THE UNIVERSITY OF EDINBURGH

KASANKA RIVER SURVEY '97

June - September

PRELIMINARY REPORT

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INTRODUCTION

The Kasanka River Survey '97 was based in Kasanka National Park and the surrounding Kafinda Game Management area (G.M.A) which is situated on the south east fringe of the Lake Bangweulu Basin, Serenje District, Central Province, Northern Zambia.

The park is one of the smallest in Zambia, encompassing an area of 420 sq. km, having been designated a National Park in 1972. The G.M.A. covers a further 3860 sq. km of rich fertile land offering a wide diversity of habitats which support an extensive variety of flora and fauna.

The park is at an altitude of 1060 meters (3500 feet) rising to 1360 meters (4500 feet) in the rocky outcrops of Mpululwe Hill in the south east and Bwalyabemba in the west. It falls within the highest rainfall area in Zambia, averaging between 1000 and 1600mm annually though the area suffered a major drought between 1991 and 1992. The subsequent years of rainfall have not been sufficient to restore the water table to its former levels.

Zambia lies between 10° and 18° south of the equator, having average temperatures of 13 - 27° (59 - 81 °F) in the winter months (May to August) rising to between 27 - 35 °C (81 - 85 °F) in the dry season (September to November). The wet season (December to April) remains warm. This allows an extensive diversity of habitats ranging from Miombo woodlands containing species adapted to periodic burning; to Chipya woodlands which will not withstand burning. The seasonally waterlogged dambos produce a rich variety of herbs and sub-scrub around their margins including many species of orchids, though these tend to be more abundant in areas protected from fire.

The G.M.A. is occupied by the people of the Lala and Bemba tribes. These people are mainly subsistence farmers, employing 'slash and burn' techniques in order to grow cassava, millet, maize and groundnuts. Few of them keep livestock though some keep chickens and a small number of pigs or goats are to be seen. Their principal source of proteins is fish which is mainly caught in the local Mulembo and Luwombwa rivers.

The aim of the project is to investigate local fishing practices and their impact on the health of the rivers. This work was divided into three categories; an invertebrate survey, a fish survey and a community study.

The project was undertaken by a team of six undergraduates from Edinburgh University consisting of four Zoology students and two Ecology students. The team members include Joanne Thomas, team leader and organiser, studying Zoology and Lucie Evans, studying Zoology who worked on the organisation and funding of the expedition and has specialised in the field on the invertebrate survey; James Hunt, studying Ecology, held the post of treasurer and team photographer and directed the fish survey. Gavin Pratt, studying Zoology whose main area of investigation was the community survey. Andrew Woods-Ballard also studying Zoology and specialising in data analysis and Suzanne Lawson studying Ecology. Also on the team were Mabvuto Banda and Wilson Katumbi, two veterinary post graduates from the University of Zambia.

1. INVERTEBRATE STUDIES

1.1 Introduction

The assessment of water quality can take a number of forms, ranging from analysis of physical characteristics to the study of chemical and biological features. The use of biological responses to external factors is now a widely adopted and accepted method of assessing water quality and a number of tests have been established to assess the health of a water body. The method most appropriate to the Kasanka River Survey is that of macroinvertebrate analysis. Benthic macroinvertebrates are particularly suited to use as indicators of water health. They are usually relatively immobile and therefore will accurately reflect the situation at the site from which they are collected. This is very important in the detection of environmental disturbances, for example the use of poisons in the rivers. They are also abundant in aquatic ecosystems and may be collected easily and cheaply. The benthic macroinvertebrates have been widely documented in studies all over the world and several groups are well known for their tolerance or sensitivity to specific environmental conditions. The subsequent presence or absence of such groups can then be used to make qualitative assessments of the local water health at the locality of collection. Quantitative data, such as taxonomic group abundance and diversity, can also be collected and used to obtain various biotic indices. One very useful method of water quality assessment is that of the Biological Monitoring Working Party (BMWP) Scoring System. The BMWP score has been standardised by the ISO and hence can be used to give an accurate indication of the impact of organic pollution, such as that caused by poisoning of waterways for fish collection.

1.2 Methods

Sample sites were chosen on the basis of their suitability for fish sampling (see fish section). This was due to the more specific requirements needed for the fishing sites regarding depths and widths of the river for the comparative studies. Two sites were chosen, the first within the park and the second outside. The first site, on the Luwombwa river near its confluence with the Mulembo river, was contained within the furthest up and downstream net sites. The distance between these two points was found to be 357m, and this was adopted as the standard site length. Using a random number table (Fowler & Cohen 1995), a random distance of 43.3m was obtained. Samples were then collected at intervals of 43.3m along the study site. The samples were taken at three points across the river at each site, one in the centre and one on either side near the bank. A total of twenty four samples were collected and each sample was allotted a number, see table one over leaf.

Invertebrate samples were collected using a standard kick sampling method and the samples were placed in numbered bags for sorting. At this point a description of each sample site was taken, including substrate and vegetation type, depth and flow rate. Flow rate was measured timing a float over a measured distance. This information can be found in appendices 1 and 2. Each sample was emptied into a white tray and sorted, translocating all invertebrates to sample pots for identification. The individual specimens were then identified as far as family level and counted. Representatives of each family found were drawn and preserved in 70% ethanol for later study. The sample counts were collated and total numbers for the whole study site calculated.

The second site was situated near the villages on the upper reaches of the Luwombwa river. This site is heavily fished and the use of poisons is widespread, thus providing a good basis for comparison with the unfished park sites. The area chosen for the fishing study proved unsuitable for invertebrate sampling due to its depth, reaching 4.5m in some areas. Therefore, a sample site was chosen in shallower water as close to the fishing sites as possible. As before the sample site was 357m long and the samples were taken at intervals of 43.3m, again in sets of three across the river. The samples were sorted and counted using the same methods as before and the counts collated.

Tables two and three show the number of specimens within each family which were collected from the two study sites.

Table Two : Site One - Luwombwa Confluence

Family Name	Common Name	Family Code	Total No. Collected
Rhagionidae	Larva	A	22
Simuliidae	Black fly larva	B	57
Philopotamus	Larva	C	13
Hydrachnellae	Water mite-adult	D	56
Chironomidae	Larva	E	223
Limnephilidae	Caddis fly larva	Fi	
Beraeidae	" " "	Fii	
Psychomyidae	" " "	Fiii	77
Hydroptilidae	" " "	Fiv	
Leptoceridae	" " "	Fv	
Nematoda	Round worm	G	4
Ceratopogonidae	Midge larva	H	115
Potamanthidae	May fly larva	I	
Pteronarcellidae	Stone fly nymph	Ii	125
Epeorus	May fly nymph	Iii	
	May fly nymph	J	316
Elmidae	Helmet beetle-adult	K	85
Hydropsychidae	Larva	L	111
Sphaeriidae	Pea Mussel	M	50
Elmidae	Helmet beetle larva	N	35
Tabanidae	Horse fly larva	O	12
Perlodidae/Perlidae	Stone fly nymph	P	9
		Q	18
		R	1
Aeshnidae	Dragon fly nymph	S	
Agriidae	Damsel fly nymph	T	114
Libellulidae	Dragon fly nymph	Ti	
Lestidae	Damsel fly nymph	Tii	
		U	1
Tricladia	Flat worm	W	1
	Worm (incomplete specimen)		1
Hirudinea	Leech	Y	4
Unionidae	Fresh water mussel	Z	3
Dreissensiidae	" " "	"	
Dystiscidae	Beetle	AA	29
Diptera	Larva	AB	11
Decapoda	Crayfish	AC	6
	Water spider	AF	1
Physidae	Fresh water snail	AG	1
Cyclopidae	Cyclops	AH	1
Nematoda	Round worm	AI	1
Viviparidae	Fresh water snail	AJ	4
Naurcoridae	Water bug	AK	1

declined. At this early stage it is impossible to say whether this is the case but this will be looked into further in the final report.

The presence, and relative abundance of the stone fly nymphs within the park is also very encouraging. In contrast to the Chironomid larvae, Stone fly nymphs are very sensitive to pollution in the water and are among the first groups to decline and disappear when water health is compromised. Their seemingly large population within the park would therefore indicate that the water quality is good and able to support a normal, healthy ecosystem. In a similar way, their absence from the samples outside the park suggests that the water quality is not as good and hence unable to support such sensitive organisms.

At this stage the BMWP and ASPT numbers do not produce a significant comparison, being quite close in magnitude. However, it should be noted that this may be due to the incomplete family record for the two sample sites. There are still several unidentified families and some whose identification is not certain. This means that the scores cannot be accurately calculated at this point and hence are still somewhat misleading. It can be said though, that the general water quality in both sites is good and any differences are not immediately detectable by this method.

The above points will be investigated further and discussed in the final report, together with statistical analysis of the family counts and more accurate identification of the collected samples.

2. FISH STUDIES

2.1 Introduction

Throughout Zambia there exists an extensive network of river and lake systems which supports a wide diversity of fish species. Many of the rivers are tributaries to the Zambezi and lie within its catchment area. However, parts of the Luapula, Northern, Central and Eastern provinces of Zambia fall within the Zaire basin and are therefore characterised by a different set of fish species. This divide between the two catchment areas represents part of the boundary for fishes contained within Southern Africa and Central Africa (Jubb 1967, Skelton 1993). Attempts have been made in the past to document fish species south of this boundary to form identification handbooks with more recent studies providing more comprehensive and reliable information (Jackson 1961a, Jubb 1967, Bell-Cross & Minshull 1988, Skelton 1993). However, the increased diversity associated with an increase in latitude from southern to central Africa has posed problems in documenting all fish species. This is particularly true of Zambia which encompasses the Zambezi catchment area with over 178 species and the Zaire system with greater than 700 species (Skelton 1993).

Most of the species within central and southern Africa are derived from two families, the cichlids (Cichlidae) and more importantly the cyprinids (Cyprinidae). Since 30% of the total fauna in southern Africa is represented by the cyprinid family, there are still many species from this group that remain unidentified. This can also be attributed to the relatively small average size of these species which makes them harder to distinguish.

Published studies have so far been mainly limited to major fisheries in Zambia which include the Kafue flats (e.g. Dudley 1978) and lake Bangweulu (Evans 1983, Chanda *et. al.* 1996). Lack of financial resources in the fisheries department and the inaccessibility of many regions helps to contribute to a lack of research in other water bodies. With this in mind it is understandable that no previous studies have been undertaken on the fish fauna of Kasanka National Park or the outlying Game Management Area (G.M.A.).

removal by predators such as the water mongoose and the water monitor (*Varunus niloticus*), nets were retrieved at first light which was around 05:30 - 06:30 hrs.

Since the length and duration that each net was set was variable each night a standardised figure of catch / m2 / min was required to make results more comparable. The length of each net and the time each one was in the water was recorded to create values that were then suitable for graphical representation and statistical analysis of catches between sites. GPS positions were recorded for the middle net at each site along with data on pH, conductivity, air and water temperature. Fish caught in nets at each site were then returned to camp for the recording of standard and total lengths for each individual. Each species was assigned a letter for reference and local villagers were consulted for the Lala and Bemba names. This procedure was then repeated for the remaining two sites which possessed similar habitats and depth zones for setting nets.

All species that were large enough (greater than 2 inches) were photographed using a macro lens (1:4) on a plain white background with a tape measure as an indication of scale. Fish species not previously recorded in Kasanka park or the G.M.A were placed in approximately 10% formalin before being placed in 80% ethanol after two weeks. As a means of collecting as many different species as possible, dip nets and hook & line were also used to catch samples of fish on the Luwombwa and Mulembo rivers. Catches from local fishermen using baskets and gill nets were also examined for unrecorded species and local people were also asked to help find fish species that had not yet been recorded. Wherever possible, GPS position, habitat and general physical characteristics were recorded for new sites where fish were caught.

2.4 Results

Species Inventory

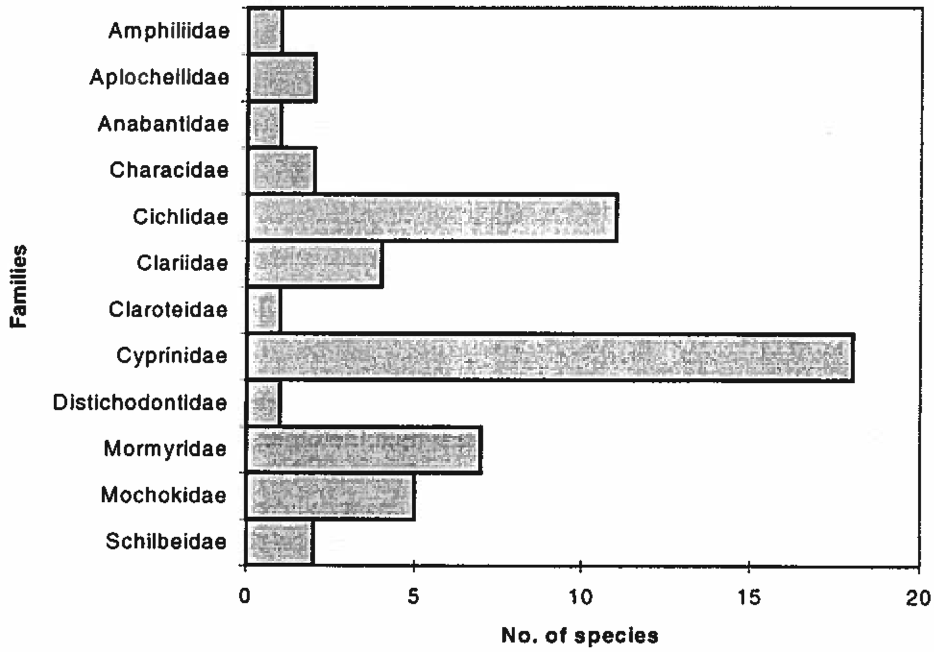

Fig 2. Comparison of the number of species contained within each family on the Luwombwa and Mulembo rivers.

Overall there were 59 different species recorded within the park and the surrounding G.M.A. as indicated in appendix 3. As expected, problems were encountered with identification, particularly to species level which is indicated by the absence of some systematic names. Many of the unidentified fish were members of the Cyprinid family, most of which were grouped into further reduced the fish diversity in the study areas. Further collections of samples that extend throughout the year at different points along the Luwombwa and Luapula river could provide further insight into the species present and migratory patterns according to the season.

Since studies were limited by the time available, samples were only collected from the Luwombwa and Mulembo rivers. This leaves room for further study on the Kasanka river which possesses stretches of deep water (4-6m) maintained by hippopotamus, but it is relatively narrow (approximately 5m width). Collection of fish samples on the lakes surrounding Wasa camp could also be undertaken, possibly using a seine net as a relatively quick method of catching a large sample of fish. This could be used to compare species composition to the rivers in the park and to search for any previously unrecorded species.

The results as indicated in figure 3 for the comparative studies suggests that there were less fish outside the park than inside. Conclusions will be made in the final report based upon further analysis of results and the consideration of information produced from the community studies. There were however a number of problems encountered in collecting this data which may affect the interpretation and conclusions of this study. The main problem was damage caused to gill nets by crocodiles that attempted to remove trapped fish. This was a problem that was only encountered at the two fishing camps within the park. As a result only one set of nets was used for a period of six days at Yewe where crocodile interference was absent. Gill nets were set at a proposed second site at Yewe but were damaged beyond repair after only one night, which left only one set of nets available for the rest of the study period. The higher incidence of crocodile interference with nets inside the park was possibly due to the greater number of fish caught in nets. It is therefore recommended that in any future comparative studies, the nets are either set during the day when crocodile activity is minimal or retrieved after a shorter period in the water to reduce the chance of fish removal.

3. COMMUNITY STUDIES

3.1 Introduction

The main aim of the Kasanka River Survey was to compare fish and invertebrate populations found in stretches of the Luwombwa river, inside and outside the park. The single most conspicuous difference between these two areas is the extent to which they are exploited for their fish stocks. It is of importance and interest to determine what techniques are used by the people outside the park, in the G.M.A., to catch fish. The main aim of the community study is to catalogue the different fishing practices and the times of year at which they are employed. Additional information has been collected on the local diet, the recent history of fish yields and rainfall and the views of the villagers towards the park.

Information on how the Luwombwa river is utilised throughout the year as a fishing resource provides a context for the fish and invertebrate studies. It is necessary to ascertain certain facts, such as the use of poisons and the time of year at which they are applied, to aid interpretation of the invertebrate study. Explanation of any difference in the numbers and types of fish inside and outside the park should take into consideration the way in which the river is fished.

From our questioning a picture can be formed, of how the villagers depend upon the river and surrounding water bodies for food. It is then hoped that we can determine, to some extent, how sustainable the river is as a food source.

3.3 Results

For the purposes of the preliminary report not all the areas investigated in the community study will be represented here, additional information remains, for inclusion in the final report. For the most part this section will deal with fishing methods, along with details of the time of year at which they are most effective. From our studies we found that a variety of fishing methods are used; hooks, nets (Amasaka), baskets (Intende and Myono) and poisons.

Rainfall

In the past people used to migrate long distances to fish on the Luwombwa river, however the villagers say that there is less fishing activity these days. The locals tend to attribute the decrease in fish stocks to the low rainfall over the last 10-15 years, especially in 91/92 and 93/94. Fig 1 shows the yearly total rainfall as recorded in Kasanka National Park. If one compares these values to the average yearly total for the area of 1100mm-1200mm, it is clear that there have been several poor years of rain over the last decade. This has caused dambos to dry up and the lower water level of the river has caused a reduction in the amount of fish migrating from downstream to breed in the area. All the villagers we talked to agree that the population is increasing, since family sizes are large, but they do not feel the requirement for more food to sustain greater numbers of people is a reason for the drop in fish stocks. The people believe that each year there are so many fish breeding that any that are caught are replaced, even though areas used for breeding have dried up.

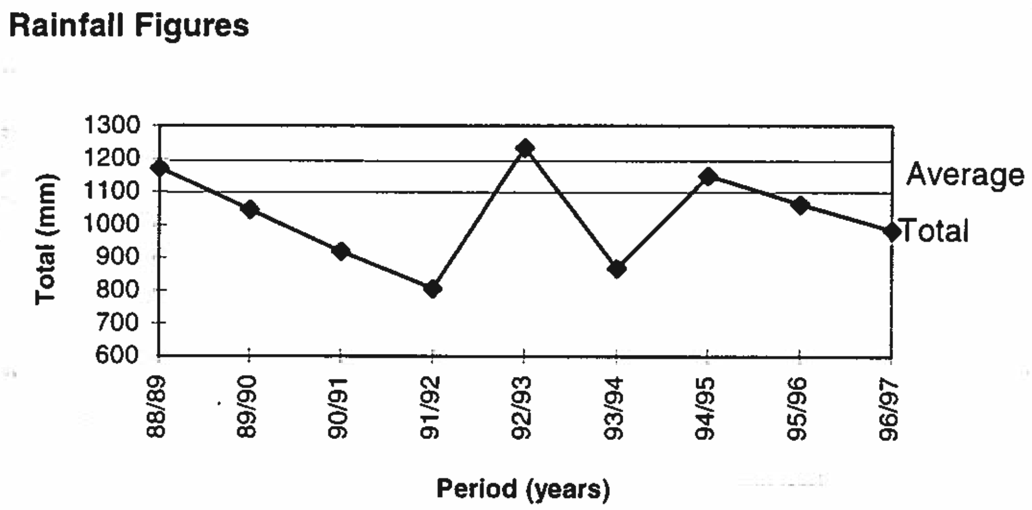

Fig. 1 'Total' yearly rainfall for Kasanka National Park and the 'average' figures for Serenje District, Central Province

Fish Catches

The most commonly caught species are :-

IMPENDE
MATUKU
NGOLA
IMPIFU
MUSENGA
IMILONGO
IMPOLWE
INKOMO
KOLONGWE
KASEPA

Basket Fishing

Baskets are used either in dambos or in rivers, from mid August to the start of the rains. There are two kinds:

1) Myono (figs. 7, 8 & 9, appendix 4) baskets which allow fish to swim inside but prevent their exit. People may scare fish into them or they are placed at the mouth of dambos which drain into the river and across man made weirs and dams in the river.

2) Intende (fig. 10, appendix 4) baskets made from strong grasses, bound together with twine, which are used in both rivers and dambos. They are employed in two ways: i. Kusaya. This method involves thrusting the basket into the water at a place where fish may be hiding and forcefully sweeping it through the water towards oneself, scooping up small fish. ii. Kupila. This is more commonly used in dambos, it involves many people, 10 or more, who empty small dambos using buckets. When the water level is low enough, stranded fish are scooped out with the buckets.

Poisons

Poisons are used when water levels are low, in the period leading up to the rainy season. There are many different sources for poisons, all derived from plants. From our studies it seems that there are essentially three main types used in this area; ububa, kanchense and umubaka. Ububa seems to be the most common and ububa plants are ubiquitous in the yards of the villagers.

Ububa is used by a group of people, often 10 or more, men and women. The poison is applied to dambos as they dry up and to slow moving rivers when the water level is low. The poison is prepared by pounding a large quantity of leaves along with clay or crushed anthills. Mixing the crushed leaves with this mud ensures that the poison disperses through the water body and is not swept away by the current. The pounding and mixing is carried out in a purpose built hole in the ground. Dambos are owned by villagers, through inheritance and owners invite friends or relatives to fish with them. Each person brings a sack filled with ububa leaves, the quantity required depends on the size of the water body.

Ububa is a very fast acting poison (starts working in minutes) and is thus favoured by the villagers. It is thought to blind, partially paralyse and disorientate fish although not all species are susceptible. Affected fish may either be scooped up using baskets, speared or caught in nets, which are laid across the river or dambo. The poison works for up to six hours and people may return the morning after application to collect fish which have been affected during the night. Imita and matuku are not caught using this poison, and if it is used in the same place on consecutive days no fish are caught on the second day.

Kanchense is derived from root tubers, similar in size to those of cassava, it's use seems to be rare due to difficulty in finding the plant. It is prepared by pounding the tubers with clay and a thorny plant called teketa. Kanchense is a potent poison, killing fish for several days in dambos. When used in a river it's effects are thought to last for several kilometres downstream before becoming too diffuse to kill further. Using this potent poison carries a two year prison sentence so the locals avoid it.

Umubaka is prepared using a particular tree bark, as before it is pounded and mixed with clay, teketa can also be added. It is very effective lasting for almost a week in some dambos and if applied in sufficient quantities turns the water blue/black. It is used from July to October and kills all the fish in small rivers. It isn't favoured as much as ububa as it makes the fish dark and tasteless.

Appendix 1 : Physical information for the invertebrate collection site

Physical Information for Site One - Luwombwa Confluence

Sample number	Depth (m)	Substrate	Vegetation
1	0.40	sand	long reeds
2	0.52	sand	long reeds
3	0.50	sand/pebbles	open
4	0.40	sand	reeds
5	0.90	sand	long weed
6	0.72	mud	short, dense weed
7	0.60	sand/pebbles	long weed
8	0.26	sand	reeds
9	0.40	sand	short weed
10	0.40	sand/pebbles	long weed
11	0.45	sand	long weed
12	0.40	sand	sparse weed
13	0.17	mud/detritus	open
14	0.48	sand/stones	sparse weed
15	0.66	sand/stones	sparse weed
16	0.34	sand/stones	open
17	0.50	sand/pebbles	sparse weed
18	0.52	sand/pebbles	open
19	0.32	sand	long weed
20	0.58	sand/pebbles	open
21	0.27	sand/pebbles	sparse weed
22	0.80	thick sand/mud	dense, short weed
23	0.20	sand/pebbles	short weed
24	0.25	silt/detritus	open

Physical Information for Site Two - Upper Luwombwa

Sample number	Depth (m)	Substrate	Vegetation
1	0.50	pebbles/detritus	open
2	0.64	stones/pebbles	long weed
3	0.52	pebbles/silt	weed/detritus
4	0.39	sand/stones	open
5	0.55	sand/pebbles	dense, short weed
6	0.20	pebbles/course sand	detritus
7	0.41	silt/sand	short weed
8	0.46	silt/pebbles	dense, short weed
9	0.51	sand/pebbles	short weed
10	0.52	stone/pebbles	open
11	0.58	silt/sand	detritus
12	0.32	silt/stones	detritus
13	0.59	sand/pebbles	detritus
14	0.69	stones/pebbles	detritus/short weed
15	0.41	mud/silt	dense, short weed
16	0.33	sand/pebbles	open
17	0.37	silt/mud	dense, short weed
18	0.56	silt/mud	weed/detritus
19	0.67	stones/pebbles	open
20	0.76	stones/pebbles	weed/detritus
21	0.57	stones/pebbles	detritus
22	0.36	stones/pebbles	detritus
23	0.67	stones/pebbles	open
24	0.33	stones/pebbles	detritus

Appendix 3 : Table of fish species caught

	LALA	BEMBA	FAMILY	GENUS SPECIES
A	Twali mene	Twali mene	Characidae	*Bryonysops*
B	Matuku	Chituku	Cichlidae	*Tilapia sparmanii*
C	Kolongwe	Kolongwe	Cyprinidae	*Labeo cylindricus*
D	Kafumbe	Nsuku	Cichlidae	*Serranochromis thumbergi*
E	Imene	Imene	Characidae	*Brycinus*
F	Buyumanda (1)		Musenga	
G	Insukubimba	Nsuku	Cichlidae	*Sewanochromis robustus*
H	Impende	Impende	Cichlidae	*Tilapia rondalli*
I	Ubukundu	Chikundu (Chalukuwa)	Cichlidae	*Pseudocrenilabrus philander*
J	Impolwe	Polwe	Cichlidae	*Serranochromis augucticeps*
K	Ubukundu	Ubukundu	Cichlidae	
M	Kafoswe	Kafoswe	Claroteidae	*Chrysichthys stapensi*
N	Bomba	Bomba	Clariidae	*Clanas stappersii*
O	Chimpuma (1)		Mormyridae	*Hippopstamyros*
Q	Bwelele	Bwelele	Cyprinidae	
R	Musenga	Musenga	Cyprinidae	
S	Solomon	Solomon	Cyprinidae	*Raiamas*
T	Cingongo (1)	Chingongo	Mochokidae	*Synodontis*
U	Senga piff	Senga piff	Cyprinidae	*Barbus staperi*
V	Musenga (1)	Musenga	Cyprinidae	*Barbus miolepis*
W	Loupata	Loupata	Schilbeidae	*Schilbe zairensii*
X	Mumbulowe		Cyprinidae	*Barbus immaculatus*
Y	Chindeba	Inchindeba		
Z	Chimpuma (2)		Mormyridae	*Petrocephalus sinus*
AA	Ngola	Umuta	Clariidae	*Clanas liocephalus*
AB	Musenga	Musenga	Cyprinidae	
AC	Musenga	Musenga	Cyprinidae	
AD	Musenga	Musenga	Cyprinidae	
AE	Imbofwe	Imbofwe	Schilbeidae	
AF	Chingongo (2)	Chingongo	Mochokidae	*Synodontis katargae*
AG	Chimpuma (3)		Mormyridae	
AH	Lemba lemba		Mormyridae	*Petrocephalus*
AI	Molombo kosweta		Aplocheilidae	*Notoarbranchius*
AJ	Inkomo	Nkomo	Anabantidae	*Ctenopoma*
AK	Chineke	Chineke	Clariidae	*Clarias stappersii*
AL	Musenga	Musenga	Cyprinidae	
AM	Musenga	Musenga	Cyprinidae	*Barbus poechii*
AN	Buyumanda (2)		Cyprinidae	*Barbus casciolatus*
AO	Mubanse	Mubanse	Cyprinidae	
AP	Buyumanda (3)		Cyprinidae	
AQ	Bwelele	Bwelele	Cyprinidae	*Aplocheilichthys*
AR	Musenga	Musenga	Cyprinidae	
AS	Musenga	Musenga	Cyprinidae	
AT	Ikusa mabwe		Mochokidae	
AU	Lukwete			
AV	Muntesa	Muntesa	Mormyridae	*Macusenius*
AW	Mulonge		Clariidae	*Clanas theodorae*
AX	Mulombo kusweta		Aplocheilidae	
AY	Musenga	Musenga	Distichodontidae	
AZ	Ikosa mabwe	Musenga	Amphilidae	
BA	Chingongo	Chingongo	Mochokidae	
BB	Ubukundu	Ubukundu	Cichlidae	
BE	Chimpoma		Mormyridae	
BF	Impolwe (2)	Impolwe	Cichlidae	
BG	Chebwa	Chebwa	Cichlidae	
BH	Inkamba	Inkamba	Cichlidae	*Oreochromis marcrochii*
BI	Impombu	Impombu		
BJ	Sampa	Sampa	Clariidae	
BK	Mukakabala			

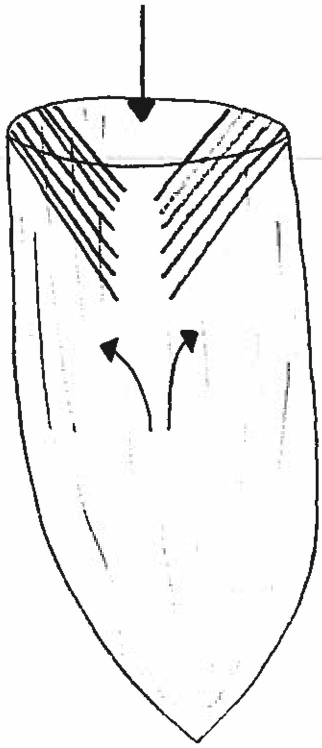

Fig. 7 The Myono

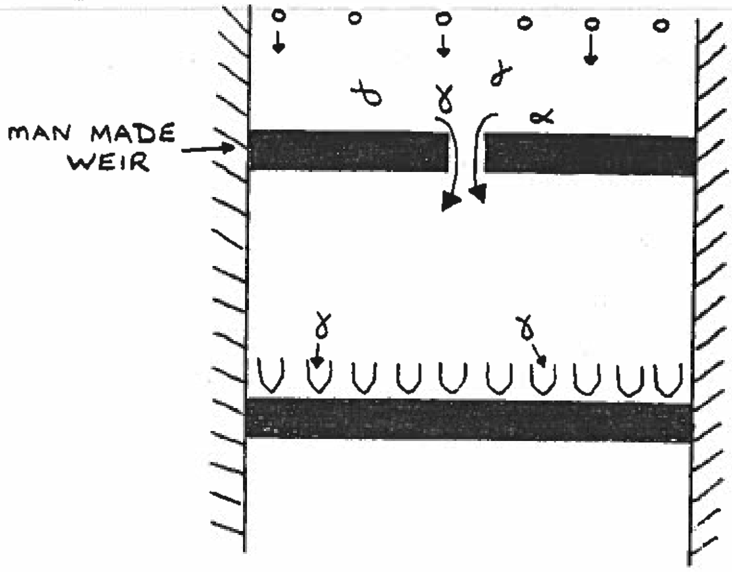

Fig. 8 Ukwalila method

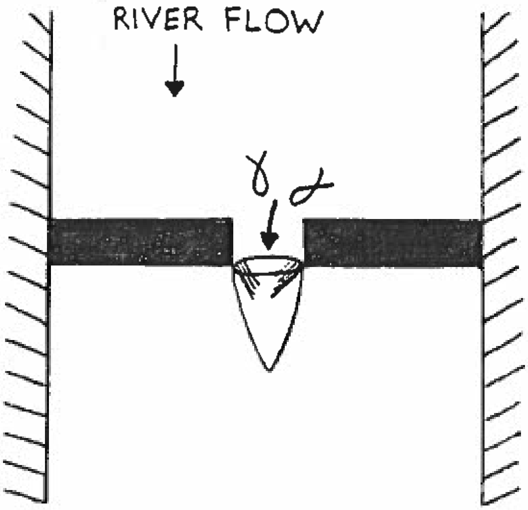

Fig. 9 Chipanda method

Fig. 10 The Intende

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