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Errata

Pike T, Ferguson T and Ferguson S. 1989. Fish survey of water bodies situated in The Sodwana State Forest Reserve, Natal Parks Board internal report.

Item	As printed	Correction
p4, para.4,	(18 ppt)	(1,8 ppt)
do	(11 ppt)	(1,1 ppt)
Table 1	Salinity ppt. 18; 16; 15; 11. (in tabulated order)	Salinity ppt. 1,8: 1,6: 1,5: 1,1 (in tabulated order)

.....

Table 4. Include the following species & collection localities.

Mesobola brevianalis	Muzi Lake 3,4.
Barbus toppini	Twin pans 6
Barbus viviparus	Twin pans 6

NATAL PARKS, GAME AND FISH PRESERVATION BOARD

FISH SURVEY OF PANS ON THE MFOLOZI RIVER FLOODPLAIN

T. Pike
Conservator Hatcheries

INTRODUCTION

Investigations of fish populations in the pans situated on the Mfolozi river floodplain were made by the author in August 1965, October 1965 and April 1971. Two further investigations were made in October 1978 and in February 1979, when fish collections were made in some lakes previously investigated, as well as in additional ones. Collections were made in the following lakes during the two most recent surveys. Approximate surface areas (hectares) are also indicated.

*	Mvamanzi ...	55
*	Mbukweni (Ngologoto)	36
*	Ntweni ...	32
*	Majamisa ...	25
	Nkata ...	19
*	Makata (Nyawothi)	16
	Mvanyamvanya ...	9
	Mgqizweni ...	7

(* Pans surveyed on previous occasions (Pike 1965, 1971))

The situation of these pans is indicated in Figure 1.

These pans, with the exception of the last, are situated within the KwaZulu homeland. Mgqizweni is situated in the Umfolozi Game Reserve.

Slight confusion occurs in the names of some of the pans, as names used by the local Zulu people sometimes conflict with reference names used on topographical maps. For the sake of reference, the first mentioned names in the above list are those appearing on the 1: 50 000 topographical map. Names in brackets are those used in previous survey reports.

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FISH COLLECTING METHODS

Gill nets with stretch mesh size varying from 50 mm to 162,5 mm with 12,5 mm increments per net were used. Each net was 25 metres long and ca 2 metres deep.

A fleet of 5 gill nets were set in each pan. Mesh size of the one fleet varied from 50 mm to 150 mm with 25 mm increments, and the other fleet varied from 62,5 mm to 162,5 mm with 25 mm increments. Gill nets were set in the late afternoon and lifted the following morning.

An exception to this procedure was when gill nets were set in Mgqizweni, a pan situated within the Umfolozi Game Reserve. It was known that there were many crocodiles in this pan and to set nets overnight would have meant that crocodiles could have been caught in the nets and nets might also have been badly damaged. Nets were therefore only set from 16h00 to 17h00 in this lake, being the only time available.

A cast net of 20 mm stretch mesh was also used in all pans. This was either cast from the shore or from a boat into the shallower areas. Specimens were also collected by spreading dissolved rotenone in shallow areas or bays, in order to stupify fish.

A seine net was not used, as many of the lakes were almost entirely surrounded by dense marginal phragmites or sedges. The presence of aquatic vegetation (mainly Potamogeton spp., Najas spp., and Ceratophyllum spp. also prevented use of the seine net.

RESULTS

Sarotherodon mossambicus (Mozambique tilapia) and Clarias gariepinus (sharptooth catfish) were found to be the most common of the larger fish, and therefore the species which had the greatest potential for commercial exploitation. These species were found in all of the pans excepting Mgqizweni, where C.gariepinus was not recorded. Most likely they do occur here as these fish are very widespread.

Gill nets were only set for 1 hour in Mgqizweni, so this catch is by no means a true reflection of the population in this pan.

Other large species of fish which were also of exploitable significance were Mugil cephalus (flathead mullet), Labeo molybdinus (leaden labeo) and Megalops cyprinoides (tarpon).

Data of gill net catches appear in Table 1. Mean catches per net were calculated only for those sized nets in which the relevant species were caught.

A list of species of fish recorded and the pans in which they were caught, appear in Table 2.

DISCUSSION

Geographical situation of pans and their water supply.

The pans which were surveyed are situated over a distance of approximately 20 km, commencing 35 km west of the Mfolosi outlet

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into the Indian Ocean. All the pans are close to the river, within the floodplain area. Some pans are fed by streams and rainfall run-off from surrounding hills including river flood waters, while others are virtually entirely dependent on flood waters and rainfall runoff. Mvamanzi pan, for instance, has no perennial inflow, and seasonal fluctuations of water levels are very marked.

During a drought in February 1979, a maximum depth of 0,69 m was recorded in Mvamanzi (Johnson & Twinch 1979) but a depth of 2,4 m was recorded in a previous survey (Pike 1971). According to local Zulu people (pers. comm.) this fluctuation is a common occurrence and the high water level mark on the marginal vegetation was clear evidence of this phenomenon.

Mvamanzi pan

A maximum depth of 0,69 m was recorded and ca 95% of the surface was covered by exposed aquatic plants (mainly Potamogeton spp.) so it was not possible to use nets. Dense marginal sedges and Phragmites restricted access to a few small gaps in the vegetation. Fish were therefore collected by treating a small open area with rotenone. Species recorded on this and previous surveys appear in Table 2.

The fluctuating water level and exposure of plants possibly account for the very large numbers of birds which were seen on the lake and in the marginal vegetation (Leslie & Walley, 1979). Bird droppings entering the pan must account for a large increase of nutrients to the system, enhancing plant growth and natural food organisms which are utilized by the birds and many species of fish in the pan.

Two groups of local fishermen catch fish by means of nets as a commercial enterprise. The size mesh of their nets permits capture of only larger fish which they sell in the local homeland. Those fish not sold in the close vicinity of the pan, depending on the size of their catch, are taken as far afield as Kwambonambi on delivery bicycles, a distance of approximately 30 km.

Three species of fish are caught which are of commercial importance viz. Clarias gariepinus (catfish), Sarotherodon mossambicus ex Tilapia mossambica (Mozambique tilapia) and Mugil cephalus (flathead mullet).

When the lake was visited on 4 October 1978, a group of fishermen were clearing their nets. Catch from one net, approximately 80 m long, comprised 18 catfish and 8 tilapia. This was worth about R7.80. They considered this to be a poor catch because the low water and exposed plants hindered the net.

An interesting observation made by the fishermen was that their catches were good during the previous summer and autumn until a large flock of pelicans arrived in June and remained on the pan for a few months. Catches of tilapia dropped off markedly after arrival of the birds, presumably due to the large numbers of fish which they had eaten.

Makata pan

Gill nets were set on two consecutive nights in this pan in an

attempt to catch certain fish which were seen jumping behind the motor boat when nets were set on the first occasion. Fish of similar appearance were not caught during the first night. Attempts were also made to catch these fish with a cast net and with rotenone treatment, but without success. Presumably these fish were tarpon (M.cyprinoides) as similar looking fish were seen jumping and were caught and identified in Mbukweni pan.

Records of the catfish and tilapia caught, which appear in Table 1, show that the first catch of tilapia was considerably better than the second. This was because larger mesh nets were set on the second occasion in an attempt to catch the larger fish. Smaller mesh nets were responsible for the greater catch of tilapia caught on the first occasion.

Weather conditions on these nights were warm and calm, therefore suitable for netting, and a good catch was made when the complete fleet of nets were set.

Two wooden boats owned by local people were seen on the edge of the pan, so presumably fish were also being netted in this pan.

Species of fish collected with rotenone treatment appear in Table 2.

Mgqizweni pan

This pan is situated within the Umfolozi Game Reserve, on the southern side of the White Mfolozi river. Water supply to the pan is in the form of runoff water from a catchment which experiences very little human disturbance. Flood water from the Mfolozi river also flows into the pan.

Mgqizweni pan is relatively undisturbed and forms a vital part of the ecology of this portion of the game reserve, acting as a major source of water supply for many animals. Crocodiles occur fairly abundantly and many species of waterfowl, and occasionally migrant hippopotami, also utilize the impoundment.

Only three gill nets were set and although not many fish were caught, many fish movements were seen. A record of the catch appears in Table 2.

Fish are not utilized to any large degree besides being occasionally caught by the local game reserve staff. Crocodiles and other fish eating animals nevertheless depend on the fish as a source of food supply.

This fish population serves as an important representation of indigenous species which occur in this area. Because the pan is situated within the game reserve and is relatively undisturbed, the chances of survival of the species is possibly greater than applies to fish populations in pans closer to human habitation and domestic animals, where siltation and pollution are more likely to occur. A more comprehensive fish collection in this pan should therefore be made. Poor weather condtions during this survey and the short time available did not allow for a comprehensive fish collection to be made.

Mbukweni pan

Very strong winds blew during the night while nets were set and 3 of the 6 nets were badly disrupted and torn by crocodiles,upsetting

the catch efficiency. A good catch was nevertheless recorded as indicated in Table 1. Species caught appear in Table 2.

Many large silvery fish were seen jumping behind the motor boat which, when caught, proved to be tarpon (M.cyprinoides). It is therefore presumed that the fish seen jumping in Makata lake (which appeared very similar), were also tarpon. A large number of fish scales were found together on the bank and a big cooking pot was seen close by amongst the reeds. On questioning local people regarding this matter, they said that netters caught many fish in the pan on occasions. Some fish were sold fresh and some were cooked before being sold.

Mvanyamvanya pan

Cold rainy weather with strong winds prevailed the night when gill nets were set, and very few fish were caught in areas exposed to winds. Three nets set in sheltered bays yielded fairly good catches, as seen in Table 1, and species which were caught appear in Table 2.

Fish were being caught in this pan by local netters, as gill nets were found in the pan and a boat was anchored on the shore.

Majamisa pan

Cold rain and wind again prevailed when gill nets were set, and a poor catch was made. Two boats were seen anchored amongst reeds, so presumably netting was also being carried out in this pan. Details of fish caught appear in Tables 1 and 2.

Mzinyeni pan

Poor weather again occurred when gill nets were set and a poor catch was made. The tilapia which were caught were all juveniles so the catch is not a true reflection of a population sample. Details of fish caught appear in Tables 1 and 2.

Nkata pan

A poor catch was again most probably due to the bad weather. Details of fish caught appear in Tables 1 and 2.

Present uses of the pans

The majority of these pans are situated closed to, or within fairly densely inhabited rural areas. The local people draw water from the pans for domestic purposes and in many cases this is their only local water supply. Bathing is also done in the pans, and cleared areas on the shores serve as laundry sites.

Fish are utilised to a fairly large degree and a number of gill nets were being used on some pans.

Fish were also caught by angling or set lines and it was reported that fair numbers of fish were sometimes caught.

Pans also served as important domestic stock and game drinking areas, and in some cases this was their only water supply.

Cattle dipping raceways were constructed near some pans, as this was the only water available for filling the raceways.

Stimulated spawning by flooding

Results of a study made by Dudley (1979) on spawning behaviour of tilapia (S.macrochir and S.andersoni) and the effects of flooding the tilapia impoundments showed that in dry years the fish enter a stress phase when fish start spawning at a reduced age and size. This has a stunting effect on the fish population.

Conversely, during floods with maintained high water levels, only the larger and older fish spawn. The smaller fish consequently grow bigger, as they are not subjected to the stress which is associated with gonadal development.

These two above mentioned species of tilapia are very closely related to S.mossambicus, one of the more important utilizable species in these pans. Jackson (pers.comm.) states that the tilapias are an extremely closely related group, especially the buccal incubating Sarotherodon genus. It is therefore highly possible that flooding would have similar effects on S.mossambicus as was found to occur with S.macrochir and S.andersoni.

If seasonal flood waters were prevented from entering the pans, which could be caused by the construction of a dam upstream of the pans, this may possibly have a stunting effect on the S.mossambicus populations in these pans which are normally flooded. People living near Mvamanzi pan said that the pan was regularly fed by flood waters from the river during the summer. Flood waters were also said to flow into some of the other pans on many occasions, and marine or estuarine fish were caught in 2 pans, indicating a connection between pans and the river.

Occurrence of estuarine fish in the pans

The presence of tarpon (M.cyprinoides)in Mbukweni pan and mullet (M.cephalus)in Mvamanzi pan was of great interest in that these pans are situated 54 km and 56 km approximately upstream from the sea. These two species of fish are marine or euryhaline which only spawn in the sea. Therefore they had travelled at least this distance from the sea and presumably had entered the pans during periods when flood waters from the river enter the pans. It is possible that these species also occur further upstream in the Mfolozi river, and they had come downstream with seasonal flood waters to enter the pans. It is doubtful if the fish would have migrated upstream against the flood waters to enter the pans. This is conclusive proof that some of the pans are at times linked to the Mfolozi river during flood periods. According to Dr Breen of the Department of Botany, University of Natal (pers.comm.) recordings which they made of the height of the river in relation to the levels of the pans indicated that it is possible for flood water from the river to flow into the pans when water overflows the river banks. One exception to this was in the case of Majamisa, where high ground between the pan and the river would probably prevent an inflow of water.

PRODUCTIVITY

Climatic factors are known to have a marked effect on net catches, and it has been proved that variations of daily temperatures and

rainfall could account for up to 83% of the variability in catches (Malvestuto et al.1979). It has also been established that catches vary according to seasonal changes in weather conditions and definite peaks of activity occur (Harding 1960). The bad weather which was experienced many evenings when gill nets were set could therefore have been the reason for poor catches on those nights. Recorded catches and calculated productivity are thus a mere indication of what could be caught under conditions which were far from ideal in many instances, and should not be regarded as mean productivity of the pans.

Catches made by local people using gill nets were assessed from a witnessed catch made by local netters in Mvamanzi pan. This was not a good example of expected normal productivity as the water level was exceptionally low (maximum 65 cm) and vast areas of aquatic plants were exposed, which hindered netting. A gill net 80 metres long yielded 18 C.gariepinus and 8 S.mossambicus. Their estimated total value was R7.80 at locally acceptable prices.

According to the netters, this was a very poor catch and far greater numbers of fish were caught after flood waters had filled the pan. Up to 60 fish of each of these two species could then be caught per gill net. Each group of fishermen had two nets, but normally only one was set while the other was being repaired.

Two previous investigations of Mvamanzi have been carried out (Pike 1965 and 1971). On the first occasion a group of netters had just made a haul before we arrived, having used a 60 metre long seine net. Four sugar pockets three quarters full of fish (S. mossambicus and M.cephalus) had been caught. This catch could not be weighed as a scale was not available.

In 1971 experimental gill nets were set, and a catch of only 2,38 kg per 100 metres of net was obtained, comprising S.mossambicus and C.gariepinus. This poor catch could perhaps have been due to poor weather experienced during the night, but heavy fishing pressure by the fishermen might also have depleted the fish population.

If the experimental gill net catches from two lakes, viz. Mbukweni and Makata, are taken as a mean expected productivity, a fairly lucrative gill netting business could be operated by local netters; as seen in Table 1, the survey nets yielded a total of 48,80 kg per 100 metres, from Mbukweni and 31,58 kg and 24,54 kg per 100 m were obtained in Makata. (On the second setting, large mesh nets were set which consequently did not catch many S.mossambicus).

These catches could be valued at ca R20.00 from Mbukweni and R14.00 and R10.00 respectively for Makata at prices which were being obtained. C.gariepinus sold at 40c per kg while S. mossambicus and other large species sold at 45c per kg. This income compares very favourably with that of Unga fishermen in the Bangweulu swamps (Brelsford 1946) where catches of 8 kg to 20 kg per week are made per fisherman.

Production from gill nets in lake Mweru (Zambia) amounted to an average of ca 8 kg/100 m (Beatty 1966) with catches comprised

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mainly of Tilapia macrochir, but also including Clarias sp. These nets were operated by Black people, and fishing formed a marginal occupation for the majority, mainly due to inefficient gear and methods. Their maximum average catch was ca 12 kg/100 m of gill net.

MacLaren (1956) quotes gill net catches from lakes in Zambia to have been as follows:

Lake Bangweulu	4,5 kg to 15,1 kg per 100 m
Lake Chisi	45,6 kg to 74,0 kg " "
Lake Mweru	11,4 kg to 15,3 kg " "

Jackson et al. (1963) state that "Direct comparison of the catch per unit effort with those recorded for other parts of Africa is not easy, because there is so much variation from place to place in methods of mounting, size of mesh, depth of net, method of laying and other factors, all of which can influence the catch per unit effort .....". Although this is not an accurate comparison, it is nevertheless an accepted method of comparing production recognising the disparities.

The mean gill net production from Kariba dam was 11 kg/100 m while mean production from the Pongolo floodplain pans was 15 kg/100 m (Coke and Pott 1970). A previous survey of the last mentioned pans (Pike 1967) gave a mean gill net production of 38 kg/100 m. Mean gill net production from the Mfolozi floodplain pans was 14 kg/100 m.

Production per unit of net from the Mfolozi floodplain pans therefore compares favourably with production from many other areas.

CONCLUSIONS

The Mfolozi pans contain fairly high numbers of fish which could be cropped on a regular basis as an extensive fishery, if harvesting was done on an organised conservative manner. Pans are situated in close vicinity to densely populated rural areas and the local people were found to relish eating fish which were caught in experimental nets.

Commercial netters operated with permits on some pans and found no difficulty in marketing their catches. Gill nets in operation and rowing boats were also observed, indicating a certain amount of fish exploitation. This could possibly be increased by additional organised netting and the use of more efficient equipment.

Relatively small shallow bodies of water such as the Mfolozi pans should produce more fish than a large dam such as that which is envisaged to be constructed on the Mfolozi river. A F.A.O.study Mission investigating freshwater fisheries in China (Tapiador et al. 1976) found that when comparisons were made of production

from large impoundments with small reservoirs or ponds, the smaller the water area and the shallower the depth, the higher the productivity was per unit area. It has also been deduced that shallow water impoundments and floodplains in Zambia were more productive than deep water reservoirs (MacLaren 1956).

Impounding the Mfolozi river would restrict seasonal flooding of the areas below the dam. This could perhaps have a detrimental effect on fish populations in the pans. S. mossambicus might become stunted in those pans which are normally flooded, and euryphaline species of fish (mullet and tarpon) would be eliminated as they do not breed in fresh water and the fish will no longer have access to the pans from the river.

Probable restricted inter-pan movement of fish due to impoundment of the river (Dept. of Botany, University of Natal report) might be important as far as some of the smaller fish species are concerned. The effect would not be as serious as on the Pongolo floodplain, since the Mfolozi has a less diverse fish fauna, with no tigerfish and only one species of labeo. Nevertheless, isolation of the pans would have a disruptive effect.

Spawning of those species of fish which utilize marginal vegetation (Clarias and small Barbus species) would be affected by an upstream impoundment. Some of these species only spawn in inundated marginal vegetation and spawning will thus be reduced in those pans which depend on floodwater from the river to raise their water levels.

Experimental gill netting indicated that fish productivity is high enough to be exploited to a greater degree than at present.

ACKNOWLEDGEMENTS

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Mr Crass and my wife Biddy checked the draft, which was typed by Mrs T. Anderson.

REFERENCES

Beatty, D.M.F. 1966. Cash surpluses of fishing units on lake Mweru in 1966. Fisheries Research Bulletin Zambia. 5, 1971. 351-377.

Brelsford, W.V. 1946. Fishermen of the Bangweulu Swamps. The Rhodes-Livingstone Papers. 12. 1946.

Coke, M. 1976. Depth distribution of fish on a bush-cleared area of Lake Kariba, Central Africa. Trans.Am.Fish.Soc.97(4): 460-465.

Coke M. and Pott R. 1970. The Pongolo Floodplain pans. Natal Parks, Game and Fish Preservation Board. Internal report.

page 10/....

Crass, R.S. 1964. Freshwater fishes of Natal. Shuter & Shooter, Pietermaritzburg.

Department of Botany, University of Natal. 1979. A report on the pans of the Umfolozi river. Internal report.

Dudley R.G. 1979. Growth and size distribution of Sarotherodon. J.Fish Biol. 14 (2): 220 -226.

Harding D. 1960. Preliminary observations on the effect of seasonal changes in water conditions on the fishery in Bangweulu area. Scientific Council for Africa South of the Sahara 63: 86-96.

Jackson P.B.N. et al. 1954. Report on the survey of northern Lake Nyasa. Government printers, Zomba, Nyasaland.

Jubb, R.A. 1967. Freshwater fishes of Southern Africa. Balkema, Cape Town.

MacLaren P.I.R. 1956. Gill net catches. Scientific Council for Africa South of the Sahara 25: 133-135.

Malvestuto S.P. et al. 1979. Predicting the precision of creel survey estimates of fishing effort by use of climatic variables. Trans. Am.Fish.Soc. 108. 43-45.

*Pike, T. 1965. Fish survey of lakes in Zululand.

*Pike, T. 1965. Investigation of nets and methods of netting carried out by Bantu on lakes in Zululand and continuation of fish survey.

*Pike, T. 1967. Fish survey of pans on Pongolo floodplain.

*Pike, T. 1971. Fish survey of lakes in Zululand Bantu areas.

Smith, J.L.B. 1949. The sea fishes of Southern Africa. Central News Agency.

Tapiador D.D. et al. 1976. Freshwater fisheries and aquaculture in China. FAO Fisheries Technical Paper 168. 11-12.

* Natal Parks, Game and Fish Preservation Board internal reports.

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TABLE 1. Numbers, mean mass and production of commercially utilizable fish caught in gill nets set in pans on the Mfolozi river floodplain

	C. gariepinus			*S. mossambicus*			Other species		
	Mean mass (g)	Mean numbers per 100 m of gill net	Mean total catch kg/100m of gill net	Mean mass (g)	Mean numbers per 100 m of gill net	Mean total catch kg/100 m of gill net	Mean mass (g)	Mean numbers per 100 m of gill net	Mean total catch kg/100 m of gill net
NTWENI	340	2,0	2,72	67	12,0	0,41			
NKATA								*Mugil cephalus*	
	1329	13,6	18,08	385	10,0	3,85	300	10,0	3,0
MVANYAMVANYA	1648	0,2	15,16	230	33,2	7,64			
MAJAMISA	2200	2,8	6,16	503	8,0	4,02		*Megalops cyprinoides*	
MBUKWENI	2420	14,0	33,88	544	16,0	8,70	(590	10,0	5,7
MAKATA (first setting)	546	10,0	5,46	349	76,0	26,12	(	*Labeo molybdinus*	
MAKATA (second ")	2460	8,0	19,68	620	8,0	4,96	(260	2,0	0,52

Note: *C. gariepinus* catch from nets with 75 mm to 162,5 mm stretch mesh
S. mossambicus " " " " 50 mm to 100 mm " "
M. cephalus " " " " 75 mm " "
M. cyprinoides " " " " 75 mm to 100 mm " "
L. molybdinus " " " " 75 mm " "

Table 2. Species of fish recorded from Mfolozi pans

Pans	FISH SPECIES												
	Sarotherodon mossambicus	*Tilapia sparrmanii*	*Pseudocrenilabrus philander*	*Alestes lateralis*	*Barbus paludinosus*	*Barbus trimaculatus*	*Labeo molybdinus*	*Engraulicyprís brevianalis*	*Clarias gariepinus*	*Anguilla mossambica*	*Glossogobius callidus*	*Mugil cephalus*	*Megalops cyprinoides*
MGQIZWENI	x			x	x	x					x		
MVAMANZI	x		x		x			x	x	x	x	x	
MBUKWINI	x		x	x	x	x	x	x	x		x	x	x
NTWENI	x	x	x	x	x	x			x		x		
NKATA	x		x		x				x		x		
MAJAMISA	x		x	x	x	x			x				
MAKATA	x	x	x		x	x		x	x	x	x		
MVANYAMVANYA	x		x		x				x		x		

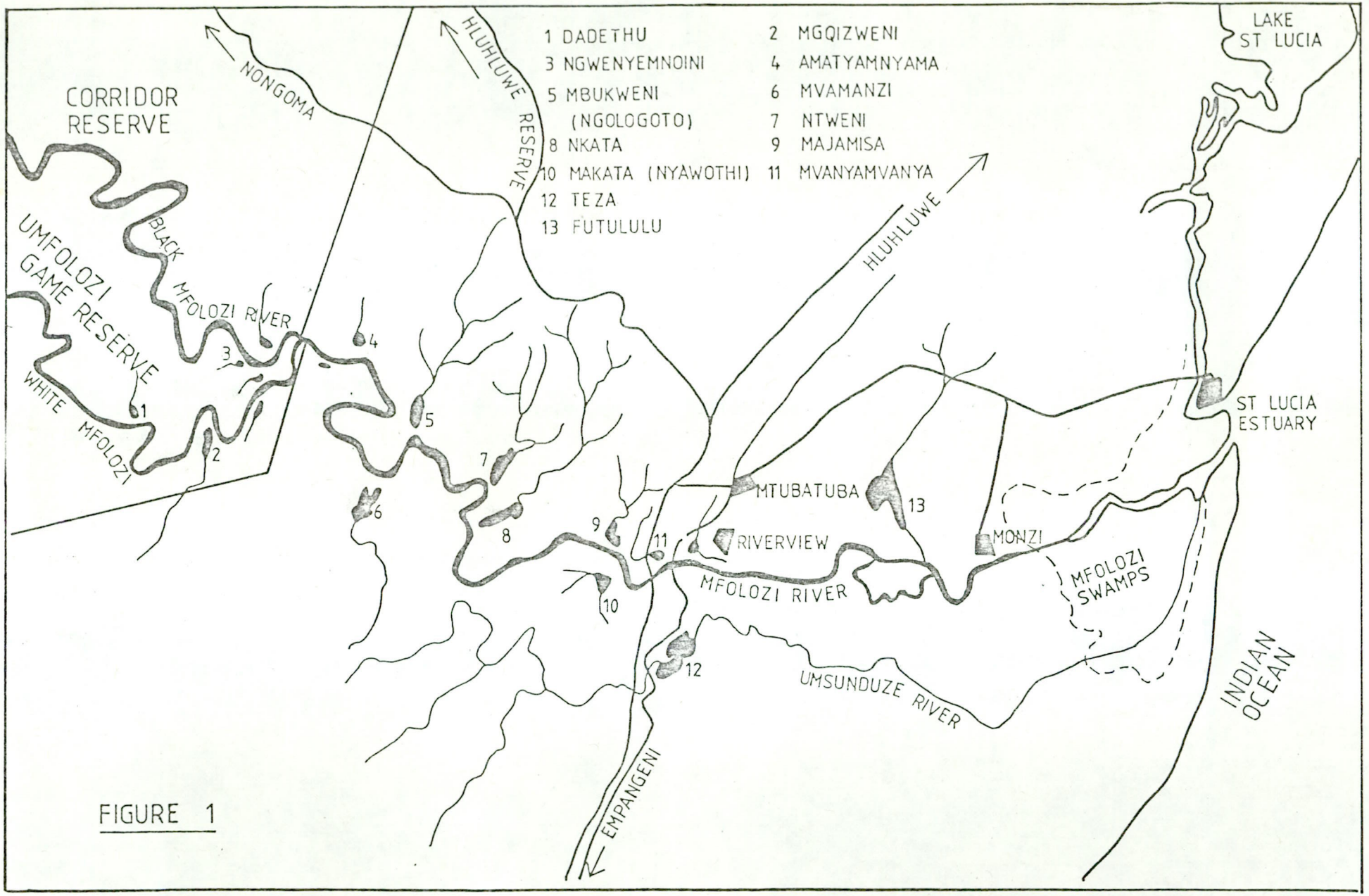
1 DADETHU
2 MGQIZWENI
3 NGWENYEMNOINI
4 AMATYAMNYAMA
5 MBUKWENI (NGOLOGOTO)
6 MVAMANZI
7 NTWENI
8 NKATA
9 MAJAMISA
10 MAKATA (NYAWOTHI)
11 MVANYAMVANYA
12 TEZA
13 FUTULULU
CORRIDOR RESERVE
NONGOMA
HLUHLUWE RESERVE
LAKE ST LUCIA
UMFOLOZI GAME RESERVE
BLACK MFOLOZI RIVER
WHITE MFOLOZI
HLUHLUWE
ST LUCIA ESTUARY
MTUBATUBA
RIVERVIEW
MONZI
MFOLOZI SWAMPS
MFOLOZI RIVER
UMSUNDUZE RIVER
EMPANGENI
INDIAN OCEAN

FIGURE 1