Range, the Arid Zone and the Coast of Tongaland, according to data from the weather stations Namacha, Catuan and Maputo in southern Mozambique (Tinley and Van Riet 1981).

MONTH	AREA		
	Lebombo Mountain Range	Arid Zone	Coast
January	74,0	67,2	75,9
February	76,0	68,3	76,0
March	77,0	69,7	77,4
April	74,1	71,1	76,3
May	68,4	70,3	74,6
June	66,8	71,3	72,2
July	67,2	71,5	73,2
August	68,3	62,0	73,0
September	67,9	62,9	72,9
October	68,9	64,0	73,9
November	67,2	63,3	74,9
December	70,7	65,8	74,9
Mean	70,5	67,3	74,6
Standard Deviation	3,7	3,6	1,6

HAIL AND FROST

During the wet season, thunderstorms, and hail as large as 5 mm in diameter, occur throughout Tongaland. Data on the duration and frequency of thunderstorms in the area are unavailable. The dry season in Tongaland is frost-free with mild temperatures (Thorrington-Smith et al. 1978).

MIST

During the dry season, dense morning mist occurs throughout Tongaland and might clear as late as 09h15 at the Muzi Border Post. No data are available on mist frequency or intensity.

EVAPORATION

The only water evaporation data available are from the Makatini Research Station, Sibaya Lake and the Ndumu Game Reserve (Table 6). According to Schulze and McGee (1978), the higher evaporation rates experienced in Tongaland during the wet season, can be ascribed to increased air movements.

CLIMOGRAPHS

Rainfall and temperature records from Ndumu and Otobotini in the west, and Kosi Bay and Mbazwana in the east, appear as climographs in Figure 8 (Walter and Lieth 1960).

Indications are that the coastal areas of Kosi Bay and Mbazwana in Tongaland experience a wet season (above 100 mm of rain per month) from October to March, compared to the area further west which has a harsher, dry, hot climate. At Otobotini mean-monthly rainfall does not exceed 100 mm per month during October to March, whereas at Ndumu, January is the only month in which mean monthly rainfall exceeds 100 mm.

Table 6 : Mean evaporation (mm) recorded from open pan, for three stations in Tongaland, northern Natal, during January and June (Maud 1980 and Natal Parks Board 1981).

STATION	YEARS RECORDED	JANUARY	JUNE
Makatini Research Station	6	9,5	4,3
Sibaya Lake	6	5,8	4,1
Ndumu Game Reserve	3	4,9	3,7

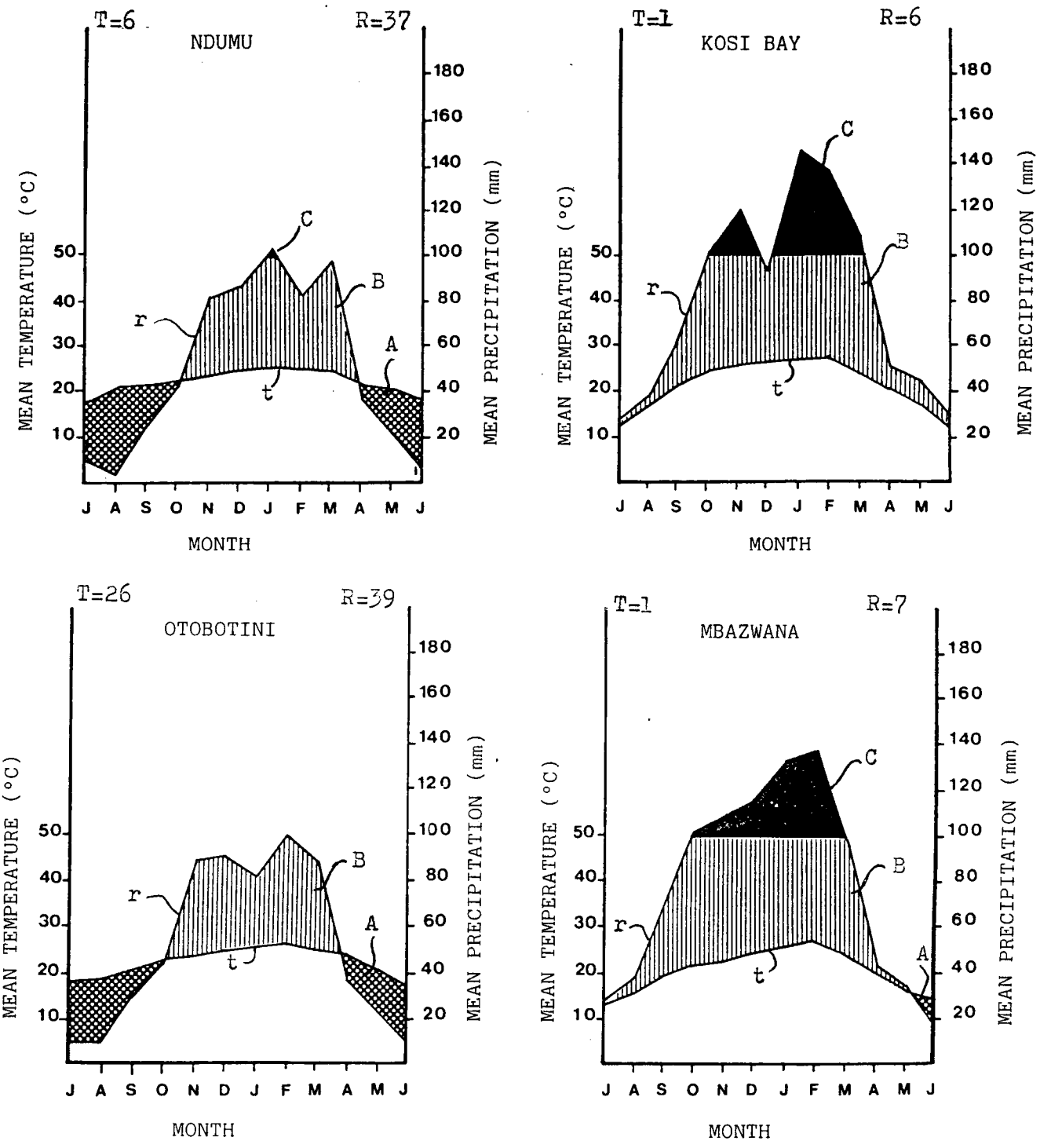


Figure 8 : Walter and Lieth (1960) climographs for Ndumu, Kosi Bay, Otobotini and Mbazwana, Tongaland, northern Natal, (Weather Bureau 1965, Maud 1980 and Tinley and Van Riet 1981).

A = arid period
B = moist period
C = wet period

r = rainfall
t = temperature

R = years of rainfall records
T = years of temperature records

Compared to Kosi Bay in the eastern region, arid conditions occur in the western region of Tongaland during the dry season. In comparison to the western region, the eastern region namely Kosi Bay, is moist throughout the year, Mbazwana on the other hand, has arid conditions only during May and June.

C H A P T E R 3

METHODS

The necessity of an ecological study of northern Tongaland, emphasizing its elephants and natural resources, has developed strongly during the past decade. Such a study should make a valuable contribution to a wildlife conservation and management programme for the Muzi-Sihangwana area, a region in which the majority of the elephants of Tongaland occur.

Because of the ca. 8 000 km^2 size of Tongaland, (Figure 2), it was impossible to cover all of it in detail, therefore, three research areas were identified, viz. first the entire Tongaland (Figure 2) in which the history, physiography and climate of the area was dealt with; second the study area of approximately 600 km^2 (Figure 2) in which local elephant movements and distribution, and water analyses were conducted, and third the proposed Tembe Elephant Reserve of approximately 400 km^2 (Figure 9) within the study area, in which research on the soil, vegetation and aspects of the ecology of the Tongaland elephants was carried out. Research in the field commenced on the 23rd of May, 1979, and terminated on the 31st of May, 1981. The study area was again visited during July, August, September and October of 1981, when final field data were collected on some aspects.

To facilitate its description the climate of Tongaland has been subdivided into two major seasons based on the climographs of Walter and Lieth (1960), viz. the dry season from 1st April to 30th September, and the wet season from 1st October to 31st March.

SOIL

INTRODUCTION

Soil analysis of part of the study area was regarded as essential to a proper understanding of the fertility of the soil.

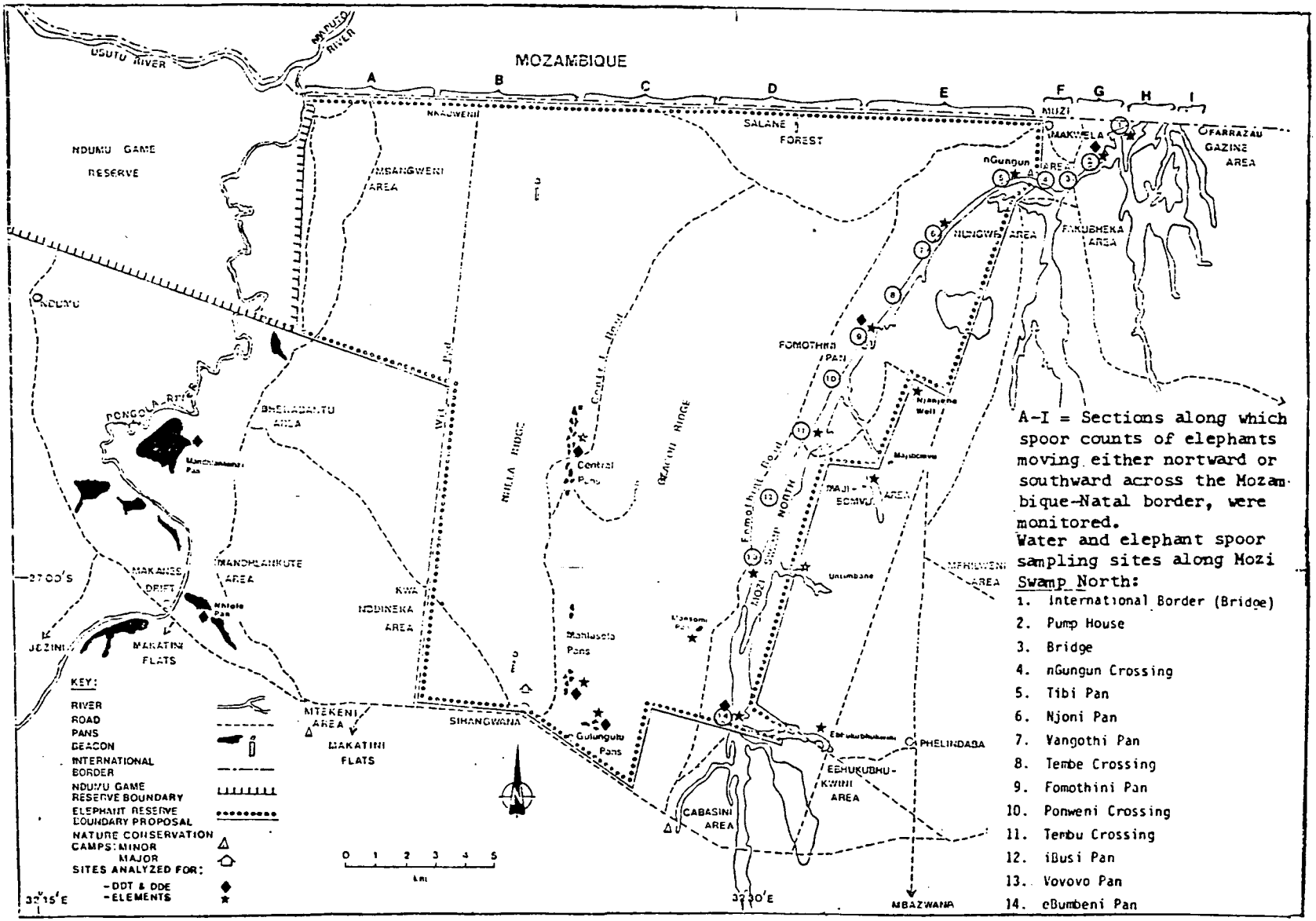


Figure 9 : Sites at which water samples were taken and elephant spoor were monitored from 1979 to 1981 within the study area, Tongaland, nothern Natal.

The aims of the analyses were:

- To investigate which factors compel the local population to practise "shifting cultivation".

- To determine to what extent the local population living at present within the boundaries of the proposed "elephant reserve" would be deprived of areas of high agricultural potential should they have to move away.

- To find out how the diverse plant communities are related to soil.

SOIL DESCRIPTION

To facilitate the description of soils in a particular stand, the scales, based on threshold values of elements found in the soil, as represented in Table 7, were used.

SOIL PROFILE

According to Loxton et al. (1969) 16 soil types occur between the Pongola River and a point 4 km east of Mozi Swamp North (Figure 10) north of the Sihangwana-Makanes Drift main road. Thirteen of the 16 soil types are represented within the proposed Tembe Elephant Reserve (Figure 10). On each of these 13 soil types, one or more representative sites were selected and 21 pits (Figure 10) were dug to a depth of 2,5 m each.

In each horizon, 1 kg soil samples across the horizon were taken and lablled A, B, C etc. from the surface to the bottom of the pit. In the field, the depth of each horizon was noted, as well as the texture (FSSA 1980), structure (FSSA 1980), consistency (Macvicar, Loxton, Lambrechts, Le Roux, De Villiers, Verster, Merryweather, Van Rooyen and Von Harmse 1977) and colour (Oyama and Takehara 1967) of the soil.

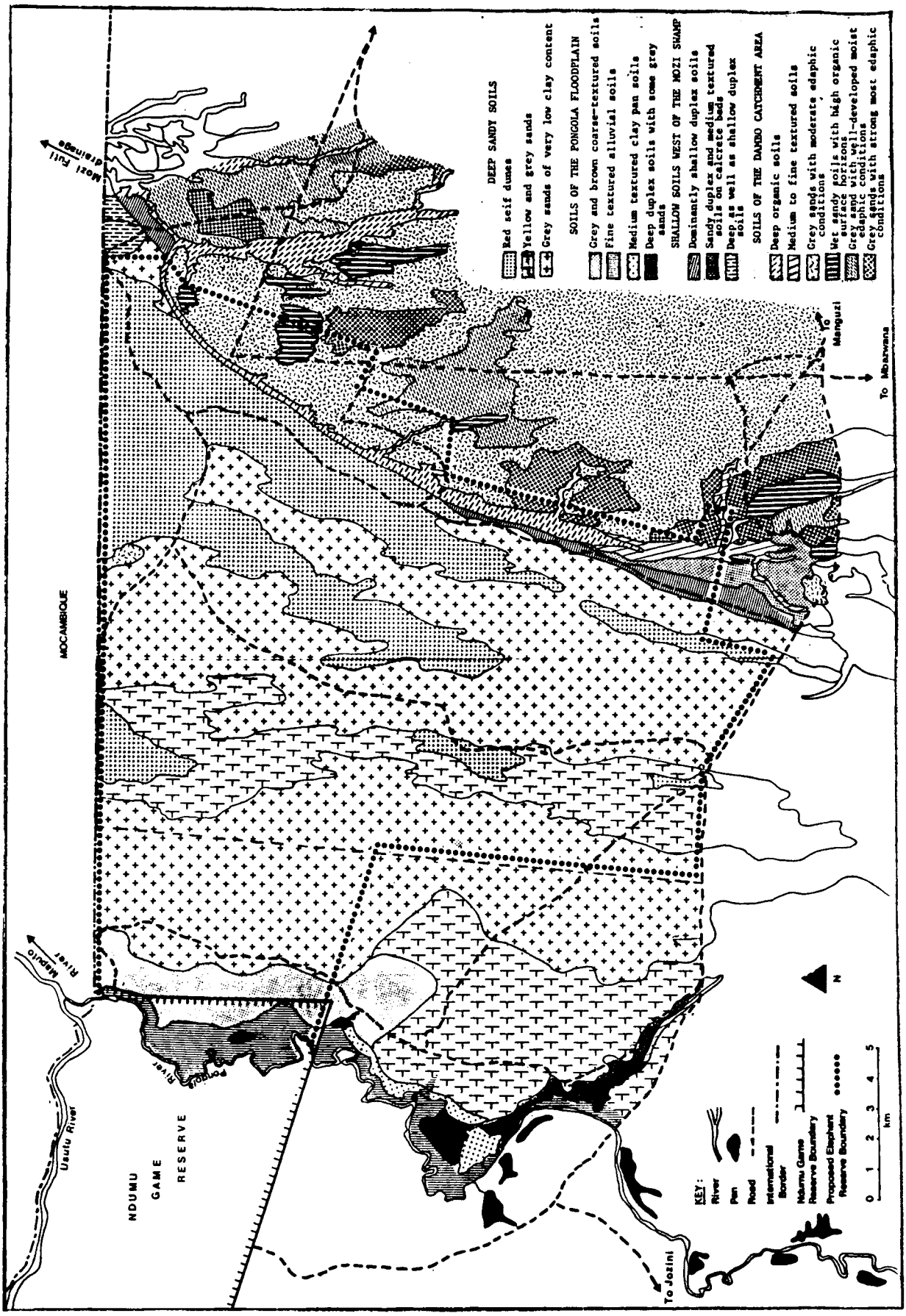


Figure 10 : Soil types within the study area, Tongaland, northern Natal, after Loxton, Hunting and Associates (1969).

SOIL ANALYSIS

Soil samples were analysed by the Citrus Board, P.O. Box 14105, Verwoerdburg, Republic of South Africa, using standard methods (FSSA 1980). All soils were analysed for phosphorus (P^+), potassium (K^+), magnesium (Mg^{++}) and calcium (Ca^{++}) as well as soil resistance. According to Coetzee (pers. comm.) the above analysis is of great value in that it provides for a general fertility evaluation of the soils. The cation exchange capacity (CEC) was calculated for each horizon, where CEC gives the total ions available in the soil for the plant (Macvicar et al. 1977). Total ions available (me/100 g soil) for the elements K^+, P^+, Ca^{++} and Mg^{++}, was calculated from available data (Table 7) but in the case of Na^+ an average value of 0,15 me/100 g soil (Buys, pers. comm.) was used throughout the calculations.

The following procedures were used for the determination of all the elements:

a) Soil samples were air-dried and all exchangeable P^+, K^+, Ca^{++}, and Mg^{++} ions were measured. Exchangeable values were expressed as parts per million (ppm).

b) Test for available K^+, Ca^{++}, and Mg^{++} : a known mass of soil was shaken for 15 minutes with a 1 mol/litre ammonium acetate solution, pH 7, at a soil/extractant ratio of 1:10 g/ml. By this procedure the absorbed and ammonium acetate soluble cations are extracted from the soil (Soil Analysis: Manual of Methods, Publication No. 74 FSSA, 1980).

c) Test for available P^+ : Sample extracted with the Bray 1 solution, consisting of a 0,03 mol/litre solution of ammonium fluoride in a 0,025 mol/litre hydrochloric acid solution at a soil extractant ratio of 1:7,3 g/mol. The procedure follows that given by the FSSA, Soil Analysis, Manual for Methods, Publication No. 74, 1980 and is based on the method of Bray and Kurz (1945, In: FSSA 1980).

Coetzee, J.G.K. (1981): P.O. Box 14105, VERWOERDBURG, 0140.

Buys, A.J. (1981): Fertilizer Society of South Africa, Box 1821, PRETORIA, 0001.

Table 7 : Rating of soil fertility and threshold values (ppm) of the available elements for soils (After Buys 1977).

ELEMENT	AVAILABLE ELEMENTS	RATING OF SOIL FERTILITY
Phosphorus	below 5/10**	limited, deficient
	above 30/50**	usually sufficient
Calcium	below 100/300**	limited, deficient
	above 1500/2500*	sufficient, possibly in excess
Magnesium	below 40/80*	limited, deficient
	above 200/400*	usually sufficient, possibly too high in comparison with K^+
Potassium	below 50/100*	deficient, limited
	above 200/350*	usually sufficient
Sodium	below 30/70*	low, harmless
	above 100/200*	high, possibly harmless
	above 300	too high, possibly brackish, possibly detrimental
CEC^+	below 3/5	poor soil
	below 6/15	very fertile soil (ideal)
	above 15/25	medium to heavy soils, moderate to potential rich

* : Low values related to infertile soils and the higher values to the element rich soils.

** : Low values for turf soils and higher values for other soils.

\+ : Cation exchange capacity

SOIL TEXTURE

The texture of the soil was classified according to the classes laid down by FSSA (1980). The classes distinguished are:

Category	Clay Percentage
Sand	⩽ 10 %
Loamy sand	> 10 % - 15 %
Sandy loam	> 15 % - 20 %
Sandy clay loam	> 20 % - 35 %
Sandy clay	> 35 % - 55 %
Clay	> 55 %

Sand grade was divided into three major groups, namely:

- Fine (F), with solid particles of > 0,02 - 0,2 mm diameter.
- Medium (M), with solid particles of > 0,2 - 0,5 mm diameter.
- Coarse (C), with solid particles of > 0,5 - 2,0 mm diameter.

SOIL STRUCTURE

Soil structure refers to the degree of aggregation between primary soil particles (sand, silt and clay). The following classes were distinguished (FSSA 1980):

- No structure (apedal)
- Blocky
- Columnar
- Platy
- Prismatic

SOIL CONSISTENCY

Consistency is the degree of adhesion or cohesion within the soil mass or its resistance to deformation or rupture (Macvicar et al. 1977). The following consistency classes were distinguished:

- Loose
- Crumbly
- Compact

SOIL COLOUR

Soil colour was determined at each horizon of every soil profile in its wet and dry state. Colour classification was determined with the help of the "Revised Standard Soil Colour Charts" (Oyama and Takehara 1967) which is based on the Munsell Colour Chart. The codes and colour classes which were used (Chapter 4) were those of the Munsell Colour Chart.

ELECTRICAL RESISTANCE OF THE SOIL

The electrical resistance of the soil is an indication of the concentration of soluble salts in the soil (Macvicar et al. 1977). The electrical resistance of a water-saturated soil paste, between two platinum electrodes, is measured by means of a Wheatstone bridge. It is determined in a saturated soil paste which is a particular mixture of soil and water. At saturation the soil paste glistens as it reflects light; it flows slightly when the container is tipped and the paste slides freely from a spatula for all soils except those with a high clay content (FSSA 1980).

The following resistance classes were used to describe the soils (Bredenkamp 1981):

Electrical Resistance	Resistance Class
⩽ 250 Ohm	Very saline
> 250 to 800 Ohm	Relatively saline
> 800 to 1 800 Ohm	Normal
> 1 800 to 3 000 Ohm	Leached
> 3 000 Ohm	Strongly leached

ACIDITY OF THE SOIL

The acidity of the soil is determined by measuring the pH of a 100 g of soil in 1 mol/litre KCℓ solution suspension using a pH meter fitted with a glass electrode (FSSA 1980).

The following pH classes were distinguished (Macvicar et al. 1977):

pH	Category
⩽ 5,5	Strongly acidic
> 5,5 - 6,5	Relatively acidic
> 6,5 - 7,4	Neutral
> 7,4 - 8,4	Relatively alkaline
> 8,4	Strongly alkaline

CARBONATES

To determine the presence or absence of carbonates in the soil, a soil sample of 15 mg was treated with three drops of a 10% HCl solution. The degree of fissing that occurs after application indicates the presence or absence of carbonates. The degree of fizzing is divided into the following classes (Barnard, pers. comm.):

0 - No fissing
1 - Poor fissing
2 - Mild fissing
3 - Strong fissing

WATER

INTRODUCTION

One aim of this part of the study area was to investigate what factors played a role in the utilization of pans by man, wildlife and cattle within the study area.

Chemical analysis of the following major elements: Sodium (Na^{+}), Calcium (Ca^{++}), Magnesium (Mg^{++}), Sulphate ($SO_4^{=}$) and Chlorine (Cl^{-}) was undertaken.

Barnard, R.O. (1981): Department of Soil Science and Nutrition, University of Pretoria, Hillcrest, PRETORIA, 0001.

Water samples for chemical analysis were taken during August and November 1980, and February, May and July 1981, at seven sampling sites along Mozi Swamp North viz: the International Border, Pump House, Tibi Pan, Njoni Pan, Fomothini Pan, Tembu Crossing and Vovovo Pan (Figure 9). At the sampling site et eBumbeni Pan in the south, only one sample was taken during February 1981, as there was no surface water there during the greater portion of the study period.

In the study area other sampling sites for chemical analysis of water were: the areas east and west of Mozi Swamp North, including tributaries of the swamp, a well and seasonal pans (Figure 9). All the latter sites were sampled only once during February 1981 as the prevailing drought during the study period had a marked influence on sampling frequency.

Analysis for the presence of p', p' DDT and p', p' DDE residues in the water was also undertaken. The purposes of this analysis was to determine whether the pans were contaminated by organochloride pesticides.

Pans selected for p', p' DDT and p', p' DDE analysis were: the Pumphouse, Fomothini Pan, eBumbeni Pan along Mozi Swamp North, 'n Gulungulu Pan, Mahlasela Pan, the Central Pans in the Central Area between Nhlela and Beacon Ridges and Mandhlankunzi and Nhlole Pan along the east bank of the Pongola Floodplain (Figure 9).

The decision to sample a pan, was based on its ecological importance (to man, his domestic animals and the elephants) and pans (as listed above) which were considered to be subjected to the inflow of chemicals from agricultural runoff and pesticides used for malaria control.

The concentrations (ppm) of elements analysed for each pan were compared with each other as well as with rain water (Reid 1961) and sea water. Furthermore, pans were classified according to the salinity gradients put forward by Reid (1961).

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p', p' DDT = 1,1 - bis (4-chlorophenyl - 2,2,2, - trichloroethene).
p', p' DDE = 1,1 - bis (4-chlorophenyl - 2,2 - dichloroethene).

SAMPLING

Water samples for chemical analysis were collected in 750 ml plastic bottles. These were sealed air-tight and stored in a cool place.

Water samples for p', p' DDT and p', p' DDE analysis were collected on 15th August 1981 in 1 litre glass bottles, sealed air tight, and handed to the SABS for analysis on the 18th August 1981.

ANALYSIS

Chemical analysis for the elements Ca^{++}, Cl^{-}, Na^{+}, Mg^{++} and $SO_4^{=}$ (expressed in ppm) salinity (conductivity in mS/m) and pH, was undertaken by the National Institute for Water Research of the CSIR Hydrological Research Section, using the standard method for the examination of water (Anon 1946).

The SABS analysed the water samples quantitatively for p', p' DDE and p', p' DDT residues in the water. The procedures followed for the analyses were as follows:

Each sample was mixed well and 300 ml of each sample was extracted and used for analysis. Samples were transferred to separation funnels and extracted three times with 100 ml hexane. In cases where an emulsion was formed, it was broken down by centrifuging the sample (Viljoen pers. comm.).

After this, the hexane was filtered through sodium-sulphate, vaporised, and adjusted to a pre-determined volume. The p', p' DDE and p', p' DDT content of the sample was determined gas chromatography with the aid of an electron receiver detector. A control water sample, as well as a retrieving determination, was determined together with the other samples. The values of the retrieving determinations, done on a level of 0,003 mg/kg for p', p' DDE and

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mS/m : micro Siemens per metre.

CSIR : Council of Scientific and Industrial Research, P.O. Box 395, PRETORIA, 0001.

SABS : South African Bureau of Standards, Private Bag X 91, PRETORIA, 0001.

Viljoen, A.J. (1982) : South African Bureau of Standards, Private Bag X 91, PRETORIA, 0001.

p', p' DDT were 103% and 100% respectively (Viljoen pers. comm.)

CHARACTERISTICS OF MOZI SWAMP NORTH AND THE SEASONAL PANS

PHYSICAL CHARACTERISTICS

The size of each pan (m^2), its depth (cm) and light penetration was noted at 14 sites (Figure 9) along Mozi Swamp North including the nGulungulu, Mahlasela and the Central Pans between Nhlela and Beacon Ridges (Appendix 1).

Light penetration (i.e. visibility) was measured with a metal plate (25 cm in diameter), which was painted white and attached to a string, calibrated in centimetres. The metal plate was lowered into the water and when the metal plate disappeared from view, the depth of the water i.e. from the metal plate to the surface of the water was recorded (Appendix 1).

ECOLOGICAL CHARACTERISTICS

At each of the 14 sites along Mozi Swamp North (Figure 9) including nGulungulu, Mahlasela and the Central Pans, aquatic plant species present were noted. The extent to which each site was utilized by the local inhabitants, their cattle and/or by the elephants and hippopotami (Hippopotamus amphibius) also received attention. This information was collected on a monthly basis and was based on spoor and reliable reports received from the local people (Appendices 1 and 2).

VEGETATION

INTRODUCTION

Large-scale delineation of the southern African savanna into vegetation types or communities on a physiognomic basis is possible, and the distribution of ungulates appears to coincide with the distribution of

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Viljoen, A.J. (1982): South African Bureau of Standards, Private Bag X 91, PRETORIA, 0001.

certain vegetation types on a broad level (Hirst 1975). However, physiognomy is a rough criterion of differentiation, especially when attempting subjective delineation on a finer scale. Although there are important discontinuities in physical habitat and vegetation components which make delineation both feasible and ecologically valid (Daubenmire 1968), detection of these on a subjective basis is difficult.

Some objective to semi-objective methods for classification of vegetation, e.g. the Braun-Blanquet method (Werger 1974), offers a practical solution to the delineation of the vegetation into different plant communities. These communities can each be described structurally and floristically by means of e.g. the variable plot method (Coetzee and Gertenbach 1977).

An attempt was made to classify and describe the vegetation of the study area as proposed for the Tembe Elephant Reserve, using the above-mentioned methods. However, the complexity, density and heterogeneity of the vegetation, forced one to disregard both these methods. Instead a more subjective approach was adopted which complied with the aims of the present study.

VEGETATION MAPPING

The vegetation map was prepared from aerial photographs of October 1978, obtained from the KwaZulu Department of Agriculture and Forestry Office at Ulundi. Physiographic, physiognomic and homogeneous units were delineated first on these aerial photos and compared with the vegetation map of Loxton et al. (1969) for the study area. The vegetation delineation by Loxton et al. (1969) coincided with the physiographic and physiognomic units found on the aerial photographs. However, delimited units were only accepted as practical if:

- They could be recognised easily on the basis of physiognomy, topo-edaphic features or dominant plant species.

- Their appearance on the aerial photographs was distinctive and uniform enough to permit accurate mapping of those parts not covered by the actual survey.

- Separate patches of such habitat types covered areas of at least 5 ha each.

Where possible, habitat type was incorporated whilst mapping the vegetation, but this was difficult on a subjective basis.

After the map was compiled, three representative areas within each delimited unit was visited in the field for the physiognomic description and characterization of each unit.

Plant specimens were identified by staff from the Ndumu, Mkuze and Umfolozi Game Reserves, and the Botanical Research Institute in Pretoria.

PHYSIOGNOMIC DESCRIPTION

For the physiognomic description of each plant community, Edwards (1983) classification method was followed and the different stratum, formation classes, and canopy covers as suggested by Edwards (1983) are represented in Table 8.

SURVEY TECHNIQUE

At each site in each plant community, as classified after Edwards (1983), the various strata present were recorded and the dominant plant species in each stratum were listed.

This was done whilst walking and noting the names of all woody species encountered within a 100 m radius of a site which was selected randomly. Herbaceous components of each stratum were listed in order of abundance.

The growth forms of woody plant components and their definitions in different strata are as follows (Edwards 1983):

Table 8 : Formation classes, percentage canopy cover and number of canopies apart of the vegetation, used for classification purposes of the tree, shrub and grass strata of Tongaland, northern Natal (after Edwards 1983).

STRATUM	FORMATION CLASS	CANOPY COVER IN STRATUM					
		Tree		Shrub		Grass	
		Percent cover	Number of canopy covers apart	Percent cover	Number of canopy covers apart	Percent cover	Number of canopy covers apart
Tree	Forest	> 75 - 100	0 - 0,1	< 10	2	-	-
	Closed Woodland	> 10 - 75	> 0,1 - 2	< 10	2	-	-
	Open Woodland	> 1 - 10	> 2 - 8	< 10	2	-	-
	Sparse Woodland	> 0,1 - 1	> 8 - 30	< 10	2	-	-
Shrub	Closed Woodland	Seldom	Seldom	> 10 - 100	0 - 2	-	-
	Open Woodland	to	to	> 1 - 10	> 2 - 8	-	-
	Sparse Woodland	absent	absent	> 0,1 - 1	> 8 - 30	-	-
Grass	Closed Grassland	-	-	-	-	> 10 - 100	0 - 2
	Open Grassland	-	-	-	-	> 1 - 10	> 2 - 8
	Sparse Grassland	-	-	-	-	> 0,1 - 1	> 8 - 30

- Tree growth form (T) : Any single-stemmed woody plant over 2 m high, sometimes with a few definite trunks.

- Shrub growth form (S) : Any multi-stemmed low-branching woody plant, 1 - 5 m high with stems from at or near ground level.

- Dwarf shrub growth form (DS) : Any woody plant less than 1 m high.

Four height strata were distinguished:

$\leqslant$ 0,5 m
> 0,5 m - 5,0 m
> 5,0 m - 12,0 m
> 12,0 m

A planimeter was used to measure the area (ha) covered by each plant community from a 1:50 000 topocadastral map.

PHENOLOGY

The availability of leaves, flowers and fruits of specific species of trees and shrubs selected by elephants was determined. Such phenological information was collected for the 12 months from August 1980 to July 1981.

The presence or absence of leaves, flowers (or buds) and fruit was recorded on a monthly basis on ten individuals of each major plant species. Four classes of abundance viz. 0 - 25 %, 26 - 50 %, 51 - 75 %, and 76 - 100 % were arbitrarily decided on for recording the presence of leaves, flowers (or buds) and fruit on trees; a method which has also been used with success by Hall-Martin (1972) and Tinley (1977).

The plant species investigated were:

TREES : Acacia karroo, Acacia nilotica, Acacia robusta, Afzelia quanzensis, Albizia adianthifolia, Albizia versicolor, Balanites maughamii, Combretum molle, Dialium schlechteri, Garcinia livingstonii, Hymenocardia ulmoides, Sclerocarya birrea.

SHRUBS : Bridelia cathartica, Dichrostachys cinerea, Mimusops caffra, Strychnos madagascariensis, Strychnos spinosa.

ELEPHANT ECOLOGY

INTRODUCTION

There are numerous techniques which can be used to determine the size, number and movements of animal populations, to determine sex and age and to recognise individual elephants. The techniques used depend on the area and the species studied.

Elephant research in the Addo Elephant National Park or in the Kruger National Park cannot be compared with elephant research in Tongaland. Compared with the above two areas, the Tongaland area was unfenced and involved an unstable elephant population with continuous movement across the Mozambique-Natal border.

FOLLOWING ELEPHANTS ON FOOT

According to Douglas-Hamilton and Douglas-Hamilton (1975), an ecological study of elephants requires one to get close to the subject to be studied. This was virtually impossible in the Tongaland study, due to the density of the vegetation, the continual change in wind direction and the unpredictable behaviour of these elephants towards humans. It is not without reason that the elephants in Tongaland have gained a reputation for ferocity, considering the number of complaints that were voiced by the local inhabitants

of rogue elephants. During the current study numerous attempts were being made to follow the Tongaland elephants on foot. This however, had to be terminated after two incidents in which the author nearly lost his life.

MOVEMENTS ACROSS THE MOZAMBIQUE-NATAL BORDER

Elephant activity across the Mozambique-Natal border was noted daily for a distance of 30 km from the Pongola River to Farrazau, 5 km east of Muzi Border Post (Figure 9.)

This part of the study started on 1 July 1979, and ended on the 31 July 1981. Data were collected with the help of four scouts and the staff responsible for maintaining the foot-and-mouth disease control fence along the Mozambique-Natal border.

For study purposes the Mozambique-Natal border was divided into section A to I (Figure 9) from the Pongola River to Farrazau. Two scout camps were erected along the border: one at Muzi Border Post and the other at Nkauweni, 4,5 km east of the Pongola River. The former camp (Figure 9) was used as main base, from which all patrols were initiated. The latter camp was used mainly as a stop-over.

The tasks of the scouts were to count on a daily basis all north-going spoor (out of the study area) and south-going spoor (into the study area) across the Mozambique-Natal border in a 20 m wide strip of debushed area; and also to measure the size of all spoor. The number of elephants that had only come to feed on the sisal growing on a 5 m wide strip adjacent to the Mozambique border line or from the Natal side was also noted. All the data were recorded daily on field data sheets supplied to the scouts. A certain degree of error is to be expected in these figures, because of the constant change of scouts during the first 12 months of the study.

From the data collected it was hoped to find answers to the following:

- Was there a seasonal occurrence of elephant activity across the Mozambique-Natal border?

- Did the elephants use specific paths?

- To what could one relate the north-south and south-north movement across the Mozambique-Natal border?

LOCAL ELEPHANT MOVEMENTS

Movements of elephants east of Mfhilweni, south of the Makanes Drift-Phelindaba road and west of a line extending from the eastern fence of Ndumu Game Reserve, south to Mtekeni, were noted (Figure 9).

Data were collected on a day-to-day basis by the author, by the scouts of the KwaZulu Government based at Sihangwana, and by the local human population living on the periphery of the Muzi-Sihangwana area.

LOCAL ELEPHANT DISTRIBUTION

The distribution map for the elephants (Figure 25) is based mainly on spoor, as visual observations of actual elephants made on foot and from the air were infrequent.

On a quarter-year basis the study area (600 km^2) was covered, either by foot and/or by vehicle. All spoor encountered along the pans of Mozi Swamp North and on all roads were noted.

From the available data, a wet and a dry season distribution map for the elephants was then compiled (Figure 25).

OBSERVATIONS OF ELEPHANTS AT WATERING SITES

Due to the secretive habits of the elephants of Tongaland, direct observations on these elephants were rare.

Direct observation of elephants was only possible during full moon periods and from hides built above the reach of an elephant's trunk in trees. Thus the selection of the location for a hide was of vital importance.

Mozi Swamp North and the Central Pans were scouted during July 1979. From observations made then it was decided to erect a hide at Fomothini Pan in Mozi Swamp North. This pan was ideally situated, with no reeds obstructing the view, and the number of spoor and dung heaps noted indicated that elephants frequented this pan. A marula tree Sclerocarya birrea on the east bank, 75 m from the water's edge, was chosen in which a hide was built.

A second hide was built at Vovovo Pan (Figure 9) on the western bank of Mozi Swamp North, and two more hides were envisaged, i.e. one at the Central Pans and one at Tibi Pan. However, after completion of the hide at Vovovo Pan, the hide was dismantled by the local people.

No further hides were consequently built during the study period, for the following reasons:

- The elephants, especially the family units, were nervous when approaching open water sites; it was therefore aimed to keep human disturbance at a minimum in the study area.

- The Central Pans were dry for most of the study period.

- At Tibi Pan there was no safe place for a hide.

- Fifty to 150-hour counts were only possible during full moon periods, which meant that monthly observations at various other pans would have been impossible, as only one pan could be manned per month during full moon.

- Data obtained on a monthly basis for one pan over a 24-month period, were of more scientific value than data collected at three pans at irregular intervals.

FOMOTHINI PAN OBSERVATIONS

For 23 months, from July 1979 to May 1981, day and night observations were made at Fomothini Pan, during full moon. Continuous observation times ranged from 18 hours and 30 minutes to 160 hours 30 minutes per month.

Whenever elephants approached the water, the following data were collected:

- Time of arrival and departure of lone bulls, family units and bachelor groups.

- Separation of data on those elephants that only drank, those which went for a swim and those which also had a mud wallow.

- Behaviour, e.g. fighting and mating.

- Photographs were taken of all elephants whenever circumstances permitted.

- Sketches of ear scars and tusk information for identification purposes and age estimation where possible.

Sikes' (1967) method of aging elephants was used throughout the study.

On three occasions a spotlight was used on two lone bull elephants and a hippopotamus (Hippopotamus amphibius). Vision was thus improved, but this method had to be halted because it caused the animals to flee.

AERIAL ECOLOGICAL RECONNAISSANCE

Ten aerial surveys were undertaken in Tongaland during the study period (Table 9). The flight times for the surveys ranged from 35 to 105 minutes.

The objectives of these flights were to:

- Scout the area.

- Take aerial photographs of the vegetation.

- Map the kraal distribution of local inhabitants.

- Count elephants.

Census methods used by Jolly (1969); Watson, Parker and Allan (1969); Sinclair (1972); Laws, Parker and Johnstone (1975); and Caughley, Sinclair and Scott-Kemmis (1976) to count large game, were referred to.

A total count of elephants within the study area was impossible. This was due to the closed canopy of the vegetation, which obstructed visibility throughout the year, and the fact that the elephants, who sought refuge in the sand forests, tended to clump into herds ranging in size from four to 51 animals. Numerous logistic problems were also a contributing factor towards the failure of a successful total elephant count.

A stratified random transect sample count (Laws *et al*. 1975) was attempted using a high-winged four-seater Cessna aircraft. For this sample count, a known fraction of the total area was covered. The average density of elephants per km^2 ($\bar{d}/km^2$) recorded in the sample area was multiplied by the surface area of the transects sampled, giving an elephant estimate (Y) for the total area. This method was also unsuccessful in Tongaland and was abandoned because the elephants were unevenly distributed throughout the area, leading to a large sampling error. Instead, spot-counting was done, over areas where elephants were expected to be located. These expectations were based on field information on elephant movements and distribution.

FEEDING HABITS

It was originally planned to record the food utilization by elephants quantitatively within the study area. Before fieldwork commenced, numerous works on the feeding habits of elephants as done elsewhere in Africa were consulted. These included works by: Buechner and Dawkins (1961) (Murchison Falls National Park, Uganda); Glover (1963) (Tsavo National Park, Kenya); Lamprey, Glover, Turner and Bell (1967) (East Africa); Agnew (1968) (Tsavo National Park, Kenya); Van Wyk and Fairall (1969) (Kruger National Park, South Africa); Laws (1970) (East Africa); Field (1971) (Queen Elizabeth National Park, Uganda); Wyatt and Eltringham (1974) (Rwenzori National Park, Uganda); Guy (1976) (Sengwa Wildlife Research Area, Zimbabwe); Walker (1976) (National Parks, Zimbabwe), and Tinley (1977) (Gorongoza National Park, Mozambique)

From the above list, certain methods were tested in the field to determine which were most suitable for sampling quantitative data. Difficulty was, however, encountered by the author in successfully implementing these methods. The cause of failure can be ascribed to the numerous restrictions and logistic problems in Tongaland. These included:

- The ferocity of the elephants which prevented one from following an elephant herd or an individual closely on foot.

- The inaccessibility of the terrain to which the elephants tended to confine themselves.

Due to the lack of success in obtaining quantitative data of direct observations on the feeding habits of elephants, qualitative data were collected instead, from August, 1980, to July, 1981. This was done by following the spoor of a herd or of a single elephant, on condition that the spoor were not older than 24 hours. This was most frustrating at times as any encounter with elephants forced one to retreat and to discontinue the survey. Whilst following the spoor, signs of plant utilization by the elephants were noted.

Table 9 : Type of aircraft involved and timing of aerial ecological reconnaissances of the study area during 1979, 1980, and 1981, Tongaland, northern Natal.

YEAR	DAY	AIRCRAFT USED
1979	1 October	Bell Jet Ranger: four-seater
1980	13 June	Cessna 185: four-seater (low-wing)
	17 October	Cessna 185: four-seater (high-wing)
	27 November	Bell Jet Ranger: four-seater
1981	20 February	Cessna 185: four-seater (high-wing)
	25 February	Cessna 185: four-seater (high-wing)
	3 April	Cessna 185: four-seater (high-wing)
	26 April	Cessna 185: four-seater (high-wing)
	18 May	Cessna 185: four-seater (high-wing)
	9 August	Cessna 185: four-seater (high-wing)

Specific note was taken of the species fed on, including the part of each plant which was utilized.

Furthermore, the phenology of 14 of the major trees and shrubs utilized by the elephants, was monitored on a monthly basis. The objective of this was to investigate the seasonal variation in the availability of leaves, flowers and fruit of selected trees and shrubs to elephants.

A systematic collection of plants utilized by the elephants between August 1980 and July 1981 was also undertaken. This included leaves, twigs, barks and roots. The date and locality for each specimen collected were noted. The objective of the survey was to do in vitro tests on the fermentation of components of the plants utilized by the elephants. Protozoa involved in the digestion of elephants culled in the Kruger National Park will be used for this study. Prof. W. van Hoven of the Department of Zoology, University of Pretoria, has offered to undertake these studies which will be completed at a later stage. The results will therefore appear in a separate paper as soon as analyses have been made available. To date the 156 specimens involved here have been ground up and stored in glass jars.

FAECAL ANALYSES

Over the entire study area a systematic collection of elephant dung from bachelor groups and family units was done over a 12-month period from the beginning of August 1980 to the end of July 1981. For each sample of dung collected, its locality and date was noted.

The sampling procedure entailed the collection of 500 g of wet material from the centre of each dung heap. This sample was then air-dried, stored in a glass jar, and labelled.

The objective of this study was to analyse samples for crude protein, crude fibre and lignin. The analysis technique in this study is to be the same as that used in the analysis of elephant dung collected from the Addo Elephant National Park by the Department of Zoology of

the University of Port Elizabeth. This Department has offered to assist with this analysis (Erasmus, pers. comm). Comparisons of these results with those from other areas where elephants presently occur, are planned.

Experimental work on the above-mentioned analysis is still to be undertaken. The results and the discussion will appear in a separate paper when more data are available.

DISTRIBUTION AND ESTIMATES OF MAMMALIAN FAUNA WITHIN THE PROPOSED TEMBE ELEPHANT RESERVE

During the study period a species-list of mammalian fauna, including their distribution within the boundaries of the proposed reserve (Figure 9) was made. The portion of land east of the Pongola River, which at present forms part of Ndumu Game Reserve, was excluded from the survey. Data on mammalian fauna occurring in the latter area were provided by the Natal Parks Board.

Data on the mammalian fauna were collected on a day-to-day basis.

The orders Chiroptera and Insectivora were excluded from the survey and of the order Rodentia only three species, viz. Hystrix africae-australis (porcupine), Thryonomys swinderianus (greater cane-rat), and Paraxerus palliatus (red squirrel) were included.

Records of certain mammal species were based on spoor and/or droppings as the density of the vegetation and the nocturnal feeding habits of the species, made visual sightings impossible.

Population estimates were made of all species as total counts were impossible. Because only population estimates were possible and no accurate numbers could be ascertained, population numbers per

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Erasmus, T. (1982): Department of Zoology, University of Port Elizabeth, P.O. Box 1600, PORT ELIZABETH, 6000.

species were divided into three categories of abundance irrespective of the populations concerned, viz:

- Rare : less than five individuals per species.
- Satisfactory : five to 24 individuals per species.
- Common : twenty-five and more individuals per species.

C H A P T E R 4

VEGETATION

INTRODUCTION

The proposed Tembe Elephant Reserve is situated in the transitional zone between the Tropical and Sub-Tropical Regions (Moll 1977) which consists of a mosaic of sand and riverine forests, swamp, open and closed woodland, palm veld and pure stands of grassland. According to the vegetation description of Acocks (1975), this reserve lies within the Tropical Bush and Lowveld Savanna (Veld Type 10) and part of the Coastal Tropical Forest (Veld Type 1).

Seven major plant communities were identified by Loxton et al. (1969) in Tongaland of which six occur within the proposed Tembe Elephant Reserve. These include: Open and Closed Woodland, Open Shrub Veld, Thicket (referring to the Sand Forests), Mozi Drainage System and Mozi Swamp North.

Moll (1977) classified the vegetation of Tongaland into 13 basic vegetation types of which six fall within the proposed Tembe Elephant Reserve, namely: the Pongola River Floodplain, Sand Forests, Pallid Sand Bushveld, Mozi Swamp, Palm Veld and Grassland.

On the other hand, Tinley and Van Riet (1981) divided Tongaland into six ecological zones, of which three fall within the proposed Tembe Elephant Reserve, namely, the Pongola River Zone, the Sand Forest Zone and the Mozi Palm Zone. Within these zones the four major vegetation types are: Forest/Thicket, Savanna, Grassland and Wetland.

The purpose of this part of the study was to delineate the vegetation within the proposed Tembe Elephant Reserve into vegetational types or communities on a physiognomic basis.

RESULTS AND DISCUSSIONS

The vegetation within the proposed Tembe Elephant Reserve was grouped into three major physiognomic formations, namely: forest, woodland and hygrophilous communities. These formations were further subdivided into 13 plant communities namely:

Newtonia hildebrantii - Cleistanthus schlechteri Sand Forest;
Ficus sycomorus - Trichilia emetica Riverine Forest;
Albizia petersiana - Acacia grandicornuta Closed Woodland;
Acacia burkei - Spirostachys africana Closed Woodland;
Terminalia sericea - Albizia versicolor Open Woodland;
Acacia burkei - Terminalia sericea Open Woodland;
Acacia burkei - Combretum molle Open Woodland;
Acacia karroo - Acacia nilotica Open Woodland;
Strychnos madagascariensis - Hyphaene natalensis Open Shrub Woodland;
Combretum molle - Hyphaene natalensis Open Palmveld;
Sorghum verticilliflorum - Hemarthria altissima Floodplain Grassland;
Hemarthria altissima - Ischaemum arcuatum Grassland;
Phragmites australis - Typha littoralis Swamp and Dambos.

FORESTS

SAND FOREST

Newtonia hildebrantii - Cleistanthus schlechteri Sand Forest.

The Sand Forest occurs on crests and slopes of north-south running sand dunes parallel to the coastline (Figure 11) which form a mosaic of Sand Forest patches (Figure 12) in a matrix of Open Woodland. The highest crests of these dunes are 143 m above sea-level near the Mozambique-Natal border and 126 m above sea-level near Sihangwana, between the northern Pongola River and Mozi Swamp North.

This community represents a forest (Edwards 1983) and is characterized by Newtonia hildebrantii and Cleistanthus schlechteri.

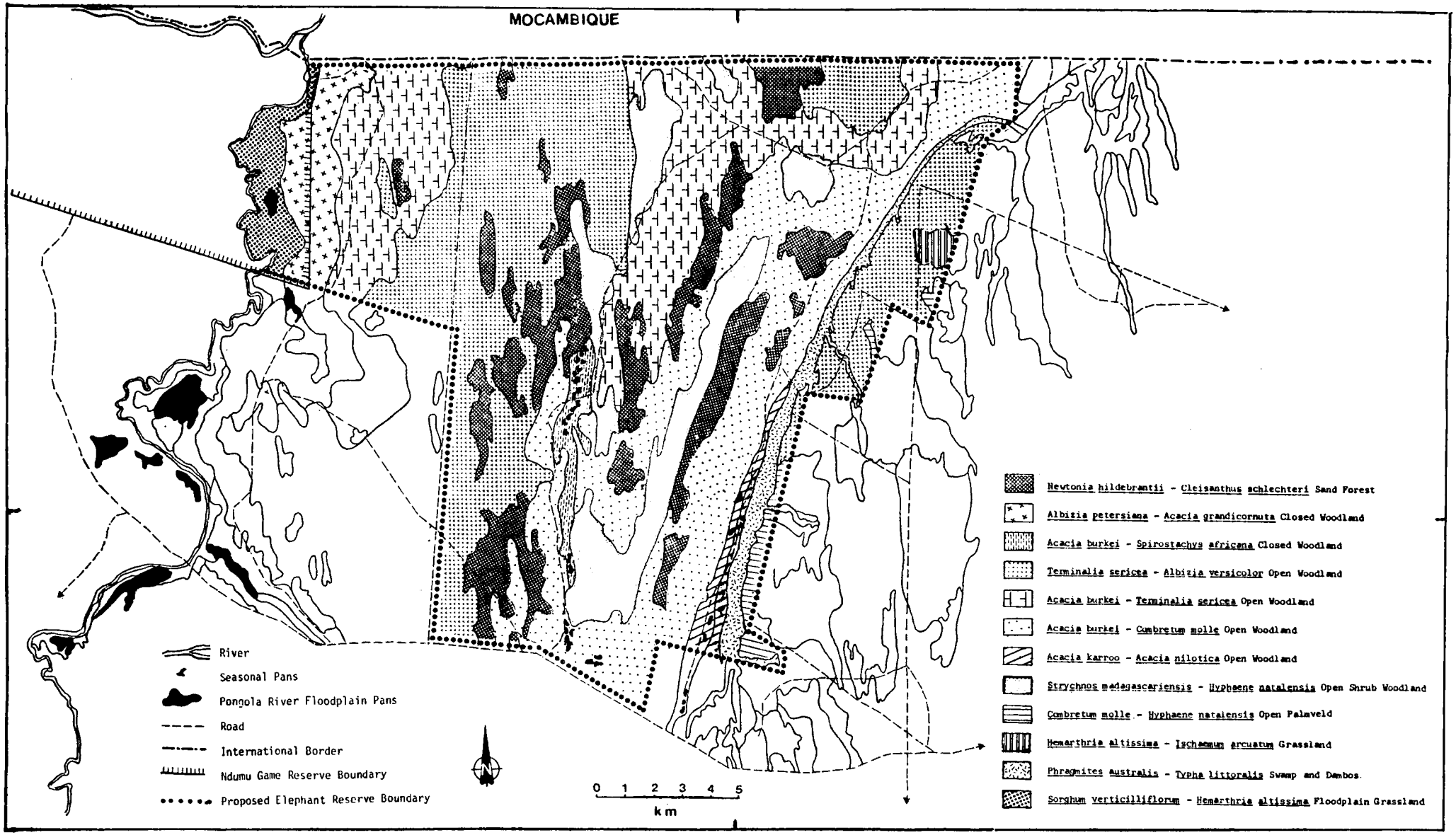

Figure 11: Vegetation of proposed Tembe Elephant Reserve, Tongaland, northern Natal, modified after Loxton, Hunting and Associates (1969).

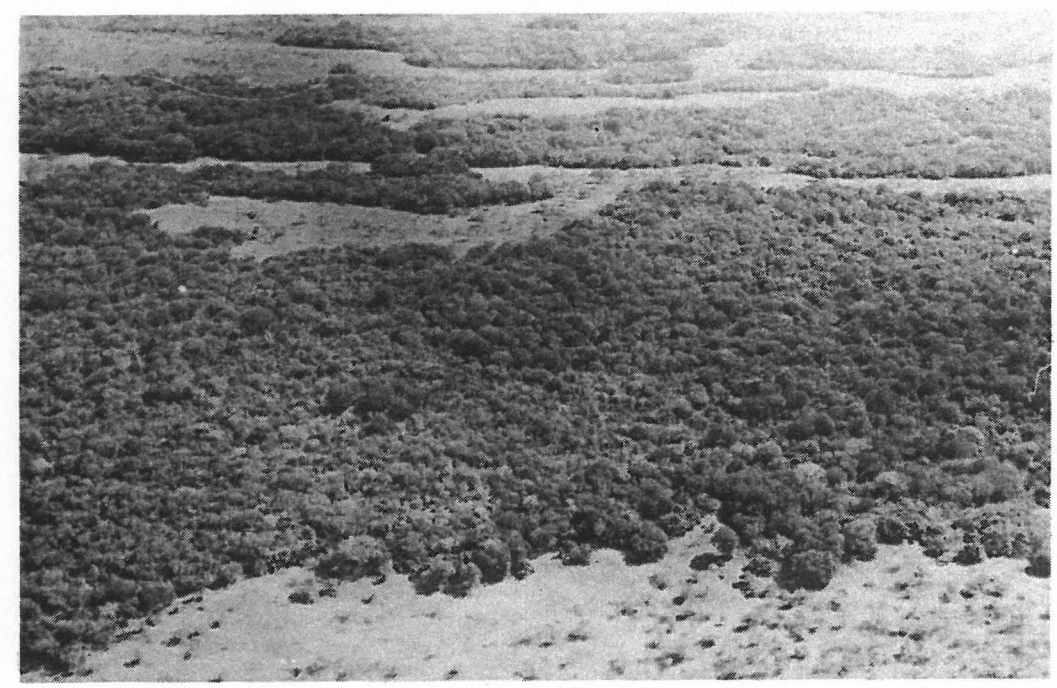

Figure 12 : Newtonia hildebrantii - Cleistanthus schlechteri Sand Forest, Tongaland, northern Natal.

Habitat:

Stands of this forest occur on sandy soils which are predominantly brown to yellowish-red (profile numbers 9, 10, 11 and 12 - Table 10 and Figure 10). The soils are strongly acid in the A-horizon with a pH of 3,4 - 4,7 (profile numbers 9, 10, 11 and 12 - Table 11). The topsoils are of low nutrient status with the cation exchange capacity below 3 meq. % (Table 11) and is considered to be very poor (Buys 1977). The available phosphorus in the soil is 2 - 5 ppm, indicating a phosphorus deficiency (Buys 1977) with the exchange cations potassium, calcium and magnesium all rated as insufficient. The B-horizon soils show no marked differences from the topsoils. The soils remain strongly acid with a pH of 3,6 - 4,1. The total exchangeable cations is also below 3 meq. % and can be rated as very poor (Buys 1977) (Table 11).

Community description and floristic composition:

Stands of the forest consist of trees of different heights and scrub (stunted trees and shrub) which form a dense undergrowth difficult to penetrate. Stratification is largely obscured in the thickets but several different synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 12 m): Newtonia hildebrantii, Cleistanthus schlechteri, Ptaeroxylon obliquum, Balanites maughamii, Erythrophleum lasianthum and Afzelia quanzensis.

Tree layer (Stratum B; > 5 m - 12 m): Hymenocardia ulmoides, Dialium schlechteri, Drypetes arguta, Brachylaena huillensis and Cladostemon kirkii.

Scrub layer (Stratum C; > 0,5 - 5 m): Croton gratissimus, Croton pseudopulchellus, Carissa spp., Vitex wilmsii, Cussonia spp. and Pavetta spp.

Ground layer (Stratum D; ⩽ 0,5 m): Commelina spp. and Sanseviera spp. Due to the closed forest canopy few grasses occur. The dominant grass species present include Panicum deustum and Setaria chevalieri.

Table 10: Physical characteristics of the soil within the proposed Tembe Elephant Reserve, Tongaland, northern Natal.

ASPECT	HORIZON	PROFILE NUMBER																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Texture	A	M S	F S	F S	M C	M C	M SL	M CSL	M S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S
	B	F SC	F S	F S	C SC	M C	F S	F S	F LS	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S	F S
	C	F SC	F S	F S	• •	M C	F S	F S	• •	• •	• •	• •	F S	F S	F S	F S	• •	• •	F S	F S	F S	M SCL
	D	• •	• •	• •	• •	• •	F S	• •	• •	• •	• •	• •	F S	F S	• •	F S	• •	• •	F S	F S	M SC	• •
	E	• •	• •	• •	• •	• •	F S	• •	• •	• •	• •	• •	F S	• •	• •	F S	• •	• •	F S	• •	M SC	• •
Structure	A	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	B	I	I	I	II	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	C	I	I	I	•	I	I	I	•	•	•	I	I	I	I	•	•	•	I	I	I	I
	D	•	•	•	•	•	I	•	•	•	•	•	I	I	•	I	•	•	I	I	I	•
	E	•	•	•	•	•	I	•	•	•	•	•	I	•	•	I	•	•	I	•	I	•
Colour	A	5yr 6/1	7.5yr 4/3	5yr 5/1	7,5yr 3/1	5yr 5/1	10yr 3/1	7,5yr 2/1	5yr 3/1	7,5yr 5/1	5yr 5/1	5yr 5/8	7,5yr 5/1	5yr 4/2	2,5yr 5/1	7,5yr 5/4	7,5yr 4/1	5yr 6/1	5yr 5/1	5yr 5/1	7,5yr 5/1	5yr 5/1
	B	5yr 6/1	7.5yr 4/4	5yr 7/1	N 80	5yr 1/5	10yr 5/4	7.5yr 4/2	5yr 5/2	7.5yr 5/4	5yr 6/3	5yr 5/6	7.5yr 5/R	5yr 4/3	5yr 5/2	7,5yr 5/7	7.5yr 4/2	5yr 6/1.5	5yr 6/1	5yr 6/1	7.5yr 5/2	5yr 6/1
	C	5yr 4/3	7.5yr 4/6	5yr 7/2	• •	5yr 5/2	10yr 6/1	7.5yr 7/2	• •	• •	• •	• •	7.5yr 5/3	5yr 4/4	2.5yr 5/6	7.5yr 5/3	• •	• •	5yr 6/2	5yr 6/2	7.5yr 5/7	5yr 5/3
	D	• •	• •	• •	• •	• •	10yr 6/2	• •	• •	• •	• •	• •	7.5yr 5/4	5yr 4/6	• •	7.5yr 5/4	• •	• •	2.5yr 7/3	5yr 6/3	7.5yr 5/3	• •
	E	• •	• •	• •	• •	• •	10yr 7/4	• •	• •	• •	• •	• •	7.5yr 5/1	• •	• •	7.5yr 5/4	• •	• •	2.5yr 7/2	• •	2.5yr 5/4	• •
Consistency	A	CRM	L	L	CRM	CRM	CRM	CRM	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	B	L	L	L	CMP	CMP	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	C	L	L	L	•	CMP	L	L	•	•	•	•	L	L	L	L	•	•	L	L	L	CMP
	D	•	•	•	•	•	L	•	•	•	•	•	L	L	•	L	•	•	L	L	CMP	•
	E	•	•	•	•	•	L	•	•	•	•	•	L	•	•	L	•	•	L	•	CMP	•
Carbonates	A	0	0	0	2	3	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	3	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	•	3	1	1	•	•	•	•	0	0	0	0	•	•	0	0	0	0
	D	•	•	•	•	•	2	•	•	•	•	•	0	0	•	0	•	•	0	0	0	•
	E	•	•	•	•	•	2	•	•	•	•	•	0	•	•	0	•	•	0	•	0	•

S = Sand
LS = Loamy Sand
SL = Sandy Loam
SCL = Sandy Clay Loam
SC = Sandy Clay
C = Clay

I = No structure
II = Blocky
III = Columnar
IV = Platey
V = Prismatic
(FSSA 1980)

0 = No fissing
1 = Poor fissing
2 = Mild fissing
3 = Strong fissing
(Buys, 1977)

SAND GRADE
F = Fine
M = Medium
C = Course
(FSSA 1980)

L = Loose
CRM = Crumbly
CMP = Compact
(FSSA 1980)

• : No data

Table 11 : Soil factors measured as ppm in each horizon of 21 soil profiles in different plant communities within the proposed Tembe Elephant Reserve, Tongaland, northern Natal.

ELEMENT	HORIZON	PROFILE NUMBER																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Phosphorus (P)	A	68	32	1	5	0	3	0	1	5	2	4	4	4	2	2	2	1	2	2	11	2
	B	37	10	1	0	0	2	2	0	6	2	5	2	4	2	3	2	1	1	1	13	2
	C	34	8	1	*	3	2	1	*	*	*	*	2	6	3	6	*	*	2	9	5	2
	D	*	*	*	*	*	1	*	*	*	*	*	5	10	*	6	*	*	2	3	3	*
	E	*	*	*	*	*	1	*	*	*	*	*	3	*	*	7	*	*	2	*	3	*
Potassium (K^+)	A	248	262	34	305	390	93	196	6	48	29	106	41	112	51	63	3	3	37	28	50	43
	B	231	188	120	54	134	61	25	46	35	8	147	14	76	16	51	3	38	28	19	24	13
	C	306	156	16	*	98	73	61	*	*	*	*	11	64	18	46	*	*	11	12	47	43
	D	*	*	*	*	*	43	*	*	*	*	*	21	63	*	55	*	*	12	25	50	*
	E	*	*	*	*	*	29	*	*	*	*	*	14	*	*	74	*	*	15	*	39	*
Calcium (Ca^{++})	A	1004	430	79	3095	5122	744	396	116	104	5	113	107	168	165	34	9	21	43	113	274	94
	B	1540	104	78	4287	5642	2479	790	84	8	9	8	19	22	58	16	9	9	9	64	5	35
	C	628	81	95	*	5472	2713	172	*	*	*	*	23	20	46	7	*	*	10	15	16	66
	D	*	*	*	*	*	2737	*	*	*	*	*	28	8	*	16	*	*	10	25	6	*
	E	*	*	*	*	*	2687	*	*	*	*	*	25	*	*	27	*	*	4	*	5	*
Magnesium (Mg^{++})	A	165	148	22	145	781	98	764	48	35	10	61	49	77	67	24	10	11	43	39	88	93
	B	178	64	32	28	389	155	147	31	13	2	55	35	64	40	20	6	1	50	29	36	41
	C	126	51	107	*	389	206	43	*	*	*	*	36	67	38	57	*	*	53	23	28	427
	D	*	*	*	*	*	197	*	*	*	*	*	36	61	*	70	*	*	30	22	140	*
	E	*	*	*	*	*	129	*	*	*	*	*	46	*	*	89	*	*	22	*	141	*
pH (KCl)	A	6,1	5,4	6,0	7,3	6,7	5,5	6,9	4,3	3,4	3,9	4,1	4,7	4,6	5,1	4,0	4,0	4,3	4,8	4,7	4,6	4,3
	B	6,0	3,8	7,0	9,1	7,5	8,0	8,5	6,1	3,6	4,2	4,1	4,3	4,1	4,5	3,8	4,5	4,4	4,4	4,7	4,0	4,4
	C	4,3	3,8	5,2	*	7,6	8,8	8,7	*	*	*	*	4,2	4,0	4,3	4,0	*	*	4,3	4,4	4,3	4,3
	D	*	*	*	*	*	8,8	*	*	*	*	*	4,2	4,0	*	4,1	*	*	4,4	4,5	3,9	*
	E	*	*	*	*	*	8,8	*	*	*	*	*	4,3	*	*	4,0	*	*	4,5	*	3,9	*
Resistence (Ohms)	A	1160	2000	5000	760	100	1000	450	300	3000	7600	6600	6000	3500	6400	9400	8000	12000	4700	8000	4400	6200
	B	2600	4500	3100	350	70	1800	580	2400	3800	2000	7000	8000	5800	9600	13400	8000	15000	6000	8400	6800	4700
	C	2100	4300	1200	*	80	840	880	*	*	*	*	9000	11000	11000	7200	*	*	9400	11400	4500	560
	D	*	*	*	*	*	500	*	*	*	*	*	8000	9400	*	5000	*	*	20000	5400	2000	*
	E	*	*	*	*	*	520	*	*	*	*	*	7600	*	*	4600	*	*	19000	*	1400	*
Cation exchange capacity	A	7,5	5,0	1,0	18,0	34,0	6,0	10,0	2,0	1,0	0,5	1,0	1,0	2,0	1,5	1,0	0,5	0,5	0,75	0,75	2,5	1,5
	B	9,5	3,0	1,5	22,0	31,0	14,0	5,5	7,0	0,5	0,5	1,0	0,5	1,0	1,0	0,5	0,5	0,5	0,75	0,5	0,75	1,0
	C	5,5	2,5	2,0	*	31,0	16,0	1,4	*	*	*	*	0,5	1,0	1,5	1,0	*	*	0,75	0,5	0,79	5,0
	D	*	*	*	*	*	16,0	*	*	*	*	*	0,5	1,0	*	1,0	*	*	0,5	0,5	1,5	*
	E	*	*	*	*	*	16,0	*	*	*	*	*	0,5	*	*	1,5	*	*	0,5	*	1,5	*

* : No data

Climbers and scramblers present include: Sarcostemma viminale, Strophanthus spp., Senecio spp. and Landolphia kirkii.

Epiphytes include Ansellia gigantea and Usnea spp.

General:

Due to its waterless nature the Sand Forest habitat is that zone most sparsely populated by humans in the region. Evidence of tree felling or other human disturbance is negligible. The surface area covered by Sand Forests is 38,8 km^2. The forests appear to have reached a climax stage. This can, however, only be confirmed by further research. The forests are primarily used for protection and secondarily for feeding by the elephants.

RIVERINE FOREST

Ficus sycomorus - Trichelia emetica Riverine Forest

This Riverine Forest occurs as a broken strip of forest along the banks of the Pongola River, typically on the levees. The Riverine Forest is too minute to map and has therefore been included in the Sorghum verticilliflorum - Hemarthria altissima Floodplain Grassland (Figure 11) which lies within the Ndumu Game Reserve.

The stands of this community represent a forest (Edwards 1983) and are characterized by Ficus sycomorus and Trichilia emetica.

Habitat:

Stands of the Riverine Forest occur on medium to fine-textured sandy or clay alluvial soils (profile number 1 - Table 10 and Figure 10). The soils are relatively acid in the A-horizon with a pH of 6,1 (profile number 1 - Table 11). The nutrient status of the topsoil is high with a cation exchange capacity of above 6 meq. % and can be rated as a fertile soil (Buys 1977). The exchange cations calcium, magnesium and potassium were all classified as sufficient (Table 11).

The C-horizon soil shows several differences from the topsoil. The soil is more strongly acid with a pH of 4,3 (Table 11). There is a slight decrease in total exchangeable cations, but it can still be classed as fertile (Buys 1977).

Community description and floristic composition:

Along sections of the Pongola River course a woody fringe of tall trees up to 25 m high occurs.

However, the stratification of these forests is less well developed than in the Sand Forest. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 12 m): Ficus sycomorus, Trichilia emetica, Rauvolfia caffra, Cordyla africana, Syzygium guineense and Trema orientalis.

Tree layer (Stratum B; > 5 m - 12 m): Antidesma venosum, Tabernaemontana elegans and Sapium ellipticum.

Scrub layer (Stratum C; > 0,5 m - 5 m): Oncoba spinosa, Grewia caffra, Capparis tomentosa and Ficus capraefolia.

Ground layer (Stratum D; ⩽ 0,5 m): Justicia glabra and Achyranthes spp. Grasses include Setaria chevalieri and Panicum maximum.

General:

Riverine Forest along the new course of the Pongola River is limited but it appears that forest species from the old course (De Moore et al. 1977) are spreading steadily down the new course.

The area covered by Riverine Forest is no more than 2,0 km^2. Elephants have never been reported to penetrate as far westward to occupy these isolated forests and there exists no human disturbance as the area falls within the Ndumu Game Reserve, where the isolated forest communities enjoy protection.

WOODLAND COMMUNITIES

CLOSED WOODLAND

Albizia petersiana - Acacia grandicornuta Closed Woodland.

Albizia petersiana - Acacia grandicornuta Closed Woodland occurs in the west of the proposed reserve (Figure 11) of which a section falls within Ndumu Game Reserve. In this Closed Woodland, which forms a transitional zone between the lower river terrace and the wooded sand region, components of Sand Forest and woodland species are found.

The community represents a Closed Woodland (Edwards 1983) and is characterized by Albizia petersiana and Acacia grandicornuta.

Habitat:

The soils of this stand (profile number 2 - Table 10 and Figure 10) are fine-textured sandy soils and dull reddish-brown in colour. The soils are strongly acid with a pH of 5,4 in the A-horizon and a pH of 3,8 in the B-horizon (profile number 2 - Table 11). The available phosphorus content of 32 ppm in the A-horizon indicates a phosphorus sufficiency in the soil and the exchange cations potassium, calcium and magnesium were all classified as sufficient (Table 11). However, according to the threshold values of Buys (1977), the exchange cations for the B- and C-horizons are all deficient (Table 11) indicating a less fertile soil than the A-horizon.

Community description and floristic composition:

This community consists of trees of different heights and scrub which forms a dense growth difficult to penetrate. Stratification is obscured in the thickets but several different synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 5 m - 12 m): Albizia petersiana, Acacia grandicornuta, Manilkara concolor, Spirostachys africana, Pappea capensis, Balanites maughamii and Sideroxylon inerme.

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Strychnos decussata, Ximenia caffra, Ehretia rigida, Maytenus heterophylla, Gardenia cornuta, Carissa bispinosa and Ziziphus mucronata.

Ground layer (Stratum C; ⩽ 0,5 m): Asparagus spp. Sansevieria spp. and Aloe spp. Grasses include Panicum deustum and Sporobolus smutsii.

Climbers include: Sarcostemma viminale.

General:

Extensive shifting agriculture is evident in the Closed Woodland community where a large human settlement has established itself over the past decades. These include local people displaced from Ndumu Game Reserve and refugees from Mozambique. Elephant activity has been negligible in this area of 13,3 km^2 in size. This can be ascribed to the human presence.

Acacia burkei - Spirostachys africana Closed Woodland.

The Acacia burkei - Spirostachys africana Closed Woodland (Figure 13) occurs in the central area of the proposed elephant reserve (Figure 13), with Sand Forest patches scattered throughout the community where the soil becomes more sandy. A feature of the area is the seasonal pans (Figure 11) which are described under hygrophilous communities.

This community represents a Closed Woodland (Edwards 1983) and is characterized by Acacia burkei and Spirostachys africana.

Habitat:

Stands of this Closed Woodland occur on acid sands over clay substrates (Tinley and Van Riet 1981). The impervious subsoil results in numerous pan depressions, which are associated with termite mounds.

Community description and floristic composition:

Stands of this Closed Woodland consist of trees of different heights and scrub (stunted trees and shrubs). Stratification is largely obscured in the thickets, but several synusiae can be distinguished. The dominant plant species identified in the different strata are:

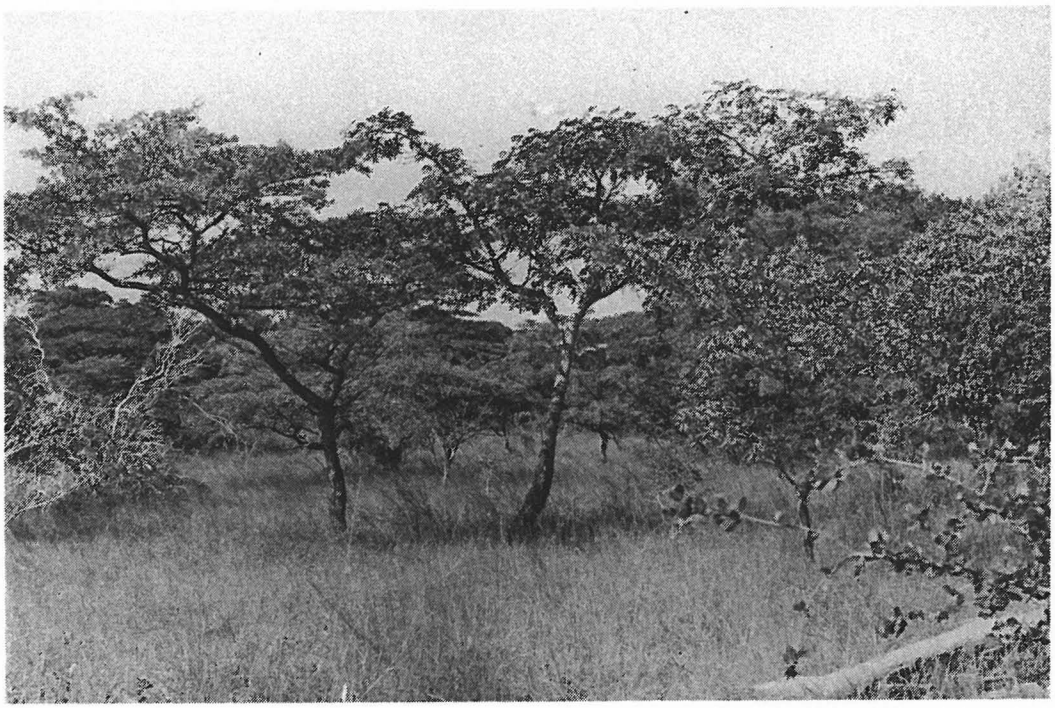

Figure 13: Seasonal pans in the Acacia burkei - Spirostachys africana Closed Woodland, Tongaland, northern Natal.

Canopy tree layer (Stratum A; > 5 m - 12 m): Acacia burkei, Spirostachys africana, Commiphora neglecta, Acacia grandicornuta, Ziziphus mucronata, Cassine transvaalensis, Pappea capensis and Euphorbia ingens.

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Commiphora neglecta, Salvadora angustifolia, Grewia caffra, Clausena anisata, Ehretia rigida, Carissa tetramera, Maytenus heterophylla and Azima tetracantha.

Ground layer (Stratum C; ⩽ 0,5 m) Grasses include: Aristida congesta subsp. congesta, Panicum maximum (in the open spaces) and Eragrostis superba.

Climbers include: Sarcostemma viminale.

General:

During the wet season there is an increased presence of elephants in the Acacia burkei - Spirostachys africana Closed Woodland of 6,9 km^2. The presence of the elephants can be attributed to the proximity of numerous seasonal pans in this community.

OPEN WOODLAND

Terminalia sericea - Albizia versicolor Open Woodland.

The Terminalia sericea - Albizia versicolor Open Woodland (Figure 14) covers a large area (Figure 11) of flat to undulating dry sand east and west of Mozi Swamp North. This stand forms a matrix of Open Woodland within which a mosaic of forest patches occur on the crests of west to east facing sand dunes. A feature of this community is Aloe marlothii of which individual plants attain a height of 3 m in places.

The community represents an Open Woodland (Edwards 1983) and is characterized by Terminalia sericea and Albizia versicolor.

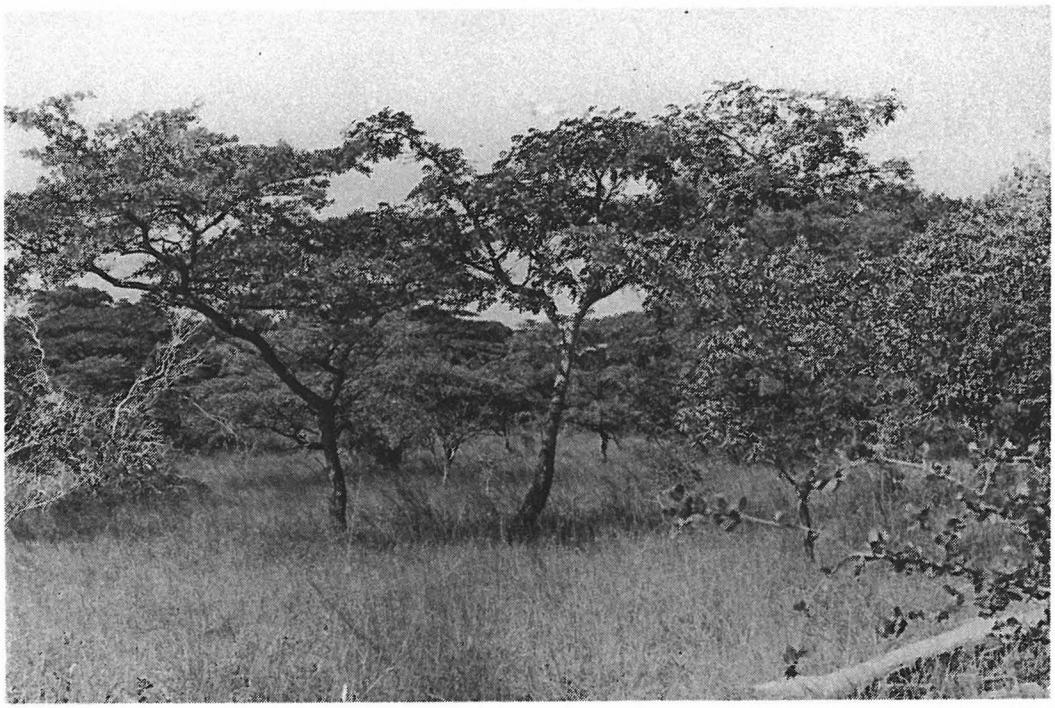

Figure 14 : Terminalia sericea - Albizia versicolor Open Woodland, Tongaland, northern Natal.

Habitat:

Stands of this Open Woodland occur on sandy soils which are fine-textured, loose, unstructured and greyish-brown (profile number 13 - Table 10 and Figure 10). The soils are strongly acid with a pH of 4,6 in the A-horizon and a pH of 4,1 in the B-horizon (profile number 13 - Table 11). The available phosphorus in the A-horizon of 4 ppm indicates a phosphorus deficiency (Buys 1977) in the soil and the exchange cations potassium, calcium and magnesium were also classified as being limited (Table 11). According to the threshold values of Buys (1977) the exchange cations for the A-, B- and C-horizons are all deficient, indicating an infertile soil.

Community description and floristic composition:

In this community three definite synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 5 m - 12 m): Terminalia sericea, Albizia versicolor, Acacia burkei, Sclerocarya birrea, Trichilia emetica, Albizia adianthifolia, Combretum molle, Afzelia quanzensis (along forest margins) and Tabernaemontana elegans.

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Strychnos madagascariensis, Strychnos spinosa, Ximenia caffra, Ziziphus mucronata, Euclea undulata, Vangueria infausta, Grewia caffra, Annona senegalensis, Eugenia capensis, Salacia kraussii, Mimusops obovata, Dichrostachys cinerea and Ozoroa obovata.

Ground layer (Stratum C; ⩽ 0,5 m): There exists a good grass cover which forms a mosaic of pure swards in some parts. Grasses recorded include: Hyperthelia dissoluta, Themeda triandra, Aristida congesta subsp. congesta, Pogonarthria squarrosa, Perotis patens, Panicum maximum and Digitaria spp.

General:

The Terminalia sericea and Albizia versicolor Open Woodland appears to be in a fire climax stage and it is likely that in the complete absence of fire this Open Woodland could become a Closed Woodland and

eventually go to a climax Sand Forest community. Large portions of this Open Woodland are burnt regularly by the local people to make the grazing more acceptable for their cattle. Elephants readily utilize this area which covers an area of 106,6 km^2 within the proposed reserve.

Acacia burkei - Terminalia sericea Open Woodland.

The Acacia burkei - Terminalia sericea Open Woodland occurs on flat to undulating dry sand (Figure 11) similar to that of the Terminalia sericea - Albizia versicolor community interspersed with Sand Forest species.

This community represents an Open Woodland (Edwards 1983) and is characterized by Acacia burkei and Terminalia sericea.

Habitat:

The soils of this Acacia burkei - Terminalia sericea Open Woodland are fine-textured, loose, unstructured and bright reddish-brown (profile number 11 - Table 10 and Figure 10). The soil of the A-horizon is strongly acid with a pH of 4,1 (profile number 11 - Table 11). The available phosphorus content of the soil is 4 ppm, which according to Buys (1977) is insufficient, including also the exchangeable cations potassium, calcium and magnesium. The soils of the B-, C- and D-horizons showed a further cation deficiency (Table 11) which are indications of a highly leached soil, rendering it useless for agricultural purposes.

Community description and floristic composition:

In this community three synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 5 m - 12 m): Acacia burkei, Terminalia sericea, Combretum molle, Albizia adianthifolia, Sclerocarya birrea, Tabernaemontana elegans, Syzygium cordatum, Ziziphus mucronata, Garcinia livingstonii, Ozoroa obovata, Trichilia emetica, Spirostachys africana and Afzelia quanzensis (along forest margins).

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Strychnos madagascariensis, Tephrosia sericea, Vangueria infausta, Dichrostachys cinerea, Phyllanthus reticulatus, Euclea divinorum, Mimusops obovata, Strychnos spinosa, Eugenia capensis and Annona senegalensis.

Ground layer (Stratum C; ⩽ 0,5 m): Grasses include: Panicum maximum, Diheteropogon contortus, Cymbopogon plurinodis, Aristida congesta subsp. congesta, Themeda triandra and Eragrostis superba.

General:

Elephants are recorded regularly in this community which covers a surface area of 57,4 km². The local people frequently burn large parts of this community at the end of the dry period to stimulate new grass growth for their cattle.

Acacia burkei - Combretum molle Open Woodland.

The Acacia burkei - Combretum molle Open Woodland occurs west of Mozi Swamp North (Figure 11) on flat to undulating dry sand, on which a mosaic of Closed Woodland of Acacia burkei - Spirostachys africana occurs in a matrix of Open Woodland interspersed with Sand Forest components.

This community represents an Open Woodland (Edwards 1983) and is characterized by Acacia burkei and Combretum molle.

Habitat:

Stands of this Open Woodland occur on loose, sandy soils which are predominantly greyish-brown (profile numbers 3, 14 and 15 - Table 10 and Figure 10). The soils are strongly acid in the A-horizon with a pH of 4,0 - 5,1 (profile numbers 14 and 15 - Table 11) tending to remain strongly acid in the B- and C-horizons. The A-horizon of soil profile number 3 (Table 11) is relatively acid, becoming neutral with a pH of 7,0 in the B-horizon. The available phosphorus in the soil of the A-, B-, and C-horizons is 1 - 6 ppm, indicating a phosphorus deficiency according to the threshold values of Buys (1977) for profile numbers 3,14 and 15 (Table 11). The exchange cations potassium, calcium and magnesium are all rated as insufficient for all horizons. Total exchangeable cations is below 3 meq. % and is therefore rated as infertile soil (Buys 1977) (Table 11).

Community description and floristic composition:

In this community three definite synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 5 m - 12 m): Acacia burkei, Combretum molle, Terminalia sericea, Sclerocarya birrea, Albizia versicolor, Albizia adianthifolia and Syzygium cordatum (along Mozi Swamp North).

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Strychnos madagascariensis, Strychnos spinosa, Antidesma venosum, Euclea undulata, Dichrostachys cinerea, Bridelia cathartica.

Ground layer (Stratum C; ⩽ 0,5 m): Grasses: Urochloa spp., Sporobolus spp., Panicum maximum, Themeda triandra and Aristida spp.

General:

Elephant utilization of this Acacia burkei - Combretum molle Open Woodland, comprising 82,3 km^2, was noticeable and closer to Mozi Swamp North signs of past agricultural activities were evident.

Acacia karroo - Acacia nilotica Open Woodland.

The Acacia karroo - Acacia nilotica Open Woodland lies on flat sandy duplex soils on the western edge of the Mozi drainage area (Figure 11). This community is associated with termite mounds which are discussed under the hygrophilous communities.

This community represents an Open Woodland (Edwards 1983) characterized by Acacia karroo and Acacia nilotica.

Habitat:

The topsoil consists of fine-textured sandy soil and is brownish-grey, which is underlain by a medium-textured and compact sandy clay loam soil dull reddish-brown in colour (profile numbers 20 and 21 - Table 10 and Figure 10).

The pH of the soils of the A-horizon is strongly acid with a pH of 4,3 - 4,6 (profile numbers 20 and 21 - Table 11). The available phosphorus content of the soil of the A-horizon ranges from 2 - 11 ppm which according to Buys (1977) is insufficient including the exchangeable cations potassium, calcium and magnesium (Table 11). The soils of the B-horizon showed no marked difference from that of the A-horizon. The soils remain strongly acid with a pH of 4,0 - 4,4 with exchangeable cations insufficient (Table 11).

Community description and floristic composition:

In this community, three synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 5 m - 12 m): Acacia karroo, Acacia nilotica, Spirostachys africana, Acacia robusta and Berchemia zeyheri.

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Dichrostachys cinerea, Maytenus senegalensis, Acacia borleae, Strychnos madagascariensis, Strychnos spinosa, Hyphaene natalensis and Phoenix reclinata.

Ground layer (Stratum C; ⩽ 0,5 m): Grasses include Panicum maximum, Cynodon dactylon and Eustachys paspaloides. Succulents include Aloe parvibracteata.

General:

This Open Woodland of 9,4 km² represents a sweet veld on which grazing pressure by cattle is evident. Further north, where agriculture was less intense and the area less populated by local inhabitants, elephants were frequently encountered.

Strychnos madagascariensis - Hyphaene natalensis Open Shrub Woodland.

This Open Shrub Woodland (Figure 15) occurs in the central part of the proposed reserve (Figure 11) on flat sandy depressions.

The community represents Open Shrub Woodland (Edwards 1983) and is characterized by Strychnos madagascariensis and Hyphaene natalensis.

Figure 15 : Strychnos madagascariensis - Hyphaene natalensis
Open Shrub Woodland, Tongaland, northern Natal.

Habitat:

Stands of this community occur on fine-textured soils which are predominantly brownish-grey (profile numbers 18 and 19 - Table 10 and Figure 10). The soils are strongly acid in the A-horizon with a pH of 4,7 - 4,8 (profile numbers 18 - 19 - Table 11). The available phosphorus in the soils of the A-horizon is 2 ppm, indicating a phosphorus deficiency (Buys 1977) with the exchange cations potassium, calcium and magnesium all rated as insufficient (Table 11). The B-horizon soils show no marked difference from those of the A-horizon. The soils remain strongly acid with a pH of 4,4 - 4,7 and the total exchange cations being below 3 meq. % (Table 11). According to the threshold values of Buys (1977) the soils of both horizons are considered to be infertile.

Community description and floristic composition:

In this community three definite synusiae can be distinguished. The dominant plant species in the different strata are:

Canopy tree layer (Stratum A; > 5 m - 12 m): Terminalia sericea, Albizia versicolor, Combretum molle, Antidesma venosum, Sclerocarya birrea and Acacia burkei.

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Strychnos madagascariensis, Hyphaene natalensis, Strychnos spinosa, Dichrostachys cinerea, Garcinia livingstonii, Ozoroa obovata, Maytenus senegalensis, Tephrosia sericea, Euclea divinorum, Crotalaria capensis and Dalbergia melanoxylon.

Ground layer (Stratum C; ⩽ = ,5 m): Ground layer consists of grasses and forbs of which the dominant species are: Grasses: Cymbopogon excavatus, Themeda triandra, Hyperthelia dissoluta, Diheteropogon amplectens, Aristida spp., Eragrotis spp., Pogonarthria squarrosa, Sporobolus fimbriatus, Setaria sphacelata and Panicum maximum (under trees and shrubs). Forbs: Parinari mobola, Deinbollia oblongifolia, Eugenia capensis and Dichapetalum cymosum.

General:

There is evidence that veld fires pass through readily. Long-term monitoring of the grass and shrub composition would indicate if these frequent fires benefit the area or not. During the fruiting season of Strychnos madagascariensis and S. spinosa, elephants are regularly observed in this community which covers a surface area of 39,8 km^2 within the borders of the proposed Tembe Elephant Reserve.

HYGROPHILOUS COMMUNITIES

OPEN PALMVELD

Combretum molle - Hyphaene natalensis Open Palmveld.

The Combretum molle - Hyphaene natalensis Open Palmveld (Figure 16) of Mozi Swamp North, is limited within the proposed reserve but occurs abundantly east of Mozi Swamp North, outside the proposed reserve (Figure 11).

This community represents an Open Palmveld (Edwards 1983) and is characterized by Combretum molle and Hyphaene natalensis.

Habitat:

Stands of Open Palmveld occur on fine sandy soils (profile numbers 16 and 17 - Table 10 and Figure 10). The high water table between 1 - 1,5 m, produces moist edaphic conditions. The soils of the A-horizon are strongly acid with a pH of 4,0 - 4,3 (profile numbers 16 and 17 - Table 11). The available phosphorus content of the soil is 1 - 2 ppm which is insufficient (Buys 1977) as well as the exchangeable cations potassium, calcium and magnesium (Table 11). The soils of the B-horizon showed no marked difference from those of the A-horizon. The soils remain strongly acid with a pH of 4,4 - 4,5 with the exchangeable cations insufficient (Table 11).

Community description and floristic composition:

In this community three synusiae can be distinguished. The dominant plant species in the different strata are:

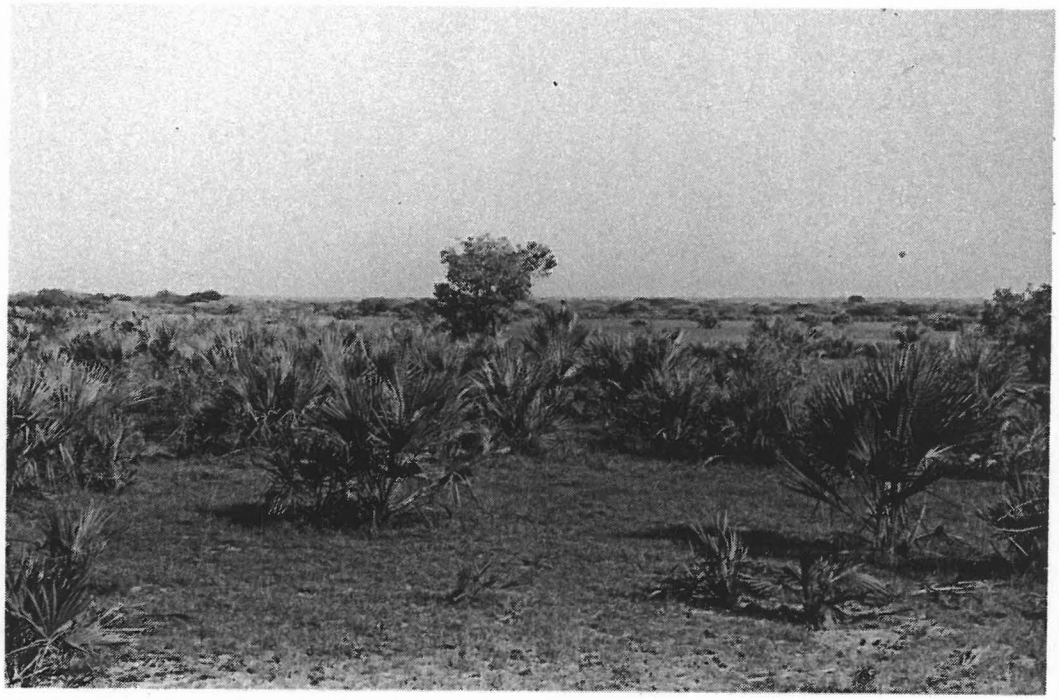

Figure 16 : Combretum molle - Hyphaene natalensis Open Palmveld, Tongaland, northern Natal.

Tree layer (Stratum A; > 5 m - 12 m): Combretum molle, Terminalia sericea, Syzygium cordatum, Antidesma venosum and Garcinia livingstonii.

Subordinate tree and shrub layer (Stratum B; > 0,5 m - 5 m): Hyphaene natalensis, Dichrostachys cinerea, Vangueria infausta, Strychnos madagascariensis and Phoenix reclinata.

Ground layer (Stratum C; ⩽ 0,5 m): Consists of grasses and sedges which include: Eragrostis lappula, Urelytrum squarrosum, Aristida congesta subsp., congesta and Cyperus spp.

General:

The ilala palm /Hyphaene natalensis/ has been reduced to shrub growth form by the local people who cut the stems of the palm to tap the sap for cider production. The area of this community which is included within the proposed reserve is limited and totals only 4,6 km^2. Elephants were seldom reported to occur in this community and actual utilization by the elephants on the Palm Veld was subsequently not observed.

PONGOLA FLOODPLAIN

Sorghum verticilliflorum - Hemarthria altissima Floodplain Grassland.

The Pongola Floodplain Grassland is situated east of the Pongola River within the Ndumu Game Reserve (Figure 11) and includes broken strips of riverine forests.

This community represents Floodplain Grassland (Edwards 1983) and is characterized by Sorghum verticilliflorum and Hemarthria altissima.

Habitat:

The soils of this Floodplain Grassland are rich in clays and are poorly aerated and seasonally waterlogged (Loxton et al. 1969). Similar conditions have been described by Hall-Martin (1972) in the

Lengwe National Park in Malawi. The soils can be classified as fertile, although no soil analyses were undertaken in this stand. This statement is supported by the fact that agricultural products are produced on a large scale by the local people, along the Pongola floodplain south of Ndumu Game Reserve.

Community description and floristic composition:

The Pongola Floodplain is covered by a dense growth of tall grass, sedges and reeds up to 2 m high. The dominant species are: Hemarthria altissima, Echinochloa spp. and Cyperus fastigiatus, which occur mainly on wet mud. The grasses and reeds along the edge of the floodplain and on raised levees are: Sorghum verticilliflorum, Chloris gayana, Panicum coloratum, Urochloa mozambicensis, Paspalum commersonii, Digitaria spp., Phragmites mauritianus, and P. australis. Ficus capraefolia forms a discontinuous transitional area between the riverine forests and the grasslands.

General:

The Pongola Floodplain, before it was affected by the Jozini Dam, was either inundated for several weeks each summer or sometimes not at all (De Moore et al. 1977). However, once the dam started controlling the flow of the Pongola River, the floodplain was inundated to its highest levels at unseasonal times and for extended periods of time, as was the case during February and March 1980. This will in time to come have an effect on the composition of grasses and sedges of the floodplain. The area covered by the floodplain totals 8,6 km^2.

The northern floodplain enjoys protection since it is included in the Ndumu Game Reserve. On two occasions during the study period, elephants have been reported to have gone as far east as Polwe Pan which is situated on the floodplain.

GRASSLAND

Hemarthria altissima - Ischaemum arcuatum Grassland..

The Hemarthria altissima - Ischaemum arcuatum Grassland (Figure 17) within the proposed Tembe Elephant Reserve on the north eastern sector of the Mozi Swamp North is limited in extent (Figure 11). However, outside the reserve, further eastwards of Mozi Swamp North, it is abundant.

This community represents Grassland (Edwards 1983) and is characterized by Hemarthria altissima and Ischaemum arcuatum.

Habitat:

The soils (profile number 8 - Table 10 and Figure 10) of this stand are poorly aerated and seasonally waterlogged. The soils of the A-horizon are strongly acid with a pH of 4,3 (profile number 8 - Table 11). The available phosphorus content of 1 ppm indicates a phosphorus deficiency in the soil. There is also insufficient potassium, calcium and magnesium in the topsoil with a total exchangeable cation content of below 3 meq. %. This is, therefore, a mineral deficient soil (Buys 1977).

The B-horizon soils can be considered as fertile (Buys 1977), with total exchangeable cations of more than 6 meq. % (Table 11).

Community description and floristic composition:

The Grasslands are dominated by hygrophilous grasses, sedges and herbs, namely:

Grasses: Hemarthria altissima, Ischaemum arcuatum, Imperata cylindrica and Eragostis lappula.
Sedges : Cyperus spp.
Herbs : Hydrocotyle spp.

The only woody plants present are those occurring on termite mounds, on the edges of the Grassland or on islands which are above the

Figure 17 : Hemarthria altissima - Ischaemum arcuatum Grassland east of Mozi Swamp North, Tongaland, northern Natal.

seasonal flood levels. These include: Syzygium cordatum, Schotia brachypetala, Hyphaene natalensis, Terminalia sericea and Acacia robusta.

General:

The Hemarthria altissima - Ischaemum arcuatum Grassland covers a surface area of 2,9 km^2 and are burnt frequently by the local people to provide grazing for their cattle. Along the edges of this community, extensive agriculture is practised.

Elephants only frequent this area to quench their thirst at man-made wells. No signs of elephant utilization of the vegetation were ever observed.

SWAMP AND DAMBOS

Phragmites australis - Typha littoralis Swamp and Dambos.

The hygrophilic community of the Swamp and Dambos has been subdivided into four major zones, from the middle to the edge, namely:

Najas marina - Potamogeton pectinatus - Submerged Zone
Phragmites australis - Typha littoralis - Reed Zone
Cyperus thunbergii - Scirpus articulatus - Sedge Zone
Sporobolus virginicus - Imperata cylindrica - Grass Zone

These herbaceous zones occur along the entire Mozi Swamp North (Figure 11) dominated by Phragmites australis and Typha littoralis. True dambos were too limited to map separately and have therefore been mapped as part of the swamp community. True dambos, outside the proposed reserve east of Mozi Swamp North are, however, abundant and are also dominated by Phragmites australis and Typha littoralis.

The above stands represent a Swamp (Martin 1960) and is characterized by the main herbaceous genera Phragmites, Typha and Cyperus.

Habitat:

The soils fringing Mozi Swamp North consist of deep organic sandy clay loam and clay soils which are medium-textured and brownish-grey to black (profile numbers 5 and 7 - Table 10 and Figure 10). The pH of the soils of the A-horizon is neutral with a pH of 6,7 - 6,9 (profile numbers 5 and 7 - Table 11). Total exchangeable cations for both soil profiles in the A-horizon is above 5 meq. % which is an indication that these soils are fertile (Buys 1977) although no traces of phosphorus were recorded. The soils of the B-horizon on the other hand are relatively acid to alkaline (Buys 1977) with a pH of 7,5 - 8,5 (Table 11). The soils were classed as fertile soils (Buys 1977) where total exchangeable cations for profiles 5 and 7 are above 10 meq. %.

Community description and floristic composition:

Najas marina - Potamogeton pectinatus Submerged Zone.
Representatives of this community occur throughout the swamp and form large concentrations where the reed community has been disturbed by either elephants or man.

The Phragmites australis - Typha littoralis Reed Zone.
Dense fringing reed stands of Phragmites australis (Figure 18) occur in pure stands or locally mixed with Typha littoralis along the entire swamp.

Cyperus thunbergii - Scirpus articulatus Sedge Zone.
This Sedge community occurs in open water where the reed community has been disturbed. Associated species in this community include Lemna minor, Nymphaea capensis and Pistia stratioides.

Sporobolus virginicus - Imperata cylindrica Grass Zone.
Along the margins of the Mozi Swamp North, lawnlike margins of salt grass Sporobolus virginicus (Figure 19) occur. Other dominant grasses include Imperata cylindrica and Cynodon dactylon.

General:

The local population depends largely on Mozi Swamp North for building material such as Phragmites australis. Sections of the swamp are burnt

Figure 18 : Phragmites australis Reed Zone of Mozi Swamp North, Tongaland, northern Natal

Figure 19 : Sporobolus virginicus - Imperata cylindrica Grass Zone along Mozi Swamp North, Tongaland, northern Natal

annually by the local people most probably to stimulate new growth. The swamp and dambos within the proposed reserve include an area of 8,7 ha. Elephant impact on the swamp is evident especially during the dry season when elephants frequent the swamp as it is then the only permanent water supply in the area.

SEASONAL PAN PLANT ZONES

Three major plant zones were identified at the numerous seasonal pans (Figure 13) within the proposed reserve. These pans, which are less than 1 m deep and vary in size from 9 m^2 to 600 m^2, occur in three plant communities viz. Acacia burkei - Spirostachys africana Closed Woodland (Figure 11), Acacia burkei - Combretum molle Open Woodland (Figure 11) and Acacia karroo - Acacia niloctica Open Woodland (Figure 11).

The smaller pans dry up soon after the onset of the dry season and the bigger ones hold water until late in the dry season. Three major plant zones identified at the seasonal pans are: Ludwigia stolonifera - Lemna minor Floating Zone, Juncus spp. - Cyperus spp. Emergent Rooted Zone, and Schotia brachypetala - Acacia robusta Pan Edge Zone.

Habitat:

The seasonal pans occur in isolated areas (Figure 13) on duplex soils with a sandy clay loam surface overlying prismatic calcareous brack sandy clays (profile number 4 - Table 10 and Figure 10). The soils are medium- to coarse-textured and predominantly brownish-black (Table 10) in colour. The soils of the A- and B-horizon are rich in calcium with a cation exchange capacity of 18 - 20 meq. % (profile number 4 - Table 11). The soils are neutral to strongly alkaline (brakish), with a pH range of 7,3 - 9,1 Table 11).

Community description and floristic composition:

This hygrophilous community consists of floating-, emergent rooted- and pan edge-plants. The dominant plant species in these three plant zones identified are:

Ludwigia stolonifera - Lemna minor Floating Zone:
Associated with the above species was the water lily Nymphaea caerulea which only occurred in limited number in certain pans.

Juncus spp. - Cyperus spp. Emergent Rooted Zone:
Within this plant zone the sedge Scirpus articulatus and one of the hygrophilous grass genera Echinochloa occurred widespread in association with the above two dominant genera.

Schotia brachypetala - Spirostachys africana Pan Edge Zone:
Along the Pan Edge Zone occur termitaria on which the most consistantly associated trees and shrubs are: Pappea capensis, Acacia robusta, Sideroxylon inerme, Berchemia zeyheri, Cassine aethiopica, Ziziphus mucronata, Euclea divonorum, Schotia capitata, Azima tetracantha, Carissa tettetramera and Maytenus senegalensis.

General:

Excessive utilization by elephants was observed to take place on the termite mounds whereas human disturbance was negligible.

PHENOLOGY OF TREES AND SHRUBS

The results are presented as 19 phenograms in Figures 20, 21 and 22.

LEAVES

Forest trees:

All four of the forest trees are deciduous although examples of Balanites maughamii, Dialium schlechteri and Hymenocardia ulmoides had leaves present throughout the year. Most individual trees, however, are almost leafless for a short period of about three weeks between July and September. These three tree species can therefore be classified as semi-decidious.

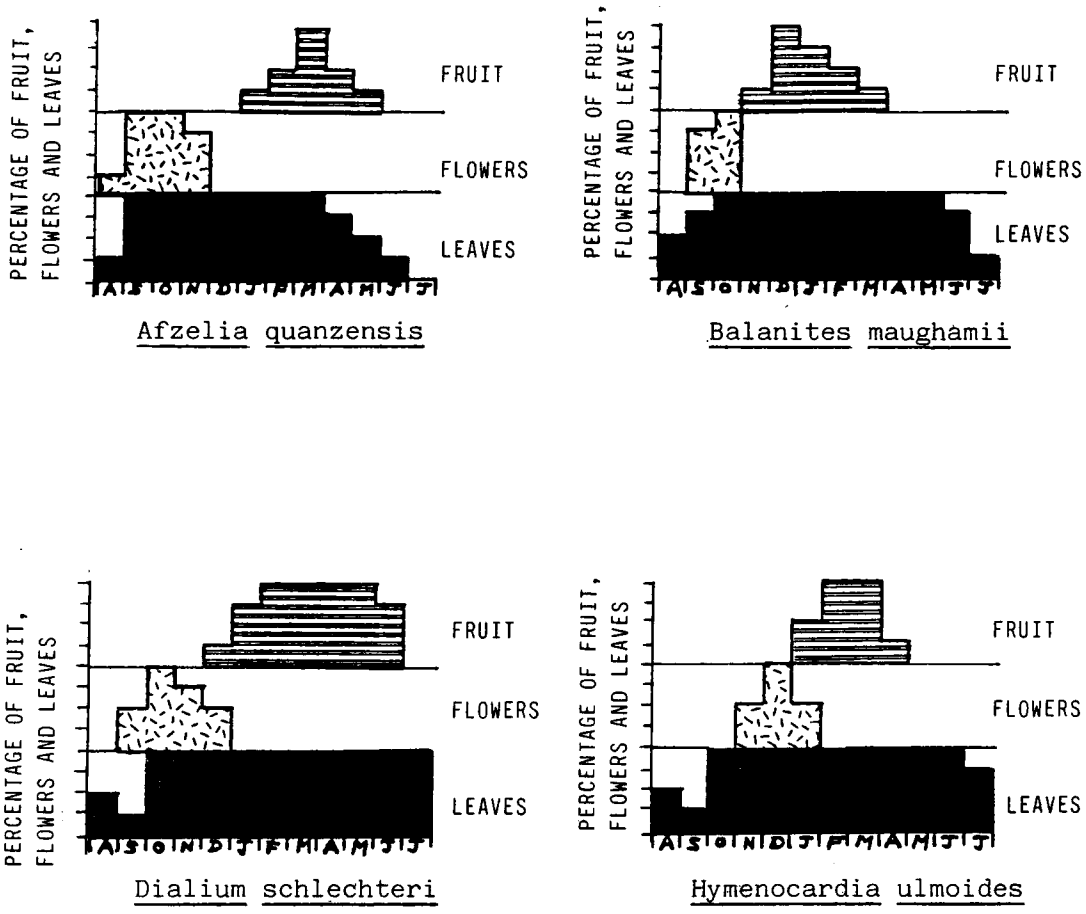

Figure 20 : Phenograms showing phenology of selected Sand Forest trees in Tongaland, northern Natal, from August 1980 to July 1981.

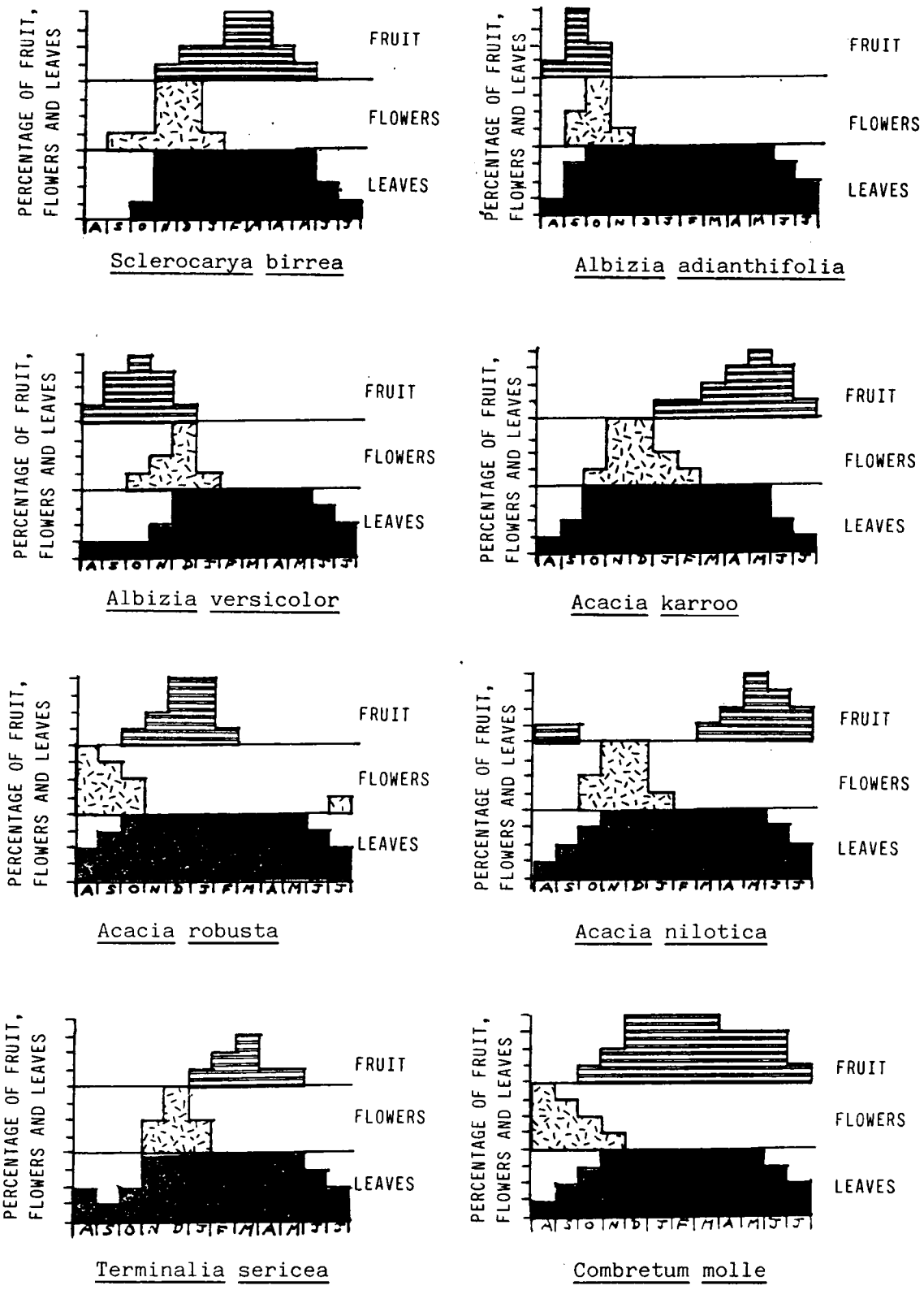

Figure 21 : Phenograms showing phenology of selected woodland trees in Tongaland, northern Natal, from August 1980 to July 1981.

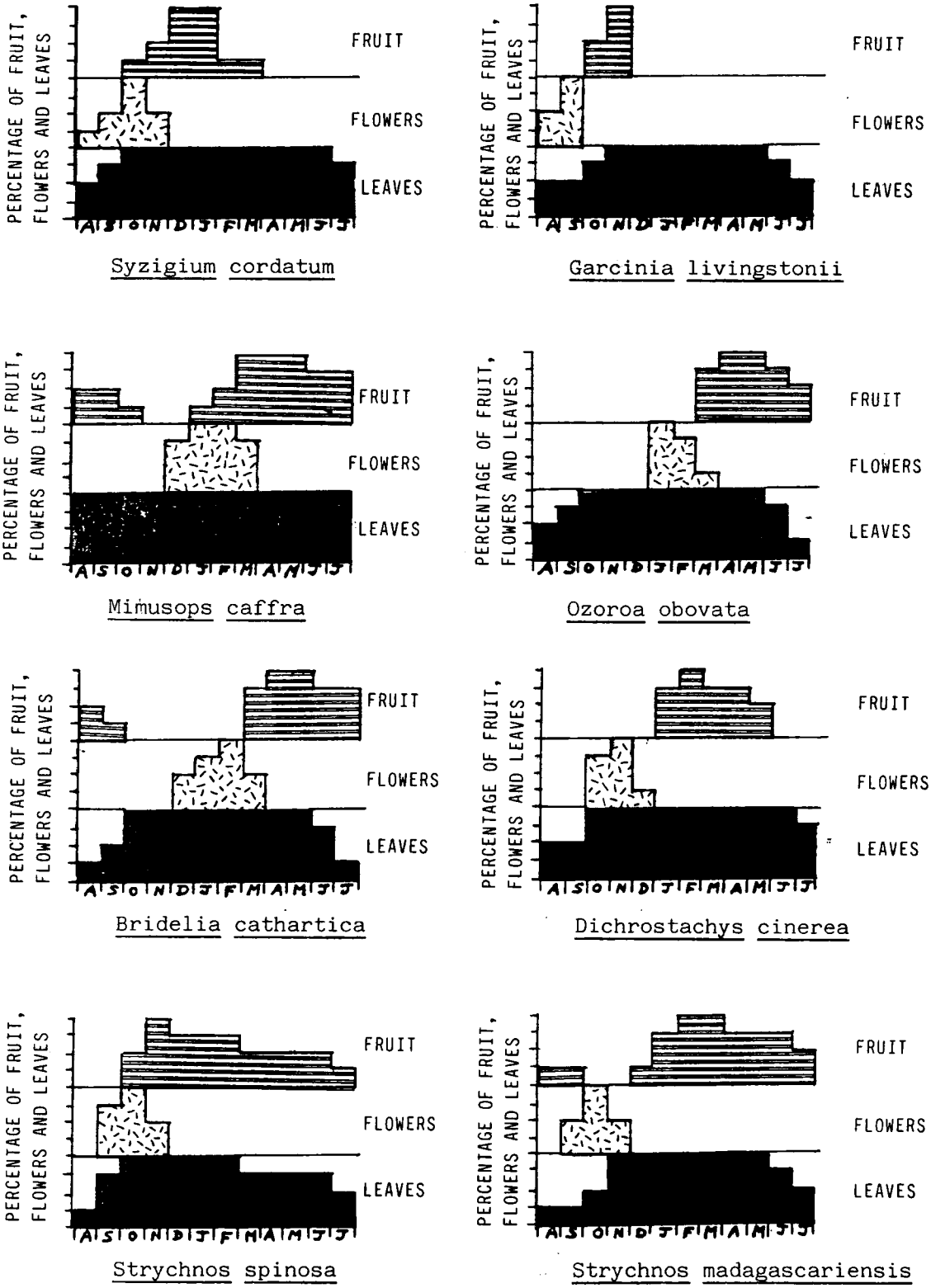

Figure 22 : Phenograms showing phenology of selected woodland trees and shrubs in Tongaland, northern Natal, from August 1980 to July 1981.

Afzelia quanzensis in contrast loses all its leaves for a period of about four weeks. Some individuals start to lose their first leaves as early as April and towards July all individuals investigated were leafless. The first new leaves appeared early in August prior to the rains.

Woodland Trees:

First leaf-fall was noticed amongst individuals of Sclerocarya birrea, Albizia adianthifolia, Albizia versicolor, Acacia karroo, Acacia robusta, Acacia nilotica, Terminalia sericea, Combretum molle and Garcinia livingstonii towards the beginning of June and amongst individuals of Syzygium cordatum as late as July.

Not all tree species lost their leaves at the same time. While some tree species were still losing their leaves others were already almost in full new leaf.

Scelorocarya birrea was the only species of which all individuals were completely leafless during August and September.

Except for Sclerocarya birrea, Terminalia sericea and Albizia versicolor, all other tree species produced their first new leaves towards the end of August and beginning of September. New leaves were produced, by the three species specifically mentioned, from October onwards.

Woodland Shrubs:

Among the six species of shrubs studied, Mimusops caffra was the only evergreen species. The remaining shrub species Ozoroa obovata, Bridelia cathartica, Dichrostachys cinerea, Strychnos spinosa and S. madagascariensis lost all their leaves in one season, but before all leaves had fallen the new leaves of the next wet season had already appeared.

FLOWERS

Forest Trees:

Afzelia quanzensis is the first forest tree species to flower in August. Balanites maughamii and Dialium schlechteri follow in September while Hymenocardia ulmoides only starts to flower in November. The peak of flowering for the first three species mentioned was September to October, which coincided with the beginning of the rainy season.

Woodland Trees:

All woodland species started to flower before the new leaves appeared amongst individuals such as Sclerocarya birrea, Albizia versicolor, Combretum molle, Syzygium cordatum, Garcinia livingstonii and Acacia robusta.

With the exception of Acacia robusta, Combretum molle and Garcinia livingstonii the flowering period of the remaining species studied, peaked from October to December. Peak flowering period for the specifically mentioned three species was from August to September. Albizia versicolor was the only species which reached peak flowering as late as December.

Woodland Shrubs:

In contrast to the trees, the shrubs Mimusops caffra, Ozoroa obovata and Bridelia cathartica, started to flower late in the wet season from January to March.

Dichrostachys cinerea, Strychnos madagascariensis and S. spinosa on the other hand reached peak flowering in October which is the beginning of the wet season.

FRUIT

Forest trees:

The onset of fruiting followed the flowering period with a time-lag of

up to one month in the case of Afzelia quanzensis. The fruit-bearing period varied amongst species from 4 - 7 months.

Woodland Trees:

Among the trees studied, fruit was abundant during the wet season. In some cases fruiting lasted until just before the onset of the next flowering season, for example in Acacia karroo, Acacia nilotica and Combretum molle.

Species such as Garcinia livingstonii which produce fleshy fruits, ripened and dropped their fruits earlier and faster than those producing dry fruits such as e.g. Combretum molle.

Albizia versicolor and Albizia adianthifolia only bore their first mature fruit towards the end of the dry season, in August, prior to the next flowering season which begins in September for Albizia adianthifolia and in October for A. versicolor.

Woodland Shrubs:

Fruit was available almost throughout the year, up to 10 months in the case of Strychnos spinosa, S. madagascariensis and Mimusops caffra.

C O N C L U S I O N

The classification of the vegetation of the proposed Tembe Elephant Reserve on the basis of Edwards's (1983) physiognomic classification method provided an adequate summary of the floristic data collected. The plant communities can easily be recognized in the field with this classification system, even by untrained conservation staff with only a slight knowledge of the dominant plant species of the area.

However, an effort should be made to collect more detailed quantitative data for each vegetation type described. This could serve as a

record of the status of the different plant species in the different plant communities. Those data should be used to monitor vegetation changes along permanent transects.

The investigation of the soils has indicated that the soils of the greater part of the proposed reserve are of low agricultural potential. This has led to the practice of shifting agriculture by the local people who clear a new area every third year. This form of agriculture coupled with indiscriminate burning has had a negative effect on the vegetation. A judicious burning programme and the termination of agricultural practices within the proposed borders of the reserve, should receive first priority.

There are many similarities between the Sand Forest vegetation of the proposed reserve and the vegetation of Lengwe National Park (Hall-Martin 1972). The Sand Forest of the Parque Nacional da Gorongoza in Mozambique is even closer in species composition to that of Lengwe National Park. The dominant tree in Gorongoza include, among others, Newtonia hildebrantii and Cleisanthus schlechteri (Tinley 1977). The sandveld vegetation of the northern parts of the Kruger National Park also has a sandveld substrate (Van Rooyen 1978). The species composition of these communities show relationships with the Sand Forest of the Mozambique Plain, Tongaland, Lengwe National Park and Kalahari sands in Barotseland (Hall-Martin 1972). The dominant tree species of these forest communities reach their southernmost distribution limit in northern Natal (28° 15'S) on either side of St. Lucia Lake (Tinley 1964).

The phenological survey revealed that a constant supply of food in the form of leaves, flowers and fruits was available to mammals, birds and insects throughout the year, which can be ascribed to the different physiological behaviour, controlled either by exogenous or endogenous factors, of the different species of trees and shrubs studied.

C H A P T E R 5

WATER

RESULTS AND DISCUSSION

CHEMICAL ANALYSIS

Analysis of pH and conductivity of water and concentrations of trace elements of water sampled from eight sites along Mozi Swamp North, three tributaries of Mozi Swamp North, one well and three seasonal pans (Figure 9) was conducted.

MOZI SWAMP NORTH

The mean and the standard deviation for the five sample periods for sample sites 1 - 7 and the value for a single sample for site 8, for chlorine, sulphate, magnesium, sodium and calcium ion concentrations, pH and salinity are presented in Table 12.

A comparative analysis, using the Anova test, showed no differences in chlorine, sulphate, magnesium, sodium and calcium ion concentrations, pH and salinity gradients in samples 1 - 6 (Table 13) of the northern part of Mozi Swamp North. Conversely sample 7 in the south differed significantly from samples 1 - 6 for all ion concentrations except for pH where no significant difference in samples 1 - 7 occurred (Table 13).

Because of only one sampling period at site 8 (Table 12), it could not be incorporated into the above statistical calculations. However, indications are that sample 8 is greater in ion concentrations than sample 7. It can thus be concluded that sample 8 probably also differs from samples 1 - 6 (Table 12).

The ion concentrations tended to show an increase from north to south (Table 12). The higher ion concentrations in the south (viz.

Table 12 : Mean and standard deviation (SD) of concentrations (ppm) of chlorine, sulphate, magnesium, sodium and calcium ions, and pH and salinity (%) found in eight areas of Mozi Swamp North, Tongaland, northern Natal, from August 1980 - July 1981. Five samples each were taken in sampling sites 1 - 7, but only a single sample was available for sampling site 8.

ITEM	SAMPLING SITE														
	1 International Border		2 Pump House		3 Tibi Pan		4 nJoni Pan		5 Fomothini Pan		6 Tembu Crossing		7 Vovovo Pan		8 eBumbeni Pan
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Value
Cl^-	794	25,10	788	38,34	822	58,91	852	57,62	902	52,63	896	52,25	1 328	252,82	1 500
$SO_4^=$	53	32,71	65	36,40	74	30,50	55	29,58	110	72,46	132	66,12	608	170,79	300
Mg^{++}	42	16,43	43	18,69	46	20,22	48	20,75	59	17,34	69	20,20	129	40,13	300
Na^+	634	54,59	630	52,44	660	39,37	686	58,83	712	69,07	730	78,42	1 140	323,19	1 000
Ca^{++}	72	25,23	73	32,35	82	38,84	86	30,08	103	52,55	115	41,17	264	109,10	1 000
pH	7,74	0,37	8,07	0,30	7,59	0,69	7,70	0,71	7,84	0,34	8,22	0,35	7,56	0,23	8,14
Salinity	1,35	0,22	1,38	0,20	1,53	0,29	1,64	0,22	1,97	0,25	1,99	0,28	4,44	1,42	2,38

Table 13 : Comparison of the mean ion consentration (ppm), pH and salinity (%) of water for seven sampling sites, when compared with each other, viz. the International Border, Pump House, Tibi Pan, Njoni Pan, Fomothini Pan, Tembu Crossing and Vovovo Pan, along Mozi Swamp North, Tongaland northern Natal, from August 1980 to July 1981. Five samples of water were analysed at each sampling point, and the F-values were obtained using an Anova test with 6 and 28 degrees of freedom.

ITEM	P-VALUE	F-VALUE
Cl^-	$\leq 0,01$	15,97
$SO_4^=$	$\leq 0,01$	32,74
Mg^{++}	$\leq 0,01$	8,63
Na^+	$\leq 0,01$	8,94
Ca^{++}	$\leq 0,01$	7,93
Salinity	$\leq 0,01$	17,49
pH	$> 0,05$	1,38

Vovovo and eBumbeni Pan - Table 12) can be ascribed to the predominantly shollower duplex soils, which are rich in minerals (Loxton et al. 1969). The lower values in the north (viz. Tembu Crossing to the Mozambique-Natal border of sample sites 1 - 6, Table 12), can be related to the numerous tributaries (Table 17) containing low ion concentrations and which feed into Mozi Swamp North.

Ion concentrations of sample sites 1 - 6 (i.e. northern sector of Mozi Swamp North), when compared with sample sites 7 and 8 (i.e. southern sector of Mozi Swamp North) (Table 14), showed a significant difference (Table 15) when comparing the southern sector with the northern sector of the swamp.

The mean salinity in the northern sector of Mozi Swamp North was 1,6 % (SD = 0,28) versus 3,4 % (SD = 1,46) in the southern sector (Table 14). According to Reid (1961) the water of the northern and southern sector of Mozi Swamp North falls within the mixo-oligohaline zone which has a salinity gradient of between > 0,5 % and 5 %. Mean salinity levels ⩽ 0,5 % on the other hand fall within the limnetic zone which is regarded as fresh water.

The local human population living along the south-eastern and south-western sectors of Mozi Swamp North take advantage of the high water table in these areas, viz. at Cabasini and Ebhukubhukwini (Figure 9) and they consequently dig wells (1,5 m in depth) from which they collect water for human consumption. In contrast, the water of the southern sector of Mozi Swamp North is used mainly for washing purposes, while water from Mozi Swamp North is used for drinking and washing purposes.

TRIBUTARIES EAST OF MOZI SWAMP NORTH

All ions occur in low concentrations (Table 16) and the mean salinity for the three tributaries, viz. Ebhukubhukwini, Untimbane and Majibomvu was 1,4 % (SD = 0,7). These low ion concentrations explain why the local human population there prefer the water of the upper reaches of the tributaries (Figure 9) for human consumption to that of the southern sector of Mozi Swamp North which is brackish.

Table 14: Mean and standard deviation (SD) of concentrations (ppm) of chlorine, sulphate, magnesium, sodium and calcium ions, and pH and salinity (%) gradients found in sea water. (Wilson 1975), fresh water (Reid 1961), and Mozi Swamp North, from August 1980 to July 1981, Tongaland, northern Natal.

ITEM	MOZI SWAMP NORTH				SEA WATER	RAIN WATER
	Sites 1 - 6		Sites 7 - 8			
	Mean	SD	Mean	SD		
Cl^-	842	49,47	1 414	121,62	19 354	50
$SO_4^=$	82	32,23	469	196,58	2 712	200
Mg^{++}	50	7,76	229	141,70	1,290	10
Na^+	675	41,10	1 070	98,00	10 770	40
Ca^{++}	89	17,14	282	25,46	412	50
pH	7,7	0,24	7,9	0,41	6,5	4,5
Salinity	1,6	0,28	3,4	1,46	35	0,4

Table 15 : Comparison of ion concentrations (ppm), pH and salinity (%) of water of sites 1 - 6 (30 samples per area), i.e. the International Border, Pump House, Tibi Pan, nJoni Pan, Fomothini Pan and Tembu Crossing in the north of Mozi Swamp North vs. sites 7 and 8 (six samples per area) i.e. Vovovo Pan and eBumbeni Pan in the south, Tongaland, northern Natal. Values of t were obtained using a t-test and a 34 degrees of freedom.

ITEM	P-VALUE	t-VALUE
Cl^-	$\leqslant 0,01$	19,58
$SO_4^=$	$\leqslant 0,01$	17,20
Mg^{++}	$\leqslant 0,01$	7,33
Na^+	$\leqslant 0,01$	16,44
Ca^{++}	$\leqslant 0,01$	23,22
pH	$> 0,05$	0,08
Salinity	$\leqslant 0,01$	6,38

$t_{(\alpha = 0,05 \; ; \; 35 \; df)}$

Table 16 : Concentrations (ppm) of chlorine, sulphate, magnesium, sodium and calcium ions, and pH and salinity (%) found in water of three tributaries of Mozi Swamp North and a well east of Mozi Swamp North, Tongaland, nortern Natal. One sample per locality was taken during February, 1981.

ITEM	TRIBUTARY			WELL
	Ebhukubhukwini	Untimbane	Majibomvu	Njanjene
Cl^-	210	640	750	110
$SO_4^=$	80	50	50	100
Mg^{++}	130	440	340	20
Na^+	120	400	460	130
Ca^{++}	100	620	410	20
pH	7,05	6,61	7,97	4,43
Salinity	0,60	1,90	1,70	0,40

WELLS

Wells, dug by the local human population up to a depth of 1,5 m occur in abundance along the south-eastern and south-western sectors of Mozi Swamp North.

Analysis of water from Njanjene Well (Figure 9) explains why the Tonga people prefer this source of water for human consumption. According to the classification of Reid (1961) the salinity of 0,4 % which was there, falls within the limnetic zone, i.e. it is fresh water.

SEASONAL PANS

nGulungulu Pans

The salinity for the nGulungulu Pans (Figure 9) was low (Table 17) when compared with that of Mozi Swamp North. It, therefore, stands to reason why these pans are used extensively by the local population for human consumption and for their cattle. The absence of shallow calcrete beds in this area accounts for this low salinity.

Central Pans

As with the nGulungulu Pans, the salinity of the Central Pans was low (Table 17), and an absence of calcrete beds also accounts for this low salinity.

Mansomi Pan

Mansomi Pan (Figure 9) on the other hand, showed a high salinity (Table 17), almost equaling the salinity of the southern sector of Mozi Swamp North. The reason for this increase in ion concentrations is the shallow duplex soils comprised of calcrete beds on which Mansomi Pan occurs (Loxton et al. 1969).

Because the seasonal pans i.e. nGulungulu, Central and Mansomi were only sampled once, no clear-cut conclusions can be made. However, indications are that the salinity there is lower in the

Table 17 : Concentrations (ppm) of chlorine, sulphate, magnesium, sodium and calcium ions, and pH and salinity (%) found in water of three seasonal pans within the proposed Tembe Elephant Reserve, Tongaland, northern Natal. One sample per pan was taken during February 1981.

ITEM	PAN		
	nGulungulu	Central	Mansomi
Cl^-	390	340	1 060
$SO_4^=$	110	99	140
Mg^{++}	70	52	130
Na^+	260	180	790
Ca^{++}	100	58	170
pH	6,42	6,45	6,51
Salinity	0,91	0,76	2,34

nGulungulu and Central Pans compared to that of Mozi Swamp North. This explains why conflict between man and elephants escalated when the seasonal pans held water.

ANALYSES FOR P', P'-DDT AND P', P'-DDE

MANDHLANKUNZI, NHLOLE, PUMPHOUSE, FOMOTHINI, eBUMBENI, nGULUNGULU, MAHLASELA AND CENTRAL PANS

No concentrations of DDT and DDE at a level above 0,0005 mg/kg or ppm, were detected by the South African Bureau of Standards, in water samples of pans between and along Mozi Swamp North and the Pongola River.

Concentrations of DDT and DDE are, however, difficult to detect in water, especially at levels of 0,0005 ppm (Gardiner pers. comm.). Viljoen (pers. comm.) states that the South African Bureau of Standards uses 0,0005 ppm as the limit and everything below this threshold is reported as non-detectable.

It has, however, been proved that even low concentrations of DDT and DDE, such as 0,0001 ppm, can be dangerous to any water system, because DDT and DDE accumulates as it proceeds along in the food chain (Greichus, Greichus, Amman, Call, Hamman and Pott 1977). Results obtained from the Hartebeespoort Dam during 1974 showed that at a level of 0,0001 ppm DDT and DDE, the canary kurper fish Shetia flaviventris contained in its fatty tissue 0,27 ppm DDE and 0,23 ppm DDT. Higher up the food chain, the cormorant Phalacracorax africanus contained in its fatty tissue 2,6 ppm DDE and 0,3 ppm DDT (Greichus et al. 1977).

Taking the above concentration levels of DDT and DDE into consideration, it can be concluded that concentration levels of DDT and DDE,

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p', p'-DDT = 1,1-bis (4-chlorophenyl-2,2,2-trichloroethene).

p', p'-DDE = 1,1-bis (4-chlorophenyl-2,2-dichloroethene).

Gardiner, B. (1981) : P.O. Box 1700, CONGELLA, 4013.

Viljoen, A.S. (1982) : South African Bureau of Standards, Private Bag X 191, PRETORIA, 0001.

lower than 0,0001 ppm, can be detrimental to any ecosystem (Gardiner, pers. comm.).

In South Africa DDT has officially been banned for private use since 1971, but is still in use in malaria-stricken areas (Seme, pers. comm.). This is the case in Tongaland, where large amounts of DDT are sprayed annually to control the malaria-carrying mosquito Anopheles funestus during the wet season (October to March) (Seme, pers. comm.).

The Department of Health and Welfare of KwaZulu in Tongaland maintains that DDT is the cheapest and most effective method for controlling mosquitos. It is, however, known elsewhere that mosquitos are able to develop a genetic immunity to DDT (Begg 1980).

According to figures obtained from the Department of Health and Welfare of KwaZulu on the tonnage of DDT used per annum in this area, and knowing that 3 g of DDT are mixed to 1 ℓ of water, one can conclude that between five to 12 million litres of DDT (Table 18) are sprayed per annum in Tongaland.

Incidences of malaria reported from 1977 to 1981 are listed in Table 19. According to Seme (pers. comm.) the peak of malaria incidences are being experienced in April.

It is encouraging to mention that the Department of Agriculture and Forestry, KwaZulu, have embarked on an intensive study of the presence of DDT and DDE in water, mud, fatty tissue of fish and of birds in the northern parts of Tongaland (Bourn, pers. comm.).

The most encouraging news of all is that the Department of Health and Welfare of KwaZulu are to be testing a new insecticide (Delta Mephrim) which is said to be less harmful than DDT to combat malaria (Seme, pers. comm.).

Gardiner, B. (1981) : P.O. Box 1700, CONGELLA, 4013.

Seme, M. (1981) : Department of Health and Welfare, P.O. Box 43, JOZINI, 3969.

Bourn, H. (1981) : P.O. Box 328, MELMOTH, 3835.

Table 18 : The mass of DDT (kg) converted to litres (3 g/ℓ) as used from January 1977 to December 1980 by the Department of Health and Welfare, KwaZulu, Tongaland, northern Natal (Seme, pers. comm.).

YEAR	KILOGRAMMES	LITRES
1977	15 000	5 000 000
1978	36 000	12 000 000
1979	20 000	6 500 000
1980	30 000	10 000 000

Seme, M. (1981) : Department of Health and Welfare, P.O. Box 43, JOZINI, 3969.

Table 19 : Malaria cases reported per year from a human population of 5 459, from January 1977 to July 1981, in the areas of Muzi Border Post, Sihangwana and Makanes Drift, Tongaland, northern Natal (Seme, pers. comm.).

AREA	YEAR				
	1977	1978	1979	1980	1981
Muzi Border Post	18	16	13	33	10
Sihangwana	176	25	6	20	14
Makanes Drift	80	51	32	110	15
Total	274	92	51	163	39
Percentage of Population	5,0	1,7	1,0	3,0	0,7

Seme, M. (1981) : Department of Health and Welfare, P.O. Box 43, JOZINI, 3969.

CONCLUSION

Based on the mean salinity levels, Mozi Swamp North can be divided into two definite sectors, viz. the northern sector (Mean = 1,6 %; SD = 0,28) and the southern sector (Mean = 3,4 % ; SD = 1,46).

With regards to the elephants it can be speculated that the presence of human settlements determine pan utilization. The local population on the other hand avoid pans of Mozi Swamp North with high salinity levels and dig wells instead from which they obtain their water for human consumption.

However, more quantitative data (taken over a longer period) on salinity gradients of seasonal pans and pans of Mozi Swamp North, are needed. Qualitative data on the utilization of these pans by elephants, man and their domestic stock, should also be considered before final conclusions can be reached as to what kind of limiting factors determine pan utilization.

Although no traces of DDT and DDE were detected at a level above 0,0005 ppm in the water of pans sampled between Mozi Swamp North and the northern Pongola River, the amount of DDT sprayed per annum in Tongaland raises concern. Further research in this field should receive priority.

C H A P T E R 6

ASPECTS OF THE ECOLOGY OF THE ELEPHANTS OF TONGALAND

INTRODUCTION

Reference to the past movement and distribution of the elephants of Tongaland, including population numbers and herd composition, is scarce. The elephants of Tongaland have therefore remained a mystery to biologists and conservationists. A major controversy concerning these elephants was the existence of breeding herds or not. Since 1945, there have been no positively confirmed reports on the presence of cows and calves in the Sihangwana area (Hall-Martin 1976).

In December 1978, i.e. six months prior to the start of the present study, the Chief Regional Nature Conservator of Tongaland (Freeman pers. comm) mentioned that he had seen signs of the presence of elephant calves west of Mozi Swamp North. However, he was unable to locate them at that stage.

In the present study the secretive nature of the elephants coupled with their aggressive behaviour towards humans made it difficult to give a complete account of the elephants' population dynamics, habitat utilization, drinking intervals and behaviour.

The elephant population in Tongaland was not static during the study period as these elephants were able to move freely across the Mozambique-Natal border. The prevailing political climate in Mozambique during the study prevented the author from entering Mozambique with the result, that various aspects necessary to give an overall picture of the ecology of the elephants, could not be documented.

In Tongaland, for the past three decades, elephants have been protected and the only elephants shot during that period included

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Freeman, D.W. (1979) : P.O. Box 75, FELIXTON

rogues, wounded elephants and/or crop raiders (Freeman pers. comm.). The number of elephants shot during the past three decades is estimated at 26 (Freeman pers. comm.). In southern Mozambique there were similar laws protecting these elephants. However, since the independence of Mozambique in 1974, law-enforcement slackened and the elephants were left at the mercy of the local people (Tinley and Van Riet 1981).

The last documented report estimated the elephant population in Tongaland at 30, consisting of bulls only (Hall-Martin 1976).

During the present study an escalation in elephant movement across the Mozambique-Natal border was experienced which resulted in an increase in the elephant population in northern Tongaland. This was also confirmed by the local people living in northern Tongaland who had never before seen so many elephants in the area.

This increased elephant activity in northern Tongaland resulted in clashes with the local Tonga tribe. It therefore became increasingly imperative that a management policy be formulated for these elephants and it was suggested that this policy must also ultimately lead to the establishment of a conservation area.

To attain this goal, various aspects of the ecology of the elephants were investigated. These included:

- Movement across the Mozambique-Natal border.
- Local movements and distribution.
- Observations at Fomothini Pan.
- Aerial ecological reconnaissance surveys.
- Elephant population dynamics.
- Elephant-human conflicts.
- Food utilization.
- Habitat requirements.

Freeman, D.W. (1979) : P.O. Box 75, FELIXTON, 3875.

RESULTS AND DISCUSSION

MOVEMENT ACROSS THE MOZAMBIQUE-NATAL BORDER

During the past decade an expanding human population has displaced the elephants of the "Reserva dos Elefantes do Maputo" from their former range in southern Mozambique (Hanlon 1980). In 1979 there remained 80 elephants in the Maputo Elephant Reserve from a population of 269 elephants in 1972 (Tinley pers. comm.). These displaced elephants established a new home range by moving southwards, colonizing the Maputo floodplain, the Futi-drainage system and northern Tongaland.

Although spoor counts of elephants moving either north or south across the Mozambique-Natal border between the Pongola River and Farrazau, were done daily from July 1979 to July 1981 (Figure 23), these data (Appendices 3 and 4) were processed using statistical moving 12-point averages from which the mean of the north-south spoor counts were calculated (Table 20). This allowed a more meaningful illustration of seasonal elephant movements across the Mozambique-Natal border (Figure 23). Using specific numbers could be misleading as one elephant could be recorded two or more times, moving either north or south across the border during a 24-hour period due to random foraging. By identifying individual spoor, however, double counting was avoided as far as possible.

From the results in Table 20 and Figure 24, a seasonal rhythm in elephant movements across the Mozambique-Natal border is evident. An escalation in elephant activity between the Pongola River and the Muzi Border Post is experienced during the wet season (October to March) compared to the dry season (April to September), when a decrease in elephant activity across the Mozambique-Natal border takes place. Limiting factors controlling this seasonal movement include:

Tinley, K.L. (1980) : Department of Conservation and Environment, Mount Street 1, PERTH, 6000, WESTERN AUSTRALIA.

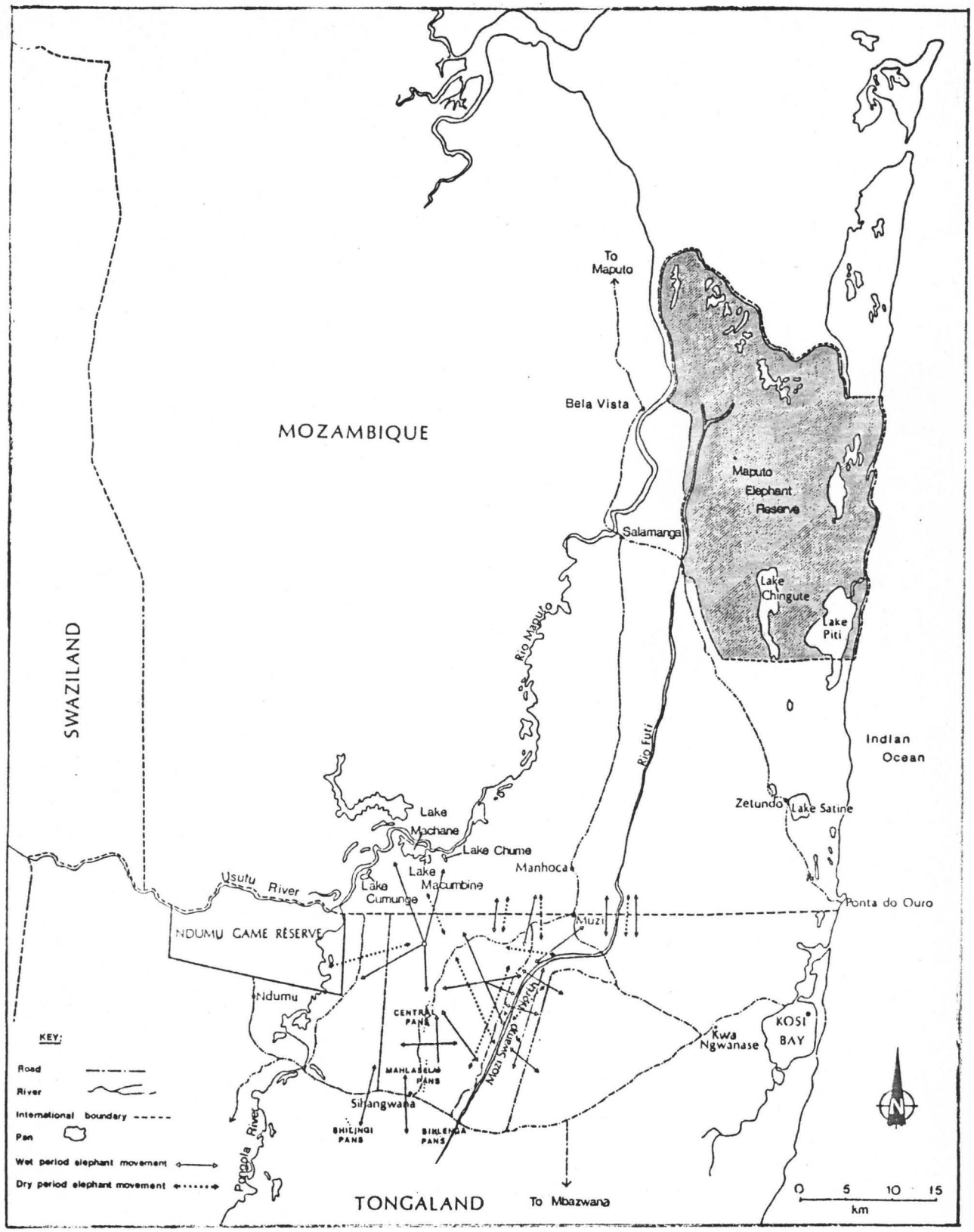

Figure 23 : Movements of elephants during the wet and dry seasons in northern Tongaland and southern Mozambique, from July 1979 to May 1981.

Table 20 : Seasonal index (moving 12-point averages) of elephant spoor leading southward and northward across the Mozambique - Natal border, between the Pongola River and Muzi Border Post, Tongaland, northern Natal, from July 1979 to July 1981.

MONTH	INDEX OF SPOOR COUNTS				
	Direction - based		Both directions combined		
	Southward	Northward	Mean	Standard deviation	Coefficient of variation (%)
January*	135,2	127,3	131,3	5,6	4,3
February*	126,7	127,7	127,2	0,7	0,6
March*	163,0	170,4	166,7	5,2	3,1
April+	42,1	44,2	43,2	1,5	3,4
May+	28,7	23,9	26,3	3,5	13,1
June+	16,6	14,7	15,6	1,3	8,4
July+	43,9	73,6	58,8	21,0	35,7
August+	71,6	79,4	75,5	5,5	7,3
September+	118,5	113,3	115,9	3,8	3,2
October*	126,9	98,6	112,8	20,0	3,2
November*	162,8	157,7	160,1	3,5	2,2
December*	164,0	169,2	166,6	3,6	2,2
Totals for wet-season months	878,6	850,9	-	-	-
Totals for dry-season months	321,4	349,1	-	-	-
Total	1 200,0	1 200,0	-	-	-

* : Wet-season months

+ : Dry-season months

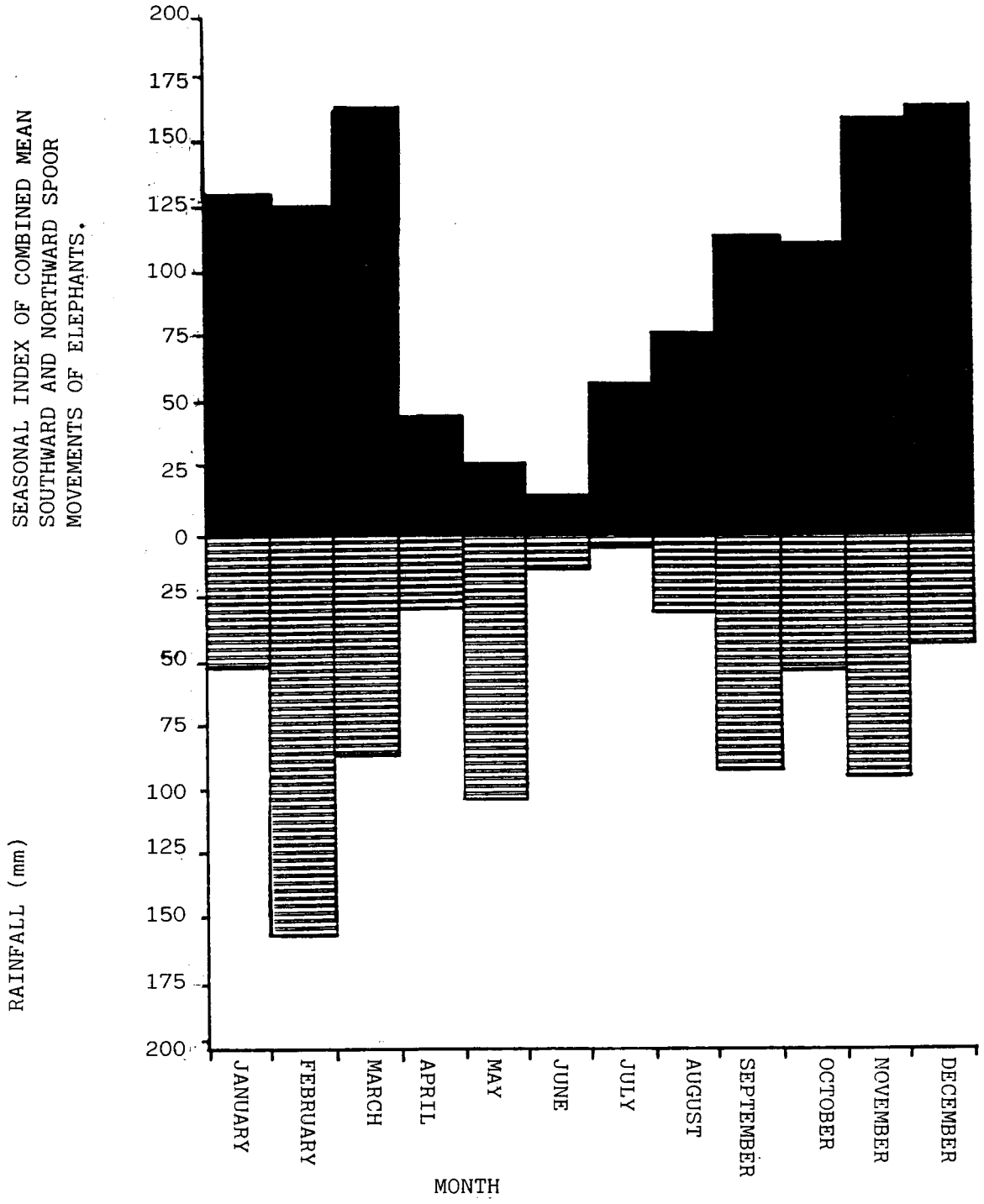

Figure 24 : Seasonal index (moving 12 - point averages) of combined mean northward and southward elephant spoor leading across the Mozambique - Natal border, between the Pongola river and the Muzi Border Post, from July 1979 to July 1981, as plotted against the mean monthly rainfall for the same period in Tongaland, northern Natal.

- An additional source of food between Nhlela and Beacon Ridges.
- The availability of surface water at the Central Pans following rainfall.

It can be concluded that at the onset of rain, seasonally filled pans coupled with induced vegetation growth, leads to the north-south movement of elephants across the Mozambique-Natal border (Figure 24).

A reversed seasonal pattern of elephant movement was noticed to occur between the Muzi Border Post and Farrazau (Table 21). Negligible elephant movement took place there across the Mozambique-Natal border during the wet season (October and December only), (Table 21) and an increase in elephant movement occurred during the dry season. This difference in seasonal movement along the above-mentioned stretch of the Mozambique-Natal border can be ascribed to the following factors:

- During the dry season there is an increase in elephant activity along the Futi-drainage system in southern Mozambique close to the Mozambique-Natal border.

- During the wet season the elephants move westwards utilizing the seasonal pans between the Maputo floodplain and Futi-drainage in southern Mozambique.

Elephants crossing the Mozambique-Natal border between the Pongola River and Muzi Border Post consisted of lone bulls, bachelor groups and breeding groups, but in the area between the Muzi Border Post and Farrazau, only lone bulls and bachelor groups crossed the border. The major factor determining this difference is the presence of the large human settlement on the Tongaland side near to Muzi Border Post and along the banks of the northern Mozi Swamp North. It was observed that breeding groups tended to avoid densely populated human settlements in contrast to the lone bulls and bachelor groups which showed a greater tolerance towards human presence.

Table 21 : Seasonal index (moving 12-point averages) of elephant spoor leading Southward or northward across the Mozambique - Natal border, between the Muzi Border Post and Farrazam, Tongaland, northern Natal, from July 1979 to July 1981.

MONTH	INDEX OF SPOOR COUNTS				
	Direction - based		Both directions combined		
	Southward	Northward	Mean	Standard deviation	Coefficient of variation (%)
January*	0,0	0,0	0,0	0,0	0,0
February*	0,0	0,0	0,0	0,0	0,0
March*	0,0	0,0	0,0	0,0	0,0
April+	56,0	0,0	28,0	39,6	141,4
May+	198,9	376,1	287,5	125,3	43,6
June+	0,0	50,5	25,3	35,7	141,4
July+	230,5	42,3	136,4	133,0	97,5
August+	105,6	311,1	208,4	145,3	69,7
September+	513,6	345,6	429,7	118,9	27,7
October*	95,4	36,4	65,9	41,7	63,4
November*	0,0	0,0	0,0	0,0	0,0
December*	0,0	38,0	19,0	26,9	141,4
Totals for wet-season months	95,4	74,4	-	-	-
Totals for dry-season months	1 104,6	1 125,6	-	-	-
Total	1 200,0	1 200,0	-	-	-

* : Wet-season months

+ : Dry-season months

In Table 20 it is evident that coefficient of variation in the months May and July are high, i.e. greater than 10,0 percent compared to the remaining months which all have a low coefficient of variation i.e. less than 7,3 percent. This phenomenon can be ascribed to a sudden increase in movement of elephants i.e. an escalation in elephant numbers into Tongaland and an exodus of elephants back into Mozambique during July (Appendix 3).

In Table 21 on the other hand, the low coefficient of variation (i.e. 0,0 percent) in the months January, February, March and November could be due to no elephant movement being recorded during the above-mentioned months between Muzi Border Post and Farrazau. The high coefficient of variation recorded in contrast to the above, in certain months i.e. (greater than 27,0 percent but less than 142,0 percent) could be due to elephant movements taking place in one direction only i.e. either north or south across the Mozambique-Natal border (Appendix 4).

Other factors that could have attributed to the high coefficient of variation value are:

- Human error in recording north-south elephant movement.
- Elephant spoor erased by vehicles of the security forces and the Department of Health.

Movements of elephants from southern Mozambique and northern Tongaland that only came to feed on the sisal which grow in a 25 m strip along the entire Mozambique-Natal border, are presented in Tables 22 and 23 (Appendices 5 and 6).

From Table 22 it is evident that during the wet season, when surface water was abundant, the elephants in Tongaland used to frequent the Mozambique-Natal border more often to feed on the sisal, while the elephants in Mozambique, except for the months December and January, seldom frequented the Mozambique-Natal border. The sudden increase in elephant numbers, recorded from Mozambique and only feeding on sisal, could have been due to the result of a human counting error.

Table 22 : Seasonal index (moving 12-point averages) of elephant spoor coming from the Mozambique and the Tongaland side, to feed on sisal plants only along the Mozambique-Natal border, between the Pongola River and Muzi Border post, Tongaland, northern Natal, from July 1979 to July 1981.

MONTH	SPOOR ORIGIN	
	Tongaland	Mozambique
January*	138,8	0,0
February*	88,6	236,7
March*	87,2	295,8
April+	51,7	28,4
May+	37,0	39,
June+	44,1	0,0
July+	46,8	0,0
August+	148,2	157,3
September+	88,8	147,8
October*	192,8	234,6
November*	177,6	59,7
December*	98,4	0,0
Totals for wet-season months	783,4	826,8
Totals for dry-season months	416,6	373,3
Total	1 200,0	1 200,0

* : Wet-season months + : Dry-season months

Table 23 : Seasonal index (moving 12-point averages) of elephant spoor coming from the Mozambique and the Tongaland side, to feed on sisal plants only along the Mozambique-Natal border, between the Muzi Border Post and Farrazau, Tongaland, northern Natal, July 1979 to July 1981.

MONTH	SPOOR OF ORIGIN	
	Tongaland	Mozambique
January*	0,0	0,0
February*	0,0	0,0
March*	0,0	125,9
April+	0,0	105,7
May+	857,1	112,1
June+	0,0	155,7
July+	342,9	0,0
August+	0,0	144,7
September+	0,0	136,2
October*	0,0	221,7
November*	0,0	119,7
December*	0,0	78,3
Totals for wet-season months	0,0	545,6
Totals for dry-season months	1 200,0	654,4
Total	1 200,0	1 200,0

* : Wet-season months

+ : Dry-season months

Movement of elephants between Muzi Border Post and Farrazau that only came to feed on sisal plants (Table 23), was erratic and in all cases only lone bulls or bachelor groups of elephants were recorded. No seasonal pattern in movement could be determined as sampling sizes were too small. This low number (Table 23) could be attributed to the low number of elephants to be found on either side of the Mozambique-Natal border along the Futi-drainage and Mozi Swamp North. It is concluded that the large human settlement in the latter two areas had a direct influence on elephant movement and distribution.

LOCAL MOVEMENTS AND DISTRIBUTION

From Figure 25, it is evident that elephant movements and distribution during the dry season is almost confined to Mozi Swamp North in contrast to the wet season when the elephants disperse and utilize a larger area.

DRY AND WET SEASON

As soon as the Central Pans (Figure 25) become too murky or dry up from April onwards, the elephants move away from the central area and confine themselves to Mozi Swamp North which offers a permanent water supply. However, not all the pressure is exerted on Mozi Swamp North, as a number of elephants move northwards across the Mozambique-Natal border into southern Mozambique where they frequent the Cummange, Machane, Macumbine and Chume Lakes (Figure 23) in the west and the Futi-drainage system in the east. This information was obtained from local residents living in Mozambique. Occasionally bull elephants venture westwards into northern Tongaland and enter Ndumu Game Reserve at its eastern boundary (Jackson pers. comm.) to quench their thirst at Polwe Pan (Figure 9).

The distribution of the family units during the dry season is more area-specific than that of the wet season, with a wet season

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Jackson, G. (1981) : Private Bag X 501, MKUZE, 3965.

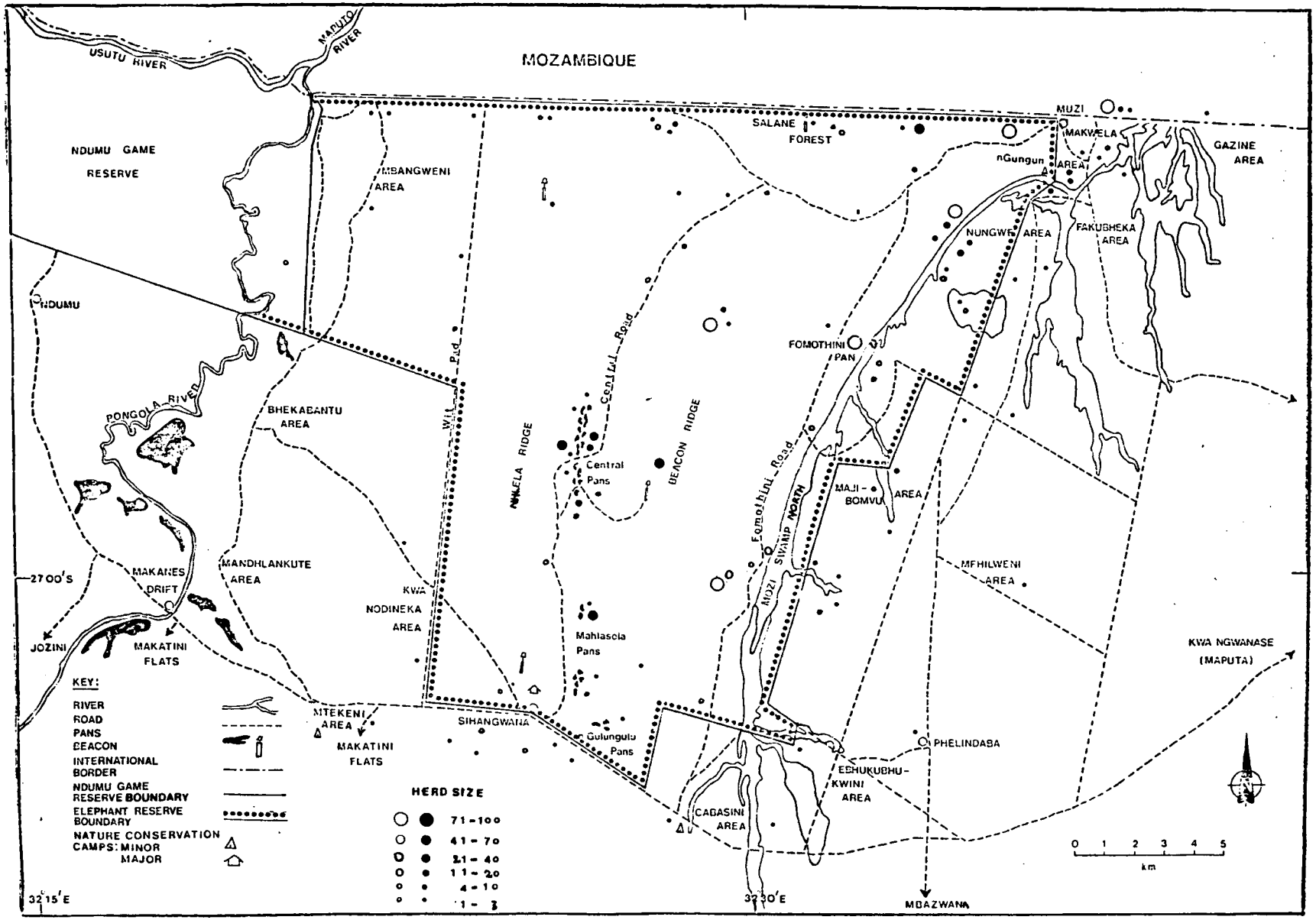


Figure 25 : Seasonal distribution and abundance of elephants during the dry and wet season, July 1979 to May 1981, Tongaland, northern Natal.

home range of only 150 km² (Figure 25). Family units were never observed to cross either east of Mozi Swamp North nor south of the Phelindaba-Makanes Drift main road. The lone elephant bulls and the bachelor groups on the other hand, covered greater distances thus increasing their dry season home range to 250 km² (Figure 25).

During August, September, October and November, the green flush and the ripening of fruit lured the lone bull elephants and the bachelor groups south of the Phelindaba-Makanes Drift main road (Table 24).

During the months December, January and February, the elephants confined themselves to the Central Pans where water was abundant. At the end of February of 1980, 196 mm of rainfall was recorded. This resulted in a sudden southward elephant movement across the Phelindaba - Makanes Drift main road, from the beginning of March, tapering off in May to no more elephant movement recorded in June and July. The latter two months were the driest months of the year when seasonal pans were either dry or muddy.

It can be concluded that two major limiting factors determined south elephant movement across the Phelindaba - Makanes Drift main road viz:

- The availability of clear surface water at the Sihlenga and Shilingi pans.
- The ripening of agricultural crops at Mtekeni (Figure 9).

During the wet season, when there is an abundance of water at the Central Pans (Figure 25) there seems to be a definite trend of elephant movements away from Mozi Swamp North, in a westerly direction towards the central area and northwards across the Mozambique-Natal border (Figure 23). Home ranges of the lone bulls and the bachelor groups of elephants in Tongaland increases from 250 km² to 525 km², whereas the family units tend to confine themselves to the area between Nhlela Ridge and Mozi Swamp North, an area of approximately 225 km², where human presence was limited. It was

Table 24 : Seasonal index (moving 12-point averages) of elephant spoor leading northward and southward across the Sihangwana main road, between Phelindaba and Makanes Drift, Tongaland, northern Natal, from July 1979 to July 1981.

MONTH	INDEX OF SPOOR COUNTS
January	0,0
February	0,0
March+	174,9
April*	36,0
May*	47,4
June	0,0
July	0,0
August+	265,7
September+	113,9
October+	443,3
November+	118,2
December	0,0
Total	1 200,0

* : Surface water and agricultural crops available.

+ : Ripening of fruit and green flush of vegetation.

never observed that family units either moved to the south of the Phelindaba-Makanes Drift main road or eastwards across Mozi Swamp North.

LIMITING FACTORS CONTROLLING ELEPHANT MOVEMENT AND DISTRIBUTION

Availability of surface water:

After the first spring rains, from late September to early October, many scattered depressions are filled with water, thus creating a series of pans. These pans, which are extensively utilized by the elephants, retain their water until the onset of the dry season. The pans are localized in the central area, south of the Phelindaba-Makanes Drift main road, viz. Shilingi and Sihlenga Pans and west of Mozi Swamp North on the duplex soils with a high clay content in the A-horizon (Figure 25). During the dry season available surface water in the above-mentioned areas is restricted, resulting in an increased concentration of elephants along Mozi Swamp North, which has a permanent water supply.

Availability of food:

The food sources which play a limiting role in elephant movement and distribution, include:

- Sisal plants along the Mozambique-Natal border.
- The ripening of fruit in the veld, viz: Sclerocarya birrea, Strychnos madagascariensis, S. spinosa and Landolphia kirkii.
- The green flush at the end of the dry season.
- The ripening of agricultural crops of the local human population living on the periphery of the elephant home range.

Distribution of the local human population:

It is evident that human presence definitely restrict the movement and distribution of the elephants throughout the year. This applies especially to the family units which never venture near human settlements, do not raid agricultural crops nor utilize pans which were close to a human settlement. Similar conditions prevail in

southern Mozambique (Tello 1973). The lone bull elephants and the bachelor groups on the other hand, seemed less concerned about the presence of human settlements. They tended to raid crops and to compete strongly with the domestic stock of the local people at pans and wells.

Vehicular traffic:

During the study period vehicular traffic played a minimal role in effecting elephant movement and distribution. The situation, however, can change as development in northern Tongaland escalates, and also due to the possible increase in vehicular traffic through the proposed elephant reserve by the security forces.

It can be concluded that there is a definite seasonal pattern in movement and distribution amongst the elephants in northern Tongaland. This is evident especially for the family units which have definite separate home ranges during the dry and wet seasons, in contrast to that of the lone bull elephants and bachelor groups whose home range during the dry and wet seasons tend to overlap. Should the international border between Mozambique and Natal ever be sealed off, thus preventing north-south and vice versa elephant movement, an increase in elephant activity along Mozi Swamp North during the dry season can be expected. To alleviate this increased elephant pressure, it would then be essential to have the northern part of the Pongola River included in the proposed elephant reserve, thus making a west-east movement possible.

OBSERVATIONS AT FOMOTHINI PAN

Observations of elephants at Fomothini Pan revealed that there were definite seasonal differences in the number of elephants observed there per month, the drinking times and the time spent at that pan by the different social units.

In Table 25 the number of elephants observed per month are expressed as the number of elephants per hour. Comparing this with the mean

Table 25 : Number of elephants sighted per hour per month at Fomothini Pan in Mozi Swamp North, Tongaland, northern Natal, from July 1979 to May 1981.

YEAR	MONTH	DAYS OBSERVED	TOTAL HOURS OBSERVED	NUMBER OF ELEPHANTS COUNTED	ELEPHANTS SIGHTED PER HOUR
1979	July+	3	18,5	59	3,2
	August+	6	22,3	20	0,9
	September+	4	135,3	19	0,1
	October*	6	158,8	52	0,3
	November*	3	47,5	6	0,1
	December*	1	22,0	4	0,2
1980	January*	2	56,5	7	0,1
	February*	2	53,0	19	0,4
	March*	6	130,5	19	0,2
	April+	3	68,5	28	0,4
	May+	6	134,5	195	1,5
	June+	4	160,5	153	1,0
	July+	4	88,0	3	0,0
	August+	6	140,5	71	0,5
	September+	3	68,5	2	0,0
	October*	6	115,5	29	0,3
	November*	4	65,8	0	0,0
	December*	3	68,0	0	0,0
1981	January*	3	72,5	32	0,4
	February*	3	54,0	4	0,1
	March*	3	61,0	13	0,2
	April+	5	196,5	0	0,0
	May+	3	58,5	7	0,1

* : Wet-season months + : Dry-season months

monthly rainfall during the period in which the observations were made (Figure 26 and Appendix 7) it is clear that during the dry season there is an increase in the number of elephants that frequent the Mozi Swamp North. This underscores the importance of Mozi Swamp North as an essential habitat of the elephants during a period when the seasonal pans in the central area are dry.

Similar reports of an increased concentration of elephant numbers along the Futi-drainage system during the dry season were received from the local inhabitants of southern Mozambique.

Elephant observations at Fomothini Pan during the wet season on the contrary decreased due to the availability of surface water throughout the study area. Table 26 indicates the mean number of elephants observed per hour over a 23-month period at Fomothini Pan in the wet and dry season.

The coefficient of variation varied from 150,0% to 17,2%. This great variation could be due to small sample sizes in some cases and for the irregular number of days and hours spent at Fomothini Pan per month, which varied from one to six days (Table 26).

In Table 27 the mean number of elephants observed per 180-minute observation period over a 24-hour period during the wet and dry season is shown. During the wet season the peak number of elephants arrived at Fomothini Pan from 18h00 to 21h00, i.e. from the onset of sunset. During the dry season the peak was between 15h00 to 18h00, viz. also from the onset of sunset. During both the wet and dry seasons visits of elephants at Fomothini Pan decreased as the night proceeded (Figure 27) and increased from sunrise towards midday. This increase from midday towards late afternoon consisted mainly of lone bulls and bachelor groups during hot, humid days. The family units preferred to arrive at Fomothini Pan during the wet and dry season, at or soon after sunset. This preferred drinking time confirms the caution exercised by all elephants, especially amongst the family units who only ventured out of the Sand Forest at sunset and in the dark. According to

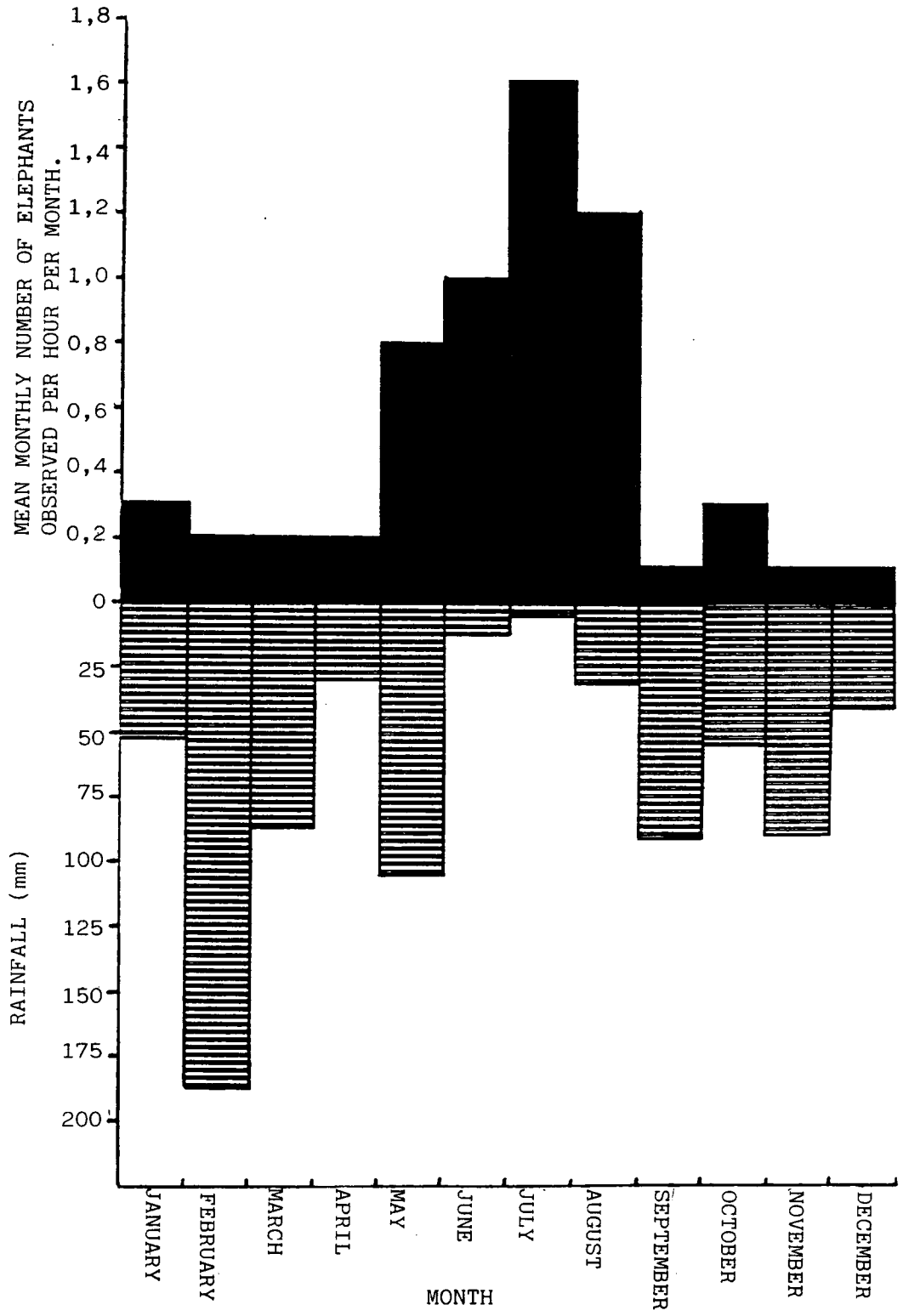


Figure 26 : Mean number of elephants observed per month at Fomothini Pan in Mozi Swamp North, from July 1979 to May 1981, as plotted against mean monthly rainfall (mm) for the same period, Tongaland, northern Natal.

Table 26 : Mean, standard deviation (SD) and percent coefficient of variation (CV) for the number of elephants observed per hour for each month over a 23-month period at Fomothini Pan of Mozi Swamp North, Tongaland, northern Natal, from July 1979 to May 1981.

MONTH	ELEPHANTS PER HOUR			
	Mean	Standard deviation	Coefficient of variation (%)	Months sampled
January*	0,3	0,2	82,1	2
February*	0,2	0,2	105,0	2
March*	0,2	0,0	22,2	2
April+	0,2	0,3	133,3	2
May+	0,8	0,9	120,5	2
June+	1,0	-	-	1
July+	1,6	2,3	138,7	2
August+	1,2	0,3	24,1	2
September+	0,1	0,1	88,9	2
October*	0,3	0,1	17,2	2
November*	0,1	0,1	150,0	2
December*	0,1	0,1	144,4	2

* : Wet-season months + : Dry-season months

Table 27 : Mean, standard deviation (SD) and percent coefficient of variation (CV) for the number of elephants (N1) observed per 180-minute observation periods (N2) at Fomothini Pan, during the dry and the wet season, in Mozi Swamp North, Tongaland, northern Natal, from July 1979 to May 1981.

OBSERVATION PERIOD	DRY SEASON					WET SEASON				
	Mean	SD	CV	N1	N2	Mean	SD	CV	N1	N2
12h00 - 15h00	3,2	0,9	29,2	83	26	0,8	0,3	34.7	21	28
*15h00 - 18h00	5,3	0,9	16,7	165	31	1,7	0,3	16,4	43	26
+18h00 - 21h00	5,1	0,7	13,7	143	28	3,5	0,7	19,4	70	20
21h00 - 24h00	2,2	0,5	23,5	53	24	1,3	0,5	40,2	25	19
24h00 - 03h00	1,6	0,5	30,9	34	21	0,9	0,3	29,8	17	18
03h00 - 06h00	0,7	0,2	35,3	13	19	0,6	0,3	42,6	11	18
.06h00 - 09h00	0,2	0,1	58,8	4	23	-	-	-	0	20
°09h00 - 12h00	0,1	0,1	50,0	1	23	1,7	0.2	12,3	46	27

* : Approximate sunset time in dry season: 17h00

\+ : Approximate sunset time in wet season: 19h00

. : Approximate sunrise time in dry season: 06h30

° : Approximate sunrise time in dry season: 04h30

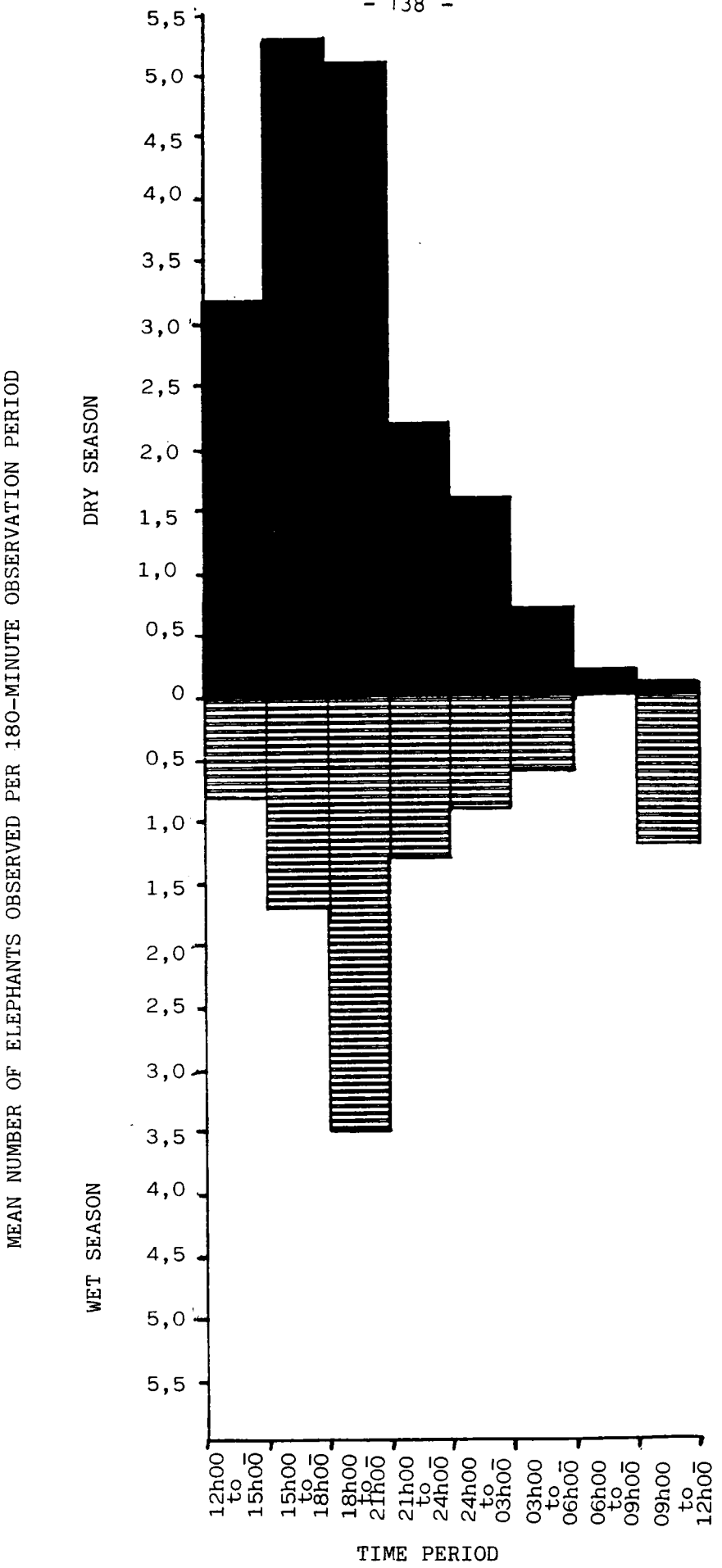


Figure 27 : Times of arrival of elephants at Fomothini Pan of Mozi Swamp North, during the dry and wet season, Tongaland, northern Natal, from July 1979 to May 1981.

unconfirmed reports, this type of behaviour is due to the continual harrassment and poaching by the local human population in southern Mozambique on the elephants there, since the independence of Mozambique in 1974. Elephants were recorded at Fomothini Pan at most hours of the day and night but visits to the pan show a pronounced evening peak between 15h00 to 18h00 during the dry season, and during the wet season between 18h00 to 21h00.

The time spent by different social groups, viz. family units, lone bulls and bachelor groups at Fomothini Pan during the dry and wet seasons appears in Table 28. The high coefficient of variation is probably due to the small number of observations. The times spent by the family units and by the bachelor groups at Fomothini Pan during the wet versus the dry season were statistically similar (Table 30). However, lone bulls spent a significantly longer time at Fomothini Pan during the wet than during the dry season (Table 30). When comparing the use of Fomothini Pan by family units, lone bulls and bachelor groups for the wet and dry season, in time spent in minutes and hours at Fomothini Pan, significant differences existed for family units versus bachelor groups and for lone bulls versus bachelor groups (Table 29). There was, however, no significant difference in time spent at the water (Table 29), for family units compared with lone bulls.

From these results it is clear that the family units, probably associating open water spaces with danger, spent a minimum of time at Fomothini Pan (Table 28). Unconfirmed reports state the elephants were ambushed in southern Mozambique at open water sites by poachers using heavy calibre rifles. The lone bulls, although they remained at Fomothini Pan for a few minutes longer than the family units, showed no significant difference from the latter in minutes spent at this Pan (Table 29).

AERIAL SURVEYS

Ten aerial surveys were undertaken in northern Tongaland during the study period and flying time per survey varied from 25 to 90 minutes.

Table 28 : Mean, standard deviation (SD), percent coefficient of variation (CV) and number of observations (N) for the minutes spent by different social units of elephants at the water at Fomothini Pan, during the dry and the wet season, in Mozi Swamp North, Tongaland, northern Natal, from July 1979 to May 1981.

SOCIAL UNIT	DRY SEASON				WET SEASON			
	Mean	SD	CV	N	Mean	SD	CV	N
Family units	11,4	7,4	65,0	15	14,0	11,5	82,4	3
Lone bulls	14,8	15,4	104,5	32	26,3	27,3	103,8	32
Bachelor groups	74,6	59,1	59,2	25	78,1	63,4	81,2	20

Table 29 : Statistical results of the comparison of minutes spent during the dry and wet season by different social units of elephants, at Fomothini Pan, in Mozi Swamp North, Tongaland, northern Natal.

SOCIAL UNITS	DRY SEASON			WET SEASON		
	t	P	df	t	P	df
Family units vs Lone bulls	0,9	$\leq$ 0,05	45	0,9	$\leq$ 0,05	33
Family units vs Bachelor groups	4,1	> 0,05	38	2,4	> 0,05	21
Lone bulls vs Bachelor groups	5,5	> 0,05	45	3,8	> 0,05	50

Table 30 : Mean, standard deviation (SD), percent coefficient of variation (CV) and the number of observations (N) for the comparison of minutes spent during the dry and the wet season, by different social units of elephants at Fomothini Pan in Mozi Swamp North, Tongaland, northern Natal, from July 1979, to May 1981.

SOCIAL UNIT	DRY SEASON				WET SEASON				STATISTICAL RESULTS: WET VERSUS DRY SEASON		
	Mean	SD	CV	N	Mean	SD	CV	N	t	p	df
Family units	11,4	7,4	65,0	15	14,0	11,5	82,4	3	0,5	$\leq 0,05$	16
Lone bulls	14,8	15,4	104,5	32	26,3	27,3	103,8	32	2,5	$> 0,05$	62
Bachelor groups	74,6	59,1	79,2	25	78,1	63,4	81,3	20	0,1	$\leq 0,05$	43

On the 17th October 1980, 27th November 1980 and 20th February 1981, only three lone bulls were counted per survey and on the 1st October 1979 and 13th June 1980, a mixed herd of between 50 and 60 elephants was counted. Factors responsible for the poor counts could be due to:

- Flying speed too high, i.e. more than 80 km/h, (Cessna 185: four-seater).
- Limited flying hours i.e. ten flights of a total of 9 hours and 10 minutes.
- Clumping behaviour of elephants into large herds.
- Poor visibility due to dense plant canopy cover.

It is suggested that towards the end of every dry season, i.e. from July to August, an intensive census on the Tongaland elephants should be undertaken. A helicopter, which is more manoeuvreable than a fixed-wing aircraft, should preferably be used.

The census method recommended for a future total aerial count is the block counting method (Laws et al. 1970), i.e. prior to censussing, the study area is divided into blocks which are demarcated by physical features present on the ground (e.g. rivers and swamps, roads and tracks, ridge tops, international boundaries etc.). Once the blocks are marked in on a map, the aircraft visits each block in turn and locates and counts every elephant sighted within them. The advantage of block censussing is that the aircraft can spend as long as is necessary in counting each block, compared to the transect method (Watson, Parker and Allan 1969 and Laws et al. 1975); where the observers have only one chance to locate and count groups or individuals because the aircraft makes only a single pass along each transect line.

POPULATION DYNAMICS

The results obtained on the population of the Tongaland elephants, do not provide data for direct estimation of certain parameters such as birth rate, death rate, immigration, emigration and population size and structure. The reasons are:

- The elephant population was not stable due to free movement across the Mozambique-Natal border.
- The direct observations on elephants could seldom be made as a result of dense vegetation and unpredicted aggressive behaviour of the elephants.

To understand the dynamics of a population, we need to know how many individuals it contains and how fast the population is increasing or decreasing. According to Caughley (1976) the rate of increase of a population is determined either by immigration or the production of newborn and the rate of decrease which is determined by either mortality or emigration.

From the few direct observations that could be made, the following four conclusions on the population dynamics of the elephants of Tongaland are possible:

NUMBERS

Further research is required to gain a clear picture of the actual number of elephants resident in Tongaland. It can, however, be concluded that the number of elephants in northern Tongaland fluctuate between 50 and 150 individuals. This fluctuation is due to the free movements of elephants across the Mozambique-Natal border.

HERD STRUCTURE AND COMPOSITION

The following social groups of elephants were positively identified within the borders of the proposed Tembe Elephant Reserve.

Family units:

The smallest family unit identified was one prime adult cow with one juvenile and one calf. Larger family units included:

- Two prime adult cows with one calf each.
- Two prime adult cows with one juvenile and one calf each.
- Three prime adult cows with three juvenile, two calves, one infant and one prime adult bull.
- Seven prime adult cows with three juvenile, three calves, one infant and one prime adult bull.

Bachelor herds:

During the study it became evident that bachelor herds had a temporary association in contrast to the family units which were permanently grouped together. Herd sizes of bachelor groups fluctuated between two and seven bulls and were comprised of sub adults, prime adults and senior bulls.

Lone bull elephants:

The lone bull elephants sighted were either prime adults more than 30 years old or senior bulls more than 40 years old.

Mixed herds:

The association of family units with bachelor herds to form large herds of several hundred is common in East Africa (Hanks 1979). It is generally accepted that these large herds are formed following disturbance and disruption of the normal pattern of social life, in particular when the matriarch or lead cow has been shot (Hanks 1979). Douglas-Hamilton and Douglas-Hamilton (1975) suggest that this bunching could have evolved largely from a need for collective defence against predators including man.

The largest mixed herd sighted at Fomothini Pan was 51 elephants in June 1980. The same herd was also sighted by Hall-Martin (pers. comm.) during October 1980 from a helicopter.

KNOWN MORTALITY FACTORS

From 1969 to 1982, the shooting of rogue male elephants in northern Tongaland accounted for 14 elephants. The only natural mortality recorded was during 1980 which was due to a fight which resulted in the death of both bulls.

FUTURE POPULATION TRENDS

With the presence of cows and calves in northern Tongaland positively established, this ensures the future survival of the Tongaland elephants.

Hall-Martin, A. (1980): Kruger National Park, Private Bag X 402,
SKUKUZA, 1350.

Should the harassement of elephants in southern Mozambique continue with its present severity, one could expect an increased number of elephants staying permanently within the proposed elephant reserve as well as a further influx of elephants from across the Mozambique-Natal border.

To ensure that the vegetation does not become degraded as experienced in other parts of Africa (Laws et al. 1970, Hanks 1979 and Eltringham 1979), it is suggested to maintain 0,35 elephants per square kilometer (Laws et al. 1970 and Hanks 1979), which is equivalent to 150 elephants for the area proposed as the Tembe Elephant Reserve.

Should this figure be exceeded, culling of elephants will have to be introduced either on elephant bulls living on the periphery within the proposed elephant reserve or on rogue elephants.

ELEPHANT-HUMAN CONFLICT

Due to their requirements for water, land surface and food, the Tongaland elephants have come into sharp competition with the local people who are both agriculturalists and pastoralists.

Conflict between the local Tonga tribe and the elephants has existed for many decades (Thomson 1974). The incidence, however, has increased since 1979, when elephants displaced from the Maputo Elephant Reserve in Mozambique due to increased re-settlement of people in that reserve, have started to use northern Tongaland as part of their new home range.

Today, the co-existence of elephants and man is neither realistic nor desirable, and in the study area, this fact is a major factor in the continued survival of the elephants. The local people living within the study area require crop fields and an ample supply of fresh water for their mode of existance. These two facets form a direct clash of interest between man and the elephants and has resulted in such bitterness that the local people have requested the complete destruction of all elephants resident in Tongaland.

With an increasing attack by elephants on the local people and the resultant death in February 1981 of two tribesmen, these cries have readily grown in tempo.

A survey of the complaints of destruction by elephants revealed, that there were two distinct periods when this clash of interest was most frequent. In the dry season elephants compete with domestic stock and local tribesmen for water, especially at Mozi Swamp North and at some man-made wells. During the wet season elephant raid crops such as maize, peanuts and pumpkins.

Known crop-raiding by lone bulls and bachelor groups of up to eight individuals occur exclusively at night. The areas suffered most under these attacks, are discussed later.

The conflict between the local people and the elephants can be expected to intensify as human use of land increases. Unfortunately, elephants are not compatible with agriculture and will therefore have to be restricted to smaller fenced areas such as the proposed Tembe Elephant Reserve. The future of the survival of these elephants lies in the erection of an elephant-proof barrier along the borders of the proposed elephant reserve, which will ensure the future protection of the local people living on the periphery of the proposed reserve, for once and all. The mutual use of the natural resources such as water and reeds from Mozi Swamp North within the proposed Tembe Elephant Reserve, by the elephants and the local inhabitants, are discussed in the next chapter.

FOOD UTILIZATION

Elephants have a wide range of food preferences, depending on the environment they are in (Field 1971). In their preferred natural habitat the elephants are primarily browsers of arboreal plants and shrubs (Field 1971). In some areas the elephants have, however, in recent times been forced to become primarily grazers. Buss (1961) found that in Kabalega National Park of Uganda, 88 percent of the elephants' diet consisted of grass in the dry season. According

to Laws (1970) increasing amounts of grass in elephants' diets can be correlated with conversion of woody habitats into grasslands.

The optimal daily food requirement of an adult elephant is about 6 percent of it's live weight (Laws 1970). Thus, a male elephant of 4 000 kg would require 240 kg of food per day, and an adult female of 2 800 kg, 168 kg food per day.

From feeding observations in Tsavo National Park, Kenya, it is apparent that elephants alter their feeding habits in relation to season (Leuthold and Sale 1973). In the wet season, there is a change from browsing to grazing. This is probably related to the protein content of the food available. Field (1971) noticed that grazing by elephants decreased in importance when the grass became dry and coarse and that browsing increased in importance as the dry season progressed. Fruits are also important and elephants are frequently observed moving from one Balanites tree to another to pick up fallen fruits (Field 1971).

It has been proved by Bourliere (1965) that the elephant has a marked predilection for the bark of certain tree species. Tree pushing as previously believed, was not related to bull dominance behaviour but rather to nutrition (Croze 1974) and appears to be seasonal (Croze 1974 and Guy 1976). Bax and Sheldrick (1963) analysed the bark utilized by the elephants and were suprised to find that most of the bark commonly sought after were poor in protein but rich in calcium (3,04 - 5,68 percent calcium).

According to Field (1971), the main reason for the bark stripping is the search for an indispensible trace element, which other ungulates obtain by eating soil.

TONGALAND RESULTS

A complete list of plant species utilized by the Tongaland elephants is unavailable. However, a preliminary list of woody plants utilized by the elephants during the dry and wet season has been compiled (Table 31).

Table 31 (a) : A list of plant species and plant parts utilized by the elephants during the dry and wet season, Tongaland, northern Natal, from July 1979 to May 1981.

SPECIES	LEAVES		FRUIT		BARK		ROOTS	
Acacia burkei	+	*	-	-	-	-	+	-
A. karroo	-	*	-	-	-	-	+	-
A. kraussiana	-	*	-	-	-	-	-	-
A. nilotica	+	-	+	-	-	-	-	-
A. robusta	+	*	-	-	-	-	-	-
Afzelia quanzensis	+	*	-	-	+	*	-	-
Albizia forbesii	+	*	-	-	-	-	-	-
A. petersiana	+	*	-	-	-	-	-	-
A. versicolor	+	*	+	-	+	-	-	-
Aloe parvibracteata	+	-	-	-	-	-	-	-
Annona senegalensis	-	*	-	*	-	-	-	-
Antidesma venosum	-	*	-	-	-	-	-	-
Apodytes dimidiata	+	*	-	-	-	-	-	-
Balanites maughamii	-	*	-	*	-	-	-	-
Bauhinia galpinii	+	*	-	-	-	-	-	-
B. tomentosa	+	*	-	-	-	-	-	-
Brachylaena transvaalensis	-	*	-	-	-	-	-	-
Bridelia cathartica	-	*	-	-	-	-	-	-
Canthium obovatum	+	*	-	-	-	-	-	-
Capparis tomentosa	+	-	-	-	-	-	-	-
Clerodendron glabrum	+	*	-	-	-	-	-	-
Cola greenwayi	+	-	-	-	-	-	-	-
Combretum collinum	+	*	-	-	-	-	-	-
C. molle	+	*	-	-	-	-	-	-
C. zeyheri	+	*	-	-	-	-	-	-
Commiphora neglecta	+	*	-	-	-	-	+	-

* : Wet-season months

+ : Dry-season months

Table 31 (b) : A list of plant species and plant parts utilized by the elephants during the dry and the wet season, Tongaland, northern Natal, from July 1979 to May 1981.

SPECIES	LEAVES		FRUIT		BARK		ROOTS	
Crotalaria capensis	+	*	-	-	-	-	-	-
Croton pseudopulchellus	+	*	-	-	-	-	-	-
Dalbergia armata	-	*	-	-	-	-	-	-
D. melanoxylon	-	*	-	-	-	-	-	-
Deinbollia oblongifolia	-	*	-	-	-	-	-	-
Dialium schlechteri	+	*	-	-	-	-	-	-
Dichrostachys cinerea	+	*	+	-	-	-	-	-
Dovyalis longispina	+	*	-	-	-	-	-	-
Ehretia rigida	-	*	-	-	-	-	-	-
Ekebergia capensis	+	*	-	-	-	-	-	-
Eugenia capensis	+	*	+	-	-	-	+	*
Ficus stuhlmanni	+	*	-	-	-	-	-	-
Garcinia livingstonii	+	*	-	*	-	-	-	-
Grewia caffra	+	*	-	-	+	-	+	-
Halleria lucida	-	*	-	-	-	-	-	-
Hymenocardia ulmoides	+	*	-	-	-	-	-	-
Indigofera natalensis	-	*	-	-	-	-	-	-
Landolphia kirkii	-	*	-	*	-	-	-	-
Manilkara discolor	-	*	-	-	-	-	-	-
Maytenus senegalensis	-	*	-	-	-	-	-	-
Mimusops caffra	+	-	+	-	-	-	-	-
Newtonia hildebrantii	-	*	-	-	-	-	-	-
Ozoroa obovata	+	*	-	-	-	-	+	-
Panicum maximum	+	*	-	-	-	-	-	-
Phoenix reclinata	+	-	+	-	-	-	-	-
Phragmites australis	+	-	-	-	-	-	-	-
Phyllanthus reticulatus	-	*	-	-	-	-	-	-
Portulacaria afra	+	-	-	-	-	-	-	-
Raphia spp.	-	-	-	-	-	-	+	-

* : Wet-season months + : Dry-season months

Table 31 (c) : A list of plant species and plant parts utilized by the elephants during the dry and wet season, Tongaland, northern Natal, from July 1979 to May 1981.

SPECIES	LEAVES		FRUIT		BARK		ROOTS	
Rhoicissus digitata	-	*	-	-	-	-	-	-
Rhus guenzii	-	*	-	-	-	-	-	-
Sansevera spp.	+	-	-	-	-	-	-	-
Sarcostemma spp.	+	-	-	-	-	-	-	-
Senecio spp.	+	*	-	-	-	-	-	-
Schotia brachypetala	+	*	-	-	-	-	-	-
S. capitata	+	*	-	-	-	-	-	-
Sclerocarya birrea	+	*	-	*	-	-	-	-
Sterculia rogersii	-	*	-	-	-	-	-	-
Strychnos madagascariensis	+	*	+	*	-	-	+	-
S. spinosa	+	*	+	*	-	-	-	-
Syzygium cordatum	-	*	-	*	-	-	-	-
Tabernaemontana elegans	-	*	-	-	-	-	-	-
Tecomaria capensis	+	*	-	-	-	-	-	-
Tephrosia sericea	-	*	-	-	-	-	-	-
Typha littoralis	+	*	-	-	-	-	-	-
Vangueria cyanescens	-	*	-	*	-	-	-	-
Vepris undulata	+	*	-	-	-	-	-	-
Vitex harveyana	-	*	-	-	-	-	-	-
Ximenia caffra	-	*	-	*	-	-	-	-

* : Wet-season months

+ : Dry-season months

From the ad hoc observations done on the plant species utilized by the elephants, it can be concluded that the Tongaland elephants were forest-dwelling browsers. It was further found that during the dry season the elephants dug up the roots of Commiphora neglecta, Strychnos madagascariensis, Acacia karroo, Maytenus senegalensis and Grewia caffra. Trees that were ringbarked included: Albizia adianthifolia and Afzelia quanzensis.

At present it is difficult to determine seasonal variation and the degree of species preference in the diet of elephants in northern Tongaland, because the short-term qualitative data tend to give biased results. To obtain a more meaningfull picture on food utilization by the elephants a concerted effort should be made to collect samples over a longer period and at regular intervals.

During the study it was nevertheless observed that food utilization by the elephants decreased with increasing distance from water supply. The dry season ranges of the elephants which are linked with the only available permanent water supplies viz. Mozi Swamp North, are the most vulnerable and therefore impose definite limits on the potential carrying capacity of the area proposed for the Tembe Elephant Reserve. A recommended conservative elephant density of 0,35 elephants/km^2 will prevent habitat degradation by elephants taking place.

According to Caughley (1976) the ecological carrying capacity of an animal population is the maximum density of animals that can be sustained indefinitely without inducing retrogressive changes in the vegetation.

HABITAT REQUIREMENTS

Numerous studies on elephant-habitat relationships have been conducted in various parts of Africa (e.g. Glover 1963, Laws 1970, Caughley 1976, Laws et al. 1970 and Hanks 1979). All these studies confirm three important points, viz. that the elephant habitat available in Africa has decreased markedly; that elephants are incompatible

with human activities and are therefore restricted to certain sanctuaries, and that these sanctuaries soon become devastated by a rapid increase in the elephant populations as a result of their longevity, low mortality rate and diverse feeding strategy. Furthermore, the elephant-habitat relationships in each sanctuary differ markedly from one another and comparisons are often difficult to make. The result is that management implications of one area are mostly inapplicable elsewhere.

After man, probably no other animal has had as great an effect on African habitats as the African elephant, which itself was indirectly influenced by man. This is largely due to the confinement of elephants in reserves. It has become apparent during the past two decades that this confinement of elephants in parks, poses a major conservation problem in Africa (Hanks 1979).

Caughley (1976) said that there is no attainable natural equilibrium between elephants and forests in eastern and southern Africa. The relationship is viewed instead as a stable limit cycle in which elephants increase while thinning the forest and decline until reaching a low density which allows resurgence of the forest. This in turn triggers off an increase of elephants and the cycle repeats itself. The period of the cycle, if the hypothesis of Caughley (1976) is correct, is in the order of 200 years. This was possible in the past when elephant could roam about freely. Deprived of their seasonal wanderings, the elephants have to make use of a limited area which leads to habitat destruction if elephant numbers are not artificially controlled i.e. by cropping.

According to Hanks (1979) elephant populations used to be regulated by a combination of three factors viz:

- Birth rate variation.
- Death rate.
- Migration.

Game reserves and parks today are surrounded by human settlements and agricultural fields, thus emigration by elephants from their sanctuaries can no longer be seen as a population regulation mechanism

today, because of the occupation by people of their former home ranges. In fact, at a time when surplus elephants should be emigrating, a so-called invasion of elephants into the protected elephant sanctuaries is experienced (Lamprey, Glover, Turner and Bell 1967). This so-called invasion of elephants is also experienced in Tongaland. The result is that with an increasing invasion of elephants and a possible annual growth rate of 4 % (Hanks 1979), the carrying capacity will eventually be exceeded and damage to the habitat could follow.

In Tongaland it was observed that seasonal movements of the elephants consisted of a temporary expansion of their home range which was related to additional sources of food and water following rainfall.

During the study period the basic seasonal movement and distribution of the elephants in Tongaland and southern Mozambique, is a concentration of numbers along Mozi Swamp North, the Futi-drainage system and the Maputo floodplain (Figure 23) during the dry season and a dispersal or spreading out onto the drier areas during the wet season (Figure 24). The duration and periodicity of the wet and dry season habitat-use are related to rainfall intensity and periodicity, the severity of droughts, the survival of rainfall-fed pans in the interior and the availability of fruit of certain tree species.

Should elephant movements across the Mozambique-Natal border ever be terminated by the erection of an elephant-proof barrier, present elephant home ranges will shrink, resulting in an increased concentration of elephants along Mozi Swamp North during the dry season.

Two suggestions are made to prevent the habitat in northern Tongaland being destroyed by elephants as was the case in Tsavo National Park (Laws 1970) and Serengeti National Park (Lamprey et al. 1967), where large trees were being destroyed at a rate of 6 percent per year, changing the landscape from woodland to grassland:

- To enlarge available elephant range in northern Tongaland (a short-term solution only).
- To eventually have to crop excess elephants.

The inclusion of a portion of the Pongola Floodplain i.e. by linking Ndumu Game Reserve with the proposed elephant reserve, will be a major key to the viability and productivity of the area. This will ensure a greater range to be utilized by the elephants. Boundary proposals for the proposed elephant reserve, which aim to include optimum elephant habitat, are discussed in the next chapter.

Before discussing cropping quotas a recommended carrying capacity for the proposed elephant reserve has to be determined. It is clear that the degree of habitat degradation is related to the density of elephants (Van Wyk and Fairall 1969). Van Wyk and Fairall (1969), determined that a density of 0,24 elephants/km^2 could be regarded as a safe stocking rate in the Kruger National Park, South Africa, as no undue damage was caused to the vegetation. At 0,84 elephants/km^2 severe habitat damage was found in Kabalega National Park, Uganda (Buss and Savidge 1966). Glover (1963) recommended a safe stocking rate of 0,4 elephants/km^2 for Tsavo National Park, Kenya, whereas Laws et al (1975) recommended that elephants should not be allowed to exceed 0,8 elephants/km^2 in general.

A stocking rate of 0,35 elephants/km^2 is recommended for the proposed elephant reserve. It is suggested not to exceed this recommended low elephant density so that habitat degradation within the proposed elephant reserve by elephants can be prevented.

FUTURE RESEARCH

The proposed Tembe Elephant Reserve, is one of many islands which is surrounded by ever-increasing human settlements forever asking for more space. This "island", is not a self-maintaining ecosystem, and thus has to be managed with utmost care, depending on the goals of the reserve. The more artificial the situation, the higher will be the required degree of management.

To be able to manage an area effectively, the abiotic and biotic components have to be continuously monitored. With specific reference to the elephants the following aspects should receive further attention:

- Continue to monitor daily north-south elephant movements across the Mozambique-Natal border.
- Monitor local elephant movements on a monthly basis and to investigate what major factors determine this local movement.
- Quantitatively assess the past and recent utilization or damage to the vegetation by elephants within each plant community.
- Determine the degree and rate of utilization of the vegetation presently occurring in different seasons.
- Undertake monthly observations at selected pans so as to build up a catalogue of elephants positively identified in the area.
- Monitor the dynamics of the elephant populations throughout the year.
- Attempt to collect, where possible, information on elephant numbers, their present distribution and movements north of the Mozambique-Natal border, and south of the Maputo River.

CONCLUSION

There lacks a considerable volume of data on the total number of elephants resident or semi-resident in northern Tongaland, between the Pongola River and Mozi Swamp North. These include data on herd composition, age structure, herd sizes, calving intervals, elephant impact on the vegetation, habitat requirements and factors regulating elephant movements and distribution in Tongaland as well as in southern Mozambique. To understand the seasonal patterns in elephant movement on either side of the Mozambique-Natal border, access to southern Mozambique and a longer period of research are essential.

Seasonal rhythms in elephant movements across the Mozambique-Natal border and within the study area, were observed. This consisted of a temporary expansion of the elephants' home range during the wet season which can be related to additional sources of food and water following rainfall. It has been confirmed that breeding herds do occur within the proposed reserve boundaries, thus ensuring the survival of the Tongaland elephants.

In Tongaland, increased elephant activity and an escalation in numbers were observed. The increase in elephant numbers has been caused by the resettlement of humans within the Maputo Elephant Reserve in southern Mozambique, which has forced the elephants there to leave the reserve and to move southwards to include the Maputo floodplain, the Futi-drainage and northern Tongaland in their new home range.

Observations at Fomothini Pan indicated that the elephants remained close to Mozi Swamp North during the dry season when surface water further inland had dried up. During the wet season the number of elephants utilizing Fomothini Pan decreased considerably. Peak drinking times during the wet and dry season took place during sunset and time spent by elephants at the water differed significantly amongst each other under the following categories viz. lone bulls, bachelor groups and family units.

The ultimate survival of the Tongaland elephants lies in the erection of an elephant-proof barrier along the borders of the proposed reserve which will guarantee the protection of the local people living on the periphery of the proposed elephant reserve.

The consolidation of Ndumu Game Reserve (8 000 ha) and the proposed elephant reserve (37 500 ha) into one management unit, is the key to the area's viability and productivity especially for elephant use. The link of the proposed elephant reserve with Ndumu Game Reserve, will also incorporate a section of the Pongola Floodplain, thus ensuring and safeguarding a possible east-west movement between the two drainage lines, should the sealing off of the Mozambique-Natal border ever stop the present north-south elephant movement across this international border.

C H A P T E R 7

BOUNDARY AND MANAGEMENT RECOMMENDATIONS FOR THE PROPOSED TEMBE ELEPHANT RESERVE

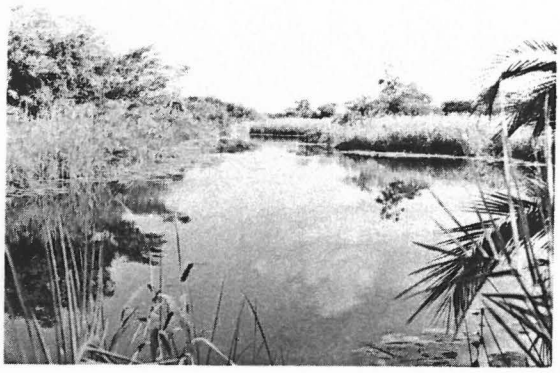
INTRODUCTION

Tongaland's fauna, flora, and scenery are some of the areas's greatest natural attributes. To preserve this, the conservation management plan given here and first suggested in 1981 and 1982, was designed to ensure the survival of its fauna and flora, and to lead to the sustained utilization of Tongaland's natural resources.

The proposed conservation area, with its different utilization areas, should, with sound management, be in the direct interest of the people of Tongaland. Schumacher (1973) summarised this issue as follows: "Why care for people? Because they are the primary and ultimate source of wealth. If the local inhabitants are ignored or pushed around by self-styled experts and high-handed planners, then all is to no avail." As a result of the current study, it was hoped to find a solution whereby elephants and the local population could co-exist in harmony. The ultimate aim was to proclaim a conservation area in northern Tongaland which will include Mozi Swamp North (Figure 28), the northern part of the Pongola River and the Sand Forests (Figure 29) on Beacon and Nhlela Ridges in the central area. This should ensure the survival of the Tongaland elephants (Figure 30), and the protection of Mozi Swamp North and the Sand Forests.

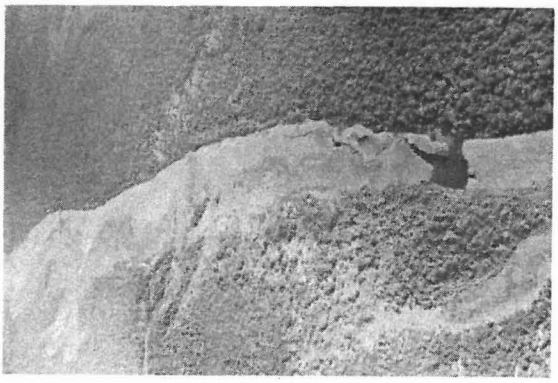
If nature conservation were seen as an integral part of the development plan for Tongaland, nature reserves have to be established. In the case of the proposed Tembe Elephant Reserve this would mean the inclusion of Mozi Swamp North and a section of the northern Pongola River which at present is fenced into the Ndumu Game Reserve.

To be viable, the proposed nature conservation area thus has to be an ecological unit with suitable habitat, for wildlife to live in harmony with their environment.



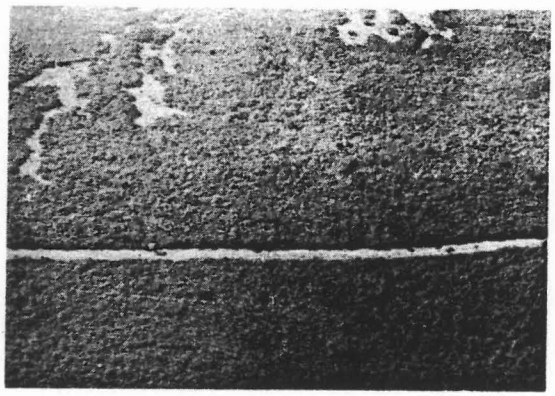
Mozi Channel, 3 km south-east of
Muzi Border Post

Phragmites australis reed beds of
Mozi Swamp North

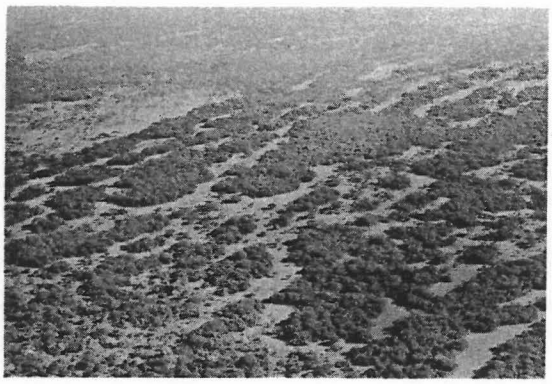


Mozi Swamp North, with Fomothini Pan
on the right hand side

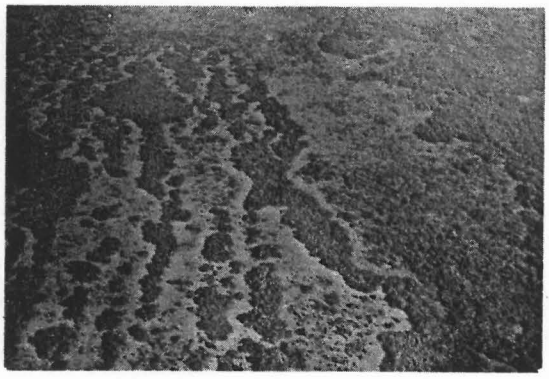
Figure 28 : Mozi Swamp North, Tongaland, northern Natal.



Salane Sand Forest, along the Mozambique-Natal border

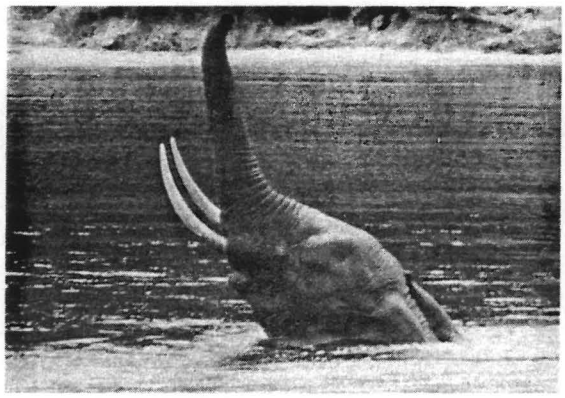


Sand Forests sloping east-west along Beacon Ridge



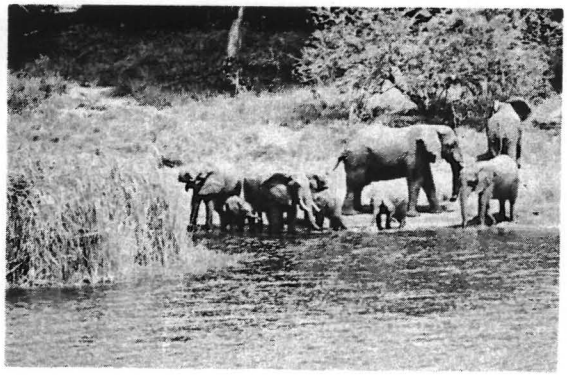
Sand Forests sloping east-west along Nhlela Ridge

Figure 29 : Sand Forests in the proposed Tembe Elephant Reserve, Tongaland, northern Natal.



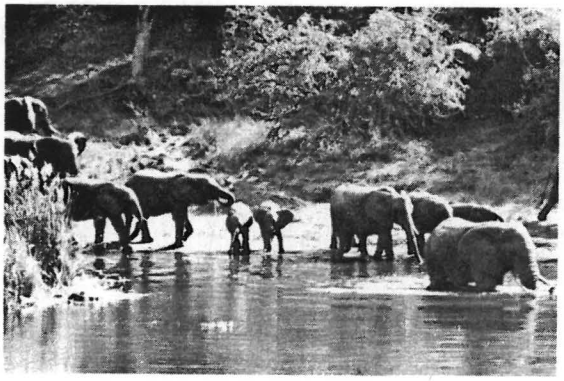
Lone bull elephant

Bachelor group

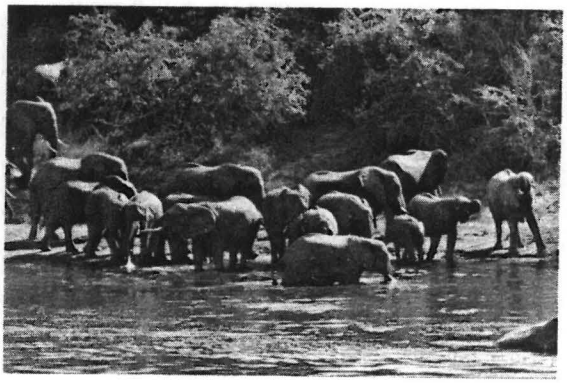


Family unit

Calves, a cow and a bull



Mixed herd of cows,
calves and bulls



Mixed herd of cows,
calves and bulls

Figure 30 : Some of the elephants observed at Fomothini Pan, along Mozi Swamp North, Tongaland, northern Natal, from July 1979 to May 1981.

Whilst deciding on the boundaries for the proposed Tembe Elephant Reserve, two important aspects had to be taken into consideration, viz:

- The nature and position of the veterinary (red) line.
- The distribution of the local human inhabitants.

The red line has had a marked influence on the planning of the southern boundary of the proposed reserve. The eastern boundary demarcation was determined by the dense human population resident on the eastern bank of Mozi Swamp North. The northern boundary demarcation on the other hand is governed by the Mozambique-Natal border and part of the western boundary by the Pongola River.

For nature conservation to be accepted by the local population of Tongaland, it must be justified economically. The proposed nature conservation area has no significant mineral resources or agricultural potential. Tourism and game cropping done on a scientific basis can thus be two possible sources of future income.

The sound utilization of a natural resource can only occur on a long-term basis. Primary utilization, i.e. direct utilization of the natural resources in a specific area as here in Tongaland, includes the utilization of the indigenous game as a source of protein in such a way that in the long-term the natural productivity of the area will not be harmed.

Secondary utilization of the wildlife as a natural resource occurs indirectly via tourism. Tongaland as a whole offers a unique opportunity to the people of southern Africa and the rest of the world to view one of Southern Africa's prime wilderness areas. Therefore, there is a definite advantage for the area's local inhabitants in this form of land-use. The conditions under which tourists be allowed to enter this area still have to be spelled out.

Cunningham (1985) supports the above view and emphasizes the point that the demands of local people have to be considered when proclaiming conservation areas. The demands of the local people on the natural

resources in northern Tongaland, adjacent to the proposed Tembe Elephant Reserve, were dealt with by Cunningham (1985) in detail. The main aims of his study were:

- To record plant species used for hut-building, palm-wine tapping, craftwork, fencing, food and drink, firewood and fish-kraals.

- To evaluate the nutritional, economic and utilitarian value of these species.

- To put forward management proposals to allow a compromise between conservation and the aspirations of the local people through controlled use of certain plant resources within the area.

From the above study it became evident that the local people living adjacent to or on the periphery of the proposed Tembe Elephant Reserve, were not deprived of essential natural resources, except those few people living close to the east banks of Mozi Swamp North, who were dependent on the swamp reed beds necessary for hut construction. Recommendations by Klingelhoeffer (1982) to allow the local people living on the east bank of Mozi Swamp North, to enter the proposed Tembe Elephant Reserve to cut reeds, was supported by Cunningham (1985). In view of the sparse human population along the east bank of Mozi Swamp North, viz. Nungwe and Majibomvu areas (Figure 9), support was given, because of the low subsistance demand on the reed beds. Furthermore the southern sector of Mozi Swamp North, where vast reed beds occur (viz. Cabasini and Ebhukubhuk-wini areas) have been excluded from the proposed Tembe Elephant Reserve.

The recommended boundaries and the suggested management and development plans for the proposed Tembe Elephant Reserve have already been submitted as interim reports to the then Department of Co-operation and Development (today called the Department of Constitutional Planning) and the Department of Agriculture and Forestry of KwaZulu during 1981 and 1982, for consideration and implementation. At the end of this chapter a summary is given of the current situation of the Tembe Elephant Reserve, which was officially proclaimed on the

21st of October, 1983, in the KwaZulu Government Gazette by the Honourable Chief Minister, Dr. M.G. Buthelezi.

ECOLOGICAL CONCLUSIONS

There are few accounts of the past history of the Tongaland elephants. The earliest known report on the elephants in Tongaland was made in the early 1940's. Elephants then seemed to have occurred throughout Tongaland, and even as far south and inland as the White Umfolozi River, herds of up to 40 individuals occurred. The most recent documented report on the Tongaland elephants was that by Hall-Martin (1976) who estimated the number of elephants at a maximum of 30 bulls confined between Nhela Ridge and Mozi Swamp North.

There is a striking variation in rainfall across Tongaland from east to west. At the coast in the east of the region, the average rainfall is close to 1 000 mm (Kozi Bay) but declines progressively inland, i.e. westwards, to 641,7 mm per annum in the west at the foot of the Lebombo Mountain Range (Ndumu). On the crest of the Lebombo Mountain Range the annual rainfall is 836,6 mm (Ingwavuma).

The greater part of the area in Tongaland which is recommended for the elephant reserve, lies in an agriculturally marginal zone unsuitable for cultivation or domestic stock due to poor soil and unpredictable rainfall.

Large-scale shifting cultivation was evident during closer investigation of the areas which are to be set aside for the elephants. This has left many areas bare of vegetation. If this disturbance of a delicate ecological balance proceeds, it can force the woodlands and Sand Forests back to a pioneer stage. This may lead to the permanent disappearance of the elephants and eventually to the extermination of numerous plant and animal species found there at present.

The description of each plant community is superficial and is based largely on qualitative data. The classification on the vegetation of the proposed reserve on the basis of Edwards' (1983)

physiognomic classification provided an adequate summation of the floristic data collected. The plant communities can easily be recognised in the field with this classification system, even by untrained conservation staff with only a slight knowledge of the dominant plant species of the area. However, an effort should be made to collect more detailed quantitative data for each vegetation type described, which could then serve as a record of the status of the different plant species in the different plant communities. These data should be used to monitor vegetation changes along permanent transects.

Northern Tongaland with its rich flora and different habitats is able to support a wide variety of mammal fauna including elephants. The phenological survey revealed that a constant supply of food in the form of leaves, flowers and fruits is available in the proposed elephant reserve area to mammals, birds and insects throughout the year.

Mozi Swamp North can be divided on the basis of percentage salinity levels, into two definite sectors, viz. the northern sector (Mean = 1,6; SD = 0,28) and the southern sector (Mean = 3,4 %; SD = 1,46). More quantitative data on salinity gradients of seasonal pans of Mozi Swamp North, taken over a longer period, are needed before final conclusions can be reached as to what extent limiting factors determine pan utilization by elephants, man and their domestic cattle.

No evidence of DDT and DDE at < 0,0001 ppm were detected in the water of pans sampled. Further research in this field, however, should receive priority, since the amount of DDT sprayed per annum to combat malaria is escalating.

There is a considerable lack of data on the number of elephants in the area which escalate between 50 to 150 elephants at times; their herd composition; age structure; herd sizes; calving interval; elephant impact on the vegetation and factors which determine their movements and distribution. Nevertheless, a better understanding of the elephant's seasonal habitat-use patterns viz. movement

and distribution, pan utilization and habitat requirements were achieved. Seasonal movement rhythms are governed by either availability of surface water, food and/or human settlements. The presence of cows and calves, ensuring the survival of the Tongaland elephants, was positively identified.

The sparsely human populated area between the Nhela and Beacon Ridges has become one of the last refuges of certain animal species in northern Tongaland. Twenty-five mammal species were recorded within the proposed reserve, and the area east of the Pongola River. The list, however, is far from complete and especially lacks data on the smaller mammals of the orders Chiroptera, Insectivora and Rodentia.

SUGGESTED BOUNDARIES

REVIEW OF MEETINGS AND EVENTS THAT TOOK PLACE PRIOR TO AND DURING THE RESEARCH PERIOD

Before the arrival of the author in Tongaland, various meetings concerning boundaries for an elephant reserve were arranged between different instances and Chief Msimba Tembe and his Counsellors, under whose control the proposed elephant reserve area falls.

On 13th July 1979, a meeting was held at Chief Msimba Tembe's Kraal by the Chief Regional Conservation Officer of KwaZulu. Present were: Chief Msimba Tembe, his Counsellors, the author and three indunas. At this meeting it was agreed that the eastern boundary was to extend as a straight line from Muzi Border Post to the cattle Sale Pen (Figure 31) in the south, and 4 km east of Mozi Swamp North.

At previous meetings held during 1978, the proposed western, southern and northern boundaries (Figure 31) had already been agreed upon (Freeman, pers. comm.). These included:

Freeman, D.W. (1979) : Department of Economic Affairs, KwaZulu, Box 75, FELIXTON, 3875.

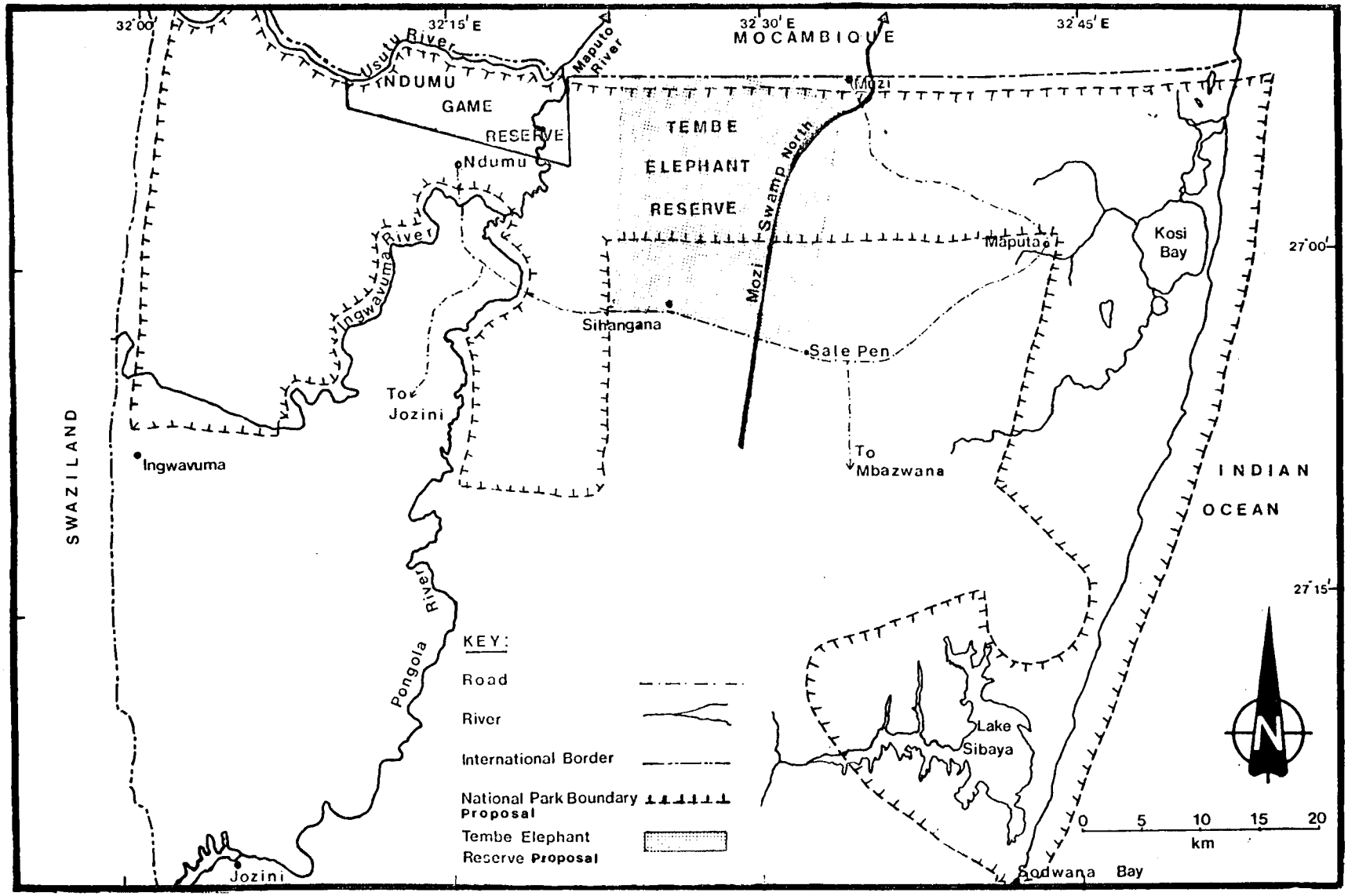


Figure 31 : National Park boundaries suggested by Thorrington-Smith, Rosenberg and McCrystal (1978) and the area proposed by Chief Msimba Tembe for the elephants, Tongaland, northern Natal.

- The southern boundary : the Kwa Ngwanase-Sihangwana road.
- The western boundary : from the main road 3,5 km west of Sihangwana to the Mozambique-Natal border, 5,6 km east of the Pongola River.
- The northern boundary : the Mozambique-Natal border.

However, during all the meetings held with Chief Msimba Tembe during 1978/79, no agreement was ever signed.

In March 1980, Van Riet was approached by the then South African Department of Co-operation and Development to draw up a zonal ecology and rural land use plan for the whole of Tongaland, for the Department of Agriculture and Forestry, KwaZulu.

A meeting, arranged by the Nature Conservation Division of the then Department of Agriculture and Forestry, KwaZulu, was attended by the author on the 21st July 1980, at the Tribal Authority Office. On this day, Tinley, consultant to Van Riet, explained to Chief Msimba Tembe what the future of Tongaland could offer in terms of benefits to the local population if the northern part of Tongaland was seen as a natural resource area, managed by a responsible body.

Chief Msimba Tembe had by then made it clear on various occasions that he was willing to hand over the Mozi-Sihangwana area to the Nature Conservation Division of KwaZulu, exclusively for the elephants. It was up to the then Department of Agriculture and Forestry, KwaZulu, to come forward with a viable plan concerning the final decision on boundaries for an elephant reserve.

DISTRIBUTION OF THE LOCAL INHABITANTS

The distribution of the local inhabitants in the study area (Figure 32) and their dependence on the area, were seen as an essential prerequisite to be satisfied before the final recommendations on boundaries for an elephant sanctuary could be accepted.

Van Riet, W.F. (1980) : Department of Architecture, University of Pretoria, PRETORIA, 0002.

Tinley, K.L. (1980) : Department of Conservation and Environment, 1 Mount Street, PERTH, WEST-AUSTRALIA, 6000.

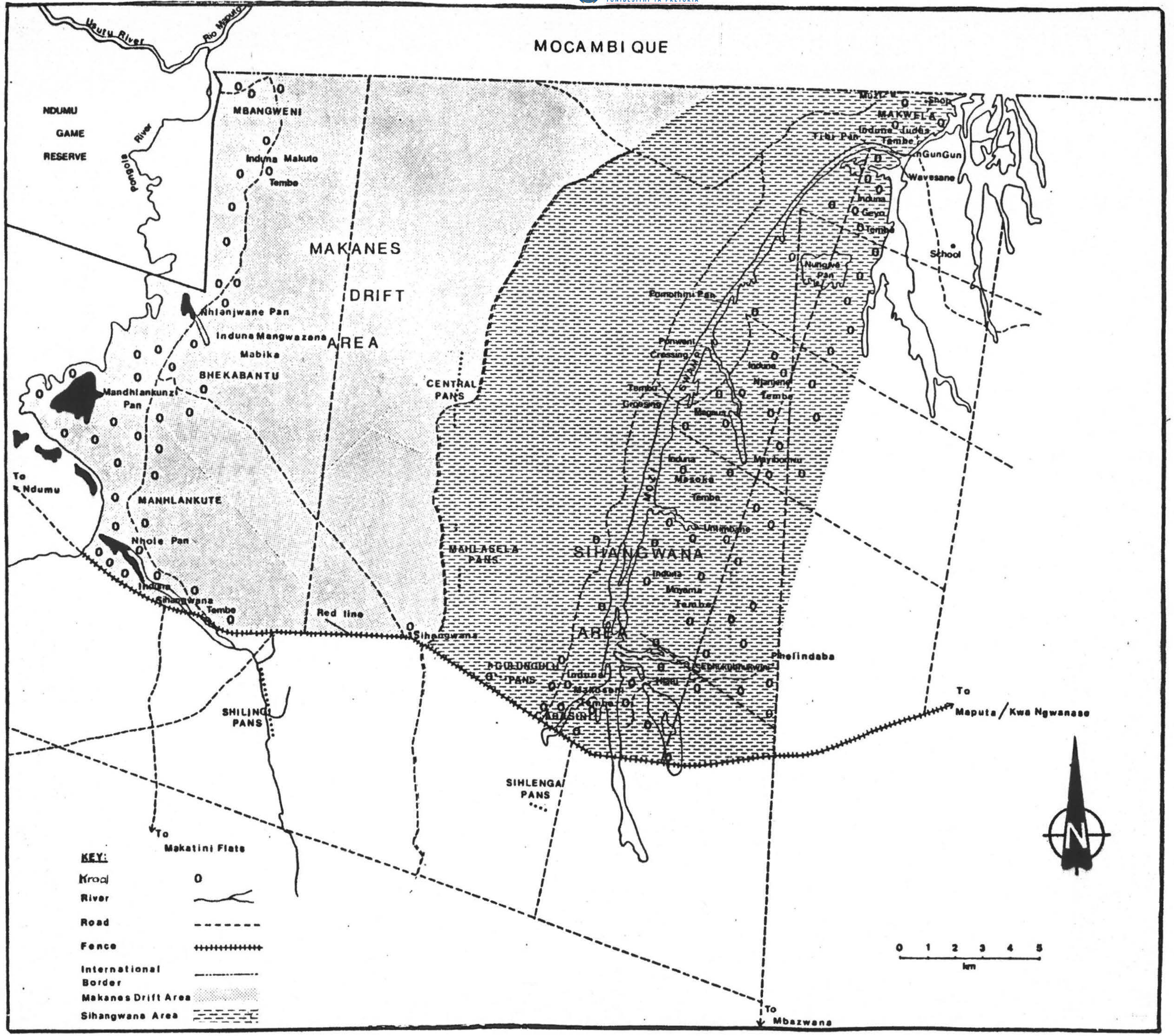


Figure 32 : The distribution of the local human population during February 1981 in the Makanes Drift and Sihangwana areas, Tongaland ...

The study area north of the red line comprised two major areas, namely the Makanes Drift area and the Sihangwana area (Figure 32). The number of people living in these areas and the number of kraals, huts, cattle and goats present in the study area in February 1981, are listed in Table 32.

The main concentration of people (Figure 32) was found along the east bank of the Pongola River, near Cabasini and along the south and north-eastern banks of Mozi Swamp North. The absence of people in the central area between Mozi Swamp North and Nhela Ridge (Figure 32) is due to the lack of permanent water in that area.

ELEPHANT MOVEMENTS AND DISTRIBUTION

Another important factor that played a role in the demarcation of boundaries for the proposed elephant sanctuary, was the movement and distribution of elephants during the wet and dry seasons from May 1979 to June 1981 (Figure 23).

BOUNDARIES FOR A NATIONAL PARK IN TONGALAND PROPOSED BY THORRINGTON-SMITH ET AL. (1978)

The boundaries as proposed by Thorrington-Smith et al. (1978) for a National Park in Tongaland appear in Figure 31. The aims of this National Park were two-fold:

- To preserve one of southern Africa's prime unspoilt areas.
- To be of benefit to the local inhabitants of Tongaland.

The proposed National Park was to include the northern and south-eastern sections of Tongaland, an area of approximately 2 500 km².

AREA SET ASIDE BY CHIEF MSIMBA TEMBE FOR THE ELEPHANTS

The area designated for elephant conservation as agreed to by Chief Msimba Tembe and his Counsellors during July 1979 (Figure 31), is approximately 375 km² in size and includes Mozi Swamp North, areas of

Table 32 : The presence of the number of people, kraals, huts, cattle and goats in the Makanes Drift and Sihangwana areas, Tongaland, northern Natal, as in February 1981 (Seme, pers. comm.).

CATEGORY	MAKANES DRIFT	SIHANGWANA
People	3 476	1 983
Kraals	612	419
Huts	1 606	980
Cattle	2 241	4 867
Goats	204	688

Seme, M. (1981) : Department of Health and Welfare, P.O. Box 43, JOZINI, 3973.

Woodland, Sand Forests and Palmveld in the immediate vicinity of the swamp. An area such as this would be difficult to proclaim, because it would mean having to displace 3 Indunas and all their people and possessions to other vacant areas - a task almost impossible to put into practice in modern times.

BOUNDARIES SUGGESTED FOR AN ELEPHANT RESERVE BY TINLEY AND VAN RIET (1981).

The boundaries (Figure 33) as suggested by Tinley and Van Riet (1981) are as follows:

- The eastern boundary : extending from opposite the quarry south of Mozi Swamp North, northwards, parallel to the east bank of the Swamp to Muzi Border Post, crossing the swamp at nGungun.
- The southern boundary : a straight line drawn from the quarry westwards to join the Pongola River 1,5 km below Mandhlankunzi Pan.
- The western boundary : the Pongola River.
- The northern boundary : the Mozambique-Natal border.

The area at Mandhlankunzi and Nhlanjwane Pans is densely populated and extensive agriculture is practised by the local inhabitants in this area. The incorporation of this area to the proposed Tembe Elephant Reserve would cause widespread discontent amongst the local people living in Bhekabantu (Figure 33) a situation which should be avoided near an international border.

There was no marked difference between the northern and eastern boundary as proposed here by the author.

THE BOUNDARIES CURRENTLY BEING SUGGESTED FOR THE PROPOSED TEMBE ELEPHANT RESERVE

The boundaries (Figure 33) as suggested here are as follows:

- The eastern boundary : extending from opposite the quarry in the south of Mozi Swamp North, northwards parallel to the east bank of the swamp to Tembu Crossing. From here up to Majibomvu and from there

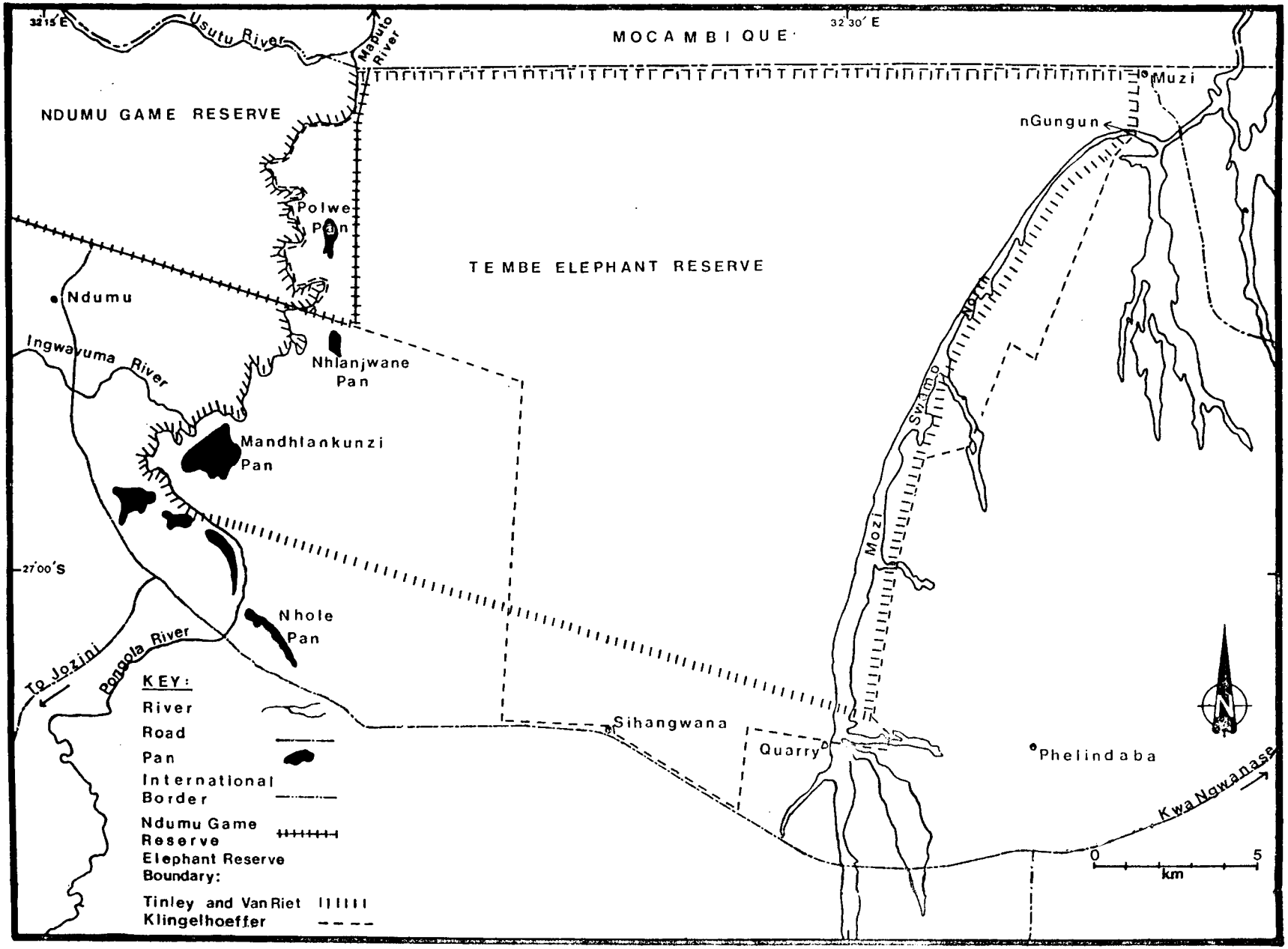


Figure 33 : Suggested elephant reserve boundary by Tinley and Van Riet (1981) and Klingelhoeffer (1981), Tongaland, northern Natal.

in an almost straight line to Muzi Border Post, crossing Mozi Swamp North at nGungun.

- The western boundary : from the Sihangwana-Kwa Ngwanase main road, northwards in a straight line, to a point 9 km from the Mozambique-Natal border, then westwards to join the south-eastern corner boundary fence of Ndumu Game Reserve. Thus the inclusion of Ndumu Game Reserve to the proposed Tembe Elephant Reserve becomes a reality.
- The northern boundary : the Mozambique-Natal border.
- The southern boundary : the Sihangwana-Kwa Ngwanase main road.

The 108 kraals which would fall within these proposed boundaries compared to the 1 131 kraals which fell outside in the Makanes Drift and Sihangwana areas, are listed in Table 33.

The reaction of Chief Msimba Tembe towards these boundary proposals was more positive than to the boundary proposals of Tinley and Van Riet (1981). Chief Msimba Tembe's main concern towards the boundary proposals of Tinley and Van Riet, was the inclusion of Mandhlankunzi and Nhlanjwane Pans, which would mean the displacement of a large human settlement presently living near these two pans.

MANAGEMENT AND DEVELOPMENT PLAN

REVIEW OF MANAGEMENT POLICIES DURING 1979 - 1981

FIELD STAFF

From July 1980 to June 1981 the Nature Conservation Officer for Tongaland was based at Mbazwana and used to visit the elephant area in northern Tongaland between the Pongola River and Mozi Swamp North, Sibaya Lake and Kosi Bay weekly.

Staff in the proposed Tembe Elephant Reserve as in June 1981, consisted of:

Table 33 : Number of kraals that would be involved in the boundaries suggested by Klingelhoeffer (1981) for the elephant reserve in the Makanes Drift and Sihangwana areas, of Tongaland, northern Natal as in February 1981.

AREA	INDUNA	KRAALS	
		Inside	Outside
Makanes Drift	Makuto Tembe	57	
	Mngwazana Mabika	0	
	Sihangwana Tembe	0	
Sub-total	3	57	555
Sihangwana	Judas Tembe	3	
	Geyo Tembe	2	
	Njanjene Tembe	5	
	Masoka Tembe	4	
	Mnjama Tembe	7	
	Makoseni Tembe	30	
Sub-total	6	51	311
Total	9	108	866

- Two nature Conservation Officers, both based at Sihangwana; their responsibilities being to manage the Sihangwana-Muzi area including Sibaya Lake and who also had to do all the administrative work for the entire Tongaland. Both had a diploma in Nature Conservation, obtained at Cwaka College, Natal.

- One Professional Nature Conservation Officer, partly based at Sihangwana, who did research on the utilization of the natural resources of the whole Tongaland by the local inhabitants.

- 20-25 scouts based at Sihangwana and nGungun Camp. During the maize crop season (December to April) scouts were also based at Mtekeni and Cabasini (Figure 34). Duties imposed on these scouts were to clamp down on poachers and to guard the maize fields against crop-raiding elephants during the crop season.

- Labourers, partly based at Sihangwana Camp; the remainder lived at home and walked to work every day. Duties imposed on them were to cut reeds and grass for the building of huts, and to be responsible for the general maintenance of the main conservation camp at Sihangwana.

EXTENSION WORK

The then Nature Conservation Division of the Department of Agriculture and Forestry, KwaZulu, conducted extension work in the form of lectures on conservation, and also arranged field trips to Ndumu Game Reserve. The educational work was done throughout Tongaland amongst the local population.

Extension work was focused mainly on senior high school children and aimed to make the youth aware of conservation. Groups were first taken to Sihangwana Camp, where they were given a lecture by one of the Nature Conservation Officers, before being taken to the Ndumu Game Reserve. The Natal Parks Board officials based at the Ndumu Game Reserve co-operated with the KwaZulu officials on these field trips to the reserve.

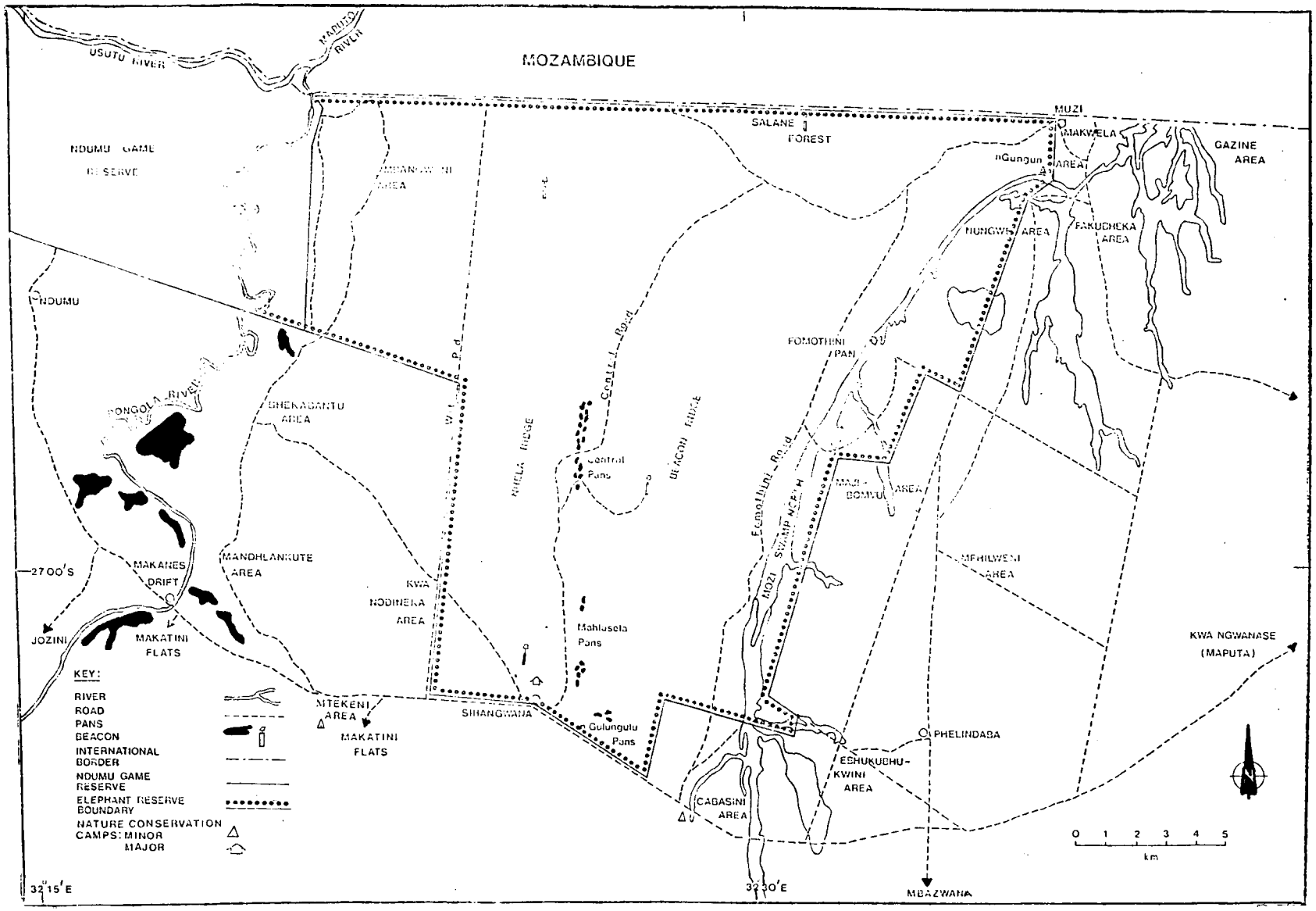


Figure 34 : Existing physiography and infrastructure of the proposed Tembe Elephant Reserve as in June 1981, Tongaland, northern Natal.

Extension work was also done in the rural areas, where the Indunas and their clans were enlightened on the activities of the Nature Conservation Division of KwaZulu, as well as on the overall importance and benefit of conservation to man.

TOURISM

In November 1980, the Endangered Wildlife Trust was given permission by the then Department of Agriculture and Forestry, KwaZulu, to conduct educational wilderness trails in northern Tongaland.

The number of people per trail consisted of nine individuals including the Trails Officer. The duration of each trail was six days, of which two days were spent travelling from Johannesburg to Tongaland and back. The remaining four days were spent on the east bank of Mozi Swamp North, near Fomothini Pan and along the coast at Kosi Bay.

The cost per person amounted to R250 of which R50 was handed to the Tribal Authorities.

Overall the trails proved to be a great success, but had to be terminated in May 1981, due to the distance of travel and the rough terrain, which led to high fuel costs and vehicle maintenance.

CAMPS

There was one major existing Nature Conservation camp at Sihangwana in the proposed Tembe Elephant Reserve (Figure 34). This camp was well equipped with housing for all field staff including a store-room and numerous garages for vehicles.

There were a further three minor scout camps, of which the one at nGungun consisted of four reed huts and was manned throughout the year. The other two scout camps, which had a tin hut each, were at Cabasini and Mtekeni (Figure 34) and were manned only during the crop season.

ROADS

There was no comprehensive road network within the proposed Tembe Elephant Reserve or its peripheral areas (Figure 34) which was an obstacle for the efficient control of the area.

Roads in the area were sand roads, which at certain places were only passable for four-wheel drive vehicles. During 1980, the road referred to as "Wit Pad" (Figure 34) was hardened with a layer of clayey soil which became very slippery during the wet season. Similar conditions prevail on the Makanes Drift-Sihangwana-Kwa Ngwanase road during the wet season, which also had been hardened by a layer of calcrete and red clayey soil.

The sand roads on the other hand, are difficult to travel on during the dry season. They, however, become firm at the onset of the wet season making travelling on these roads easy. The low percentage of clay in these sands prevents the sand roads from becoming slippery during the wet season (Loxton et al. 1969).

ELEPHANT MOVEMENT CONTROL

During the crop season scouts were based at Cabasini and Mtekeni to protect the crops of the local inhabitants against crop-raiding elephants. Scouts based at nGungun had a large area to protect yearly. This included Makwela, Gazine and Fakubheka (Figure 34) areas.

Complaints received from distant areas such as Mbangweni, Bhekabantu. Majibomvu and Mfhilweni (Figure 34) on elephant crop-raiders, were followed up by the scouts based at Sihangwana Camp.

Until 1980, the elephant problem was kept to a certain extent under control during the crop season. However, during 1981, the situation had virtually got out of hand, especially in the Muzi Border Post area and the surrounding Sihangwana area.

WATER

The north-eastern and north-western area of the proposed Tembe Elephant Reserve have adequate water throughout the year, coming from Mozi Swamp North in the east and the Pongola River in the west.

The area between the Pongola River and Mozi Swamp North has seasonally-filled pans of which the Central Pans, Mahlasele Pans and nGunlungulu Pans are the largest (Figure 34).

During the dry season months of 1981, two water troughs were built at the Central Pans in July 1981. Both these troughs were daily filled with water from the Pongola River trucked from Makanes Drift. After two weeks the carting of water to the troughs was terminated because the elephants had damaged the troughs beyond repair.

BURNING PROGRAMME

Areas in excess of 3 000 ha of the proposed Tembe Elephant Reserve, are burnt annually during the dry season. The greatest incidences of fires occured during July and August when the area is at its driest. The source of these fires is invariable local inhabitants robbing beehives and or poaching. Lightning was rarely responsible for the starting of veld fires.

During the study period there was no burning programme for the area and from casual observations during the past two years, no damage to the veld has yet been seen. The Open Woodlands seem to be kept open by the accidental fires, and the encroachment of Dichrostachys cinerea into the grasslands seems to be curbed to a certain degree by these accidental fires.

LOCAL INHABITANTS

During the study period there was no restriction on the movement of people through the proposed Tembe Elephant Reserve. The local

inhabitants had free access to the area to collect building material such as reeds at Mozi Swamp North.

The local inhabitants living within the boundaries of the proposed Tembe Elephant Reserve were allowed to continue as in the past with agricultural practices. Cattle and goats were also tolerated in the area. However, all forms of hunting were prohibited and poachers were dealt with accordingly.

WEATHER RECORDING STATION

The collection of rainfall records was begun in 1959 at Sihangwana Camp and was terminated during 1975. These were commenced again in May 1979, and during January 1981 another rainfall recording station was erected at nGungun Camp in the north. No other meteorological data have been collected in the past for the whole of the proposed Tembe Elephant Reserve.

SUGGESTED MANAGEMENT AND DEVELOPMENT PLAN FOR THE PROPOSED TEMBE ELEPHANT RESERVE IN TONGALAND

The variety of fauna and flora, occurring within the proposed Tembe Elephant Reserve is surprisingly large (Moll 1977) and the existence of such an extensive natural area in northern Tongaland is a tribute to the KwaZulu Government. Some suggestions for management are submitted below in the hope that this scientifically and aesthetically valuable ecosystem will be effectively conserved for all time. The following aspects concerning the management of the proposed Tembe Elephant Reserve are suggested:

FIELD STAFF

Specialized nature conservation staff is an essential prerequisite for the effective management of a conservation area. During the study period it was noticed that there was an urgent need for qualified staff in the proposed elephant area. The following posts

with their respective duties were then suggested for the proposed Tembe Elephant Reserve:

1. Chief Regional Nature Conservation Officer : based at Jozini. This person should preferably be in possession of a B.Sc. (Hons) degree in Wildlife Management. The three major conservation areas of KwaZulu, namely Sibaya Lake, Kosi Bay and the Tembe Elephant Reserve, should fall under his jurisdiction. It was recommended that he should be the link to the Department of Agriculture and Forestry, KwaZulu, and that he worked in close conjunction with all military security forces and Natal Parks Board. Other responsibilities should include long term planning, the drawing up of the budget and that the area is soundly managed.

2. Senior Nature Conservation Officer : based at the proposed Tembe Elephant Reserve. It was suggested that he should hold the most senior post in the Elephant Reserve. Besides the ability to cope with normal routine work it would be an asset:

   - To be able to converse in Zulu.
   - To have the ability and knowledge to hunt big game.

   This officer should be in possession of a B.Sc. in Zoology and Botany or have had at least six years of field experience including general management and administrative work of a nature reserve.

3. Nature Conservation Officers : it was suggested that there be at least five nature conservation officers based at the Tembe Elephant Reserve and that each one is allotted one of the following specific tasks:

   - To be in charge of the scouts; their training and all other aspects which are associated with their daily routine.

   - The general maintenance and the building of camps, making roads, erection of fences and the cutting of reeds..

- The resettlement of people to other areas; this is a major and very sensitive task and needs a person who has a knowledge of the language and of the cultural background of the local inhabitants. Seeing that he would be in constant touch with Chief Msimba Tembe, the Indunas and local inhabitants, he needs to have the qualities of a diplomat too; this would be a temporary post only and this officer could later be put in charge of the proposed wilderness trails.

- To be responsible for the stores, vehicles, machinery and clerical work.

- To be responsible for veld management and who should work closely with the professional research officers.

The Nature Conservation Officers should preferably be in possession of a Diploma in Nature Conservation or have had at least four years field experience on a nature reserve.

4. Professional Nature Conservation Officers : based at the main conservation camps, and to include at least one botanist and one zoologist to do research in the area, without being burdened with management or administrative responsibilities. An honours degree in plant and animal ecology should be the minimum requirements for both the above-mentioned posts. Research staff would be directly responsible to the Chief Regional Nature Conservation Officer based at Jozini.

5. Scouts : their main task should be law enforcement and assistance to the Senior Nature Conservation Officer with elephant, hippopotamus (Hippopotamus amphibius) and crocodile (Crocodylis niloticus) control work. Other duties would be to guard all the entrances to the reserve and to protect the fields of the local people near the borders of the elephant reserve from raiding elephants, until an elephant-proof barrier has been erected.

The scouts should have a good field experience and preferably a Standard 8.

6. Labourers : they should be used in various fields, assisting the other staff members in their various tasks.

Such a body of well-disciplined men should ensure a prosperous future for all those concerned either directly or indirectly with Tembe Elephant Reserve. The eventual success will depend entirely on the attitude and approach of those in charge of managing the area.

MEETINGS

It is suggested that quarterly staff meetings should be held by the Chief Regional Nature Conservation Officer at the main conservation camp near Sihangwana with all his staff, including the professional officers, who hold senior positions in the Tembe Elephant Reserve. It would be essential for the Chief Regional Nature Conservation Officer to hold these quarterly meetings, to ensure that matters proceed according to the policy laid down by the Nature Conservation Division of KwaZulu.

At these meetings the opportunity should be taken to have discussions and to inform the staff on latest development plans - should there be new management plans to be implemented. General aspects, such as field staff, the budget and research projects, should also be discussed.

REPORTS

It is recommended that monthly reports should be submitted to the Chief Regional Nature Conservation Officer of Tongaland by all senior staff based in the Tembe Elephant Reserve.

In these reports information on:

- Weather data.
- Game movements.
- Game sightings.

- Veld fires.
- Poaching.
- Tasks accomplished.
- Work programme for the next month.

should be included, which in the long-term will be invaluable for record purposes.

EXTENSION WORK

During 1981 extension work was carried out successfully in Tongaland by field staff based at Sihangwana and it is hoped that this would continue. The local population of Tongaland, however, need to be enlightened on matters concerning nature conservation and management. This can be done by showing conservation orientated films and by presenting talks backed with displays which depict themes such as the pros and cons of veld burning, why do we conserve, water pollution and general aspects on ecology.

CAMPS

Staff members play an important role in any game reserve. Their task is demanding and often dangerous. If one wishes to get optimum productivity from the staff employed, it is important that the conditions under which they will live in the proposed Tembe Elephant Reserve will be of a satisfactory stand, viz:

1. Staff Camps

   It is recommended that a new main nature conservation camp be built near Sihangwana as well as ten minor scout camps within the Tembe Elephant Reserve (Figure 35). The site for the main conservation camp should take the following aspects into consideration: the camp must be easily accessible by means of a good road network; at least 15-20 km from the Mozambique-Natal border due to military security reasons and be on the periphery of the proposed Tembe Elephant Reserve.

It is suggested that such a new main conservation camp should be erected 1 km north of the Makanes Drift-Sihangwana main road (Figure 35) and 250 m east of the western boundary. (At present the main conservation camp is still at its present site at Sihangwana.) It is suggested that this camp be equipped with the following facilities and housing:

- Offices.
- Storerooms.
- An underground 20 000 litre water tank.
- Toilet and washing facilities.
- Windmill.
- Radio communication set.
- Housing.
- Outdoor recreation facilities.
- Power plant.

The type of housing which should blend in with its surrounding should be left to the decision of the authorities in charge. The present main conservation camp could then be used as a store place for fencing material and a training centre for the scouts.

The proposed ten minor camps (Figure 35) should each blend with the immediate surrounding and be in the form of a rustic camp, each with housing, toilet and washing facilities; furthermore, each should be equipped with a 2 000 litre water tank, a windmill to be erected wherever possible, a radio communication set and transport in the form of a motorbike.

2. Tourist Camps

No luxury camps should be erected in the proposed Elephant Reserve and adjacent areas. The types of tourist camps suggested for the area are rustic and wilderness camps.

(a) Rustic camps : housing should be in the form of reed huts, similar to those in which the Tonga people live. Toilet and washing facilities should be provided. It would be

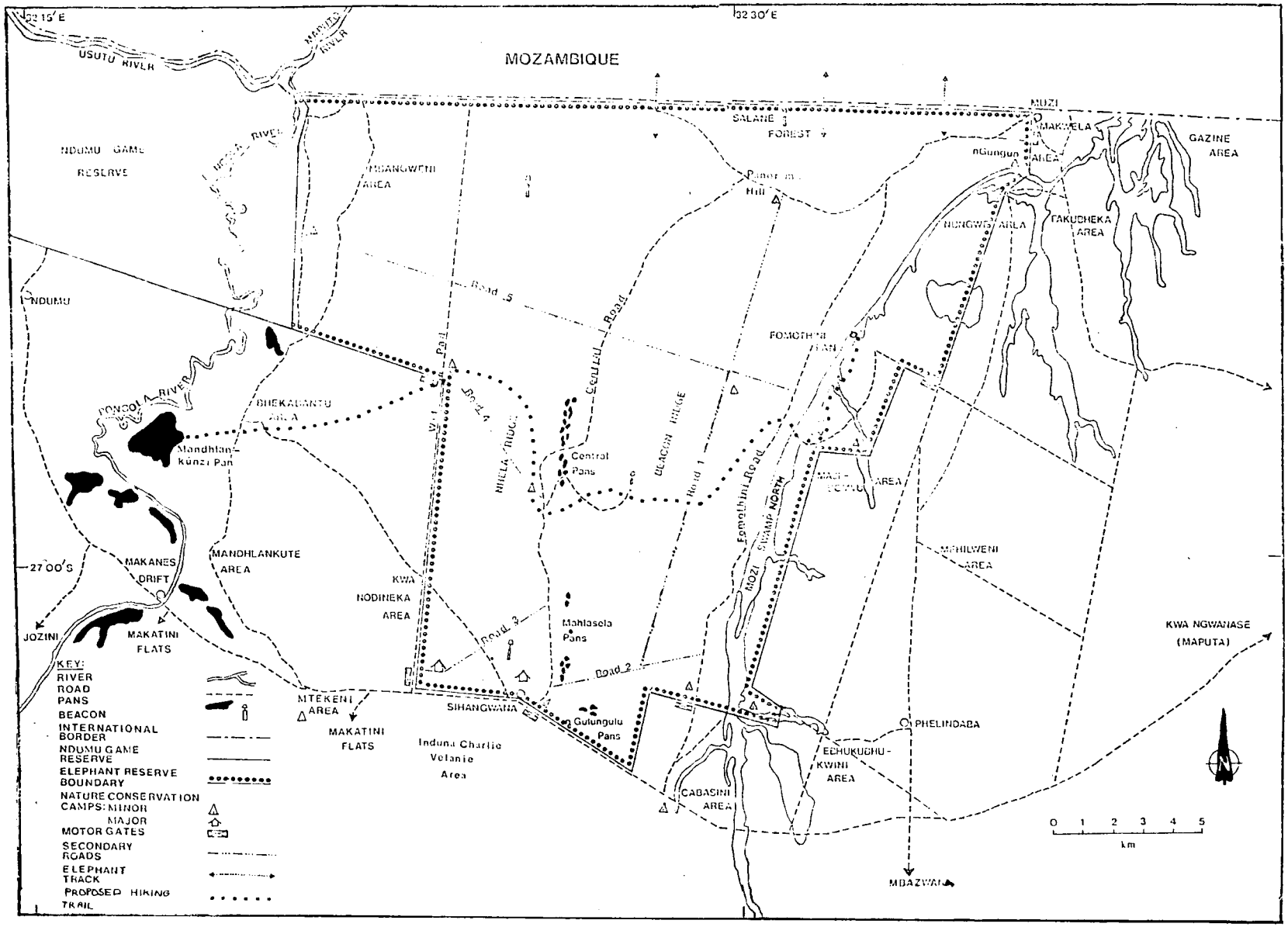


Figure 35 : Suggested infrastructure for the proposed Tembe Elephant Reserve, Tongaland, northern Natal.

desirable to erect rustic camps, which will be a complement to the landscape and not disturb the environment. Two of these camps suggested are to be erected at (Figure 35):

- Mandhlankunzi Pan (outside the proposed Tembe Elephant Reserve)
- Nhlela Ridge near the Central Pans (within the proposed Tembe Elephant Reserve).

(b) Wilderness camps : these should be camping places with minimal housing and should be used only by over-night campers. Toilet and braai facilities and a simple roof erected to protect trailists from rain or sun, are sufficient. Only one wilderness camp is recommended at this stage for the proposed Elephant Reserve, namely at Fomothini Pan (Figure 35) on the eastern bank of the Mozi Swamp North, approximately 15 km from the rustic camp at Nhlela Ridge. Here a hide has already been erected in a tree, which is ideal for viewing purposes.

LOCAL INHABITANTS

The interest of the local inhabitants of northern Tongaland were taken into consideration when the final suggestion on boundaries was made. An effort was made to set aside an area for the proposed Tembe Elephant Reserve which in the end would be of benefit to all people living in Tongaland. The number of kraals which occurred in each area of each induna respectively, in the proposed Tembe Elephant Reserve, appears in Table 34.

Two major problems that were to be encountered in the implementation of the plan, were the area of indunas Makoseni Tembe and Makuto Tembe. In the case of Induna Makoseni, 30 kraals fell within the proposed Elephant Reserve. It was suggested that those people living near Sihangwana, which consisted of 11 kraals, should be moved to the area of Induna Charlie Valanie (Figure 35). The remaining 19 kraals of which six were along the west bank of Mozi Swamp North and the other 13 kraals at the nGulungulu Pans, should be

Table 34 : Number of kraals counted in February 1981 in each of seven areas that fall within the boundaries of the proposed Tembe Elephant Reserve, Tongaland, northern Natal.

AREA	INDUNA	NUMBER OF KRAALS
Sihangwana/Cabasini	Makoseni Tembe	30
Ebhukubhukwini	Mnjama Tembe	7
Majibomvu	Masoka Tembe	4
Fomothini	Njanjene Tembe	5
Nungwe	Msela/Geyo Tembe	2
Makwela	Judas/Mapumpo Tembe	3
Mbangweni	Makuto Tembe	57
Total	7 Indunas	108

moved to Cabasini (Figure 35) where water is abundant and where there are sufficient reeds for building material. There is also a school nearby and Cabasini is only 6 km east of Sihangwana Store.

In the case where a whole community was to be resettled as was the case with the inhabitants of Mbangweni under Makuto Tembe, an alternative vacant area had to be found. The inhabitants of Mbangweni are mainly refugees from southern Mozambique as well as other displaced people from Ndumu Game Reserve. An alternative could be to move these people to Kwa Nodineka (Figure 35). Here vast areas were still uninhabitated. A windmill should be erected in the area and the people to be settled here would thus be closer to the Sihangwana shop, the clinic at Makanes Drift and the main bus route.

The local population east and west of Mozi Swamp North who lived within and on the periphery of the proposed Tembe Elephant Reserve will be deprived of reed building material obtained from the swamp. To overcome this problem the women should be allowed to enter the elephant reserve to cut reeds along Mozi Swamp North.

The inhabitants east and west of Mozi Swamp North do not depend so much on the swamp for drinking water. Instead they prefer to dig for water rather than have to drink the brackish water of the swamp. Fortunately the water table, especially on the eastern side of the swamp, is high, with a low salinity of 0,4 % compared to Mozi Swamp North, which has a salinity of 1,64 % (SD = 0,28 %) in the north and 3,41 % (SD = 1,46 %) in the south.

WATER

It is recommended that no further artificial water points be made available to the elephants within the proposed Tembe Elephant Reserve, without further supportive research results. However, windmills should be erected at conservation camps whereever possible, which should be used exclusively by the staff.

A windmill at Kwa Nodineka (Figure 35) is suggested to be erected for those local inhabitants who are recommended for resettlement from the Mbangweni area (Figure 35).

Following the reintroduction of other wildlife into the Tembe Elephant Reserve, after having obtained the permission from the Department of Veterinary Services, it is suggested that a thorough study be made of the utilization and distribution of all seasonal pans within the proposed Tembe Elephant Reserve, Mozi Swamp North and Pongola River by all wildlife.

VEHICLES

Although one was unable to determine the exact number of vehicles needed for personnel, the following bare minimum number of vehicles are recommended for the proposed Tembe Elephant Reserve:

- Two, eight-ton lorries.
- Ten, four wheel-drive pick-ups.
- Ten, 125cc "fat cat" motorbikes.
- One grader - D9.
- Two tractors: One, four-wheel-drive (1 200 serie).
  One, two-wheel-drive (990 serie).

FENCING

The necessity for the proposed Tembe Elephant Reserve to be enclosed by an elephant-proof fence cannot be over emphasized. Without an elephant barrier, it would be virtually impossible to control elephant movements across the boundaries of the elephant reserve, especially during the crop season when the elephants cover great distances during the night to invade the fields of the local population.

The situation at Muzi Border Post and areas east of Mozi Swamp North concerning elephants raiding fields and turning over huts of the local human population, had reached serious proportions during

1981. Repetition of this situation has to be avoided. The same applies to an incident which occurred in January 1981, when two bull elephants, found wandering about in the densely populated area of Ubombo (Figure 2), had to be shot.

In South Africa, the Addo Elephant National Park is enclosed by a fence made of railway sleepers and cables. This has proved to be successful in stopping the elephants moving beyond the borders of the park. In the Zimbabwe National Parks, trenches dug around windmills have been successful in preventing the destruction of the windmills by the elephants (Smithers, pers. comm.).

The borders of the proposed Tembe Elephant Reserve along which an elephant-proof fence was suggested to be erected, covers a distance of 60,5 km. This excluded the 24,5 km along the Mozambique-Natal border as well as the Ndumu Game Reserve. The erection of an elephant-proof fence along the boundaries of Ndumu Game Reserve can be undertaken only after incorporation to the Tembe Elephant Reserve has been granted. The Mozambique-Natal border on the other hand should be kept open as long as circumstances permit. This will enable the elephants to continue to move freely within their home range which includes the area northwards up to the Maputo River.

The sealing off of the Mozambique-Natal border, thus putting an end to the elephants' north-south movements and vice versa, should only take place if the protection of elephants on the Mozambique side cannot be guaranteed.

However, before the final sealing off of the Mozambique-Natal border, an assessment should be made of the elephant population to ascertain whether a viable population of family units and bulls is present within the borders of the proposed Tembe Elephant Reserve at that moment. If it is found that too few elephants occur within the Reserve at that time, two openings, each of 250 m wide should be left at two of the main elephant paths (Figure 34) used at that stage. Once the Conservation Authorities have positive proof that

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Smithers, R.H.N. (1982) : Transvaal Museum, Paul Kruger Street, PRETORIA, 0002.

viable elephant herds are present within the borders of the proposed elephant reserve, the openings can be sealed.

To contain elephants within a specific area has always been a problem to conservationists, because of the costs involved in erecting an elephant-proof fence. In Tongaland one question remained: - what would an effective but cheap elephant barrier be? Possibilities included a game fence which was either electrified or lined with railway sleepers and cables, or a trench, or dolosse (similar to those found along South African beaches and harbours to prevent wave action during high tide damaging property) or even concrete slabs 1,5 m wide with spikes, lined along the boundaries of the proposed Tembe Elephant Reserve. The following types of barries were considered:

Veldspan Fence

The current price for a 2 m veldspan fence as for 1983 was R8,60 per metre. It was suggested that five strands of barbed wire were to be erected above the veldspan fence to raise the height of the fence to approximately 3 m.

Trench

A trench of 1,5 m wide and 2 m deep, dug along the borders of the proposed Elephant Reserve, would be a cheap solution to stop elephants from crossing the boundary of the reserve. How effective such a barrier would be remains to be seen, considering that the greater portion of the reserve is comprised of loose sand.

The walls of the trench will tend to collapse if either trodden on by the elephants or after heavy rains when the weight of the soaked sands forces the walls to cave in. To prevent this, the walls of the trench will have to be lined with concrete and enforced with steel. This will be a costly undertaking considering that the price for 1 m^3 of concrete was R75,00 during 1983 (Burnett, pers. comm.). In addition a trench can also become a death-trap for smaller game.

Burnett, G. (1983) : Department of Water Affairs, Private Bag X 313, PRETORIA, 0001.

Dolosse

Dolosse of 1 m^3, weighing 2,4 tons each, lined in a row, three interlocking each other every 3 m, would seem to be an effective barrier in stopping elephants from crossing the borders of the elephant reserve. The lining of this elephant barrier, 60,5 km in length, (i.e. presently excluding the 24,5 km along the Mozambique-Natal border) would cost the authorities during 1983 R70,00 per metre (approximately a total of R4,13 million).

Concrete Slabs

Precast slabs of 3 m long, 1,5 m wide and 0,5 m high (equavalent to 2,25 m^3) lined with spikes and cast on site along the boundary of the proposed Tembe Elephant Reserve, could be an alternative to prevent elephants from crossing the boundaries of the elephant reserve. The estimated price for this barrier was R60,00 per meter during 1983.

Electric Fence

An electrified fence can be an effective barrier as long as there is continued current and the shock is sufficient. In theory sound, but in practice, logistic problems are foreseen. During 1983 an electrified fence was erected at the Sihangwana-Cabasini area. According to verbal reports it seems to be serving its purpose in stopping elephant movement. However, time will tell if the elephants will not find methods to break the fence.

Conclusion

Whatever the decision of the authorities is with regard to the type of elephant barrier to be erected in northern Tongaland, the cost will be high.

Along the borders of the proposed Tembe Elephant Reserve a strip of approximately 20 m wide should be cleared to provide for an elephant barrier and a veldspan fence. The debushed areas of 6 m wide, on either side of the barrier (Figure 36) could be traversed either by vehicle or motorbike, to check for breaks in the barrier.

TEMBE ELEPHANT RESERVE

	ROAD	8 m
	ELEPHANT BARRIER	2 m
	OPEN AREA	3 m
	VELDSPAN FENCE	
OUTSIDE	ROAD	8 m

Figure 36 : Schematic representation of the boundary design for the proposed Tembe Elephant Reserve, Tongaland, northern Natal.

The dolosse lined in a row, interlocking each other, along the borders of the proposed Tembe Elephant Reserve, seem to be the answer in providing an effective elephant barrier. The initial costs of such a barrier will be high. However, if maintenance of the dolosse barrier is to be compared with those of the other mentioned barriers, the former will supercede the other barriers in the long run.

It was suggested that the erection of the fence and the elephant barrier should begin in the three most sensitive areas (Figure 35), where the majority of people live, viz. at:

- Mbwagweni area, i.e. from the south-eastern corner of Ndumu Game Reserve to the Wit Pad.
- Sihangwana and Cabasini area, i.e. from Sihangwana along the main road to the west bank of Mozi Swamp North.
- Makwela area, i.e. from Muzi Border Post to nGungun.

GATES

The women of the local population living on the eastern bank of Mozi Swamp North should be permitted to go into the swamp to collect reeds for building material. It is suggested that grid-grates 1m wide should be placed at 6 km intervals along the eastern boundary fence of the Tembe Elephant Reserve with steps over the elephant barrier.

Six motor-gates for vehicles should be erected (Figure 35) to permit entry into the reserve. All these gates seem to be necessary from a geographical and strategic point of view. It is essential that these should always be guarded by scouts.

ELEPHANT MOVEMENT CONTROL

The areas most harassed by elephants during the crop season were Makwela, Gazine, Fakubheka, Nungwe, Majibomvu and Charlie Vilane. Crop damage by elephants at Bhekabantu, Cabasini and Mtekeni areas (Figure 35) was less severe.

The elephants responsible for crop damage were lone bulls and some bachelor groups. During the study period no elephant family units were recorded raiding the fields of the local Tonga population.

Elephants responsible for crop damage in the areas Makwela, Gazine and Fakubheka were elephants which cross the Mozambique-Natal border near Muzi Border Post at dusk and return to Mozambique again during the early morning hours. Occasionally elephants living south of Tibi Pan, east and west of the Mozi Swamp North were reported to be raiding the above-mentioned areas.

An effective system should be worked out by which the elephants could be driven away from a certain area. During the study period this was done by firing shots into the air with a shotgun. In most cases this proved to be successful. Should all measures, however, fail to drive a specific elephant crop-raider from a certain village, and if it promises to become a threat to the local inhabitants, there will be no alternative but to shoot it.

The meat of any elephants shot should be distributed amongst the local population to compensate for the crop losses caused by the elephants. The tusks and skin of the elephant shot should be collected by the authorities and sold. It is recommended that 30 % of the money thus received should be handed over to the local Tribal Authority.

The annual maize crop season, from December to April, should not be taken lightly, because the failure of controlling the area effectively could jeopardise the future of an elephant reserve for once and for all. The argument is often heard that the continuous elephant threat and the destruction of the lands of the local population by the elephants is the reason why the people over the past years have become discontented.

RESEARCH

If conservation areas were to be used optimally, one must treat the life-sustaining ecosystems with respect. Continued research is needed

to manage such areas effectively, an aspect which cannot be emphasized enough. Only through systematic research does one get a better understanding of the nature of problems facing one at present and those which one has to expect in the near future. Some suggested research proposals to be initiated in the Tembe Elephant Reserve are as follows:

ELEPHANTS

It is recommended that one of the professional nature conservation staff members appointed in the Tembe Elephant Reserve is to be given the following tasks:

- To continue to monitor daily north-south elephant movements across the Mozambique-Natal border.
- To monitor local elephant movement on a monthly basis and also to investigate what major factors determine this local movement.
- To undertake monthly observations at various pans to build up a catalogue of elephants positively identified in the area.
- To monitor the dynamics of the elephant populations throughout the year.
- To attempt to collect, where possible, information on elephant numbers, their present distribution and movements beyond the Mozambique-Natal border, south of the Maputo River.
- To undertake an in-depth study on the impact of the elephants on habitat utilization, with emphasis on the Sand Forests.

VEGETATION

An in-depth botanical survey of the proposed Tembe Elephant Reserve is recommended which should include:

- A species checklist.
- A complete herbarium collection.
- A phytosociological study.
- Phenology of some of the major plant species.

- To investigate food availability for herbivore species that are to be re-introduced into the proposed reserve.
- To monitor change in vegetation along permanent transects to detect elephant damage.
- To monitor reed utilization by the local people.

The placement of control blocks, which are well protected from burning by means of fire-breaks, within the different plant communities, is recommended. These control blocks should then be carefully monitored so that recommendations can eventually be made to the management sector, who will then be able to design and carry out a burning programme for the entire reserve more successfully.

BURNING PROGRAMME

Fire can be used successfully in retarding woody plant growth, in opening woodland, maintaining Open Woodlands and Grasslands, and for manipulating game movements (Lambrecht 1974, In: Krüger 1978).

A burning programme for any specific area is a more complex and delicate matter than one at first realises it to be. The effect of over protection of a certain area against veld fires on the one hand and the resultant stimulated bush and shrub growth due to burning at the wrong season on the other hand, can be among the most important factors contributing to bush thickening and encroachment (Lambrecht 1974, In: Krüger 1978).

For the proposed Tembe Elephant Reserve, it is suggested that a burning programme be drawn up. Such a burning programme should take the following into consideration:

- The nature of the soil.
- Rainfall.
- Type of plant community.
- Frequency and season of burn.
- Strategically placed fire-breaks.
- Topography.
- Burning blocks of controllable size.
- Type and intensity of grazing pressure.

WEATHER RECORDING STATIONS

During the study period only rainfall had been recorded in the Sihangwana-Mozi area. It is suggested that two weather recording stations are to be erected within the proposed Tembe Elephant Reserve : namely at the proposed new main conservation camp near Sihangwana in the south (Figure 35) and at nGungun Camp in the north near the Mozambique-Natal border. At these proposed weather recording stations, the following data should be recorded daily:

- Radiation.
- Sunshine.
- Cloud cover.
- Temperature.
- Wind direction and velocity.
- Rainfall.
- Relative humidy of the air.
- Frequency of frost and mist.
- Evaporation.

The above data are of utmost necessity as they contribute towards the future planning for the proposed reserve.

OTHER SUGGESTED STUDIES

The following data on the proposed Tembe Elephant Reserve would also be of benefit:

- To monitor water levels of pans throughout the elephant sanctuary on a tri-monthly basis.
- To determine salinity levels along Mozi Swamp North, the Pongola River and the inland pans during the dry and wet season months on a tri-monthly basis.
- To monitor eastward movement of game out of Ndumu Game Reserve, after the eastern boundary fence of that reserve has been removed, on a day to day basis.
- To monitor ungulate-habitat relationship on a day to day basis.

MANAGEMENT PROPOSALS IMPLEMENTED: 1982 - 1985

Proclamation:

On the 21st October 1983, the Tembe Elephant Reserve, mainly as proposed by Klingelhoeffer (1981), was officially proclaimed as an elephant sanctuary in the KwaZulu Government Gazette by the Honourable Chief Minister Dr. M.G. Buthelezi of KwaZulu.

Reserve Boundaries:

The present reserve boundaries on which agreement was finally reached, incorporated the boundaries as then proposed in 1981 (Klingelhoeffer 1981), with only three deviations having been made to the original proposals. The present boundaries deviate from the original proposals at the north-eastern, south-eastern and north-western sectors (Figure 34). The reason for the exclusion of the north-eastern sector was due to internal political pressure forced onto Chief Msimba Tembe by his Indunas. This was also the case with the north-western boundary at Mbangweni which has been excluded (Figure 35). With regard to the south-eastern sector (Figure 35), it was purely out of a practical point of view that this boundary was slightly altered. According to Ostrosky (pers. comm.) it will only be a matter of time and the north-western sector adjacent to Ndumu Game Reserve, viz. Mbangweni, will be incorporated into the present proclaimed elephant sanctuary, thus forming the desired link with Ndumu Game Reserve.

Fencing:

Fencing of the proclaimed Tembe Elephant Reserve began in June 1983, four months prior to its official proclamation (Carr, pers. comm.). Towards the end of 1985, the entire southern, eastern and a third of the western boundary had been game-proof fenced (Figure 35), whereas the entire reserve boundary with the exception of 20 km along the Mozambique-Natal border had been electrified.

Ostrosky, E. (1985) : P.O. Box 43, KWA NGWANASE, 3973.
Carr, D. (1983) : P.O. Box 51, MKUZE, 3965.

The decision not to electrify the entire Mozambique-Natal border was to ensure the continued north-south and vice versa elephant movement.

The electrified fence seems to be effective in containing the elephants within its boundary because during the 1984/1985 crop season, no complaints of elephant crop damage were reported in northern Tongaland (Ostrosky, pers. comm.). The decision to make use of an electrified fence instead of a trench or dolosse as proposed as an alternative (Klingelhoeffer 1981 and 1982), was due to its apparent effectiveness in controlling elephant movement out of the reserve, low initial costs involved in erecting the fence and the low degree of maintenance required.

Field Staff:

A strong force of capable men are presently managing the Tembe Elephant Reserve. These include a chief nature conservator, two research officers, four nature conservators and an effective scout force who are solely responsible for the well-being of the reserve.

Tourism:

At present the Tembe Elephant Reserve is closed to the public (Ostrosky, pers. comm.). However, as soon as the planning and development of the reserve is completed it is envisaged to open the reserve to exclusive safaris.

Road Network:

The proposed tar road from Jozini via Sihangwana to Kwa Ngwanase is complete. The tar road runs along the southern boundary of the Tembe Elephant Reserve. Roads within the Tembe Elephant Reserve are unaltered.

Research:

Two research officers are based at the Tembe Elephant Reserve who are involved in ecological research.

Ostrosky, E. (1985) : P.O. Box 43, KWA NGWANASE, 3973.

Future:

The proclaimed Tembe Elephant Reserve has a promising future. The aims and objectives of the research project have become a reality whereby both the elephants and the local Tonga people have benefitted.

CONCLUSION

The goals of the proposed Tembe Elephant Reserve can be summarized as follows:

- To protect the local population, who live on the periphery of the elephant reserve, from rogue and crop-raiding elephants by means of an elephant-proof fence.
- To protect important biological remnants, i.e. the Sand Forests, Mozi Swamp North and the elephants.
- To provide the local population with job opportunities and thereby improving their living standards.

Most, if not all areas, set aside for conservation in Natal as well as elsewhere in South Africa, are small islands. These islands, which are not self-maintaining ecosystems and into which category the proposed Tembe Elephant Reserve also falls, must therefore be managed with utmost care, depending on the goals of such a reserve. The more artificial the situation, the higher the required degree of management.

With the stated goals of the proposed reserve in mind, it should, however, always be ensured that management strives towards maintaining all the natural resources of the area in a healthy state.

Conservation is only successful if the advantages become relevant in the everyday life of the people. One must be aware of the dangers of malpractice and guard against short-term gains. Patience is needed in all sectors, especially from the people who are to benefit from these areas.

This proposed plan will only render its efficiency and practicality if a body of conscientious men are installed in the field who would be responsible for the implementation of such a plan.

Before a final decision was taken on the boundaries here suggested for the proposed Tembe Elephant Reserve, many aspects were taken into consideration. These included: human dependence on the area, elephant movements and distribution, elephant habitat requirements and the protection of the Sand Forests and Mozi Swamp North. The former received most attention during the drafting of the boundaries, because the success of any boundary proposal depends largely upon the contentment of the local human inhabitants.

The displacement of local human inhabitants from one area to another is a matter not to be taken lightly. This major task should be undertaken with great care and diplomacy by a body of responsible men, both recognized and respected by the local population.

The future of the Tembe Elephant Reserve's development depends on a realistic approach to human requirements. These must be central to any future land-use programme. This means that we must really practise ecology in its total context.

C H A P T E R 8

THE DISTRIBUTION AND STATUS OF MAMMALS WITHIN THE PROPOSED TEMBE ELEPHANT RESERVE

INTRODUCTION

Twenty-five species representing seven mammal orders were recorded in the proposed Tembe Elephant Reserve from May 1979 to May 1981.

The present status of the mammalian fauna is alarming. The precarious foothold of certain species is due to the indiscriminate poaching by hunters during the past decades.

There is reason for concern when the present status of the faunistic species is compared to that of a century ago, when mammalian species occured in abundance throughout the entire region (Baldwin 1863 and Drummond 1875).

For the entire region of Tongaland 102 species of mammals are known to have occurred, which, if compared to other areas, is a particularly high species diversity (Rautenbach, Skinner and Nel 1980). It is evident that the Sand Forests have become the last refuge of certain species.

The 25 mammal fauna recorded within the proposed Tembe Elephant Reserve were classified after the numbering system of Smithers (1984).

CHECK-LIST OF LARGER MAMMALS RECORDED WITHIN THE PROPOSED TEMBE ELEPHANT RESERVE

ORDER PRIMATES

Family Cercopithecidae

Cercopithecus pygerythrus (F. Cuvier, 1821) Vervet Monkey
A common and widespread species occurring mainly close to Mozi Swamp North and the seasonal pans.

Cercopithecus albogularis (Sykes, 1831) Samango Monkey
Occurs in satisfactory numbers in dune forests along Beacon and Nhlela Ridges.

Family Lorisidae

Galago crassicaudatus E. Geoffroy, 1812 Bush Baby
A common inhabitant of the Sand Forests.

ORDER LAGOMORPHA

Family Leporidae

Lepus saxatilis F. Cuvier, 1823 Scrub Hare
A widespread and common species in grassland areas.

ORDER RODENTIA

Family Hystricidae

Hystrix africaeaustralis Peters, 1852 Porcupine
Recorded on two occasions only at Sihangwana. The local inhabitants, however, maintain that the porcupine is common throughout the area.

Family Thryonomyidae

Thryonomys swinderianus (Temminck, 1827) Great Cane Rat
A common species which is widely distributed along Mozi Swamp North and its tributaries.

Family Sciuridae

Paraxerus palliatus (Peters, 1852) Red Squirrel
A common species in Sand Forests.

ORDER CARNIVORA

Family Mustelidae

Ictonyx striatus Perry, 1810 Striped Polecat
A common species although not often encountered due to its nocturnal habits.

Family Viverridae

Genetta tigrina (Schreber, 1776) Large-spotted Genet
One of the most common of all nocturnal carnivores in forested areas.

Gaberella sanguinea (Rüpell, 1836) Slender Mongoose
A common and widely distributed diurnal carnivore in woodland and savanna areas.

Atilax paludinosus G. Cuvier, 1829 Water Mongoose
The water mongoose occurs in satisfactory numbers along Mozi Swamp North and its tributaries.

Mungos mungo Gmelin, 1788 Banded Mongoose
A common and diurnal inhabitant of woodlands.

Family Felidae

Panthera pardus (Linnaeus, 1758) Leopard
Spoor identified on a single occasion, during the study period, along the Mozambique-Natal border. The spoor, which were followed for 12 km, led to Ndumu Game Reserve. In October 1985 leopard spoor were seen at the Central Pans (Bothma, pers. comm.).

Felis serval Schreber, 1776 Serval
Occurs in rare numbers in Open Woodland close to the vicinity of water.

ORDER PROBOSCIDEA

Family Elephantidae

Loxodonta africana (Blumenbach, 1797) African Elephant
Common and widespread throughout the area. Family units keeping to the Sand Forests between Nhlela and Beacon Ridges.

Bothma, J. du P. (1986) : Zoology Department, University of Pretoria, PRETORIA, 0001.

ORDER PERISSODACTYLA

Family Rhinocerotidae

Diceros bicornis (Linnaeus, 1758) Hooked-lipped Rhinoceros
Occurs east of the Pongola River within Ndumu Game Reserve in satisfactory numbers (Jackson, pers. comm). The above area (Figure 34) has been proposed to be included to the proposed Tembe Elephant Reserve.

Family Equidae

Equus burchelli (Gray, 1842) Burchell's Zebra
In 1985 the first zebra from Mkuze Game Reserve were re-introduced into the Tembe Elephant Reserve (Jackson, pers. comm.).

ORDER ARTIODACTYLA

Family Suidae

Potamochoerus porcus (Linnaeus, 1758) Bushpig
A common nocturnal animal confined to Mozi Swamp North and its associated dense vegetation.

Family Giraffidae

Giraffa camelopardalis Linnaeus, 1758 Giraffe
In 1985 eleven giraffe from Mkuze Game Reserve were re-introduced into the Tembe Elephant Reserve (Jackson, pers. comm.).

Family Hippopotamidae

Hippopotamus amphibius (Linnaeus, 1758) Hippopotamus
A rare species; no more than six individuals between Tibi Pan and Ponweni Crossing (Figure 9) of the Mozi Swamp North.

Family Bovidae

Tragelaphus angasii Gray, 1849 Nyala
A common species within Ndumu Game Reserve, east of the Pongola River (Jackson, pers. comm.).

Jackson, G. (1981 and 1985) : Private Bag X 501, MKUZE, 3965.

Tragelaphus scriptus (Pallas, 1766) Bushbuck
A rare species confined to dense riparian forests. The bushbuck's abundance is most likely underestimated as a result of its retiring habits.

Cephalophus natalensis A. Smith, 1834 Red Duiker
A shy and retiring inhabitant of dense bush. Common and widely spread throughout the region.

Sylvicapra grimmia (Linnaeus, 1758) Common Duiker
One of the most common herbivore species in Open Woodland.

Redunca arundinum (Boddaert, 1785) Reedbuck
A common species throughout the region in Open Shrub Woodland and Dambos along Mozi Swamp North.

Aepyceros melampus (Lichtenstein, 1812) Impala
A common species east of the Pongola River (Jackson, pers. comm.). In 1985 impala, from Mkuze Game Reserve, were re-introduced into the Tembe Elephant Reserve (Jackson, pers. comm.).

Neotragus moschatus (Von Dueben, 1846) Suni
A common species of the Sand Forests but is rarely seen due to its retiring habits.

CONCLUSION

The sparsely inhabited area between Nhlela and Beacon Ridges (Figure 34) has become one of the last refuges for certain mammal species in Tongaland.

It is in the interest of the authorities to introduce stricter law enforcement measures to prevent the further reduction in numbers of the existing wildlife populations.

Jackson, G. (1981 and 1985) : Private Bag X 501, MKUZE, 3965.

The species list, with regards to the smaller mammals, is far from complete. The reason for this is that the orders Chiroptera and Insectivora were excluded from the survey and that little attention was given to the order Rodentia. It can therefore be said with confidence that, if the Sand Forests and wooded areas were to be thoroughly surveyed for the above three orders, it could increase the list of mammal species present in the proposed Tembe Elephant Reserve from 25 to well over 50.

C H A P T E R 9

THE RE-INTRODUCTION OF ANIMAL SPECIES INTO THE PROPOSED TEMBE ELEPHANT RESERVE

INTRODUCTION

The travel accounts and correspondence of the early explorers and hunters, who traversed Tongaland during historical times, were studied. From these records it is evident that the Tongaland plains used to teem with a large variety of wildlife (Drummond 1875 and Selous 1908). Certain species, which used to occur in Tongaland have at present either become locally extinct or have decreased to low numbers.

As far as can be determined from previous records, 102 species of small and larger mammals are known to have occurred in Tongaland (Rautenbach, Skinner and Nel 1980). Four members of the Artiodactyla, viz. the roan antelope Hippotragus equinus, eland Taurotragus oryx, tsessebe Damaliscus lunatus lunatus and Lichtenstein's hartebeest Alcelaphus lichtensteinii are at present locally extinct, as are three species of Carnivora viz. the wild dog Lycaon pictus, brown hyaena Hyaena brunnea and lion Panthera leo (Rautenbach, Skinner and Nel 1980). Two species also believed to be locally extinct are the klipspringer Oreotragus oreotragus, and the oribi Ourebia ourebi (Rautenbach, Skinner and Nel 1980).

The list of locally extinct species would have been far in excess of those listed, were it not for Natal Parks Board who re-introduced certain locally extinct species into the Mkuzi and Ndumu Game Reserves.

The re-introduction of animal species into the proposed Tembe Elephant Reserve could further contribute to re-establishing nuclei herds of locally extinct species and also to boosting wildlife populations which at present have reached low numbers.

PREVIOUS RECORDS OF ARTIODACTYLA AND PERISSODACTYLA

The presence of the Artiodactyla and Perissodactyla in Tongaland have been recorded and described in detail by the early explorers and hunters of the 19th century (Table 35), and in the latter decades by scientists. In total, 27 species (three of Perissodactyla and 24 of Artiodactyla) have been recorded (Table 35) to have occurred in Tongaland, which is a particularly high species diversity for an area of that size.

SPECIES OF PERISSODACTYLA AND ARTIODACTYLA RECOMMENDED FOR INTRODUCTION

The vegetation of the proposed Tembe Elephant Reserve has the potential to accommodate a wide variety of hoofed species. Twelve of the 27 species of the Perissodactyla and Artiodactyla recorded previously (Table 35), already occur in the tract of land between the Pongola River and Mozi Swamp North, which is suggested to be incorporated into the proposed Tembe Elephant Reserve.

The different habitat types that occur within the proposed Tembe Elephant Reserve are unable to support all species as listed in Table 35, because the required habitat for certain species is lacking on the one hand, and for the fear of foot-and-mouth disease carriers on the other hand.

Antelope recommended for re-introduction include: Burchell's zebra, giraffe, kudu, Lichtenstein's hartebeest, oribi, roan antelope, steenbok, square-lipped rhinoceros, tsessebe and waterbuck (Table 36).

If the proposed Tembe Elephant Reserve were to be kept in perpetuity for the conservation of nature in its broadest sense, then it will be necessary also to re-introduce predators to maintain a healthy predator/prey relationship. However, no predators are recommended to be re-introduced for at least the next five years. The introduction of predators should only occur when the area

Table 35: A checklist of the Artiodactyla and Perissodactyla that used to occur in Tongaland, northern Natal, as based on various reports in old literature.

ORDER	ANIMAL	SCIENTIFIC NAME	SOURCE	
			Author	Date
Perissodactyla	Hooked-lipped rhinoceros*	Diceros bicornis	Drummond Baldwin	1875 1863
	Square-lipped rhinoceros	Ceratotherium simum	Selous Bryden	1908 1899
	+Burchell's zebra	Equus burchelli	Drummond Baldwin	1875 1863
Artiodactyla	Blue wildebeest	Connochaetes taurinus	Drummond Baldwin	1875 1863
	Bushbuck*	Tragelaphus scriptus	Drummond	1875
	Waterbuck	Kobus ellipsiprymnus	Drummond	1875
	Roan antelope	Hippotragus equinus		
	Hippopotamus*	Hippopotamus amphibius	Drummond	1875
	Eland	Taurotragus oryx	Drummond	1875
	+Giraffe	Giraffa camelopardalis	Drummond	1875
	Reedbuck*	Redunca arundinum	Drummond	1875
	+Impala*	Aepyceros melampus	Drummond Baldwin	1875 1863
	Tsessebe	Damaliscus lunatus lunatus	Drummond	1875
	Lichtenstein's hartebeest	Alcelaphus lichtensteinii	Selous	1908
	Kudu	Tragelaphus strepsiceros	Drummond Baldwin	1875 1863
	Buffalo	Syncerus caffer	Drummond	1875
	Nyala*	Tragelaphus angasii	Drummond Selous	1875 1908
	Red duiker*	Cephalophus natalensis	Bryden	1899
	Common duiker*	Sylvicapra grimmia	Bryden	1899
	Suni*	Neotragus moschatus	Selous	1908
	Blue duiker	Cephalophus monticola	Bruton	1976
	Oribi	Ourebia ourebi	Drummond	1875
	Klipspringer	Oreotragus oreotragus	Dixon	1964
	Steenbok	Raphicerus campestris	Roberts	1936
	Bushpig*	Potamochoerus porcus	Dixon	1964
	Warthog	Phacochoerus aethiopicus	Dixon	1964
	Mountain reedbuck	Redunca fulvorufula	Dixon	1964

* : Occurring between the Pongola River and Mozi Swamp North.

+ : Introduced into the Tembe Elephant Reserve in 1985 (Jackson, pers. comm.).

Jackson, G. (1985) : Private Bag X 501, MKUZE, 3965.

Table 36 : The estimated area (km^2) and suitable habitat (Figure 10) for ten herbivores recommended to be re-introduced into the proposed Tembe Elephant Reserve, Tongaland, northern Natal.
(Refer to Figure 10 - Vegetation Map - for locality of plant communities.)

SUITABLE HABITAT	SIZE	ANIMAL									
		Burchell's zebra	Giraffe	Kudu	Lichtenstein's hartebeest	Oribi	Roan antelope	Steenbok	Square-lipped rhinoceros	Tsessebe	Waterbuck
Sand Forest	38,8	-	-	✓	-	-	-	-	-	-	-
Riverine Forest	2,0	-	✓	✓	-	-	-	-	-	-	✓
Closed Woodland	20,2	-	-	✓	-	-	-	-	-	-	-
Open Woodland	255,7	✓	✓	✓	✓	-	✓	✓	✓	-	-
Shrub Open Woodland	39,8	✓	✓	✓	-	✓	✓	✓	✓	✓	-
Open Palmveld	4,6	✓	-	-	-	✓	-	✓	✓	✓	✓
Floodplain Grassland	8,6	✓	-	-	-	✓	-	-	✓	✓	✓
Grassland	2,9	✓	-	-	-	✓	-	✓	✓	✓	✓
Swamp and Dambos	8,7	-	-	-	-	-	-	-	-	-	✓

✓ : Suitable habitat

- : Unsuitable habitat

has been securely fenced in and after nuclei herds of re-introduced antelope have reached near optimum stocking rate.

The recommended optimum stocking rate of an area is determined by the capability in which veld is able to support wildlife at the driest time of the year without any supplementary feeding and without causing damage to plant production or related sources. Such a long-term recommended stocking rate for the proposed Tembe Elephant Reserve according to Agricultural Technical Services is 12 ha per large stock unit (LSU). With such a conservative stocking rate wildlife can be sustained in equilibrium with its environment.

CONCLUSION

After permission has been obtained from the Department of Veterinary Services for the re-introduction of certain animal species, the dynamics of the animal populations and the effects of animal pressure on the vegetation should be monitored. Measures to control certain animal populations might be necessary in the near future, and the economic returns possible from culling should be borne in mind. It is recommended that competent advice be sought regarding whether, when and how much culling is necessary after wildlife populations have reached numbers above the recommended stocking rates.

C H A P T E R 1 0

CONCLUSION

Accounts of the past history of the Tongaland elephants are scarce, because scientific observations on the Tongaland elephants were not documented until 1946 (Bruton et al. 1980), with more detailed documentation following thereafter (Dixon 1964, Thomson 1974 and Hall-Martin 1976).

Taking the following ecological factors into consideration the following conclusions with regard to the proposed Tembe Elephant Reserve can be made:

The striking variation in rainfall across Tongaland from east to west i.e. a high rainfall on the crest of the Lebombo Mountains as well as along the coast and a low rainfall in the central area, explains why the human population is less dense in the central area. This makes the area an ideal elephant reserve, which will have a minimal disruption on human life.

The investigation of the soils has indicated that the soil of the greater part of the proposed elephant reserve is of low agricultural potential, with the exception of the Pongola Floodplain and sectors of Mozi Swamp North, which have rich alluvial deposits. This has led to the practice of shifting agriculture by the few local people, who reside in the central area and who clear a new area every third year. This form of agriculture coupled with indiscriminate burning has had a negative effect on the vegetation within certain areas of the proposed elephant reserve.

The vegetation, within the proposed elephant reserve, was found to comprise plant communities which were either absent or occurring in small isolated areas within the borders of the Republic of South Africa, such as the Sand Forests and the hygrophilous plant communities of the Mozi Swamp North. Disruptive farming procedures by the local people on the vegetation, which is a rarity in the

Republic of South Africa, further stresses the importance of including sections of the central area into a proposed elephant reserve.

The phenological survey revealed, that a constant supply of food in the form of leaves, flowers and fruits, within the proposed area for the elephants, was available to mammals, birds and insects throughout the year. This concludes that the area proposed for the elephant reserve, is suitable for a variety of wildlife.

More quantitative data on salinity gradients of seasonal pans of Mozi Swamp North, taken over a longer period, are needed, before final conclusions can be reached as to what are the limiting factors determining pan utilization by elephants, man and their domestic cattle. It was, however, observed that the local people made little use of the swamp for human water consumption. Wells, adjacent to the swamp were dug instead. No detectable DDT and DDE were found in the water of pans sampled. Further research in this field, however, should receive priority, since the amount of DDT sprayed per annum to combat malaria is escalating.

There still remains a considerable lack of facts and figures on elephants in northern Tongaland. However, after the study seasonal patterns were observed (which were governed either by availability of surface water, food and/or human settlements) and it became clear that the elephants made considerable use of the proposed elephant reserve, which was sparsely populated by the local inhabitants. The previous impression that northern Tongaland contained elephant bulls only (which would not have justified the proposals for an elephant reserve in northern Tongaland) was nullified by the discovery of the presence of cows and calves.

From all data collected i.e. rainfall, soil fertility, salinity gradient and availability of surface water, it can be concluded that the area proposed for the elephant reserve is more suitable for elephants than human settlement.

Boundary proposals put forward for the elephant reserve includes the greater part of Mozi Swamp North and the area north of Sihangwana linking up with Ndumu Game Reserve, which covers a surface area of 375 km^2 .

This area will ensure the survival of the Tongaland elephants as well as the protection of Mozi Swamp North, representative of Sand Forests and certain rare and endangered faunistic species, with a minimal disruption of human life in northern Tongaland. It has further been suggested that Ndumu Game Reserve should be included to the proposed elephant reserve which will increase the area by a further 80 km^2 , thus forming a more viable unit.

Finally it can be stated that on the 21st October 1983, the Tembe Elephant Reserve, as proposed during 1981, was actually officially proclaimed as an elephant sanctuary by the Hon. Chief Minister Dr. M.G. Buthelezi.

C H A P T E R 1 1

SUMMARY

The proposed Tembe Elephant Reserve is situated in northern Tongaland, KwaZulu (also referred to as northern Natal) between 32°21' E and 32°26' E longitudes, and 26°51' S and 27°04' S latitudes. The proposed reserve is approximately 375 km^2 in size and if linked in the north-west with Ndumu Game Reserve will increase in size by another 80 km^2.

A literature review on the past history of Natal, dating as far back as 1840, revealed that elephants formerly occurred widely throughout Tongaland with the furthest southern record being at the White Umfolozi River. The colonization of Tongaland by the Tonga people began during the mid 19th century after the Tembe Tribe living in southern Mozambique, were displaced by Zulus who had fled from Shaka.

The proposed elephant reserve has three major physiographic regions viz. the Pongola Zone, the Sand Forest Zone (129 m above sea level), and the Mozi Drainage Zone (50 m below sea level).

The Pongola River in the west and Mozi Swamp North in the east, are the only two permanent water supplies of the proposed reserve. Numerous seasonal pans occur in duplex soils in the central area but they dry up in the dry season months (April to September).

Grey and red sands cover the greater part of the proposed reserve, under which occur Port Durnford beds, sandy limestone, shale, siltstone, conglomerates and rhyolites. The soils are recent wind re-distributed grey sands of which 13 different soil types occur within the borders of the proposed elephant reserve. These soils can be subdivided into four main categories viz. deep sandy soils, soils of the Pongola Floodplain, shallow soils and soils of the dambo catchment area.

There is a seasonal rhythm in rainfall and temperatures resulting in a hot, wet-season months from October to March and a cool dry frost free season from April to September.

The vegetation of the proposed reserve is classified physiognomically after Edwards (1983) into 12 plant communities. The sandveld vegetation of the proposed reserve shows a resemblance to that of the Gorongoza National Park in Mozambique, the Lengwe National Park in Malawi, northern Kruger National Park in the Republic of South Africa and the Kalahari Sands in Barotseland (Botswana). A phenological study of a selection of trees and shrubs indicated that there is a constant supply of food for various animals in the form of leaves, fruit and flowers.

Mozi Swamp North can be divided, according to salinity levels, into two definite sectors viz. the northern sector (Mean = 1,6; SD = 0,28) and the southern sector (Mean = 3,4; SD = 1,46). Although 33 600 ℓ of DDT and DDE have been sprayed for malaria control in Tongaland between 1977 - 1980, no traces of DDT and DDE were isolated in the water of the pans sampled in the study area.

Increased elephant activity and an escalation in numbers was experienced during the study period. The re-settlement of humans within the Maputo Elephant Reserve in Mozambique, has forced the elephants to move southward including the Maputo floodplain, Futi-drainage and northern Tongaland as their new home range. Seasonal rhythms in movement and distribution of elephants was observed which was governed by: availability of surface water, food (green flush at the end of the dry-season months and the ripening of fruit), and the presence of human settlements. Further it was established that resident breeding herds occurred within the borders of the proposed elephant reserve.

A management plan for a proposed elephant reserve has been put forward of which the most important suggestions are: the boundary proposals, the management and development of the reserve, and future research projects to be initiated.

Twenty-five species representing seven orders of the class mamalia were recorded within the boundaries of the proposed Tembe Elephant Reserve and recommendations for the re-introduction of a further ten herbivore species into the proposed Tembe Elephant Reserve were also made.

SAMEVATTING

Die voorgestelde Tembe Olifantreservaat is in Noordelike Tongaland, KwaZulu (ook bekend as Noordelike Natal) tussen 32°21' O en 32°26' O lengtegrade, en 26°51' S en 27°04' S breedtegrade geleë. Die voorgestelde reservaat is ongeveer 375 km^2 groot en indien dit in die noord-weste met Ndumu Wildreservaat gekoppel word, sal dit met nog 80 km^2 vergroot.

'n Literatuuroorsig van die geskiedenis van Natal, wat tot so ver as 1840 terug dateer, het onthul dat olifante voorheen dwarsdeur Tongaland wyd voorgekom het. Die olifante is in die suide so ver as die Wit Umfolozirivier aangeteken. Die kolonisasie van Tongaland deur die Tongavolk het gedurende die middel van die 19de eeu begin nadat die Tembestam, wat in suidelike Mosambiek woonagtig was, verplaas is deur Zoeloes wat voor Shaka gevlug het.

Die voorgestelde olifantreservaat omvat drie fisiografiese gebiede, naamlik die Pongolagebied, die Sandwoudgebied (129 m bo seevlak), en die Mozidreineringsgebied (50 m onder seevlak).

Die Pongolarivier in die weste en Mozimoeras Noord in die ooste, is die enigste twee permanente waterbronne van die voorgestelde reservaat. Heelwat seisoensgebonde panne kom in die dupleksgronde van die sentrale gebied voor, maar droog egter in die droë maande op (April tot September).

Grys- en rooisande bedek die grootste gedeelte van die voorgestelde reservaat, waaronder Port Durnford lae sanderige kalksteen, leiklip, "siltstone", konglomerate en rieoliete voorkom. Die gronde is grys sand wat onlangs deur wind herversprei is waarvan 13 verskillende grondtipes binne die grense van die voorgestelde olifantreservaat voorkom. Hierdie grondtipes kan in vier hoof kategorieë onderverdeel word, naamlik diep sanderige grond, grond van die Pongolavloedvlakte, vlak grond en grond van die vlei-agtige opvanggebied.

'n Seisoenale ritme in reënval en temperatuur het 'n warm, nat seisoen vanaf Oktober tot Maart en 'n koel, droë rypvrye seisoen vanaf April tot September tot gevolg.

Die plantegroei van die voorgestelde reservaat word fisionomies volgens Edwards (1983) in 12 plantgemeenskappe geklassifiseer. Die sandveld plantegroei van die voorgestelde reservaat toon 'n ooreenkoms met die Gorongoza Nasionale Park in Mosambiek, die Lengwe Nasionale Park in Malawi, die noordelike Nasionale Kruger Wildtuin in die Republic van Suid-Afrika en die Kalahari Sande in Barotseland (Botswana). 'n Fenologiese studie van geselekteerde bome en struike toon aan dat daar 'n konstante bron van voedsel vir 'n verskeidenheid diersoorte in die vorm van blare, vrugte en blomme is.

Mozi Moeras Noord kan op grond van soutgehalte in twee definitiewe gedeeltes verdeel word, naamlik die noordelike gebied (middelterm = 1,6; SD = 0,28) en die suidelike gebied (middelterm = 3,4; SD = 1,46). Alhoewel 33 600 ℓ DDT en DDE gespuit was ten einde malaria in Tongaland tussen 1977 en 1980 te beheer, is daar geen waarneembare spore van DDT en DDE in monsters van die water in die studiegebied gevind nie.

Verhoogde olifantaktiwiteit en 'n styging in getalle is gedurende die studieperiode ondervind. Die hervestiging van mense binne die Maputo-olifantreservaat in Mosambiek het daardie olifante gedwing om suidwaarts te beweeg en die Maputo vloedvlakte, die Futi-dreineringsgebied en noordelike Tongaland in hulle nuwe tuisgebied in te sluit. Seisoenale ritmes in beweging en verspreiding van olifante is waargeneem en dit was gereguleer deur die beskikbaarheid van oppervlakwater, voedsel (groen uitloopsels aan die einde van die droë seisoen periode en rypwordende vrugte) en die teenwoordigheid van menslike tuistes. Daar is verder vasgestel dat plaaslike teeltroppe olifante binne die grense van die voorgestelde olifantreservaat voorgekom het.

'n Bestuursplan vir 'n voorgestelde olifantreservaat word voorgelê, waarvan die belangrikste voorstelle die volgende insluit: grensvoorstelle, die bestuur en ontwikkeling van die reservaat en toekomstige navorsingsprojekte wat geïnisieer moet word.

Vyf-en-twintig spesies wat sewe ordes van soogdiere verteenwoordig is binne die grense van die voorgestelde Tembe-olifantreservaat aangeteken en aanbevelings vir die hervestiging van 'n verdere tien spesies herbivore in die voorgestelde Tembe-olifantreservaat, word ook gemaak.

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Appendice 1 : Size (m^2), depth (m), visibility (m) and a species check list of hygrophilous plants at 14 sites along Mozi Swamp North and seasonal pans between Nhlela and Beacon Ridges, Tongaland northern Natal, March 1981.

SITE	SIZE	DEPTH	VISIBILITY	HYGROPHILOUS PLANTS
Mozambique-Natal International Border	No data	0,80	0,80	Phragmites australis, Utricularia spp.
Pump House	2000,0	3,15	1,35	Phragmites australis, Typha littoralis, Nymphaea spp., Najas marina Potamegeton pectinatus, Utricularia spp.
Bridge	No data	0,75	0,75	Phragmites australis, Typha littoralis, Nymphaea spp., Utricularia spp.
nGungun Crossing	90,0	0,85	0,85	Phragmites australis, Lemna minor, Juncus spp., Cyperus spp.
Tibi Pan	2500,0	1,75	1,50	Phragmites australis, Typha littoralis, Lemna minor, Utricularia spp., Najas marina.
Njoni Pan	2500,0	1,35	1,35	Phragmites australis, Lemna minor, Pistia spp., Utric laria spp., Nymphaea spp., Potamegeton pectinatus, Najas marina.
Vangothi Pan	1000,0	1,00	0,50	Phragmites australis, Pistia spp., Najas marina, Lemna minor, Nymphaea spp.
Tembe Crossing	1500,0	0,50	0,50	Phragmites australis, Lemna minor, Utricularia spp.
Fomothini Pan	3000,0	2,40	1,00	Phragmites australis, Lemna minor, Juncus spp., Cyperus spp., Nymphaea spp., Potamegeton pectinatus, Najas marina, Utricularia spp.
Ponweni Crossing	1500,0	0,45	0,40	Phragmites australis, Typha littoralis, Juncus spp., Cyperus spp., Utricularia spp.
Tembu Crossing	150,0	0,50	0,50	Typha littoralis, Phragmites australis, Utricularia spp.
iBusi Pan	48,0	0,35	0,35	Phragmites australis, Typha littoralis, Nymphaea spp.
Vovovo Pan	18,0	0,35	0,35	Phragmites australis, Typha littoralis.
eBumbeni Pan	27,0	0,30	0,35	Phragmites australis, Typha littoralis.
Central Pans	9,0-500,0	0,25-1,50	0,20-0,45	Lemna minor, Ludwigia stolonifera, Cyperus spp., Juncus spp., Scirpus spp., Nymphaea spp.
Mahlasela Pans	9,0-300,0	0,25-1,00	0,20-0,45	Lemna minor, Ludwigia stolonifera, Cyperus spp.
nGulungulu Pans	9,0-300,0	0,25-1,00	0,20-0,45	Lemna minor, Ludwigia stolonifera, Cyperus spp.,

Appendix 2 : The extent of utilazation of 14 sites along the Mozi swamp north and seasonal pans between Nhlela and beacon ridges by the local human inhabitants, cattle and elephants, Tongaland, northern Natal.

SITE	PEOPLE	CATTLE	ELEPHANTS
Mozambique-Natal International border	None	None	Seldom
Pump House	Frequent	None	Seldom
Bridge	Frequent	Seldom	Seldom
nGungun	Frequent	Frequent	Frequent
Tibi Pan	Seldom	Frequent (on east bank only)	Frequent
Njoni Pan	Seldom	Frequent (on east bank only)	Frequent
Vangothi Pan	Seldom	Frequent (on east bank only)	Frequent
Tembe Crossing	Seldom	Frequent (on east bank only)	Frequent
Fomothini Pan	Seldom	Frequent (on east bank) Seldom (on west bank)	Frequent
Ponweni Crossing	Seldom	Frequent (on east and west bank)	Frequent
Tembu Crossing	Frequent	Frequent (on east and west bank)	Frequent
iBusi Pan	Frequent	Frequent (on west bank)	Frequent
Vovovo Pan	None	Frequent (on west bank)	Frequent
eBumbeni Pan	Frequent	Frequent (on east and west bank)	None
Central Pans	None	Seldom	Frequent
Mahlasela Pans	Seldom	Seldom	Frequent
'nGulungulu Pans	Frequent	Frequent	Seldom

Appendix 3 : Number of elephant spoor leading southward and northward across the Mozambique - Natal border, between the Pongola River and Muzi Border Post, Tongaland, northern Natal, from July 1979 to July 1981.

YEAR	MONTH	MOVEMENT	
		Southward	Northward
1979	July	62	57
	August	69	24
	September	144	106
	October	93	63
	November	126	94
	December	147	167
1980	January	128	103
	February	121	108
	March	159	151
	April	43	41
	May	33	24
	June	20	16
	July	56	84
	August	93	85
	September	165	141
	October	182	128
	November	250	217
	December	261	241
1981	January	177	156
	February	228	210
	March	178	151
	April	164	157
	May	112	95
	June	62	61
	July	36	32

Appendix 4 : Number of elephant spoor leading southward and northward across the Mozambique - Natal Border, between Muzi Border Post and Farrazau, Tongaland, northern Natal, from July 1979 to July 1981.

YEAR	MONTH	MOVEMENT	
		Southward	Northward
1979	July	0	0
	August	0	0
	September	0	0
	October	0	0
	November	0	0
	December	10	6
1980	January	0	0
	February	0	0
	March	0	0
	April	3	0
	May	11	8
	June	0	1
	July	12	1
	August	6	9
	September	29	10
	October	5	1
	November	0	0
	December	0	1
1981	January	11	18
	February	2	0
	March	0	0
	April	0	0
	May	3	3
	June	0	0
	July	5	4

Appendix 5 : Number of elephant spoor coming from the Tongaland an the Mozambique side to feed on sisal plants only, along the Mozambique - Natal border, between the Pongola River and Muzi Border Post, Tongaland, northern Natal, from July 1979 to July 1981.

YEAR	MONTH	REGION	
		Southward	Northward
1979	July	25	0
	August	29	6
	September	36	15
	October	30	0
	November	20	5
	December	21	0
1980	January	70	0
	February	47	16
	March	49	20
	April	31	2
	May	21	3
	June	23	0
	July	24	0
	August	73	12
	September	43	9
	October	88	12
	November	78	3
	December	44	0
1981	January	32	9
	February	53	2
	March	29	2
	April	6	0
	May	18	3
	June	39	0
	July	17	0

Appendix 6 : Number of elephant spoor coming from the Tongaland and the Mozambique side, to feed on sisal plants only, along the Mozambique - Natal Border, between Muzi Border Post and Farrazau, Tongaland, northern Natal, from July 1979 to July 1981.

YEAR	MONTH	REGION	
		Tongaland	Mozambique
1979	July	0	6
	August	0	2
	September	0	2
	October	0	10
	November	0	3
	December	0	0
1980	January	0	0
	February	0	0
	March	0	14
	April	0	16
	May	5	21
	June	0	32
	July	2	0
	August	0	40
	September	0	44
	October	0	75
	November	0	40
	December	0	25
1981	January	0	43
	February	0	95
	March	0	52
	April	0	22
	May	0	3
	June	0	7
	July	0	9

Appendix 7 : Mean monthly rainfall (mm) recorded at Sihangwane from May 1979 to May 1981, Tongaland, northern Natal.

MONTH	RAINFALL
January	50,8
February	158,3
March	85,6
April	26,9
May	103,7
June	12,7
July	3,2
August	30,7
September	93,3
October	51,8
November	93,2
December	43,6