A project funded by the United Nations Development Programme/Global Environment Facility (UNDP/GEF) and executed by the United Nations Office for Project Services (UNOPS)

Fishing Practices Special Study (FPSS)
Final report

Fishing Gears of Lake Tanganyika at the turn of the Millennium.

PART A

Date of Issue: June 2000

Pollution Control and Other Measures to Protect Biodiversity in Lake Tanganyika (RAF/92/G32)

Lutte contre la pollution et autres mesures visant à protéger la biodiversité du Lac Tanganyika (RAF/92/G32)

Le Projet sur la diversité biologique du lac Tanganyika a été formulé pour aider les quatre Etats riverains (Burundi, Congo, Tanzanie et Zambie) à élaborer un système efficace et durable pour gérer et conserver la diversité biologique du lac Tanganyika dans un avenir prévisible. Il est financé par le GEF (Fonds pour l'environnement mondial) par le biais du Programme des Nations Unies pour le développement (PNUD)"	The Lake Tanganyika Biodiversity Project has been formulated to help the four riparian states (Burundi, Congo, Tanzania and Zambia) produce an effective and sustainable system for managing and conserving the biodiversity of Lake Tanganyika into the foreseeable future. It is funded by the Global Environmental Facility through the United Nations Development Programme.

NRI

GEF

MRAG

Institute of Freshwater Ecology

By:
Mr Robert Lindley, FPSS Regional Facilitator
MRAG, 47 Prince's Gate, London SW7 2QA

Acknowledgements

The work of the teams of the Fishing Practices Special Study is gratefully acknowledged as having formed the basis of much of the information given in this report. The support and assistance of the staff of the various Fisheries Departments, and of the LTBP administrative and field staff was also extremely useful in assisting the study, particularly that of the Administrative Assistants; Bahati Barongo (Kigoma), Mamert Maboneze (Bujumbura) and Clement Mwelwa (Mpulungu): the Regional Facilitators of the other three Special Studies; Mr Olivier Drieu – Sedimentation Special Study; Ms Karen Zwick – Socio Economic Special Study and Mr Richard Paley – Biodiversity Special Study. Dr Kelly West, the Scientific Liaison Officer and Jerod Clabaugh, the LTBP Technical Officer also materially assisted greatly in smoothing the road and sorting out administrative and technical matters. Ms Vicki Cowan, the FPSS Co-ordinator at MRAG in UK provided continual support and encouragement, as well as assisting with editing and content of this report.

FPSS 1999/2000 Country Participants:

Fishing Practices Study Members – Burundi	
Antoine Kiyuku	Title: Fisheries Consultant Address: B. P. 335, Bujumbura, Burundi
Bernard Sinunguka	Title: Conseilleur – Departament de Peche, BP 1119, Bujumbura, Burundi

Fishing Practices Study Members - D. R. Congo	
Mr. N'sibula Mulimbwa	Title: Fishing Practices Coordinator - D. R. Congo & Scientific Director, CRH Address: Centre de Recherche en Hydrobiologie (CRH), Uvira.
Mr. Bahane Byeragi	Title: Technician Address: Centre de Recherche en Hydrobiologie (CRH), Uvira.
Mr. Nyiringabi Mateso	Title: Technician Address: Centre de Recherche en Hydrobiologie (CRH), Uvira.
Mr. Wa Ombo Muyenga	Title: Technician Address: Centre de Recherche en Hydrobiologie (CRH), Uvira.
Mr. Mkila Mwendanababo	Title: Technician Address: Centre de Recherche en Hydrobiologie (CRH), Uvira.
Mr. Mayembe Milenge	Title: Technician Address: Centre de Recherche en Hydrobiologie (CRH), Uvira.

Fishing Practices Study Members – Tanzania	
Mr. Omari Kashushu	Title: Ordinary Seaman Address: TAFIRI, P. O. Box 90, Kigoma
Mr. Hamza Mabochi	Title: Community Development Officer Address: District. Community Development Office, PO Box 530, Kigoma

Fishing Practices Study Members – Zambia	
Mr Leonard Mwape	Title: Director of Mpulungu Fisheries Address: Dept. of Fisheries, P. O. Box 55, Mpulungu.
Mr Robert Sinyinza	Title: Research Officer Address: Dept. of Fisheries, P. O. Box 55, Mpulungu.
Mr. Whiteford Chomba	Title: Asst. Fisheries Technician Address: Dept. of Fisheries, P. O. Box 55, Mpulungu.

Abbreviations

Rtex	Resultant tex
%	Percent
“	Inch
©	Copyright
210d/6	6 strand of 210 dernier twine
8000/=	Eight thousand Tanzanian Shilling
BIOSS	Biodiversity Special Study (of LTBP)
CAS	Catch Assessment Survey
CF	Congo Franc
Cm	Centimetre
d	dernier
DRC	Democratic Republic of Congo
DSM	Dar es Salaam
FAO	Food And Agriculture Organisation (of the UN)
Fbu	Burundi franc
fe	Iron
Fe	Iron
FINNIDA	Finnish Development Agency
FPSS	Fishing Practices Special Study
FS	Frame Survey
ft	Feet
gms	Grammes
HP	Horsepower
hrs	Hours
kg	Kilograms
lb	Pound
LTBP	Lake Tanganyika Biodiversity Project
LTR	Research for the Management of the Fisheries on Lake Tanganyika (a FINNIDA/FAO project).
m	Meters
Md	Mesh deep
N	North
NGO	Non Governmental Organisation
NZ	New Zaire (~2,000,000 = 1US$ April 2000)
Ø	Diameter
PA	Polyamide (Nylon)
PB	Lead
PE	Polyethylene
PES	Polyester
PO Box	Post Office Box
PP	Polypropylene
PRA	Participatory Rural Appraisals
RRA	Rapid Rural Appraisal
Rub	Rubber
SESS	Socio-Economic Special Study
ss	Stainless steel
T	Tonne = 1000kg
Tsh	Tanzanian Shilling (800 = 1$US May 2000)
™	Trade mark
yds	Yards
ZK	Zambian Kwacha

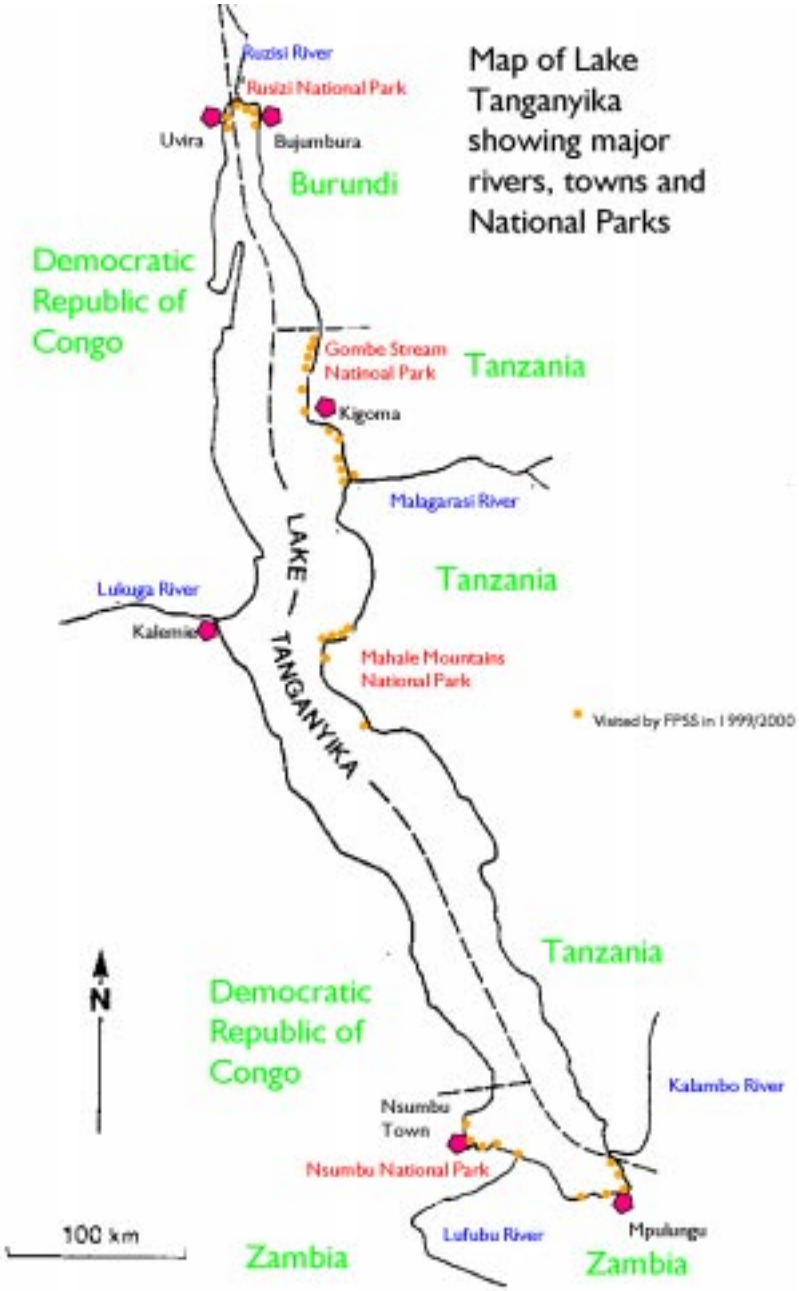
Report Structure

This report is divided into three parts, as follows

Part A: Overview (both English and French language versions available)
Part B: Detailed Gear Descriptions
Part C: Appendices

Table of Contents for Part A

Lake Tanganyika



1. INTRODUCTION

As part of the Lake Tanganyika Biodiversity Project (LTBP) the Fishing Practices Special Study (FPSS) in 1999 & 2000 undertook studies in Democratic Republic of Congo, Burundi, Zambia and Tanzania on the fishing methods & gears employed in the fisheries of Lake Tanganyika. The Fishing Practices Special Study had been active previously, undertaking a series of Participatory Rural Appraisals in Zambia and Tanzania with the Socio-Economics Special Study, between 1996 and 1997; and again in 1998/9 when preliminary studies on a variety of subjects were undertaken in all 4 countries round the lake. Other work covered by the FPSS in 1999/2000 included studies on Fishing near National Parks, and a survey of the capabilities of Fisheries Departments of the four countries to monitor and control fisheries in the lake. These topics are covered in separate reports produced by FPSS in 2000.

The results of the surveys of fishing practices form the basis of this report.

1.1 Fishing Practices in Lake Tanganyika

This report concentrates on fishing gears that are used by small scale artisanal & subsistence fishermen. These are of particular interest to this study as these fishermen's grounds are the biodiverse littoral zone of the lake, the main focus of the project.

The fishermen in the small scale commercial and subsistence fishery target any and all species, at whatever stage of maturity, that are accessible to their gears. Without motors on their canoes, and desperately poor in financial resources, they are generally able only to operate simple gears in the near margins of the lake and in shallow waters. Unfortunately these same areas are those rich in biodiversity, and contain the majority of the endemic cichlids and other species of the lake, so highly valued by biologists and taxonomists studying Lake Tanganyika's biodiverse resources.

The main fishery on Lake Tanganyika is for the two species of sardine *Stolothrissa tanganicae* and *Limnothrissa miodon*, and a pelagic fishery for *Lates stappersii*, a perch like predator of the sardines, however those gears targeting sardines and other pelagic fish were not studied in particular depth by the FPSS in 1999/2000. The fishermen targeting sardines have been exhaustively studied by others, particularly the Lake Tanganyika Research [project] (LTR) and its predecessor projects; which have spent the best part of half a century developing and researching the various aspects of the commercial fisheries of the lake[1].

Due to security considerations it was not possible to survey the gears on the whole coastlines of Congo and Burundi, but it was possible to make a detailed study of the northern part of the lake, close to Bujumbura and Uvira. During most of this period there was "no fishing" in Burundi imposed by the security forces, which limited the amount of work that could be done. The Northern Area of the lake, north of $3^{o}30'S$,, which was surveyed by FPSS in 1999/2000, is characterised by relatively shallow waters and the Rusizi Delta, which has caused large areas of littoral and sub-littoral[2] muddy and sandy bottom to be created. There are swamps and lakes near the main lagoon in the Rusizi delta, and the banks of Lake Tanganyika itself in this area are frequently characterised by reed beds and small streams running into the lake. In many ways this area of the lake is not representative of the rest of the lake, and the characteristic habitats influence the types of fishing that can be carried out there, and the gears reflect this.

In Tanzania the coast has been surveyed quite regularly, and it was possible to incorporate some of this data into the study, as well as implementing a brief gear survey in the Kigoma district. The majority of the work undertaken in Tanzania consisted of a listing of the fishing

[1] The work of the FAO/FINNIDA project "Research for the Management of the Fisheries of Lake Tanganyika" covers the pelagic fishery in great detail and overlaps into the littoral zone in many areas. The published works of this project provide a good background to the commercial fisheries of the lake and are recommended further reading.

[2] According to Coulter (1992) "Littoral" = <20m depth. "Sub-littoral" = 20 – 50m depth.

gears in use, coupled with the analysis of two years of catch and effort data and gear selectivity data.

Zambia has again been well surveyed in the past, though these surveys have tended to concentrate on the larger, and more visible gears. FPSS resurveyed in 1999/2000, based on habitat, so as to find the many different types of gear in use there. This coupled with the existing data gives a reasonable picture of the fishing practices in this part of the lake.

Over 50 fishing gears are documented in this report. Of these, the following 12 are most significant in terms of management; the list below provides a brief explanation of each of the 12 most important. Full descriptions of all the gears can be found later in the text.

1. **Industrial purse seine** - used in the industrial fishery offshore (Zambian DoF figures indicate that this fishery takes 4-5,000 tons/year, roughly 2.5% of the total of the whole lake fishery[3])
2. **Light assisted beach seine** - targets sardines that are attracted to kerosene pressure lights at night. Usually has 8mm or 10mm mesh throughout. This gear can also be used in the day and not much escapes due to the mesh size. Banned in Tanzania (enforcement difficult). Each beach seine can employ as many as 20 people, including light boat crews and net pullers.
3. **Beach seine** - catches & targets littoral fishes (Can be used day or night). Usually has a larger mesh in the wings than in the bunt or bag. Banned in Tanzania (enforcement difficult).
4. **Ring net** - "Chirimila" seine as used in Zambia in Nsumbu region. Used offshore at night with lights for sardines
5. **Bottom set gill net** - set net, various mesh sizes and depths. Ubiquitous. Cheap. All countries have some mesh size restrictions.
6. **Encircling gill net** - m'timbo or splashing water or tam tam. Like a gill net but deeper and used in a circle with draw lines from a boat with a frightening device. Catches different fish from the bottom set gill nets. Different mesh sizes for night and day. Banned in all 4 countries of the lake with enforcement only active in Zambia.
7. **Lift nets** - which can be one, two or three boat. Each boat employs roughly 6 crew members and LTR estimated 3,200 boats acknowledging that this is likely to be an underestimate. A large percentage of the catch of the lake is hauled by this gear – giving it a very high value in the region. Investment needed to set up a lift net operation is substantial.
8. **Simple lines** - which includes vertical hand lines. Used everywhere round the lake. Baited hooks, targeting fish on or near the bottom
9. **Jigged lines** - mainly for *Lates stappersii*. With 50 or more hooks. Used during the day in deep waters. Not baited. Very important for the economy of some villages, particularly north Tanzania. Found all round the lake as a subsistence activity.
10. **Bottom set long lines** - which are lines with 40–400 baited hooks, which are laid along the bottom from a boat. Used everywhere where there is a snag free bottom substrate.
11. **Pole and line** - used mainly by children fishing the margins of the lake. Very important in terms of contribution to protein in the household diet, and to biodiversity in that there are vast numbers of them and they target littoral species.
12. **Non-return traps** - used in swamps and reed beds particularly in deltas and floodplains. Very common in Rusizi in north of lake. Made from bamboo, wooden slats and wire mesh.

1.2 Fishing Communities – a brief overview

Fishing, along with farming, is an important livelihood option for lakeside communities. Fishing is undertaken by men and is an important source of protein and cash for households in the region. In addition, Lake Tanganyika's sardines are highly valued and are transported

[3] Hanek G. 1994 Management of Lake Tanganyika Fisheries. FAO/FINNIDA Research for the Management of the Fisheries of Lake Tanganyika. GCP/RAF/271/FIN-TD/25 (En).

to areas distant from the lake, such as the Copper belt in Zambia. Fishing makes a major contribution to the nutritional and financial well being of local and national economies.

The links between fishing and farming activities are important: nearly all fishermen's households are also dependent on agriculture (a role largely taken by women). Demand for terrestrial resources (flat land for sun-drying and fuel wood for smoking) to support fishing also links the terrestrial and aquatic environment of the lake. The relative importance of fishing and farming to individual households changes according to factors such as the cycle of the moon, the season, short and long term returns from fishing or farming etc. Work by the Socio-Economic Special Study (SESS) in 2000 showed that fishermen have a strong sense of identity with fishing and as a consequence may undervalue the contribution of farming and other activities to their household livelihoods.

People who are not personally active in the fishery often own the larger fishing gears, such as lift nets and beach seines. These wealthier owners may not even live in lakeshore villages. Arrangements for payment of crews vary and may be cash or a mixture of money and fish. Security is an issue for fishermen, particularly those relying on pelagic stocks. Piracy targets engines, boats and fuel and this risk is a serious concern in the pelagic fishery.

Fishing provides a range of opportunities for associated activities including: provision of light boats (for light assisted beach seines and lift nets); boat building; rental of land for sun drying; fish smoking; transportation; marketing; even the provision of food to returning fishermen. Processing of catch includes freezing (Zambia only), sun drying of clupeids (lake-wide), smoking of larger fish (lake-wide), while the bigger towns support fresh fish markets.

1.3 General recommendations derived from this study

The core output of the FPSS, along with other special studies, was to provide advice to the process of developing a strategic action programme for Lake Tanganyika. This section briefly summarises that advice.

In essence, the pelagic fishery supports large numbers of fishermen throughout the lake. The most 'visible' practices are the purse seine fleet, the light assisted beach seines and the lift net fleet and these fall within LTR's plan. However, the pelagic species fishery is also an important livelihood option for many smaller scale artisanal fishermen who paddle some distance from the shore and use jigged lines to target *Lates stappersii.*

Prediction of what all these fishermen would do should the pelagic stocks collapse, sharpens the focus of how important the sustainable management of the pelagic fishery is. The effect of a failed pelagic fishery would be increasing pressure on the coastal zone through greater reliance on inshore fish resources and/or land for agriculture. This has serious implications for the sustainable management of the lake's ecosystem, and biodiversity in particular.

Focussing attention on the pelagic stocks and the livelihoods they support also recognises that, to riparian communities, these species are the most commercially valuable part of Lake Tanganyika's biodiversity. Sustainable use of the *Lates spp* and clupeid stocks is a key contribution to the maintenance of the 'higher profile' part of the lake's biodiversity - the species of the littoral zone. Therefore, both local and regional aims can be achieved through **implementing a sustainable management plan for the pelagic fishery.**

It is important to note that fishing pressure is not the only factor influencing the status of the commercial stocks. Environmental changes such as temperature are thought to contribute to the relative abundance of clupeids and perch species. These environmental changes and their effect on the fish stocks are not fully understood. Thus management of the fishery has to be undertaken within some uncertainty and be guided by the precautionary principle.

Many inshore fishing grounds (0-50m depth) adjacent to areas of high population settlement bear heavy pressure from a range of gears.

These littoral fisheries are complex, as they are multi-species, multi-gear, involving both artisanal and subsistence fishermen whose pattern of effort is primarily dictated by the moon but with the rains also affecting fishing activity.

Of the twelve significant practices the majority are deployed in the inshore area: light assisted and day beach seines; gill nets (bottom set and encircling); traps, and lines (simple, bottom set, pole). Each of these gears catches a range of species, (lists of all species recorded by specific gears are given in Appendix 2, Part C).

Both artisanal and subsistence fishermen operate in the littoral zone: this fishing ground is an important resource for the livelihoods of riparian communities.

The current trend in management of fisheries worldwide is to look toward partnership arrangements amongst groups of people with a stake in the fishery (e.g. fisher communities, NGO's and governments). This is often called **co-management**, a broad term used to describe a range of **partnerships from those which are primarily community-led through to those in which governments retain more responsibility in managing a fishery**. Ultimately this is what FPSS recommends as a management model for the littoral zone.

1.4 Outline of the Fishing Industries of Lake Tanganyika

There is extreme confusion round the lake with nomenclature. "Traditional", "Industrial", "Artisanal", "Advanced Artisanal", "Subsistence", "Small scale", "Sport" and "Individual" fishermen are mentioned in different laws, papers, articles and documents. In addition it is very difficult to present a clear picture, as each country round the lake legally defines different fishermen differently.

It is here recommended, that for clarity and leaving aside the legal status of the word "Artisanal", it would be better to refer to all fishermen who do not catch pelagic fish with purse seines from diesel powered vessels (= Industrial) as Artisanal or Subsistence. Artisanal fishermen fish mainly for money. Subsistence fishermen fish mainly for food, though opportunistically sell surpluses.

The LTR frame survey (Paffen et al. 1997) of the lake in 1995 found:-

- 786 landing sites
- 44957 fishermen
- 19356 vessels, of which 15980 were active

Gears:

Artisanal:	2976 lift nets
	128 Apollo lift nets
	16 ring nets
	1143 beach seines
	154 light assisted beach seines
Subsistence:	20744 lines
	6300 gill nets
	316 scoop nets
	13 traps
	Miscellany of other gears
Industrial:	52 units, 28 still operational

LTR in (Paffen et al 1998) came up with an estimate of 196570 tonnes (range of estimates, 176913 to 216227 tonnes) for the total catch from the lake, with the country totals:

- Burundi 24946 tonnes;
- DRC 94517 tonnes;
- Tanzania 60701 tonnes; and,

- Zambia 16406 tonnes.

1.4.1 The Industrial Fishery.

An Industrial Fishing Unit is defined in Burundi in the 1961 ministerial regulation on Fishing in the Lake as one or several boats, bigger than 10m, engine powered or not, using either a seine net, one or several set nets whose total length or total combined length does not exceed 5000m or lift nets. In Tanzania an industrial boat is more than 11m and in Zambia it is a boat used for commercial fisheries, with the lake being defined as a commercial fishery; whilst in Congo an industrial unit is motorised or un-motorised boats with a seine or several nets who length is more than 2500m[4]. Implied in this law is the fact that the set net exceeds the sizes given for the Artisanal fleet. Definitions here vary by country with gear and boat and commercialisation being used as the defining agent.

For FPSS purposes an Industrial Unit, and the Industrial Fishery, consists of motorised boats with **inboard diesel engines**, targeting the **pelagic resources** of the Lake with **purse seines**. At present every "Industrial" vessel operating on the lake falls into this category.

1.4.2 The "Artisanal" Fishery

A Burundi Artisanal Fishing Unit is defined in the 1961 ministerial regulation on Fishing in the Lake as one or several boats, engine powered or not, using either lift nets, or set nets whose total length is more than 1000m but less than 2,500m. In Congo (Kivu Region) the permitted length of set net is 4,500m, but otherwise the definition is the same. Tanzania and Zambia do not have such a definition[5].

In common parlance in the two francophone countries, and in their tax gathering regimes, an Artisanal Fisherman is one who targets sardines using lights and a lift net. The nomenclature has partly come about by attempts to improve fishing gears and catches round the lake. Those that adopted the new method of lift netting introduced in the 1950s were redefined as "Artisanal", and anyone who did not was defined as "Traditional" or even "Individuel". For statistical purposes these definitions have remained enshrined in the literature. (Technically, in Burundi, any fisherman with more than 1000m of gill net would be an "artisanal fisherman" even if he never caught a sardine at all, and there are several as such, but none are so identified in the licenses).

FPSS proposes that (leaving aside the legal definitions) an Artisanal Fisherman **fishes for money**. Some of the catch may be auto consumed, or given away, but the inputs to the operations they undertake (fuel, kerosene, wages, the purchase of boat and engines) require that **income is regularly made**.

Artisanal Fishermen throughout the lake use one main gear to persecute the sardine stocks, a lift net, operated between two planked canoes (a catamaran of which the advanced motorised version using a larger net is called "Apollo", none of which operate (1999), in the northern part of the lake, but are very popular further south). Some vessels have dedicated "light" boats, which serve to attract fish only and do not take part in the fishing activity itself. The fishery is carried out at night with the aid of pressure lamps and cannot be sustained during the period of the full moon, as the fish are not adequately attracted to the lamps. LTR (1995) estimates more than 3200 of these lift nets operating round the lake whilst admitting this is probably an underestimate.

Some of these lift net operators are migratory, in that they follow the seasonal movements of the fish, down the coasts, and even across of the lake. Since 1995 their movements have been interrupted by a decline in security in both Burundi and Democratic Republic of Congo. Many have left these countries and live as refugees in Tanzania. The fishing operations of those that remain are severely curtailed by fishing stoppages for security purposes.

---

4 Or a lift net, but the size of the lift not is not defined.

5 Artisanal means small scale, not industrial, in these two countries

Nearly 90% of the catch of the lift net fishery was sardines, 9% *Lates spp* and almost nothing (>1%) "mixed fish". (Bellemans 1990), but there are ongoing changes in the composition of the catch (Coenen et al 1998) which are probably attributable to limnological changes rather than over fishing.

The further south down the lake one travels the more *Lates stappersii* appear in the catch. In the southern part of Tanzania the perch makes up most of the catch.

There not so much lift netting in Zambia, the gears used there by the Artisanal Fleet is the Ring Net and light assisted beach seines. In May 2000 there were only 5 lift nets operating there (E Reynolds Pers Com).

Other gears used by Artisanal Fishermen are scoop nets (Lusenga), gill nets, beach seines (Light Assisted and Day), and jigging lines. Of these the most important economically are the light assisted beach seines targeting sardines (now banned in Tanzania), which in some areas provides a large amount of employment (albeit very low paid) and fairly large support industries (smoking, transport, drying etc). Beach seines operated during the day are also socio-economically very important due to the number of people employed.

1.4.3 The Subsistence Fishery

A traditional fishing unit is defined in Congo and Burundi as a pirogue or dugout canoe using traditional fishing gear including a beach seine, or set nets whose combined length does not exceed 1,000m or a Lusenga (stick held scoop net). In Congo an "Individual" fisherman is also recognised, who presumably does not use a boat.

In Tanzania and Zambia anyone fishing who is not an Industrial Unit, is an "Artisanal" fishermen.

FPSS proposes that subsistence fishermen **are fishermen who do not have to make an income from the fishery**. Their catch is generally auto consumed or distributed to family and friends. Occasional surpluses will be sold. However the fisherman does not have to make an income from any particular trip, since he has no marginal purchases to make to sustain his fishing operations. (Unlike a fisherman with an outboard motor – who has to buy fuel for the next trip: or a lift net operator who has to buy kerosene for lamps for his next trip)

Generally historical statistics for the subsistence fishery are very difficult to obtain. Contributory to this is an attitude that has ignored the fishery as subsistence and relatively unimportant. An understandable attitude when the sardine fishery was producing more than 20,000 tonnes of fish in the Burundi alone (Industrial and Artisanal together), compared to the estimated 425[6] tonnes (Bellmans 1990) of the "traditional" fishery. Lake wide the recorded statistics are similar.

For example in Coulter (1992), the following sentence is the only mention of gill nets in the whole chapter on fisheries[7]:

> *"Other small scale operations, conducted from dugout or plank canoes usually without motors, are hand lines, basket traps, gill-nets and beach seines, all fished in fairly shallow water near shore."*

Since the beginning of severe security problems in Congo and Burundi in the mid-1990s all statistics have become patchy. Similarly in Tanzania and Zambia the statistics collection & collation systems are not functioning as intended so data on the subsistence fishery has been difficult to obtain.

As a result of this the gears used by subsistence fishermen of the lake are not well known, are not fully enumerated, and the information on them is scattered in many different reports, censuses and databases. The LTBP FPSS provided an appropriate opportunity to identify

[6] Probably a serious underestimate.
[7] Though it appears that there were fewer gill nets then than now.

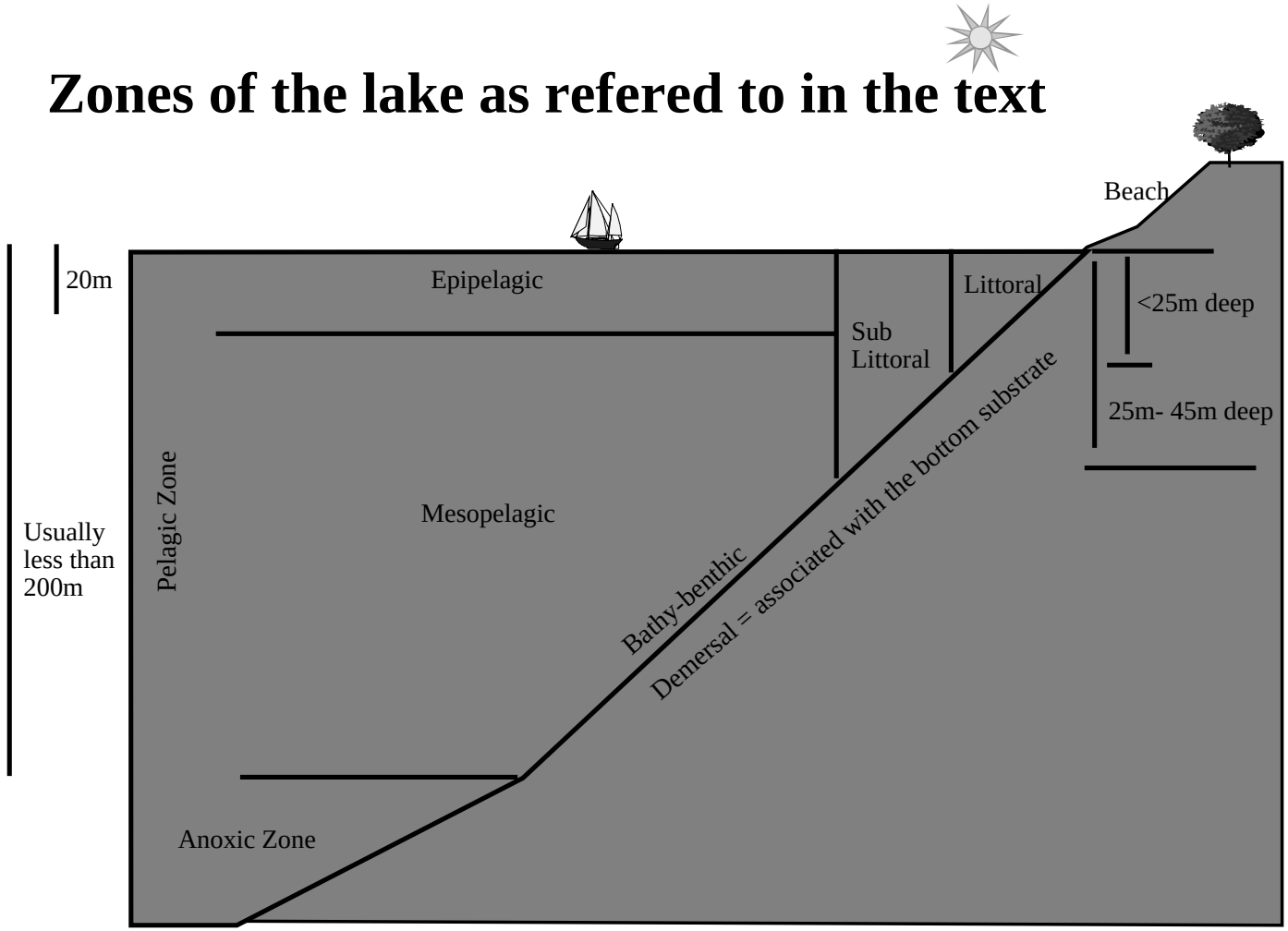
them more fully but the distances are too great and the logistics of carrying out a full census were too expensive and time consuming for the FPSS to undertake. However the gears in the area from just south of Uvira in DRC round the top end of the lake to Kibenga, just south of Bujumbura, were counted by beach survey. Follow up consisted of in depth counting of gears in Kilomoni (DRC) and Kibenga (Burundi), by visiting the households in the two villages, and making direct enquiries of the inhabitants of their fishing gears and activities. The results of this limited survey are presented in Appendix 9 (Part C), with comparisons to previous surveys carried out in this area by LTR and others. Kibenga in Burundi demonstrates well that when an in depth survey is carried out far more gear is uncovered than when a beach survey alone is done. Similarly Kilomoni in DRC. However apart from indicating that the gears of the lake have been generally underestimated in the past, this information has limited use except to serious students of the fisheries of the northern tip of the lake.

Even in the light of a presently healthy artisanal pelagic fishery for sardines in most of the lake, more effort is being put into the subsistence fishery. The reasons seem to be:-

- The economic decline of the riparian communities (in part directly due to the lack of security) has meant that the larger, more expensive gears, cannot be replaced or sufficiently repaired when they finally fall apart. Fishermen then move to smaller cheaper traditional gears, and smaller boats
- The food security along the lakeside has deteriorated so that more people are entering the fishery at the low end – the "subsistence fishery" with very cheap gears such as hand lines and pole and lines, to ensure food supplies in these uncertain times.
- Outboard motors have become very expensive so fewer and fewer vessels are motorised, reducing their range. In all 4 riparian countries armed gangs also steal them regularly.
- In Burundi the security situation has limited the amount of sardine fishing allowed in the pelagic zone. During periods of crisis, which has been very often since early 1995, the powered Apollo's and catamarans are ordered to be beached, and night fishing banned or severely curtailed. Other traditional methods in the littoral not requiring a boat generally have been permitted to continue even when offshore fishing has been banned.
- There are more people & demand for fish continues to rise
- Between 1995 and 1999[8] there was a shortage of sardines in the northern area of the lake, forcing people to fish the margins

[8] The situation was reported to have improved in early 2000.

Zones of the lake as refered to in the text



1.5 A short note on habitats in the lake

Lake Tanganyika is a deep lake, with steeply sloping sides on the east and west interspersed with rivers with delta fans of shallow mud and sand, such as the Malagarasi in Tanzania. In the northern and southern extremities the coasts are shallower sloping with more mud and sand where large rivers run into the lake, particularly the Rusizi River in DRC/Burundi, which has a large fan and extensive areas of swamp and reed in the area northwards between Lake Tanganyika and Lake Kivu. Zambia has Nkamba bay in the Nsumbu Game Reserve, where large areas of mud and sand are found, and Chituta Bay in the SE Arm, which is a large flat sandy bay.

Figure 1 A rocky beach, Nsumbu, Zambia.

Figure 2 A sandy beach in Chituta Bay, Zambia.

The design of a fishing gear is dependent on the type of habitat it is being used in. In rocky areas gears such as beach seines, which have to be pulled over the bottom cannot be deployed, whereas in mud and sand areas without obstructions they are a popular gear. Which habitats each gear is used in is noted in the text (below) for each gear.

Figure 3 Gravel beach near Gombe, Tanzania.

The habitats found on the lake are:-

- Open water pelagic, which is not particularly biodiverse, but due to the sardine fishery is the most valuable (in economic terms) part of the biodiversity of the lake

And in the littoral

- Bedrock
- Rocky including boulders, gravel (small rocks)
- Sandy, including mud
- Stromatalite reefs (only observable from underwater offshore)
- Areas of submerged macrophytes
- Shell beds (*Neothauma sp,* usually 100% coverage)
- Swamp (in estuaries or low-lying areas adjoining the lake. (Sometimes seasonal)
- Reed beds (on the lake margins)

Figure 4 Mixed pebble, rocks and reeds beach near Mpulungu, Zambia.

In Mahale National Park the Biodiversity Special Study found 40% of the littoral substrate was "Rocky" with 20% "Sandy" and 21% "Mixed". This of course was in an area of the lake where there were no large rivers or delta fans where large areas of reed and sand or mud are found.

The biodiversity of the littoral is far richer than the pelagic zone, because there are far more habitats. Of the habitats in the littoral, those that are rock dominated are indicated by work of the Biodiversity Special Study to be the most biodiverse. Plain sandy beaches are the least biodiverse, though they, like all habitats, have species that are unique to them, and are thus important to biodiversity and cannot be ignored.

In general the species richness of an area is dependent on the varied habitats in the area. The more habitats the more fish. Similarly fishermen have developed different gears for different habitats, so in areas of great habitat diversity there is a consequent diversity of the fishing gears used to catch fish.

1.6 Fishing Gear materials

1.6.1 Sources of Gears

Bujumbura is the source of all gear in NE Congo. It is also the source of all retail gear in Bujumbura and of all wholesale gear for resale in the rest of the North of Burundi. A lot of the gear in Bujumbura comes through Tanzania, and in southern Burundi much is sourced from Kigoma. Further south in Congo the supply of gear is reportedly very problematic. Near the larger towns there is supposed to be adequate supplies, but due to the security situation it was impossible to verify the true situation in this region.

In Zambia there are local manufacturers (and repackers) of gear, but little of their gear gets to Mpulungu on the lake. Most of the gear in Mpulungu is from China or Korea, imported by way of Tanzania. In Nsumbu, on the SW Arm of the lake there is more Zambian manufactured gear, particularly gill nets.

Tanzania has a great variety of gear available, and in Kigoma; for instance, it is possible to buy many items not available elsewhere. Most comes from the Far East, Korea and China predominating, but the hooks mostly come from Norway. There are some Tanzanian manufacturers of gear, but their products are not generally preferred, due to their cost.

In Kigoma and Bujumbura it is possible to buy from retailers the netting required for beach seine nets and lift nets. In Mpulungu the artisanal seine net fisherman buys his netting from the industrial purse seine companies.

Figure 5 Mr Sikazwe Humphrey, a purveyor of fishing gear and other miscellaneous goods in Mpulungu market.

1.6.2 Gear Specifications

The twine that the nets are made of is specified using the International Titre system, commonly, though incorrectly, known as “Dernier”. The yarns are designated 210d/6, 210d/15 etc. Although described by Gerhard Klust in his seminal book, ‘Netting Materials for Fishing Gear’, as

> *“…..out of date, written in the wrong way and misleading”*

These designations are still in use round the lake, and all the fishermen are aware of them and what they refer to. Thus a fisherman will confidently say that he buys No 6 twine for fixing his net, meaning a twine of 210d/6 (~R126tex). FPSS uses both the International Titre and the tex system in this report.

The nets themselves are generally[9] sold specified in imperial units for mesh size (inches), length (Yards), and number of meshes for depth. Most have a double selvage at the top and

[9] All Chinese ones are specified in imperial units.

bottom, and in many cases the "n" direction is lengthways instead of the commoner (in Europe) depth wise.

Ropes and other miscellaneous items are also available in Kigoma and Bujumbura, but are extremely expensive and difficult to obtain in remoter areas of Tanzania and in Zambia. As a result a lot of bark rope is manufactured in bush areas and sold into fishing communities. This is very cheap, but does not last as long as synthetic rope. Ropes are specified in mm Ø. Polyethylene, being the cheapest synthetic rope, is the material of choice for most wholesalers, even though it is severely susceptible to Ultra Violet radiation and degrades quickly. In many remote areas the ropes used on all but the largest gears are recycled net sennit, made by binding an old gill net with half hitches of 210d/6 nylon multifilament. This makes a strong rope that is very cheap and kind to the hand, as it is rough and gives a good grip (unlike PE which is slippery and can burn as it slips in the hand).

Monofilament nylon line is available everywhere. It is usually sold in hanks of 25m, a packet containing 4 x 25m hanks. Sometimes the nylon is sold in hanks of 25 yards.

Mending twines of a variety of sizes of multifilament nylon are also available for mending gill nets. Thicker multifilament nylon lines for mending seines is also available nearly everywhere and this is also used for some setlines and sturdy pole and lines. Multifilament nylon comes in bobbins of various sizes. Multifilament polyethylene, in a variety of colours is also becoming more common round the lake, and is sold in hanks.

Figure 6 Cone shaped lead from Zambia.

Floats for nets are very varied. Gill nets have reed, bark or cork floats throughout the lake. Seines have to have more substantial ones and these are available for sale in the larger centres such as Bujumbura and Kigoma (see Appendix 1, Part C), but elsewhere have to be scrounged from old nets, or made from old purse seine floats (usually cut in half).

Figure 7 Stones as weights and bark as floats on a gillnet in Tanzania.

Hooks are available everywhere. They are very portable and a merchant can have a reasonable selection for a very modest investment. Therefore there is little risk and even relatively tiny villages will have them available in the local store among the other essentials of life. Most are made by Mustad™ of Norway.

Lead weights can be home made, or, in the case of the purse seine fleet, imported. The leads are made by pouring molten battery lead into cones of paper set in dry sand. The lead cools to a cone shape and can be used for line fishing. Most fishermen use stones tied in with inner tube lashings as weights, particularly on gill nets, as they are free. Some weights are made from baked clay, similar to little bricks. These usually have a hole through the top for easy attachment of the twine, obviating the need for inner tube lashings. D size batteries are also used extensively in remote areas.

1.6.3 Prices

Given the distance from the sea and major import centres, high transport charges, and the high taxes prevalent at this time, prices tend to be high, compared to the rest of the world. However, they are not outrageous, and the merchants are certainly not making an extraordinary profit. The fishermen of course, consider that they are being exploited.

Everywhere, fishermen advise that gear prices are a severe constraint to fishing activities. One of the fishermen's responses to high prices has been to adapt local materials to reduce

the cost of fishing gears. Floats are made of bark, weights of stones, lashings of recycled inner tube, and ropes of recycled discarded netting sennit. With many gillnets the only things bought in are the mesh itself, and in some cases this is hand made from spools of twine. Another response is the constant mending of nets, which increases their lifetime, if not their efficiency. Some of the larger gears have been abandoned because the fishermen cannot catch enough to generate enough income to repair them.

The prices and origin of different specifications of gears available in Burundi, Kigoma and Mpulungu are given in Appendix 1 (Part C).

2. BOATS

2.1 Safety

The only "large" boats used in fisheries on Lake Tanganyika are purse seiners, targeting the pelagic resources offshore. These boats are licensed and have to follow basic safety regulations, regarding numbers of lifejackets, presence of fire extinguishers, VHF radios, flares and other such fundamentals.

The smaller fishing vessels are not safety inspected and do not have to pass any survey. Nor do the people operating them have to be qualified in any way. Most of the boats are hardly seaworthy and have no safety equipment at all

Despite this it is relatively rare for people to be drowned. The reasons are that:

- the lake is relatively benign;
- most people in inadequate boats do not go out far onto the lake;
- the boats float when swamped;
- the weather does not "blow up" suddenly. There are plenty of warning signs; and,
- the lake is fresh water so nobody dies from dehydration.

The addition of alcohol to any fisherman's regime negates the positive side of the lakes benevolence, and is the cause of some accidents.

2.2 Industrial fishing boats

Figure 8 An Mpulungu based purse seiner.

The industrial fleet in Zambia uses a variety of designs of Purse Seiner, with varying designs of light boats. Some of these boats are converted into Purse Seiners from something else, but most are locally built, steel and very flat bottomed. They vary in length and beam, but are generally between 15 and 20m long and very beamy. Those boats with power blocks for hauling the net use a one-boat method of shooting and retrieval, whereas those with no power block use a two-boat method, with one boat, the mother ship, being considerably larger than the secondary boat. The illustration here shows a typical one-boat purse seiner from Zambia, (this one owned by St George Fisheries of Mpulungu). Forward and aft can be seen the large brackets holding the lights (T shaped) which are powered by the generator which can just be seen near the forward light bracket. The power block is very obvious forward of the wheelhouse and the net is stored aft (with the crew sitting on). All these seiners have associated light boats, which are fibreglass or steel and equipped with a generator, typically a one or two cylinder Lister™.

The fishing method and more illustrations can be found above in this report.

2.3 The Artisanal and Traditional fishing Fleet

The Artisanal and Traditional fishing boats that can be seen on the lake are nearly all wooden. Attempts to introduce fibreglass and steel boats do not seem to have worked in the long term. A particularly good graveyard for steel boats from an old FAO project is in Kibenga in southern Bujumbura, where several steel boats can be seen poking out of the sand like sausages in a "toad in the hole"[10].

In essence there are 4categories of traditional and artisanal fishing boats. These are:

- dugout canoes;
- planked paddling and sail boats without frames;
- planked paddling and sail boats with frames; and,
- planked & motorised framed boats.

Two types of ancillary boats:

- Tug boats (lift net fishery); and
- [Fish transport boats].

2.4 Dugout canoes

Dugout canoes are found throughout the lake. They are, however becoming rarer, as the large trees from which they are made are no longer available. Thus new dugout canoes are not often seen.

Figure 9 A large dugout canoe in Southern Tanzania.

Dugout canoes, in their present form, are small, up to 7m long, but with a very limited carrying capacity. They easily take water but can be bailed from full by the fisherman in a calm sea. They are never motorised on Lake Tanganyika, being paddle propelled. They are completely unsuitable for serious offshore work though they are sometimes found far from land, paddled by intrepid fishermen, usually bottom long lining.

Dugout canoes are usually used for the smaller gears, near the shore. These gears include vertical lines, long lines and gill nets. Up to three people can fit in a larger canoe, but most are used by one fisherman only.

Due to the reduction in the number of suitable trees it seems that the end of the second millennium will probably roughly coincide with the end of the construction of new dugout canoes on Lake Tanganyika.

2.5 Planked Un-motorised fishing boats.

Planked canoes are normally 4-7 metres long, and have a method of construction that shows Arab influence. The bow is sharp and slightly slanted with flair. The transom is square with rounded lower edge. The maximum width is approximately central. The boat is flat bottomed with hard chines.

In the southern part of the lake the ribs are normally made up in five parts, three straight pieces, nailed to the sides and bottom and two elbows on the chines; these latter cut from suitable timber so that the grain follows the shape. In many boats the 5 parts of the ribs are

[10] A traditional English dish consisting of sausages embedded in mashed potato, with their ends poking out of the potato.

not necessarily in the same place, so that although they are all present and strengthening the structure, they do not approximate to a full frame round the inside of the boat. The ribs are cut from nearby trees.

The planks are normally about 20cm wide and are so positioned that the only place where they are subjected to bending strain is in the bow, Construction is, in Zambia, usually from "Mulomhwa" (*Pterocarpus angloensis*) for the planks and fastening is normally with 3 and 4 inch steel nails. These nails are hammered in to the planks to attach them to the frames. The nails are clinched over on the inside if they protrude through the frame.

There are three seats and normally provision in the forward seat for the stepping of a mast, used to carry a sail made of mealie meal sacks when running before the wind over long distances. In Zambia the sail is basically square and in Tanzania and Burundi the sail is approximate to a lateen.

Figure 11 A small planked canoe without frames. Nth. Tanzania.

The timbers used for planks in boat building in N. Tanzania are *Pterocarpus angolensis* and *Milicia excelsa,* according to Petit (1997), and both are imported to the region.

Figure 10 A small planked boat with frames. Kasisi, Zambia.

In the northern areas of the lake the small planked boats are of similar shape but do not have frames. The planks are held together with staples, which are made at local blacksmiths, and also mass produced elsewhere. (5cm gape staples were retailing for 18 Tsh each in Kigoma market in November 1999). These are clinched over on the inside and are very effective in joining the planks. Rigidity is given to the structure by the seats, a strengthened gunwale and the clinched staples.

A step for the sail is often included under the forward seat.

Figure 12 Large planked boat with frames. 0ne seat (fwd), Sth. Tanzania.

No machine tools are used in the manufacture of boats on Lake Tanganyika.

All over the lake the small-planked boats are initially caulked by the boat-builder using cotton wool, soaked in unrefined palm oil (as a lubricant whilst caulking and perhaps also as a preservative). No lead, putty, paint or similar is used. After a while the cotton falls out from between the planks and the owner will re-caulk using whatever materials are to hand. This is often cloth from old shirts or trousers, kapok from nearby trees or old bits of seine netting. The appearance of these re-caulked boats can be very shabby, with multicoloured cloth and cotton wool trailing from various parts of the boat.

The boats are generally paddled, though the sail will be used (if a step & sail is installed) when there is a following wind. The vessels cannot sail into the wind at all. Two or three fishermen will operate the boat. These vessels are large enough that nearly all fishing methods are used from them, except from the offshore methods like Ring Netting and Lift

netting. In north Tanzania many boats of relatively small size go long distances off shore to catch *Lates stappersii* using lines, jigging at great depth, demonstrating that the fishermen, at least, have confidence in their vessels in open waters.

(In very rare cases a motor may be installed on this sort of boat, but this is for passenger or cargo transport. The low returns from fishing in small boats generally preclude this form of installation).

These boats have no safety features at all, though they can be paddled and sailed and have nothing to break down or catch fire on board.

Normally, but not always, these boats are hauled up onto the beach if they are to be left for any length of time. The lack of watertight integrity of most of them would mean that they would sink if left in the water.

Professional boat-builders and carpenters make the boats to order from the fisherman. Sometimes the fishermen will make his own boat, but it is seldom that the skills of fishing and carpentry reside in one craftsman.

2.6 Planked, motorised, framed boats

Larger than the planked boats intended or sail or paddle are the framed boats used for lift netting offshore. These are much more substantial than the smaller boats, and have frames, strengthened gunwales and a series of seats acting as stiffeners across the beam of the boat to add rigidity. They are also often powered with an outboard motor so the transom is substantial. The transom is sometimes set inside a frame to provide protection to the engine during fishing operations.

These boats are often painted, and the paint serves in some ways to enhance the waterproofing provided by the cotton caulking. As such they can be anchored off when not in use.

These boats are described by Petit (1997) as follows:-

> *The catamaran is the connection of two boats by means of two wooden poles. One pole is fastened on the fore end of each boat parallel to the fore athwartships; and the other is fastened parallel to the off athwartships of both vessels. The two connecting poles have lengths varying from 9.9 to 12.8m long while the two boats have a length of 7.5m with 1.4 or 1.5m of width, a catamaran fishing with a traditional lift net of circumference ranging between 60 and 72m. As for the catamaran the Apollo is the combination of two boats connected also by two poles which lengths range from 10 to 25m. The two boats forming an Apollo have lengths of 8.6m to 10.5m and with a width of 1.6-1.9m. An Apollo has the advantage of a larger lift net and hence a large fishing ground.*

Figure 13 A lift net boat in Nth Tanzania.

In north Tanzania those boats made from *Pterocarpus angolensis* last 10 years and those made from *Milicia excelsa* last for only 3 years. The choice of material depends on the wealth of the fisherman.

The boats are made by boat-builders on order to the fishermen (or lift net operator, who may not be the same person).

These boats do not have even rudimentary safety equipment, unless a paddle is so described. Where there is a licensing system, it does not extend to vessel safety. Safety equipment is very expensive. A set of flares is expensive, and who would respond to a flare remains to be ascertained in these days of poor security?

There do not seem to be many losses of life, perhaps because the vessels are catamarans, and each half can operate independently of the other in an emergency. The vessels also tend to operate in fleets.

There has been a serious problem with piracy in recent years. Gangs of armed men attack the fishermen whilst on the lake and steal their outboard motors, and anything else that can be carried off. Catamarans are very visible on the lake, since they use lights to attract the fish, and these lights can be seen for many miles. [These same thugs also attack land-based targets as well. The FPSS in NW Burundi and NE Congo in 1999/2000 did not observe a single outboard motor on the beaches of either stretch of coastline. They had either been stolen or the owners were too frightened to use them].

2.7 Towing boats

Piracy and the expense of outboard engines has led to the construction of a different type of boat – the towing boat.

This boat is wooden and of similar construction to the catamarans, though of a very different shape. Of significant interest is the towing point, a curved beam of timber attached to the port side of the boat, near the transom, visible in the accompanying photo here. The seats of the boat are set internally and a motor is attached to the transom.

Figure 14 A towing boat in Northern Tanzania.

This vessel is used to tow several catamarans out to the lake at once, where they can fish without the fear of having their motors stolen by pirates. The towing boat can then either return to the beach or return later in the night to pick up the catamarans and tow them home, or it can loiter in the dark, away from the main body of the fishing fleet, and remain undetected by any passing brigands.

Reports that these boats also act as gunboats, with armed men on board, ready to repel pirates and buccaneers should not be discounted.

These boats have only been seen by FPSS in northern Tanzania.

2.8 Wooden Cargo boats

Wooden cargo boats are found all round the lake, and are made in a few large scale boat yards round the lake, though there does not appear to be one of these yards in Zambia. Ujiji, in Tanzania is a good example of a boat-building beach where several large trading vessels are constantly under construction or repair.

Figure 15 A wooden cargo boat loaded with dried Lates stappersii destined for Burundi (Malagarasi Delta, Tanzania). Note dugout canoe for size comparison.

The basic construction techniques are similar to those of the catamarans. Most of these vessels have inner longitudinal ribs.

The shape becomes wider and deeper forward than the hull of a

catamaran boat, coming to resemble the hull of a Yemeni Sambuk or trading dhow. The Arab influence is even more apparent than in the smaller planked boats.

The outboard is placed in a protective well aft, and often there is a access ladder permanently attached to the transom. The boat is usually reversed up close to the beach when loading or unloading as the photo of Ujiji beach shows. Sandy beaches are preferred as landing places.

Figure 16 The outboard well on a cargo boat, Tanzania.

Figure 17 A cargo boat moored at Ujiji beach, Tanzania.

Although not used for fishing, these boats are used to transport large amounts of dried fish round the lake, and are thus very important to the small scale fishing industry. Some of the vessels make epic journeys of hundreds of kilometres up and down the lake. They are usually powered by outboards of between 40 and 75 horsepower, with a 55 hp Yamaha™ seemingly being one of the more popular models.

These boats have no safety features. They are subject to attack, and the crews of boats travelling in the north of the lake often have automatic weapons of some sort on concealed on board. The same design is also used as passenger transport, and seats are put in. For the "executive" style a shade cover is also installed.

3. PROCESSING AND MARKETING

The majority of processing around lake is sun drying. There is no refrigeration of any sort in the artisanal fisheries. All fish is landed fresh, without ice. This restricts its keeping time fresh to a few hours, depending on how long and under what conditions the fish has been kept on board the fishing boat and the ambient temperature. The lack of refrigeration is a real constraint to transport of fresh fish and offers the best opportunity for improving fish quality on the lake. Adding value to the existing catch is an important issue around lake Tanganyika and offers potential to improve livelihoods without adding pressure to the fishery.

Fresh fish keeps better than marine fish, due to a chemical difference which limits the off odours produced by fresh fish. This is fortunate as fish landed fresh must be processed rapidly if it is to be transported any distance at all, or kept for more than a few more hours.

The methods of preservation of fish on the lake are:

- fresh;
- iced;
- frozen after landing (industrial fishery in Zambia only);
- sun dried;
- sun dried and subsequently smoked;
- sun dried and subsequently salted;
- smoked;
- salted & sun dried; and,
- "roasted".

3.1 Fresh fish

Fish is sold fresh from the fishing boat to merchants or directly to the consumer. No ice is used on the boat, though many fishermen use dampened weed and leaves to keep the fish damp, and out of direct sunlight whilst in the boat. Wet sacks are also sometimes used. Both these preservation methods reduce the fish temperature somewhat by the evaporation of the water. The hygiene of the on board storage of fresh fish leaves much to be desired, with the fish typically sloshing about in the bilge of the boat in water that has leaked in through the boats planking. The fish may also have been dead in the net for several hours before the gear was retrieved. Thus much of the fish arrives at the landing beach in poor quality.

The fish sold to merchants is then transported to towns or large villages and retailed. Sometimes the boat is used both as transport and sales platform, if the market area is near the lake, such as in Mpulungu. Containers used to move the fish are generally wooden or basketwork, and subject to contamination from first use. The urban retailing areas round the lake are universally squalid, without adequate clean water supplies, clean surfaces and sometimes without shade and invariably open to flies and dust. Residual contamination from previous days sales and overnight rodent contamination contribute to the general lack of hygiene.

Figure 18 A boat being used as a sales platform in Mpulungu fish market.

There is no doubt that were even rudimentary health regulations enforced on the urban fresh fish markets of the Lake Tanganyika region then every market would be closed down. In mitigation it must be said that the cuisine of the region does not allow for undercooked products. Everything is cooked for a long period, usually in an onion and tomato sauce, or fried until crisp on the outside and thoroughly cooked inside. This serves to sterilise the food so that food poisoning pathogens are completely destroyed, and the toxins that they may have produced are neutralised.

3.2 Iced fish

Fish sold on ice is very limited, and consists of fish from the purse seine fishery, which is sold wholesale to women who retail it in markets in Mbala and Kasama inland from Mpulungu. The fish is packed in wire baskets, with sacking for insulation, and ice purchased from the purse seine companies is added. The parcels are then strung up using cheap sisal twine and put on vehicles heading inland. The insulation is not good, but the product seems to be popular in the inland towns. This trade provides work for a good many women.

3.3 Frozen fish

Fish frozen after landing are produced only in Zambia in the industrial fishery *for Lates stappersii*. The fish are caught during the night and boxed, but not iced. They are then returned to the shore base where they are frozen in blast freezers. The frozen product is sent to the main centres of population in Zambia (Copper belt mainly), by road.

The fish when they arrive at the shore base are already up to 7 hours dead. They have not been iced. Thus the peak of quality is lost, and the fish being frozen are already second grade. However the consumers do not know better, and are many hundred of miles from alternative sources of fish. The companies do not seem to have ever had any problem selling their catch.

These fish would have to be iced at sea (and then sold either iced, or frozen after being frozen at the shore base) or frozen at sea, to maintain premier quality.

3.4 Sun-dried

By far the largest amount of fish landed on Lake Tanganyika is laid out on the ground and dried by the sun. This is particularly prevalent in the sardine fishery for *Stolothrissa tanganicae*. The fishermen sell the catch to (normally) women, who proceed to dry it. Special areas of ground are cleared of all vegetation and the fish are laid on the ground. Normally the ground in these "drying fields" is covered with small stones (rather than just sand) which reduces the amount of sand that is picked up by the fish. The oil from the fish tends in time to stick the sand and form a hard surface.

Figure 19 Sardine drying fields at Katonga, near Kigoma in Tanzania. Lift net fleet anchored in bay.

In some areas of Zambia large cement drying areas were constructed in the 1960s though these are unused due to the collapse of the sardine fishery there. In areas where there are no suitable areas for drying fields, such as in SW arm of the Zambian zone of the lake and in Congo, fishing nets may be laid out on rocky shores and the fish dried on the nets. (This non sand contaminated fish fetches a premium price).

Figure 20 A dried fish turning fork.

The sardines are laid out for 24 to 36 hours on the ground, and are turned at least twice using a wooden fork. After being suitably dried they are collected and marketed in sacks of up to 70kg.

There is a very important trade in dried sardines round the lake. Production is in excess of 160,000 tonnes per year. The networks of the sardine trade extend throughout east Africa, from Lusaka in the south, deep into Congo to the west and up to Lake Victoria and Rwanda in the north. Much Tanzanian fish goes down to the coast at Dar es Salaam.

If there is rain or overcast conditions whilst drying is ongoing this is a serious problem for the fish dryers, as the fish will spoil beyond the standard expected for human consumption, quite rapidly, if not exposed to the drying action of the sun. Much of this fish that is not dried quickly is downgraded to a lower price in recognition of its poor quality, and some is downgraded to chicken food grade.

There are however two further processing steps that a fish drying operative can take when there is rain or overcast. The under-dried fish can either be **smoked** or **salted**. Salting is done with brine and smoking is done in a typical smoke kiln, like that used *for Lates stappersii*). Both of these are fall back measures, since the product that is in demand is a dried one. It also considerably increases the costs, without increasing the return, and neither method can be done in large quantities.

3.5 Smoking, salting and roasting

Any fish at all may be smoked. There are in nearly all fishing villages some fish smoking kilns available. In villages where there are large landings of *Lates stappersii* from lift net operations or meso-pelagic jigging many of these kilns can be found. Specialist smokers of fish, usually women, buy the fish.

Figure 21 A fish smoker in Mwamgongo in Tanzania. *Lates stappersii* on sticks in smoker.

Figure 22 Smoked *Lates stappersii* on a stick from a smoking kiln. Mwamgongo, Tanzania.

Due to its shape *L stappersii* is particularly suited to being formed into a circle with the tail through the gill covers and placed on poles, which are then put over the smoking fire in the kiln. They then are smoked for 18 – 24 hours, which is adequate to preserve them for onward transport and sale.

The fish so produced can be very brittle and losses from breakage are a problem. Inadequately smoked fish, or fish which then subsequently get wet in the rain or in the bilges of transport boats are subject blowfly attack. This causes yet more waste, as consumers are sensitive to the presence of blowfly larvae.

Far more fish is eaten by the larvae of *Dermestes spp*, a beetle, which can be seen in most batches of stored smoked fish (unless very recently smoked). The losses from beetle attack must be significant, if the prevalence of these beetle pests is a guide.

No reports of the use of insecticide on smoked or dried fish have been made.

Very infrequently there are instances of fish being **salted and dried**. This is not done on a large scale since salted fish is not a preferred product for the consumer. It occurs mainly for littoral species, when it is wet or no smoker is available.

Roasting fish is a stopgap measure when fish is caught that cannot be sold fresh for whatever reason, cannot be dried, due to its type (thick, littoral species) or the weather, is too small to be split and salted or smoked, and has little value. The fish is then put on a grill above a fire and roasted. The product is cooked, and often burned and charred. This serves to preserve the fish for about 24 hours at ambient temperature. Only small quantities can be preserved in this way. Some roasted fish finds its way into the urban markets. It seems that the small fish caught by beach seining are often processed in this way.

Figure 23 *Oreochromis tanganicae* salted and laid out to dry. Malagarasi, Tanzania.

4. SUMMARY OF FISHING PRACTICES USED ON THE LAKE

The gears used by the traditional and artisanal fishery on the lake are minimalist, in that fishermen use the simplest and cheapest materials, and no gears exploiting the biodiverse littoral zone are mechanised in any way. That said, the gears are also cheap, efficient, appropriate to the human and other resources of the lacustrine peoples. The diversity of the gears reflects the fishermen's attempts to exploit every niche, every species and every habitat.

The gears are classified as in the table below (after A von Brandt 1972)[11]. The classification is based on the way that the fish is restrained so that it cannot escape. As Mr von Brandt himself admits regarding his classification it "…. requires benevolent agreement"; as does the one below.

[11] The FPSS Regional Facilitator (1999/2000) adopts this classification due to its simplification and ease of explanation.

Table 1 Summary of Fishing Methods and Gears of Lake Tanganyika

	Method	No	Gear	B	C	T	Z	Target species	Comment
1.	Without tools	1	By hand. Opportunistically of fish in drying ponds & paddies. Usually an adjunct to agricultural activities	O[12]	O	R	O	*Clarias* mainly	These are all very low intensity fisheries
		2	With extensions to the hand. Machetes, stones and sticks in shallow waters adjoining the lake			O	R	*Clarias* mainly	
		3	The Frog Fishery	O				Frogs	
		4	Bivalve clams	O				Clams	
		5	Night hand fishery using lights, of fish in shallow waters of the lake.		R			Unknown	
2	Grappling or wounding gear	6	Fish spears, barbed or barb less	E	O	O		*Clarias* mainly	
3	Stupefying devices	7	Plant poisons	E	R	R	R	Totally non selective Illegal	Already illegal & not common
		8	Chemical poisons			E		Totally non selective. Illegal	Only use of pesticide in 1970's in Tanzania reported. Gives the fish consumer violent headaches, so not popular
		9	De-oxygenation		R			*Clarias* sp mainly	Only in limited areas
		10	Explosives		R			Opportunistic and illegal	Already illegal & not common. Grenades are expensive relative to the catch
		11	Electro fishing		R			Aquarium fish	For collecting aquarium fish in DRC only

[12] O= Observed by FPSS investigations 1999/2000. R= Reported by previous FPSS surveys or to FPSS staff as existing. E= No longer used though reported, usually anecdotally, or in reports, as previously used, or reported (however) but not found by subsequent enquiry by FPSS.

	Method	No	Gear	B	C	T	Z	Target species	Comment
4	Lines	12	Vertical hand lines (demersal fish)	O	O	O	O	Mixed littoral	Cheap and plentiful
		13	Pole & line	O	O	O	O	Juvenile mixed littoral *Clarias spp* & *O tanganicae* in swamps	Ubiquitous. Cheap. Only protein source for some families
		14	Vertical hand line (baited, mesopelagic)			O		*Lates sp*	Not commonly used
		15	Vertical hand line (jigging, epi-pelagic & littoral un-baited)			O	O	Day: *Limnothrissa miodon &* mixed littoral Night: *L. stappersii*	Cheap and plentiful
		16	Vertical hand line (jigging, meso-pelagic, un-baited)	R	R	O	O	*Lates stappersii*	Far more important than normally acknowledged.
		17	Bottom set long lines	O	O	O	O	Mixed littoral and sub littoral	Cheap and plentiful
		18	Staked lines				O	Riverine species	Very rare
		19	Floating lines			O		Swamp species	Very rare
		20	Bottom trolling			O		*Lates angustifrons Boulengerochromis microlepis*	Requires a flat snag free bottom. Rare gear
		21	Surface trolling			O		*Lates mariae*	Occurs round light boats in the lift net fishery
		22	Sport fishing	O			O	*Lates spp Boulengerocromis microlepis Hydrocynus goliath*	Sport fishing in Nsumbu National Park is important for biodiversity and the local economy. Elsewhere it is insignificant.

O= Observed by FPSS investigations 1999/2000. R= Reported by previous FPSS surveys or to FPSS staff as existing. E= No longer used though reported, usually anecdotally, or in reports, as previously used, or reported (however) but not found by subsequent enquiry by FPSS.

	Method	No	Gear	B	C	T	Z	Target species	Comment
5	Traps, barriers etc	23	Bottom set non return traps (in swamps & reed beds) Several designs on a theme	O	O	O	O	*Clarias sp* & *Tilapine* species	May become serious for biodiversity in habitat
		24	Mid water non return fish traps				O	*Dinotopterus cunningtoni*	Used in the water column . 3 in lake. Rare.
		25	Tubular traps				O	Various riverine	In rivers leading to the lake. Targets lake species moving up or down river depending on season.
		26	Barrier/Labyrinth traps				O	Swamp species	In reed beds in Zambia. More common in wet season
		27	Fish Fences & Fish Weirs			O	O	Riverine species	In rivers connecting to the lake only. Often associated with traps.
6	Bag nets	28	Scoop net – Lusenga.	O	O	O	E	Juvenile *S. tanganicae*	Sardine fishery. Only catches immature sardines in shallow water.
		29	Scoop net – Lusenga like with large mesh	O				Unknown	Only in southern Burundi
		30	Scoop net (hand operated in reed beds)	O		O	O	*Clarias* sp	Rare gear
7	Dragged gears	31	Dragged scoop nets (mousquitaire)	O	O	O		Juvenile .*S tanganicae*	Illegal everywhere. Only catches immature sardines and incidental immature littorals

O= Observed by FPSS investigations 1999/2000. R= Reported by previous FPSS surveys or to FPSS staff as existing. E= No longer used though reported, usually anecdotally, or in reports, as previously used, or reported (however) but not found by subsequent enquiry by FPSS.

	Method	No	Gear	B	C	T	Z	Target species	Comment
8	Seine nets	32	The Day Beach seine	O	O	O	O	Mixed littoral	The threat to biodiversity is assumed but not proven: though it appears that locally biodiversity is affected by this method. All beach seines are illegal in Tanzania
		33	"Swamp" Beach seine	O				Mixed littoral	
		34	Beach seine with lamps at night	O	O	O	O	*S tanganicae*	
		35	Open water seine (Development of encircling gill net)			O		Mixed littoral	Very similar to an encircling gill net. The same threat to bio-diversity exists
		36	Double stick net	O				Juvenile S.*tanganicae*	Children's subsistence gear. Not common. Catches juvenile sardine in shallows
9	Surrounding nets	37	Purse seine (in the Industrial Fishery with separate light boats)	E	R	E	O	*L stappersii*	Zambia (and Congo?) only
		38	Purse seine (Artisanal, near shore)				O	*S tanganicae*	Modification of a night assisted beach seine
		39	Purse seine (Artisanal, epi-pelagic, open water, canoe operated)					*S tanganicae*	A myth?
		40	Ring Nets (Chirimila seine)				O	*S tanganicae*	Only found in Zambia
		41	Surround net with divers (Aquarium fish)				O	*Mixed*	Aquarium fish
10	Drive in gear	42	Frightening line in shallow waters		O			Unknown. Littoral?	Very rare gear
11	Lift nets	43	Lift net, one, two and three boats	O	O	O	O	*S tanganicae*	The basis of the Sardine fishery

O= Observed by FPSS investigations 1999/2000. R= Reported by previous FPSS surveys or to FPSS staff as existing. E= No longer used though reported, usually anecdotally, or in reports, as previously used, or reported (however) but not found by subsequent enquiry by FPSS

	Method	No	Gear	B	C	T	Z	Target species	Comment
12	Falling gear	44	Cast nets	E	R	O		*O tanganicae and Labeo sp*	Not common gear
13	Gill nets	45	Bottom Set gillnets	O	O	O	O	Mixed littoral. Selective	Locally the numbers of gill nets targeting the littoral and sub littoral give cause for concern.
		46	Floating Gill net			O	O	River and estuary species	Not common gear.
		47	Encircling gill net (With boat & frightening device) day & night	O	O	O		Mixed littoral	Locally the numbers of encircling gill nets targeting the littoral and sub littoral give cause for concern.
		48	Encircling gill net (with boat & divers) Also used in aquarium fish trade		O		O		
		49	Encircling gill net (Used in the shallows without boat).	O			O		
		50	Reed float gill net placed round *Tilapia* nets			O		Tilapine fishes	Targets nests in reed beds and swamps
		51	Dragged gillnet, with listening device				E	*O tanganicae*	Reported but apparently not now used
		52	Drive in gill net	O	O	O	R	Mixed littoral	Various methods of driving the fish into a static gill net exist
		53	Seined gill net				O	Mixed littoral	A gear found only in Zambia in Chituta Bay.
		54	Staked gill net				E	Probably now no longer extant	Used near reed beds
14	Tangle nets	55	Single wall monofilament entangling net	O				Mixed littoral and benthic	Very rare and expensive. Mostly stolen from LTBP. Illegal for commercial fishing.

O= Observed by FPSS investigations 1999/2000. R= Reported by previous FPSS surveys or to FPSS staff as existing. E= No longer used though reported, usually anecdotally, or in reports, as previously used, or reported (however) but not found by subsequent enquiry by FPSS.