RESEARCH FOR THE MANAGEMENT
OF THE FISHERIES ON LAKE TANGANYIKA

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HISTORICAL DATA REPORT ON THE FISHERIES, FISHERIES STATISTICS, FISHING GEARS AND WATER QUALITY OF LAKE TANGANYIKA (TANZANIA)

by
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(ed.)

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FOOD AND AGRICULTURE ORGANIZATION
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PREFACE

The Research for the Management of the Fisheries on Lake Tanganyika project (Lake Tanganyika Research) became fully operational in January 1992. It is executed by the Food and Agriculture Organization of the United Nations (FAO) and funded by the Finnish International Development Agency (FINNIDA) and the Arab Gulf Programme for United Nations Development Organizations
(AGFUND).

This project aims at the determination of the biological basis for fish production on Lake Tanganyika, in order to permit the formulation of a coherent lake–wide fisheries management policy for the four riparian States (Burundi, Tanzania, Zaïre and Zambia).

Particular attention will be also given to the reinforcement of the skills and physical facilities of the fisheries research units in all four beneficiary countries as well as to the build-up of effective coordination mechanisms to ensure full collaboration between the Governments concerned.

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1. Introduction:

As a follow-up to Reynolds' mission (Reynolds, 1992) around Lake Tanganyika to gather as much as possible historical data concerning f isheries, f isheries statistics, limnology, metereology, f ishing gears, ornamental f ish trade, etc., the staff of Fisheries Departments and Research Institutions of the 4 riparian countries 0f Lake Tanganyika, working closely with RTL, was asked to assist in the task of assembling, compiling and present the available data under a series of historical reports.

This report presents four historical data reports com—piled by the staff of the TAFIRI Centre in Kigoma, Tanzania. These reports deal, for the Tanzanian waters of Lake Tanganyika, with f isheries in general, f isheries statistics, f ishing gears and water quality.

The four historical reports are presented in their original language, i.e. english.

2. Historical Data Reports

1. Introduction:

Suite à la mission de Reynolds (1992) autour du lac Tanganyika pour collectioner le plus possible de données historiques sur la pêche, les statistiques de pêche, la limnologie, la météorologie, les engins de pêche, la commerce des poissons ornementaux, etc., le personnel des Départements des Pêches et des Institutions de Recherche des 4 pays riverains du lac Tanganyika, travaillant avec RTL, a été demandé d'assister dans le travail d'assembler, compiler et de présenter les données disponibles sous forme d'une série de rapports historiques.

Le rapport—ci présente quatre rapports de données historiques, compilés par le personnel du Centre de TAFIRI à Kigoma, Tanzanie. Ils contiennent, pour les eaux Tanza—niennes du lac Tanganyika, des données historiques sur la pêche en général, les statistiques des pêches, les engins de pêche et la qualité de l'eau.

Ces quatre rapports sont présentés en langue originale, c.—a—d. l'anglais.

2. Rapports Historique

HISTORICAL REVIEW OF THE ARTISANAL AND INDUSTRIAL FISHERIES OF LAKE TANGANYIKA IN KIGOMA AND RUKWA REGIONS, TANZANIA

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ABSTRACT

Lake Tanganyika is the seventh largest and second deepest lake in the world. The Lake is shared by four riparian states: Burundi, Tanzania, Zaïre and Zambia. The main fishing methods in the lake include the traditional scoop net (lusenga), the artisanal beach-seine (mkwabo), the lift net (kipe), and the industrial purse—seine.

The catch and effort data for the artisanal and industrial fisheries of Kigoma and Rukwa Regions for the period between 1984 and 1991 have been analyzed. It has been observed that over 99 % of the fish production of Lake Tanganyika in Kigoma Region is contributed by the artisanal fisheries. It has also been observed that over 98 % of the fish production in Kigoma Region is contributed by the six pelagic fish species, whereas in Rukwa Region the pelagic species represent on average 61 % of the total catch. The industrial fish production contribution to Lake Tanganyika in Kigoma Region for the same period (1984 - 1991) is between 0.07 % and 0.5 %.

Since the Lake's fish resources are shared by four riparian States, close regional co—operation in research, management and exploitation of common resources is essential. The formation of a regional body, Lake Tanganyika Fisheries Commission, is hereby suggested to oversee the above functions.

1. INTRODUCTION

Lake Tanganyika is one of the rift valley lakes of East Africa (Fig. 1). It is the world's seventh largest Lake by area and the second deepest (Brichard, 1978; Lindqvist and Mikkola, 1989). The total surface area is 32,900 km^2 of which 45 % is in Zaïre; 41 % in Tanzania; 8 % in Burundi and 6 % in Zambia (Fig.2) (Hutchinson, 1957; Herman, 1977; Stride, 1976). The Lake has a maximum depth of 1470 m and a mean depth of 570 m (Lindqvist and Mikkola, 1989)

Lake Tanganyika is permanently stratified. It has been classified by Hutchinson (1957) as meromictic. Three layers in the thermal structure of the Lake have been distinguished by Capart (1952): the hypolimnion (below the depth of 200 m), the thermocline (between 100 and 200 m) and the epilimnion (down to 60-100 m). The Lake harbours life only in the upper layer as only this layer with the indispensable oxygen can sustain life. Deeper down, around the 200 m level, the Lake water, laden with hydrogen sulphide and depleted of oxygen, is dead and void of life. Under such conditions, only coastal waters less than 200 m deep and superficial open waters have been colonized.

The geographic region occupied by the Lake has two main seasons: the dry season from May through August and the wet season during the rest of the year. The dry season is characterized by cooler dry conditions and a fairly constant southerly wind. In the wet season, winds are generally lighter and mainly northerly.

In Tanzania, Lake Tanganyika is shared by two regions: Kigoma Region in the north and Rukwa Region in the south (see Fig. 3). Kigoma Region has only one district sharing the lake (i.e. Kigoma district), whereas Rukwa Region has three districts (i.e. Mpanda, Nkasi and Sumbawanga). Kigoma district has 11 fish recording stations which include Kagunga, Mwamgongo, Mtanga, Kibirizi, Ujiji, Kaseke, Mwakizega, Sunuka, Kapalamsenga, Mgambo and Kalya. Mpanda district has one station namely Karema; Nkasi district has four namely Kirando, Kipili, Kizumbi and Kala; and Sumbawanga district has only one station namely Kasanga (Fig.2).

The aim of this paper is to present an historical outline of the fisheries of Lake Tanganyika in Kigoma and Rukwa Regions and to suggest measures to be taken to ensure that the Lake resources are exploited at their optimum level.

2. LAKE TANGANYIKA FISHERY

The fishery of Lake Tanganyika is of great importance to the surrounding region where protein food is scarce. It is based on two clupeid species, namely *Stolothrissa tanganicae* (locally known as dagaa) and *Limnothrissa miodon* (lumbo), and four *Lates* species, namely *Lates stappersii* (migebuka), *L. mariae* (sangara), *L. microlepis* (nonzi), and *L. angustifrons* (gomba) (Bayona, 1988; Lindqvist and Mikkola, 1989). The Lake Tanganyika fishery is also based on two organizational components, a traditional and an artisanal inshore fishery operated by

thousands of fishermen in both Kigoma and Rukwa Regions; and a commercial offshore purse– seine fishery in Kigoma Region. Over 90% of annual harvestable weight of fish in this Lake is contributed by the six pelagic species mentioned above. Of the clupeids, *Stolothrissa tanganicae* is the most abundant species in the pelagic zone (Katonda, 1992).

2.1 Traditional and artisanal fishery

The traditional (scoop-net fishery) and artisanal (beach-seine and lift–net fishery) are operated in inshore waters by thousands of fishermen (see Tables I, II, III). The catch data (Table II) show that the artisanal fishery accounts for more than 99% of the total catch in Kigoma region. Rukwa region has no industrial fisheries.

The artisanal fishery in Tanzania has undergone a process of transition, from the traditional scoop-net to the lift–net.

2.1.1. Scoop-net (lusenga) fishery

Scoop-net (lusenga) fishing is a traditional fishery operated during dark nights using light for attracting the small pelagic fish locally known as “dagaa”.

Fishing with light attraction on Lake Tanganyika is said to have been started by Babembe fishermen. To attract fish, these fishermen used to burn canes in the prow of their dug–out canoes and scooped up the attracted fish with a locally made scoop-net made from plant fibers. Later, pieces of old tyres mixed with pieces of wood were burned to attract the fish and the lusenga nets were made from cotton threads. In 1952, kerosine pressure lamps were introduced for the attraction of fish (Andrianos, 1977). During the same period, nylon nets replaced the cotton nets (Haling, 1974). Lusenga is a hand held scoop-net with an elliptical mouth and attached to a handle (stick). The net is operated from a dug–out canoe. The paddle–powered canoe normally carries a crew of two fishermen. The pressure lamps with top shades are attached to a protruding frame from the canoe, for attracting fish. When “dagaa” is concentrated in the “light attracted area”, one of the crew operates the net for catching the fish while the other crew manoeuvres the canoe. The net is scooped in and out several times until the depletion of fish in the light attraction area.

Most of the lusenga catch is composed of clupeids and a small proportion of juvenile *Lates stappersii* (Sasidharan, 1976; Van Well and Chapman, 1976). Although the attracted fish shoal consists of both “dagaa” and big fishes, the big fishes are not captured because they either do not approach the close range of the lamp or else they swim faster and thus escape the relatively small net (Andrianos, 1977).

2.1.2. Beach-seine (mkwabo) fishery

Dagaa fishing by means of beach-seine nets is widely used in Tanzania. It can be operated during day time or at night. At

day time dagaa beach-seining can take place at any time of the day when the “dagaa” are seen by the fishermen watching from the beach. The night dagaa fishing involves sending a canoe equipped with a pressure lamp at a distance of 300-400 m from the beach. The “dagaa”, attracted by the light, come up and follow the light when the canoe is paddled slowly back to the shore. When the canoe is at a distance of some 50 m from the beach, the seine net is put into the water by means of another canoe which surrounds the one equipped with the pressure lamp. The net is then pulled out of the water by the fishermen.

2.1.3 Lift-net (kipe) fishery.

The lift-net fishing with catamaran was first attempted in Burundi waters of Lake Tanganyika in 1957 (Haling, 1974). It was introduced in the Tanzanian part of the Lake in 1972 by the migrant fishermen of Burundi (Colaris, 1973). Since then, the number of kipe units has been increasing year after year particularly in Kigoma Region (see Figs. 14 and 15).

There are two types of lift-net units, presently in operation, i.e. catamaran and trimaran: two boats forming a catamaran (Fig. 4a) and three boats forming a trimaran (Fig. 4b). The boats are joined side by side by means of wooden poles.

A trimaran has the advantage of a large net and hence a large fishing area. However, the high cost of boat construction has forced fishermen to use catamarans instead: in order to have a large net, fishermen have eliminated the third boat and have increased the length of poles joining the two boats by joining two poles to make one long pole (see Fig. 4c).

In this way, fishermen are able to use a large net as it is in the trimaran . The “kipe” net is a square dipping net which has a shape of an up down pyramid (see Fig. 4d). Lift-net fishing also operates during dark nights using pressure lamps for attracting fish as in the case of scoop—net (lusenga).

The lift-net catches depend on where fishing is done. In offshore waters, catches are mainly composed of *Lates stappersii* with a small proportion of clupeids whereas in inshore waters “kipe” catches are composed mainly of clupeids *(Stolothrissa* and *Limnothrissa)* with a small proportion of juvenile *Lates stappersii* (pers.obs.).

2.1.4. Other fishing gears and methods

Other fishing gears in use in Lake Tanganyika include gill-net (makira), hook and line (kachinga) and traps (madema) (see Tables I, II and III).

Gill—nets are highly size-selective fishing gears and are worldwide used in commercial fisheries. A gill—net is a passive fishing gear which is set straight out in the water, forming a vertical net wall. It consists of a piece of network with a certain mesh size, generally expressed in millimeters for the stretched mesh, and ply, expressed by a number indicating the thickness of the twine. The network is hung between a float and a lead line by a certain ratio. This ratio is called the hanging

ratio and is equal to the length of the line divided by the length of the network. The total surface of the gill-net which can be made out of a piece of network thus depends on the used hanging ratio. The gill-net fishery is particularly important in Rukwa Region (see Figs. 14 and 15). Catches of gill-nets are mainly eaten by fishermen and their families.

2.2 Industrial Fisheries

The industrial fishery in Lake Tanganyika was developed during the fifties, mainly by Greek fishermen. The first attempt made by a foreign fisherman to exploit the pelagic fish stocks using a purse–seiner was made in 1946 at Kalemie (Zaïre). The trial fishing, however, had very poor results.

In 1952, a second attempt was made by a Greek fisherman (George Maniatis). A wooden purse–seiner was constructed for him by a Greek technician (Nick Sahpazis). The boat, however, was destroyed by fire before fishing operation started. In 1953, the same people built a metal purse–seiner and this time the operation became very successful. The year 1953, therefore, is considered as the year that purse–seine fishing was introduced in Lake Tanganyika (Andrianos, 1977). The Lake's purse-seine fishery expanded rapidly, especially in Burundi waters. Figure 16 shows the evolution of the purse-seine fishery of Lake Tanganyika in Tanzania.

The industrial purse–seine unit usually consists of a large mother boat seiner, an auxiliary boat and 4–6 smaller lamp boats. As in the case of scoop–net and lift–net, purse–seining is done during dark nights. Industrial catches are mainly composed of *Lates stappersii* and a small proportion of other *Lates* spp. (*L. mariae, L. microlepis* and *L. angustifrons*).

2.3 Fish marketing

In the past, fish was harvested mainly for food and most of the fishermen were also subsistence farmers. This was due to lack of markets for fish. Marketing of catches in excess of local needs was generally difficult because of poor communication systems along the lake. Because of the steep shores, there are no roads linking the scattered populations around the shore. In recent years, water transport carried out by large plank–built canoes powered by outboard engines and a weekly service by M/V Liemba (or M/V Mwongozo) have provided service to these scattered populations and have thus encouraged more fishing in the Lake.

For fish landing stations far from Kigoma town, once the catch is landed, it is either processed by fishermen or sold to processors. Clupeids are dried in the sun on the beach whereas *Lates stappersii* are smoked. The other big fishes are eaten fresh by fishermen. For landing stations near Kigoma town, the *Lates* spp. and some clupeids are sold fresh in the town markets (Kigoma, Mwanga, Buzebazeba, Ujiji and Mwandiga) and nearby centres (Bitale, Mahembe, Simbo, Kidahwe, Mayenge, Pamila and

Kalinzi). Most of the clupeids, however, are preserved by drying them in the sun on sand and rocks. The dried clupeids are sold to traders who take them to other towns like Tabora, Dodoma and Dar es Salaam. Some dried clupeids are also exported to our neighbours, Zaïre and Zambia.

3. DISCUSSION

Catch (total and by species) and effort evolution for Lake Tanganyika (Tanzania) are presented in Figures 5, 6, 7 and 8 and total catch for Kigoma and Rukwa regions (1984-91) in Figure 9.

The catch data of Lake Tanganyika in Kigoma Region (Table II) show that the artisanal fishery represents 99 % and the industrial fishery only around 0.2 % of the total catch. Over 98 % of fish production in the lake in Kigoma Region is contributed by pelagic fish species of which *Stolothrissa tanganicae* and *Limnothrissa miodon* contribute an average of 78.4 %, *Lates stappersii* an average of 19 % and the other three *Lates* spp. (i.e. *Lates mariae, L. microlepis* and *L. angustifrons)* contribute an average of 1.5 % (Table IV; Fig. 10). Data for Rukwa Region (Table V; Fig. 11) for the same period show that *Stolothrissa* and *Limnothrissa* contribute an average of 34.7 *%; L. stappersii* an average of 15.5 % and the other three *Lates* spp. an average of 11.2 %.

The contribution of *Stolothrissa* and *Limnothrissa* in Rukwa Region was high in 1984 and 1985, 69.6 % and 44 % respectively but started to drop from 18 % in 1986 to 16.7 % in 1987 and 14.3 % in 1988. It increased again in 1989 to 45.6 **%.** The contribution of *Lates stappersii* was low in 1984 at 1.3 % when the "dagaa" contribution was highest (69.6 **%).** As the *Lates stappersii* contribution increased, the "dagaa" contribution decreased up to 1988 when the contribution of both "dagaa" and *L. stappersii* was about the same at 14 % (Table V; Fig. 11) As the *L. stappersii* contribution decreased further in 1989 to 9.2 **%,** the contribution of "dagaa" increased to 45.6 **%.** The data show that *Stolothrissa* catches correlate negatively with those of *L. stappersii.* This has been interpreted as indicating that *L. stappersii* imperfectly locates schools of *Stolothrissa* and does not follow its rapid vertical and lateral movements closely. Chapman (1976) hypothesized that by these movements *Stolothrissa* avoids *L. stappersii* attacks with the result that catches are composed predominantly of one or other species. The contribution of the other *Lates* spp. *(L. mariae, L. microlepis* and *L. angustifrons)* has remained constant at 12 % between 1985 and 1987 and then decreased to 10.4 % in 1989. The contribution of *L. mariae, L. microlepis* and *L. angustifrons* in Rukwa Region is higher than that in Kigoma Region.

For Kigoma Region, the contribution of *Stolothrissa* and *Limnothrissa* has almost remained constant at 76 % with the exception of the years 1989 and 1991 when it increased to 84.2 % and 82.6 % respectively (Table IV; Fig. 10). The *Lates stappersii* contribution was low in 1984 and 1985 at 17.7 % and 14.4 % respectively and then increased to 23 % in 1986 and remained almost constant at 22 % in 1987 and 1988. In 1989, it

dropped to 14.6 %. The contribution of the other three *Lates* spp., however, has been decreasing over the same period. Similar results have been reported for other areas where fishing is intense. In Burundi and Zaïre, where fishing activity is most intense, three of the predatory species (i.e. *Lates mariae, L. microlepis* and *L. angustifrons)* have been reported to have shown a pronounced decrease in population since the fifties when commercial fishing began on the Lake (Coulter, 1965 - 66, 1976; Roest, 1988). Population sizes of the remaining centropomid *(Lates stappersii)* and clupeid prey species *(Stolothrissa* and *Limnothrissa)* have fluctuated dramatically during the same time interval.

Data from Kigoma Region (Fig. 10) are in agreement with the initial observation from the Burundian and Zaïrian parts of the Lake where industrial fishery resulted in increased clupeid yields as Predators were being fished out (Coulter, 1970). It is also in agreement with the predictions of Coulter (1981) that increased fishing pressure should result in the pelagic community being dominated chiefly by clupeids as *Lates* species are fished out.

The fishing effort, expressed by the number of fishermen, in Kigoma Region is almost twice the fishing effort in Rukwa (Figs. 12 & 13). Since fish stocks in Lake Tanganyika tend to be locally distributed within certain areas (Coulter, 1970; Chapman and Van Well, 1978), the present fishing effort at Kigoma is likely to be the cause of its persistently very low catches (Bayona et. *al.,* 1990; Chitamwebwa, 1989). More research, however, is needed to be able to explain why catches are low even in areas which are not heavily exploited like Rukwa Region. In Tanzania, fisheries research in the Lake is done by the Kigoma Centre of the Tanzania Fisheries Research Institute (TAFIRI). The Centre, however, has been facing a lot of problems ranging from lack of equipment to inadequate funds for research (Katonda, 1990)

Gulland (1974) defines fishery management as "any control or adjustment of fishing operations (the amount of fishing, type of gear used, size of fish caught) to optimize the use of the natural resource". This includes not only restrictive measures, like closed seasons, associated with management in the narrower sense, but also development plans and activities that take into account the limitations set by the resource. Proper management, therefore, is one of the major problem facing many fisheries and their administrators. As Gulland (1974) points out, action to manage or conserve a fish stock is best taken early in the development of a fishery, not after it is in trouble. The management measures will be of no use unless the actions proposed are actually carried out. Adequate enforcement is therefore an essential part of any effective management regime. Enforcement of some regulations, however, may require costly actions such as inspection of gears, etc. This is the major drawback in Tanzania (Bwathondi and Katonda, 1991).

In Tanzania, the Fisheries Division in the Ministry of Environment, Natural Resources and Tourism is the body responsible for the management and conservation of territorial

aquatic resources. Several acts and regulations have been instituted to safeguard and conserve these resources. The fisheries Act No. 6 of 1970 makes provision for the protection, conservation, development, regulation and control of fish, fish products, aquatic flora and products thereof, and for matters incidental thereto and connected there with. This act came into force in 1973 by the Government issuing the Fisheries (General) Regulation of 1973 (Government Notice No. 57 of 16.03.1973). Since then, several amendments have been made to these fisheries (General) Regulations e.g. Government Notice (GN) No. 138 of 27.06.1975; GN No. 1 of 13.01.1978; GN No. 84 of 17.09.1982; GN No. 109 of 17.09.1982 and the most recent, the Fisheries (Principal) Regulations of 1989 (GN No. 317 of 15.09.1989). The District Fisheries Officers are the officers responsible for the enforcement of the Fisheries Regulations. There are four districts sharing Lake Tanganyika in Tanzania: Kigoma district in Kigoma Region; Mpanda, Nkasi and Sumbawanga districts in Rukwa Region. Unfortunately, the District Fisheries Officers are employees of the Local Governments (District/Town Councils) and not the Central Government (Fisheries Division). The District/Town Councils are more interested in money generating projects, hence issues like fisheries statistics data collection and enforcement of fisheries regulations are given very low priority. No funds are allocated for such functions. The fisheries staff who are supposed to collect fisheries statistics and enforce the fisheries regulations are sometimes assigned other duties not related to fisheries. The problem of our institutional framework of government/institutions/agencies dealing with Lake Tanganyika fisheries has been discussed in details in our Historical Data Report on Fisheries Statistics (Katonda, 1993).

Considering the biological and hydrological dynamics of Lake Tanganyika, the overall biology and fish production in particular cannot be understood or managed, in the long term, by each country alone. A concentrated effort by all four countries working together is clearly needed. Since the Lake's fish resources are shared by four riparian states, close regional co-operation is essential in the management of the common resources. It is hereby suggested that a regional body, Lake Tanganvika Fisheries commission, be formed. The purpose of the body would be to coordinate planning, conservation and research activities within Lake Tanganyika and disseminate information and policy recommendations among the four riparian states. The Commission should be responsible for:

a) making recommendations on the standardization of laws and regulations pertaining to the Lake management;

b) coordinating and developing communication links between the four riparian states;

c) coordination of activities to conserve the Lake's environment;

d) preparation of reports, newsletters and scientific journals targeted at various users of the Lake resources (e.g. fishermen, students, administrators,

policy makers and the scientific community);

e) other functions which the riparian states will assign to the Commission.

The four riparian states should finance the Commission with the assistance of friendly countries and UN bodies.

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Table I: Fishing gears in Lake Tanganyika (Tanzania)

Year	S.nets	L.nets	B.seines	P.seines	G.nets	Hooks
1971	3516	n.a	286	n.a	5649	15157
1972	n.a	n.a	n.a	n.a	n.a	n.a
1973	4316	n.a	132	3	20451	23570
1974	4281	n.a	122	5	41936	n.a
1975	5281	175	409	4	60397	n.a
1976	n.a	n.a	n.a	n.a	n.a	n.a
1977	4973	389	200	5	26297	n.a
1978	n.a	n.a	n.a	n.a	n.a	n.a
1979	501	814	145	4	23476	51058
1980	n.a	n.a	n.a	n.a	n.a	n.a
1981	n.a	n.a	n.a	n.a	n.a	n.a
1982	n.a	n.a	n.a	n.a	n.a	n.a
1983	n.a	n.a	n.a	n.a	n.a	n.a
1984	3851	360	534	3	44661	15996
1985	2974	451	493	6	16559	6919
1986	2312	1203	627	7	2892	3297
1987	1655	540	510	7	2188	16156
1988	2519	634	562	5	2131	9184
1989	1183	612	397	3	5332	30022
1990	1267	673	407	4	4967	23889
1991	1019	993	259	3	5480	25405

Source: Fisheries Division, Dar es Salaam.
Note: n.a = data not available
S.nets = Seine—nets
L.nets = Lift-nets
B.nets = Beach—seines
G.nets = Gill-nets

Table II: Summary of fishery statistics from Tanzania territorial waters of Lake Tanganyika, Kigoma Region.

Year	1984	1985	1986	1987	1988	1989	1990	1991
Fishermen	9473	9569	10564	10241	10470	9429	9304	8822
vessels	6091	4367	2942	2450	1710	1498	1650	1664
Weight Artisanal (m.tons)	42402	55947	56291	78513	39199	29961	28506	27847
Value Artis. (millions Tshs)	806.5	2084	1255	2306	1455	1258	2079	1870
Weight Industrial (m.tons)	117.3	320	306.1	182.8	74.3	20.4	—	—
Value Industrial (000's Tshs)	1453	6731	5772	6427	3709	1481	-	-
Total Weight (m.tons)	42519	56267 (m.tons)	56597	78696	39273	29982	28506	27847
Total Value (millions Tsh)	808	12613	1545	2312	1463	1573	2079	1870
Gill—nets	-	361	538	1478	708	925	717	1073
Hooks	-	2377	1624	12449	5305	14370	8237	9753
Purse-seines	-	6	7	7	5	3	4	3
Beach-seines		221	282	295	170	240	250	229
Lift-nets		376	376	482	537	583	593	647
Scoop-nets	-	2142	2156	1340	738	606	680	550
Traps	-	-	-	-	-	-	-	-
Out-board engines	-	108	120	139	210	124	294	222
In-board engines	-	6	7	7	5	3	4	3

Source: Fisheries Division Annual Statistics Reports, Ministry of Environment,Natural Resources and Tourism, Dar es Salaam.

Note:— = Data not available.

Table III: Summary of fishery statistics from Tanzania territorial waters of Lake Tanganyika, Rukwa Region.

Year	1984	1985	1986	1987	1988	1989	1990	1991
Fishermen	4423	4056	3273	3287	6095	5971	6495	4829
Vessels	1640	1612	1595	1170	2591	2249	2845	1628
Weight Artis. (m.tons)	64709	30690	13761	15215	23537	29533	36359	35656
Value Artis. (Millions Tsh)	677.1	601.2	270.5	286.1	753.2	1078	1431	1584
Weight Industrial (m.tons)	0	0	0	0	0	0	0	0
Value Indus. (000's Tsh)	0	0	0	0	0	0	0	0
Total Weight (m.tons)	64709	30690	13761	15215	23537	29533	36359	35656
Total Value (millions Tsh)	677.1	601.2	270.5	286.1	753.2	1078	1431	1584
Gill-nets	-	16198	2354	710	1423	4407	4282	4407
Hooks	-	4542	1673	3707	3879	15652	15652	15652
Purse-seines	0	0	0	0	0	0	0	0
Beach-sienes	-	272	345	285	392	157	157	30
Lift-nets	-	75	827	58	97	80	80	346
Scoop-nets	-	832	56	315	1781	587	587	469
Traps	-	136	10	29	29	-	-	-
Out-board engines	-	99	118	112	91	241	-	-
In-board engines	-	5	-	13	4	3	-	-

Source: Fisheries Division Annual StatisticsReports, Ministry of Environment, Natural Resources and Tourism, Dar es Salaam.

Note:— = Data not available.

Table IV: Weight of fish caught by species (m.tons) and species composition by percentage (in brackets) from Lake Tanganyika (Kigoma Region), artisanal fisheries.

Year	Dagaa	*Lates stappersii*	Other *Lates* spp.	Other Fish spp.	Total
1984	30402 (76.6)	7036.5 (17.7)	1743 (4.4)	484.7 (1.2)	39666 (100)
1985	69029 (81.9)	12100 (14.4)	2001.4 (2.4)	1142.8 (1.4)	84273 (100)
1986	42658 (76.3)	12896 (23.1)	45.62 (0.1)	347.25 (0.6)	55947 (100)
1987	59193 (75.4)	17624 (22.5)	299.13 (0.4)	1397.9 (1.8)	78514 (100)
1988	29730 (75.8)	8442 (21.5)	600.5 (1.5)	426.5 (1.1)	39199 (100)
1989	25220 (84.2)	4380.8 (14.6)	151.8 (0.5)	208.1 (0.7)	29961 (100)
1990	24674 (86.6)	3234 (11.3)	132 (0.5)	466.9 (1.6)	28506 (100)
1991	22998 (82.6)	4647.5 (16.7)	65.2 (0.2)	136.8 (0.5)	27847 (100)

Source: Fisheries Division Annual Statistics Reports, Ministry of Environment, Natural Resources and Tourism, Dar es Salaam.

Table V: Weight of fish caught by species (m.tons) and species composition by percentage (in brackets) from Lake Tanganyika (Rukwa Region), artisanal fisheries.

Year	Dagaa	*Lates stappersii*	Other *Lates* spp.	Other fish spp.	Total
1984	45099 (69.6)	829 (1.3)	3123.9 (4.8)	15717.8 (24.3)	64769.7 (100)
1985	13493 (44)	4760.7 (15.5)	3770.6 (12.3)	8665.8 (28.2)	30689.9 (100)
1986	2468 (18)	2797.4 (20.3)	1722.71 (12.5)	6772.5 (49.2)	13760.7 (100)
1987	2542 (16.7)	4893.5 (32.2)	1847.29 (12.1)	5932.2 (39)	15214.7 (100)
1988	3359 (14.9)	3380.5 (15)	3500.5 (15.5)	12297 (54.6)	22537 (100)
1989	13473 (45.6)	2701.2 (9.2)	3056.8 (10.4)	10301.6 (34.8)	29533 (100)
1990	17409 (48.3)	5062.4 (14)	3560.2 (9.9)	10024.8 (27.8)	36056.2 (100)
1991	13520 (37.9)	7310.1 (20.5)	2397.9 (6.7)	12427.9 (34.9)	35656.2 (100)

Source: Fisheries Division Annual Statistics Reports, Ministry of Environment, Natural Resources and Tourism, Dar es Salaam.

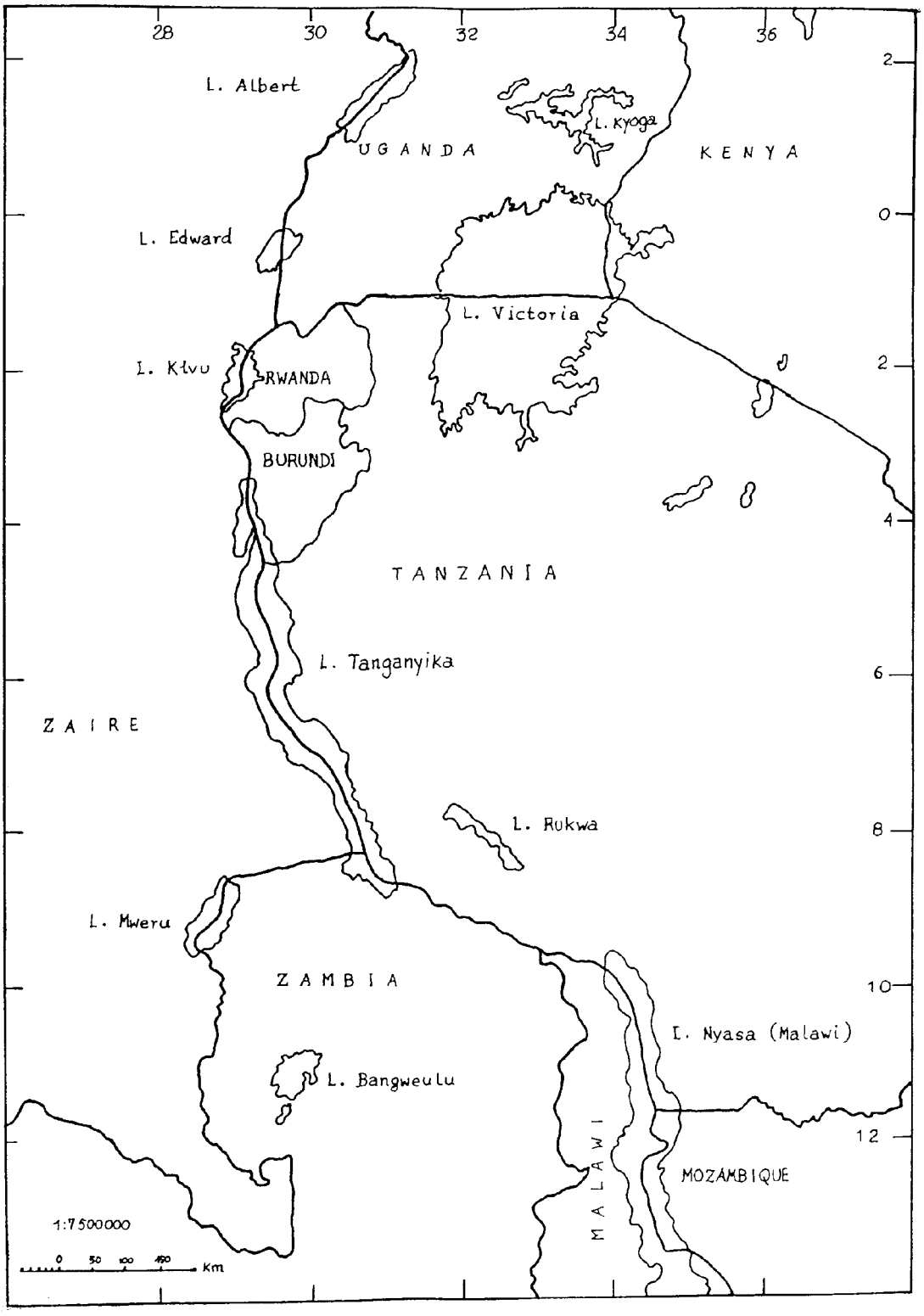


Fig. 1. MAJOR LAKES OF EAST AFRICA

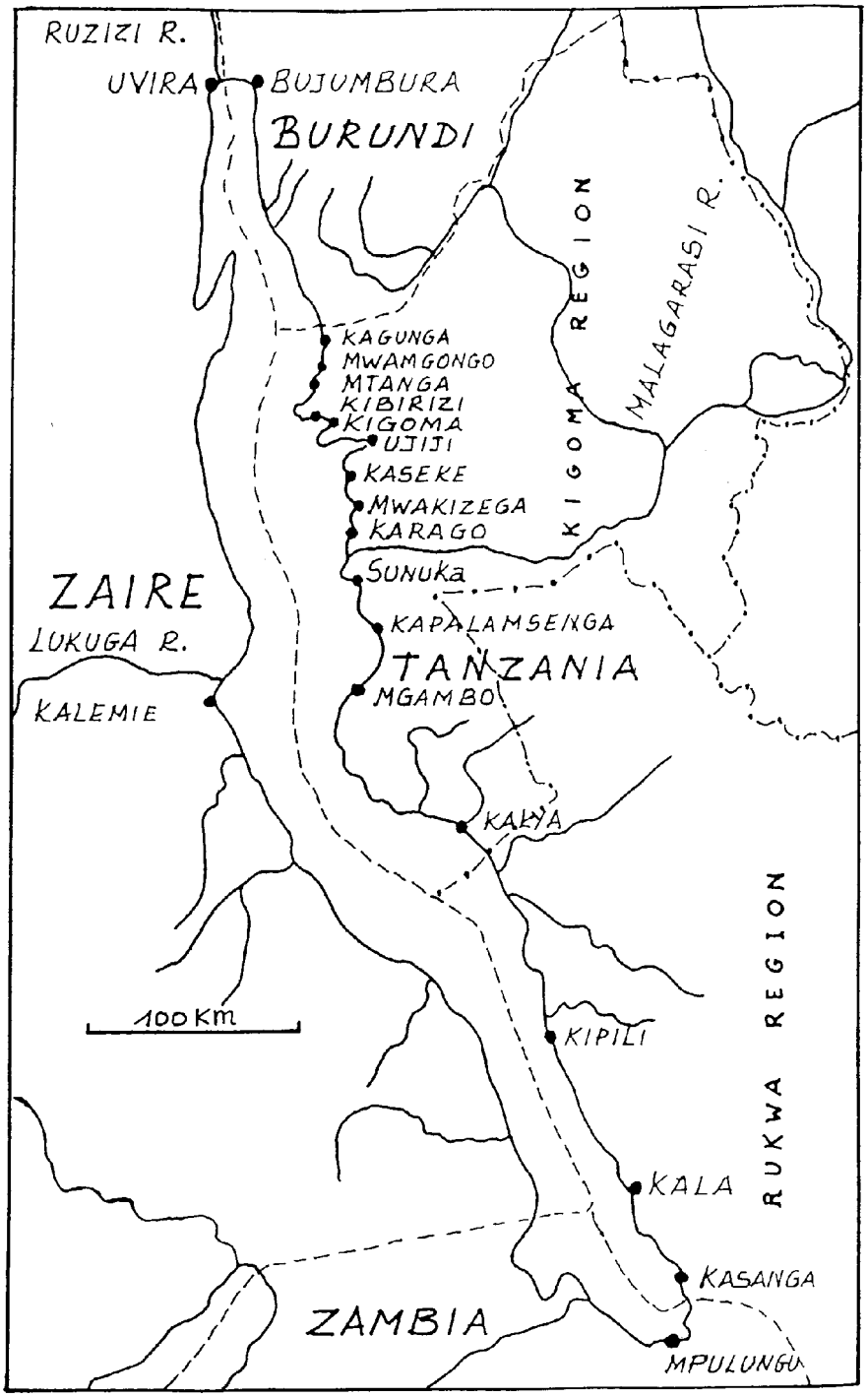


Fig. 2 MAP OF LAC TANGANYIKA SHOWING KIGOMA AND RUKWA REGION BOUNDARIES AND MAIN FISH LANDINGS.

------ INTERNATIONAL BOUNDARIES
_ . _ . _ REGIONAL BOUNDARIES.

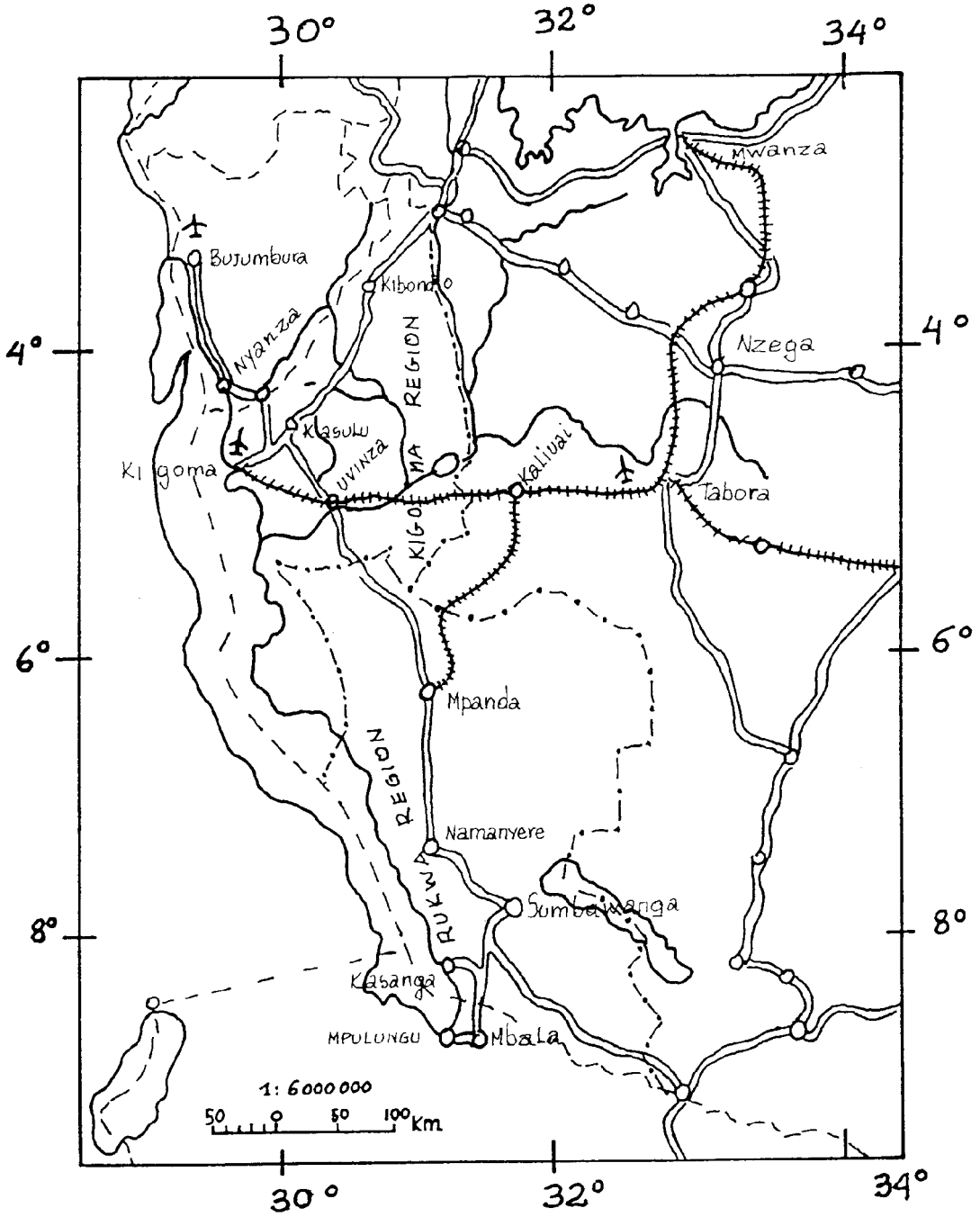
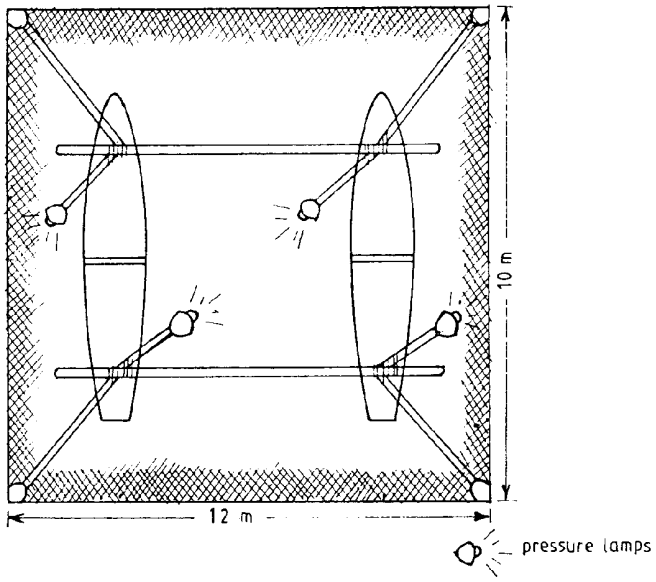


Fig 3. MAP SHOWING KIGOMA AND RUKWA REGION BOUNDARIES, MAJOR TOWNS AND ACCESS ROUTES TO LAC TANGANYIKA

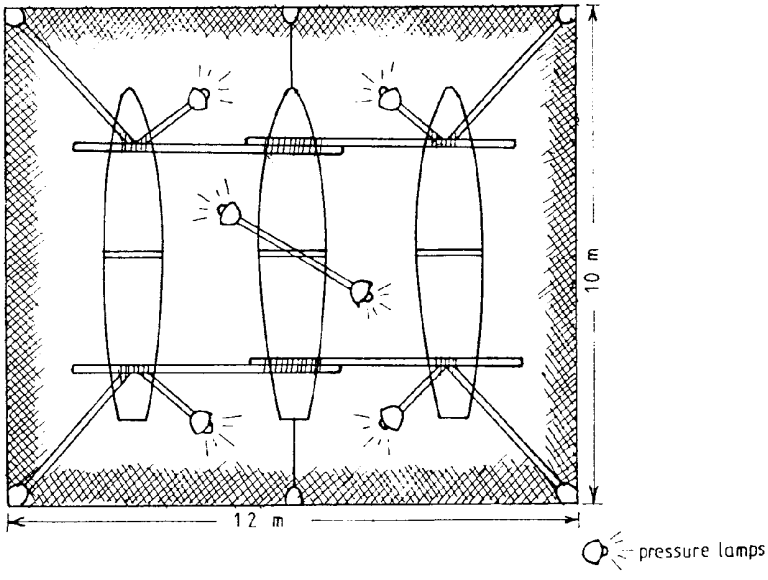
_ _ _ _ _ INTERNATIONAL BOUNDARIES.
_.-._.-._ REGIONAL BOUNDARIES.
ROADS
RAILWAY LINE.

Fig.4 EVOLUTION OF LIFTNET (kipe) FISHERY:

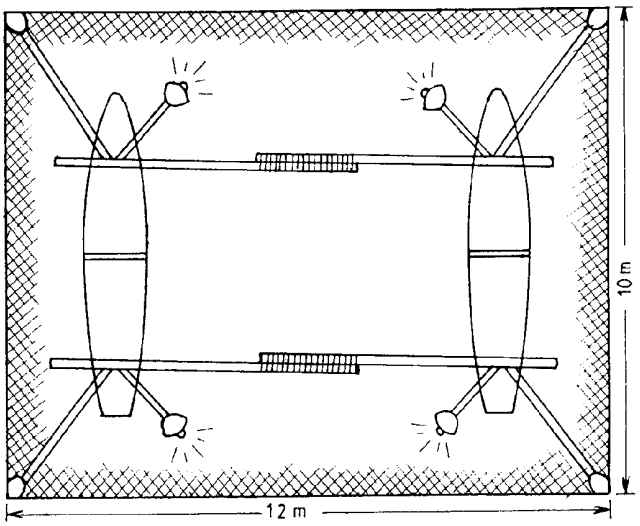
4.a) CATAMARAN:



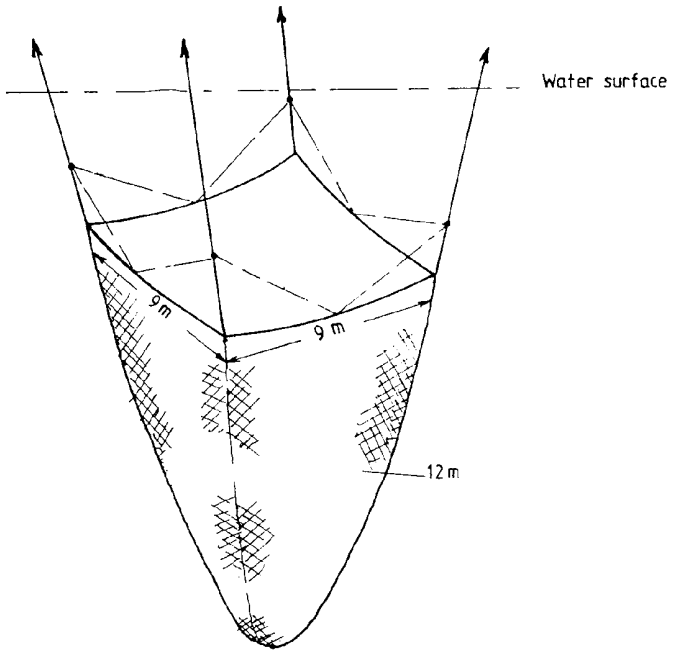
4.a) TRIMARAN:



4.c) MODIFIED CATAMARAN



4.d) LIFT NET (kipe)



Fish production in L. Tanganyika
1966 - 1991

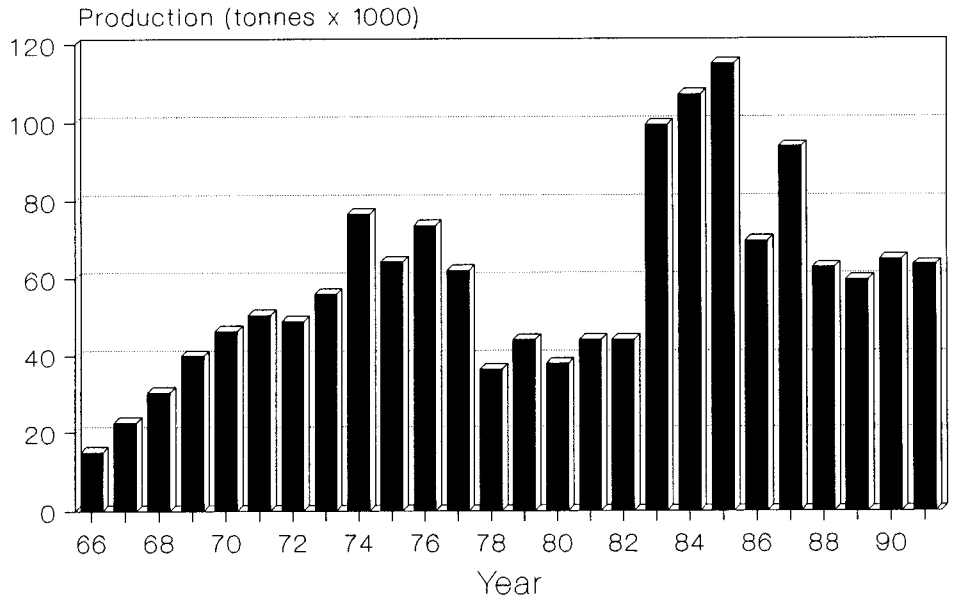


Fig. 5

Effort and catch evolution
Lake Tanganyika (Tanzania)

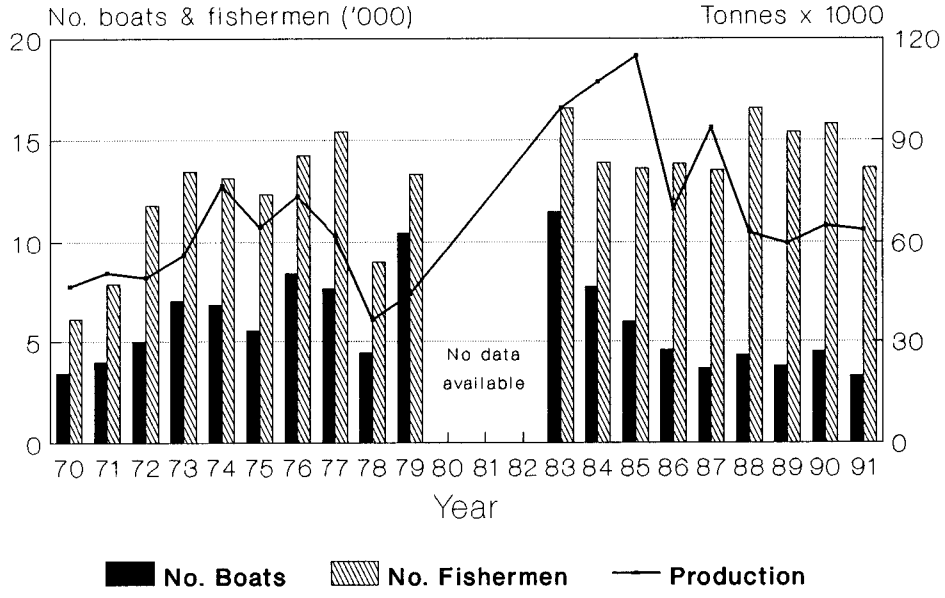


Fig. 6

Production by major species
Lake Tanganyika (Tanzania)

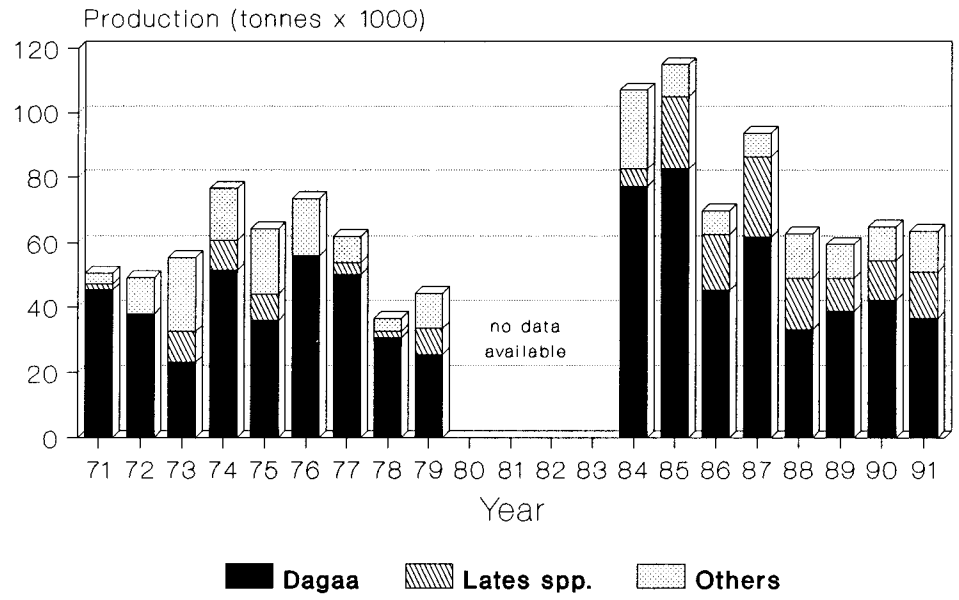


Fig.7

Catch composition by major species
Lake Tanganyika (Tanzania)

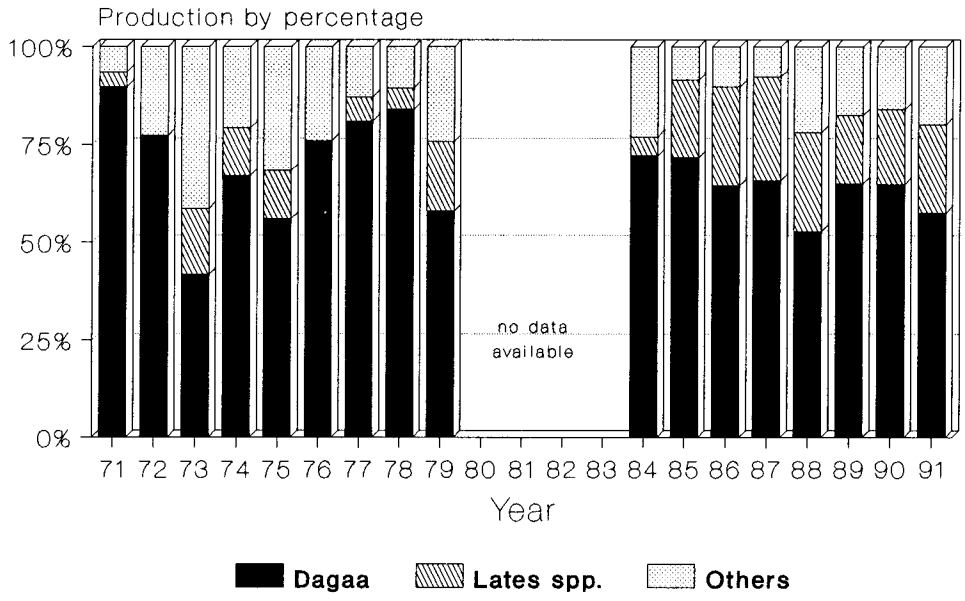


Fig.8

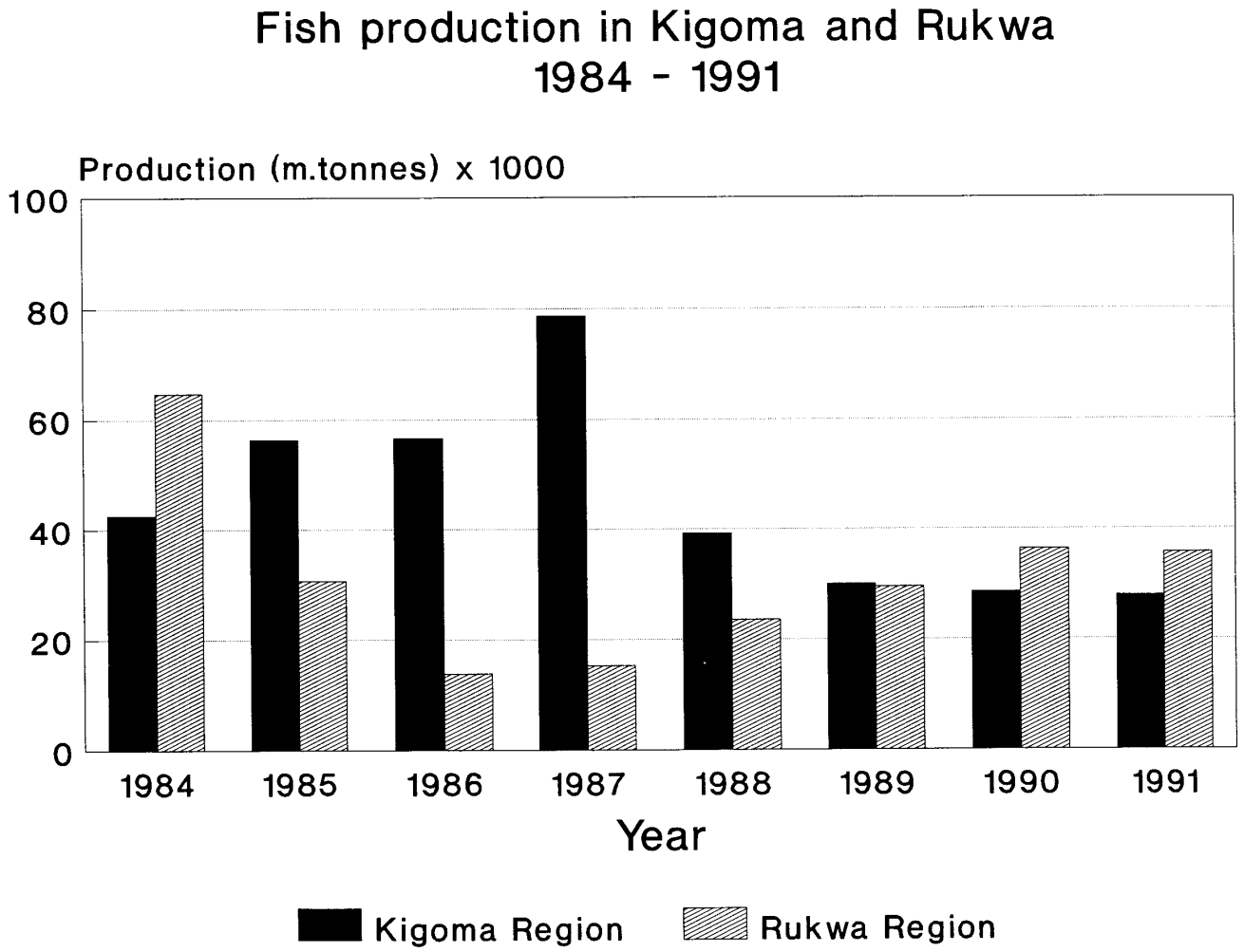

Fish production in Kigoma and Rukwa
1984 - 1991
Production (m.tonnes) x 1000
100
80
60
40
20
0
1984
1985
1986
1987
1988
1989
1990
1991
Year
Kigoma Region
Rukwa Region

Fig. 9

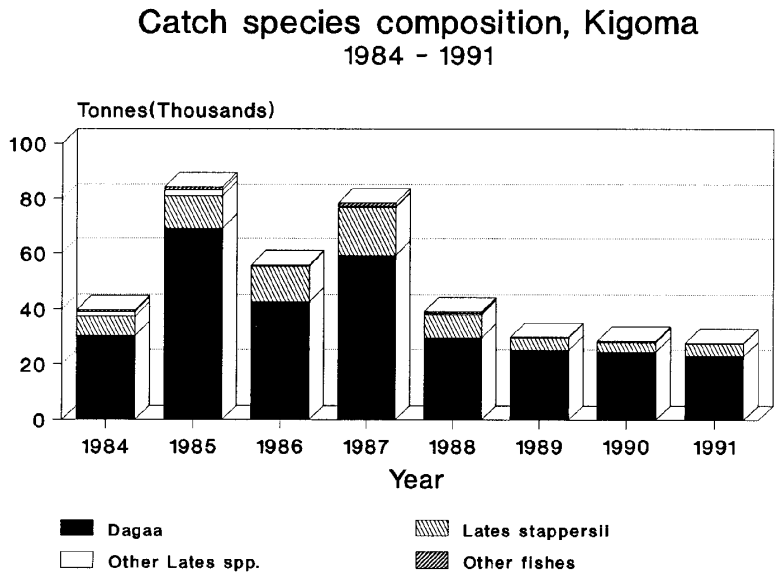

Catch species composition, Kigoma
1984 - 1991
Tonnes(Thousands)
100
80
60
40
20
0
1984
1985
1986
1987
1988
1989
1990
1991
Year
Dagaa
Other Lates spp.
Lates stappersii
Other fishes

Fig. 10

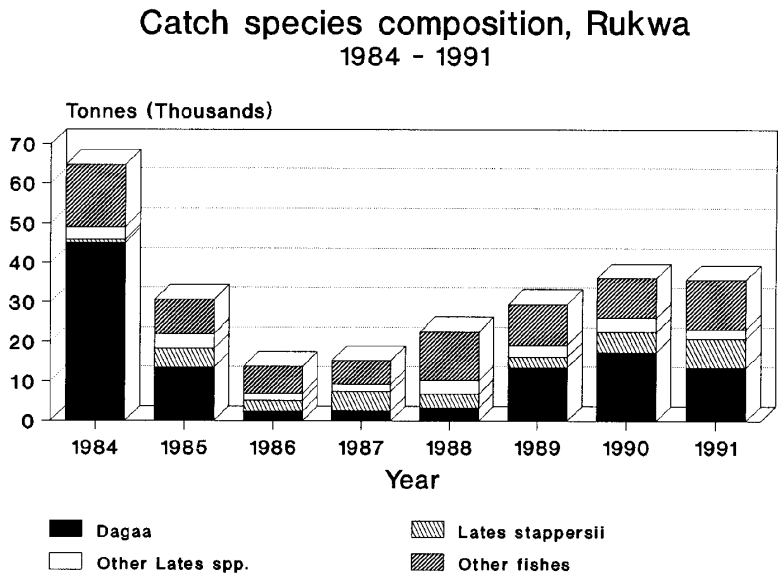

Catch species composition, Rukwa
1984 - 1991
Tonnes (Thousands)
70
60
50
40
30
20
10
0
1984
1985
1986
1987
1988
1989
1990
1991
Year
Dagaa
Other Lates spp.
Lates stappersii
Other fishes

Fig. 11

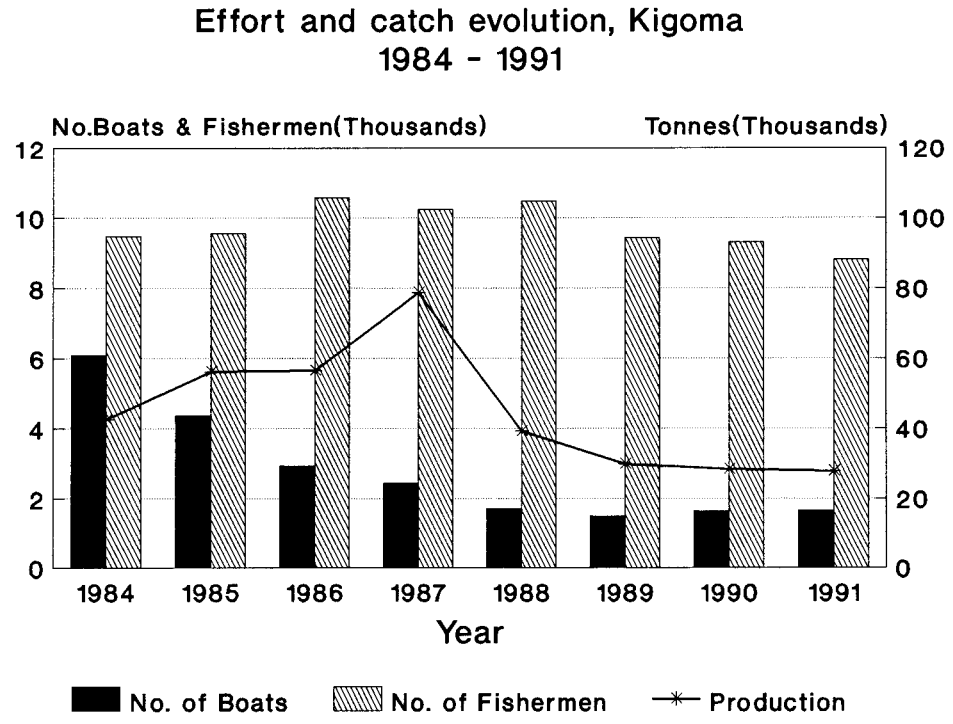

Effort and catch evolution, Kigoma
1984 - 1991
No.Boats & Fishermen(Thousands)
Tonnes(Thousands)
12
10
8
6
4
2
0
120
100
80
60
40
20
0
1984
1985
1986
1987
1988
1989
1990
1991
Year
No. of Boats
No. of Fishermen
Production

Fig.12

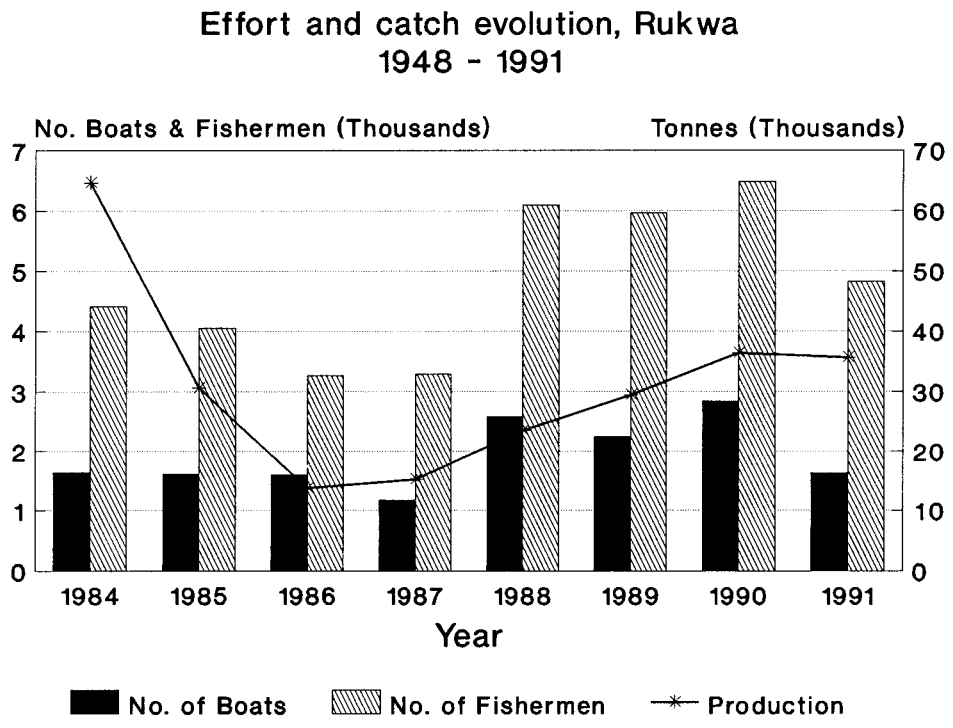

Effort and catch evolution, Rukwa
1948 - 1991
No. Boats & Fishermen (Thousands)
Tonnes (Thousands)
7
6
5
4
3
2
1
0
70
60
50
40
30
20
10
0
1984
1985
1986
1987
1988
1989
1990
1991
Year
No. of Boats
No. of Fishermen
Production

Fig. 13

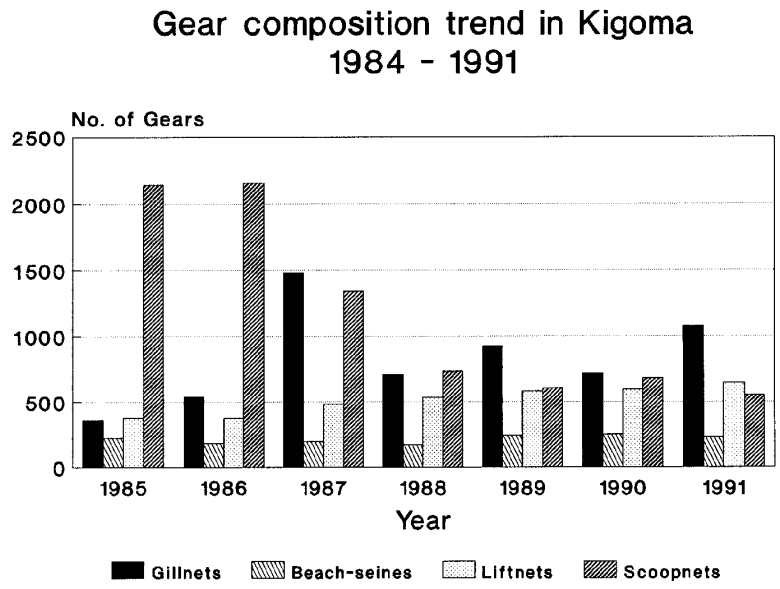

Gear composition trend in Kigoma
1984 - 1991
No. of Gears
2500
2000
1500
1000
500
0
1985
1986
1987
1988
1989
1990
1991
Year
Gillnets
Beach-seines
Liftnets
Scoopnets

Fig. 14

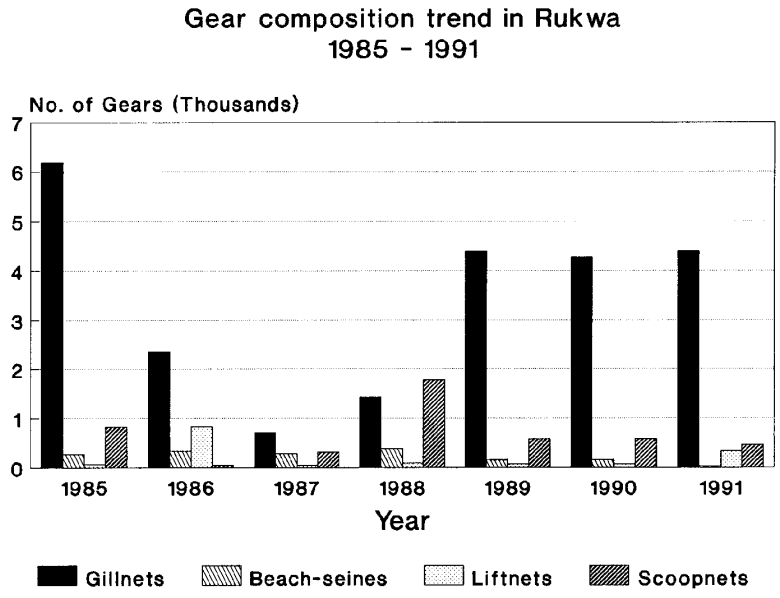

Gear composition trend in Rukwa
1985 - 1991
No. of Gears (Thousands)
7
6
5
4
3
2
1
0
1985
1986
1987
1988
1989
1990
1991
Year
Gillnets
Beach-seines
Liftnets
Scoopnets

Fig. 15

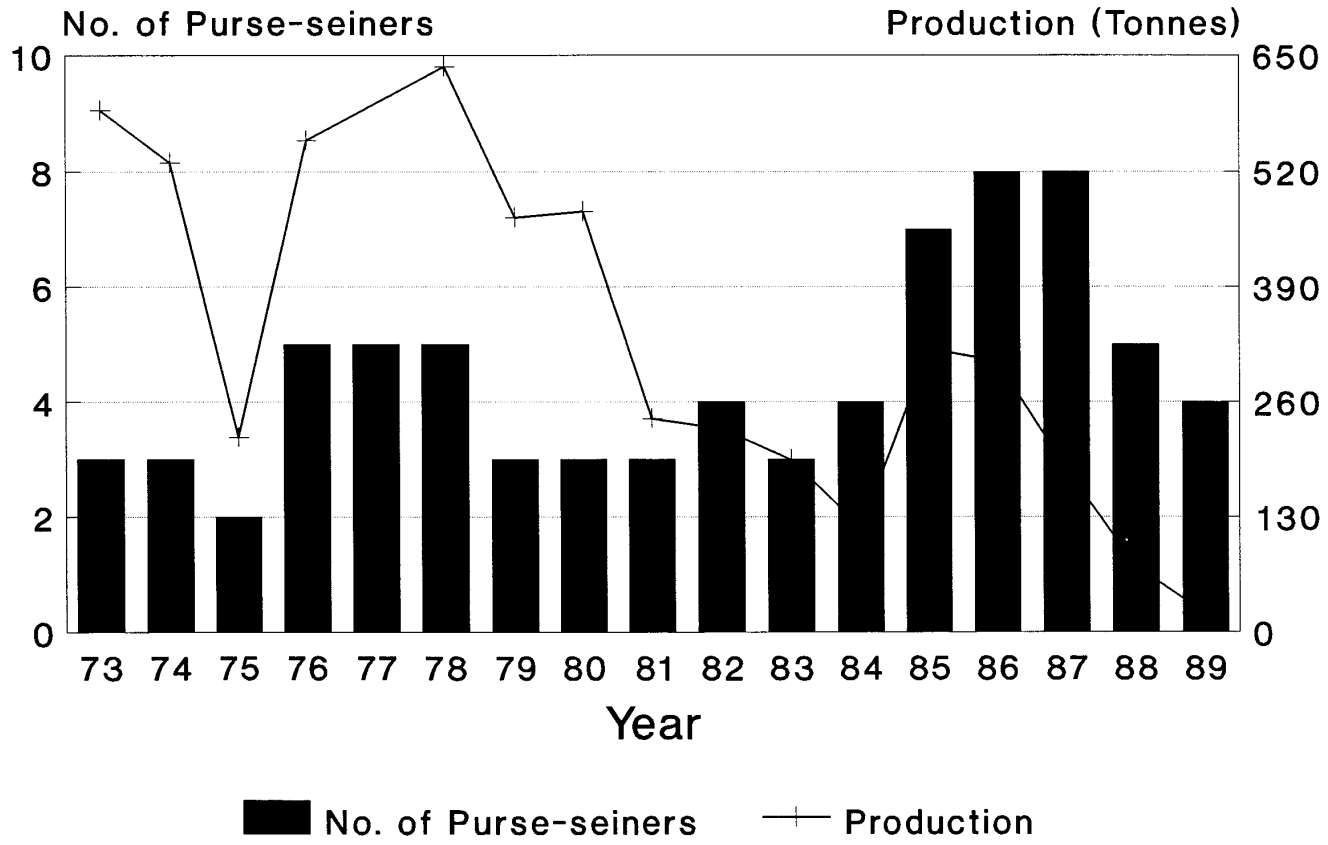

Industrial Fish Production, Kigoma
1973 - 1989
No. of Purse-seiners
Production (Tonnes)
10
8
6
4
2
0
650
520
390
260
130
0
73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89
Year
No. of Purse-seiners
Production

Fig. 16

HISTORICAL REVIEW OF THE FISHERIES STATISTICAL SYSTEMS ON LAKE TANGANYIKA (TANZANIA)

by

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KIGOMA
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ABSTRACT

The estimated annual fish production (catches) in Lake Tanganyika (Tanzania) fluctuated between 15,000 metric tonnes in 1966 and a maximum of 114,963.3 metric tonnes in 1985. Production for 1991 was 63,503.4 metric tonnes. These estimates were made using an old system which was divided into two phases: the frame survey which is a census or complete enumeration of landing sites, fishermen, fishing vessels and gears; and the sample survey of catch and effort (catch assessment survey). The frame survey was conducted annually in November/December, whereas information on catch and effort was collected daily from selected landing beaches around the lake. From the annual frame survey, raising factors were derived, which, together with average catch rates were used to estimate the annual catches in each region. The total catch of Lake Tanganyika (Tanzania) is the sum of the estimated annual catches of Kigoma and Rukwa regions.

From December 1992, a new system proposed by the UNDP/FAO Fisheries Statistics Project (URT/87/016) and directed at improving fisheries data collection and analysis, started being used actively in Lake Tanganyika. This system is also divided into two phases. Phase I is the inventory of all fish production factors (frame survey), to be done once in every two years. This survey produces the baseline data to be used as the raising factors in the estimation of total production. The second phase is the catch assessment survey (CAS), where information on daily catch and related effort is collected on selected days at selected beaches. Using this data and the baseline data obtained from the frame survey, the annual fish production is estimated.

Shortcomings of the two methods are discussed and suggestions for improvement made.

1. INTRODUCTION

Lake Tanganyika (Fig. 1) has a total surface area of 32,900 km^2 of which 45% is shared by Zaïre, 41% by Tanzania, 8% by Burundi and 6% by Zambia (Hutchinson, 1957; Herman, 1977; Stride, 1976). The Lake has a maximum depth of 1470 m and a mean depth of 570 m (Brichard, 1978; Lindqvist and Mikkola, 1989).

Annual fish production from the Tanzanian waters of Lake Tanganyika fluctuated between 15,000 metric tonnes in 1966 and a maximum of 114,963 metric tonnes in 1985. Production for 1991 was 63,503.4 metric tonnes (Table I; Fig. 2). The fishing effort trend in the Tanzania's waters of Lake Tanganyika is shown in Fig. 3.

The fishery of Lake Tanganyika is mainly targeted on two clupeid species, namely *Stolothrissa tanganicae* (locally known as dagaa) and *Limnothrissa miodon* (lumbo); and four *Lates* species namely *Lates stappersii* (migebuka), *L. mariae* (sangara), *L. microlepis* (nonzi), *L. angustifrons* (ngoinba) (Johanneson, 1974; Ellis, 1978; Bayona, 1988; Lindqvist and Mikkola, 1989; Coulter, 1991). These pelagic species constitute over 80% of the total fish production in the Tanzanian waters of Lake Tanganyika (Katonda and Kalangali, 1993). Of the clupeids, *S. tanganicae* is the most important commercial species in the Lake (Katonda, 1993).

Fisheries statistics are important for fisheries planning, development and management. Without reliable statistics, development projects can neither be planned nor their effects be evaluated. The history of fisheries management in Tanzania goes back to the pre-independence days. It was prompted by the decline of catch rates, particularly in Lake Victoria, following the introduction of cotton gill-nets in 1905 and flax gill-nets in 1916. After a survey carried out in Lake Victoria in 1927-1928, it was recommended to form a body to enforce fishery regulations and collect fish catch statistics. In 1947, the Lake Victoria Fisheries Services (LVFS) was formed with the duty to manage the lake's fisheries including the collection of fisheries statistics. The LVFS, however, was dissolved in 1960.

After independence, Tanzania's effort at developing and managing her fishery resources started with the establishment of the Fisheries Division in 1974. The Fisheries Division prepared a system for catch statistics data collection and analysis which started being used in the early seventies in the whole country. For Lake Tanganyika, this system was in use up to November 1992. From December 1992, a new system proposed by the UNDP/FAO Fisheries Statistics Project (URT/87/016) started being used. This system has been in use in the country, on experimental basis, since 1989 (Shila, pers. comm.).

The aim of this paper is to present the old and the new systems for collecting and analysing fisheries statistics for Lake Tanganyika. Shortcomings of the data collecting systems are discussed and suggestions for improvement are made.

2. FISHERIES DATA COLLECTION AND PROCESSING SYSTEMS

2.1 OLD SYSTEM

The old system of fisheries statistics data collection was introduced in the country in the early seventies (Lyimo *et al.*, 1990). A number of landing beaches were selected where data were collected from a number of sampled boats on a daily basis. These are called recording stations. For Lake Tanganyika, the 17 recording stations selected are indicated in Annex 1. The selection was not done randomly. Selection was based on the road accessibility and the number of fishing vessels landing at these stations. Each recording station was manned by two or more enumerators depending on the size of landings and availability of staff (Annex 1).

The fisheries statistical system was divided into two surveys:

- the annual frame survey or census: complete enumeration of fishermen, fishing vessels and gears; and

- the daily sample survey of catch and effort data: Catch Assessment Survey (CAS).

2.1.1 ANNUAL FISHING VILLAGE FRAME SURVEY OR CENSUS

The annual fishing village frame survey for Lake Tanganyika (Tanzania) was done annually during the months of November and/or December. During this survey, the following information was collected using the form shown in Annex 2:

(i) total number of fishermen for each landing site/village: the fishermen were categorised as residents and non–residents. The resident fishermen are those who are residing in that village permanently. The non–residents are those who may move into the village at certain seasons and later go back to where they came from;

(ii) fishing vessels by type: registered and non-registered ones. In Lake Tanganyika, there are mainly two types: the traditional dugout canoe and the planked canoe;

(iii) motorization/mode of propulsion: information is collected on the mode of propulsion of the fishing vessels, whether it is by means of paddles, sails or engines. In case of motorized vessels, the number of outboard and inboard engines is recorded;

(iv) fishing gears: the number of fishing gears (by type and size) is recorded. The gears used in Lake Tanganyika include gill–nets of varying mesh sizes, scoop-nets, lift–nets, beach–seines, hand–lines, long–lines and purse–seine nets.

The census field operations were carried out using boats because of the poor road communication system along the coast: due to steep slopes there are no roads linking the scattered fishing villages along the shores of Lake Tanganyika. This

exercise provided the parameters and raising factors for arriving at the estimates of total production in an area based on the sampled data in the selected landing sites.

2.1.2 CATCH - EFFORT DATA (CATCH ASSESSMENT SURVEY)

The catch and effort data were collected from sampled boats on a daily basis at the selected recording stations. Data were collected on specially prepared statistical forms.

The field enumerators were provided with a Daily Fish Landing Work Book. Form 21A (Annex 3), in which the enumerator recorded the registration number of the sampled vessel, the number and type of fishing gears used, weights and values of fish landed by species and by gear. Records were taken daily. In stations with few landings the enumerator was supposed to record all the vessels but in stations with many boats landing at the same time, the enumerator was advised to take a random sample of as many boats as he could record. At the end of the day the information collected in Form 21A was transferred to a daily record sheet. Form 21B (Annex 4), where data were categorized with respect to gear used (i.e. a separate sheet for every different type of gear used).

At the end of the month these forms (21B) were sent to the District Fisheries Office for further processing. At the District Fisheries Office, the collected data in Form 21B were transferred to monthly summary sheets. Form 24 (Annex 5), and monthly totals were arrived at. A separate form was used for every recording station. The average catch per boat landings (CPBL) were worked out and filled in Form 26 (Annex 6). The recorded landings in percentages by species for each station were worked out and filled in Form 27 (Annex 7). A copy of these forms were sent to the Regional Fisheries Office for checking and submission to the Fisheries Division Headquarters in Dar es Salaam for further processing.

At the Fisheries Division Headquarters, the monthly totals by fish species with the number of boats landing, number of fishermen landing and the number of days when data were recorded were transferred into the Annual compilation of recorded data form, Form 30 (Annex 8), and the annual totals were worked out (see 2.1.3).

2.1.3 ESTIMATION OF THE TOTAL CATCH AND RAISING FACTORS USED

At the end of the year, the total annual catch was estimated using data obtained from the catch assessment and the annual fishing village surveys. The total recorded annual weight and value of every station is divided by the total number of boatslandings recorded over the year to give the average catch per boat landing (ACPBL),

$$\text{i.e. ACPBL} = \frac{\text{total recorded weight of sampled boats}}{\text{total number of boat landings}}$$

The average catch per boat landing (ACPBL) is multiplied by 250 days to get the catch per boat/year (CPBY), that is: **ACPBL x 250** = **CPBY.** The 250 activity days per year were obtained from an earlier survey conducted in the early seventies (Lyimo *et al.,* 1990).

The estimated annual catches (EAC) were computed using the total number of vessels obtained from the annual fishing village survey for every station i.e. **EAC = CPBY x Number of fishing** vessels in the station. The total annual catches of a particular water body (e.g. Lake Tanganyika) were obtained by adding together the estimates of the 17 recording stations.

2.1.4 MARKET STATISTICS

Retail market statistics for fresh/processed fish were collected in a few markets in urban areas with high population densities. The information was collected at selected markets by using Fishery Survey Form 22 (Annex 9). The information collected included the following:

(a) type of product: whether the fish was fresh or processed, and whether the processed fish was smoked, sun-dried, or fried;

(b) source of product (species were indicated along with the source of the fish product);

(c) weight in kilograms and the retail price.

However, the receipts of these data at the Fisheries Division Headquarters were irregular and did not seem to serve any useful purpose.

2.1.5 MOVEMENT OF FISH

Form 28 (Annex 10) is used to collect information on movement of fish from the source to consumer centres. This information, collected at railway stations, bus stations, etc,, include the following:

(a) species and type of product: whether the fish is fresh or processed;

(b) mode of transport: whether transported by rail, bus or water vessels;

(c) weight of fish;

(d) destination.

2.1.6 ANNUAL REPORT

The results of the annual village survey and the repetitive monthly surveys are published by the Fisheries Division as an Annual Statistics Report. Tables showing the relevant statistics for Lake Tanganyika were as follows:

Table I: Summary of fishery statistics from the territorial waters of Lake Tanganyika for the current year (Annex 11);

Table II: Comparison of statistics for the territorial waters of Lake Tanganyika for the current and previous year (Annex 12);

Table III: The weight of fish caught in metric tonnes from the territorial waters of Lake Tanganyika for the current year (Annex 13)

Table IV: The value of fish caught in thousand shillings from the territorial waters of Lake Tanganyika for the current year (Annex 14);

Table V: The average selling price per kilo by species by station for fish caught in the territorial waters of L. Tanganyika for the current year (Annex 15);

Table VI: Species composition in percentage by station for fish caught in territorial waters of Lake Tanganyika for the current year (Annex 16);

Table VII: The average catch per boat per gear type in kilos for fish caught in the territorial waters of Lake Tanganyika for the current year (Annex 17)

2.2 NEW SYSTEM

The new system, as proposed by the UNDP/FAO Fisheries Statistics Project URT/87/016 (Chakraborty, 1991; Chakraborty *et al.,*1992), started being used in Lake Tanganyika actively in December, 1992 (Kweka, pers. comm.). The system aims at improving data collection and analysis. This system is also divided into two surveys as shown in the old system.

2.2.1 ANNUAL FRAME SURVEY OR CENSUS

2.2.1.1 Objectives

The objectives of the survey are:

(i) to secure data on the number and nature of fish producing factors such as fishing households, fishing boats, fishermen, landing centres, fishing villages

and fishing units as well as information relating to facilities available at landing sites/fishing villages, processing and marketing facilities in order to quantify the economic structure of the industry in Lake Tanganyika;

(ii) to provide raising factors for estimating the total fish production;

(iii) to provide sampling frames for the various sample surveys that should be undertaken in the Lake.

The survey will cover all the fishing villages/fish landing sites in the Lake within the territorial waters of Tanzania.

2.2.1.2 Basic definitions

The following basic definitions are used in the survey:

(i) Landing site: a site where fishermen land their catches for the first time after carrying out fishing operations;

(ii) Fishing village: a village where at least 5 fishermen have been residing at least for the last six months;

(iii) Fisherman: an individual earning whole/part of his live-hood through fishing operations. A further division is made as follows:

- Owner: a fisherman who owns either a fishing boat and/or fishing gear and actually goes to the Lake for fishing;
- Labourer: a fisherman who participates in actual fishing but does not own any fishing boat or gear. The fisherman is paid either in cash or kind;
- Absentee: a fisherman who owns either a fishing boat or gear but does not actually do fishing operations by himself and engage labour fishermen to carry out fishing operations;
- Resident: a fisherman is considered to be resident if he has been living in the fishing village visited for at least six months during the previous year;
- Non–resident: a fisherman is considered to be non-resident if he has not been living in the fishing village for six months during the previous year;

(iv) Fishing unit: it is the economic unit for carrying out fishing operations. It is a combination of fishing boat, fishing gear and man–power employed and generally known by the type of gear used (for example

a unit using gill-nets is known as a gill-net fishing unit);

(v) Fishing boat: a boat which can be used for commercial fishing operations; it may be a plank boat, dugout canoe or any other type. A further division is made as follows:

- Active fishing boat: a fishing boat which has been used for commercial fishing at least for 10 days during the period of the previous three months;

- Non-active fishing boat: a fishing boat which has not been used for commercial fishing at least for 10 days during the period of the previous three months;

(vi) Auxiliary boat: a boat in operation with another boat to complete the fishing activity. For example in lift-net, a trimaran will have three boats while a catamaran will have two boats working together to complete the fishing activity.

(vii) Household: a residential unit where individuals live together on permanent/temporary basis having a combined eating arrangement. A household is divided into fishing, farming etc. by taking into considerations the quantum of time devoted for the occupation; when more than one occupation is practiced, then the major one is considered;

— Permanent household: lived in the household at least
for six months during the previous year;

— Temporary household: lived in the household less than six months during the previous year.

2.2.1.3 Survey frame and methodology

The existing list of the landing sites/fishing villages serves as the frame of the survey. The survey is based on complete enumeration of all fish landing sites and fishing villages. The field operation is carried out by overland approach when it is possible to do so; otherwise in the islands and inaccessible areas, water approach or the combination of both approaches are used.

The Tanzanian coast of Lake Tanganyika is divided into two administrative regions namely Kigoma and Rukwa (Fig. 1). These are in turn divided into districts. Kigoma Region has three districts (Kigoma, Kasulu and Kibondo) but only Kigoina District has the share of the Lake. Rukwa Region has also three districts (Mpanda, Nkasi and Suinbawanga) and all of them share the Lake. In each district there are stations (see Annex I). The inventory survey is carried out simultaneously in all stations. The field enumerators cover the length of the coast kilometer by kilometer

listing down all the survey items.

Questionnaires are designed and coded for computer processing to cover all the items of enquiry. In the landing site approach. Inventory Form I (Annex 18) is used. The form is completed by interviewing the fishermen at the landing site. Data are collected by physical verification. In the household approach. Inventory Form II (Annex 19) is used. During this approach, the enumerator moves from one household to another interviewing the fishermen. Apart from using these data to compare with those obtained during the landing site approach, some information on boats which were away for fishing during the survey period may be obtained.

2.2.1.4 Periodicity

During the old system, the annual fishing village survey was conducted annually in November/December. In the new system the survey will be conducted once in every two/three years depending on the need and availability of funds (Lyiino *et al.,* 1993).

2.2.1.5 Publication of results

The information collected is tabulated through the computer and summaries published in the Annual Fisheries Statistics Report.

2.2.2 CATCH ASSESSMENT SURVEY (CAS)

2.2.2.1 Objectives

(a) Catch and effort data are collected on a daily basis so as to provide data on fish production by fishing units, species/species group and value at each of the selected landing sites for a calendar month;

(b) To construct estimates for an area e.g. Kigoina Region, and finally the water body (in this case L. Tanganyika) based on the data from the selected landing sites.

2.2.2.2 Survey design

The design involves sampling over space and time.

(i) Recording stations

In the new system the number of recording stations remained the same, i.e. 17 stations. However, one new station in Kigoina District, Katonga, has been selected to replace Kibirizi. Each recording station is manned by one or more enumerators depending on the size and availability of staff.

(ii) Primary sampling unit (PSU)

Within the recording station a "day" is taken as the primary sampling unit and a boat landing is the enumeration unit. A calendar month is the period of estimation. Data are collected for 16 days selected randomly every month using a table of random numbers. Selection of the days on which data will be collected is done by the Regional Fisheries Statistics Supervisor and distributed to all recording stations in the Region. A copy of the work programme is sent to Fisheries Division Headquarters for reference.

(iii) Survey forms

Two types of forms are used for data collection; Form 21A (Annex 20) and Form 21B (Annex 21). The difference between these forms and the old forms 21A (Annex 3) and 21B (Annex 4) is that a few items of information have been added to the new forms. Items added include the following:

(a) Time of arrival of the boat

(b) Time spent on fishing

(c) Type of unit:

- Fishing unit (FU): an ordinary single fishing unit;
- Fish carrier (FC): a boat used to collect fish from fishing vessels on the lake and bring the fish to the landing sites;
- Multiple fishing unit (MFU): a fishing boat which on its way to the landing site collects fish from other units on the Lake and brings it to the landing site.

(d) Number of fishes (for big sized fish which can be counted)

(e) Gear size/type

2.2.2.3 Survey operations

An enumerator is provided with a booklet, revised Form 21A (Annex 20), which is used at the beach. On the sample day, the enumerator is required to enumerate all boats landing at the beach. The landing boat (fishing unit) is the enumeration unit. Data for each fishing unit are recorded separately. At the end of the day, data collected on revised Form 21A are transferred to revised Form 21B (Annex 21). Two sets of forms 21B are prepared. At the end of the month forms 21B are sent to the District/Regional Fisheries Office where they are checked for any mistakes and/or inconsistencies. One set of Form 21B is forwarded to the Fisheries Division Headquarters for data input into the computer and final processing, while the second set is retained by the Regional Fisheries Office.

2.2.2.4 Processing of data

(a) Processing at District/Regional level

According to the new system, no processing is done at this level. However, Chakraborty (1991) proposed that at this level data should be processed, using the old system, so as to give annual estimates for comparison purposes. The Fisheries Division has now proposed that data input be decentralised so as to ease data input and hasten data analysis (Lyimo *et al.,* 1993). Nine laptops have been acquired and training carried out so as to start decentralization on a pilot scale (Sobo, pers. comm.).

(b) Processing at Fisheries Division Headquarters

At the Fisheries Division Headquarters in Dar es Salaain, Forms 21B from Kigoma and Rukwa regions are scrutinised for accuracy and then the data are entered in the computer for further processing. Two types of information are entered into the computer:

(i) baseline data obtained from the Frame Survey;

(ii) catch effort data from Form 21B.

End results are obtained as computer printouts. The following reports are generated:

(i) Monthly estimates by landing sites (recording stations);

(ii) Monthly estimates for the region;

(iii) Monthly estimates for a specific water body (in this case Lake Tanganyika);

(iv) Sample statistics by landing site;

(v) Sample statistics by region;

(vi) Data ranges by landing site;

(vii) Data ranges for the region.

2.2.2.5 Presentation of results

Data are presented in the Fisheries Annual Statistics Report produced every year in the form of summary tables. It has been proposed to maintain the old system summary tables (see 2.1.6).

3. DISCUSSION

The fisheries statistical data collection and processing methods in operation in Lake Tanganyika (Tanzania) have shown shortcomings at different levels of the process. As Coenen (1993) points out, the theoretical concepts of the fisheries statistical systems (Frame and Catch Assessment Surveys) are well designed, but the practical execution of the surveys show a lot of deficiencies. These are due to a complicated administrative system; financial constraints; communication problems at all levels; lack of supervision and lack of training.

In Tanzania, the Fisheries Division in the Ministry of Tourism, Natural Resources and Environment is the body responsible for fisheries management and conservation. Prior to 1972, all government employees in the fisheries sector were employed by the Central Government represented by the Director of Fisheries. The administrative, planning and management relationship of government organizations involved in fisheries matters was then as shown in Fig. 4. The Director of Fisheries had the control of all fisheries staff through the Regional and District Fisheries Officers. In 1972, however, it was decided to decentralise the system so that the fisheries staff in the districts and regions became employees of the District and Regional Development Directors. The Director of Fisheries lost his administrative control over the fisheries staff employed by the District and Regional Development Directors. The only relationship left was that of advice and flow of technical information. The situation was further complicated when the local governments (Town and District Councils), which had been abolished in 1972, were reintroduced in 1982 (Fig. 5). In order to improve this situation, it is recommended that the Government should seriously think of centralising all the Ministries activities in the Regions/Districts so that the field staff will be employed by their respective Ministries. This will give the Ministry the administrative power over the Regional and District Fisheries Officers; and the Regional Fisheries Officer will have the administrative power over the District Fisheries Officers and the beach data recorders.

Financial constraints are noticeable at all levels.Salaries are very low and in some districts payments are delayed for several months. The Regional and District Fisheries Officers have no working budgets, hence no payment of any kind of allowance (mission/subsistence, transport, overtime, etc.) is made; and protective clothing (raincoats and gumboots), which are essential during the rainy season, are not provided to the data recorders. Due to lack of funds, the District Fisheries Officers and Officers in charge of Statistics in the District, who are supervisors of data recorders, are unable to visit the recorders. Since supervision is lacking, the practice of inventing or producing “cooked” data is done in some stations, the final result being that the accuracy of our fisheries statistics data is questionable. The new system has not solved these problems. It is unlikely that the new system will improve the data collection process as long as the above problems are prevailing.

To overcome the financial constraints, the government should increase the budget allocation for fisheries statistics data collection system at all levels.

The data recorders need weighing scales for weighing the catches. Two types of weighing scales (50 kg and 200 kg scales) have been distributed to a few recording stations along the coast of Lake Tanganyika. Unfortunately, the distribution of these scales was not based on the amount of catch of a station. There are cases where a landing station with very low catches was given a 200 kg scale whereas a station with very high catches was given a 50 kg weighing scale (Shila, pers. comm.). It is suggested that weighing scales be provided to all recording stations; and the distribution should be based on the amount of catch of a station.

Bad communication system due to big distances on bad roads, lack of transport means and non payment of transport allowances has greatly affected the operations of the Regional/District Fisheries Officers and data recorders. The monthly statistical reports are not received in time at the District/Regional Offices, hence their submission to Dar es Salaam is also delayed; the final result being the delay in the preparation of the Annual Statistics Report.

The new system demands total enumeration of landing boats. This has been found to be practically impossible in big landing stations where a lot of boats land at the same time (e.g. Katonga landing station near Kigoma town). Since enumerators are unable to enumerate all landing boats as demanded by the system, they are forced to invent (i.e. produce “cooked” data) to satisfy their bosses. In view of this problem, the new system will not give better estimates than the old system. This problem might have been solved by employing more recorders, but this is not possible due to the government’s directive to stop employment of new staff. Since it is unlikely that the number of data recorders will be increased so that total enumeration of landing boats can be done, it is hereby suggested that we revert to the old system whereby catch and effort data will be collected from sampled boats on a daily basis.

It is our sincere hope that the Tanzania government will take some positive measures which will improve the fisheries statistical system.

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TABLE I: LAKE TANGANYIKA (TANZANIA) BASIC HISTORICAL DATA

Year	Fishermen	Fishing Vessels	Number of purse-seiners	Production (m.tonnes)
1966	-	-	-	15000
1967	5360	3259	-	22500
1968	8633	3505	-	30387
1969	-	-	-	40000
1970	6102	3405	-	46452
1971	7877	3958	-	50567.8
1972	11781	4950	-	49017.3
1973	13448	7017	3	55922.4
1974	13150	6840	3	76619
1975	12350	5520	2	64300
1976	14238	8408	4	73600
1977	15426	7654	4	61900
1978	8978	4428	4	36500
1979	13342	10432	3	44200
1980	-	-	-	38000
1981	-	-	-	44200
1982	-	-	-	44200
1983	16558	11468	3	99355.2
1984	13896	7731	4	107111.6
1985	13625	5979	6	114963.3
1986	13837	4537	7	69707.6
1987	13528	3620	7	93728.5
1988	16565	4301	5	62755.6
1989	15400	3747	4	59494.1
1990	15799	4495	4	64865.6
1991	13651	3292	3	63503.4

Source: Fisheries Division Annual Statistics Reports, Dar es Salaam

Note: - Data not available

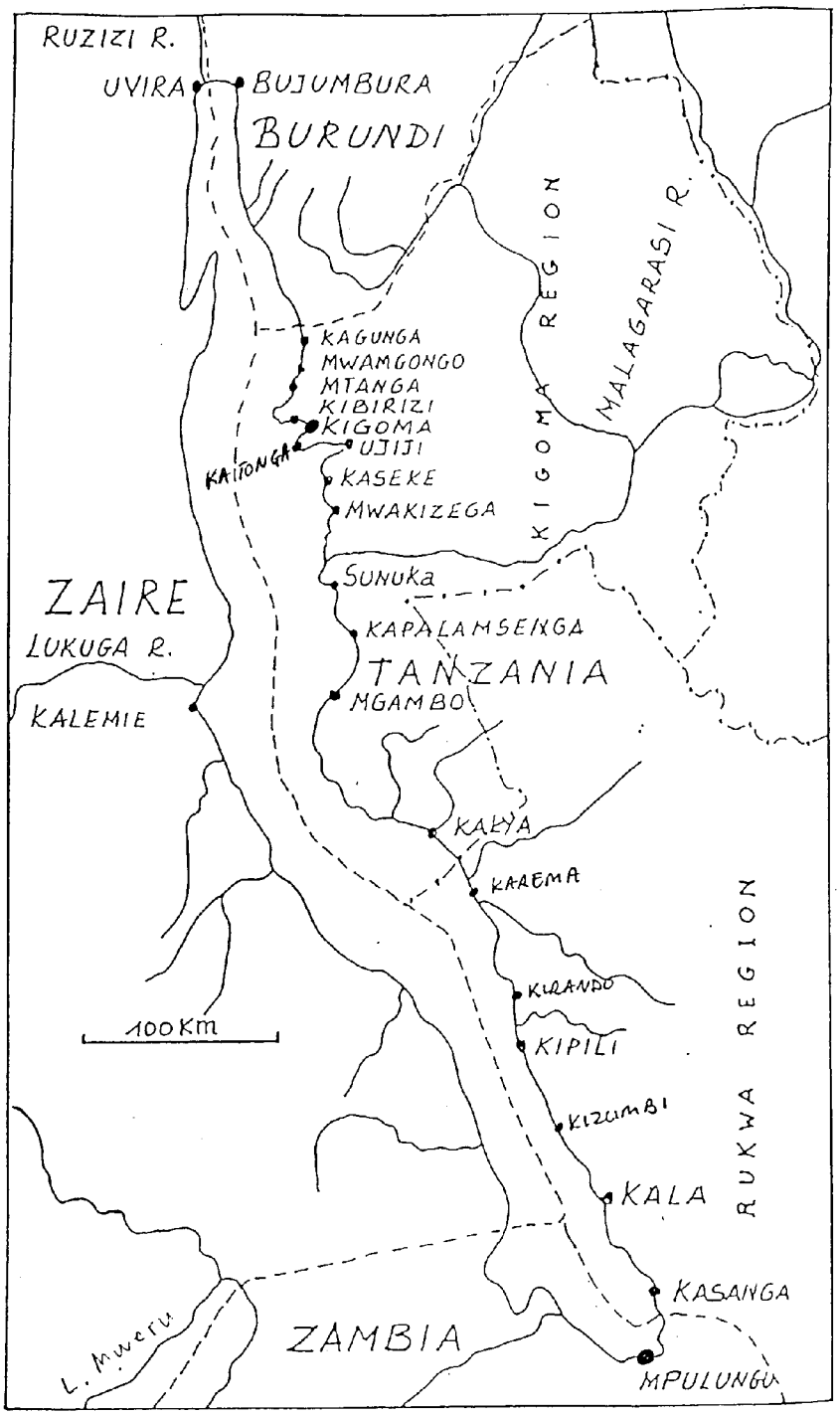

Fig. 1. MAP OF LAKE TANGANYIKA SHOWING KIGOMA AND RUKWA REGION BOUNDARIES AND MAIN FISH LANDINGS.

------ INTERNATIONAL BOUNDARIES
-.-.-.-. REGIONAL BOUNDARIES.

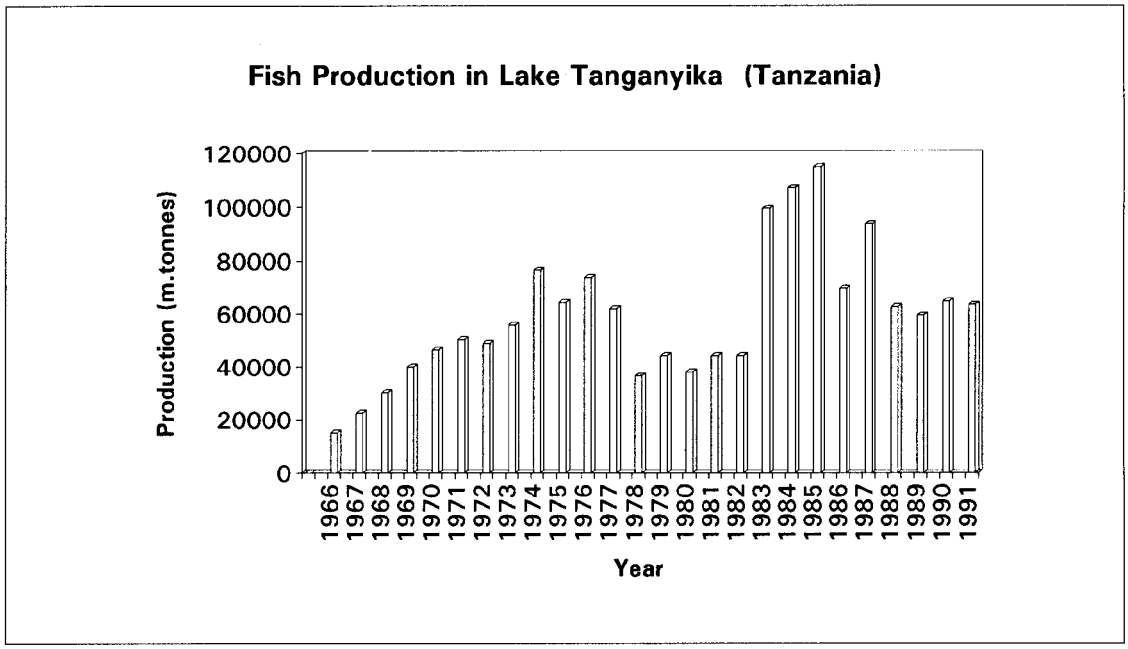
Fish Production in Lake Tanganyika (Tanzania)
Production (m.tonnes)
120000
100000
80000
60000
40000
20000
0
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
Year

Fig. 2

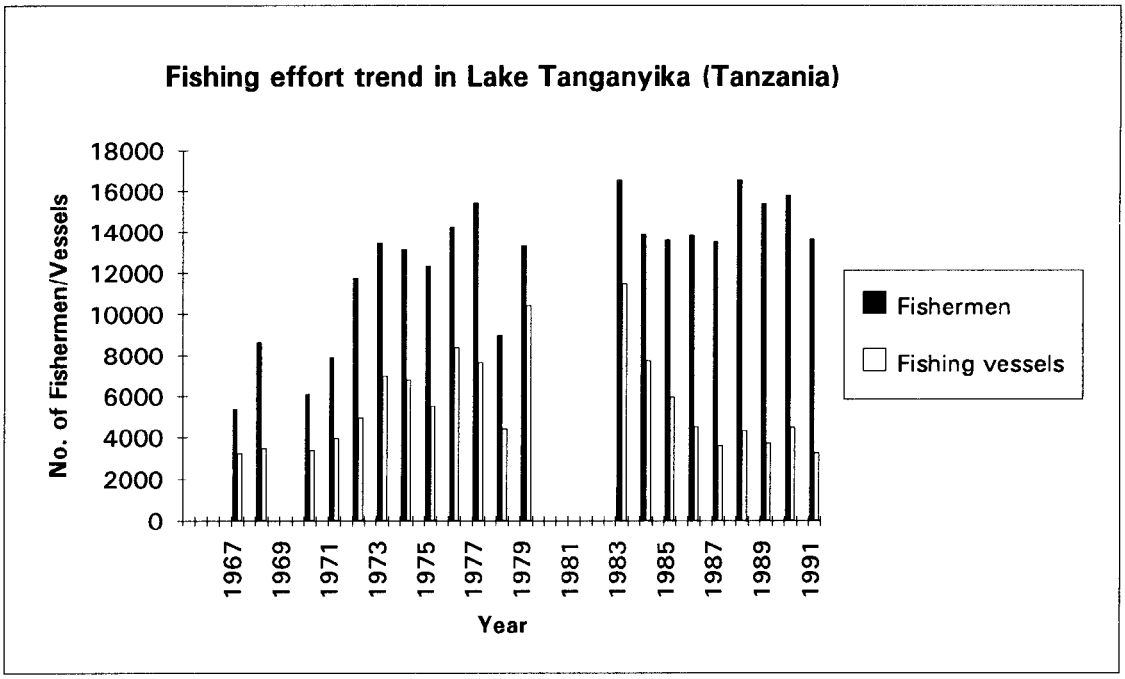
Fishing effort trend in Lake Tanganyika (Tanzania)
No. of Fishermen/Vessels
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
Year
Fishermen
Fishing vessels

Fig. 3

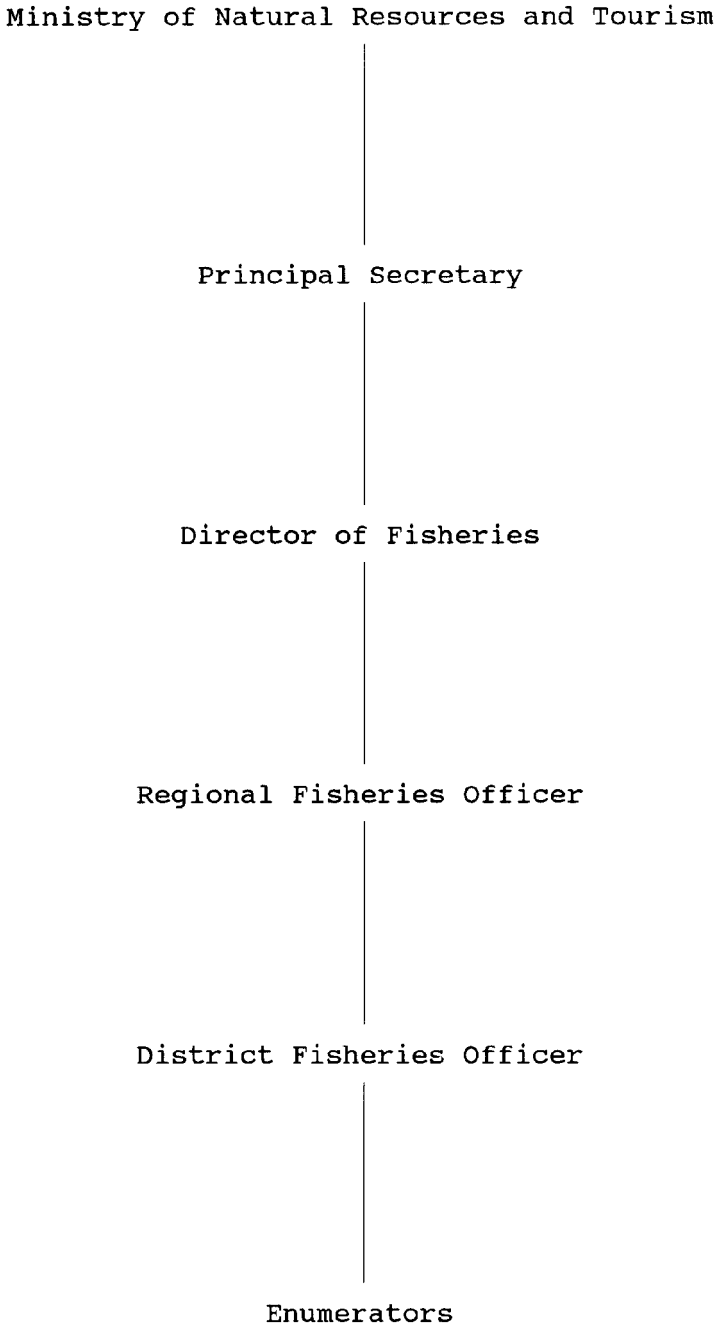

Fig. 4. The administrative, planning and management relationship of government organizations involved in fisheries matters before decentralization of 1972.

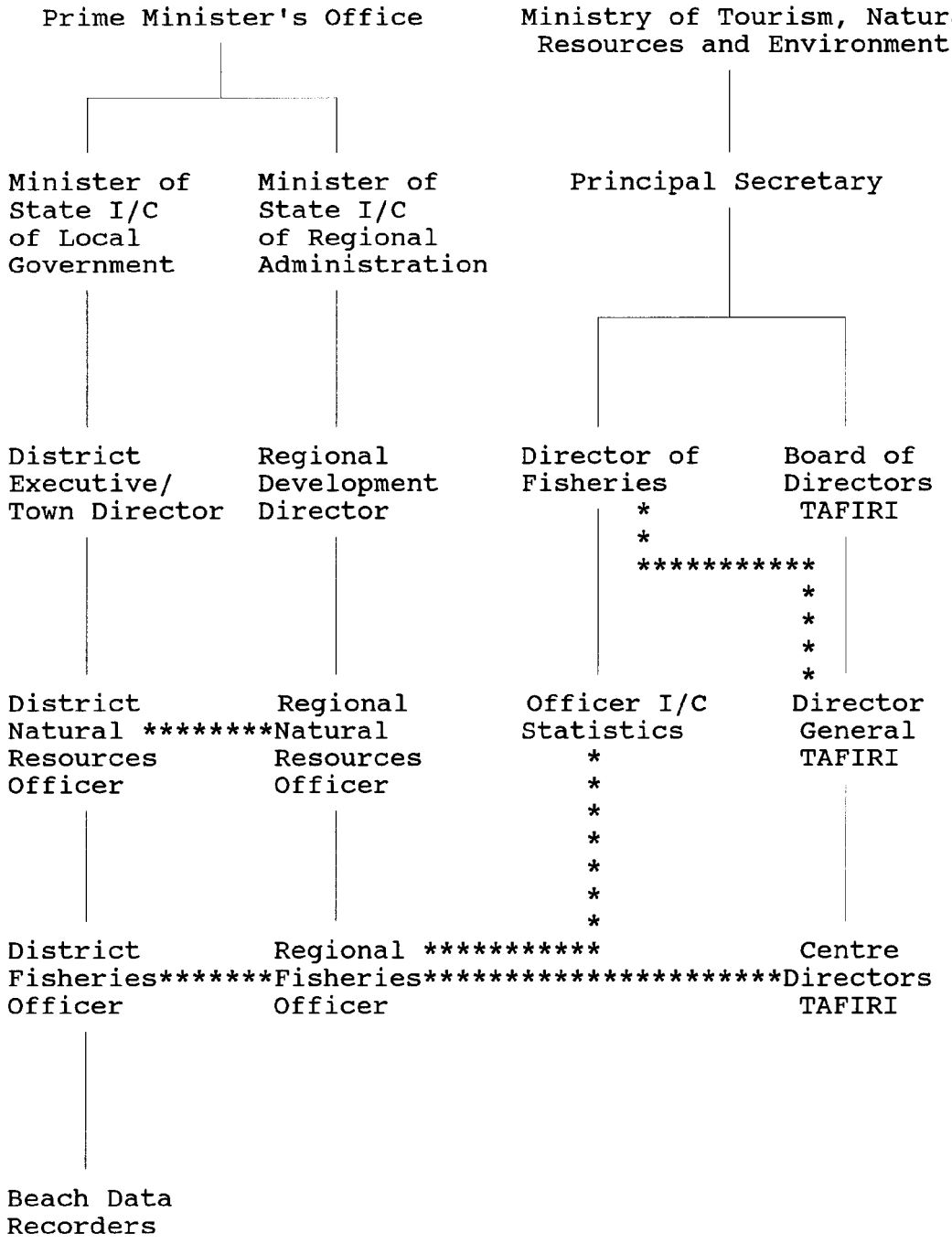

Fig. 5. The administrative, planning and management relationship of various government organizations involved in fisheries matters in Tanzania at present.

Key: ——— Administrative and management responsibility
***** Technical information flow

ANNEX I

RECORDING STATIONS IN LAKE TANGANYIKA

REGION	DISTRICT	RECORDING STATIONS	NUMBER OF FIELD STAFF
KIGOMA	KIGOMA	Kagunga	1
		Mwamgongo	2
		Mtanga	3
		Kibirizi	4
		Ujiji	1
		Kaseke	2
		Mwakizega	3
		Sunuka	3
		Kapalamsenga	6
		Mgambo	2
		Kalya	1
RUKWA	MPANDA	Karema	2
	NKASI	Kirando	3
		Kipili	1
		Kizumbi	2
		Kala	1
	SUMBAWANGA	Kasanga	5

ANNEX 2

ANNUAL VILLAGE FISHING SURVEY FORM FOR THE YEAR .....

STATION: .....

STATION	FISHMEN	LIFT NETTERS		BOATS BY TYPES METHOD OF FISHING							GEARS BY TYPES AND SIZED								
									ENGINES							GILL NETS			
		Trimaran	Catamaran	Beach Seiners	Scoop Netter	Gill Netter	Purse Seiners	Other Boats	I/B	C/B	Lift Nets	Scoop Nets	Beach Seines	Purse Seines	Hooks Line	2½"	3"	4"	6"

ANNEX 3

DAILY FISH LANDINGS WORK BOOK (FORM 21A)

Name of Recorder:.....

Station:.....

Date:.....19.....

Type of Boat	Boat Reg. No.	Gear Size	No. of Gear	No. of Men	Spp.	Weight (Kgs.)	Value (Shs)

THE UNITED REPUBLIC OF TANZANIA

ANNEX 4

F.S.F. 2'B

MINISTRY OF LANDS. NATURAL RESOURCES AND TOURISM

FISHERIES DIVISION

DAILY RECORD OF FISH LANDED

TYPE AND SIZE OF GEAR ____________________

CTE: In the columns below put weight in kilograms in (a) and value in Shillings in (b)

Region ____________ Station ____________ Waters ____________

1	2	3	4	5	6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26	
					S P E C I E S																																									
Date	Type of Boat	Boat Registration No.	No. of Gear	No. of Men																																									TOTAL	
					a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b

The United Republic of Tanzania

Ministry of Natural Resources and Tourism
Fisheries Division

ANNEX 5

F.S.F. 24

MONTHLY SUMMARY OF RECORDED WEIGHTS IN KILOGRAMS AND VALUES IN SHILLINGS BY SPECIES AND NUMBER OF RECORDED GEAR, FISHERMEN AND BOAT LANDINGS

FOR THE MONTH OF ..... 19.....

NOTE: In the columns below, put weight in kilograms in (a) and value in Shillings in (b).

Region : ..... Station : ..... Waters : .....

1	2	3	4	5	6		7		8		9		10		11		12		13		14		15		16	
Site and Type of Gear	No. of Gear Landings	No. of Boat Landings	No. of Fishermen Landings	No. of Days Recorded	SPECIES																				TOTAL	
					a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
TOTAL																										
AVERAGE PRICE PER KILOGRAM = $\frac{\text{Total Value}}{\text{Total Weight}}$																										

ANNEX 6

UNITED REPUBLIC OF TANZANIA

MINISTRY OF NATURAL RESOURCES AND TOURISM

F.S.F 26

FISEERIES DIVISION

AVERAGE BOAT PRODUCTIVITIES (CATCH PER BOAT LANDING = CPBL)

FOR ALL STATIONS

(a) Weight in Kgms.

(b) Value in Shs.

REGION: .....

WATERS: .....

MONTHS: .....

STATION																														
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b

C.P.B.L. = Total Weights (Values) / Boat landings

(From data on F.S.F. 24)

ANNEX 7

F.S.F. 27

UNITED REPUBLIC OF TANZANIA

MINISTRY OF NATURAL RESOURCES AND TOURISM

FISHERIES DIVISION

RECORDED LANDINGS IN PERCENTAGES BY SPECIES FOR EACH STATION

REGION: .....

WATERS: .....

MONTH: .....

S P E C I E S

																							TOTAL
																							100%
																							100%
																							100%
																							100%
																							100%
																							100%

The United Republic of Tanzania

Ministry of Natural Resources and Tourism
Fisheries Division

ANNEX 8

F.S.F. 30

ANNUAL COMPILATION OF RECORDED DATA FOR THE YEAR 19____

Region : _____ Station : _____ Waters : _____

MONTH																									TOTAL
January																									
February																									
March																									
April																									
May																									
June																									
July																									
August																									
September																									
October																									
November																									
December																									
TOTAL																									

ANNEX 9

MINISTRY OF NATURAL RESOURCES AND TOURISM

F.S.P. 22

THE UNITED REPUBLIC OF TANZANIA

FISHERIES DIVISION

RETAIL MARKET SURVEY DAILY RECORDING SHEET FOR FRESH/PROCESSED FISH

REGION: ..... MARKET: .....

Source			Source			Source			Source		
Type and Species	WT (kgm)	VALUE in (Shs)	Type and Species	WT (kgm)	VALUE in (Shs)	Type and Species	WT (kgm)	VALUE in (Shs)	Type and Species	WT (kgm)	VALUE in (Shs)
TOTAL			TOTAL			TOTAL			TOTAL		

Date: .....19.....

Surveyed by: .....

Designation: .....

ANNEX 10

The United Republic of Tanzania

Ministry of Natural Resources and Tourism
Fisheries Division

F S F 28

TRANSPORTATION OF FISH

From ______ During the Month of ______ 19__

NOTE: In the columns below (1) "Type" — Fresh, Frozen, Dried, Smoked, Fried
(2) "Mode of Transport" — Rail, Road, Bus, Air, Private Transport

TYPE AND SPECIES	MODE OF TRANSPORT	PLACE OF DESTINATION												TOTAL (Kilograms)
		WEIGHT IN KILOGRAMS												

TABLE 1

SUMMARY OF FISHERY STATISTICS FROM THE TERRITORIAL WATERS OF L. TANGANYIKA FOR THE YEAR 1991.

	Kigoma	Rukwa	Total
Total No. of Fisherman	8822	4829	13651
Total No. of Vessels	1664	1628	3292
Wt. of Fish in M.tons	27847.4	35656.2	63503.4
Value of Fish in 000's Tshs	1870305.2	1584077.3	3454382.5
Gears in use by Type & Size:-			
Gillnets:-			
2"	-	76	76
21/2"	660	-	660
3"	263	2192	2455
31/2"	123	1760	1883
4"	17	254	271
41/2"	-	9	9
5"	-	116	116
6"	10	-	10
Total No. of Gillnets	1073	4407	5480
Total No. of Liftnets	647	346	993
Total No. of Purse Seine	3	-	3
Total No. of B/Seines	229	30	259
Total No. of Scoopnets	550	469	1019
Total No. of Hooks	9753	15652	25405
ENGINES:-			
Number of Outboard engines	222		
Number of inboard engines	3		

TABLE 11

COMPARISON OF STATISTICS FOR THE TERRITORIAL WATERS OF LAKE TANGANYIKA FOR THE YEARS 1990 1991

Station / Years	No.of Fisherman 1990	No.of Fisherman 1991	No.of Vessels 1990	No.of Vessels 1991	Wt.of Fish (M.Tons) 1990	Wt.of Fish (M.Tons) 1991	Wt/Fishermen 1990	Wt/Fishermen 1991	Wt/Vessels 1990	Wt/Vessels 1991	Value of Fish (000's) 1990	Value of Fish (000's) 1991	Value/Fishermen 1990	Value/Fishermen 1991	Value/Vessels 1990	Value/Vessels 1991
KAGUNGA	920	1036	40	39	630.6	276.9	0.7	0.2	15.8	7.1	39179.0	20714.3	42.6	19.9	979.5	714.2
MWAMGONGO	2164	1882	107	102	4656.9	1425.4	2.2	0.7	43.5	13.9	278003.0	92516.9	128.5	49.1	2598.2	907.0
MTANGA	1306	944	59	72	588.3	663.3	0.5	0.7	10.0	9.2	33526.0	48832.8	25.7	51.7	568.2	678.2
KIBIRIZI	750	775	170	205	6144.5	10521.6	8.2	14.0	36.1	51.8	592562.0	773108.8	790.1	1023.9	3485.7	3771.2
UJIJI	77	78	33	24	105.9	83.7	1.4	1.0	3.2	3.4	11195.0	6864.5	145.4	88.0	339.2	286.0
KASEKE	296	771	88	296	1929.1	1173.7	6.5	1.5	21.9	3.9	116330.0	85789.4	393.0	111.2	1321.9	289.8
MWAKIZEGA	851	229	337	71	4104.3	2474.7	4.8	10.8	12.2	34.8	282380.0	299889.9	331.8	1309.5	837.9	4223.8
SUNUKA	757	1192	141	417	1638.7	1141.7	3.5	0.9	11.6	2.7	93089.0	80283.9	197.6	67.3	660.2	192.5
KIPALAMSE	1266	540	472	107	4747.6	7177.8	3.8	13.2	10.1	67.0	301341.0	188906.3	238.0	349.8	638.4	1765.4
MGAMBO	710	892	131	144	2950.2	2253.4	4.2	2.5	22.5	15.6	267454.0	233336.4	376.7	261.5	2041.6	1620.3
KALYA	493	503	72	87	1007.3	555.6	2.0	1.1	14.0	6.3	64207.0	40062.0	130.2	79.6	891.8	460.4
SUB-TOTAL	9304	8822	1650	1664	26506.4	27847.2	3.1	3.1	17.3	16.7	2079266.0	1870305.2	223.5	212.0	1260.2	1123.9
KALA	726	408	365	162	7781.1	6364.8	10.7	17.0	21.3	42.9	174039.3	105520.8	239.7	258.6	476.8	651.3
KIZUMBI	660	857	268	270	1036.7	1834.7	1.6	2.1	3.9	6.7	15201.7	70191.7	23.0	81.9	56.7	259.9
KIRANDO	1252	1385	1137	535	6400.1	5521.2	5.1	3.9	5.6	10.3	376367.8	263560.4	300.6	190.2	331.0	492.6
KASANGA	2599	1027	427	316	14886.0	14886.0	5.7	14.4	34.9	47.1	642335.9	642335.9	247.1	625.4	1504.3	2032.7
KIPILI	511	594	433	202	3111.0	4610.1	2.0	7.7	7.2	22.8	127452.7	406918.1	249.4	685.0	294.3	2014.4
KAREMA	745	558	215	203	3144.3	1839.2	4.2	3.2	14.6	9.0	95550.4	95550.4	128.3	171.2	444.4	470.6
SUB-TOTAL	6493	4829	2845	1628	36359.2	35556.2	5.6	7.3	12.8	21.9	1430947.8	1584077.3	220.4	32.8	503.0	97.3
TOTALS	15797	13651	4495	3292	64865.6	63503.4	4.1	4.6	14.4	19.2	3510213.8	3454382.5	220.2	253.0	780.9	1049.3

TABLE III

THE WEIGHT OF FISH CAUGHT IN METRIC TONS.FROM THE TERRITORIAL WATERS OF LAKE TANGANYIKA FOR THE YEAR 1991

REGION	STATION	Tilapia	Haplochr.	Boul.	Simochr.	Thylo.	Bagrus	Clarius	Synod.	Euch.	Barbus	Cithar.	Hydro.	Lates	Luciol.	Dagaa	Gipno.	Capocta	Bathyb.	Others	TOTALS
	KAGUNGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	260.0	0.0	0.0	0.0	0.0	276.9
	MWAMGONGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	561.9	863.5	0.0	0.0	0.0	0.0	1425.4
	MTANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.0	621.3	0.0	0.0	0.0	0.0	663.3
	KIBIRIZI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3195.5	7426.1	0.0	0.0	0.0	0.0	10621.6
	UJIJI	3.8	23.5	3.2	1.9	4.3	4.2	4.2	0.0	7.9	1.1	1.1	3.4	11.6	0.0	0.5	4.0	2.1	7.0	0.0	83.7
KIGOMA	KASEKE	0.0	2.5	1.5	0.0	5.9	1.0	0.0	0.0	1.3	0.2	0.4	0.1	9.4	37.5	1110.6	0.3	0.0	3.0	0.0	1173.7
	MWAKIZEGA	0.0	0.0	3.2	0.0	2.5	0.3	0.0	0.0	4.5	0.1	0.0	0.0	9.3	627.3	1826.1	0.0	0.0	0.8	0.0	2474.2
	SUNUKA	0.0	0.0	3.0	0.0	6.6	0.0	0.0	0.0	1.9	0.0	0.0	0.0	30.4	77.4	1017.7	0.0	0.0	4.7	0.0	1141.7
	KIPALAMSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.0	7088.8	0.0	0.0	0.0	0.0	7177.8
	MGAMBO	0.0	0.3	0.4	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	2251.5	0.0	0.0	0.0	0.0	2253.4
	KALYA	0.4	5.5	2.1	2.1	3.1	1.4	0.0	0.0	1.4	0.3	0.0	0.0	4.2	0.0	531.6	0.2	0.1	3.2	0.0	555.6
	SUB-TOTAL	4.2	31.8	13.4	4.0	23.2	6.9	4.2	0.0	17.0	1.7	1.5	3.5	55.2	4647.5	22997.8	4.5	2.2	18.7	0.0	27847.2
	KALA	73.8	261.1	103.3	0.0	112.5	11.9	0.0	0.0	34.5	0.0	4876.4	0.0	850.1	595.0	14.4	7.9	13.6	10.3	0.0	6964.8
	KIZUMBI	0.0	0.0	14.5	0.0	25.6	6.7	0.0	0.0	2.0	0.0	0.0	0.0	25.1	1729.9	5.4	20.1	1.8	3.6	0.0	1834.7
RUKWA	KIRANGO	443.1	740.4	957.4	47.2	1096.4	97.2	47.4	20.7	192.7	0.0	0.0	0.0	585.3	1009.1	27.1	80.5	176.8	0.0	0.0	5521.2
	KASANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1412.6	13473.4	0.0	0.0	0.0	0.0	14886.0
	KIPILI	241.4	119.6	563.2	0.0	262.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	653.3	1516.7	0.0	1196.9	0.0	56.9	0.0	4610.1
	KAREMA	126.8	80.0	79.1	50.8	70.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	284.1	1046.8	0.0	20.4	11.4	59.2	0.0	1839.2
	SUB-TOTAL	885.1	1201.1	1717.5	98.0	1567.3	115.8	47.4	20.7	229.2	0.0	4876.4	0.0	2397.9	7310.1	13520.3	1325.8	203.6	140.0	0.0	35656.0
	GRAND TOTAL	889.3	1232.9	1730.9	101.9	1590.5	122.7	51.6	20.7	246.2	1.7	4877.9	3.5	2453.1	11957.6	36518.1	1330.2	205.9	158.7	0.0	63503.2

TABLE 1V

THE VALUE OF FISH CAUGHT IN 000'S T.SHS. FROM THE TERRITORIAL WATERS OF LAKE TANGANYIKA FOR THE YEAR 1991

REGION	STATION	Tilapia	Haplochr.	Boul.	Simochr.	Thylo.	Bagrus	Clarius	Synod.	Euch.	Barbus	Cithar.	Hydro.	Lates	Luciol.	Dagaa	Dipno.	Capocta	Bathyb.	Others	TOTALS
KIGOMA	KAGUNGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1086.7	19654.6	0.0	0.0	0.0	0.0	20741.3
	MWAMGONGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38536.4	53980.5	0.0	0.0	0.0	0.0	92516.9
	MTANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3237.9	45594.9	0.0	0.0	0.0	0.0	48832.8
	KIBIRIZI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	166266.1	606842.7	0.0	0.0	0.0	0.0	773108.8
	UJIJI	360.0	1276.6	292.2	179.2	412.9	393.5	363.6	0.0	758.4	70.1	119.4	309.0	1072.7	0.0	46.7	336.3	209.0	664.9	0.0	6864.5
	KASEKE	0.0	0.0	319.3	0.0	639.0	218.7	0.0	0.0	71.1	59.9	0.0	11.0	2016.8	3461.1	78404.4	21.5	0.0	566.0	0.0	85789.4
	MWAKIZEGA	0.0	1167.2	498.2	0.0	1854.6	117.6	0.0	0.0	945.7	0.0	299.8	0.0	1550.1	2006.8	291084.8	235.2	0.0	129.1	0.0	299889.1
	SUNUKA	0.6	0.6	454.0	0.3	540.2	0.0	0.0	0.0	207.3	0.0	0.0	0.0	88.1	8407.6	70342.4	0.0	0.0	242.8	0.0	80283.9
	KIPALAMSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.5	7198.7	180946.1	0.0	0.0	0.0	0.0	188906.3
	MGAMBO	0.0	21.2	55.2	0.0	132.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.2	0.0	233083.2	0.0	0.0	0.0	0.0	233336.4
	KALYA	102.9	514.5	291.6	171.5	768.4	329.3	0.0	0.0	233.2	75.4	0.0	0.0	867.9	0.0	36203.1	54.8	34.3	415.1	0.0	40062.0
	SUB-TOTAL	463.5	2980.1	1911.1	351.0	4347.7	1059.1	363.6	0.0	2215.7	205.4	419.2	320.0	5401.3	230201.3	1616183.4	647.8	243.3	2017.9	0.0	1870331.4
RUKWA	KALA	3693.0	12941.8	5107.9	0.0	5627.1	525.7	0.0	0.0	1726.4	0.0	24382.5	0.0	19333.9	29271.6	720.4	395.9	674.2	519.2	0.0	105520.8
	KIZUMBI	0.0	0.0	626.2	0.0	1960.2	430.1	0.0	0.0	141.9	0.0	0.0	0.0	2280.8	61639.0	0.0	2726.6	145.4	241.2	0.0	70191.7
	KIRANDO	16479.3	17223.7	10059.6	2871.6	60280.1	2965.6	682.3	243.1	6257.5	0.0	0.0	0.0	44454.1	21472.1	9335.2	1220.6	10015.6	0.0	0.0	263560.4
	KASANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68385.1	573950.8	0.0	0.0	0.0	0.0	642335.9
	KIPILI	8665.6	3176.0	44509.3	1217.9	9810.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65328.1	151673.2	0.0	119689.9	0.0	2846.8	0.0	406918.1
	KAREMA	2349.0	8685.4	9543.0	0.0	17257.0	1600.0	685.4	0.0	0.0	685.5	0.0	0.0	22686.0	15887.1	0.0	0.0	3200.0	12972.0	0.0	95550.4
	SUB-TOTAL	31187.9	42025.9	129846.0	4089.5	94934.7	5521.4	1367.7	243.1	8125.8	685.5	24382.5	0.0	154682.9	348328.1	584006.4	124033.0	14035.2	16579.2	0.0	1584077.3
	GRAND TOTAL	31651.4	45007.0	131757.1	4440.5	99282.4	6580.5	1731.3	243.1	10341.5	890.9	24801.7	320.0	161084.2	578529.4	2200189.8	124680.8	14278.5	18597.1	0.0	3454407.2

TABLE V

THE AVERAGE SLLING PRICE PER KILO BY SPECIES BY STATION FOR FISH CAUGHR IN THE TERRITORIAL WATERS OF LAKE TANGANYIKA FOR THE YEAR 1991.

REGION	STATION	Tilapia	Haplochr.	Boul.	Simochr.	Thylo.	Bagrus	Clarius	Synod.	Euch.	Barbus	Cithar.	Hydro.	Lates	Luciol.	Dagaa	Otpno.	Capocta	Bathyb.	Others	TOTALS
	KAGUNGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.3	75.6	0.0	0.0	0.0	0.0	74.9
	MWAMGONGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.6	62.5	0.0	0.0	0.0	0.0	64.9
	MTANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.2	73.4	0.0	0.0	0.0	0.0	73.6
	KIBIRIZI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.0	81.7	0.0	0.0	0.0	0.0	72.8
	UJIJI	95.0	54.3	91.6	95.8	95.8	93.7	87.6	0.0	95.8	64.3	107.6	92.2	92.5	0.0	86.5	84.3	99.5	95.5	0.0	82.0
KIGOMA	KASEKE	0.0	0.0	207.7	0.0	109.0	212.3	0.0	0.0	54.7	299.5	0.0	91.7	213.9	92.4	70.6	0.0	0.0	189.3	0.0	73.1
	MWAKIZEGA	0.0	0.0	155.7	0.0	747.8	392.0	0.0	0.0	210.2	0.0	0.0	0.0	167.2	3.2	159.4	0.0	0.0	161.4	0.0	121.2
	SUNUKA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108.7	69.1	0.0	0.0	0.0	0.0	70.3
	KIPALAMSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.9	25.5	0.0	0.0	0.0	0.0	26.3
	MGAMBO	0.0	0.0	145.3	0.0	142.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	147.3	0.0	103.5	0.0	0.0	0.0	0.0	103.5
	KALYA	257.3	0.0	138.9	81.7	251.1	238.6	0.0	0.0	172.7	260.0	0.0	0.0	206.6	0.0	68.1	0.0	263.8	129.7	0.0	72.1
	SUB-TOTAL	110.6	93.7	142.9	88.4	187.5	153.3	87.6	0.0	130.6	119.4	277.6	91.2	98.2	49.5	70.3	145.6	109.1	108.0	0.0	67.2
	KALA	50.0	0.0	49.4	0.0	50.0	44.2	0.0	0.0	0.0	0.0	0.0	0.0	23.4	49.2	50.0	50.1	0.0	50.4	0.0	15.2
	KIZUMBI	0.0	0.0	43.2	0.0	76.6	64.2	0.0	0.0	71.0	0.0	0.0	0.0	90.9	35.6	0.0	135.7	80.8	67.0	0.0	38.3
	KIRANDO	37.2	23.3	73.2	0.0	55.0	30.5	14.4	11.7	32.5	0.0	0.0	0.0	76.0	21.3	0.0	15.2	56.7	0.0	0.0	47.7
RUKWA	KASANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.4	42.6	0.0	0.0	0.0	0.0	43.2
	KIPILI	35.9	0.0	79.0	0.0	37.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	0.0	88.3
	KAREMA	18.5	108.6	120.6	0.0	244.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.9	15.2	0.0	0.0	279.7	187.6	0.0	52.0
	SUB-TOTAL	35.2	35.0	75.6	0.0	60.6	47.7	28.9	11.7	35.5	0.0	0.0	0.0	64.5	47.7	43.2	93.6	68.9	118.4	0.0	44.4
	GRAND TOTAL	35.6	36.5	76.1	43.6	62.4	53.6	33.6	11.7	42.0	518.0	5.1	91.2	65.4	48.4	60.2	93.7	69.4	117.2	0.0	54.4

TABLE Y1

SPECIES COMPOSITION IN PERCENTAGE BY STATION FOR FISH CAUGHT IN TERRITORIAL WATERS OF LAKE TANGANYIKA FOR THE YEAR 1991.

REGION	STATION	Tilapia	Haplochr.	Boul.	Sirochr.	Thylc.	Bagrus	Clarius	Synod.	Euch.	Barbus	Cithar.	Hydro.	Lates	Luciol.	Dagaa	Dipno.	Capocta	Bathyb.	Others	TOTALS
	KAGUNGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	93.9	0.0	0.0	0.0	0.0	100.0
	MWAMGONGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.4	60.6	0.0	0.0	0.0	0.0	100.0
	MTANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	93.7	0.0	0.0	0.0	0.0	100.0
	KIBIRIZI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	69.9	0.0	0.0	0.0	0.0	100.0
	UJIJI	4.5	28.1	3.8	2.2	5.1	5.0	5.0	0.0	9.5	1.3	1.3	4.0	13.9	0.0	0.6	4.8	2.5	8.3	0.0	100.0
KIGOMA	KASEKE	0.0	0.2	0.1	0.0	0.5	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.8	3.2	94.6	0.0	0.0	0.3	0.0	100.0
	MWAKIZEGA	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.4	25.4	73.8	0.0	0.0	0.0	0.0	100.0
	SUNUKA	0.0	0.0	0.3	0.0	0.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0	2.7	6.8	89.1	0.0	0.0	0.4	0.0	100.0
	KIPALAMSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	98.8	0.0	0.0	0.0	0.0	100.0
	MGAMBO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.9	0.0	0.0	0.0	0.0	100.0
	KALYA	0.1	1.0	0.4	0.4	0.6	0.2	0.0	0.0	0.2	0.1	0.0	0.0	0.8	0.0	95.7	0.0	0.0	0.6	0.0	100.0
	SUB-TOTAL	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	15.7	82.6	0.0	0.0	0.1	0.0	100.0
	KALA	1.1	3.7	1.5	0.0	1.6	0.2	0.0	0.0	0.5	0.0	70.0	0.0	12.2	8.5	0.2	0.1	0.2	0.1	0.0	100.0
	KIZUMBI	0.0	0.0	0.8	0.0	1.4	0.4	0.0	0.0	0.1	0.0	0.0	0.0	1.4	94.3	0.3	1.1	0.1	0.2	0.0	100.0
RUKWA	KIRANDO	8.0	13.4	17.3	0.9	19.9	1.8	0.9	0.4	3.5	0.0	0.0	0.0	10.6	18.3	0.5	1.5	3.2	0.0	0.0	100.0
	KASANGA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	90.5	0.0	0.0	0.0	0.0	100.0
	KIPILI	5.2	2.6	12.2	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	32.9	0.0	26.0	0.0	1.2	0.0	100.0
	KAREMA	6.9	4.3	4.3	2.8	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.4	56.9	0.0	1.1	0.6	3.8	0.0	100.0
	SUB-TOTAL	2.5	3.4	4.8	0.3	4.4	0.3	0.1	0.1	0.6	0.0	13.7	0.0	6.7	20.5	37.9	3.7	0.6	0.4	0.0	100.0
	GRAND TOTAL	1.4	1.9	2.7	0.2	2.5	0.2	0.1	0.0	0.4	0.0	7.7	0.0	3.9	18.8	57.5	2.1	0.3	0.2	0.0	100.0

TABLE VII

THE AVERAGE CATCH PER BOAT PER GEAR TYPE IN KGS. FOR FISH CAUGHT IN THE TERRITORIAL WATERS OF LAKE TANGANYIKA FOR 1991

REGION	STATION	D/SEIN	SC/NETS	LIFT NETS	B/TRAPS	TRAPS	H.LINES	GN2"	GN2 1/4"	GN2 1/2"	GN3"	GN3 1/2"	GN4"	GN4 1/2"	GN5"	GN6"	GN7"
	KAGUNGA	28.5	-	28.8	-	-	-	-	-	-	-	-	-	-	-	-	-
	MWAMGONGO	56.3	-	110.6	-	-	-	-	-	-	-	-	-	-	-	-	-
	MTANGA	31.3	-	36.5	-	-	-	-	-	-	-	-	-	-	-	-	-
	KIBIRIZI	-	-	251.4	-	-	-	-	-	-	-	-	-	-	-	-	-
	UJIJI	-	-	-	-	-	-	-	-	-	9.2	11.9	-	-	-	-	-
KIGOMA	KASEKE	-	-	91.3	-	-	20.2	7.3	5.8	9.4	8.3	6.7	-	-	-	-	-
	MWAKIZEGA	-	22.5	54.7	-	-	-	-	-	-	-	-	-	-	-	-	-
	SUNUKA	-	229.6	48.8	-	-	-	-	-	-	-	-	-	-	-	-	-
	KIPALAMSE	-	41.4	51.7	-	-	9.3	-	-	-	-	-	-	-	-	-	-
	MGAMBO	-	88.8	59.3	-	-	-	-	-	-	8.7	-	-	-	-	-	-
	KALYA	62.2	-	-	-	-	-	-	-	6.3	7.6	8.6	-	-	-	-	-
	SUB-TOTAL	178.3	382.4	733.0	0.0	0.0	29.5	7.3	5.8	15.7	33.8	27.2	0.0	0.0	0.0	0.0	0.0
	KALA	21.2	-	54.1	-	-	11.7	-	-	-	-	-	-	-	-	-	-
	KIZUMBI	-	-	21.8	-	-	199.1	-	-	4.3	6.3	-	-	-	-	-	6.0
RUKWA	KIRANDO	-	-	211.3	-	-	-	-	-	-	22.3	-	-	-	-	-	-
	KASANGA	274.2	-	-	-	-	23.7	-	-	-	-	-	-	-	-	-	-
	KIPILI	164.4	-	-	-	-	98.5	-	-	-	-	34.8	70.2	-	54.5	-	-
	KAREMA	49.8	-	-	-	-	31.1	-	-	-	-	-	-	-	-	-	-
	SUB-TOTAL	509.7	0.0	287.1	0.0	0.0	364.1	0.0	0.0	4.3	28.6	34.8	70.2	0.0	54.5	0.0	6.0
	GRAND TOTAL	1197.7	382.4	1307.3	0.0	0.0	757.6	7.3	5.8	24.3	90.9	96.8	140.5	0.0	109.0	0.0	12.0

PISHERY INVENTORY FORM - 1

ANNEX 18

INVENTORY OF FISHING FACTORS (LANDING SITE APPROACH)

Landing site _____
District _____
Approach _____

Permanent ( )
Seasonal ( )
→ season _____

Main Pishery _____

(1)	(2)	(3)						(4)				(5)								(6)		(7)	(8)	(9)
Landing site	Sr ~~#~~ of Craft	Pishing craft						Pisherman				Gear								Auxiliary boat		Owner (village)	Disposal (Market)	Remarks
		Type (Reg ~~#~~)	Type Non Reg.	Active/ Inac- tive	Propulsion			Resident		Non Resident										Type	No (Reg ~~#~~)			
					S/P	IB (HP)	OB (HP)	own er	Lab our	Own -er	Lab- -our														
Name: _____																								
Amenities:																								
Bicycle ( )																								
Pick up ( )																								
Kiln ( )																								
Prying unit( )																								
Market ( )																								
Fishing eq. shop ( )																								
Boat repair shop ( )																								
Water trans ( )																								
Others (specify) ( )																								
Processed fish land: YES( ) No ( )																								
↓																								
Origin _____																								
Frequency _____																								
Transport _____																								

Supervisor

Name: _____

Signature: _____

Date: _____

Enumerator

Name: _____

Signature:

FISHERY INVENTORY FORM - 2

ANNEX 19

INVENTORY OF FISH PRODUCING FACTORS - HOUSEHOLD APPROACH

Village : .....

District: .....

Approach: .....

(1)	(2)	(3)			(4)					(5)							(6)	(7)	(8)	(9)
Sr of House hold	Head of House hold (Respondent)	Fishermen			Craft					Gear							Auxiliary Craft	Landing site	Disposal / Market	Remarks
		Owner	Labour	Absentee	Type (Reg.)	Active/ Inactive	Propulsion			Lift net		BS	Sc. Net				Type No. Reg.)			
							S/P	IB/HP	OB/HP	TM	CM									

Supervisor

Name: .....

Signature: .....

Date: .....

Enumerator

Name: .....

Signature: .....

Date: .....

ANNEX 20

Date:_____19____

Type of Boat	Boat Reg. No.	Type & Gear Size	No. of Gear	No. of Men	Species	Weight (Kgs.)	Value (Shs.)	No. of Fish	FU, FC, & MFU	No. of FU	Arr. Time	Time for Fish	Remarks	Super-visor	Beach Leader

Ministry of Tourism, Natural Resources and Environment

(F.S.F. 21B)

Fisheries Division

ANNEX 21

DAILY RECORD OF FISH LANDED

Region..... District..... Station..... Waters.....

NOTE: (a) Weight in kilograms
(b) Value in T.Shs.
(c) No. of Fish

	1	2	3	4	5	6	7	8	9			10			11			12			13			14		
									SPECIES															TOTAL		
Date	Type of boat	Registration No.	Type/ No. of Gear & size	No. of men	FU FC MFU	No. of FU	Arrival time	Duration for fishing/ collection	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
TOTAL																										

Recorder's Name..... Designation.....

TAFIRI CATALOGUE OF FISHING GEARS FOR THE KIGOMA AND RUKWA REGIONS OF LAKE TANGANYIKA (TANZANIA)

by

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HISTORICAL DATA REPORT **NR. 3**

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ABSTRACT

Different types of fishing gears around Kigoma and Rukwa were studied. These included: surrounding nets (purse seine and beach seine), lift nets, scoop nets, gill nets, longlines, handlines, traps and pole and line.

For each type, different designs were studied. The study included taking measurements of fishing vessels respective to the fishery in consideration.

Around Kigoma (and Rukwa) three designs of purse seine have been recognized (designated A, B & C). These differ in size, construction material and the location of the bunt. Details of construction are given.

There are also three designs of lift net operating around Kigoma (and Rukwa). The designs differ according to the direction of the net mounting and the quantity of the netting material required to construct one unit of lift net. Advantages and disadvantages of each design are discussed.

The study also showed that beach seines differ in size and construction material depending on the size of fish they are required to catch, and they also differ in presence or absence of a cod–end. Normally, beach seines constructed for catching dagaa are smaller than those which are constructed for catching table fish. Altogether, there are three designs based on the differences above.

In all cases, the study concentrated on the modifications done so far on these fishing gears since they were introduced here in Kigoma. Therefore, the starting point for this study was the original gear used in each fishery, i.e. industrial and artisanal fisheries. Other fishing gears were found to have little interest because no modifications have been done on them since they were designed (e.g. scoop and gill nets). Little modification has been done on handlining except for increasing greatly the number of curbed hooks per string. The resulting gear is called “Kachinga”.

Finally, drawings for different designs are presented to show the differences between or among the designs.

1. INTRODUCTION

Lake Tanganyika has been an active fishing site since the early fifties when fishing activities started (Herman, 1977; Roest, 1988).

Apart from providing a transport network among the bordering countries and water for domestic purposes, Lake Tanganyika forms a home for many fishes most of which are believed to be endemic (Brichard, 1978). Therefore, fishing is a major occupation of the inhabitants all along the Lake. The potentiality of Lake Tanganyika as a fishing site has not been evaluated over the past two decades (about 18 years). It is not easy therefore to estimate how much has been exploited and how much remains unexploited. However, judging from the type of fishing gears used in the Kigoma and Rukwa Regions, and of course from their numbers, an assumption can be made that the resources have not been sufficiently exploited. Johannesson (1974) estimated the pelagic fish bioinass in Lake Tanganyika at 2.800.000 metric tons.

The fisheries activities in Lake Tanganyika can be divided in three categories, namely the industrial, artisanal and traditional fisheries.

While there has been very little development of the industrial fisheries around Kigoma and Rukwa, adequate modifications have been observed concerning the fishing gear involved. This fishery is very expensive to establish, because it requires a fleet of boats and a large purse net, both too expensive for the ordinary fisherman to afford. Probably, the major modification of the purse seine so far is the reduction of the total weight and the bulkiness of the net. The original purse seine found in Kigoma was constructed by using netting material of very small mesh size (10 mm), hence it was heavy and bulky. The second modification was the shifting of the bunt from the central position to a position near one of the wings. As said above, these modifications did not tally with the development of the industrial fisheries itself. At present, there are only two industrial fisheries units operating. These are the National Service Bulombora and the Kibirizi. The other five units (Ujamaa, Uvira Kigoma 2 units, Hassan Fisheries 2 units) were grounded some years back. TAFIRI's units have been grounded recently.

The nature of the Lake itself has contributed to the low catches found in this area. This is because it is difficult to employ some of the most efficient fishing gears such as the trawl net. The extended depth of Lake Tanganyika (1470 m) seems to be a barrier on the operation of bottom trawl nets. Surveys on the possibility of introducing a pelagic trawl were done way back in early eighties using M.V. METALUSA but results were not encouraging. Due to these snags, it is evident that maximum exploitation of fish in Lake Tanganyika has never been reached at any time.

Also improvements for the artisanal fishery have been done where public institutions, namely TAFIRI and a Fisheries

Project, run by FAO, have been working hard to modify a traditional lift net in order to improve its efficiency. The traditional lift net is characterized by a poor opening due to the fact that the net is mounted in N-direction (from mouth to cod-end) during its construction. This means the netting panels are oriented longitudinally (lengthwise) from the mouth opening of the net or the mount rope to the cod—end. In other words, the netting panels are attached to the mounting rope by their widths. Therefore, the trend has been to shift the direction of mounting the net from N to T direction, where the netting panels are oriented latitudinally (parallel) to the net mouths or the mount rope. However, there have been some problems (beliefs) to achieve this development and as a result these modifications have not been assimilated by local fishermen and the catch landings have not increased greatly. A slight modification has been done on the beach seine namely the installation of the cod-end. It seems that the majority of fishermen like this modification.

This catalogue has been prepared to show the different types and designs of fishing gears involved in both industrial and artisanal fisheries as well as in traditional fishery, so as to help the reader and fisheries officers in general to study them and put them in use, and where necessary to make the required modifications. To those who want to invest in fisheries activities in Lake Tanganyika, this catalogue gives a choice of the suitable design of fishing gear for good results. This study covers Kigoma and Rukwa regions within Tanzanian waters of Lake Tanganyika. Hopefully, other neighbouring countries will find some useful information for the development of the fisheries sectors in their respective countries.

2. METHODS

Most of the observations on fishing gear was done at Luanza beach near Kigoma post. This place is a very famous landing station because it is from here that most people in town buy the fish.

A number of lift nets were randomly picked and measured. Also the lengths (LOA) and the width (Beam) of the corresponding boats were taken. In certain cases, owners were required to give the needed information concerning their fishing units. This happened where it was not possible to take measurements due to season or for other reasons.

3. FISHING GEAR CHARACTERISTICS.

The success of fisheries activities as far as the catch is concerned depends on the numbers of fishing gears put into operation at a given time, and largely on the efficiency of these gears.

As put down in the introduction, most nets, particularly those used in artisanal fisheries, are less efficient due to poor design and construction. The design and construction of

these nets (especially lift nets) have been greatly associated with traditional belief instead of adhering to the modern fishing gear technology.

The "traditional" lift net (design A_L; see Fig. 1) is constructed in such a way that it closes up during hauling, thereby reducing the fishing area covered by the net and at the same time catching juveniles together with adult specimens. The fishermen believe that if the net is constructed otherwise, the fish will get out of the net through the opening meshes. This idea is not true because however wide the meshes may become during hauling, the final size of fully stretched mesh will always be smaller than that of the mature sardine (dagaa). Their idea therefore is only true when referring to juveniles. Contrary to this, both designs B_L and C_L (see Figs. 2 and 3) which are modifications by TAFIRI (Kigoma Centre) and FAO respectively have been designed to increase the fishing area during hauling. This has been achieved by mounting the net in T—direction as opposed to N-direction for the traditional lift net (A_L). As a result, designs B_L and C_L allow juveniles to escape together with water as hauling continues. This reduces the risk of overfishing (Bayona *et al.*, 1990) and makes the operation easier because water drips off much easier than in design A_L. However the "local fishermen" cannot be blamed indefinitely for their design (A_L):it is easier to construct than design BL in which there are too many net panels to be cut and joined together (design B_L: construction work is tedious). As for design C_L, construction is easier but "local fishermen" find it difficult to adapt because for every unit this design requires almost double the quantity of construction material than that required by designs A_L and B_L (too expensive for an ordinary fisherman). Therefore, modifications of fishing gears should consider the existing economical conditions on one hand and the expected returns on the other. In this case, design B_L (apart from the tedious construction work) remains the best design of lift net at present because it requires the same quantity of construction material as the traditional lift net (A_L) but it has three advantages over design A_L namely 1) increased fishing area due to opening up of the net during hauling; 2) easy drip of water thus easy hauling; and 3) it allows juveniles to escape through the meshes. A random survey of lift nets around Kigoma showed that lift nets can be put into three size groups. These are (circumference x depth) 64 m x 18 m, 72 m x 20 m and 80-85 m x 24 m (see Table 1).

A lift net unit is either catamaran or trimaran, i.e. two or three boats (or canoes) respectively. These boats are connected together by means of connecting poles. A catamaran unit requires two connecting poles of at least 7 m each. One pole is fastened on the fore end of each boat parallel to the fore athwartships; and the other is fastened parallel to the aft athwartships of both vessels. In this case, the boats (vessels) are oriented parallel to each other (see Fig. 9). A trimaran unit requires four connecting poles because three boats are involved (Fig. 12). Normally, a catamaran unit is especially designed to operate lift nets of 64 m circumference x 18 m deep, while a trimaran unit is designed to operate lift nets of all sizes (64 m x 18 m, 72 m x 20 m and 80-85 m x 24 m).

Sometimes, to cut down capital expenses, catamaran units are modified to operate nets of 72 m x 20 m and 80-85 m x 24 m which would otherwise be operated by a big trimaran unit. Thus, a catamaran unit operating a lift net of 72 m x 20 m must have two extension poles (Fig. 10). An extension pole is made by connecting two connecting poles together. The connecting poles are of eucalyptus tree and the connection is done by means of strong rubber bands. This connection produces a single straight pole at least 13 m long. It increases the area of the fishing ground covered by the vessels, hence by the net (it compensates for the third boat omitted in the trimaran unit).

When a catamaran unit is required to operate a lift net of 80-85 m x 24 m, in addition to extension poles, each unit requires two extra poles called sideway poles. These are fixed on the beam of each boat opposite to the extension poles. The hanging sides of these poles (sides away from the boat) bear pulleys through which hauling ropes pass (see Fig. 11). Therefore, sideway poles perform a dual function of increasing the area covered by the fishing vessel and at the same time being used as hauling poles. In this last category, the number of hauling poles increases from the usual four (2 per boat) to six (2 fore poles, 2 aft poles and 2 sideway poles). Apart from these different poles, a lift net unit requires lamp holders (brackets). These are constructed from wooden material. Their fore ends are expanded and partitioned such that two lamps can be tied up (by means of ropes) at a time. A catamaran unit requires a minimum of two lamp holders (for 4 pressure lamps) while a triinaran unit requires 3 to 4 lamp holders. Often fishermen fix extra lamp holders because they can afford to buy additional lamps. Lift nets also possess sinkers attached to their cod—ends. The sinkers (one per net) are constructed from tyre rims and sometimes stones are tied on them to make them heavy enough (Fig. lb, 2b, 9 & 10). Sometimes, sinkers are made from square welded pipes (Fig. 3b).

Little can be said about the industrial fisheries around Kigoma and Rukwa because most units have ceased to operate. This fishery was expected to be the most profitable one because the nets used are big enough to cover a relatively large fishing area compared to other gears (artisanal). While the biggest lift net has a circumference of 85 m x 30 m deep, an ordinary purse seine has a circumference of 200 m x 70 m deep (see Table 1). Also the operation of purse seine requires the use of standard lamps of at least 2000 candle light power as opposed to pressure lamps whose candle power is less than 100. Standard lamps have a high attracting power such that fish hiding in the deeper waters become attracted to the surface and are eventually caught.

But these requirements are rarely being adhered to. For instance, the use of standard lamps ceased/stopped some years back, apparently due to their shortage around Kigoma. This has greatly affected the catch landed by industrial fisheries units such that at present there is no marked difference in catch between an industrial fisheries unit and an artisanal fisheries unit. Since industrial fisheries units require higher inputs than artisanal ones and because both units give the same

returns, it has been uneconomical to operate these big units. That's why industrial units have almost ceased to operate: only two units are still operating at present in Kigoma.

Three designs of purse seines exist (see Figs. 4, 5 and 6):

* design A is the original design of purse seine found in Kigoma. It differs from the other two in that it was constructed from uniform mesh size netting material (10 mm). As such, this net is both heavy and bulky, and it is also more expensive than nets of the same size but of different designs. Another characteristic of this design is that its bunt was centred between the wings.

* design B is a modification of design A. Here, only the bunt - which is still centrally placed - consists of small mesh size (10 mm) netting material. The mesh size increases steadily to 50 mm towards the wings. This reduces both the weight and bulkiness of the net. The design is also cheaper than A because a large portion of the expensive small mesh size netting material is replaced by the less expensive large mesh size material.

* design C which is a modification by TAFIRI (Kigoma) differs from B only by the position of the bunt. In this design, the bunt is not centred but has been shifted to somewhere near the end of one wing. Although in terms of costs, both designs B and C are of equal cost, design C is more desirable because the position of the bunt reduces stacking time and therefore makes the operation more easier.

Beach seines are both difficult to construct and in terms of manpower, expensive to operate. Whereas lift nets require four to six people to operate, the beach seine needs eight to ten people (depending on size). Although there are three designs of beach seine based on size and presence or absence of the cod—end, the difference in size is not regarded in itself as a modification because functionwise the small beach seine performs a different function from that of a big beach seine. The original beach seine whether small in size (thus meant to catch dagaa or sardines) or big in size (thus constructed for catching table fish) had no cod-end (e.g. see Fig. 7). This type of fishing gear was efficient in those days when the exploitable stock was still virgin. Nowadays, beach seining requires a more efficient net which will prevent the fish from escaping. Therefore, a cod—end, which is a narrow purse structure protruding backwards at the centre of the net has to be fitted (Fig. 8). This reduces the chances of fish to escape, particularly the fast swimmers.

The small beach seine is of the size 130 m x 25 m to 150 m x 30 m. It is constructed using small mesh size netting material 10 mm at the centre and 19 mm at the wings. The big beach seine has its centre constructed using 25 mm mesh size net and the wings 50 mm. The size is 150—200 m x 10 m.

The traditional fishery has been going on hand in hand with the other two fisheries, i.e. industrial and artisanal fisheries. However, the fishing gears involved in this fishery were of little interest during the study because their contribution to the local catch is very little and no modifications have ever been done on them. For the purpose of making this work complete, details of construction of each of these gears is given below. The fishing gears considered under this section include the scoop net, gill net, handline, longline, pole and line and traps.

The scoop net is one of the most famous traditional gear in Kigoma and Rukwa regions. Its construction is done by seaming together two pieces originally cut in a taper form from the net webbing (see Fig. 13a). The net webbing is one of nylon material 10 mm—144 RTex. The mouth of the seamed pieces is mounted around a ringlike wooden structure (made from strong wooden poles) of between 2 and 3 cm diameter. The mounting ratio of a scoop net is normally 100. After mounting, a handle is attached to the ring structure with two short supporting poles (Fig. 13b). The operation of the scoop net involves light attraction, therefore, a canoe with lamp holders as these used in lift nets are required.

Also gill netting is common among the subsistence fishermen in both Rukwa and Kigoma regions. However, the number of gill nets used annually in both regions has been fluctuating greatly possibly due to poor catches (see Table 2). Normally, gill nets are operated in units where a single unit possesses 5 to 10 nets depending on the financial ability of the fisherman. A single net (1 piece) is 50 m long x 27 meshes deep. The meshes differ in size according to fishermen's preference. The fish net industries (Tanzania Fish Net Industries) based in Dar—es—Salaam and Mwanza manufacture gill nets of various mesh sizes between 50 mm — 100 mm. Several pieces of gill nets (5 to 10 or more) are mounted on a continuous mounting rope at a hanging ratio of 0.5, or 0.66 or 0.75. A unit of gill nets may contain nets of the same mesh size or may have nets of different mesh sizes. Most fishermen prefer gill net units of mixed mesh sizes, because these are believed to have wider chances of catching fish. Like the scoop net fishery, a canoe is required for setting and hauling the nets but lamps are not necessary. The nets are usually set late in the evening and hauled early in the morning. A single fisherman can operate this fishery (scoop net requires two), but the majority prefer going in twos. Plastic floats and stone sinkers are used to balance the net up-right in the water (Fig. 14).

On the other hand, handlines are very common in Kigoma and Rukwa regions. There are two types, one is operated during the day, called Kachinga, and the other is operated at night along with lift nets. This is called Bushpa (see Fig. 15). Both types are vertical handlines and catch the pelagic predators (*Lates* species), *Lates stappersii* are being caught during day fishing while other *Lates* species are caught at night. These lines consist of a main line, usually a monofilament one of about 150 to 200 m long with a diameter of 0.6 mm. In both cases, the

first 100 m are not rigged with hooks. This helps to keep the line in a vertical position until it reaches deeper waters where these predators stay. Snoods are fixed to the main line from a depth of 100 in onwards. These hooked snoods are of 0.6 mm diameter and 15 cm long. They are spaced at intervals of 20 cm each. In day operated handlines, i.e. Kachinga, the number of snoods is higher (between 100 - 150 per line) while the number of rigged snoods decreases to between 60 and 70 in night fishing. Another difference between day and night handlining is that the day handlines are not baited, instead the fishermen move the lines up and down, a process which creates bubbles which are confound with prey by the fish. Bushpa operation on the other hand involves baiting the hooks. Since bushpa takes place along with lift nets, the lines have to be set in a leeway side to avoid entanglement with the net. Each line (bushpa) is kept away from the lift net unit (net + boat) by a buoy attached to a piece of twine (100 m long) and placed as far away as possible from the boats.

There are some similarities between handlining and longlining. Both types of fishing consist of a main line and hooked snoods. While handlines are monofilament material, main lines in longlines are either nylon twines 1380 R—Tex or polythene ropes of 2—4 mm diameter. The snoods are of nylon material (twine) 0.3-0.5 m long x 0.5-1.0 mm diameter. Each line consists of 150—200 hooks. The snoods are spaced at 2 in intervals. Intermediate buoys are fixed after every 10 snoods to keep the hooks slightly above the ground to prevent them from sinking into the mud (see Fig. 16). Fishermen use floating wood pieces as intermediate floats and mask buoys while stones are used as sinkers. Usually longlines are horizontal and are baited with sardines or cichlids or any other flesh. Traditionally, longlining is known as Kawambwa but it is not common in Kigoma. Fisheries Division reports show that this fishery became famous in 1989 in Rukwa region where 1559 longlines were used in fishing activities (see Table 2).

The pole and line fishery consists of either a nylon twine or inonofilainent line/string 15 to 20 m long at the end of which a hook of 15-40 mm x 0.5-1.4 mm is fixed. The other end of the line is attached to a thin bamboo pole or reed of 3 to 4 m long. This gear is applied near the shore to catch cichlids, catfishes and other inshore species depending on the bait used. Usually, baits include worms, porridge, insects or artificial lures.

The last gear observed are traps. These are constructed using wire mesh or gauze and most commonly by using reeds or strips of bamboo poles. When the construction is done by using wire mesh or gauze, the material is bent to give the trap a rectangular, square or cylindrical structure (see Fig. 17). This plan is then rigged with a non return valve of the same material. Such traps possess small doors of 15 cm x 15 cm on the top side for inserting baits and removing catches. Wire mesh traps are set in relatively deep waters and are intended to catch big fish. If needed, weights for sinking the traps are either inserted in the traps through the doors or are attached on the sides by means of ropes. Traps used in rivers (and other

shallow areas) are normally constructed from reeds or strips of bamboo poles. The strips are woven with strands of creeping plants to form a conical structure, with the wider end bearing a spiral funnel— like mouth through which the victims (fish) pass. These traps do not possess non—return valves.

4. CONCLUSION AND RECOMMENDATIONS.

Kigoma and Rukwa regions which cover the Tanzanian waters of Lake Tanganyika have been experiencing fluctuations in fishing pressure as implied by the number of fishing vessels and gears involved. Based on the Fisheries Division Annual Statistics Reports 1985—89, the number of fishing vessels has decreased from 5,979 in 1985 to 3,747 in 1989 while the number of fishermen has increased from 13,625 in 1985 to 15,400 in 1989. A general outlook on the fishing gears used during 1985-89 shows that eight types of fishing gears were used. These are the purse seine for industrial fisheries, lift net and beach seine for artisanal fisheries and gill nets, scoop nets, hooks (handlines), traps and longlines for traditional fisheries. The study showed that some fishing gears were localized in one region only, eg. traps and longlines are found in Rukwa region only, none was found in Kigoma, while the purse seine was found in Kigoma only. There is no good explanation for this distribution because both regions bear almost the same ecology. The remaining fishing gears were relatively equally distributed in the two regions (see Table 2).

Of the two regions, Kigoma shows stable patterns with regard to fishing gears invested in its waters. For example, there is a decreasing trend for both the purse seine and the scoop net: from 7 purse seines in 1985 to 3 in 1989 and from 2156 scoop nets in 1986 to only 606 in 1989. The number of beach seines in Kigoma has almost been constant, ranging between 221 in 1985 and 240 in 1989. An increasing trend has been shown by lift nets and gill nets which have increased from 376 lift nets in 1985 to 533 in 1989 and from 361 gill nets in 1985 to 925 in 1989.

In Rukwa region, the number of fishing gears has been fluctuating greatly. These fluctuations could probably be related to the availability of fish (actual fish caught), and the availability of certain netting materials on one hand, and the operational costs on the other hand. Some fishermen abandon certain types of gears and try others if the preceding gears do not give good results.

For target gears such as handlines, traps and longlines, their occurrence is an indication of the presence of target species. If the target species migrate or if the stocks become depleted, such gears may not be as useful. This is why handlining, traps and longlines show unusual occurrence in the field (see Table 2).

However, if the two regions are considered together as one fishing site it can be concluded that lift nets have received a

positive response from the fishermen in this area, as their number increased from 451 to 613 in 1985 and 1989 respectively. This could be due to a change from scoop net fishery to lift net fishery by Kigoma fishermen. A decrease in scoop nets in Kigoma has been compensated by the increase in lift nets. Still, scoop nets and gill nets (traditional fisheries) show an unstable situation. Since these gears are cheaper than either lift net or beach seine, people use them as temporary occupation, investing in them when other businesses, like cultivation are not paying, and abandoning them when the situation of other businesses improves. This has been the case for Burundi refugees who leave their camps in Mishamo-Mpanda and go to Rukwa for temporary fishing activities (pers.obs.).

Overall observation shows that the beach seines have decreased from 627 in 1986 to 397 in 1989. Beach seines are known for their destructive effects since repeated application in the same fishing ground destroys spawning areas and hiding places for juveniles. Bayona (1991) criticizes the use of beach seines due to their excessive efficiency in catching juvenile inshore fish species and suggests the use of lift net and scoop net to tape up the resources. It is also our observation that beach seines should not be allowed to operate freely. Fishing seasons involving the beach seines should be introduced in order to save fish species for which the juveniles are endangered by the use of this gear.

In general, the level of fisheries activities in Kigoma and Rukwa regions is still very low and the catches landed are very poor compared to the fishing area covered (Tanzania covers 41 % or 13,489 km^2 of the total surface area of Lake Tanganyika). Fisheries Division Annual Statistics Reports 1974-87 show that the total catch from Lake Tanganyika (Tanzania side) increased steadily from 36,455 metric tons/year in 1978 - which gives an average of only 2.7 metric tons/km^2 of surface area/year (or 27 kg/ha/yr) - to 114,963 metric tons/year in 1985, an average of 8.52 metric tons/km^2/year or 85.2 kg/ha/yr (see Table 3). Out of these values, the contribution of the industrial fisheries was only 0.03 metric tons/km^2/year in 1978 and 0.02 metric tons/km^2/year in 1985. These values are much lower than those published by Roest (1988) in which the industrial fisheries alone in Burundi contributed between 1.14 to 1.52 metric tons/km^2 /year between 1977 and 1983. Although the study by Bayona *et al.*, (1990) has indicated poor catches to be due to "local overfishing", it is thought that the number of fishermen and the number and level of utilization of the fishing gears involved are too low to give any reasonable catch (e.g. the absence of standard lamps in industrial fisheries and poor designs and construction of artisanal fishing gears).

To alleviate this situation, more people should be encouraged to invest in fishing activities and traditional beliefs should be discouraged. Also fishermen should be advised to construct nets that are easy to operate (according to the recommended design), and which will not affect the regular recruitment of exploitable stocks. This can be achieved if the introduction of any modified fishing gear puts into consideration the existing economical conditions around this

area as related to the returns expected. Most of fishermen are poor and live at a subsistence level. Therefore, they cannot afford to invest heavily in fishing gears whose modifications do not grant any marked increase in catch. Also the government institutions (e.g. Tanzania Fisheries Research Institute - TAFIRI, and the Cooperative and Rural Development Bank - CRDB), which in most cases are the modifier of fishing gears, should be ready to give the technology free of charge.

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TABLE I: CHARACTERISTICS OF ARTISANAL AND INDUSTRIAL FISHING UNITS AND THEIR FISHING GEARS

TYPE OF FISHERIES	DESCRIPTION OF THE UNIT	LOA	BEAM	CIRCUMFERENCE OF THE NET	DEPTH	OWNER
ARTISANAL (LIFT NET)	CATAMARAN	6.0 m	1.5 m	72 m	20 m	TAFIRI
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Salvatory Kabanilo
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Lubwiliza
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Abel
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Simon
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Kumwaga
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Zwiba
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Ramadhani
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Hamza
	CATAMARAN	5.5 m	1.5 m	64 m	18 m	Nicholas Challe
	CATAMARAN	5.5 m	1.5 m	64 m	18 m	Rajabu Mbano
	CATAMARAN	5.5 m	1.5 m	64 m	18 m	Masawa
	CATAMARAN	5.5 m	1.5 m	64 m	18 m	Mengi
	CATAMARAN	5.5 m	1.5 m	64 m	18 m	Mbaruku
	CATAMARAN	7.0 m	1.6 m	85 m	24 m	Enock Karabagega
	CATAMARAN	7.0 m	1.6 m	85 m	24 m	Buzenzeri
	CATAMARAN	6.5 m	1.5 m	80 m	24 m	Miforo Israel
	CATAMARAN	6.5 m	1.5 m	80 m	24 m	Benjamin
	CATAMARAN	6.5 m	1.5 m	80 m	24 m	Chubwa
	CATAMARAN	6.5 m	1.5 m	80 m	24 m	Kivu
	TRIMARAN	6.0 m	1.5 m	85 m	24 m	FAO I
	TRIMARAN	6.0 m	1.5 m	85 m	24 m	FAO II
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Samson Sago
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Jah Athman
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Miforo Israel
	CATAMARAN	6.0 m	1.5 m	72 m	20 m	Athman Bivubila
INDUSTRIAL FISHERIES	PURSE SEINER	12.0 m	3.30m	235 m	65 m	TAFIRI
	PURSE SEINER	15.6 m	3.65m	200 m	55 m	Uvuvi - Kigoma Ltd
	PURSE SEINER	15.2 m	3.50m	350 m	110 m	Bulombora

N.B.: Purse seine dimensions are given before mounting.

TABLE 2: LAKE TANGANYIKA (TANZANIAN WATERS) FISHERIES STATISTICS FOR YEARS 1985-1989

	1985			1986			1987			1988			1989		
	Kigoma	Rukwa	Total	Kigoma	Rukwa	Total	Kigoma	Rukwa	Total	Kigoma	Rukwa	Total	Kigoma	Rukwa	Total
Fishermen	-	-	13625	10564	3273	13837	10241	3287	13528	10470	6095	16565	9429	5971	15400
Fish. vessel	-	-	5979	2942	1595	4534	2450	1170	3620	1710	2591	4301	1498	2249	3747
Gill net	361	16198	16559	538	2354	2892	1478	710	2188	708	1423	2131	925	4407	5332
Handlines	2377	4542	6919	1624	1673	3297	12449	3707	16156	5305	3879	9184	14370	15652	30022
Purse seine	6	0	6	7	0	7	7	0	7	5	0	5	3	0	3
Beach seine	221	272	493	282	345	627	295	285	580	170	392	562	240	157	397
Lift nets	376	75	491	376	827	1203	482	58	540	537	97	634	533	80	613
Scoop nets	2142	832	2974	2156	56	2212	1340	315	1655	738	1781	2519	606	587	1193
Traps	0	136	136	0	10	10	0	29	29	0	29	29	0	0	0
Longlines	-	-	-	-	-	-	-	-	-	-	-	-	-	1559	1559

NOTE: Fish. Vessel: fishing vessel

SOURCE: FISHERIES DIVISION ANNUAL STATISTICS REPORTS 1985 - 1989

REMARK: The evolution of increasing/decreasing numbers from year to year for certain gears in this table seems to be irrealistic/inconsistent. This is thought to be due to poor data collection methods used (double recordings, etc.)

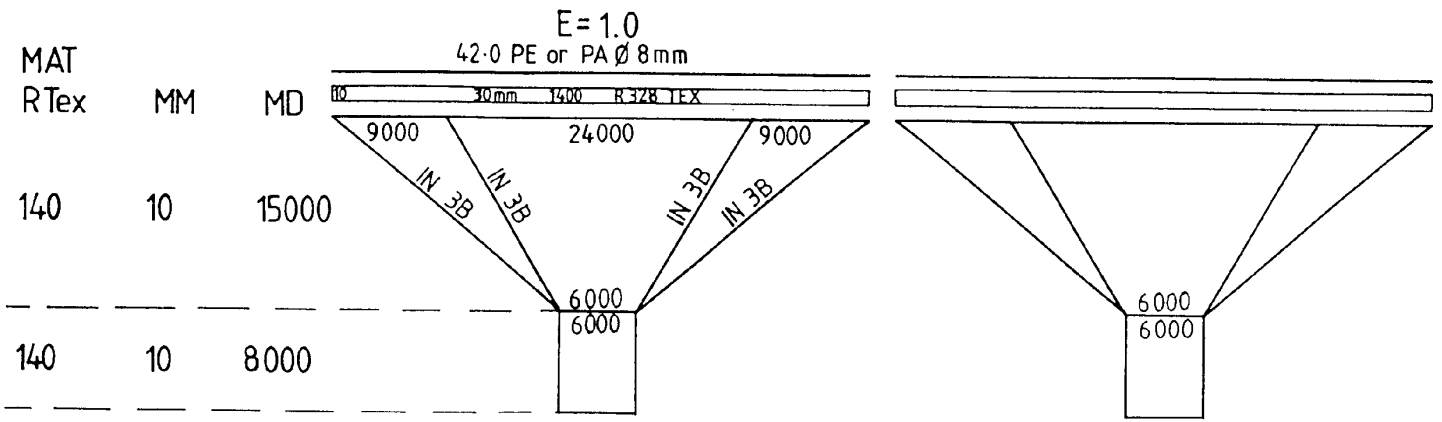
TABLE III: TOTAL AND AVERAGE CATCHES OF TOTAL FISHERIES (TRADITIONAL, ARTISANAL AND INDUSTRIAL FISHERIES) AS COMPARED TO THOSE OF INDUSTRIAL FISHERIES (ALONE) OF LAKE TANGANYIKA (TANZANIA) FROM 1974 - 1987

YEAR	TOTAL CATCH metric tons / year	AVERAGE CATCH metric tons /km²/year	INDUSTRIAL FISHERIES metric tons /year	AVERAGE CATCH metric tons /km²/year
1974	76,619	5.68	244.04	0.02
1975	64,345	4.77	190.43	0.01
1976	73,556	5.45	607.75	0.05
1977	61,838	4.58	469.65	0.03
1978	36,455	2.70	342.60	0.03
1979	44,174	3.27	121.60	0.01
1980	*	-	*	-
1981	*	-	*	-
1982	60,130	4.45	236.92	0.02
1983	99,355	7.36	180.15	0.01
1984	107,111	7.93	192.35	0.01
1985	114,963	8.52	265.89	0.02
1986	69,707	5.16	213.91	0.02
1987	93,911	6.96	160.08	0.01

NOTE: Tanzania covers 41% (13,500 km²) of the total surface area of Lake Tanganyika
* : Data not processed

SOURCE: FISHERIES DIVISION ANNUAL STATISTICS REPORTS 1974 - 1987

Fig 1a: LIFT NET – Design AL



VESSEL: 2 or 3 Plank canoes

LOA - 5.5 - 7.0m

Beam - 1.5m

PM - Paddles or OB - 15 HP

Fig 1b
SKETCH FOR LIFT NET - Design A_L

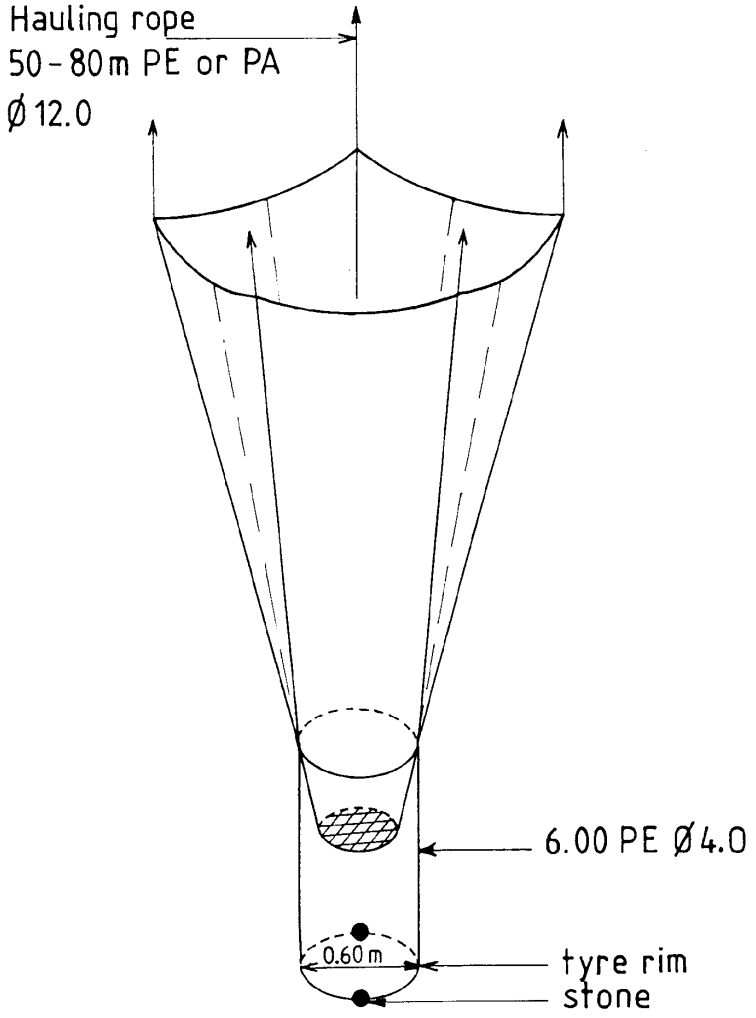
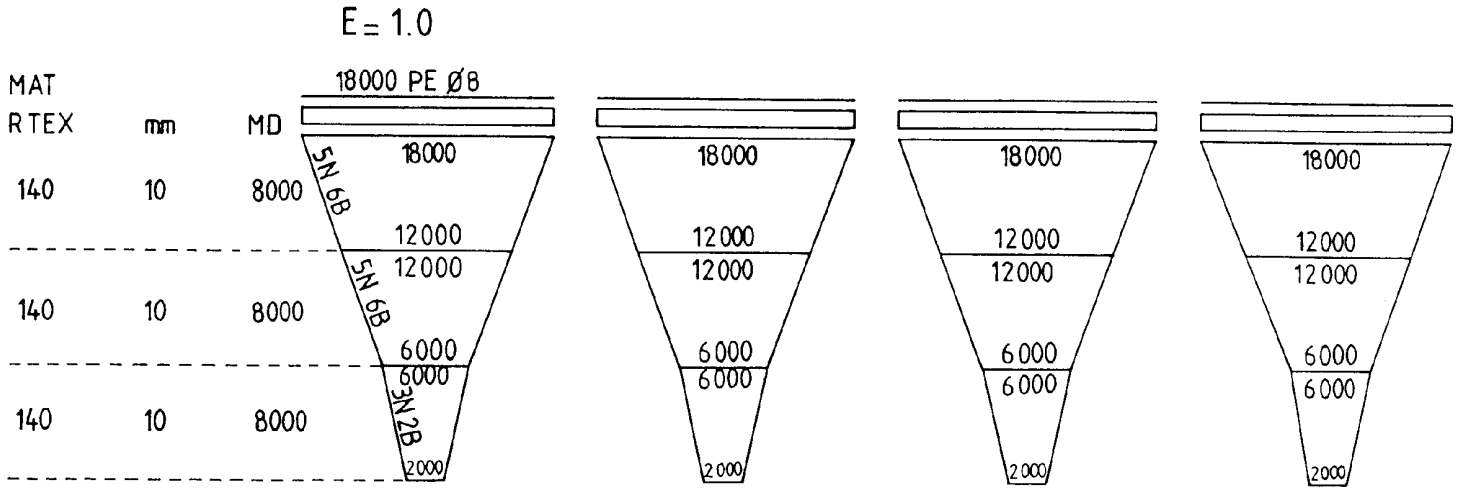


Fig 2a: LIFT NET– Design B_L



VESSEL : 2 or 3 Plank canoes
LOA – 5.5 – 7.0 m
Beam – 1.5m

Fig 2b: SKETCH FOR LIFT NET – Design B_L

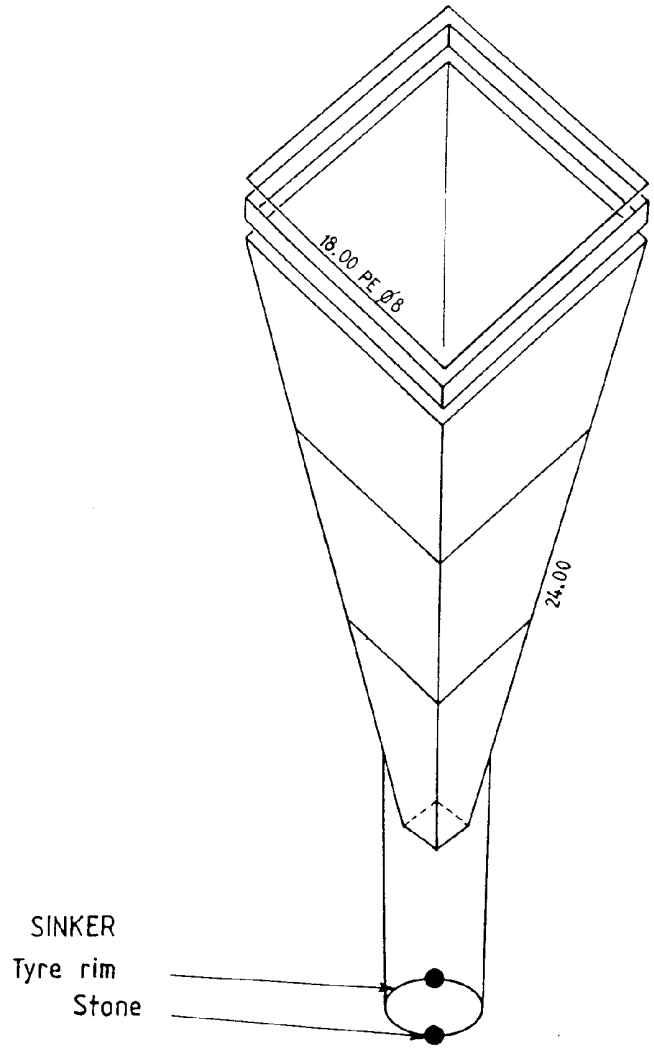
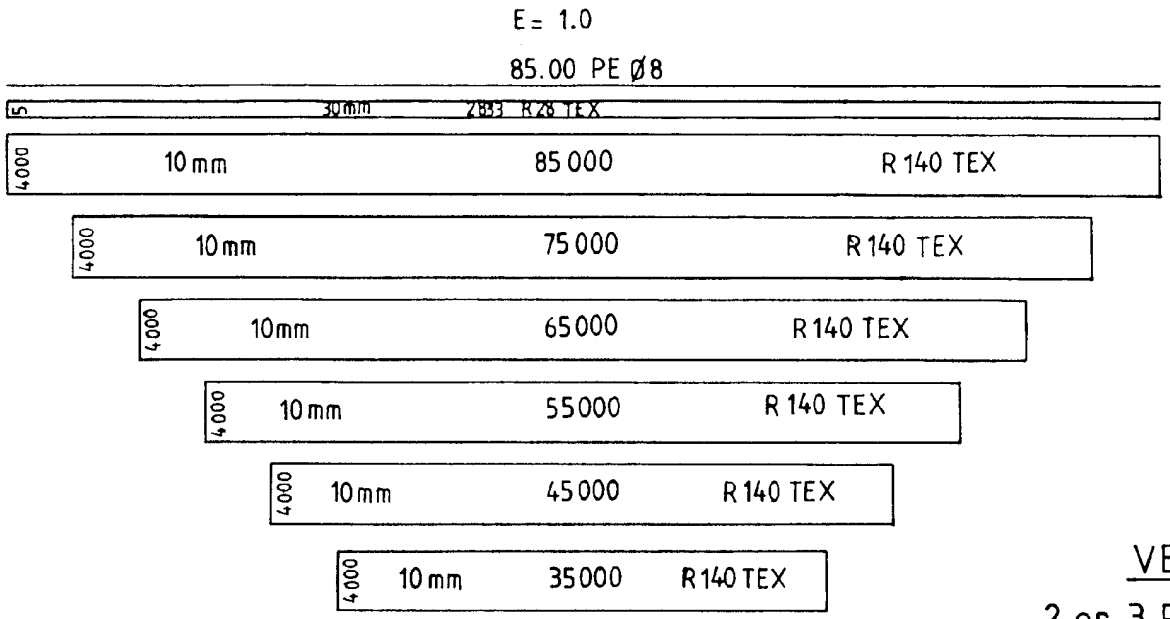


Fig 3a : LIFT NET – Design C_L



VESSEL

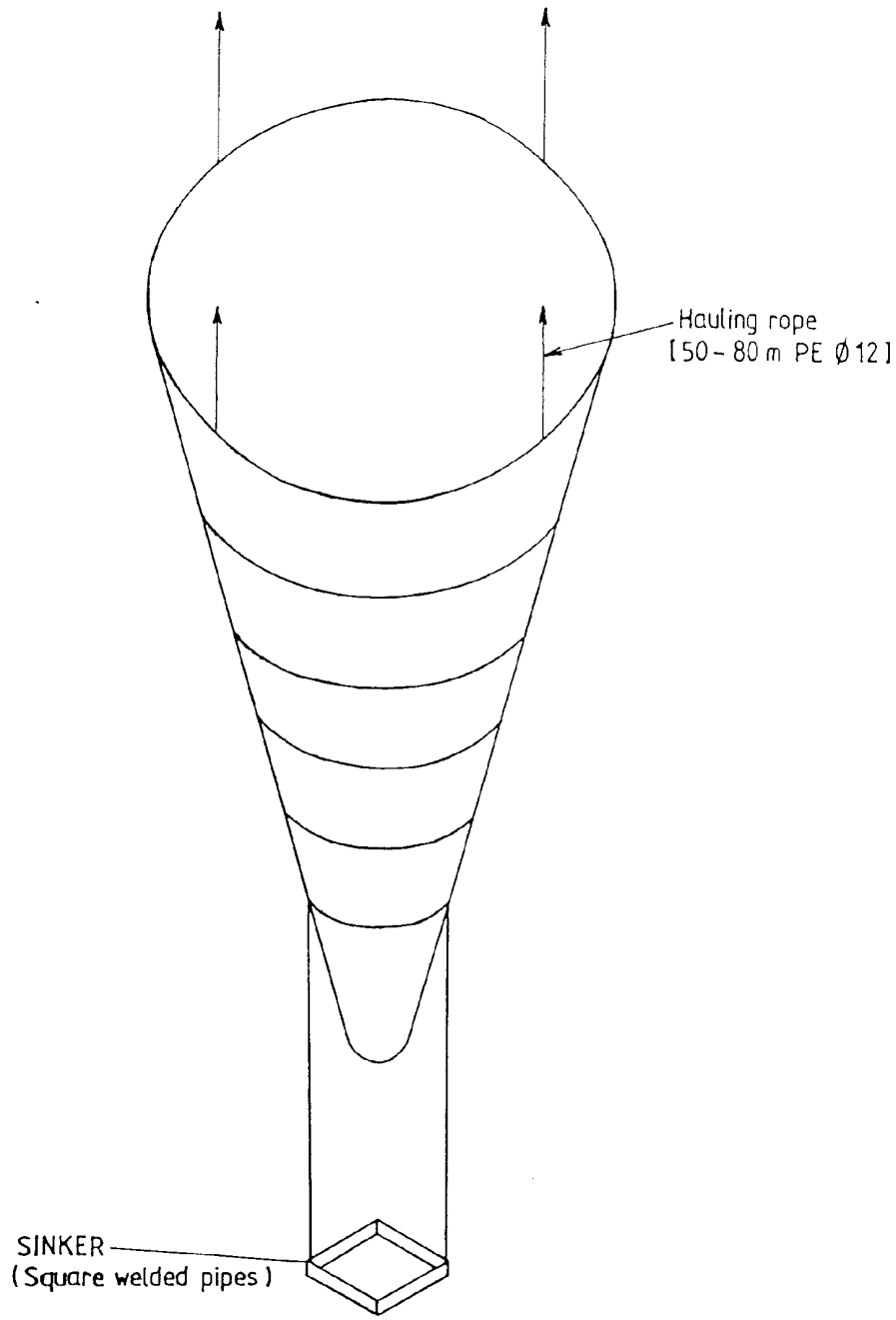
2 or 3 Plank canoes

LOA – 6.0 – 7.0 m

Beam – 1.5 – 1.6 m

PM – Paddles / OB 15 hp

Fig 3b : SKETCH FOR LIFT NET - Design C_L



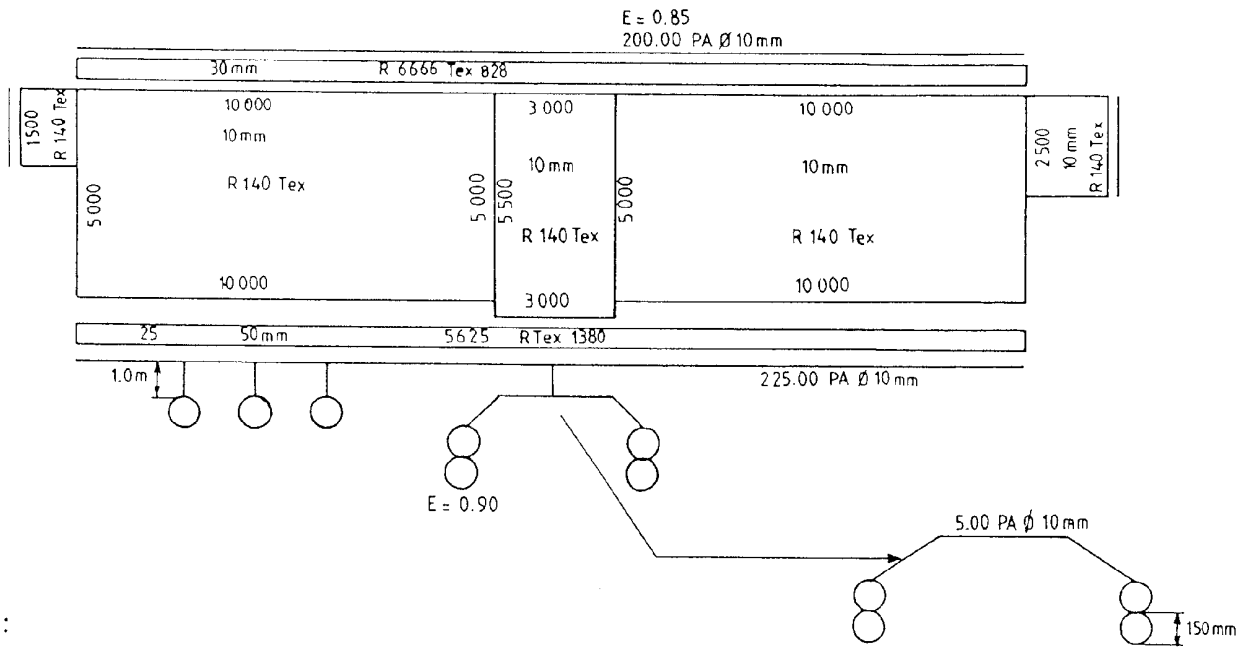


Fig 4a:

PURSE SEINE – Design A

VESSEL: LOA – 15.6m

Beam – 3.65m

HP – 115

Fig 4b : SKETCH OF PURSE SEINE - Design A

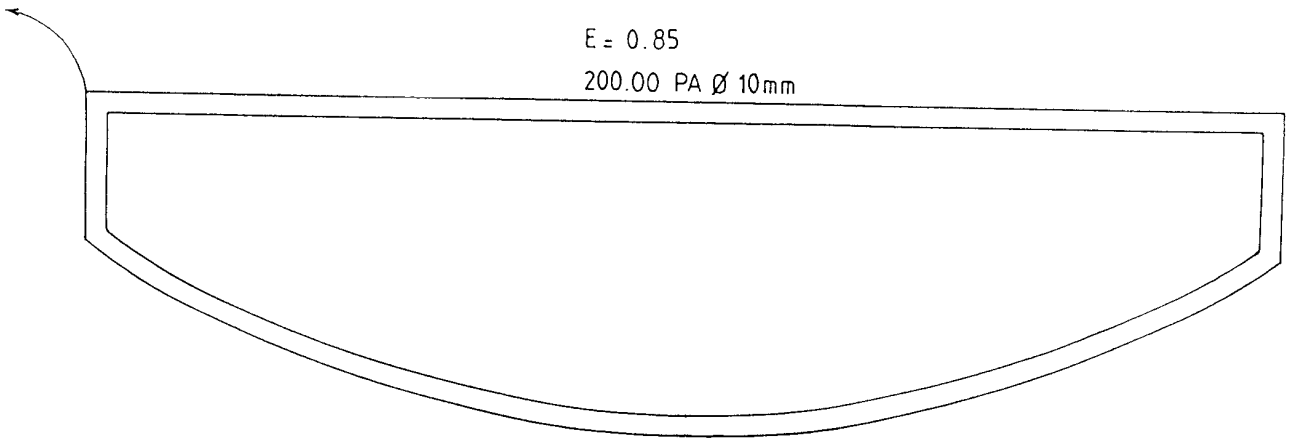


Fig 5 : PURSE SEINE – Design B

VESSEL: LOA – 15.2 m

Beam – 3.5 m

HP – 140

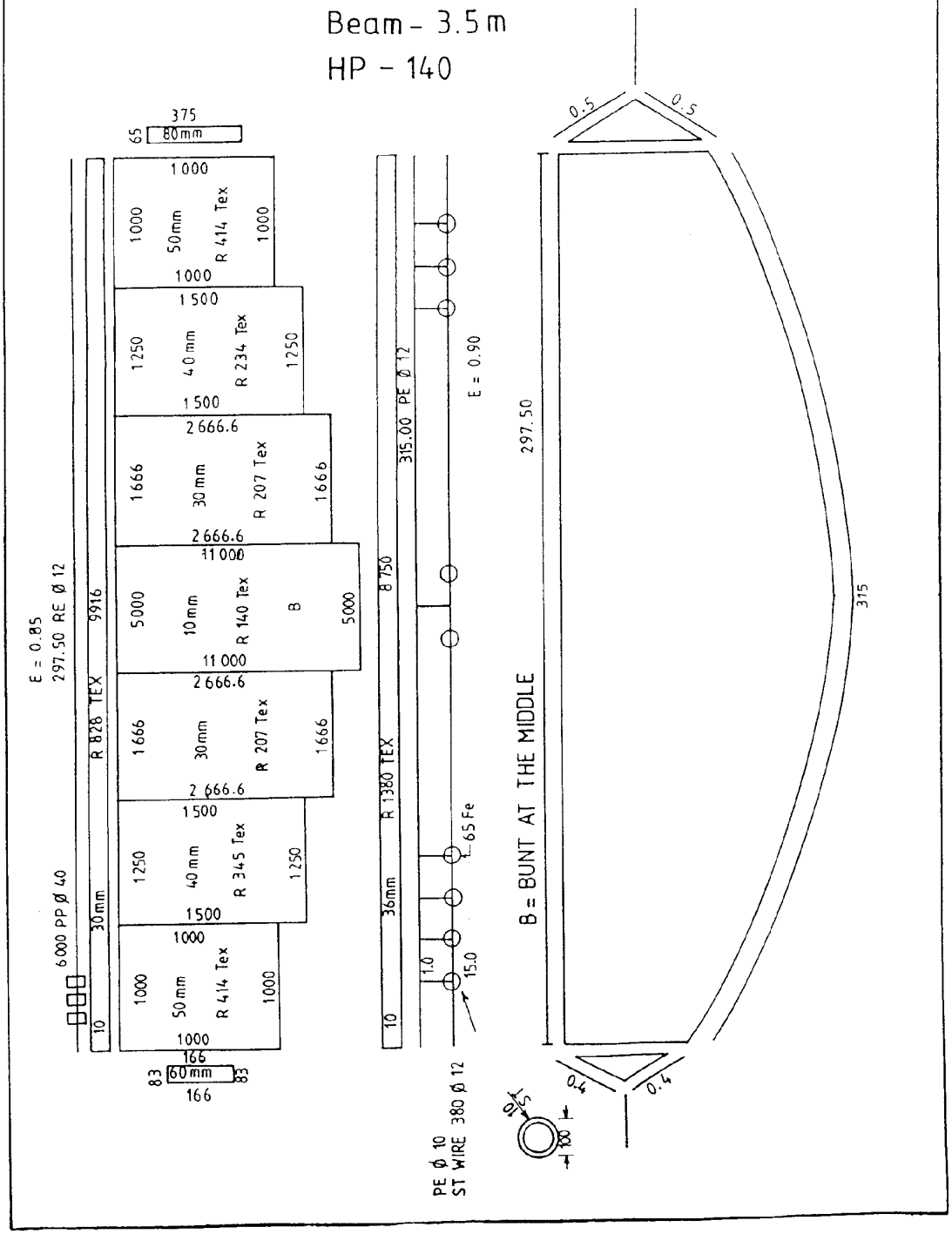


Fig 6 : PURSE SEINE – Design C

VESSEL : LOA – 12 – 15.0 m
Beam – 3.30 m
HP – 35–60
B – BUNT near the wing

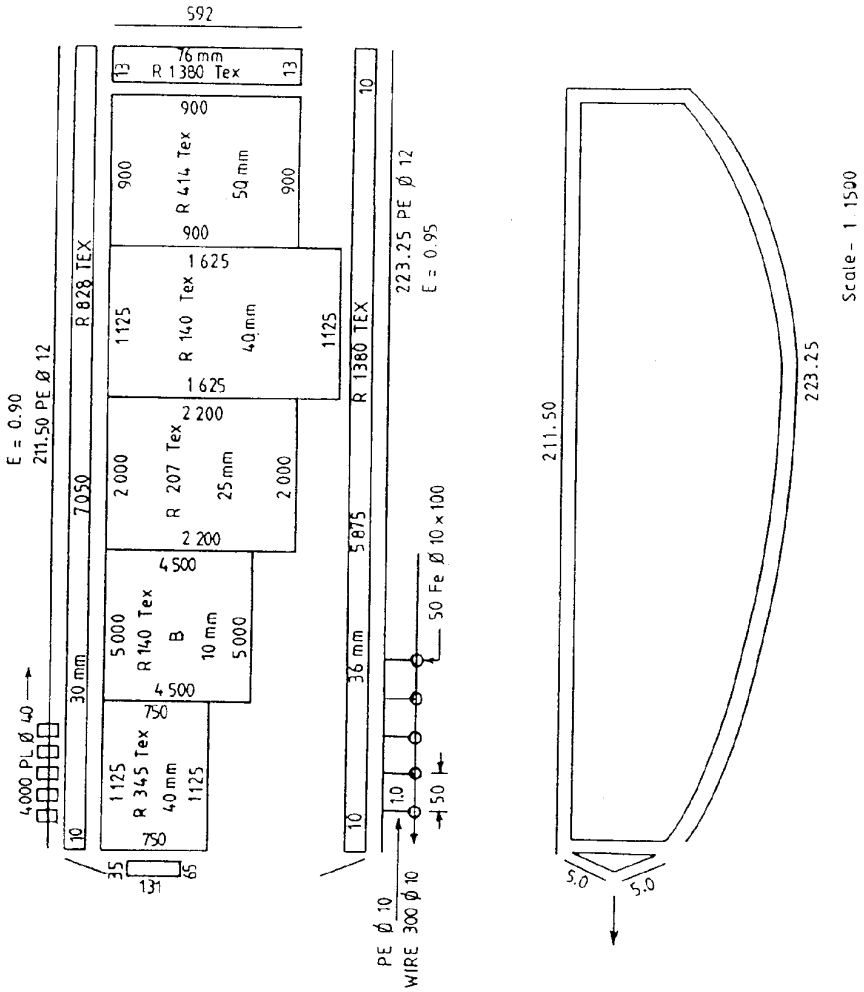


Fig 7 : Beach Seine Net (dagaa)

VESSELS

One plank canoe
LOA - 7.0m

One small canoe for light attraction
LOA - 4.0m

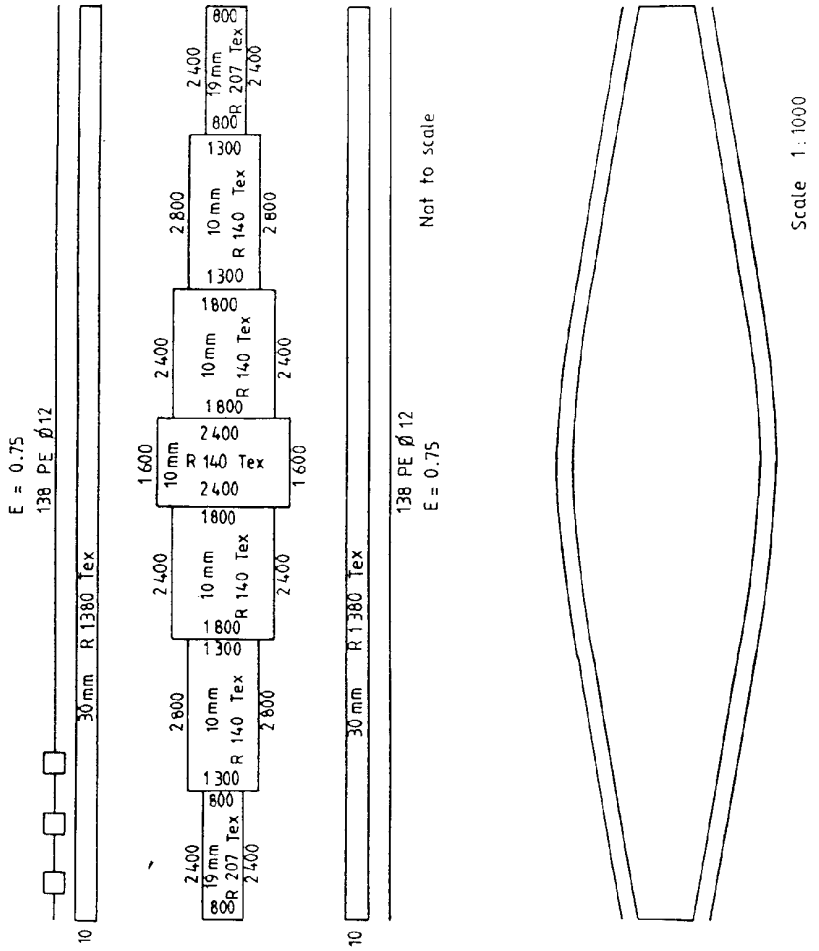
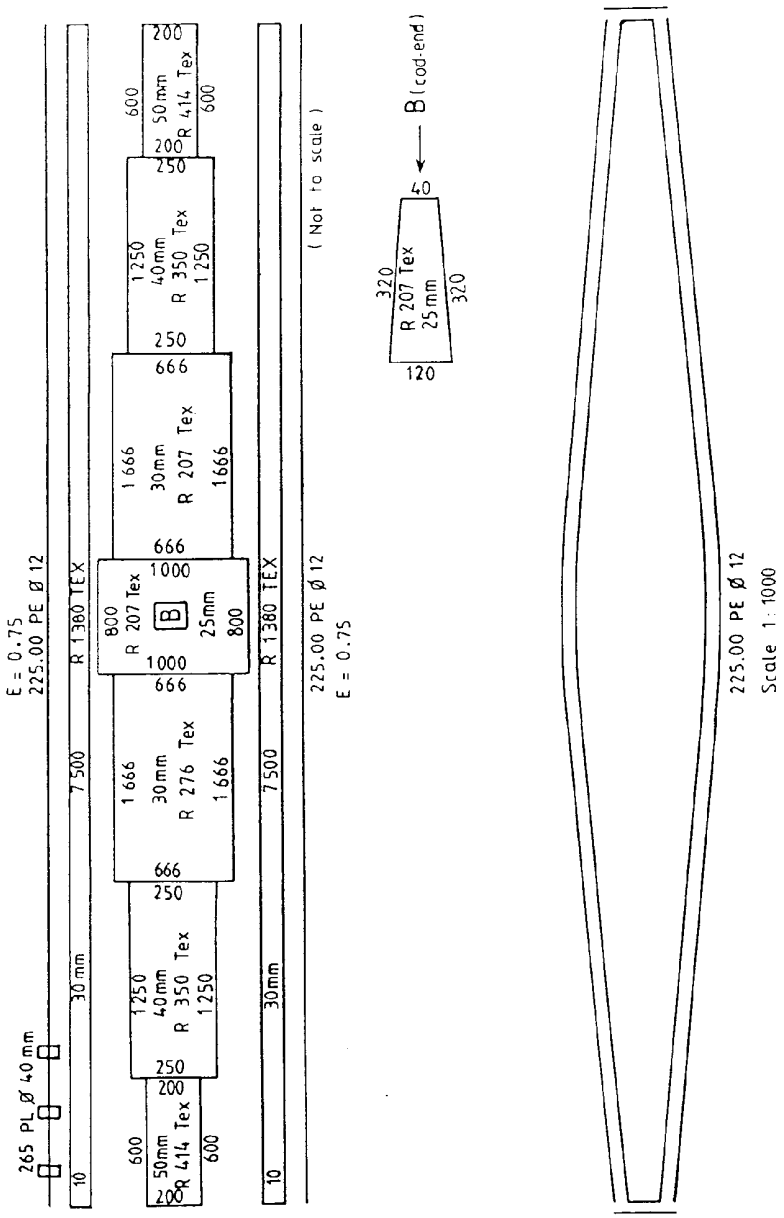


Fig 8 : Beach Seine (table fish)

VESSEL : Plank canoe
LOA – 5.5 - 6.0 m
PM-Paddles



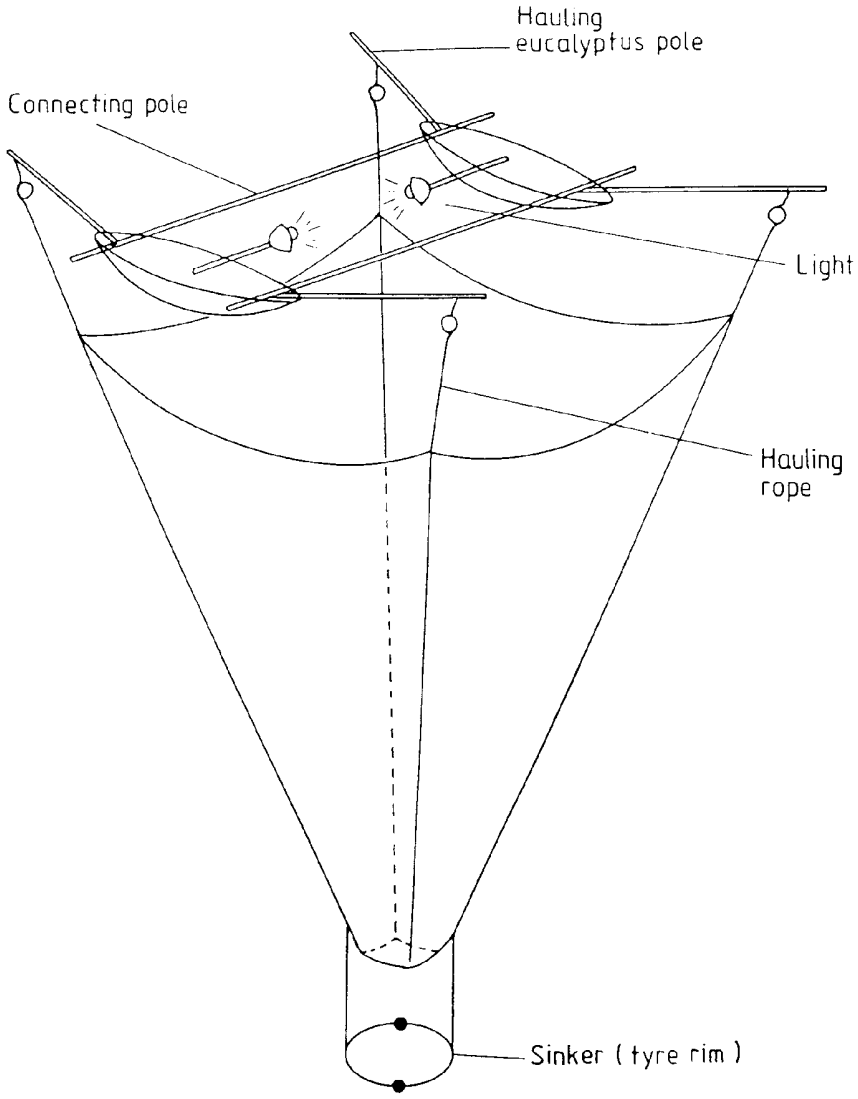


Fig 9 :

A sketch of catamaran unit in operation
with a net of 64m x 18m

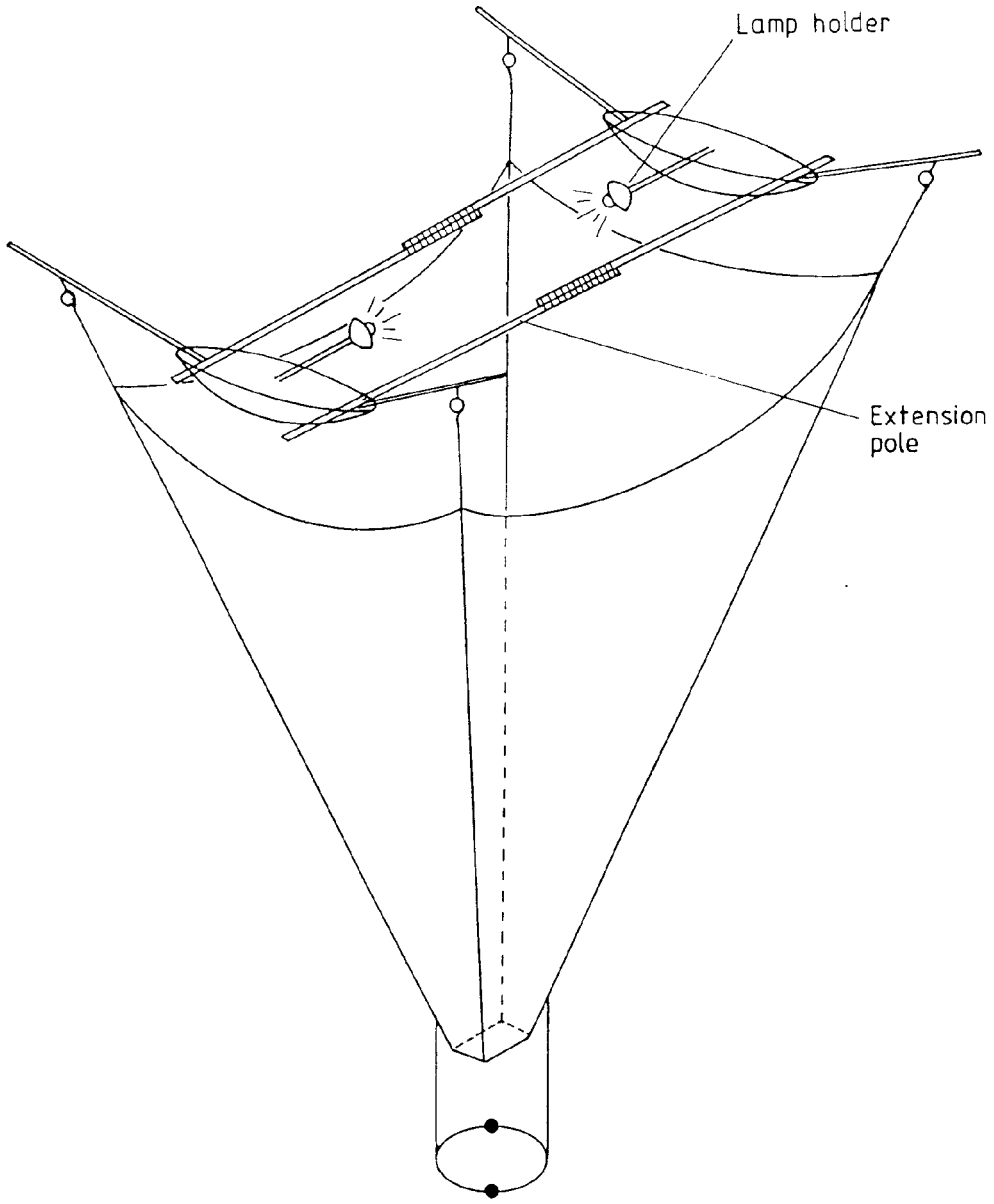
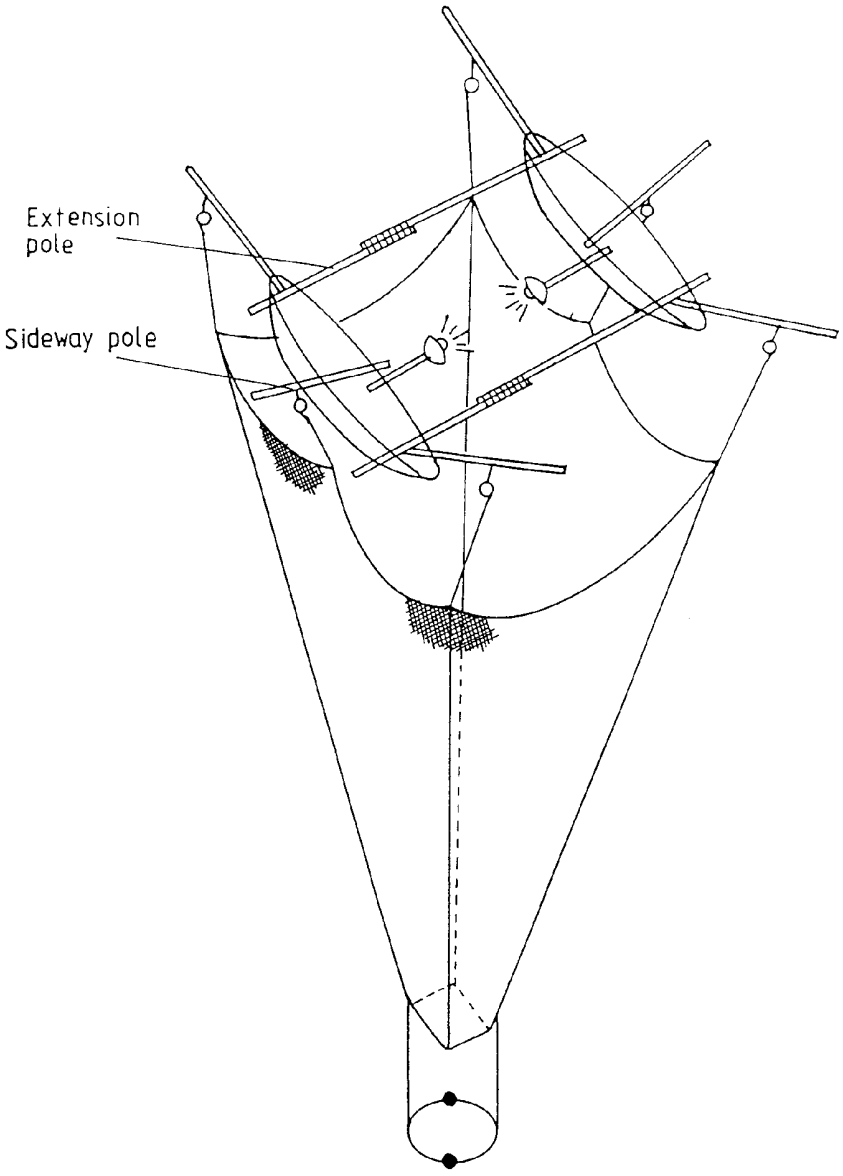


Fig 10

A sketch of catamaran unit in operation with a net of 72m x 20m

Fig 11

A sketch of catamaran unit in operation
with a net of 80-85 m × 24 m
Sideway poles are fixed on each canoe



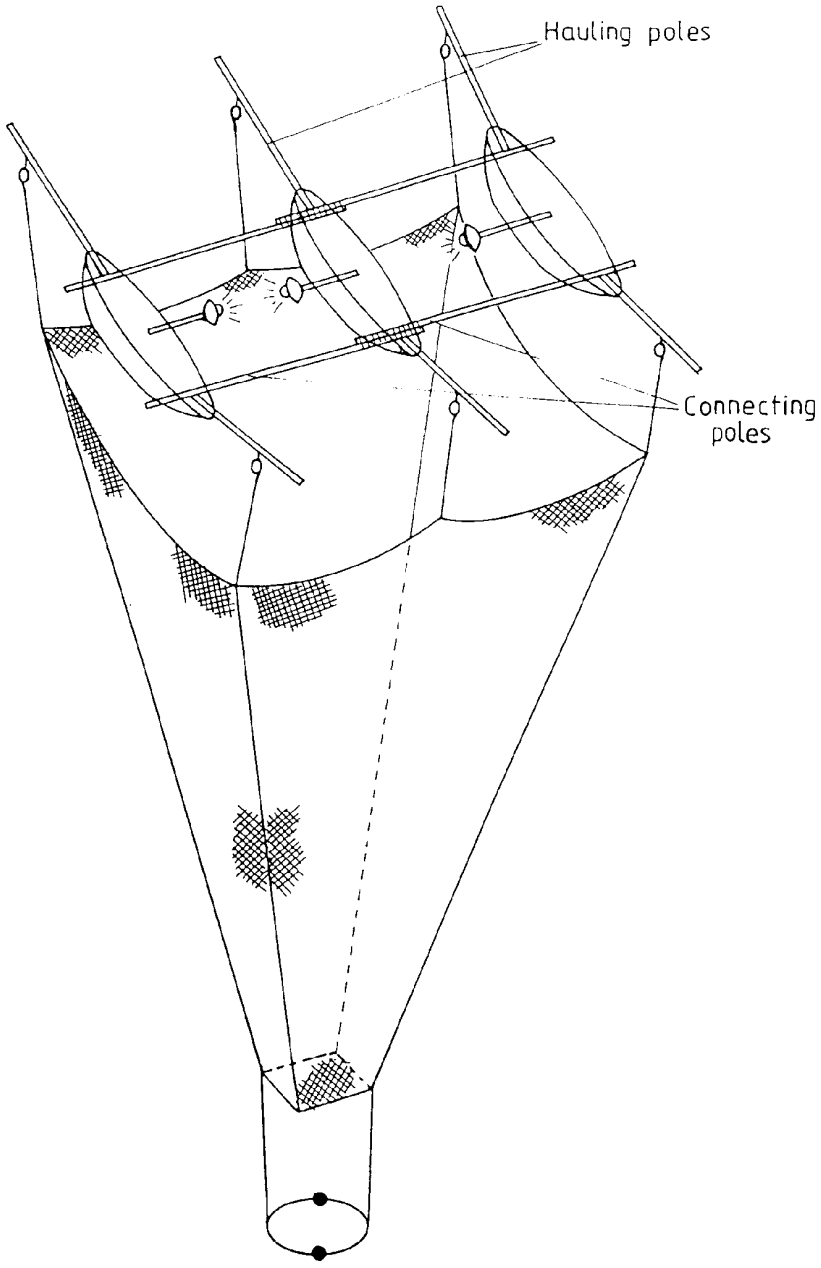


Fig.12

A trimaran unit above can be used to operate lift nets of any size from 64 × 18m – 85m × 24m

Fig.13 Scoop net

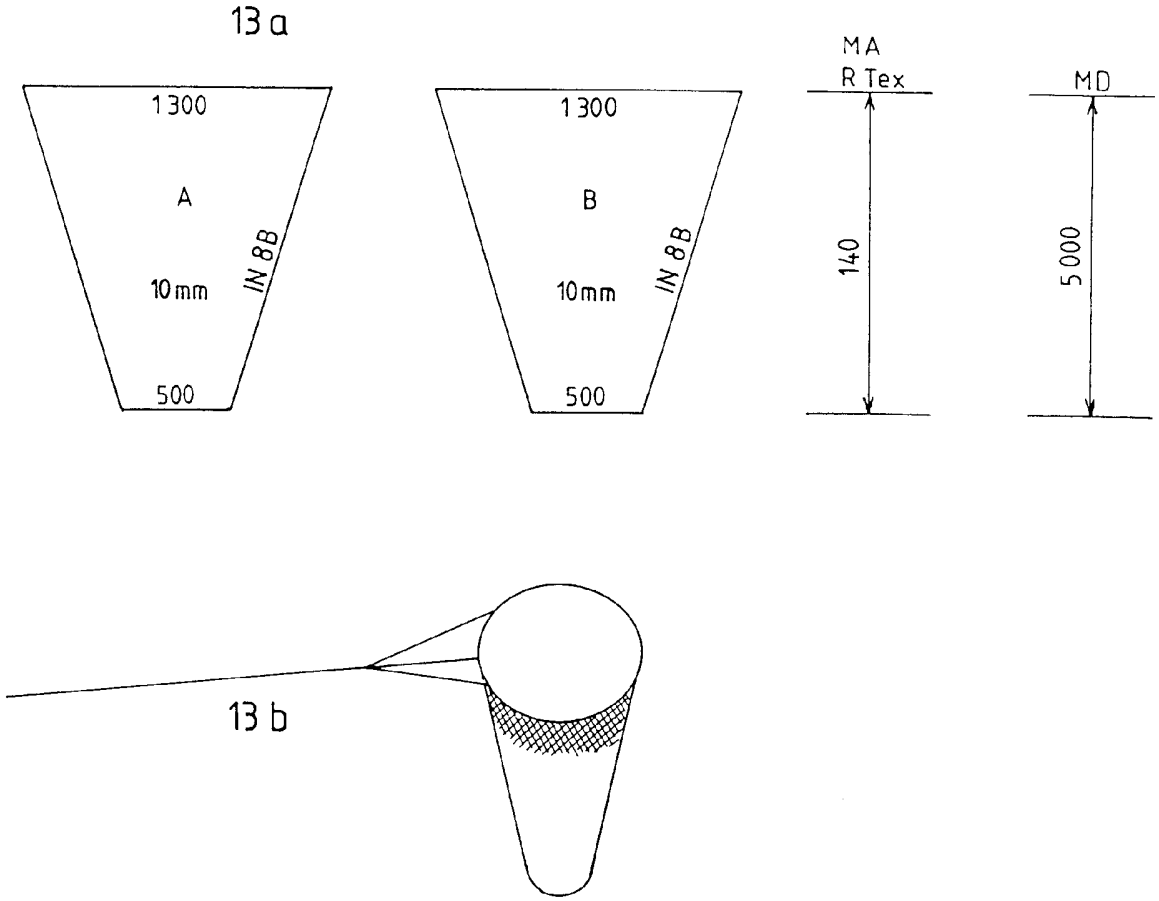


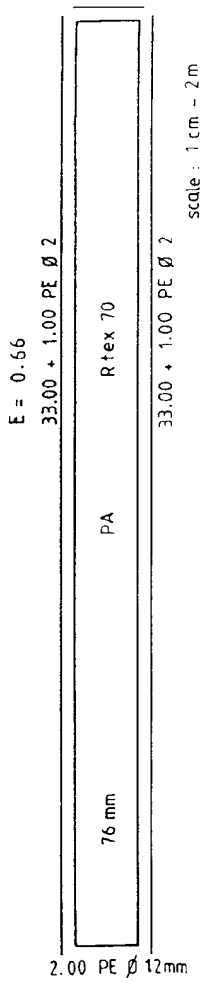
Fig 14

GILL Nets

Bottom set
Cichlids & Cat fish
Kigoma Tanzania

VESSELS

Dugout or
Plank canoes
LOA 4 - 5.0 m
PM - Paddles



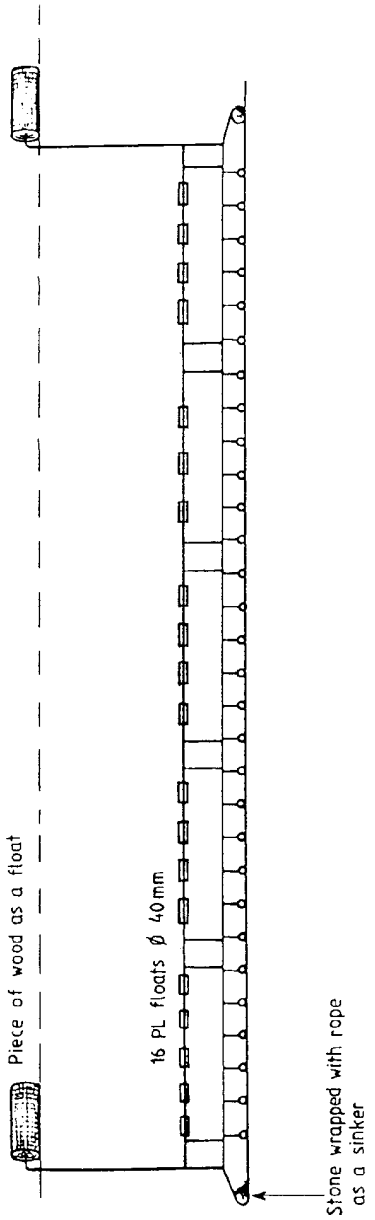


Fig. 15

Hand Line - Vertical
(Bushpa)

The line is operated along with Lift net units at night

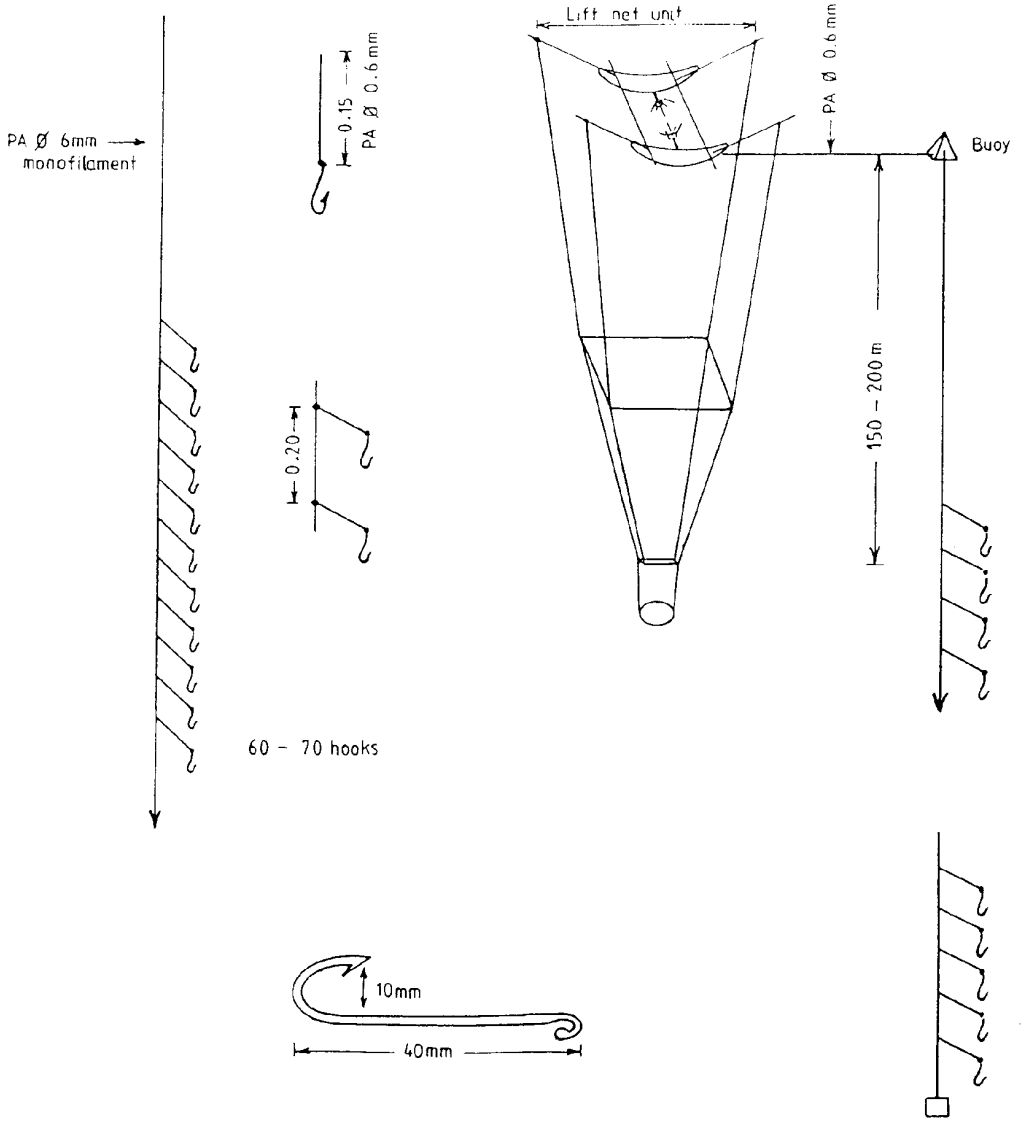


Fig. 16

Long Line
Bottom Set

VESSELS
LOA 4 - 5m
PM - Paddles

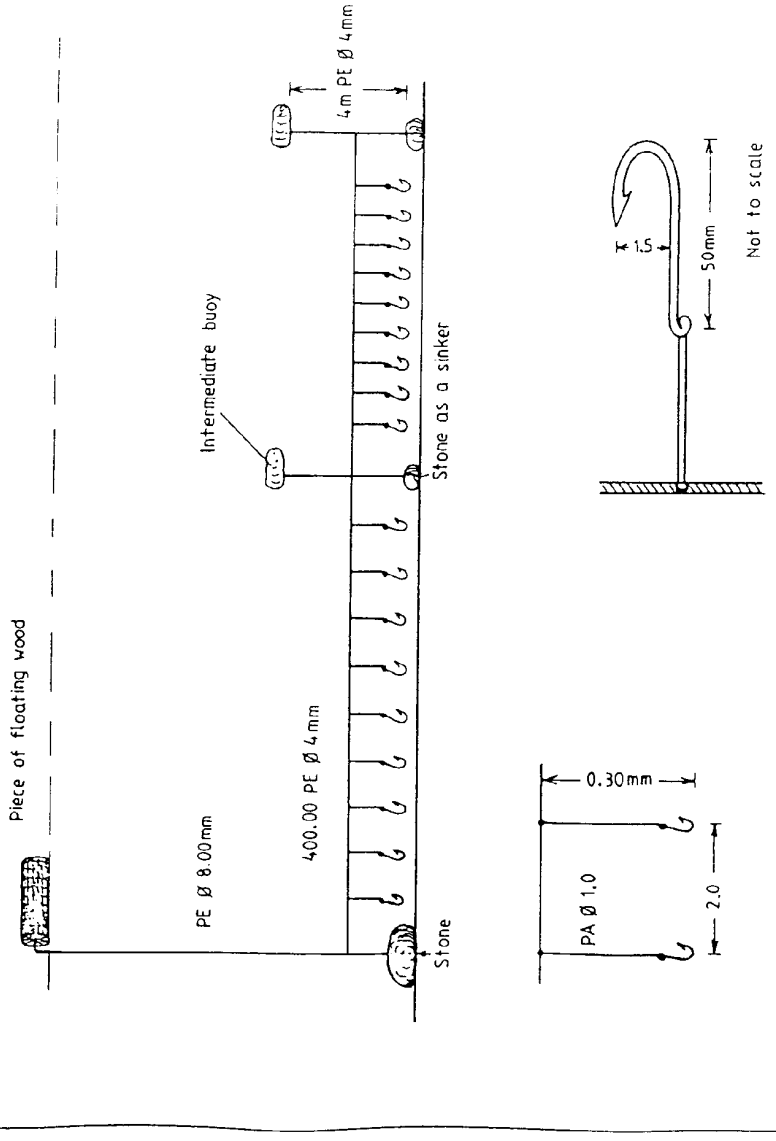
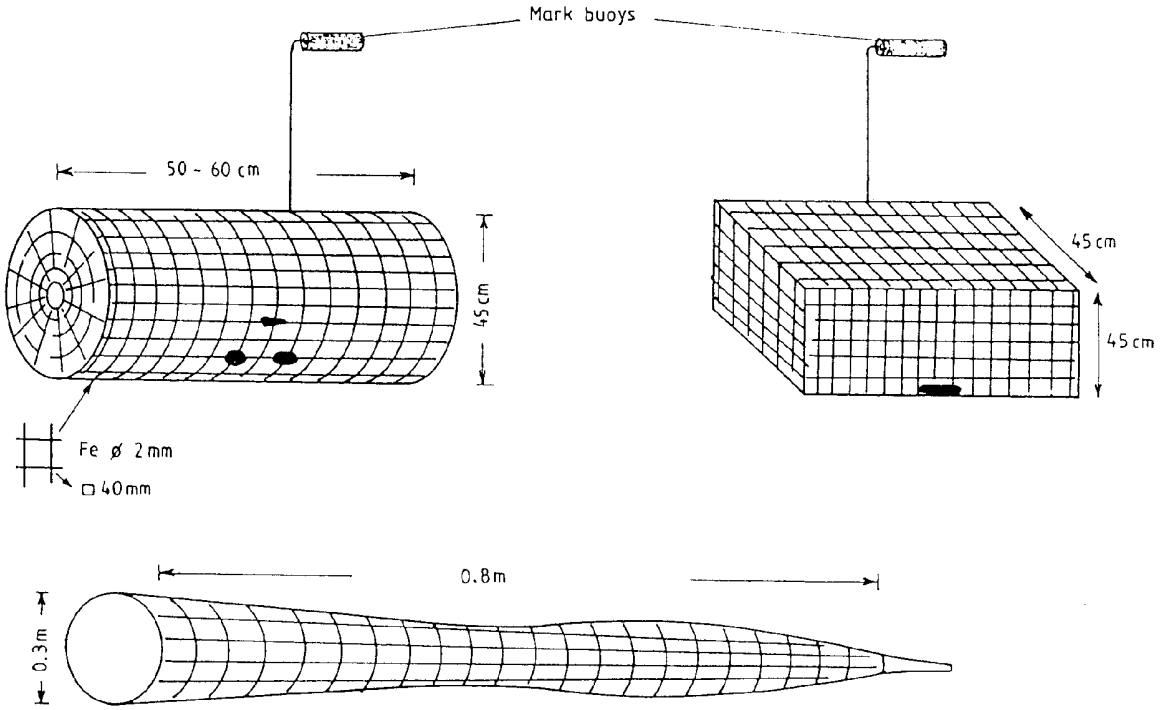


Fig. 17 TRAPS



HISTORICAL REVIEW OF WATER QUALITY STUDIES IN THE TANZANIAN PART OF LAKE TANGANYIKA (TANZANIA)

by

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ABSTRACT

Water quality investigations on the Tanzanian part of Lake Tanganyika have been carried out by short-term scientific missions and research projects since the 1930s. As such, continuous data on the subject are lacking.

Results from the above investigations show that the waters of Lake Tanganyika have high ionic concentrations but low nutrient concentrations in the surface waters. The hypolimnion is permanently anoxic and acts as a nutrient sink. Partial mixing during the dry, cool season replenishes nutrients in the photic zone from the hypolimnion. The Lake is apparently oligotrophic but has algal communities with high rates of production supporting dense populations of zooplankton and small pelagic fish.

Unique conditions and a long time of isolation of the Lake have resulted in a high degree of endemism of the organisms that have colonized the Lake.

1. INTRODUCTION

The existence and distribution of organisms in a given water body depends, to some extent, on the quality of that water. Conversely, the quality of water in a given aquatic ecosystem may determine the kind of organisms that are able to colonize it. The same determines its suitability for various uses by man.

From the above assertions, the study of water quality of a given water body is of an immense importance, especially if the quality is liable to undergo changes through natural and man-induced processes in the course of time, changes which would inevitably affect organisms that inhabit it.

From the time of the discovery of Lake Tanganyika by Europeans in the middle of last century, the diversity and uniqueness of its flora and fauna have attracted the attention of scientists. This has, in turn, led to the desire to study the Lake's water quality which should have some influence on these organisms. This paper reviews water quality work done on the Tanzanian part of Lake Tanganyika. The account is not quite exhaustive; only the works which were accessible to the authors are narrated here. An additional bibliography at the end of the paper includes the works not seen by the authors but carrying titles which seem relevant to the present topic.

2. CHRONOLOGY OF WATER QUALITY INVESTIGATIONS

Probably the first detailed study of water quality in the Tanzanian part of lake Tanganyika is that done by R.S.A.Beauchamp in 1939. He had some of the water samples analyzed in Dar es Salaam and others in London (Beachamp, 1939, 1940 & 1946).

Then followed the Belgian Hydrobiological Exploration Team on Lake Tanganyika (1946-47). The team explored the whole Lake and results on water quality were published by Capart (1952), Kufferath (1952) and Van Meel (1987, 1988).

Other scientists to study the Lake from the Tanzanian part were Tailing and Talling (1965) during the early 1960s. Further studies were done by the UNDP/FAO supported Lake Tanganyika Fishery Research and Development Project at Kigoma from 1973 to 1978 (Chapman *et al.,* 1974; van Well and Chapman, 1976) and other scientists who collaborated with the above project team (Craig, 1974; Coulter *et al.,* 1976; Hecky *et al.,* 1978).

More recently, work on water quality was further carried out in the 1980s by the Kigoma and Rukwa Water Master Plans which were concerned with clean water distribution in Kigoma and Rukwa Regions. Sources of water along Lake Tanganyika and its catchinent area were investigated for suitability as domestic water sources for rural and urban supplies. Results of these investigations have been published in a series of technical reports to the parties concerned (Governments of Tanzania and Norway, NORAD and Norconsult). However, results from Rukwa

Region were not accessible to the authors.

3. CHARACTERISTICS OF LAKE TANGANYIKA WATERS

3.1 Physico-chemical properties

3.1.1 Temperature

Surface temperatures generally range between 26—28°C. The water is permanently stratified with a thermocline around 50 m depth. But the temperature never drops beyond 23°C at the bottom (Kufferath, 1952).

3.1.2 Water current

An average of 0.4 km/h north to south current was estimated (van Well and Chapman, 1976). The current had a high speed variance; the speed was significantly higher in the wet than in the dry season but the current showed no significant difference in direction.

3.1.3 pH values

Lake Tanganyika waters are alkaline, with pH values ranging between 7.8 and 9.2 (Beauchamp, 1939; Kigoma Water Master Plan, 1982)

3.1.4 Conductivity

The Lake has a high ionic content compared to the other African Great Lakes (Beadle, 1974). Conductivities of 600—750 µS/cm at 25°C have been recorded (Kigoma Water Master Plan, 1982). Lower values are recorded around areas influenced by inflows of lower ionic contents, e.g. near the Malagarazi River.

3.1.5 Turbidity

Turbidity of the Lake water in Nepheloinetric Turbidity Units (NTU) or in equivalent Formalin Turbidity Units (FTU) is less than 10 (van Well and Chapman, 1976; Kigoma Water Master Plan, 1982)

3.1.6 Colour and visibility

Colour ranges between 5 and 10 mg Pt/l depending on season and vicinity to inflows. Secchi disk transparencies vary from about 8 m inshore to 22 m and slightly above in offshore waters. Transparency is higher during the wet season (Capart, 1952; Van Well and Chapman, 1976; Kigoma Water Master Plan, 1982).

3.1.7 Dissolved Oxygen and Hydrogen sulphide

Surface waters may be supersaturated with oxygen,that is, attain up to 9 mg 0_2/1. But oxygen content decreases with depth and reaches zero value at about 200 m depth. Beyond that depth the water contains no oxygen and is laden with hydrogen sulphide which increases with depth to reach a value of about 1.0 mg

H_2S/l (Kufferath, 1952; Van Well and Chapman, 1976).

3.1.8 Permanganate Value

Lake Tanganyika waters contain oxidizable substances giving values up to 30 mg $KMnO_4$/l (Kigoma Water Master Plan, 1982).

3.1.9 Total Hardness

Average value for total hardness is about 200 mg $CaCO_3$/l (Kigoma Water Master Plan, 1982).

3.1.10 Total Alkalinity and Phenolphthalein Alkalinity

Values for total and phenolphthalein alkalinities are about 400 mg/l and 40 mg/l, respectively, indicating that most of the carbon dioxide is present in the form of bicarbonate. The above values tend to increase slightly with depth (Van Well and Chapman, 1976).

3.1.11 Calcium and Magnesium

Lake Tanganyika contains more magnesium than calcium ions, about 40 and 15 mg/l, respectively (Beauchamp, 1939; Kufferath, 1952; Van Well and Chapman, 1976; Van Meel, 1987, 1988). This phenomenon is unusual among most freshwater bodies (Beadle, 1974)

3.1.12 Potassium and Sodium

Potassium and sodium are present in high concentrations, about 34.5 mg K/l and 68.0 mg Na/l (Beauchainp, 1939; Kufferath, 1952; van Well and Chapman, 1976).

3.1.13 Nitrogenous Compounds

Nitrate and nitrite ions are present in low concentrations in epilimnetic waters, less than 5 mg/l (van Well and Chapman, 1976; Kigoma Water Master Plan, 1982; Van Meel, 1988). Nitrate values increase slightly with depth while those of nitrite remain more or less constant. On the other hand, ammonium ions are present in the anoxic hypolimnion and increase with depth from the oxic-anoxic layer (Van Meel, 1988).

3.1.14 Ortho-phosphate and Silica

These nutrients are also present in low concentrations in surface waters, that is, about 0.01-0.04 mg $P0_4$/l and 0.1-0.8 mg $Si0_2$/l. The concentrations of these nutrients are much higher in the hypolimnion, 0.5 mg $P0_4$/l and 16 mg $Si0_2$/l beyond 500 m depth (Kufferath, 1952; van Well and Chapman, 1976).

3.1.15 Sulphate and Chloride

At all depths, these ions are more or less present in uniform concentrations. Their values are situated around 3 mg $S0_4$/1 and 27 mg Cl/l (Beauchamp, 1939; Kufferath, 1952; Van Well

and Chapman, 1976; Van Meel, 1988).

3.1.16 Iron, Copper and Manganese

Surface values of iron, copper and manganese are around 0.02, 0.05 and 0.2 mg/l, respectively. Iron and manganese tend to increase slightly with depth (Van Well and Chapman, 1976).

3.1.17 Fluoride

Surface values for fluoride seem to be constant at about 0.9 mg F/l. Only one station, Rukoma, had about twice the above value (Kigoma Water Master Plan, 1982).

3.2 Bacteriological Properties

Bacteriological properties of the waters of Lake Tanganyika were investigated by Kigoma Water Master Plan (1982) to test whether harmful bacteria were present at water sources meant for domestic supplies. Counts for total coliforms, faecal coliforms and faecal streptococci ranged from zero to over 1000 colonies per 100 ml of sample water among he stations investigated (Table
1)

4. DISCUSSION

4.1 Water Quality with Respect to Biological Production

Lake Tanganyika is permanently stratified and surface temperatures range between 25 and 28°C but local variations do exist (Capart, 1952); a maximum of 31°C was observed by Van Well and Chapman (1976) at Kigoma in March 1974. A thermocline which oscillates seasonally between about 25 and 100 m around Kigoma divides the oxic epilimnion from the essentially anoxic hypolimnion. Temperatures in the hypolimnion are more or less constant and never drop below 23°C. Being anoxic, the hypolimnion is laden with hydrogen sulphide from the oxygen limit layer. Physico-chemical properties of the Lake indicate low values of inorganic nutrients, which might limit primary production; on the other hand, high alkalinity, pH and transparency favour high primary production. Nutrients are supplied to the euphotic zone mainly from the hypolimnion sink (Hecky and Bugenyi, 1992) through the annual turn—over by strong south east trade winds that blow along the Lake from May to September causing water to pile up in the north. The thermocline then sharpens and tilts towards the north bringing about upwelling in the south. The nutrient—rich upwelled waters in the south are then transported by wind across the Lake to the north. Also changes in the wind stress induce internal waves which travel along the Lake while transporting nutrients vertically from the hypolimnion to the epilimnion.

High water transparency indicates that phytoplankton is sparse and therefore the Lake is oligotrophic. However, Hecky and Fee (1981) were struck by the high primary production rates which they ranked as “high” among lakes. Previously, the Belgian

Hydrobiological Exploration Expedition (1946-47) was also surprised to find a lot of zooplankton attracted to the light at night (Kufferath, 1952).

Due to permanent stratification and morphometry, Lake Tanganyika may be differentiated into littoral and pelagic ecosystems. The littoral ecosystem largely embraces the benthic communities which are limited to the narrow oxygenated bottom strip around the Lake, characterized by steep and rocky shores, interrupted by small riverine plains with marshy, muddy and sandy beaches. These offer a variety of biotopes (Kufferath, 1952) which are colonized by a remarkably diverse endemic fauna showing special features that, together with the high ionic contents of the Lake, convinced early workers on the Lake to believe that the Lake had a marine connection in the past (Kufferath, 1952; Leloup, 1952; Beadle, 1974).

The pelagic ecosystem is characterized by the life-bearing oxic layer, about 200 m deep, and the extensive anoxic hypolimnion descending to more than 1000 m (Capart, 1949 & 1952; Kufferath, 1952). The oxic layer supports phytoplankton which has a high production rate and is rich in species, over 300 (Brichard, 1978; p. 21), especially those of Chrysophyceae in which the Lake leads among tropical lakes (Hecky, 1991).

Energy transfer across trophic levels suggests that fish production (accounted for largely by the small endemic clupeids) cannot be supported by primary production alone (Hecky and Fee, 1981; Hecky *et al.,* 1981). Other sources have been suggested to supplement energy to the system, e.g. chemoautotrophic processes at the oxic-anoxic interphase (Rudd, 1980; Hecky and Fee, 1981; Hecky *et al*., 1981).

4.2 Water Quality in Hygienic Perspective

When comparing data in chapter 3 and Table 2, it can be concluded that, from the physico-chemical point of view. Lake Tanganyika waters fall under acceptable drinking water standards. But from the bacteriological point of view (Tables 1 and 3), the fact that faecal coliforms appear in the Lake water samples implies contamination at various levels by human faeces. Thus, water directly drawn from the Lake may not be safe for drinking without prior treatment. Luckily, if the water is made to stand for several days in a covered container, the bacteria die off almost completely, an exception being *Klebsiella pneumoniae,* a human pathogen which may actually multiply in certain environments (Kigoma Water Master Plan, 1982). In this regard, treatment of water by boiling is advised. As the faecal bacteria originate from human faeces, the most reliable step to make the Lake water safe for drinking would be strict use of toilets (pit latrines) by riparian human communities, such that faeces do not find contact with Lake water either directly or through land wash—offs during the rainy season. Otherwise, Lake Tanganyika is potentially a very large drinking water reservoir for the riparian population.

In the Tanzanian part of Lake Tanganyika no work has been done on monitoring the effect of agro-chemicals on the Lake. With increasing use of these chemicals in the effort to raise food and cash crop production for sustenance of the growing riparian population, it is likely that bioaccumulation of the chemicals could reach lethal levels in top predators in the Lake. This needs investigation now. Perhaps the more direct impact of the riparian population is the land clearing practice in subsistence agriculture. This results in deforestation with consequent increase in sediment loads entering the Lake. Suspended matter is not only likely to alter the drinking qualities of the water but also to affect some organisms, especially filter feeders in the littoral zone.

Lake Tanganyika serves as a transport medium among its riparian states. One of the cargoes that could threaten the quality of the Lake water is petroleum and its products. Oil prospecting is being carried out in the Ruzizi and Malagarasi plains. Should oil drilling be successful, it would increase chances of oil spills into the Lake. Dangers of pollution , such as oil spills, have been reported by Coulter (1991 & 1992) to have irreversible effects on the Lake because of the latter's long water residence time.

At present there are no industries and their associated fouling or toxic discharges on the Tanzanian part of Lake Tanganyika, but some oil may be spilling into the Lake at the Kigoma Oil Siding during the filling of small tankers which take fuel to Burundi and Zaïre and also during fueling and waste oil discharges of water vessels that ply between Burundi, Tanzania and Zambia ports. In calm weather, a slight oil film may be seen on the surface of the water at the port. There exists also a little waste oil discharge entering Kigoma Bay at the Tanzania Electric Supply Company (TANESCO) plant environs. This seemingly insignificant pollution ought to be checked as it could lead to dangerous accumulation with time.

Although Lake Tanganyika waters on the Tanzania part may need slight treatment for bacteriological contamination, they are generally of good quality (Water Master Plan, 1982). The waters are largely threatened by cumulative pollutants such as non degradable pesticides and herbicides. These chemicals need careful administration to keep them out of reach of the Lake water.

5. ACKNOWLEDGEMENTS

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Table 1. Bacteriological properties of waters adjacent to settlements along Lake Tanganyika, Tanzania

Station	Date	TVC[1] / lOOml	TC[2] / 100 ml	FC[3] / 100 ml	FS[4] / 100 ml
Ilagala	17.3.81	-	35	32	25
Kagunga	23.3.81	-	130	60	140
Kapala-msenga	17.2.81	-	20	16	40
Kigalye	24.3.81	-	20	2	2
"	"	-	10	10	20
"	"	-	2	2	2
Kigoma	19.6.80	-	11	2	1
"	27.7.80	18	2	2	2
"	29.7.80	7-37	<2-10	<2-2	<2-2
Kirando	18.3.81	-	190	150	50
Mwamgongo	24.3.81	-	30	30	30
Rukoma	17.3.81	-	<2	<2	<2
Sigunga	18.3.81	-	>1000	340	290
Sunuka	18.3.81	-	100	100	80
Zashe	23.3.81	-	400	500	>500

[1]Total viable counts
[2]Total coliforms
[3]Faecal coliforms
[4]Faecal streptococci

Source: Modified from Kigoma Water Master Plan, Final Report, Volume 9, Table 9-2.2, 1982

Table 2. Some physico-chemical international standards for drinking water

Group	Parameter	Unit	Criterion
P	pH-Value	-	6.5—9.2
P	Total Hardness	mg $CaCO_3$/l	600
P	Sulphate	mg $S0_4$/l	600
P	Chloride	mg Cl/l	800
P	Colour	mg Pt/l	50
P	Turbidity	mg $Si0_2$/l	30
P	Taste	-	n. o
P	Odour	-	n. o
P	Iron	mg Fe/l	1.0
P	Manganese	mg Mn/l	0.5
P	Copper	mg Cu/l	3.0
P	Zinc	mg Zn/l	15.0
H	Fluoride	mg F/l	8.0
H	Nitrate	mg $N0_3$/l	100
T	Lead	mg Pb/l	0.1
T	Cadmium	mg Cd/l	0.05
T	Arsenic	mg As/l	0.05
T	Chromium VI	mg Cr/l	0.05
T	Cyanide	mg CN/l	0.02

n.o = unobjectionable
P = substances that may affect the palatability of drinking water
H = substances that may affect human health
T = substances which may be toxic

Source: Kigoma Water Master Plan, Final Report, Volume 9, Table 9—2.2, 1982

Table 3. Some bacteriological drinking-water standard quality criteria

Class of water	Type of test Coliform count per 100 ml at 37°C	Type of test *E. coli* (faecal coliform) count per 100 ml at 44°C
Excellent	0	0
Satisfactory	1-3	0
Suspicious	4—10	0
Unsatisfactory	>10	1

Source: Kigoma Water Master Plan, Final Report, Volume 9, Table 9—2.2, 1982

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