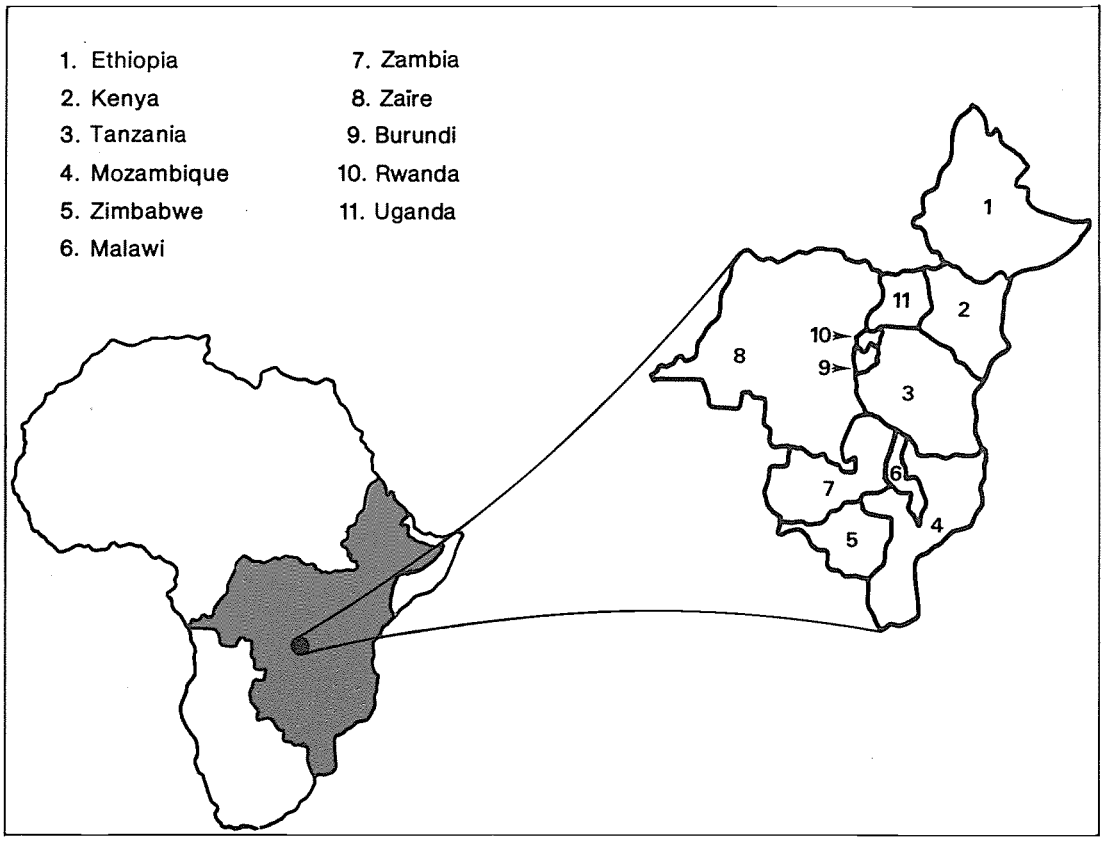
REGIONAL PROJECT FOR INLAND FISHERIES PLANNING, DEVELOPMENT AND MANAGEMENT IN EASTERN/CENTRAL/SOUTHERN AFRICA (I.F.I.P.)

IFIP PROJET

RAF/87/099-TD/17/90 (En) January 1991

A REVIEW OF THE FISHERIES OF LAKE KARIBA AND THEIR MANAGEMENT



UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNDP/FAO Regional Project
for Inland Fisheries Planning
Development and Management in
Eastern/Central/Southern Africa

RAF/87/099-TD/17/91 (En)

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A REVIEW OF THE FISHERIES OF LAKE KARIBA AND THEIR MANAGEMENT

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS DEVELOPMENT PROGRAMME
Bujumbura, January 1991

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PREFACE

The IFIP project started in January 1989 with the main objective of promoting a more effective and rational exploitation of the fisheries resources of major water bodies of Eastern, Central and Southern Africa. The project is executed by the Food and Agriculture Organisation of the United Nations (FAO), and funded by the United Nations Development Programme (UNDP) for a duration of four years.

There are eleven countries and three intergovernmental organisations participating in the project: Burundi, Ethiopia, Kenya, Malawi, Mozambique, Uganda, Rwanda, Tanzania, Zambia, Zaire, Zimbabwe, The Communauté Economique des Pays des Grands Lacs (CEPGL), The Preferential Trade Area for Eastern and Southern African States (PTA) and the Southern African Development Coordination Conference (SADCC).

The immediate objectives of the project are: (i) to strengthen regional collaboration for the rational development and management of inland fisheries, particularly with respect to shared water bodies; (ii) to provide advisory services and assist Governments in sectoral and project planning; (iii) to strengthen technical capabilities through training; and (iv) to establish a regional information base.

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The present document is a general review of the fisheries of Lake Kariba. It focuses on the resource base, the major socio-economic aspects of the main fisheries and their management. The document contains two papers, one by Dr. C. Machena and the other by V. Kanondo, which respectively concentrate on the Zimbabwean and Zambian side of the lake. The first paper was originally prepared as a case study and presented at the IFIP/SWIOP Workshop on Economic Aspects of Fisheries Development and Management held in Dar-es-Salaam, Tanzania, from October 30 to November 9, 1989 (see **TD/12/90 (En)**).

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For both series, reference is further made to the document number (17), the year of publication (91) and the language in which the document is issued: English (En) or French (Fr).

For bibliographic purposes this document should be cited as follows:

C. Machena and V. Kanondo, A Review of the Fisheries of Lake Kariba and
1991 their Management. UNDP/FAO Regional Project for Inland Fisheries Planning (IFIP). RAF/87/099-TD/17/89 (En): 58p.

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INTRODUCTION

This document contains two papers on selected aspects of the fisheries of Lake Kariba shared between Zambia and Zimbabwe.

The first paper by Dr. C. Machena gives an overview of the status of both the artisanal and commercial fisheries of Lake Kariba. Research programmes and management strategies are discussed in the context of the biology of the fish, specifically on the extent to which the fish are adapted to the lacustrine or pelagic systems. Fisheries management is not without problems. These are also highlighted and some measures to resolve these are given in the context of a sub-regional DANIDA/NORAD sponsored project on the lake. The paper gives emphasis on the situation on the Zimbabwe side based on the experience of the author.

The second paper by V. Kanondo examines the fish resources of Lake Kariba on the Zambian side. The paper reviews the socio-economic aspects of the Kariba fishery with particular reference to the artisanal sector. Drawing from a number of recent investigations, it provides information on fishermen, fish processors and traders, and on the major socio-economic characteristics of their activities. Issues related to the role of fish traders and fishing co-operatives are examined. The paper also reviews the various regulations in place and adresses related issues such as enforcement.

THE STATUS AND MANAGEMENT OF THE LAKE KARIBA FISHERIES (Zambia/Zimbabwe)

by
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1. INTRODUCTION

Lake Kariba (16 28' to 18 6' S ; 26 40' to 29 03' E, Table 1) had an annual fish landing of 36,749 tonnes in 1988 with a total landed value of Z$ 54,000,000[1] and this is entirely a capture fishery which is both commercial and artisanal. The need for an effective management programme for this fishery is clear.

Lake Kariba is shared between Zambia (45%) and Zimbabwe (55%). Whereas the Kariba fishery is the most important for land locked Zimbabwe, Zambia which is also land locked enjoys the exploitation of other important fisheries e.g. on Lake Tanganyika, Mweru, the Kafue flood plains etc.

The commercial fishery exploits the pelagic Limnothrissa miodon (locally known as kapenta) a freshwater sardine endemic to Lake Tanganyika. Limnothrissa was introduced in the lake in 1967/68 to exploit the pelagic water which comprised an open niche (Balon, 1971 ; Bell-Cross & Bell- Cross, 1971). In 1988 the commercial fishery landed 30 000 tonnes (18,000 tonnes from Zimbabwe and 12,000 tonnes from Zambia) with a total landed value of Z$ 40,000.00 (Machena et al., 1989).

The artisanal fishery is traditional and unmechanized and is based on gill-netting in the inshore areas. It is operationally simple and requires a low capital outlay. The fishery landed 6,749 tonnes in 1988 (4,537 tonnes in Zambia and 2,212 tonnes in Zimbabwe) with a retail value of Z$ 14,000,000.00 (Murphree et al., 1989).

The introduction of the pelagic sardines created an economically viable industry on the lake. A programme of fisheries and limnological research on the lake has also been developed to enhance an understanding of the fisheries ecology.

This paper gives an overview of the status of both the artisanal and commercial fisheries on the lake, with emphasis on the Zimbabwean side. Discussion on research programmes and management strategies is carried out in the context of the biology of the fish, specifically on the extent to which the fish are adapted to the lacustrine or pelagic systems. Fisheries

[1] £1.00 = Z$ 3.50

management is not without problems. These are also highlighted and some measures to resolve these are given in the context of a sub-regional DANIDA/NORAD sponsored project on the lake. What needs to be emphasized is that fisheries management has been conducted separately on the lake by the two countries because political of factors. The sub-regional project is viewed as setting the basis for an effective joint management programme (between the two countries).

2. THE INSHORE FISHERY

2.1 Fish Composition and Ecology

Table 2 lists 41 species of fish recorded in Lake Kariba. Of these 65% are predators, 26% are omnivorous and 9% are herbivores. In the category of predators only Hydrocynus forskahlii Cuvier is more specialized. Hydrocynus is an active and efficient piscivore preying on fish up to 40% of its own length (Bell-Cross, 1976). The fry and fingerlings, however, occupy a different habitat and are generalised predators feeding on zooplankton, aquatic insects and fish (Bowmaker, 1973 ; Kenmuir 1975 ; Mitchell, 1976). The rest of the predators Mormyrops deliciosus, Mormyrus Longirostris, Marcusenius macrolepidotus, Alestes imbeli, A. lateralis, Microlestes acutidens, Hippopotamyrus discorhyncus, Heterobranchus longifilis, Clarius gariepinus, Eutropius depressirostris, Synodontis zambezensis, S. nebulosus, Haplochromis dalingii, H. codringtoni and Pseudocrenilabrus philander tend to be generalised (Machena, 1988). The feeding habits of these are discussed by Kenmuir (1975), Burne (1971), Joubert, (1975), Mitchell (1976) and Bell-Cross & Minshull (1988). The following comprise the food items but their relative importance in the diet varies from species to species:-Caridina and Cyclaestheria (crustacea), Povilla adusta nymphs, anistopteran nymphs, tricopteran larvae Chaoborus larvae, chironomids, terrestial insects, mollusca, fish etc. For example, the mormyrids prey heavily upon Caridina and Povilla nymphs whilst molluscs (Bulinnus, Biomphalaria, Cubicula etc.) are important as prey items for Synodontis zambezensis, Serranochronmis codringtoni, S. giardi, S. carlottae, Clarius gariepinus.

The fact that the majority of the fish species of Lake Kariba are benthic and predatory (Mitchell, 1976) is significant in emphasizing the riverine origin of these fishes before the formation of the lake. Lowe-McConnel (1987) points out that most rivers provide a little diversified habitat. Because of the rapid flow of the river planktonic and submerged macrophytes may not form important food items. The fish therefore depend to a large extent on benthic items, allochthonous material e.g. insects and other fishes. The nature of the Zambezi River before the formation of the lake fits the description of Lowe-McConnel (1987).

The Zambezi River was described by Jackson (1961) as a sand bank river. During the rainy season, the river flooded violently inundating flood plains for a short space of time. After the rains, in the dry season, flood waters receded and the river dwindled and flowed in deep sand banks. Aquatic vegetation was therefore scarce. The river was therefore a much less structured environment than a seasonal water body with well developed benthic, littoral and pelagic habitats.

The fish fauna of the river had therefore a preponderance of generalised predators with a few species making up the greater part of the biomass. The two Labeo spp, the two Distichodus spp, Hydrocynus, Clarius, and Alestes imberi comprised the bulk of the biomass (Jackson, 1961). Cychlids were poorly represented in catches. There were only low quantities of Tilapia rendalii Oreochromis mortimeri and Seranochromis condringtoni (Jackson, 1961). Predation by Hydrocynus was intense and was a major controlling factor of other fish populations.

What needs emphasis is that the ecological preferences of the fish in the lake have not changed much from the situation in the river before lake formation. In other words most of the fish have not adapted to lacustrine conditions. Their current abundance and distribution are determined by proximity to rivers and the distribution of preferred food items. Variation in these two factors also influenced the development of the fish population during the filling phase of the lake (Kenmuir, 1984).

A dependence on rivers by a large number of the species e.g. Cyprimids, Distochodus, Hydrocynus, Siluriids follows the need to utilise the river for spawning purposes. The species are therefore found in proximity to rivers with the exception of the Hydrocynus (Fig.1). Before lake formation there was an ecological need for spawning - runs up flooded rivers as the flooded river plains provided more food. This was important for the fingerlings before they had to face the harsh environment in the river when flood waters receded.

The cichlids are an exception and were able to colonise the estuarine waters.

Overall the fish fauna of the Zambezi river before flooding was not able to colonise the pelagic waters but only approximately 30% of the lake surface area in the shallow water and rivers around the lake's margins (Coke, 1968, Balon, 1974). This has a bearing on the nature of management strategies adopted for the inshore fishery e.g. prohibition of fishing in rivers. This is also why there was a need for a successful introduction of Limnothrissa miodon to exploit the pelagic niche.

2.2 Biomass estimates

Estimates of the fish biomass of the inshore areas of Lake Kariba were carried out by Balon (1974), Mitchell, (1976) and Marshall & Langerman (1984). Balon and Mitchell worked in shallow areas where they were able to block off coves with nets and poison all the fish with rotenone within the enclosures. Balon sampled deeper area than Mitchell. This approach limited the programme to shallow coves and bays which could be completely netted off. Marshall & Langerman conducted their sampling by using an explosive grid (cortex with pentoline boosters at two meter intervals) and extrapolating the weight of the fish covered from each quadrant to one hectare. This approach was more flexible and permitted sampling in deep water and rocky shores that were not easily accessible. Whereas Balon's work was more extensive, covering large areas of the lake, Mitchell limited his sampling to the eastern basin while Marshall & Langerman collected their data from 13 transects spaced to cover the whole lake. These differences in approach may explain the differences in the results. The biomass estimates of these workers are summarised in Table 3.

Marshall and Langerman's (1984) ichythiomass values are much lower than those of Balon (1974) and Mitchell (1976). Whereas the ichythiomass range given by Balon (1974) of 276 kg/ha to 1,225 kg/ha is similar to that of Mitchell (1976) of 46 kg/ha to 1,400 kg/ha, both these ranges are much higher than that of Marshall & Langerman (1984). However because Marshall & Langerman did not sample in water more than 6 m deep, they increased their ichythiomass value by 12%, to allow for fish biomass not sampled in water between 6 and 15 m depth. Coke (1968) took 88% of his total fish sample from water 6 m deep. With this adjustment Marshall & Langerman came with a total biomass estimate of 10,000 tonnes.

Following the indication of Mahan & Balon (1977) that only 46.4% of the inshore biomass of Kariba consists of economically preferred species Marshall & Langerman (1984) argue that the inshore fishery is therefore based on only a biomass of 4,500 tonnes. This would appear to be a considerable underestimate when it is realised that the inshore fishery of both Zambia and Zimbabwe yielded 6,749 tonnes in 1988. Despite this underestimation, however, the point to bear in mind is that the inshore fishery resource of Lake Kariba is low and sets a definite limit on yields.

Both Mitchell (1976) and Marshall & Langerman (1984) describe a correlation between ichythiomass and vegetation cover. The development of vegetation described by Mitchell (1969), Marshall & Junor (1981), Machena and Kautsky (1988), Machena (1989) led to the development of benthic fauna (McLachlam, 1969; McLachlam & McLachlam, 1971). Generally vegetation increases habitat diversification.

2.3 The set up of the inshore fishery

There are 2,831 artisanal gill-netting fishermen on Lake Kariba. Of these 1,931 are operating on the Zambian shore and 892 on the Zimbabwean shore.

The set up of the fishermen on the Zambian shore is quite different from that on the Zimbabwean side. Fishermen in Zambia are at liberty to camp and fish where they please along the shore. They are not forced to settle in groups or co-operatives (Murphree et al., 1989). Consequently Zambian fishermen are widely dispersed all over the shore line. This makes collection of fisheries statistics and enforcement of fisheries regulations rather difficult.

The fishermen on the Zimbabwean side are located in 40 fishing camps (Murphree et al., 1989). Locations of these camps are shown in Fig.2. Areas C2, C4 to C7 contain independent fishermen. Areas C1 and C3 contain contract fishermen. Independent fishermen operate individually whereas contract fishermen operate in the concession areas of one major company Irvin & Johnson (Pvt) Ltd (I&J) (Machena, 1985). Since 1986 however, the contract fishermen have mobilised themselves into two cooperatives in C1 and one in C3. I&J still owns both concessions and hence has a monopoly to purchase fish from respective cooperatives. There is a fourth co-operative with its own newly awarded concession next to area C1. This brings the number of gill-net fishing co-operatives to four, with a total of 102 members.

As shown in Fig 2, the boundaries of these fishing areas were adjusted twice, in 1972 and 1976 to accommodate increasing heavy boat usage and recreational fishing in the area close to Kariba (K1 in Fig. 2a).

The shore areas, outside the areas indicated above are permanently closed from fishing. These areas belong to the Department of National Parks and Wildlife Management. The Department does not allow permanent settlement in such areas.

2.4 Number of fishermen

The number of fishermen varies frequently. Changes have taken place since fishing began in 1958. At that time 407 fishermen were in operation in the Zambian side (Scudder, 1982) and this number increased to 2,000 by 1962. Zambian fishermen fell below 500 by 1967.

Fishing in Rhodesia started in 1963 and fishermen reached the highest number at 1,000 in 1966 (Minshull, 1973). The number in Rhodesia declined markedly in 1970 and between that time and 1974, there were only 210 to 280 fishermen (Marshall et al., 1982). This number declined further to about 130 to 140 in 1977.

During the Rhodesian war fishermen were not recorded but the first full scale enumeration took place in 1983 when 643 fishermen were recorded (Bourdillon et al., 1985, Murphree, 1985). This number had increased by 39% to 893 in 1988 (Murphree et al., 1989). Enumerating in Zambia also show that fishermen increased from 1,674 in 1986 to 1,939 in 1988, a 15% increase.

Changes in the number of fishermen in the early years of the fishery are related to changes in fish yields. Fish yields were initially high but declined in the late 1960's due to ecological factors (Coche, 1974). The decline in the mid 1970's was related to closure of fishing camps and reduced fishing activities during the war.

The recent increase in fishermen suggests increases due to demographic growth and the effects of drought. The early 1980's were drought years in Southern Africa and because of failed farming and the state of the economy especially in Zambia more people went into fishing. These were not necessarily licensed fishermen. They simply acquired nets and started fishing.

2.5 Development of fishing co-operatives

Development of fishing co-operatives has initiated in Lake Kariba. Artisanal fisheries are generally considered a poor credit risk because of the nature of their fishing operations. Catches and income are often very seasonal and variable and loan repayment could be irregular. Co-operatives can form an established organisational structure through which the government and financiers can interact with. Co-ops can be credit worthy even though individual fishermen are not (Copac, 1984).

2.6 Fish yields and marketing

Table 4 gives inshore fish yields in the early development of the artisanal fishery. Early fish yields were good (Jackson, 1960, Minshull, 1973). The fishery benefitted from a high nutrient level following flooding of new land and vegetation. The decline in fishing followed the rapid depletion of

nutrients from the system. The lake has a replacement time of 3 years as water is continually lost through the hydro-electric turbines. Catches stabilised at 1,200 tonnes on the Zimbabwean side.

The inshore fish yields of 6,749 tonnes (4,537 in Zambia and 2,212 in Zimbabwe) for 1988 cited earlier may give an overall impression of increased fish productivity as compared to say 1963 (Table 4). This is hardly the case as productivity has decreased as compared to the early development of the fishery. The increased yield is a reflection of the high number of fishermen. In Zimbabwe fishermen generally realised an average of Z$ 100 per month and the reasons for this has been outlined in Machena, (1986). Outstanding amongst the problems fishermen face are the remote nature of most fishing camps and the related lack of dependable buyers.

The fishermen have for a long time depended on one commercial company and fish traders. The fish traders are unreliable. Because of the sheer distances, and costs involved their services are unpredictable. The commercial company forms the more dependable buyer in camps it services and so in effect establishes a monopoly and effects this in purchasing fish at low prices. The company provides cooler boxes and ice blocks to some camps and has boats which buy fish from these.

In a detailed analysis of the fishing communities in the inshore fishery Murphree (1985) points out clearly that despite low fish yields and low income the fishery has a tremendous impact in this impoverished area bearing in mind that over 4,000 people in the area are wholly or partially dependent on it. The area is marginal in terms of agriculture - low rainfall and poor soils as well as tsetse infestation. Most of the area has been set aside for wild life management.

The contradictions between heavy demand on the fishery and the low fishery potential underline the root problem the Department faces in managing this fishery.

3. THE PELAGIC FISHERY

3.1 Development of the fishery

The introduction of the sardine Limnothrissa miodon (Bell-Cross, 1971) to utilise the pelagic water (which was an unoccupied niche) is a success story. After introduction of 360,000 live fish in 1967 to 1968, the first evidence of their establishment came in 1969 when they were found in the stomach content of tiger fish Hydrocynus forskahlii (Bell-Cross & Bell-Cross, 1971). Experimental fishing was carried out between 1970 and 1974 (Begg, 1974). A variety of fishing methods were examined by the Lake Kariba Fisheries Research Institute. These included pumping, use of explosives, drifting small-mesh gill-nets which did not succeed (Marshall et al., 1982). The hand scooping technique with the use of kerosene lamps for lighting (as used in Lake Tanganyika) was not successful either.

Limnothrissa behaves differently in Lake Kariba as compared to Lake Tanganyika. Whereas in Lake Tanganyika they come feeding to the surface at night, they generally remain below 10 m in Lake Kariba. Also visibility in

Lake Kariba is much lower than in Lake Tanganyika. As a result of these factors, heavy vessels with powerful lights and which can support large lift nets are required for fishing in Lake Kariba.

The commercial fishery is highly mechanised utilising fishing vessels each equipped with a winch (hydraulic or manual), a propulsive motor and a generator. The vessel itself is a platform mounted on two cylindrical pontoons. The winch operates a lift net (with a diameter varying between 60 and 90 m and a depth of 14 m) which is lowered to more than 10 m into the water during the fishing. The generator is a power source. Fishing is carried out at night when the fish are light attracted above the lowered net. Mercury vapor bulbs are often used. In addition to these basic items, some of these vessels are now equipped with echo sounding devices which are increasing efficiency in the industry. Each fishing vessel with all this equipment costs well over Z$ 60,000.00, a figure far beyond the means of the local fishermen. It is not surprising therefore that the local fishermen are excluded from this fishery.

The commercial fishery is much more productive than the artisanal fishery. In 1988, the commercial fishery alone landed 30,000 tonnes with a total value of Z$ 40,000,000.00 assuming most were marketed when dry. The common processing technique is brining (dipping freshly caught kapenta for 10 to 15 minutes in brine) and sun drying on racks (for 2 to 3 days) when vessels reach the harbour in the morning. One company markets frozen sardine. This company has freezing facilities on shore and provides ice for its boats.

3.2 Biomass estimates

Estimates of the biomass of Limnothrissa have been carried out by Lindem (1989) and Marshall (1985a, 1988). Marshall estimated biomass by fish capture using a conical lift net without the aid of light. These studies were carried out between 1981 and 1983. He obtained estimates ranging from 1 to 723 kg/ha with an overall mean of 59.23 kg/ha . Marshall's biomass estimates were made in the eastern part of the lake and extrapolated for the whole lake.

The density of the sardines in the lake has also been assessed using hydroacoustics. Lindem (1988) carried out 12 survey transects over the whole lake using a portable Simrad EY-M echo-sounder operating at 70 kHz. The survey gave biomass values ranging between 16 and 120 kg/ha with a mean of 37 kg/ha. It is generally understood that the Limnothrissa spawns twice a year in Kariba and develops from egg to adult in 5 to 6 months. The production potential of this fish is therefore high and this is why the fishery can support yields of up to 60 kg ha/year.

The hydro-acoustic technique was used for the first time in Lake Kariba. It was carried out in the pre-project phase of the sub-regional SADCC Zambia/ Zimbabwe Lake Kariba Project. The idea was to test the feasibility of the technique in the Kariba system. Length frequency curves obtained using this technique correlate well with length frequency analysis of commercially caught fish.

The equipment and the technique have been recommended for use in the main project phase.

The hydroacoustic analysis was carried out in one month only - September 1988 and this month coincides with the peak fishing period. Biomass estimates would need to be carried out over the whole year and over a number of years to get an impression of seasonal as well as annual variation.

3.3 Fishing Areas

This was initially based at Kariba town. With the expansion of the fishery other areas were opened up. These are Bumi, Chalala, Sengwa and Binga/Mlibizi. These areas lie west of Kariba. These areas were opened up to spread the fishing pressure over the whole lake.

3.4 Sardine yields

Annual sardine catches in Kariba have increased from 66 tonnes in 1973 when fishing started (Marshall et al., 1982) to 18,000 tonnes in 1988 on the Zimbabwe side (Table 5). Increase in yields reflect increase in fishing pressure as more permits were issued after 1973. Yields from the Zimbabwean side are also shown by area of the lake (Table 6). Total catches from the lake (30,000 tonnes) in 1988 equivalent to a production of 60 kg/ha/year and this is high production.

This yield is much higher than yield predicted from models. Machena & Fair (1986) predicted a figure of 27 kg/ha. Marshall (1985b) predicted a value of 27 kg/ha. Prediction models e.g. Melack's (1976) model often used fish yields as one of the regression parameters. Therefore their utility would be dependent upon fishing intensity in the lakes where the data were collected.

The catches of Limnothrissa in the lake show a distinct seasonal pattern with a major peak in August and a minor in April/May (Fig. 3). This pattern is determined by the sequence of physio-chemical events in the lake (Marshall, 1988). The lake is dependent on the inflow of rivers for its supply of nutrients. As most of the river flow is seasonal the bulk of nutrients are introduced in the rainy season (November to March). The lake is monomictic and turn-over takes place in June to July contributing to another input of nutrients into the surface waters.

Marshall (1982) has demonstrated a relationship between catches and the flow of the major river feeding the lake. Such a relationship indicates the dependence of the sardine population on weather conditions. These factors need to be considered where management strategies pertain. For example the effect of rainfall levels over a number of years on fish stocks needs to be averaged to gauge the level of stocks over varying climatic conditions.

3.5 Catch and effort data and mean fish length

The relationship between catch and effort is shown in Table 7, from the time commercial fishing began. Catch decreases with increasing effort. When the data are plotted in another way (total catch against effort, Fig. 4) total catch increases with effort. This is clear with each of the fishing areas on the Lake Kariba - Bumi, Chalala, Sengwa and Binga/Mlibizi. There is some difference on the plot comprising data for the whole lake. An asymptote seems

to have been attained. So far as the Zimbabwe fishery is concerned, current fishing is probably close at maximum level.

Since the catch data from the Zambian fishery are not included, the plots do not reflect the actual situation on the lake. The plots can only be taken to give an indication of the actual situation.

Data from the Zimbabwean sardine fishery are fairly accurate and can be relied upon to give an indication of the performance of the fishery.

Mean fish length varies with season following seasonal differences in the availability of nutrients. Mean length has also varied annually. According to Marshall (1988) mean length varied from 55.16 mm to 49.88 mm in 1983. Analysis of commercial catches have shown mean length was 5.17 and 5.61 mm in 1987 and 1988 respectively. Mean length analysis tends to indicate that over fishing has not yet set in.

3.6 Development of Co-operatives

The first 2 co-operatives in the pelagic fishery started fishing operations in June 1987. They have been successful and as a result the government has encouraged the formation of 4 more. Following the success of the first 2 co-operatives which were funded by the EEC and the government, other credit organisations like banks have shown much interest in funding more co-operatives. This is an interesting turn of events as far as locals are concerned in the Kariba fishery. This also emphasizes the point that an organised group of poor people is likely to attract funding than individuals. But the encouraging response of credit organisations only follows the success of the co-operatives. No doubt the situation would have been different if the co-operatives had collapsed.

Reasons for the success of these co-operatives are outlined in Machena (1986). Formation of these co-operatives was initiated by the Lake Kariba Fisheries Research Institute and the Department readily gave them permits. Credit is given to the government through forming the proper structures for aiding co-operative development.

4. RESOURCE MANAGEMENT AND RELATED PROBLEMS

The management of the Lake Kariba fisheries is aimed at maintaining optimum sustainable yields of fish populations by promulgating and enforcing conservation principles. All fishery and aquatic resources in Zimbabwe belong to the government and are managed by the Department of National Parks and Wildlife Management. The Department has a number of research establishments at each of the major water bodies within the country. The Lake Kariba fishery is managed by the Lake Kariba Fisheries Research Institute which is based in the Kariba town.

4.1 Staff establishment

The Institute has an establishment of 5 research ecologists and 39 supporting staff. These include general hands, enumerators, typists and the executive

officer. Efforts to increase the staff establishment to meet the increasing need for management and coverage of more fishing villages in enumeration are in vain as the government desires to cut on public expenditure. In fact over the past year, all vacant posts have been frozen.

4.2 Research Programme

The Institute is responsible for fisheries research, fisheries data collection, extension work within the fishing communities and management of the fisheries. Research is carried out to continually assess the level of stocks and to understand environmental factors that influence the biomass of fish in the lake.

Current research programmes include assessing the level of both inshore and pelagic fish stocks; the way environmental factors affect fish species and biomass distribution; the movement of fish between areas closed from fishing and heavily fished areas as well as the movement of pelagic fish species.

Do protected or "reserve" areas serve the function of providing fish to restock heavily fished areas bearing in mind a lot of the fish species are territorial? A lot of trees that were submerged when the lake formed are still standing. Do these areas with standing trees provide a different habitat and are they colonised by different fish species? What factors control the movement of pelagic fish stocks? These are some of the problems that the research projects attempt to answer.

4.3 Policy, administration and management problems

(a) The inshore fishery

The following refers particularly to the Zimbabwean fishery:

(i) Licensing and gear regulation

All Zimbabwean fishermen require a license and pay an annual license fee of $20.00. The minimum gill-net mesh size enforced is 100 mm. There is no restriction on the number of nets permitted. The bulk of the commercially important fish species are mature by the time they are caught in 100 mm mesh nets.

It has not been easy to enforce minimum gear mesh size as nets are set in water continuously. The fishermen have a habit of inspecting nets and collecting the fish at regular intervals and leave the nets set. Hence inspection of the nets at fishermen's houses would be fruitless. Fishermen also make their own nets and they would not be strict in ascertaining the required minimum mesh.

Zimbabwean companies that make or import gill-nets are under instructions to sell gill nets only to fishermen with fishing permits. But of late a lot of unregistered traders have been importing nets from Mozambique and sell these to anyone who can afford them.

(ii) Fishing areas

As outlined earlier rivers are important for spawning-runs of a lot of inshore fish species. These are problem areas as they provide "easy catch" for the fishermen, particularly during flood periods. Often nets are set right across the river and this potentially reduces recruitment.

As outlined earlier also, "reserve" areas coincide with National Parks land and are set aside to provide fish stocks for heavily fished areas. The Department has not experienced problems of fishing in these areas.

(iii) Controlling the number of fishermen

It is difficult for political and social reasons to limit the number of local fishermen. More locals tend to go into fishing in times of economic hardships and this makes the fishery much more of an open access resource. This has created problems of decreased catch per unit effort and has contributed significantly to the alarming degree of fishing in prohibited areas and the agitation fishermen are making for more fishing grounds. Murphree et al. (1988) have shown that during periods of economic hardship fishermen have increased by 39% and 15% in Zimbabwe and Zambia respectively. This is a world-wide problem. In Mauritius for example there are 3 500 fishermen in waters that can only support 1 000 and fishermen in Chile increased from 12 000 to 30 000 in ten years (Copac, 1984).

(iv) Enforcing laws and regulations

It requires a lot of men, money and time to continually patrol the big lake and take fish poachers to court. These resources are limited at the Lake Kariba Fisheries Research Institute. Worse, the Institute is at one end of the lake and the other end is 377 km away, making access time consuming and expensive. For example a return boat trip to the end of the lake costs the Institute over Z$1 000 and takes three days.

What is needed is to put up a new sub-station at the other end of the lake but again resources are limiting. The other problem is that poachers are not scared of court action because the small fines they have to pay are easily recovered from continued poaching.

Co-operatives have not been much of a problem. They derive much benefit from co-operative operations that they do not risk losing their fishing license.

(v) Data collection

Trained enumerators visit each village for a ten day period in each month and they record the following information:

(a) number of active fishermen;

(b) number and weight of fish species caught;

(c) number and size of nets owned by each fisherman;

(d) number of boats; and

(e) price realised for fish sold.

Co-operatives and concessionaires are required to submit the details of fish caught. The precision of data collected is low, as enumerators are unable to visit all villages because of the size of the lake. Only 15 out of 40 villages are visited each month and data from these are extrapolated to get yields for the whole lake. It is much easier to collect data, as fishermen are grouped in fishing camps. However, from time to time fishermen leave their camps and go and illegally settle on some areas far from camps. This makes coverage of these fishermen difficult.

On the Zambian shore fishermen settle wherever they choose, and data collection is a problem.

(b) The pelagic fishery

(i) Licensing and gear regulation

Licenses are issued annually by the Department of National Parks and Wildlife Management. A number of conditions are attached to the license and violations of these can lead to withdrawal of the license. No person or company may fish on the Zimbabwean side without a license. Licenses cost $1 200.00 per unit per year.

The stipulated mesh size of the nets should not be less than 10 mm when stretched. Smaller meshed nets are not permitted.

(ii) Fishing areas

Fishing takes place on the whole lake although there are more companies operating close to Kariba. This is because Kariba is more accessible to Harare.

Fishing is not permitted to waters less than 20 m deep. These areas are usually shore areas where sardine breeding takes place. A lot of these areas have submerged trees which often form a hazard to nets. These trees also provide a diversified habitat in the inshore areas.

(iii) Closed season

Catch and effort in the sardine fishery are closely monitored and the Department reserves the right to enforce a closed season should the need arise.

(iv) Catch returns

License holders are required to submit a monthly catch return, which includes nightly catches of both sardines and tigerfish. Importance is attached to these returns as reliable statistics are essential for monitoring the fishery. Data collection in the pelagic fishery is therefore much more complete than in the inshore fishery, so these data are relied on heavily.

5. ZAMBIA-ZIMBABWE LAKE KARIBA PROJECT

5.1 Introduction

The above project aims to strengthen research capabilities of the Zambian and Zimbabwean research institutions and to facilitate joint management of a shared fishery resource in Lake Kariba. Because of political factors, research on the lake has been carried out separately by the two countries. This is hardly rational for the pelagic fishery is a joint resource and a coordinated management system is necessary.

Much organisation, capital expenditure and training are required to develop a viable fishery that may go along way to meet the developmental needs of a country. Both Zambia and Zimbabwe are fraught with foreign currency problems and have not been in a position in to meet all research facilities particularly research equipment that needs foreign currency. Besides, the Sinazongwe Fisheries Training Centre in Zambia was destroyed during the Rhodesian war.

The project therefore also aims to provide infrastructural facilities that the two respective countries have been unable to meet.

5.2 The Pre-project phase

The pre-project phase lasted one year from April 1988 to May 1989. This phase was instituted to identify in detail the specific problems and requirements in the organisation and management of both the artisanal and commercial fisheries in Lake Kariba. On the basis of these, the pre-project was to identify the scope and programme activities of the main project.

These recommendations have been sent to the donors for comment and it is hoped that the main project will take off the ground in early 1990.

Specific aims and programmes of the main project are summarised below. It has been necessary to divide the project into the commercial fishery and the artisanal fishery sub-projects because the different characteristics of the two fisheries will entail a different approach. A pre-project study of the artisanal fishing communities was carried out by Murphree et al., (1989).

5.3 The commercial fishery sub-project

(a) Objectives

(i) To develop a rationalised and sustained system of joint management of the pelagic fishery of Lake Kariba. The pelagic

fishery is shared between Zambia and Zimbabwe and has been managed separately.

(ii) To increase fish production.

(b) Target groups

Members of staff of both the Department of fisheries in Zambia and the Department of National Parks and Wildlife Management in Zimbabwe.

(c) Programmes to meet the objectives

(i) To train and facilitate the training of fisheries staff at both technical and professional levels abroad, regionally and locally. Emphasis will be on the regional and local training.

(ii) To upgrade the facilities at fisheries research centers in both countries. The Zimbabwean Institute (L.K.F.R.I.) will have a modest expansion. The Zambian institution (SFTC) will have a major rehabilitation.

(iii) To establish joint research programmes to obtain data on stocks and on the population dynamics of the pelagic species that will enable formulation of joint management strategies designed to have an economically viable industry on a sustained resource.

(iv) To establish a uniform data collection system of fisheries statistics and set up a computerised data base.

(v) To conduct an economic appraisal of the commercial fishery.

(vi) To develop planning and monitoring programmes of all activities.

(d) Expected outputs

(i) Lake Kariba Fisheries Research Institute and Department of Fisheries (Zambia) will be strengthened through staff training and improvement of infrastructure.

(ii) A long term programme of collaborative research on and monitoring of Lake Kariba kapenta stocks will have been established.

(iii) A viable framework for continuous joint assessment and management of the commercial kapenta fishery of the lake will have been established.

5.4 The artisanal fishery sub-project

(a) Objectives

(i) To increase the productivity of the artisanal fisherfolk.

(ii) To increase fish production.

(b) Target groups

Artisanal fishing communities including fishing co-operatives and fish traders.

(c) Programmes to meet the objectives

(i) To research the bottle necks in the operations of the artisanal fishing communities and to recommend on their improvements.

(ii) To test and introduce better processing techniques.

(iii) To improve on extension programmes aimed at benefitting artisanal fishing communities and developing artisanal kapenta fishing.

(iv) To examine means of increasing a viable participation of women within the artisanal fishing communities.

(v) To advise, test and if appropriate introduce gear suitable for an artisanal kapenta industry and where appropriate improve on the current inshore artisanal fishing gear. If this were possible, the artisanal fishermen will participate in viable fishery.

(d) Expected outputs

(i) A joint long-term programme of biological and socio-economic study will have been established.

(ii) Long-term development and management plans for the lake and lake shore resources will have been developed.

(iii) Security of access for the lake shore community will have been established.

(iv) Investigations will have been made into reducing post harvest losses, increasing the role of women and of the commercial kapenta fishery of the lake will have been established.

6. CONCLUSION

The donor funded sub-regional project as witnessed in the pre-project phase will create a platform for dialogue and enhance communication between the two Departments, which could have been difficult without it. Collaboration will largely be on research and management of the pelagic fishing which is the shared resource. Although the approach will be the same on the inshore fishery problems, the Departments are likely to work less jointly on this fishery because the inshore fishery resource is not shared.

Furthermore, as the kapenta fishery is very productive and highly profitable, expected project outputs are likely to be significant where this fishery is concerned. Output in respect of input is expected to be marginal in the inshore fishery for reasons already advanced earlier. This pertains largely to the large number of fishermen exploiting a fishery of low potential.

The artisanal fishery sub-project will be initiated through a workshop. It is hoped the workshop will recommend an integrated approach in resource use in the area. Since inshore fishing alone is hardly viable fishermen should combine fishing with other economic activities. To facilitate this Murphree et al., (1989) have recommended a land use study of the lake shore area. The potential exists for fishermen to participate in wildlife management, crocodile ranching etc. which are profitable ventures.

In the main document a request has also been made for a sub-station at the western end of the lake. This will include an office, a store and accommodation for an officer and scouts. This will facilitate working and enumerating in the area.

The main project is intended to last 5 years and maybe extended if the need exists. Hopefully the problems identified in this document will be successfully addressed through this project.

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Table 1 : Main features and morphology of Lake Kariba at a water level of 485 m.a.s.l.

Length	277 km
Width (mean)	19.4 km
Depth (mean)	29.2 m
Depth (maximum)	120 m
Area	5,364 km
Volume	156 X 10 m

Table 2: Fish species recorded from Lake Kariba, modified from Balon (1974)

ANGUILLIDAE	Anguilla nebulosa labiata (Peters, 1852)
CLUPEIDAE	Limnothrissa miodon (Boulenger, 1906)*
MORMYRIDAE	Mormyrops deliciosus (Leach, 1818)*
	Hippopotamyrus discorhynchus (Peters, 1852)
	Marcusenius macrolepidotus (Peters, 1852)
	Mormyrus longirostris (Peters 1952)*
CHARACIDAE	Hydrocynus forskahlii (Cuvier)
	Alestes lateralis (Boulenger, 1900)
	A. imberi (Peters, 1852)
	Micralestes acutidens (Peters, 1852)
DISTOCHODONIIDAE	Distichodus mossambicus (Peters, 1852)
	D. schenga (Peters, 1852)
CYPRINIDAE	Barbus poechii (Steindachner, 1911)
	B. paludinosus (Peters 1852)
	B. unitaeniatus (Gunther, 1866)
	B. lineomaculatus (Boulenger, 1903)
	B. fasciolotatus (Gunther, 1868)
	B. marequensis (Smith, 1841)
	Labeo cylindricus (Peters, 1852)
	L. congoro (Peters, 1852)
	L. altivelis (Peters, 1852)
	Opsaridium Zambezense (Peters, 1852)
SCHILBEIDAE	Schilbe mystus (Linnaeus, 1762)
	Eutropius depressirostris (Peters, 1852)
CLARIIDAE	Clarias gariepinus (Burchell, 1822)*

	Heterobrachus longifilis (Cuvier & Valenciennes, 1840)
MALAPTERURIDAE	Malapterurus electricus (Gmelin, 1789).
MOCHOKIDAE	Synodontis zambezensis (Peters, 1852) S. nebulosus (Peters, 1852)
CYPRINODONTIDAE	Aplocheilichthys johnstoni (Gunther, 1893)
CICHLIDAE	Serranochromis codringtoni (Boulenger, 1908)* S. giardi (Pellegrin, 1904) S. carlottae (Boulenger, 1905) S. macrocephalus (Boulenger, 1899) S. robustus jallae (Boulenger, 1896) Pharyngochromis darlingi (Boulenger, 1911) Pseudocrenilabrus philander (Weber, 1987) Oreochromis (formerly Sarotherodon) andersoni (Castelnau, 1861) O. macrochir (Boulenger, 1912) O. mortimeri (Trewavs, 1966) Tilapia rendalli (Boulenger, 1896)*

* Principal commercial species.

Table 3: Standing stock of major fish families in Lake Kariba.

	Balon (1974)		Mitchell (1976)		Marshall & Langerman (1984)	
	kg/ha	%	kg/ha	%	kg/ha	%
Anguillidae	–	–	–	–	–	–
Mormyridae	206	34	249	58.5	22	0.95
Characidae	60	9.9	16	3.7	59.3	26.0
Distichodontidae	6	0.4	0.5	0.1	–	–
Cyprinidae	6	1.0	14.5	3.4	26.5	11.60
Schilbeidal	9	1.5	1.2	0.3	–	–
Clariidae	66	10.9	20	4.7	0.06	0.03
Malapteruridae	48	8.0	10	2.3	8.7	3.80
Mochokidae	21	3.5	21.4	5.0	10.9	4.77
Cyprinodontidae	–	–	–	–	–	–
Cichlidae	166	27.5	94	22.0	120.6	52.85
TOTAL	561		426		228.2	
Sampling period	1968–1971		1972–1974		1981–1982	

Table 4 : Inshore fish yields in Lake Kariba in the early development of the artisanal fishery in the lake. Data from Minshull (1973).

YEAR	ZAMBIAN SHORE (tonnes)	ZIMBABWEAN SHORE (tonnes)	TOTAL (tonnes)
1962	3 000	-	3 000
1963	4 000	1 750	5 750
1964	2 100	2 650	4 750
1965	1 633	2 450	4 083
1966	1 473	2 100	3 573
1967	1 100	1 800	2 900
1968	800	1 700	2 500
1969	?	1 400	1 400
1970	?	1 200	1 200
1971	?	1 200	1 200

Table 5 : The total catch (t) of Limnothrissa in Lake Kariba

YEAR	ZIMBABWE	ZAMBIA	TOTAL
1973	66		66
1974	488		488
1975	656		656
1976	1050		1050
1977	1172		1172
1978	2807		2807
1979	5139		5139
1980	7993		7993
1981	11137	872	12009
1982	8511	2663	11174
1983	8602	4970	13572
1984	10404	6198	16602
1985	14818	9027	23845
1986	16094	12000	28094
1987	15824	13000	28824
1988	18000	12000	30000

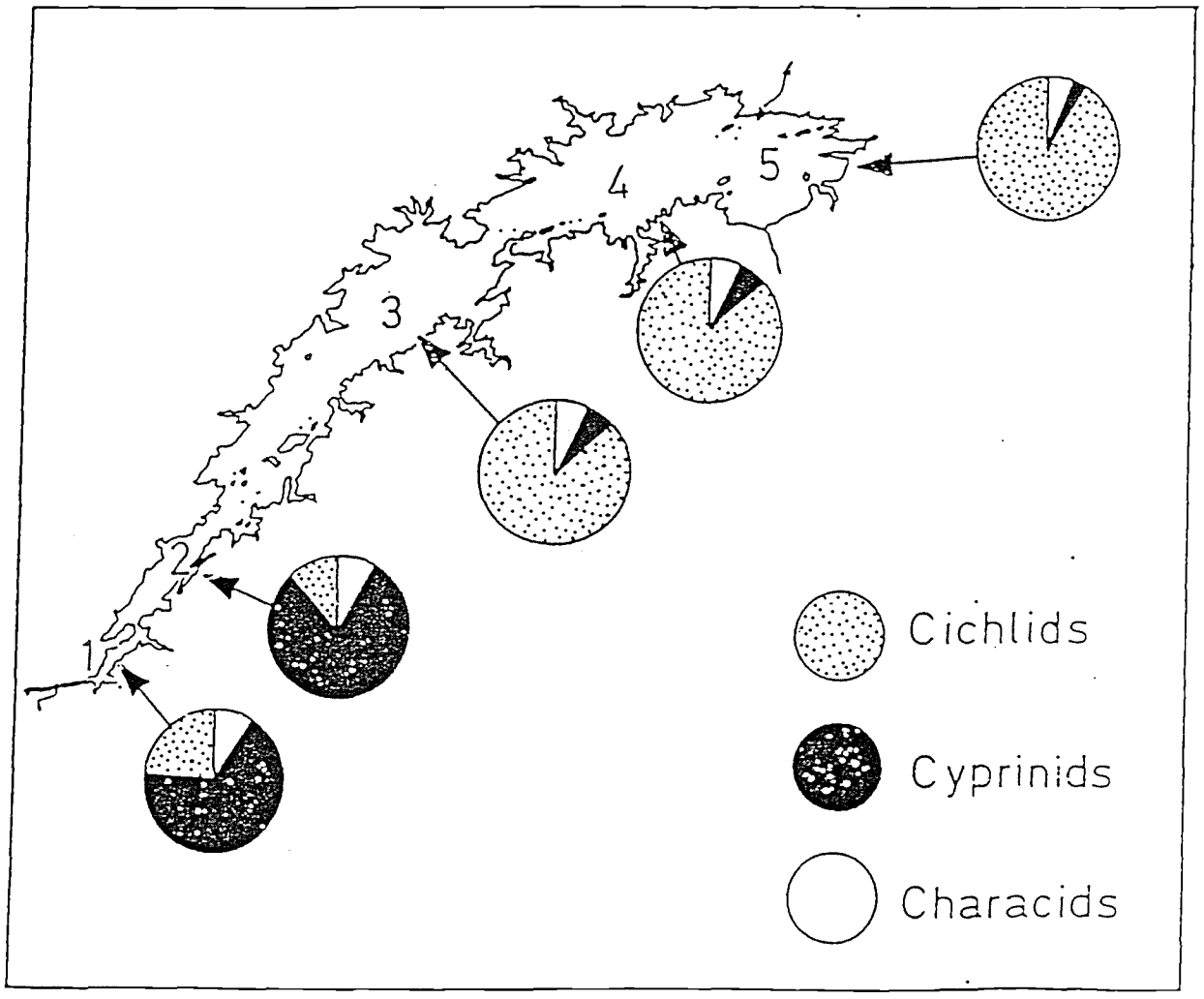
Table 6 : Limnothrissa landings (t) on the Zimbabwean side of Lake Kariba by area of the lake

	KARIBA	BUMI	CHALALA	SENGWA	BINGA/ MLIBIZI
1974	488				
1975	656				
1976	1050				
1977	1172				
1978	2772			35	
1979	1475	78	8	82	96
1980	5959	173	1261	115	485
1981	7408	285	2879	175	390
1982	5249	234	2605	113	310
1983	5590	170	2566	99	177
1984	6286	305	3417	84	312
1985	9179	-	5229	105	305
1986	9077	319	5312	4847	1832
1987	8194	288	4847	1832	663

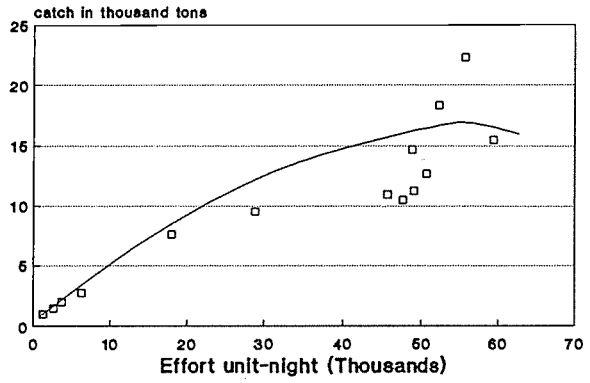
Table 7 : The relationship between catch per unit effort (tonnes per unit/night) and fishing effort (unit/night) for the sardine fishery on the Zimbabwean side of the lake.

	KARIBA		BUMI		CHALALA		SENGWA		BINGA/MLIBIZI	
YEAR	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Effort	Catch	Effort
1974	0.78	616								
1975	0.56	1297								
1976	0.54	1833								
1977	0.44	3113								
1978	0.42	8995					0.34	96		
1979	0.33	14404	0.34	195	0.18	43	0.30	319	0.22	570
1980	0.24	22818	0.21	789	0.20	5768	0.20	695	0.20	1282
1981	0.30	24393	0.17	1670	0.29	9953	0.26	668	0.23	1188
1982	0.22	23776	0.16	1459	0.25	10560	0.21	539	0.24	1291
1983	0.23	24481	0.16	1036	0.22	11643	0.18	565	0.17	1063
1984	0.25	25344	0.28	1077	0.26	13261	0.17	503	0.24	1293
1985	0.40	27815	0.36	-	0.30	14389	0.23	449	0.27	1145
1986	0.35	26153	0.26	1245	0.36	15140	0.53	1688	0.30	1475
1987	0.26	29702	0.15	1506	0.30	15966	0.50	3544	0.36	1828

Figure 1: The distribution of the major families in the main Lake basins. Redrawn from Marshall et al. (1982).



Relationship between Effort and Catch
in Lake Kariba



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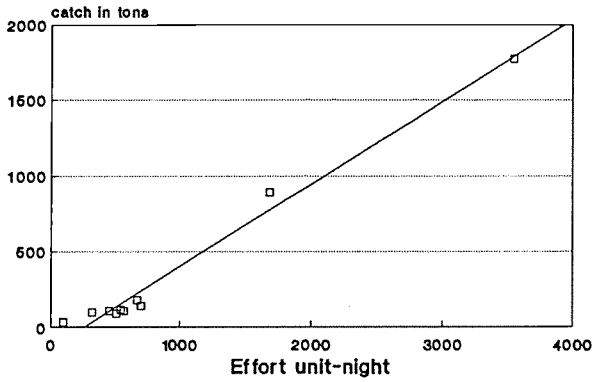

Relationship between Effort and Catch
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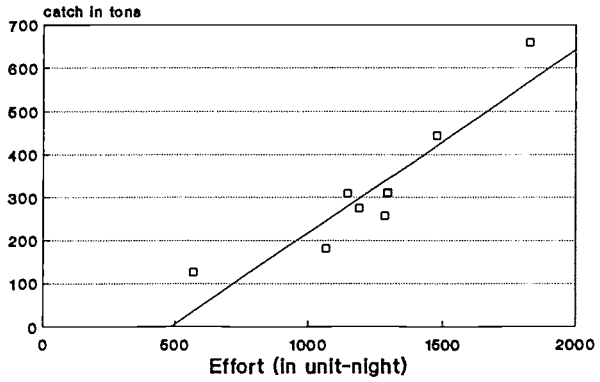

THE RESOURCE AND SOCIO-ECONOMIC ASPECTS OF THE FISHERIES OF LAKE KARIBA AND THEIR MANAGEMENT (Zambian side)

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1. INTRODUCTION

Kariba is a man-made lake. It became a lake following the damming of the Zambezi river in the late fifties and early sixties. To be precise, water impoundment started in December of 1958. The arch concrete dam was completed in 1960. It stands at the height of 128 m from the river bed and measures 850 m along the crest. The purpose for constructing the dam was to generate hydroelectricity for the two nations of Southern and Northern Rhodesia today known as Zimbabwe and Zambia respectively. The completion of the construction of the dam wall resulted in the formation of the largest man-made lake in the World at that time. It has, however, been exceeded in size in recent years by man-made lakes such as Volta of Ghana and Nasser-Nubia of Egypt.

Lake Kariba is situated on the Zambezi river between the latitudes 16. 28' - 18.04'S and longitudes 62.42' - 29.03' E. The lake is shared between Zambia and Zimbabwe. The Zimbabwe portion of the lake comprises 55% of the total water surface area while the Zambian portion is slightly smaller at 45%.The total water surface area of the lake is 5,364 square kilometers (1,700 sq. miles).

The general features of the topography and hydrobiology of the lake are summarized as follows:

Altitude	485	m
Length	277	km
Maximum width	40	km
Mean width	19.4	km
Maximum depth	120	m
Mean depth	29.2	m
Shoreline Length	2,164	km
Area	5,364	km^2
Volume	156.5	km^3

Approximate outflow. Volume ratio 1:3

1.1 Temperature and oxygen

The lake is fairly warm though water temperatures vary a lot between winter and summer. At the surface in summer water temperatures rise up to 30°c while

in winter water temperatures decrease to 21°C. Similarly air temperatures vary from 22.5°c in winter to over 35°C in summer. Kapetsky and Petr (1984) state that the thermocline of the lake develops around mid August descending from 10 m in September to 30 m in May. Stratification breaks down in June as such, the lake is isothermal for only two months in the year (i.e. July and August). The hypolimnion was deoxygenated heavily during the early years of lake formation such that hydrogen sulphide (H_2S) occurred through out the lake.

By 1963 deoxygenation became less intense and since then is rarely found. Oxygen exists only up to the depth of 12 meters in the warmer months while in the cooler months it occurs from top to bottom of the water column.

1.2 Rainfall and water chemistry

Being located within the tropics, rainfall on the lake is seasonal. Like most parts of Zambia and Zimbabwe rainfall begins around mid October. Real summer occurs between November and February. There have been drastic changes in rainfall pattern in recent years, especially during the past decade of the eighties as the region was severely hit by drought. However, during periods of normal rainfall, the southern part of the lake records 4.1 to 6.1 cm of rainfall annually. At the northern side of the lake, which is less dry, rainfall is even much better ranging from 6.1 to 18.1 cm per annum.

With respect to the chemistry of the lake, most fishery scientists like Coche, Kapetsky and Petr (Pers. Comm.) state that it is slightly oligotrophic. This means that the lake has a low potential for fish production especially the offshore fishery. Various studies have revealed that phosphorus and nitrogen are available in low amounts. Compared to other african lakes Coche (1974) has shown that in terms of average ionic composition (see table 1, p.30) Lake Kariba does not augur well.

1.3 Ecosystem development

Coche (1974) divided the history of the lake into three main phases:

- Phase 1 started from water impoundment in December of 1958 to September 1963 when the lake reached its maximum level of 487.8 meters. This period was called "Filling phase".

- Phase 2 was the "Transition phase". It started in October of 1963 and was estimated to have lasted up to mid 1966. During this period water level fluctuations were very large.

- Phase 3 was called "Stabilized phase". It occurred from 1966 onwards. This was the period when water-level fluctuations stabilized, rarely exceeding 3 meters.

1.4 Biological background

While many studies have been carried out on the Zimbabwean side, very little is known about primary production of the lake on the Zambian side. However, a few studies on phytoplankton were made by Thomasson (1965) and Hannock

Table 1: AVERAGE IONIC COMPOSITION OF LAKE KARIBA SURFACE WATER COMPARED TO AVERAGE AFRICAN AND WORLD FRESH WATERS (from A. Coche, 1974)

ION	Lake Kariba 1965 Average		World Fresh waters Average		Africa Fresh water Average		East and West African Lake and Rivers		
	Meq. L-1	%	Meq. L-1	%	Meq. L-1	Mg. L-1	Meq. L-1	%	Mg. L-1
Calcium	0.465	57	1.49	64	0.624	12.5	0.324	29	6.5
Magnesium	0.160	20	0.42	17	0.313	3.8	0.239	21	2.9
Sodium	0.153	18	0.36	16	0.479	11.0	0.392	34	9.0
Potassium	0.042	5	0.08	3	?	?	0.182	16	7.1
Total cations	0.820	100	2.35	100	-	-	1.137	100	25.5
Fixed CO2	0.756	89	1.71	74	?	?	(0.725)	(64)	(21.8)
SO4	(0.062)	(7)	0.37	16	0.281	13.5	0.229	(20)	11.0
Cl	(0.028)	(3)	0.23	10	0.341	12.1	0.183	(16)	6.5
Salinity	1.67	-	4.66	-	(4.5)	-	(2.27)	(100)	(39.3)
Sio2	12.3 mg/L		17.1 mg/L		-	23.2	-	-	15.5
Reference	Pers. data		Gorham, 1 57		Livingston , 1963		Visser cited in Imbubore 1970		

(1979). Roberts and Southall (1977) showed that phosphorous is the main factor limiting algal growth.

1.4.1 Zooplankton

A good number of studies have been conducted on Zooplankton presumably because of its importance to the pelagic fishery. Studies have shown that Ceriodaphmia ssp, Diaphanosoma ssp, and Diaptomids have been eliminated through predation (Marshall 1980). Studies by Begg (1974) indicate that zooplankton showed considerable seasonal variation in response to nutrient availability and possibly temperature. It was reported that Bosmina longirostris was abundant during the isothermal period when more nutrients are available in the water. In 1976 Berg noted striking diurnal movement of Zooplankton. Most organisms rise to the surface at night and are followed by Limnothrissa miodon, the main predator. Cochrane and Marshall examined the relationship between zooplankton abundance and sardine catches especially in winter.

1.4.2 Benthos

A major study on benthos was carried out between 1967-68. It showed that establishment of Macrophytes led to an increase in certain benthic groups. They seem to thrive best amongst a large number of submerged trees which increase the surface area available. Water level fluctuations also had a significant effect and shrironomid numbers increased following a rise in water level (Maclachlan 1969 (a) 1970 (b)). Other studies have estimated that the mussel crop stands between 33,000 tons to 167,000 (Kenmuir, 1980).

1.4.3 Macrophytes

The immediate effect of the water impoundment was a rapid increase in dissolved nutrients and conductivity increased rapidly between 1958-59. During this period, the nutrients leached from new land as well as decaying organic matter. The lake was eutrophic during the filling stage. That is why there was an explosive growth of aquatic organisms (Jackson 1960).
One such plant was the Fern Salvania also called Salvania auriculata or simply Kariba weed. In 1962, Kariba weed covered 22% of the lake surface area (Mitchel 1969). It played a vital role in retaining nutrients during this phase.

1.4.4 Fish species

Being located in the tropics, Lake Kariba is quite rich in fish species. Prior to the formation of the lake, the zambezi fish were riverain. After the impoundment, the lake fishery became predominant. Since the fish species were riverain, they continued to occupy the riverain niche thus under-utilizing the open waters of the lake. This was the fact that led scientists to think of stocking the lake with Limnothrissa miodon to make better use of the open waters of the lake.

Table 2 below shows fish species of commercial importance. At least 49 species of fish have been recorded in the middle of the Zambezi river. But only 29 species were actually collected from the flooded area. The most important fish species are listed below:

- Limnothrissa miodon (kapenta) exploited only by commercial fishermen was transplanted from Lake Tanganyika to Kariba between July 1967 and September 1968. Since 1969 kapenta has thrived and multiplied such that it is a fish species of great commercial value in the lake. It is the only pelagic fishery in the lake.

- Other fish species which are demersal stocks include Tilapia (Oreochromis) mossambicus, Oreochromis macrochir, Oreochromis rendali, Oreochromis sparrmanii, Sargochromis codrington, Synodontis sp, Labeo sp, Distichodus spp., Hydrocynus vittatus, Mormyrus spp etc. just to mention a few.

Table 2 COMMERCIAL IMPORTANT FISH SPECIES

Scientific Name	English Name	African Name
Limnothrissa miodon	Sardine	Kapenta
Mormyrus longirostris	Bottle nose	Muyanda
Gnathonemus macrolepidotus	Bull dog	------
Hydrocynus vittatus	Tiger fish	Mupenzi
Mormyrops deliciosus	Cornish jack	Zambanenje
Alestes imberi	Spot-tail Alestes	Mbiri
Distichodus mosssambicus	Nkupi	Nkupi
Distichodus schenga	Chessa	Chessa
Barbus barotserensis	Many-spotted barb	------
Barbus marequensis	Yellow fish	Mutuba
Labeo cylindricus	Mudsucker	------
Labeo altivelis	Sail fish mudsucker	Mtuba
Labeo congoro	Purple mudsucker	musizi
Varicorhinus nasutus	Horny-lipped yellow fish	-----
Heterobrachus longifilis	Vundu	Vundu
Clarias mossambicus	Shape-toothed barbel	Mubando
Eutropius depressirostris	Butter barbel	------

Synodontis zambezensis	Squeaker	Chikoto
Tilapia mossambicus	Mozambique Bream	Muchele
Tilapia macrochir	Green-headed bream	------
Tilapia rendalli	Red-breasted bream	------
Tilapia sparrmanii	Banded bream	------
Sargochromis codri ngtoni	Green bream	------

1.4.5 Biomass estimates

Studies aimed at estimating the fish biomass have been carried out by different scientists. For the inshore fishery, Balon (1974), Mitchell (1976) and Marshall and Langerman (1984) conducted research using different methods of estimating fish biomass. Balon and Mitchell worked in shallow waters (less than 6 m deep) where they blocked off covers with nets and poisoned the fish using rotenone. Fish biomass was estimated to be 561 kg/ha/yr and 426 kg/ha by Balon and Mitchell respectively. Marshall and Langerman conducted their sampling by using an explosive grid in deep waters and rocky shores that were not easily accessible. Perhaps these different approaches explain the differences in estimates of standing stock. Langerman and Marshall estimated standing stock at 228.2 kg/ha.

Biomass estimates of the pelagic fishery of Limnothrissa miodon (Kapenta) were carried out by Linden (1989) and Marshall (1985 a, 1988). Marshall's approach was very simple. He used a conical lift net to catch the fish without the aid of light attraction. The studies were carried out between 1981 and 1983. His estimates of kapenta standing stock range from 1 - 723 kg/ha with a mean of 59.3 kg/ha.

Linden used the Hydro-acoustic technique under the auspices of the SADCC Zambia/Zimbabwe Lake Kariba Project. He carried out 12 survey transects over the whole lake using a portable Simrad EY-M echo sounder operating at 70 KH_2. He estimated kapenta biomass values ranging from 16-120 kg/ha with a mean of 37 kg/ha. Machena (1989) states that Limnothrissa miodon spawns twice in a year and develops from egg to adult in 5 to 6 months. For this reason production potential for kapenta is considered very high. He therefore pegs the kapenta fishery yields up to 60 kg/ha/yr.

Table 3 STANDING STOCK OF MAJOR FISH FAMILIES IN LAKE KARIBA

Family	Balon 1974 kg/ha	%	Mitchell 1976 kg/ha	%	Marshall & Langerman 1984 kg/ha	%
Anguillidae	-	-	-	-	-	-
Mormyridae	206	34.0	249	58.5	22.0	0.95
Characidae	60	9.9	16	3.7	59.3	26.00
Distichodontidae	6	0.4	.1	0.1	-	-
Cyprinidae	6	1.0	14.5	3.4	26.5	11.60
Schilbeidae	9	1.5	1.2	0.3	-	-
Clariidae	66	10.9	20	4.7	0.1	0.03
Malapteruridae	48	8.0	10	2.3	8.7	3.80
Mochokidae	21	3.5	21.4	5.0	10.9	4.77
Cyprinodontidae	-	-	-	-	-	-
Cichlidae	166	27.5	94	22.1	120.6	52.85
Total	561		426		228.2	
Sampling period:	1968 - 1971		1972 - 1974		1981 - 1982	

Source: LKFRI, 1988

2. SOCIO-ECONOMIC ASPECTS

The most comprehensive study on the socio-economic aspects of Lake Kariba on the Zambian side was carried out by George Walter between January and March of 1988. The study was funded by the Germany Agency for Technical Cooperation under the auspices of the Gwembe District Development Programme. A follow up to the above mentioned study was the pre-project socio-economic study of the artisanal fishery by Murphree et al. This study was executed under the sponsorship of the Zambia-Zimbabwe SADCC Fisheries Project. It covered both sides of the fishery. However, on the Zambian side it was a desk review or an update of the 1988 study. The latter desk review was jointly carried out by consultants from Zimbabwe and Zambia. The review was carried out between December 1988 and January 1989. Other socio-economic related data are periodically collected by DoF staff based on Lake Kariba at Sinazongwe and Siavonga.

At this juncture perhaps it is pertinent to mention that Lake Kariba comprises of two distinct fisheries. Namely:

(i) Artisanal or small scale fishermen who catch mainly demersal fish stocks using small boats of a size ranging from 6-8 meters long.

(ii) Commercial fishermen who exploit the relatively new fishery of Limnothrissa miodon which was planted in the late sixties. This fishery has survived and multiplied such that it is the most important in terms of income generation on the lake.

2.1 Artisanal fishermen

Following the formation of the lake in 1960, the two riparian Governments of Southern and Northern Rhodesia pursued different policies with respect to the development of the fishery. The Southern Rhodesia Government devised a fishing policy along racial lines with an obvious advantage to whites as against blacks. On the Northern Rhodesian (Zambia) side, the authorities took a different view. The interests of the local population were taken to be paramount. Therefore fishing was to be exclusively in the hands of the blacks although fish marketing was open to blacks, independent whites and larger commercial firms. The Gwembe Rural Council took positive measures to ensure that fishing was carried out by Africans. These were:

- a Fisheries Training Center was built at Sinazongwe to train locals in fishing methods, handling and processing;
- a boat building shed for local builders was established and training courses were conducted periodically;
- a fishing harbor was built and harbor facilities provided; and
- an ice plant was installed.

Fishing on the Zambian side of the lake started in 1959. In this year, a survey, conducted in August, revealed that 407 Tongans fishermen operated 748 gillnets and 93 boats. The boats were mostly canoes. By 1962, Scudder (1965) estimated that 2,500 fishermen, the majority of whom were Tongans, produced 3,000 tons of fish. In the early years of the formation of the lake, the fishery was so productive that mesh size restriction was pegged at 100 mm stretched. As fish production increased, fishing effort increased such that by the middle of the sixties fish production started to decrease.

Meanwhile, as the fish catches decreased, Tongans fishermen, who by nature are not traditional fishermen (but herdsmen), when they saw fish catches decreasing the majority of them abandoned fishing and went back to their traditional occupation of subsistence crop production and cattle rearing. Beck (1988) states that by 1969 only 500 Tongans men were actively fishing. During this same period fishermen from other fishery areas notably Bembas moved into the fishery. Unfortunately,the outbreak of the Zimbabwean armed struggle for independence in the seventies interrupted fishing activities on the Zambian side of the lake .

The advent of Zimbabwean independence in 1980 led to resumption of fishing activities both at artisanal and commercial levels. The Department of Fisheries conducted a survey of fishermen in 1986. The survey revealed that the number of fishermen had increased from 500 in 1969 to 1,674 in 1986. By 1988 Walter estimated the number of fishermen at 1,939. He attributes the sudden increase in the number of fishermen to the following reasons:

- A few capture fisheries of Zambia such as Kafue, Lukanga and Bangweulu were overfished thus forcing fishermen to migrate to other fisheries in particular Kariba.
- The devaluation of the Zambian currency, general decline of the national economy and the comparatively attractive fish prices may

have attracted individuals to take up fishing as a means of earning a living.

- The rapid population growth coupled with high unemployment in urban areas could have led some people to take up fishing in Lake Kariba because of its proximity to urban areas.

Table 4 below shows details of the number of fishermen between 1986 - 1988 by stratum.

Table 4 FISHING POPULATION SURVEYS OF 1986 AND 1988 PER STRATUM

Stratum	Survey 1986	Survey %	1988	Change stated	Assumed New Total
I	602	69	417	Dec 1%	596
II	531	72	385	Inc 15%	611
III	253	41	103	Inc 39%	317
IV	288	89	257	Inc 65%	415
Total	1,674	63	1,062	Inc 14%	1,939

Source: Walter (1988)

2.2 Ethnic identity of fishermen

During the early years of formation of the lake, fishing was exclusively for Tongas. However, as fish production decreased, Tonga fishermen gave up fishing such that by 1969, only 500 were reported to be fishing as compared to the peak number of 2,500 recorded in 1962. Those that left fishing were replaced by traditional fishing tribes like Bembas and Lozis. Colson (1971) states that "by 1964 fishing was no longer a major interest of the Gwembe men. They turned back to labor migration or local wage work or began experimenting with cotton farming or other forms of cash cropping". Beck (1985) assessed the role of Bemba fishermen and concluded that it was equal to or slightly more important than that of Tonga clan members. Up to date (1990) this is the view of DoF staff involved in the collection of fisheries statistics in Lake Kariba.

Contrary to the above, Walter (1988), who took a sample of 652 fishermen, found that the ethnic distribution of fishermen was as follows:

Tonga 50.6%
Bemba 34.4%
Others 12.0%

Table 5 and 6 below show details by stratum.

Table 5 Distribution of Ethnic groups (N = 652) by stratum

Stratum	Tonga	Bemba	Others	Total	%
I	71	43	15	129	19.8
II	45	142	52	239	36.6
III	75	-	-	75	11.5
IV	139	59	11	209	32.1
Total	330	244	78	652	100.0
%	50.6	37.4	12.0	100.0	

Source: Walter (1988)

Table 6 Distribution of ethnic groups (N = 156) by tribe.

Ethnic Group	N	%
Valley Tonga	52	33.3
Plateau Tonga	14	9.0
Bemba	53	34.0
Lozi	18	11.5
Nyanja	4	2.6
Others	15	9.6
Total	156	100.0

Source: Walter (1988)

In another sample of 156 fishermen, Walter found that if plateau and valley Tonga fishermen were combined they comprise almost 45% of the fishermen in Lake Kariba followed by Bembas making up 35%. The rest of the fishermen comprise of Lozis, Nyanjas and other tribes.

On the basis of the above sample surveys Walter concluded that out of a total of 1,940 artisanal fishermen operating in Lake Kariba, 875 were Tongas. Furthermore, he estimated that Valley Tongas should be 640 while Plateau Tongas should be 235. He estimated Bembas around 650. The rest of the fishermen ranging from 400 - 430, he states, should comprise of Lozis and Nyanjas. Whether or not Walter's conclusions are correct, remains to be seen. So far no other study has been carried to affirm or dispute Walter's findings.

2.3 The history of fishing and fishing activities

Fishing as a means of earning a cash income in Kariba started soon after the formation of the lake in 1960. In those early years of lake formation, because of break down of vegetation, the waters of the lake became rich in nutrients as such fish thrived and production boomed. According to Bourdillon et al. (1985) between 1959 - 1961, the Northern Rhodesian Government (Zambia) introduced the green headed Tilapia hoping that its diet of phytoplankton

would enable it to inhabit the open waters. Similarly stocks of the red breasted bream were introduced at about the same time hoping that they would thrive on vegetation near the shore line. The red breasted bream seems to have bred well for it is easily caught by gillnet fishermen. As fish catches decreased in the mid sixties, concurrently the number of fishermen also decreased up to the time of the armed struggle in the mid seventies. From then up to 1980 fishing activities ceased on the Zambian side.

As far as training is concerned the Zambian Government, as already mentioned, built a fisheries training center at Sinazongwe in order to provide basic fishing skills to fishermen since the local Tongas, prior to the formation of the lake, knew nothing about fishing other than use of traps, fishing baskets, hook and line.

2.4 Age, marital status and educational background

Walter (1988) took a sample of 157 fishermen of the age groups ranging from 16 - 72 years. His study revealed that the average age of fishermen in Lake Kariba on the Zambian side was 38 years. From the above, it goes without saying that the fishing population comprise of young men who have good fishing experience and looking forward with enthusiasm to earning a decent livelihood through catching fishes of Lake Kariba.

Out of the sample of 157 fishermen, Walter found that 84 % were married. Out of those who were married 78% have children. The study revealed that 16% of all fishermen were single. Most of these were young men still looking forward to getting married someday. The study indicates that 15% of the fishermen were living alone. This does not mean that they were single but that probably they left their wives in their villages specifically to fish . The typical fishermen's family comprises of husband, wife and children with very few relatives. Those who live with other relatives, e.g. brothers, constitute about 25% of the fishermen.

The Tongas of Zambia have a reputation for being Polygamists. It is not uncommon for a Tonga young man of 35 years of age to have 2 - 4 wives. Fortunately, for fishermen on Lake Kariba polygamy is not as common as one would expect. Perhaps this explains why DoF staff feel that the majority of fishermen are not indigenous Tongas. Occasionally one may find a fisherman married to two wives but none was found to have more than two wives in the study conducted by Walter. Out of a sample of 130 married fishermen, the average number of wives per married man was 1.15.

The family size depends on whether a fisherman is a monogamist or polygamist. According to Walters (1988) it ranges from two up to seventeen. A fisherman with two wives can have as many as 14 children. Walter states that the average number of children per couple is 4 and about half of the children are under six years of age.

Walter also determined their literacy rate. His findings were that 23% of the fishermen never went to school in their life time. In other words these were illiterates. The bright side of the picture is that 62% of the fishermen had received primary education while 16% had attended at least one year of secondary school education. This is quite encouraging in comparison to other fishery areas of Zambia where the majority of the fishermen are illiterate. Walter's study also suggests that immigrant fishermen from other fishery areas

notably those from Northern part of the country have higher educational levels than the locals. Whether this is true or not requires further study.

3. COMMERCIAL FISHERMEN, FISHING HISTORY AND FISHING ACTIVITIES

Prior to 1980 all fishing activities on the Zambian side were restricted to the artisanal sector. Commercial fishing and fishermen evolved following the introduction of Limnothrissa miodon (kapenta) from Lake Tanganyika between 1967 and 68. The stocking of kapenta in Lake Kariba is the most interesting and successful fisheries research activity ever undertaken in Zambia. As early as October 1968, barely one month after the last transplant was made, numerous rumors reached Chilanga, the Headquarters of the Department of Game Fisheries and National Parks of Zambia that kapenta shoals were spotted by fishermen in different parts of the lake. Of course most of the rumors were simply plain lies.

Others simply mistook alestes species for kapenta which were quite plentiful at the time. The first evidence indicating that kapenta had survived and bred occurred on the 25th of july 1969. On this date, two tiger fish were caught in gillnets at different localities within the Sinazongwe fishing waters. Stomach contents of one tiger fish revealed the presence of 43 kapenta ranging in size from 3 to 55 cm long. The other tiger fish contained one kapenta 4,5 cm long. According to Matthews, the Fisheries Biologist responsible for the introduction of kapenta in Lake Kariba, when he saw kapenta in the stomach of tiger fish, he assumed that the specimens of kapenta were not of the original stock. Therefore, he concluded that kapenta had survived in the lake.

Having concluded that kapenta had survived, the next stage involved fishing trials to determine the abundance of the new fishery. Experimental fishing started on both sides of the fishery in 1970. On the Zambian side chiromila nets were used by the resident biologist at Sinazongwe. Unfortunately research did not produce conclusive results. Probably for two reasons some influential Biologist argued that kapenta did not bread successfully. They pointed to the fact that for any fishing trials conducted about 50% of the catch comprised of alestes species which could be easily mistaken for kapenta. The intensification of the armed struggle in Zimbabwe led to the temporary closure of the fishery from the mid seventies up to 1980.

While no fishing trials were conducted on the Zambian side of the lake, various methods were employed on he Zimbabwean side at the Lake Kariba Research Institute. It was finally concluded that pontoon rigs using lift nets coupled with light attraction could yield profitable results.

Commercial fishing of kapenta on Lake Kariba started on the Zimbabwean side in July 1973. At that time on the Zambian side as already stated very few fishing activities were going on because of the liberation war of Zimbabwe. Commercial fishing on the Zambian side started after the advent of Independence of Zimbabwe. Commercial fishermen on the Zambian side simply transferred the fishing technology developed in Zimbabwe and employed it to catch kapenta. It proved very effective.

3.1 Distribution and numbers of commercial fishermen

For one to be a commercial fisherman he must first obtain a piece of land from the Gwembe District Council where he has to locate his fishing operation. Once that is done, he applies for a fishing license at the Fish Licensing Committee comprising of members from the Headquarters of the Ministry of Agriculture in Lusaka. The Director of Fisheries is one of the key members of this committee. The Committee scrutinizes each application. Once satisfied, the applicant is informed in writing that he can purchase a fishing license from the Department of Fisheries Headquarters in Chilanga. The fishing license is valid for one year after which it has to be renewed. The license fee varies from year to year as determined by the Committee in line with the rising level of inflation in the Country. In 1980 the price of a fishing license was K 600.00[1]. Each license could cover four fishing rigs. By 1990, the license fee had increased to K 1,600 per fishing rig. There is no discrimination of any type as far as the issuing of fishing licenses is concerned as long as one is a Zambian and meets the required conditions.

Unhappily, because of high investment costs involved in commercial fishing, very few indigenous Zambians are involved. The majority of commercial fishermen in Lake Kariba are white Zambians.

The number of commercial fishermen and fishing vessels varies from year to year as shown in table 7 below. The number of commercial fishermen was lowest in 1980 when only 25 licenses were issued. Since then the number steadily increased up to 57 in 1989. For the past 10 years the number of commercial operators averaged 47. Similarly the number of fishing vessels increased from the initial number of 82 to a maximum of 228 in 1989. This gives an annual average of 178 fishing rigs for the past 10 years. In 1990 both the number of fishing licenses and fishing rigs decreased for some unknown reason as compared to the year 1989.

Table 7 Number of commercial fishing licenses and vessels

Year	NO. of fishing license	No. of fishing vessels
1980	25	82
1981	36	129
1982	49	187
1983	50	200
1984	50	200
1985	50	200
1986	54	182
1987	-	-
1988	51	189
1989	57	228
1990	47	185

[1] US$ 1 = Kwacha 40

Although fishing operations are not restricted to any single area, somehow, commercial operators have found it advantageous to concentrate in three localities along the shore. The localities are in Siavonga, Chipepo and Sinazongwe.
In the early eighties the majority of fishermen operated from Siavonga mainly because Siavonga is a growing town along the lake situated at the Northern end of the lake.

Moreover Siavonga is ideal in the sense that electricity is available. Furthermore there is an all weather road linking to urban areas such as Lusaka, Kafue and Mazabuka. Although the majority of commercial fishermen settled in Siavonga, others opened up fishing camps at Sinazongwe. Sinazongwe had no supply of electricity in the early eighties but it had the advantage of a good road net work connecting it to the urban areas in Southern Province such as Choma, Monze and Livingstone. The third location where commercial fishermen concentrated was at Chipepo. Unfortunately, the road network connecting Chipepo to the railway is very bad especially during the rainy season. In addition there is no electricity supply at Chipepo. Consequently the area has always attracted very few commercial fishermen.

In the early nineties, the concentration of fishing vessels of commercial fishermen shifted from Siavonga to Sinazongwe. In 1990, for instance, Sinazongwe had 79 commercial fishing vessels as compared to 78 in 1988. Chipepo lost slightly. The number of commercial fishing vessels in 1990 were 35 as compared to 37 in 1988.

Perhaps the shift in the number of commercial fishing vessels from Siavonga to Sinazongwe can be attributed to an increased fishing effort at Siavonga. Catch per boat must have declined in Siavonga as compared to Sinazongwe.

However, in terms of number of commercial fishing companies operating in the areas, there were only minor changes between 1988 and 1990. For example Siavonga maintained the same number of commercial operators between 1988 - 1990. The number of fishermen was twenty. Chipope had 9 fishermen in 1988, this number decreased to 8 in 1990.

Perhaps it is fair to conclude that while the number of fishing vessels increased in Sinazongwe in the early nineties as compared to the early eighties the exact opposite happened in Siavonga. However, the number of commercial fishermen seems to have remained the same. This is so because of heavy investment secured on the plots. Moreover, it is not easy to get plots these days.

4. FISHING GEAR AND CATCH TECHNIQUES

Fishing gear used depends on the type of fishery to be exploited. If one aims at catching demersal fish stocks, these are to be exploited at artisanal level. The fishing gear used are mainly gillnets with mesh sizes exceeding 76 mm. A fisherman can use 10 - 15 gillnets at a time if he can manage it. Muphree at al. (1989) suggests that on the Zambian side of the lake there were 6,360 gillnets of 100 meters. If this figure is correct each artisanal fisherman uses a fleet of, on average, only 3 gillnets at a time. This number of gillnets is very low. This should be understood in the context of a below

capacity supply of gillnets by Nkwazi Net Manufacturing Company due to a lack of foreign exchange to import the desired quantities of raw materials. All gillnets manufactured by Nkwazi Manufacturing Company are of a standard length of 90 m. The Net Manufacturing Company is discouraged to make gillnets of mesh sizes less then 76 mm since this is the minimum size permitted in most of the capture fisheries of Zambia, Lake Kariba included.

However, in spite of these measures taken to ensure that the appropriate mesh sizes are used fishermen do use locally made nets with a mesh size less than 76 mm. stretched. These locally made gillnets are of good quality and with proper maintenance (net mending) can last between 1 - 2 years.
In lake Kariba, because of the unstumped trees during the filling of the lake, gillnets don't last long if a fisherman is not very careful where he sets the nets.

There are two main methods commonly used when setting gillnets. The first is the "top set" method. Under this method, the gillnet fleets are set by means of weights mostly of stones tied at both ends of the fleet of nets. The gillnets are suspended into water such that the floats do not sink. Marker buoys are recommended to be tied at both ends of the fleet but most fishermen do not use them presumably because of additional cost involved.

The nets are usually set in the evening and hauled early in the morning. At times fishermen only remove the fish and leave the nets in the water for a few days.

Another method used is called "bottom set". Under this method, the aim is to catch bottom feeding fish. The net is set at the bottom of the lake. The net it completely submerged by means of weights and marker buoys are the identifying marks. This method is rarely used by artisanal fishermen although it is recommended by the staff of the Research Division of the Department of Fisheries.

In the early days of lake formation when the fishery had plenty of fish, the drifting method of setting gillnets at the river mouths was practiced. It is rarely used in recent years especially from the decade of the eighties up to date.

Ever since the introduction of the price decontrol mechanism in 1985, prices of gillnets rose sharply. It should be mentioned however that prices of gillnets vary according to mesh size, depth and the twine used. For instance, in 1987, a 76 mm gillnet of 4 ply costed K 80. In 1989, the same gillnet costed K 215. By 1990, the price had increased to K 433,30.

According to the frame survey, conducted by Department of Fisheries in 1986, there were 1,427 boats operated by artisanal fishermen . The majority of these boats were canoes of sizes ranging between 4 - 6 meters long. A few glass reinforced plastic boats (GRP) were recorded. Others included plank boats and cement boats. The latter were introduced by TAP building products company based in Chilanga but proved very unpopular with fishermen for they easily break on the rocky shores of the lake. Muphree at al. (1989) estimated the number of boats to be 1,648 giving a ratio .85 boats per fishermen.

Dugout canoes are locally made and have a lifespan of 5 - 15 years. Prices vary according to size. A canoe can costs between K 5,000 - K 7,000 each. GRP

boats cost K 89,670, while plank boats cost K 25,000. Cement boats are no longer being produced because fishermen do not like them.

According to Walter (1988) very few boats in the artisanal sector are motorized. He extrapolates that only 61 boats are motorized. These could either be GRP or plank boats. None of the canoes are motorized for they are small and thus not suitable to carry an engine.

Fishing gear used by commercial fishermen differs from that used by artisanal fishermen because the target fish species are different. Commercial fishermen aim at catching Limnothrissa miodon (kapenta). As already mentioned, the technology was simply borrowed and transferred to the Zambian side. A typical kapenta fishing operation comprises of a rig.

A fishing rig is built out of two pontoons of 7 - 8 m length and 1 - 1.5 meter diameter. A platform is mounted on the two pontoons whose size may vary from 30 to 40 m^2. On the platform an outirgger is fixed at an angle of about 45°. its length can be 7-12 meters depending on the size of the net. The net is connected to the outrigger through a mechanical winch. The net, also called ring net, is conical in shape. The recommended mesh size of the net is 10 mm, however these nets are not easily available therefore 8 mm mesh size is most commonly used. A diesel engine is mounted on the wooden platform to generate electricity since fishing is done by light attraction. Two lights are suspended on the outrigger while one is submerged into the water where the net is cast.

The ring net is hauled using a mechanical winch anywhere from 1-1/2 hours depending upon the concentration of the sardine. In the process of catching kapenta, Hydrocymus vittatus the main predator is also caught. It takes an average of 6 men to run the rig although it is propelled by a 25 HP outboard engine. In the early eighties the complete fishing rig costed K 55,000. Today the same fishing unit would cost between K 600,000 - K 800,000.

4.1 Other fishing methods

Other fishing methods relate to those used by artisanal fishermen. These methods are less efficient because they are crude. Fishermen use these methods because they are less expensive than those described in the previous chapter. The other methods include the following:

- Kutumpula method involves the use of gillnets usually still set at the surface. The fishermen drive the fish into the nets by thumping the water with paddles or kutumpula poles specially made for this purpose. This method of catching fish is more efficient than the ordinary method of setting the gillnets in the evening and hauling them the following day. For this reason it is banned in Zambia because if uncontrolled it would lead to depletion of fish stocks;

- use of poison is a crude method which fishermen use from time to time. Fishermen simply pick leaves of a rotenone plant, pound it and throw it into a lagoon. Unfortunately this method kills all the fish regardless of size and age. For this reason it is banned but because the Department of Fisheries has financial problems to enforce the ban, fishermen still use it; and

- Hook and Line is another method used by fishermen on a small scale basis. Usually young boys employ this fishing method for household consumption. This fishing method is not illegal. At times fish is also sold to obtain some cash income. Fish species caught with the hook and line method depend upon the size of the hook and the bait. They include sardine (e.g. Alestes imberi) breams, Schilbe mystus and catfish.

Unfortunately most of the fish caught with the methods described above are not included in the statistics of fish production. As already mentioned some of these methods are illegal, consequently fishing is done at awkward hours when the statisticians are resting or operating elsewhere.

5. FISH PRODUCTION

Fish production statistics have been collected by the Department of Fisheries from the time of the lake formation up to the present. However, disruption in the collection of fisheries data was experienced during the decade of the seventies when the armed struggle in Zimbabwe reached its peak. For our purpose, we will concentrate on the decade of the eighties. Suffice to say that in the sixties fish production increased from 600 short tons in 1960 to a peak of 3,783 short tons in 1963 after which it decreased.

The independence of Zimbabwe in 1980 enabled the resumption of fishing activities on the Zambian side of Lake Kariba. Since that year two types of fisheries emerged namely, the kapenta fishery which is exclusively for commercial fishermen and the artisanal fishery which exploits the inshore fishery all of which have been explained in detail in chapter 4. Since two distinct fisheries were being exploited this called for two distinct systems of collecting fish production data.

Table 8 ANNUAL FISH PRODUCTION FOR LAKE KARIBA ON ZAMBIAN SIDE IN METRIC TONS

YEAR	ARTISANAL CATCHES	COMMERCIAL CATCHES	TOTAL
1980	-		
1981	No survey	874	874
1982	2600	4135	6736
1983	1357	4929	6226
1984	1382	5386	6768
1985	1938	7153	9091
1986	1924	7733	9657
1987	3136	5529	8665
1988	2588	6073	8661
1989	2651	7758	10409

Table 9 KAPENTA ANNUAL CATCHES OF LAKE KARIBA IN METRIC TONS

YEAR	ZAMBIA	ZIMBABWE	TOTAL
1973	-	66	66
1974	-	488	488
1975	-	656	656
1976	-	1050	1050
1977	-	1172	1172
1978	-	2772	2772
1979	-	4874	4874
1980	407	7993	8400
1981	874	11137	12011
1982	4136	8511	12647
1983	4970	8602	13572
1984	5386	10404	15790
1985	7153	14817	21970
1986	7733	16094	23827
1987	5529	15824	21353
1988	6073	18000	24073
1989	7458	-	-

Source: Department of Fisheries and Lake Kariba Fisheries Research Institute.

5.1. Inshore fishery production data

Because of frequent raids by the Rhodesian forces to Zambia, most of the Departmental Boats were destroyed. Consequently it took time to replace these destroyed boats. In the light of the above, the Department of Fisheries was not able to collect data from the inshore fishery in the years 1980 and 1981. However, from 1982 up to the present the Department of Fisheries has continued to collect data using the systems of stratified sampling devised by Dr. Bazigos of FAO in Zambia in 1975. The systems used for collecting production statistics are scientifically sound but too expensive to operate.

Table 8 shows that the inshore fishery exploited by small scale fishermen produced a yearly average of 2,197 metric tons between 1982-1989. The fishery started very well in 1982 by producing 3,601 metric tons. Thereafter fish production decreased up to 1986 when a production of 1,942 metric tons was recorded. All of a sudden in 1987 fish production increased to a peak of 3,136 tons. By the year 1989 fish production decreased to 2,651 tons. The reasons for these sudden fluctuations in fish production have not been substantiated by a scientific study. But it is highly unlikely that the decrease is caused by over-fishing. It is the author's opinion that the decrease could be due to insufficient supply of gillnets in the fishery.

Murphree at al. (1988) show a higher fish production from the artisanal sector in Zambia than in Zimbabwe. This is because there are more fishermen on the Zambian side since the policy of open access is practiced. However, in terms of catch per fisherman, as Muphree pointed out, the Zimbabwean fishermen catch more.

5.2. Off-shore fishery (kapenta) production data

The collection of catch data is easy in the sense that questionnaires are given to commercial fishermen who are required by law to submit catch data on a monthly basis to the Department of Fisheries. Upto now the system has worked reasonably well since catch data are available from 1980-1989 and there is every hope that data will be collected as usual in the future.

Fish production from the off-shore fishery started from low levels of 407 tons in 1980 to increase steadily year after year. The peak production was attained in 1989 when 7,758 metric was recorded. Average fish for the past ten years was 5,000 metric tons.

What is obvious from Table 8 above is that a fishery which hardly existed twenty years ago is now the most important both in terms of tonnage of fish produced and cash income generated. Moreover, the kapenta fishery has turned Lake Kariba to be amongst the top five most productive fisheries of Zambia. The overall fish production from the whole fishery for the past ten years averaged at 7,000 metric tons. Had it not been for the introduction of kapenta fish production from Kariba this would have averaged around 2,200 metric tons for the same period.

Table 9 above shows combined catch data for the entire lake. Equally on the Zimbabwean side fish production from the commercial fishery increased from a humble figure of 66 metric tons in 1973 up to a maximum of 18,000 in 1988.

On average fish production on the Zimbabwean side is about twice as high as that produced on the Zambian side. It should be remembered that on the Zimbabwean side fishing started in 1973 i.e. 7 years before the fishery on the Zambian side was opened. Combined production of kapenta has had an increasing trend from 66 metric tons in 1973 up to 24,073 tons in 1983. This fishery is doing extremely well. The only issue that ought to be sorted out between the two riparian states is that of having one management regime. Fortunately this issue is seriously being looked into by the SADCC Project sponsored by NORAD and DANIDA.

5.3 Fish processing methods

In spite of vigorous efforts by the DoF in the late sixties and early seventies to introduce better fish processing methods fishermen still process fish in traditional ways. As such, post harvest fish losses are still high varying from 10 - 15% of annual production. The main method to process fish introduced by the Department of Fisheries is by using a drum smoker. It processes the fish by using cool smoke. Unfortunately this method in too slow for the fishermen. Consequently it has been rejected. Moreover drums are not easily available. If available they are not cheap. Along side the use of the drum smoker, it was recommended that fish be brined in order to ensure that it is properly processed. What has happened over the years is that not only the price of salt increased but it was and still is in short supply. Fish processing methods used by artisanal fishermen differ from those used by commercial fishermen.

5.3.1 Artisanal fish processing methods

Walters study of 1988 revealed that fish produced from Kariba in the artisanal sector is either sold fresh, smoked or sundried. In fact he stated that 50% of all the fish is sold fresh to traders. Only 38% is smoked or sundried while 12% is consumed by the fisherman's family.

Fish is smoked either in open pits or within the fisherman's hut. A shallow pit is dug and a wire mesh is put on top. Firewood is put in the pit and lit. Before fish is smoked it is split open from the back. All the guts are removed thereafter it is washed and slightly sundried. Then it is put on racks or a wire mesh below which is the fire pit. The fisherman or trader smokes the fish until he is satisfied. When the processor is satisfied that the fish is well processed, he or she quenches the fire. The fish is left to cool off and dry. At times the drying process is speeded up by sundrying the fish. After drying the fish it is packed in wooden bundles of variable sizes and weight. A fish bundle can weigh anywhere from 15 kg to a maximum of 80 kg.

Alternatively, during hot months August to November, fish processors take advantage of the heat from the sun. Fish is simply split open, gutted and cleaned. Then it is sundried on racks or the roof of the fisherman's hut.

The description given above on the processing of fish shows that a lot needs to be done to improve the quality of processed fish. The processed fish is open to fly attack which leads to post harvest fish losses. Dry fish is also infested with larvae of the beetle called dermestes.

In order to reduce fish infestation and post harvest fish loss, fishermen and fish traders of Lake Kariba are reported to use sevkol powder and other insecticides which could be injurious to human health. Sadly, no studies have been undertaken to determine the health hazards caused by use of these poisonous pesticides in preserving fish.

5.3.2 Commercial fish processing methods

When commercial fishing operations started in the early eighties, each pontoon rig skipper carried course salt on board for brining kapenta as it was being packed into crates. That is all they did. These days, very few fishing companies do this mainly because salt is in short supply. Furthermore salt it is expensive.

The common practice in the nineties is that fish is packed in plastic crates from the net and stored in crates until they arrive at the landing site, which is the companies' premises. Kapenta is sold directly in fresh form to traders. The fishing companies have provided drying racks made out of wire mesh. Individual traders sundry the kapenta in the hot weather on Lake Kariba, the fish dry up before noon. Thereafter it is packed in sacks and ready to be transported by railway to town markets.

Only one fishing company at Siavonga has a modern smoking kiln for processing kapenta during the rainy season when the number of fish traders decrease due to bad weather and impassable roads.

A few commercial fishermen may process kapenta by freezing it in small packets of 0.2 kg - 2 kg. Bycatch fish such as Hydrocymus vittatus is sold fresh

directly to consumers. Occasionally some of it is sold frozen. During the rainy season, most kapenta fishermen on Lake Kariba dry their catch because of the lack of fish traders. Otherwise they sell their catch to fish traders who sundry it on the racks provided by the commercial fishing companies.

During the late eighties, GTZ introduced boat transport on Lake Kariba. The boat transports fishermen and fish traders between Siavonga and Chipepo. Fish traders have taken advantage of this boat transport by preserving the fish in ice. It is quite common these days to find frozen fish being transported from the islands to Siavonga and from there to the urban markets.

6. FISH MARKETING

Since fishing is dualistic fish marketing is as well. The major difference is that while the Department of Fisheries promotes fishing activities by providing training skills to fishermen and fish processors, very little has been done to improve fish marketing. In the late sixties the Department established fish markets in some landing sites like Sinatandabale fish market near Sinazongwe. This has since run down such that fishermen and fish traders have to find their own places where to sell and buy fish.

6.1 Fish marketing artisanal sector

In the artisanal sector there are many ways in which fish can be marketed. There are no restrictions as to who should market the fish.

It could be a fisherman (himself), the fisherman's wife, a female or male trader. Moreover there are no age restrictions. During holidays even students can take up fish marketing on a part time basis. Most of the fish traded in the artisanal sector is dry. Its marketing pattern can take different forms like:

A fisherman lands his fresh fish at the fish camp where he sells it directly to a trader at producer price. Fish is sold by sight rather than by weight as there are no scales in the fishing camps. The trader processes the fish using the hot smoking method supplemented by sun drying. Once the fish is dry, the trader packs it is wooden bundles. Thereafter the fish is ready to be transported to urban markets. Means of transport could be by boat, then by bus or private lorry or pick up. Once fish is transported to a town market, the trader has two options. One is to sell the fish to a fish marketeer at wholesale price, the other is to sell the fish at retail price at a market stall directly to consumers.

Alternatively a fisherman, once he lands his catch at the camp, can decide to process it himself or to have the fish processed by family members. Once the fish is dry it is packed in wooden bundles and transported to urban markets by any member of the fisherman's family. Here the fish is sold either at the wholesale or retail market as described above.

The marketing of fresh fish is slightly different and takes fish traders to buy and pack it in an ice box. Fish is interspaced with ice until the box is full. Thereafter fish is transported (normally in a fish box or sacks) to the town markets such as Choma, Kafue, Lusaka etc.

While kapenta is caught by commercial fishermen, substantial quantities are marketed by small scale traders. Its marketing pattern can be described as follows: a commercial fisherman lands his catch at his premises and sells fresh kapenta to a trader at producer price. The trader sundries it on the racks provided by the commercial fisherman. Once dry, the trader packs kapenta into sacks and thereafter transports it by railway to town markets. At the town market the trader can sell kapenta to marketeers at wholesale price or alternatively at retail price in a market stall.

6.2 Fish marketing (commercial sector)

Very little fish is marketed by commercial fishermen themselves other then selling it directly to traders in fresh form at their premises. Occasionally however, especially during the rainy season when the number of traders decrease due to bad weather and impassable roads, commercial fishermen sundry kapenta and pack it in sacks. About once a week they transport the fish by railway to towns like Choma, Livingstone, Kalomo, Monze, Mazabuka, Kafue and Lusaka. At these towns fish is sold at wholesale price. Some of them have established stores for this purpose. Fish marketeers buy from commercial fishermen at wholesale price and sell it at retail price.

7. FISH PRICES

Before 1982 fish prices were controlled by the Government. This meant that fish prices were uniform in all capture fisheries of Zambia. At all marketing stages from the producer, wholesale up to retail level, prices were fixed. For instance in 1981 fresh kapenta of Lake Kariba used to sell at 35 n/kg at producer price while dry kapenta sold at 90 n/kg. The retail price was 86 n/kg and K 1.66/kg for fresh and dry kapenta respectively. By May 1990 the producer price of fresh kapenta had increased to K 20/kg while the retail price had increased to K 34/kg. The decontrol price mechanism has brought about substantial increases not only of fish prices but of other commodities as well.

In the case of mixed fish species, according to Statutory Instrument No. 45 of 1981 the producer price was 48 n/kg for fresh fish while dry fish sold at K 1.5/kg. For fresh and dry fish the wholesale price was 90 n/kg and K 1.90/kg fish respectively. The retail price was K 1/kg for fresh and K 2.10/kg for dry fish. By May 1990 the producer price of mixed species increased to K 30/kg similarly the retail price increased to K 80/kg. It should be mentioned that at the producer level, the stated prices are an approximation since weighing scales are not used.

8. INCOMES OF FISHERMEN

Since no survey was conducted to determine the incomes of fishermen during the period of this desk review, estimates of fishermen's income for the year 1989 will be made on the basis of available (secondary) data.

In the artisanal sector there were approximately 1,940 fishermen who produced a total of 42,651 metric tons of fish. So on average each fisherman produced

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In the artisanal sector there were approximately 1,940 fishermen who produced a total of 42,651 metric tons of fish. So on average each fisherman produced

1.37 tons of mixed species of fish. Since the producer price was around K 30/kg each fisherman earned on average a gross income of K 41,100. This gives a gross income of K 3,425 per month. Compared with civil servants this is equivalent to the salary of a Division one officer. Certainly graduates in general professional scales of grade 9 have a lower gross income than fishermen from Lake Kariba.

In 1989 there were 57 fishing licenses issued. The total recorded catch for this year was 7,758 metrics tons. At K 20 per kg producer price of kapenta this gives an annual gross income of K 2,722,200. This is a crude approach of estimating fishermen's income but, in the absence of a detailed study, it gives at least an approximation of gross income of both artisanal and commercial fishermen operating in Lake Kariba. Despite the fact that the calculation is rough it is obvious that at least commercial fishermen earn quite substantial sums of money in spite of the high investment costs

9. FISH TRADERS (ARTISANAL SECTOR)

On the Zambian side there are no restrictions whatsoever to engage in fish trading. Fish traders of Lake Kariba, like elsewhere, play a very vital role in promoting fishing activities. Traders supply essential commodities such as gillnets, sugar, matches, salt, bread etc. to fishermen in the various fish camps scattered along the shore. Fish traders therefore, in a way, assist fishermen to concentrate on catching fish. Traders develop a close friendly relationship with the fishermen with a mutual benefit for both parties. The major benefit for the traders is that they are assured of accommodation in the fishermen's huts and, above all, that they are assured of a quick supply of fish. Apart from supplying essential commodities fish traders are also involved in fish processing. Fish processing is time consuming and in some fish camps quite costly because of high prices of firewood.

During the seventies it was generally believed that the majority of traders were women. According Walter (1988) there are more male than female fish traders. In line with the Party and Government motto of "One Zambia One Nation", the major tribes of Zambia are represented in the fish trading business of Lake Kariba. According to Walter (1988) the ratio of fishermen to traders is 3:1 which is rather high. This means that one fish trader buys fish from at least 3 fishermen at a time. This explains why a friendly relationship has to be developed between the two parties. In the absence of a good relationship the trader is bound to loose most.

One major change observed in the trading business is that while in the seventies the majority of fish traders were middle aged (officially unemployed) men, mostly of primary school level, currently many young men and women under 30 years of age, who have a school certificate, are involved in fish trading.

There are basically three types of fish traders on Lake Kariba. The different types are listed below:

Group 1 - Comprises of what one would call the traditional fish traders. These buy fresh fish of mixed fish species from fishermen and process it themselves and transport it by

rail to towns and cities for sale either at the wholesale or retail market.

Group 2 - Comprises of traders who specialize in buying and selling fresh fish of mixed species. They book a pick up from, for example Lusaka, and buy ice blocks. Then they travel to a particular fish camp e.g. Mundulundulu at Siavonga. Once at the fish camp they buy fresh fish only for a day or two until the fish box is full. Thereafter they drive back to Lusaka to sell the fish at retail price at the market stall.

Group 3 - These are traders in dry kapenta. They buy fresh kapenta from commercial fishermen which is subsequently sundried on racks provided by the fishermen. Thereafter they pack the kapenta in sacks and transport it to urban markets where it is either sold at wholesale or retail price.

Apart from the above mentioned groups it could be mentioned that commercial fishermen occasionally sell kapenta themselves. The reason for them to process and market their catch themselves is the lack of fish traders during the rainy season.

9.1 Profitability of fish trading

Information on the profitability of fish trade from Lake Kariba on the Zambian side is very scanty. However, the author conducted one case study in June 1990 on a "type 3" fish trader.

Leya Malambo started fish trading with a sum of K 1,500 borrowed from her uncle in January 1989. She went to Mundulundulu fish camp near Siavonga and bought one bag of kapenta for K 1,200. The remaining money (K 300) was spent on transport, food and fish levy. By the time she reached Lusaka's Kamwala market, she sold the bag of kapenta at a wholesale price of K 1,900 thus making a net profit of K 400 per bag per trip. By May of 1990 she made two trips per month. If she was lucky, she made K 3,200 per month. There are many such traders who earn either more or less than Meleya.

Walter's cost benefit analysis of fish trading for the year 1988 is equally optimistic for traders operating on Lake kariba. He calculates an initial investment of K 1,000. The monthly net earnings would range between K 300 - K 400 per trip. Therefore, if a fish trader wanted to increase his monthly earnings all he/she had to do is to increase the number of trips per month. Some traders are known to have made a maximum of four trips per month which would give substantial net monthly incomes. Alternatively a trader could increase monthly income by increasing the initial investment and reduce the number of trips per month.

10. WOMEN'S ROLE AND STATUS

Unfortunately women's role in the fishing industry, especially in Lake Kariba, has not changed much in spite of the introduction of the kapenta fishery. Some

men feel that fishing is a man's occupation and women are not actively involved in fishing yet. In some fishing areas like Kafue, fish women from towns and cities are known to own fishing operations. They do not directly catch fish but hire fishermen instead. If this phenomenon already exists in Lake Kariba it would only be in isolated areas. This does not mean however that women are completely left out. On the contrary wherever fishermen are located, naturally women are there. They could be housewives, fish traders or simply traders of other essential commodities. Their role in the fishing industry therefore varies. The majority of them are housewives. As housewife it entails that their major role is that of being the "queen" of the house. That is to say they bring up children, cook food, carry water, fetch firewood or carry out other household duties.

Land is one asset on the Zambian side of the lake which is plentiful unlike on the Zimbabwean side where most of it is owned by commercial companies or is part of the national park. This being the case, some fishermen's wives, who are good at tilling the soil, growing maize and other food crops at subsistence level during the rainy season. During the rainy season, as usual, water is plentiful in the lake. Women are therefore involved in "Zilili" gardens. These are gardens where women grow vegetables like cabbage, rope and maize in fertile areas near the lake shore. The zilili gardens are plentiful around the Siavonga area. The existence of these gardens dates back to pre-impoundment years when the valley Tongas used to grow green maize on the banks of the Zambezi river. Since Gwembe District experiences yearly food deficits the zilili gardens are being encouraged by the Department of agriculture in order to increase food production.

The important role of women with regard to the fishing industry is in fish processing. It is housewives in conjunction with their husbands who process the fish, especially when the number of fish traders decreases.
It is housewives who process the fish when the fisherman (husband) decides not to sell fish to a fish trader but to transport it to an urban market himself.

In fact some housewives become more or less full time fish traders in spite of the fact that they are married. In many instances women are not only involved in fish processing but in fish marketing as well. Other activities carried out by women in the fish camps of Kariba include making claysinkers for the foot ropes of gillnets. They also mount and mend gillnets and make floats and ropes.

Under the Zambia/Zimbabwe SADDC Fisheries Project, Murphree at al. (1989) suggests a few activities in which women could participate in order to improve their standard of living. Amongst these activities is the formation of women's clubs where women could learn and communicate in fields such as literacy, pre-school children groups and income generating projects, like clay sinker production, float and head rope making etc. Eventually it is hoped that women too will be given incentives to participate in fishing possibly in the form of cooperatives or otherwise individually.

11. FISHING COOPERATIVES

From the time of independence in 1964, it was the Party and Government policy to encourage the formation of fishing cooperatives not only in Lake Kariba but

also in other capture fisheries of Zambia. In the late sixties and early seventies considerable effort, time and funds were spent to create functional fishing cooperatives. Credit facilities were made available to the fishing cooperatives under the Credit Organization of Zambia (COZ) but unfortunately, by the mid seventies, none of the registered fishing cooperatives had survived. They all disbanded for various reasons. It is believed that one of the major reasons for the failure of fishing cooperatives was that they were more or less imposed upon the fishermen instead of fishermen generating the idea themselves. Some social scientists call this "the problem of top down planning and implementation approach". Lack of managerial, administrative and simple book keeping skills were other factors contributing to their demise.

Had fishing cooperatives been planned along the lines of those on the Zimbabwean side like the Lwando fishing cooperative it would have been more likely that they would have succeeded. But as it were instead of fishing individually the members of the fishing cooperatives fished in a group. Little by little members left while others simply stole fishing equipment. Eventually the fishing cooperatives broke up.

As of 1989 there was not a single fishing cooperative functioning in Lake Kariba. However, it is reported that the quaker mission group purchased a fishing unit late 1989 which belonged to a commercial fisherman who passed away. The idea is to turn this fishing unit into a fishing cooperative so that local people can start fishing kapenta. It is anticipated that since this fishing cooperative will be supervised by missionaries its chances of success are fairly high. The question though is what will happen after the missionaries go back home? Whether or not this fishing cooperative will survive remains to be seen.

11.1 Fisheries credit

Provision of fisheries credit on Lake Kariba, like elsewhere in the Republic, is channelled through the offices of the Lima Bank.

The fishermen of Lake Kariba have two branches available where they can submit their credit application. Lima Bank has two branches located at both ends of Lake Kariba, Choma in the south and Mazabuka in the north. Both commercial and artisanal fishermen are in principle free to apply for fishing loans. The problem for artisanal fishermen is collateral. For commercial fishermen there is no problem at all in getting loans. The other problem experienced by artisanal fishermen with regards to provision of fishing loans is that they are paid in kind rather than cash. It so happens that a loan is approved by Lima Bank but that at that particular time the fishing equipment is out of stock. Moreover once in stock, the sellers give preference to fishermen with hard cash rather than those ordered in bulk by Lima Bank. Thus credit provision by the Lima Bank with respect to fisheries is still problematic.

11.2 Irrigation schemes

A factor of major concern to the recruitment and management of the fishery resources of Lake Kariba is the establishment of irrigation schemes along the lake shore on the Zambian side. Chief amongst these is the Gwembe Valley Development Company located within Sinazongwe area. The company runs a farm of 3,000 hectares all under irrigation. On the scheme cotton and wheat are

grown throughout the year. From the point of view of an Agriculturist, the company is doing a good job. But according to the fisheries biologist the company constitutes a threat to fish recruitment. The cause for concern emanates from the pesticides and other toxic chemicals applied in the irrigation schemes. The effluents end up in Lake Kariba. So far no studies have been undertaken to determine the level of pollution and its subsequent effect on fish recruitment and fish growth. If this is perceived to be a future problem it might be wise to blow the trumpet before it is too late. Prevention is better than cure.

12. THE MANAGEMENT OF LAKE KARIBA FISHERY RESOURCES

Although the fishery is shared almost equally between the riparian states of Zambia and Zimbabwe, up to now the management of its fish resources is executed independently by each nation.

On the Zambian side, the policy adopted towards the artisanal fishery is that of open access. As such fishermen are free to settle where ever they please and catch fish as long as they abide to the management regulations. This policy has led to numerous fish camps being established along the lake shore even including some islands. The dispersion of fishing units poses a problem for accurate data collection and enforcement of management regulations.

In order to ensure that the fishery resources of Lake Kariba are exploited rationally the Government of Zambia, through the Department of Fisheries, drew up a fisheries act (Volume VI Cap.314).

Specifically the following regulations apply to Lake Kariba under this fisheries act which was drawn up in 1986:

- Gear restriction: Draw net of mesh size less than 76 mm, monofilament net of a mesh size less than 120 mm and gillnets of less than 76 mm.
- Prohibited fishing methods include the Kutumpula method, poisons and electrical fishing devises other than for research purposes.

In the mid eighties, the closed season regulation was introduced in most capture fisheries of Zambia. The season starts on the 1st of December and ends on the 30 th of February. This is the fish breeding period. Initially Lake Kariba was included in this regulation but since the fishery is shared and Zimbabwe did not have this regulation this could not be implemented.

12.1 Enforcement of fisheries regulations

The Department of Fisheries, through its administrative fisheries offices based at Sinazongwe Fisheries Training Center and Siavonga, have sufficient manpower to effectively enforce the fisheries regulations. The major handicap is funds. The financial resources allocated for the enforcement of fisheries regulations are inadequate to purchase boats and pay subsistence allowance to the staff. However, in spite of this bottleneck extension teams do go out from time to time to enforce the regulations. Occasionally a few culprits are apprehended. It is obvious that without effective enforcement of the fisheries regulations fishermen will continue flouting the conservation measures. With

respect to enforcement there is a lot of room for improvement but the major constraint remains sufficient funds.

13. THE ROLE OF ZAMBIA/ZIMBABWE SADCC FISHERIES PROJECT

The pilot phase of the above project was implemented from June 1988 -1989. The project is funded by NORAD and DANIDA initially with a total budget of NOK 3,072,000. The objective of the first phase was to collect and analyze information in order to establish the feasibility of the main project. The major activity during the pilot phase was the conduct of an acoustic survey aimed at determining the maximum sustainable yield of the fishery. The results of this survey were inconclusive. Therefore more work is to be done during phase two of project.

Phase II of the project is currently in progress. Phase II will have a duration of 5 years. The development objective is: To have reached the maximum sustainable yield by the end of the project.

The beneficiaries of the project are:

- consumers of kapenta in Zambia and Zimbabwe
- commercial kapenta fishing companies and their employees.
- kapenta cooperatives
- the Government of Zambia and Zimbabwe (through increase in tax revenue).

The intermediate objective is:

> A rationalized and sustainable system for joint management of the kapenta fishery of lake kariba.

The immediate objectives are:

> The results of the research and monitoring programme on kapenta stocks are utilized in the design and testing of a lake wide management plan for the kapenta fishery of Lake Kariba to be reached within 5 years from project initiation.

A strategy for the development and management of the lake and lake shore resources, which will lead to greater security for the artisanal fisherfolk, will be developed and plans will be implemented during the life time of the project. The beneficiaries under this objective are the artisanal fishing communities around the shores of Lake Kariba.

With these objectives stated above the project is held in high esteem by both riparian states. The problem has been that the two riparian states have different management regulations up to now. For instance,

- mesh size restrictions are different;
- Kutumpula method of fishing is vigorously encouraged by Zimbabwe while it is banned on the Zambia side; and
- closed season is encouraged on the Zambian side while on the Zimbabwean side it has never been considered.

In addition to the formulation and implementation of one management regime, the project is expected to introduce a unified system of collecting fisheries statistics and socio-economic data. By so doing the fishery will be better managed and exploited to the benefit of both producers and consumers.

14. CONCLUSION

The primary purpose of building the Kariba dam was to generate electricity. While this purpose is being achieved successfully every year to the satisfaction of both riparian states, Lake Kariba has since also developed into a major productive and profitable fishery. In the artisanal sector, with its abundant demersal fish species, it is providing steady employment to about 2000 fisherman on the Zambian side and about 900 on the Zimbabwean side. In the absence of the lake these fishermen would most probably not earn the income they are earning now. It is not an exaggeration to say that if there was sufficient supply of gillnets of a proper mesh size this could lead to even higher fish production and consequently higher incomes for the fishermen. Provision of credit would need to be streamlined if fish catches and incomes of fishermen in Lake Kariba are to be increased. The present system of credit provision under the Lima Bank is too slow in delivering the fishing equipment. The situation is exacerbated since the early eighties. Fishing equipment such as outboard engines, spare parts and gillnets are all in short supply because of a shortage of foreign exchange. Surprisingly fishermen of Lake Kariba have continued to increase fish production in spite of the adverse economic conditions prevailing in the country. This holds especially for the commercial fishermen.

As of 1989 57 fishing licenses were issued to commercial fishing companies on the Zambian side of Lake Kariba. The fishing companies had a total of 228 fishing vessels. As noted before each fishing company earned an average gross income of K 2.8 million. It is estimated that in the same year 1,368 jobs were generated for fishermen. The introduction of Limnothrissa miodon can be seen as the most successful fisheries research activity ever undertaken by the Department of Fisheries. The kapenta fishery has thrived in Lake Kariba and has led to development of other economic activities such as tourism industry and crocodile farming notably at Siavonga. The unfortunate side of the kapenta fishery is that while it was planted specifically to assist the indigenous people of Gwembe, these people are yet to benefit. The exorbitant investment costs of exploiting kapenta have made it almost impossible for artisanal fishermen to exploit the fishery. However, there is hope that under the quacker mission group a fishing cooperative composed of artisanal fishermen will in the near future catch kapenta and derive some financial benefits.

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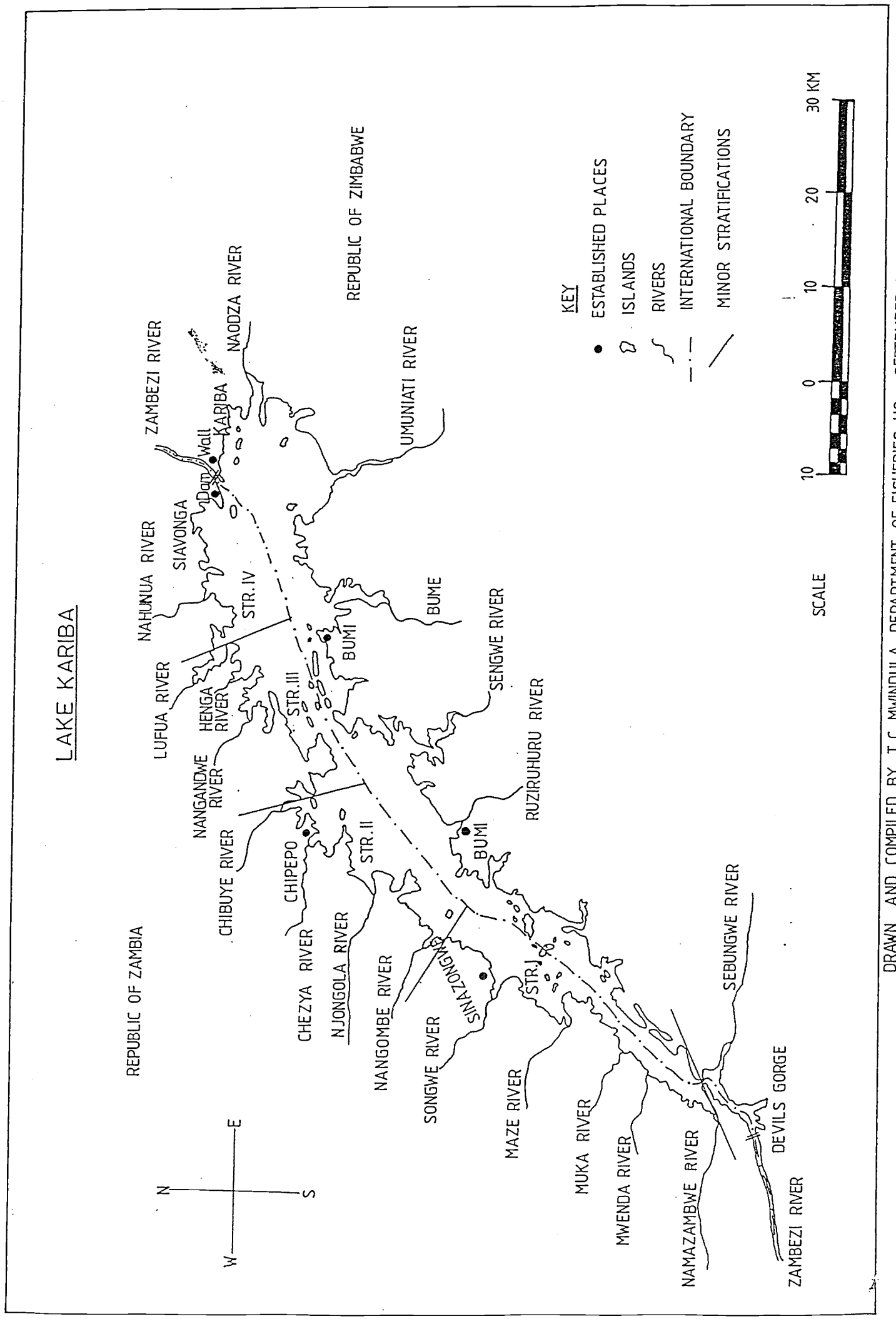
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DRAWN AND COMPILED BY J.C.MWINDULA, DEPARTMENT OF FISHERIES HQ SEPTEMBER, 1990.

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