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Fishing Practices Special Study (FPSS)
Final report

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

Part B: Detailed Gear Descriptions

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

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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 (both English and French language versions available)
Part C: Appendices

Table of Contents for Part B

5. DESCRIPTION OF LAKE TANGANYIKA'S FISHING PRACTICES

This section takes each fishing practice in turn and provides a brief description of its use. Many photographs illustrate the range of practices recorded by FPSS in Lake Tanganyika.

5.1 Without gear

Fishing without gear means picking up the fish with the hands, or with very simple instruments such as a stick, machete or iron hook which has the effect of lengthening the hand.

FPSS recorded five different "without gear" fishing practices in the environs of the lake.

5.1.1 By hand

People capture fish by hand, normally catfish (*Clarias sp*), but any fish in practice, in the ponds, rice paddies and swamps adjoining the lake. Any subsistence level farmer or fisherman takes advantage of a fish trapped in a drying pond at the beginning of the dry season, or when migrating overland (*Clarias gariepinus*). These catches are incidental to agricultural subsistence activities and are not generally significant. Many individuals who farm land adjacent to the lake admit to benefiting from these opportunist captures.

5.1.2 Extensions to the hand

The use of "extensions to the hand" to assist in the capture of the fish is widespread. Some examples noted by FPSS were:

- In the wet season, Zambian fishermen of Kakula Village set out with machetes to search the swamps of Chituta bay for migrating fish.
- The fishermen of the Chisala River in Zambia use axe handles as clubs to capture *Clarias spp* trapped by retreating waters in lagoons.
- In November 1999 the Tanzanian FPSS team, whilst in the company of the distinguished taxonomist Dr Tyson Roberts, was able to witness *Clarias spp* being collected by hand with the use of sticks and stones whilst the fish were crossing a flooded road near the beach in Ujiji, just south of Kigoma. This was in the middle of a tremendous thunderstorm. The activity was undertaken by youths and mature men, and the fish pursued with great gusto through the shallow water. For an opportunistic fishing activity like this, the catch, of in excess of 10kg between 5 men, must have made a welcome addition to the diet.

5.1.3 The frog fishery

The capture of frogs by deliberately draining ponds and paddies and then collecting by hand occurs in Burundi only and not just in ponds bordering the lake. The trapped frogs are moved to a slightly cleaner place, dispatched, and their rear legs are removed. The legs are eaten, or sent to market in town where they are considered by those with a leaning to NW Continental European cuisine to be a delicacy. In late 1999 they retailed at US$0.80 per kilo. Frogs legs provides a good cash income to subsistence farmers.

5.1.4 Bivalve clams

Bivalve clams are extracted by hand from the mud in the environs of Bujumbura. These are not eaten by the local fishermen, but there is a market among the Asian residents and restaurants of the town. The only equipment is a suitable container to put them in. This is a very small industry, demand driven through the placement of advance orders with the fishermen.

Japanese researchers studying chimpanzees in Mahale and Japanese fish researchers in Zambia have been known to experiment with bivalve consumption. In Kigoma in Tanzania, high concentrations of heavy metals have been found in clams presenting a potential health hazard (K West Pers comm).

5.1.5 Night hand fishery using lights

At night, people in DR Congo use lights to catch resting or "sleeping" fish in the shallow waters (~15cm) of the lake. The fisherman, equipped with a torch or lamp, searches the shallows and when one of these fish is observed, illuminates it closely. The fish does not swim away, but remains where it is, dazzled by the light. The fisherman then grabs the fish with his hand. This has only been reported in Congo, but in Tanzania a scoop net fishery in shallow water exists, assisted by lights, and a frightening device.

In that none of these collecting activities is very large scale they do not appear at this time to be a major threat to Biodiversity.

5.2 Grappling or Wounding Gears

Grappling and wounding gears restrain the fish by grappling, squeezing, piercing, transfixing or wounding the fish. The distinguishing feature of the method is that the spear or grappling gear restrains the fish. The point of the spear also remains on the pole. (If the point becomes detached and is attached to a string or rope the gear is a harpoon. Harpoons are not used on Lake Tanganyika, but are used on other lakes in the region, particularly in Zambia).

5.2.1 Fish spears

Fish spears are the only type of grappling or wounding gear encountered round Lake Tanganyika. The fish are transfixed on the end of usually barbless spears, basically a spike on a pole. (This type of barbless spear can and is used for hunting terrestrial animals, with large mesh entangling nets, where the spears are employed as a killing spike for the entangled animals. It is important not to assume a spear of this sort is for fishing, unless observed being used for fishing). The spear heads are between 28 and 42cm long, from base of holder to point. The poles of the spears range from 210cm to 323cm, with the longer ones predominating. One barbed spear was observed by FPSS, and this was not a typical fishing spear with barb(s) as encountered elsewhere in Africa, though is very similar to the harpoon heads found in lakes in Zambia (not on Lake Tanganyika).

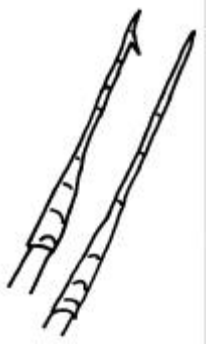

Figure 1 Fish spear heads (Tanzania).

The spears do not have a counterweight at the opposite end of the pole to the head. This confirms that they are not designed to be thrown, and can only be used as stabbing spears[11].

One spear, apparently a fish spear, was noted by FPSS in September 1999 in the Congo and Burundi area; at the border post on the Rusizi floodplain near the lake. It was impossible to measure the gear or interview the owner, as he passed into Congo rapidly at the border post, without the need to complete the usual customs and immigration checks. The FPSS Congo team found another 21 or so in the northern area of the lake, not being used in the lake itself, but in the adjoining swamps.

In Tanzania spears are also relatively rare. In Burundi and Zambia fishing with spears on or near the lake has effectively died out. In the Chasala River near Nsumbu in Zambia local

[11] Since they do not leave the hand they could perhaps be called "Lances".

fishermen are reported to use spears. Here it is to catch fish trapped by the receding waters of the local lagoons adjoining the river, rather than in Lake Tanganyika itself.

Spear fishing can be both a solitary and a communal fishing method, with up to 20 people in a line moving through the swampy area. In upstream Luiche, near Kigoma in Tanzania, a group of 12 fishermen[12] consisted of people who gathered together on occasional spare days to fish with spears in the swamp. Spear fishing in this case being both an entertainment and a chance to acquire something for the pot; and what better way to spend a Saturday afternoon?

The spears are made locally from scrap and can be sourced from any reasonable local forge – such as the one in Ujiji near Kigoma in Tanzania.

Generally throughout the lake there are very few spears in use. The 1994/5 LTR Frame Survey of the lake did not record any at all, though they were mentioned in the text as being an artisanal gear. The FPSS 1999 surveys of the lake 34 spears used for fishing were counted, 22 in Congo and the rest in Ujiji in Tanzania, though there would presumably be more, and many of those used for terrestrial hunting may well serve as fishing gears when required, particularly at the end of the wet season.

Catch rates have not been ascertained directly though the species targeted, because of the method used, must be large in size and are presumably catfish.

This fishing method seems to pose no serious threat to biodiversity.

5.3 Stupefying devices

5.3.1 Plant poisons

Plant poisons stupefy fish by directly affecting their respiration in some way. The most commonly used plant poisons are based on Rotenone in the plant (the common garden insecticide "Derris" powder originally was sourced from "Derris" root, which contains rotenone). This poison interferes with the uptake of oxygen through the gills and the fish are suffocated: however there are thousands of plants that are used for fish poisoning throughout the world and the plant poisons in use in Lake Tanganyika are not necessarily Rotenone based.

In that the use of any poison in the lake is illegal in all the riparian countries, it is very difficult to obtain accurate information on the use of plant poisons. Even in the fishing communities plant poison use is frowned on as it is acknowledged as being destructive and wasteful. Almost every fisherman knows of the principles of the use of plant poisons and most know "someone else" who has used poisons, though few fisherman admit to using the method.

Despite the breakdown of law and order, and the subsequent immunity from prosecution that this provides, Congolese and Burundian fishermen still remain reluctant to talk about the subject. Zambian and Tanzanian fishermen are still worried about prosecution, and so become very withdrawn when questioned, never admitting to using fish poisons.

However the following is apparent from the beach interviews and studies of the FPSS in 1999 and 2000:

a) The use of plant poisons is **not** widespread or commonly used in Lake Tanganyika, and was not admitted to directly by anyone except in Congo.

b) Plant poisons are occasionally used in the following locations:

[12] encountered by chance at a weekend by the FPSS Facilitator whilst on a dragonfly collecting trip

- Congo in the lake in areas of large rocks where traditional methods of fishing are less successful because the gears get tangled up. Here the vehicle of the poison is the bark of a tree, cut into strips and crushed with rocks. Tied in a bundle and weighted with stones. The fish are stupefied within 5 minutes and can be collected by diving or using scoop nets.
- Congo in bodies of enclosed water adjoining the lake.
- Tanzania in rivers, estuaries and swamps, including the Malagarasi River area but not in the lake itself.
- Zambia in rivers and other inland waters, but not reportedly in the lake
- Possibly in the Rusizi delta in Burundi but again, not in the lake itself.

In Zambia the plants used for fish poisoning are[13]:-

Scientific name	**Local or common name**	**Toxic part used**
Dolichos sp	No local name given	roots
Tephrosia sp	No local name given	leaves and pods
Syzgium guineese subsp	No local name given	bark chips
	Giant euphorbia	whole plant
	Kancense	tuber
	Cantulia	fruit
	Kantemya	leaves and roots

Despite the fact that fish poisoning using plants is totally non-selective and occurs in areas of greatest biodiversity it is relatively rare and as such is not a problem, for biodiversity nor in simple terms.

5.3.2 Chemical poisons

All the comments above about obtaining data on plant poisons apply to chemical poisons.

One single incidence of fish poisoning using chemical poisons has been reported; by an LTBP Socio-Economic Special Studies investigation in Tanzania during 1996 at the River Mungonya[14]. The agricultural pesticide Thiodon™ was reported to have been used in the river in 1970, the fishermen using 5 litres of pesticide to obtain the desired result. This fish caught by this method smelled badly and gave the consumers headaches, so was not exactly popular. According to the report, fishing with poison was subsequently made illegal and the practice was discontinued.

The FPSS in 1999 and 2000 did not uncover the use of chemical poisons anywhere in the lake. It would be hoped that this fishing practice is no longer used.

5.3.3 Deoxygenation

De-oxygenation works by the fisherman stirring up the mud in a shallow enclosed area until the mud and suspended particulate matter in the water clogs up the gills of the fish and the fish becomes stupefied though lack of oxygen.

This has been reported to FPSS enumerators, but not actually observed, as occurring in the shallow lagoons and ponds bordering the lake in the area between the Burundi frontier and the town of Uvira in Congo. Towards Lake Kivu in the Northern part of Kivu province it is apparently widespread. Presumably the fish that would be caught by such a method are those that live in these areas, with *Clarias sp* predominating.

[13] Data from the MotoMoto Museum in M'bala.

[14] Lake Tanganyika Biodiversity Project. GEF-RAF/92/G32 (1996). Fishing in the River Mungonya at Bubango Kigoma Rural District, Tanzania. Socio-Economic Special Studies (SESS).

It is a very little used technique and not particularly destructive; it poses little threat to Biodiversity.

5.3.4 Explosives

Explosives send a pressure wave through the water and stun the fish, often causing serious internal injuries. The method is totally unselective as regards size or maturity. Many fish are injured and swim away to die later. The practice is thus very wasteful.

The use of explosives, in this case grenades, for fishing, has been reported as happening (though not actually observed by any of the FPSS team) in Congo, all along the coastline from the border with Burundi to the far south of the country. Those responsible are undisciplined soldiers from several countries, sometimes resorting to this method because they have not been paid for significant amounts of time, and are hungry and bored.

Covert observation by the FPSS munitions expert reveals that the soldiers in the Uvira area of Congo at the north of the lake are usually equipped with offensive grenades of Chinese or N Korean manufacture: commonly known as “pot grenades” after their curious shape Presumably it is these grenades that are being thrown into the lake.

Despite the vast numbers of explosives of all sorts being carried along the western lakeshore (since 1995), it seems that very few actually find their way into the lake. Grenades are very expensive to buy on the open market (US$7), and the catch is small relative to the cost of the grenade; though for soldiers the cost is probably irrelevant. There may be, for military personnel, some disciplinary consequences from using the method.

In the scheme of things, although fishing with explosives is locally destructive, non selective and wasteful, it is not common enough to warrant worrying about unduly, and so poses no great threat to biodiversity.

This gear poses a serious threat to the fisherman using the technique, as these types of grenade typically have a very short time fuse; they are intended for clearing buildings and pillboxes.

5.3.5 Electro fishing

Fishing with electricity in fresh water is a very effective way of catching fish alive. The principle is that the fish are paralysed by the alternating pulses of current so that they cannot swim away. Near the electrode the fish are paralysed and cannot move (the area of narcosis), further away the fish are attracted, involuntarily to the electrode, approaching until they are paralysed, and yet further away the fish are affected, but manage to swim away. The size of the three zones depends on the strength of the current. Once the electricity is turned off the fish generally are capable of rapid recovery and swim away. (Some of those nearest the electrode, especially if high power is used, may suffer serious muscle damage and not recover).

Electro fishing was reported to the FPSS team by a voyager from Kalamie, in Congo. The fishermen are reported to be fish collectors supplying the aquarium trade, who use it in water bodies adjoining the lake and in shallow water. This report was confirmed by an aquarium fish company director in Mpulungu, who had used the method himself in Uvira District (S Kivu) prior to the current round of troubles there; and had heard of its recent use in other parts of the Congo, South of Uvira. Apparently it does not work well in the open lakeshores and most of the more valuable fish are thus not susceptible to the gear, as they live in deep water.

No further details are available as Kalamie was off limits to the FPSS team in 1999/2000, and so follow up of the report was impossible.

5.4 Lines

The principle of using a line is that the fish voluntarily takes a bait of some sort and cannot spit it out before being removed from the water. In Lake Tanganyika, hooks are used on the lines and may be baited or unbaited, barbed or barbless.

On Lake Tanganyika all hooks are curved (in the shape of a "hook") and made of steel[15]. There are no circle hooks or gorges in use. Some hooks are home made and do not have a barb, but the majority are shop bought, manufactured by Mustad™ of Norway. One other brand, Eagle™, made by Maruto of Japan is also sometimes available.

All the commercial hooks are Kirbed (have an offset crook, see Figure), and are coated against corrosion., usually with a blueing material, but sometimes they are tinned or bronzed.

Figure 2 Kirbed hooks

Flat end hooks are common in Burundi and some parts of Tanzania and are attached with an array of home grown knots. Ringed hooks are usually attached with a double overhand knot with stopper knot, or a blood knot. Home made hooks are always flat ended.

Mustad™ hooks are available round the lake in Sizes 1-20 (20 is the smallest), with sizes 8-20 being most commonly used.

A variety of lines are available. For hand lines nylon monofilament is preferred. For bottom lines multifilament of polyethylene, nylon or recycled twine from motor car tyres is popular.

The number of lines being used round the lake is huge. The Lake Tanganyika Research Project found the following numbers in use in 1994/5:-

Table 5.1 Number of handlines in lacustrine countries (from LTR data, 1995)

Country	No of Hand lines	No of long lines	Total no of lines
Burundi	193	9	202
Congo	Not differentiated		12,630
Tanzania	6,747	410	7,157
Zambia	731	24	755
Total			**20,744**

Unfortunately there are many different types of lines, used in different habitats and at different depths, with different target species. The LTR survey did not differentiate between the different types of lines. One group of lines that appears not to have been recorded is the ubiquitous pole and line, used by thousands of children round the lake to fish the margins, and though each unit catches little, their numbers make it important, particularly to biodiversity.

The FPSS detailed survey work in Burundi and Congo in 1999/2000 gives the numbers of hand lines in the area from Bujumbura to Uvira (See Appendix 9, Part C). Again this does not differentiate between different types of hand lines, but in this area of the lake there is no jigging or trolling, so all can be assumed to be "Simple Hand Lines".

5.4.1 Vertical hand lines

Vertical hand lines, or "simple lines", are one of the most basic forms of fishing, requiring just a baited hook, a weight and a piece of line. The fishing operation takes place from any platform, usually a boat out in the lake. Interestingly very few people use simple lines from the shore in Lake Tanganyika, perhaps because of problems with snags when retrieving the line from rocky habitats in the littoral zone.

[15] Petit (1997) reports an almost circular hook from Zambia, on deep set long lines for *Bagridae spp*. FPSS 1999/2000 found no such hooks

In Lake Tanganyika the line used is nearly always nylon (PA) monofilament. (PE monofilament, from unravelled PE multifilament has been observed as has single strand PE film from Mealie Meal sacks). The sizes of monofilament available in the nearby stores affect the sizes used. However as the gear is hauled by hand, lines of 0.7mmØ – 0.9mmØ are preferred to the smaller lines, as thicker lines gives more of a grip. The line is stored on any convenient line holder, which can be an old float, a bit of polystyrene, a soft drink bottle, a bit of cork or a specially made line holder, usually in an H shape. (See Gear Plan 1, Part C). The length of the line depends on the depth to be fished.

Figure 3 Fishermen using a vertical hand line from a dugout.

Crews of cargo vessels in all of the major ports of the lake fish with simple lines when in harbour. They just throw a baited hook on a weighted line over the side of the boat.

The majority of simple lines are used by fishermen from small boats, either dugout or planked. Extremely common, they can be found in every village on the lakeside,.

The gear depends on the fisherman's preference, and there are many variations on the general theme. Usually between 1 and 4 Mustad™ kirbed hooks of size 8-12 are attached on short droppers (8-15cm), and weighted with a stone or other weight tied in to the line with rubber inner tube or directly to the mainline. Sometimes lead weights are used. Old spark plugs, vehicle parts, a drill bit and bits of reinforcing rod have also been noted.

Baits observed by FPSS in 1999 and 2000 in vertical hand line fishing are:-

- Worms dug up in damp soils adjacent to the lake; a preferred bait as anyone can do this; used throughout the lake.
- The skin of the electric catfish (*Malapterurus electricus*), an organ removed and discarded when preparing this fish for the pot, and thus available free on some fishing beaches. The skin of the catfish is tough and stays on the hook well. Particularly popular in the North of the lake.
- Soap. This can be moulded in the hand into a ball of the appropriate size for the hook being used:
  - yellow laundry soap made in Tanzania;
  - blue and white laundry soap made in Tanzania; or
  - very cheap brown variety of carbolic, made in Burundi.
- Small ciclids, other tilapine fishes and sardines.
- Barley grains (from the brewery in Bujumbura, used in Bujumbura and by fishermen on Burundian cargo boats).

Figure 4 Yellow soap, made in Tanzania, a favourite line bait round the lake.

And as ground bait

- Brewery waste (from the Bujumbura brewery)
- Palm oil residues

As a general rule fishermen do not like to use sardines or small fish as bait, as these can be eaten by the fisherman himself, or his family.

Fishing takes place in all depths where fish live (up to 200m in the southern part of the lake where the oxygenated zone is deepest).

The target species depends on the depth and the substrate. Nearly all of the fish in Lake Tanganyika will accept a bait, even many of those usually reported to be herbivores. That said however, an individual fisherman knows at what depth and on what substrate he is going to catch a particular species, so the fishermen can target what they wish to catch.

Line fishing is selective in that very small fish will not be caught on a large hook. However there are vast numbers of hand lines, with a very large number of hook sizes available, fishing in most depths and substrates, so it is safe to assume that all carnivorous demersal species at most stages of their life cycles are being caught.

Hand lines contribute to the general fishing effort round the lake. Even in a small village like Kibenga south of Bujumbura, FPSS in 2000 counted more than 100 lines. Their catches contribute considerable effort to the total and are probably one of the causes of the decline in numbers of fish in densely populated areas.

5.4.2 Pole and line

Pole and line fishing is ubiquitous in inhabited reaches of the coastline of the lake. The gear is used by male children of school age, many of whom are not attending school for one reason or another, or are fishing out of school hours. During school holidays there is a noticeable increase in the number of pole and line fishers, indicating that many fishers do actually attend school when it is term time. Anecdotally some children are sent out in the morning by their parents to catch lunch. Some young adults also pole and line fish. Work by FPSS in 1999 in Kilomoni Village in northern Congo, near the Burundi border, found the following regarding who is pole and line fishing and their ages:-

Table 5.2 Occupations and ages of pole and line fishermen in Kiomoni village, Uvira Distict, DR Congo.

Occupation	Number	Average age
Farmer	2	19
Pre-school	1	6
Schoolboy	50	12.22
Truant from school	3	10.67
Unemployed	1	25
Total number /average age	**57**	**12.49**

A preponderance of school children can be noted fishing with pole and line and all fishermen are male.

The pole and line basic gear varies with geography; the extremes are as follows.

Commoner in the North of the Lake. A tapering reed pole of 2 to 4 meters with a nylon monofilament line of 0.4mm diameter slightly longer than the length as the pole. The line is weighted 10-15cm from the end with a small piece of lead (3-5 gms) and the line terminates with a hook, usually a home made bent pin without barb (though small barbed hooks are used). The hook size is very small, equivalent to a Mustad No 17 or 18. Sometimes 2 hooks are used.

With the line roughly the same length as the pole, when the fish is hooked and the pole lifted to the vertical with the right hand the fisherman conveniently receives the fish at hand

Figure 5 Little fisherman, Musende, Mpulungu. Zambia.

height with the left hand. The pole is then tucked under the right arm and the hook removed from the fish with the right hand. Alternatively the pole can be used to jerk the fish onto the beach behind, if the beach is of such a type that the catch will not then escape (such as would occur in a swamp or reed bed). The catch is kept in a bag, either woven leaf or plastic.

Commoner in the South of the lake: The pole is shorter and not usually of reed. The line is up to 10 times the length of the pole and the hook(s) is launched by swinging it round the head (sometimes to one side of the body) and releasing it in the manner of a bola. (See a typical example from Zambia in Gear Plan 2, Part C). The pole is used as a striking device, increasing the length of the hand, and serves to jerk the fish out of the water and onto the shore behind. It can also be used to jerk the line, especially if an unbaited hooks are being used, to give some action to the hook and attract the fish. It is also used as a storage device for the line.

In essence as one moves south, the length of the pole reduces and the relative length of the nylon to the pole increases, though there are exceptions.

The crews of some Congolese refugee cargo boats, fishing from the wharves and their boats in Mpulungu harbour[16], use as line holders and poles sticks cut from nearby trees with nails or pegs in them, the line being strung round the nails/pegs. These sticks are sometimes decorated with ornate designs. They are also used to cast or retrieve the hook. The length of the line however is far greater than other pole and line examples, and reflects the fact that they are fishing with the gear in various locations, and off the boats themselves, quite far up from the water.

In the Rusizi Delta area, if bait is used, the preferred bait is electric catfish skin, as it is free, tough and stays on the hook. Worms from the lake shore mud are preferred in all other areas, and are extensively used in Rusizi also. In the southern areas of the lake, where maize is a staple of the diet, broken cooked maize pieces[17] are often used as bait. Other baits noted have been fish, termites, locust/grasshopper and brewery waste. In many cases the hook is not baited.

Two of Congolese merchant boat crew in Mpulungu use 3 kirby ringed blued No 8 hooks, bound together with copper wire to make a triple hooked "perk", specifically for foul hooking *Oreochromis tanganicae* in Mpulungu harbour. Two of these triple hooks are attached on short droppers to the main line, which is then jigged using the pole across the mud bottom, the weight of the copper wire acting to hold the "perk" on the bottom. Fish investigating the movement of the hooks are foul hooked in the mouth and head region by the jigging action of the hook.

The best areas for fishing are close to "features"; the margins of reed beds, clear areas in weedy areas, paddy fields, wharves and harbours (where accessible) and in the small streams that run into the lake. However many villages do not have such features, so the children just fish in the margins.

Youths may take advantage of boats moored offshore, by swimming out to them and using them as platforms for pole and line fishing, but now in deeper water. They catch a mix of littoral species, but larger fish due to the deeper water, with *Oreochromis tanganicae* predominating.

Figure 6 Little fishermen, little fish. Nsumbu, in Zambia.

[16] Mpulungu Harbour is officially a no fishing zone

[17] Reminiscent of the "sweet corn" used by the specimen carp fisherman of the lakes and canals in England

The species composition of the catch depends on the substrate being fished. The catch of a pair of children fishing with pole and lines on the rocky beach at Zashe Village, north of Gombe Stream National Park was observed in November 1999 and the species in the catch were:-

Pseudosimochromis curvifrons
Xenotilapia sp
Lobochilotes labiatus
Cyathopharynx furcifer
(All Juveniles)

A completely different catch composition though from the same small boulder/gravel habitat just a few kilometres down the coast in Mwongongo :

Limnotilapia dardennii
Simochromis diagramma
Petrochromis famula
Lamprologus callipterus
Telmatochromis temporalis

It seems that the method will catch all carnivorous fishes in the near littoral, many of these being juveniles of ciclids who spend the early part of their life in this zone.

Figure 7 A day's catch; for lunch?

As a general rule it seems that the catch volume is dictated by quantity required rather than time or quantity available. A fisherman will continue to fish until enough fish has been caught to satisfy the requirements of the day. Typically the catch is between 300 and 500 grammes, and presumably this is considered enough to feed the average family, or provide the necessary protein to the daily menu. In any case a catch of more than 500 grammes is seldom encountered. The catch is not generally sold - though an offer to buy will seldom be refused. The catch is taken home and cooked whole, usually fried, and though small in weight, has been indicated through interview to be important to the diet of many marginal households. Indeed, in some households where the father is absent or dead this may be the primary protein component of the household diet.

The importance of these "little fishermen" appears to have been completely ignored in earlier socio-economic surveys on the lake.

These multitudes of young fishermen are catching such small fish and in such numbers that this fishing practice seems, on the surface, to pose a very real threat to biodiversity. However there really are vast numbers of these little fish in the shallow littoral, no fish in the catch is particularly rare and the fishermen only fish a small proportion of the available lakeside habitat. Thus apart from locally in highly populated areas it is **unlikely** that **at present** the method is a generalised threat to lakewide biodiversity. With increased population settlement covering more of the lakeside, and with continuing poverty, this type of fishing may become very serious for biodiversity.

In some areas, where large fish are accessible to a pole and line, the pole and line gear used can be much heavier and with a larger hook. The method then becomes an adult activity. An area where this takes place is Malagarasi delta in Tanzania, where the line is multifilament R350tex nylon with a Mustad No 8 tinned Kirby hook. The poles taper from 17mmØ to 6mmØ and are about 2.5m. The line 3 times the length of the pole. Bait is fish flesh. This is a much more substantial gear than the "children's" gear described above, and is used for *Clarias sp* and *Oreochromis tanganicae* in the rivers and swamps. In these areas, the catch is smoked for sale inland. Fishing is an adjunct to agriculture[18] in the areas where

[18] Hashish is a preferred crop due to its high value.

this pole and line activity takes place, and is also used as a recreational activity to while away the long hours in an area devoid of distractions from the daily routine.

5.4.3 Vertical hand line, baited (mesopelagic)

Some of the fishermen involved in the lift net fishery target in northern Tanzania employ their idle time whilst waiting for the target species (*Stolothrissa tanganicae*) to aggregate round the lights, by fishing for the large predators of the lake with baited lines. These are *Lates mariae* (with some *L angustifrons*). The fish are attracted to the lights because the lights aggregate their prey.

The gear is 20 to 30 hooks on a vertical line. White nylon monofilament Ø 0.65mm mainline and droppers. Each hook on an 8cm dropper and spaced about 65cm apart. The weight is Ø 25mm reinforcing rod cut to 20cm lengths, with a whipping and loop to attach the essentially smooth reinforcing rod to the mainline.

The line is kept on a softwood "H" shaped holder, with the hooks inserted into the wood to avoid tangling. When fishing from a lift net boat the line is threaded through a loop on the end of one of the long wooden spreaders for the lift net and then lowered into the water to the required depth, which was said to be 100m, though that is the depth of the deepest hook, the shallowest hook would be 70m or less. The spreader of the lift net acts as a bite indicator, in that it "nods" when a fish is caught. Several fish can be caught at one time.

Stolothrissa tanganicae is used as bait. This method is only used when the lift fishery is going on, so not during the period of the full moon. Only *Lates mariae* and the occasional *L angustifrons* are caught using this method.

Figure 8 Lates mariae (after Coulter 1992).

This method is not common. Only one example was found by the FPSS teams, at the north end of Zashe village, near the Burundi border, though others were reported to be in use. The catch rates are unknown.

The catch is of a species that finds a ready market if it can reach the market whilst fresh. However from Zashe, there is no possibility of regularly getting the fish to market fresh. So the fish is smoked and sold, or eaten by the household.

L. mariae and *L. angustifrons* are both species already in serious decline in areas fished by purse seiners or in areas of severe overfishing. In the area of Tanzania where this gear is found there are no purse seiners, but there is intensive fishing. However, in itself, due to the fact that there are so few of them, the gear does not appear to pose much of a threat to these two species, nor general biodiversity.

5.4.4 Vertical hand line, jigging (epipelagic and littoral)

Many fishermen use jigged vertical hand lines off boats to catch pelagic fish in the surface layers of the lake, or in shallow water. The fish see the moving hook, and mistaking it for prey bite at it and are hooked so they cannot escape.

The line for a sardine jigging line is monofilament, of varying sizes, but typically 0.7mmØ; with a lead or stone weight, though spark plugs and engine parts are also used. Up to 18 Kirby hooks size 14-16 are attached, on 5-8cm droppers at 12-18cm spacing. The hooks are completely bare. The line is let over the side of a boat in the epipelagic zone and jigged until fish are caught. The depth that fishing is done depends on trial and error, finding where the fish are, but is more than 8 meters, down to 20m. In the littoral zone it is jigged just above the bottom, in water of up to 30m.

Once the line is at the appropriate depth the line is jigged up and down with the hand, until fish are felt to be attached, after which it is retrieved into the boat and the fish removed. Removing the fish is the longest part of the operation, and the lines sometimes become very tangled wasting many minutes of potential fishing time in their untangling.

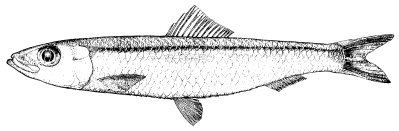

Figure 9 Limnothrissa miodon (after Coulter 1992).

Epipelagic jigging is done in the day and the target is *Limnothrissa miodon*. Fishing occurs in the late afternoon and early morning, when the fish [presumably] are aggregating in the epipelagic zone, (Coulter 1992). Evening fishing ceases when the light intensity reduces with the onset of night (the fish cannot see the hook?); and morning fishing when the sun rises and the schools disperse to the depths. Thus the period available for epipelagic fishing is very limited.

Sardines do not aggregate everywhere, nor at full moon, and can be difficult to locate. As a result only very experienced fishermen go out fishing just for *L. miodon*. Most fishermen go fishing with baited vertical hand lines, and if *L. miodon* is captured on one of the larger hooks of the vertical hand line on the way up from the bottom, the fisherman will immediately swap to his smaller hooked sardine jigging line and start fishing for sardines instead. Some fishermen just use their bottom vertical hand line to jig for sardines, but the two gears have different numbers of hooks on them, and of different sizes; the vertical hand line for bottom species thus not being an effective way of catching *Limnothrissa miodon.*

Because of the size of *Limnothrissa miodon*, and the limited time available for catching them, catches are not large. Even pulling in 6 to 8 fish with each haul, and hauling every 2 minutes, in an hour one has only caught 210 fish – a small bucket full.

It seems that there is opportunity for improving this method by the addition of fluorescent beads or tube to the hooks, to improve their visibility, so that the evening fishing period can be extended.

Epipelagic jigging is also reported (Petit 1997) to be used around light boats in the sardine fishery and the target is then *Lates stappersii* which are attracted to the lights. This activity is of annoyance to lift net fishermen who resent the presence of these interlopers, especially if their hooks become entangled with the lift net, though the same method is used by lift net crews themselves to catch *L stappersii* when waiting for sardines to aggregate to the lights.

In the littoral zone jigging without bait is also widely practised. The target is *S. tanganicae* and any other carnivorous demersal fishes, such as *Bathybates ferox*. The line is let to the bottom and then retrieved far enough that on the “down” cycle of the jigging movement the weight reaches to just above the bottom. The gear is a standard vertical hand line, used to jig instead of with bait.

The boats used are typically one or two man planked canoes, paddle powered and with perhaps a sail. Dugout canoes are also used.

This type of fishing occurs throughout the lake. Exact catch figures are unavailable. The method is small scale and does not much threaten the stocks or biodiversity generally.

5.4.5 Vertical hand line, jigging, unbaited (Mesopelagic)

This handline fishery for *Lates stappersii* in northern Tanzania does not appear recorded as a significant fishing method of the lake except that it is briefly mentioned in Petit (1997) as occurring in Mtanga, south of Gombe Park, but only as a gear of minor importance. Similarly, it only receives passing mention elsewhere.

FPSS in November 1999 noted it as a vary large and productive fishery, between Gombe and the Burundi border. It is also widely practised in the SW arm of the Zambian part of the lake (with a depth of more than 250m), south of Kigoma to Mahale and probably beyond, and reportedly in other parts of the lake also, though due to the security situation it was impossible to check areas like southern Burundi or the Congo coast south of Uvira, where the lake is deep near the coastline.

Figure 10 A young mesopelagic jigger with his gear, Mwamgongo, North Tanzania.

Figure 11 The hooks are stored on the line holder.

In Tanzania the gear noted by FPSS consists of a hand line of 150m length Nylon white monofilament Ø 0.70mm. The weight is a piece of iron reinforcing bar, 20 cm long x Ø20mm, whipped with nylon PA white mono Ø 0.70mm with one whipping used as a loop. To this the mainline of mono is attached. On the mainline 60 x size 12 Mustad Kirby ringed and blued hooks are attached on droppers of 6 cm at a spacing of 60cm. The line is kept on a soft wood line holder into which the hooks are stuck to avoid their tangling up (see figure). In some examples of the gear the shanks of the hooks are covered with strips of toothpaste tube (Colgate™) metal, metallic side out, rolled round the hook, to improve its visibility. (See Gear Plan No 3, Part C)

The gear used in Zambia is the same except that slightly less hooks are used (15 – 20), and the mainline is often of Polyethylene R350tex 3 strand. The Zambian gear is more representative of the typical gear used round the lake, the Tanzanian gear at Mwamgongo being very “commercial”.

The gear is jigged at depths of between 100 and 150m, in the mesopelagic zone. Fishing is done during the early morning daylight hours and is unaffected by moon phase. There are two people per boat.

In Mid-November 1999 an FPSS team in Mwongongo, Tanzania, observed from a nearby hill, 75 boats sailing home from the fishing grounds at 3.00pm, though more were coming into view all the time, and given the distances involved many would be out of view heading for more distant villages (Not all of these 75 vessels were from Mwamgongo[19]). Estimates of the numbers of these boats varies, but it seems that up to 200 are available to fish in the area North of Gombe Stream National Park to the border with Burundi. The sail powered boats had left during the early night (1-2am) and paddled/ sailed into the lake towards the South West, returning between 12 noon and 4.00pm. A trip length of 10-15 hours. It takes 2-3 hours to reach the fishing grounds by sail, which is faster than paddling. The fishing grounds are in the very deepest parts of the lake – more than 1000m deep.

In Kigoma from any vantage point on the lake most late mornings and early afternoons the Kigoma based jigging fleet can be seen sailing home from fishing. A majestic sight.

[19] A 1999 SESS survey of Mwamgongo reported 20 boats and 40 fishermen.

Wholesale fish in Mwamgongo are 20kg for 5000/=. An average two fisherman trip was (reported by some fishermen) to expect to earn up to 40,000/=TZ per day. The observed catches seemed to be smaller, 15–30 kg, rather than the 80 kilos that this earnings estimate would imply. The beginning of the wet season is reported as the best time for fishing *L stappersii* in this manner, so these catches could be expected to be the peak, rather than the norm

Many catches in the subsistence end of the mesopelagic fishing industry are of only 3-5 kilos.

Despite this, the reported number of artisanal boats in northern Tanzania (200 boats) catching 15 kilos a day is 4,000kg per day of *Lates stappersii* being landed in the relatively small distance between Gombe National Park and the Burundi border. Even allowing for seasonal variations and variations in effort this is a significant fishery of more than 1000 tonnes/year in this very limited area of the lake. Over the whole lake the catch of *Lates stappersii* is probably far larger than the purse seines used by the industrial fleet, though since the catch is spread out over the whole coastline is not so visible.

The gear is not new, and has been used for about 30 years. Who discovered that the *L stappersii* lived at such great depth, in the relatively distant parts of the lake, is unknown.

Zambian boats using the same method leave the village at 3.00am and return at 10.00am, a shorter trip, as the distance to the grounds is less. The Zambian boats catch significantly less *L stappersii*, but fishermen take the opportunity to use the same gear to fish for *L mariae* at great depth, using whole small littoral fish (*Bathybates sp* was observed) as bait. Their catch is a mix of *L stappersii* and *L mariae*, all of which is smoked.

Figure 12 A Zambian *L. stappersii* jigger with gear and by-catch of *L. mariae* (note *L. stappersii* curled ready for smoking aft of the *L. mariae*).

The Tanzanian boats have a sail to use whenever there is wind. In the morning there may (or may not be) a land breeze, which helps the boats out to the depths of the lake. In the afternoon the "sea" breeze brings them home. The Zambian boats are paddle powered only, though the photo above shows a boat with a hole in the front seat (and a step underneath it) for installing a sail.

The boats used in Tanzania are small, 5 – 6m, planked without frames. Three seats, one at the stern, one in the bows and one in the beam of the boat, provide stiffening for the boat. In the forward seat is a hole for the sail with a wooden step nailed onto the bottom of the boat. The lateen sail is made from PE sacking stitched together.

Stormy weather is the greatest fear of the fishermen. It is only because Lake Tanganyika is relatively benign that there are not large losses of life in the use of such rudimentary craft in a fishery so far from land.

Figure 13 Customers crowd a sail powered *L. stappersii* jigging boat. Mwamgongo. Tanzania.

Many of the vessels have attachments allowing them to be used as light boats for the lift net, or sardine beach seine fishery, which would presumably reduce the number of boats fishing when the Lift net and Light Assisted Beach Seine fleets are working.

The fish landed in Mwongongo is either sold fresh for immediate consumption or (mostly) bought by women who smoke it and send it to markets inland, mainly East of Gombe Stream National Park, rather than south to Kigoma or North to Burundi. The large amount of fish smoking going on in these villages

may explain in some way the hills denuded of trees inland.

This method is only targeting *Lates stappersii* and as such is not considered to be a threat to biodiversity. Its importance in socio-economic terms for the villages where it is practised is however very high, as it provides a large amount of income to the inhabitants, and employment for women who smoke and market the fish.

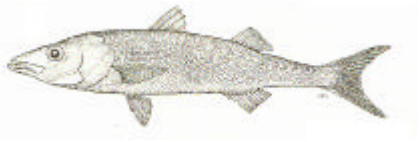

Figure 14 Lates stappersii (after Coulter 1992).

5.4.6 Bottom set long lines

Bottom set long lines are common round the northern shores of the lake, the Southern shores of the lake in both the SE and SW arms, and in areas of extensive muddy and sandy bottom such as the Malagarasi and Luiche Deltas in Kigoma District, Tanzania. Deep flat rocky areas are an acceptable substrate for long lining if there no obstructions, but on substrates with rock they are not so effective as the lines get caught up too much. Areas with rapid drop-offs to anoxic water are not favoured.

The fishing principle in all bottom set long lines is that a long line is laid along the bottom. Attached to this long line are shorter branch lines with baited hooks on. The fish takes the hook and cannot get off. The mainline and the branch lines are usually, but by no means always, monofilament of the same breaking strain, though recycled nylon from motor car tyres and PE multifilament is encountered.

The number of hooks varies with the individual fisherman; lines with 300 hooks are common. 2000 hooks have been reported. Short lines of only 40 hooks are used in Rusizi Delta in Burundi. No two long lines round the lake are the same. The hook size varies with the target species and substrate. Some of the hooks are locally made and barbless. The length of the floatline varies with the depth to be fished. The line is weighted at each end with a stone or iron vehicle part. A float, usually of bark or polystyrene, though sometimes of wood, is attached to one end, with enough spare line to reach the surface from the bottom. The layout of a bottom set long line from Ujiji can be found in Gear Plan 4 (Part C).

Figure 15 Long line in dugout, Malagarasi Delta, Tanzania. White soap bait and catch visible. Twine recycled from vehicle tyres.

The fisherman chooses his fishing area using his experience of where there are no snags and there is a likelihood of a good catch. After a period (soak time) the line is hauled and any fish that have been hooked retrieved. This period depends on location, but typically lines are set in the evening and retrieved in the morning. They are then taken home, repaired if necessary, (sometimes rebaited at home), and then reset again in the evening. This pattern has variations. In Burundi soak times may be as little as 4 hours in the Rusizi Delta area, whereas in Luiche Delta near Kigoma in Tanzania, the line may not be removed often from the water at all; merely being checked, with the catch removed, and the hooks rebaited, twice a day (morning and evening), giving a soak time of 12 hours between checking.

Some fishermen fishing offshore for large catfish and *Lates angustifrons* use a gaff made of reinforcing rod to assist them to bring the fish into the boat.

The baits that have been seen used by long line operators include:

- Worms, dug from the lake shore.
- Soap. This can be moulded in the hand into a ball of the appropriate size for the hook being used:
    - yellow laundry soap made in Tanzania;

    - blue and white laundry soap made in Tanzania; or
    - a very cheap brown variety of carbolic, made in Burundi.
- Sardines.
- If a fisherman wishes to catch lake turtles (a protected species), the lines would be baited with meat, preferably beef, but goat will serve.

When not in use or for hauling and shooting the gear, the lines are stored in any available container. Old wooden fish boxes are popular, but half plastic 20 litre jerry cans, old cooking pots and even half plastic footballs have all been noted.

A boat is needed to set the line. These are usually the common planked paddling boats with or without frames of between 4.5 and 6 meters that are found in abundance round the lake. Dugout canoes may also be used. One fisherman can shoot and haul a long line on his own. Sometimes however, especially if another fishing method is to be used on the same trip, two people occupy the boat.

The target species are large tilapine fishes including *Boulengerochromis microlepis*, catfish, *Bathybates sp* and *Lates angustifrons* and *L. mariae*. These find a ready market fresh among the relatively affluent commercial class in towns, can be smoked, and can also, of course, be consumed by the fisherman and his family.

Data from the north of Burundi in the Rusizi Delta area, collected by FPSS in 2000 showed 5 species in the catch:-

Lates mariae	32% by weight
Auchenoglanis occidentalis	32% by weight
Lophiobagrus cyclurus	19% by weight
Clarias gariepinus	13% by weight
Malapterurus electricus	3% by weight

This same data produced an average catch of 9.11 kg/trip, though unfortunately the number of hooks was not recorded.

In Tanzania in 1999 (from only one set of the line with a total catch of 10kg) three species were identified:-

Lates mariae
Boulengerochromis microlepis
Bathybates spp.

Again the number of hooks and the depth of set were not recorded.

Petit (1997) reports the reduction in numbers of long lines in the North of the Lake (Burundi), because of a lack of the target species, indicating overfishing of these stocks.

5.4.7 Staked lines

A staked line is a set line with one hook and a weight, anchored firmly to a wooden stake driven into the ground, with the baited hook in the water. The line is unattended.

One example of this gear was observed in use which employed a twine made from the strands of film polyethylene from mealie meal sacks. Three strands are woven together and the twine is knotted together every 20 – 30 cm to allow a longer twine to be constructed than just that of the length of the film polyethylene. The resultant strand of twine is between two (2) to four (4) metres in length and is tied to a pole stuck firmly in the river bank. The hooks of size number 6 are preferred and the targetted species are *Clarias sp*.

In the Lufubu River, at a fishing camp approximately one kilometre upstream from the lake, the Zambian FPSS team found a staked line. Unfortunately a return visit to re-check the gear and measure and photograph it was unsuccessful as the National Parks Authority had

ejected all the fishermen from the banks of the Lufubu in that area, and burned their fishing camps to the ground. The remains of one other staked line was observed, stuck forlornly into the bank at the site of an old fishing camp; this one was employing a Polyethylene 280d/15 multifilament as the mainline, but most of the line was lost and there was no end tackle.

One can conclude that at least two of these gears were operating in the Lufubu River until the end of 1999. No others were found round the lake by FPSS in 1999/2000, though presumably there must be some. This is not a common gear and the threat to biodiversity from it is thus unlikely to be significant.

5.4.8 Floating lines

This is a gear set in reedy areas for a variety of swamp and reed-loving species.

It is a very simple gear, consisting of a line of 210d/15 nylon multifilament of 60cm attached with a Ringed Tinned Kirby Mustad size 9 hook, to a balsa like (green and freshly cut) float. (see Gear Plan 5, Part C). The gear is baited with bits of fish flesh. It is set in the swamp in waters of 1–1.20m.

Fish targeted are all swamp species:

Polypterus aethiopicus
Polypterus ornatipinnis
Oreochromis tanganicae
2 x Clarias spp

FPSS observed this gear in use in 1999 in the Malagarasi River, where one fisherman in a dugout canoe had 30 sets of gear he was just off to set. There are no doubt others in the region who use the same method; as Petit (1995) lists them as one of the subsistence gears of Burundi – called Amatendekano. Given, the low number of these gears operating in the lake, the threat that they pose to biodiversity can be assumed to be very limited.

5.4.9 Bottom trolling

Another method not often seen in the commercial fishery (but use in sport fishing) is bottom trolling.

The gear consists of a commercial spinner, with one kirbed hook attached to 0.7mmØ mono PA - 9m. The line leads to a round stone of approx 150gms bound in mesh of nylon inner tube. To the stone is attached 90m of Ø0.7mm mono PA and then the holder of wood in shape of an 'H' (see Gear Plan 7, Part C).

Figure 16 *Boulengerochromis microlepis* (after Coulter 1992).

The spinner and stone are paid out behind a one-man paddling canoe whilst the fisherman is paddling on the way to set a long line. The stone runs along the bottom, which must be sand and free of obstructions (the hook is moving over the bottom). The depth the gear is set in varies but is typically 10-30m, and the amount of line paid out depends on the depth (the longer the more line). It would appear that the stone raises a cloud of dust; fish investigating this come across the spinner flashing behind the cloud of dust and take it[20].

The method has only been seen being used in Ujiji in Tanzania, on the Luiche Delta fan and only one fisherman there has a set of gear. Target fish are *Lates angustifrons*, *L. mariae* and *Boulengerochromis microlepis.* No mention of the use of this gear on Lake Tanganyika has been found in the literature. Therefore, such a rare gear poses no threat to biodiversity.

[20] A very similar method, using a retrieved line, is used in Europe for catching flounders in estuaries

5.4.10 Surface trolling

Surface trolling gear is not common: FPSS recorded it being used by 3 people in Zashe village in north Tanzania. The gear consisted of 19 hooks, spaced at 670cm apart on 16cm droppers of Ø0.8mm white nylon monofilament, attached to mainline of Ø0.9mm nylon white monofilament.

A PP foam doughnut shaped float is attached at far end of line, 296cm behind last hook. The line is trolled behind a paddling boat with the first hook 15m behind stern. No 9 Mustad Kirby Ringed and Blued hooks are used (see Gear Plan 6, Part C). Hooks and line are stored on an 'H' shaped piece of wood, with the hooks embedded in the soft wood to stop tangles.

The gear is used by trolling at night round the area of the light boats of the lift net fishery: the vessel is a two-man paddling canoe. The target species is adult *Lates mariae* only with sardine used as bait.

Since this is not a common gear it is presumed not to pose, in itself, a threat to biodiversity of the lake.

5.4.11 Sport fishing

Sport fishing is included here because it is permitted in National Parks in both Zambia and Tanzania, on payment of the appropriate fee. Thus it is one way in which Lake Tanganyika's aquatic biodiversity directly generates international currency for the National Parks.

Sport fishermen use the following methods on the lake[21]:

- Epi pelagic trolling
- Demersal trolling
- Vertical bottom line with baited hooks
- Mid water vertical line fishing with baited hooks and float
- Dead baiting (using a whole dead fish as bait in one of the practices above)
- Live baiting (using a whole live fish, usually trolled or on a vertical line)
- Fly fishing
- Spinning from the shore or boat

Figure 17 Watch out for those crocs! Sport fisherman at Kasaba Bay, Nsumbu National Park, Zambia.

There is no necessity to go into detail on the various gears and practices used by sport fishermen on Lake Tanganyika, even though some, like fly fishing and spinning from the shore are only carried out by sport fishermen; and could rightly take their place, fully described, in the pantheon of gears in use on the lake. The gears do not have to be fully described because sport fishermen are in reality very inefficient fishermen, being prepared to spend relatively vast sums on very low returns, the catch merely serving to enhance the fisherman's' self-esteem. The catch is minimal in quantity and of mature fish. The variety of the gears used to achieve this meagre return reflects sport fishermens' large budgets, imagination and vanity more than their actual fishing needs. As sports-fishermen know, fancy gear catches fishermen, not fish.

The target fish are *Lates angustifrons* and *Hydrocynus goliath*, the giant tiger-fish, though the latter is rare and difficult to catch. Fishermen also feel fulfilled with the capture of the "English fish", *Boulengerochromis microlepis*, which the lodge chefs are only too pleased to

[21] Nearly always with a rod of fibreglass, carbon fibre or boron, and nylon monofilament line with a mechanical reel, either "fixed spool" or "multiplier", to control the end tackle and store the line.

cook up for the successful angler and his fawning acolytes, though large ones are taken home and "stuffed"[22].

Of particular attraction to sport fishermen at Nsumbu is the presence in Nkamba Bay of the fabled "Golden" Nile Perch of Lake Tanganyika, several examples of which can be seen affixed to the walls of the lodges. This is a local variety of *Lates angustifrons* which is golden yellow when alive. The colour fades rapidly on death. Not many are captured.

Once a year the Zambia National Game Fishing Competition is held and the lodges are full for two weeks. At Christmas and Easter the lodges are also full.

The sport fishery in Nsumbu National Park in Zambia is a commercial enterprise, in that the lodges charge visitors, most of whom fly in from The Republic of South Africa, for the pleasure of targetting the stocks of the national park with rod and line. The lodges materially assist the National Park authorities in their efforts to stop fishing in the protected parts of the lake. It is in the interests of the lodges that the fish are preserved, for Nsumbu is poor in four-footed game and is very remote. Without fishing there would be few visitors. In addition to paying the lodges the fishermen pay ZK5000/day to the park authorities[23].

Whilst the catch of sport fishermen does not much affect biodiversity, sport fishing is the mainstay of the 2 lodges located in Nsumbu, and through them provides employment and income to the local populations. It is revenues from the fishing visitors that help protect the reserves' lake resources, and so in this manner sport fishing could be argued to protect biodiversity.

In Burundi some sport fishing is engaged in by local expatriates in the harbour of the Circle Nautique in Bujumbura. This occurs in the late afternoon. The catch is of small mixed littoral species and is presumably eaten by the fishermen. This is a very limited activity and of no real consequence to biodiversity.

5.4.12 Traps

Of great interest is that the number of traps appears to have been greatly underestimated in past surveys. The LTR 1995 frame survey of the lake, Paffen, P. *et al* (1996) found 13 traps in the whole of the lake, and none of these in the northern area of the lake. Even the thorough 1990 survey by Bellemans (1991) in Burundi found only 84 in all Burundi.

The FPSS survey in northern Congo (October 1999) recorded 69 active traps in the Lake, 1632 in the lagoons connected to the North of the Lake with 2687 others stored in reserve. On the Burundi side of the border another 1200[24] were estimated to be active. This makes a total of 3000 active traps – mostly in the swamps and lagoons north of, but associated with, the lake. Even in Tanzania and Zambia trap fishing was more common than previously recorded, and more types of traps were found too. The undercounting of the traps may be due to the fact that the traps remain in the water and are not returned to the fisherman's home or beach after fishing, as other gears are. Also many of these fishermen do not have a boat; hence a beach survey would not uncover them. Even a

Figure 18 A trap maker in Gatumba, Burundi, displays his wares.

[22] Actually a cast is made and the final trophy is painted fibreglass.

[23] A trifling sum compared to the price of transport to and a night in the lodge with drinks and meals.

[24] Due to immigration the village of Gatumba, at the top of the lake, is now Burundi's' second largest settlement. The population is now estimated to be in the region of 140,000 – 160,000 (April 2000).

questionnaire type survey may identify fishermen owning traps, but unless further inquiries as to the actual number owned by the individual fishermen are made, again there could be sources of error.

5.4.13 Bottom-set non-return traps

Figure 19 A fish trap from Kalambo river in Zambia.

The principle of non return trap fishing is that the fish enter the trap voluntarily and then are unable to find their way out due to a device which stops them exiting.

The commonest non return trap is conical and made of a variety of materials, most commonly bamboo slats over a wooden framework, and a mesh of recycled polypropylene twine tied into the bamboo. On larger traps the whole framework may be made of bamboo or wooden sticks. There is an ornate funnel entrance in bamboo and mesh, or sticks, formed round a steel or wooden hoop. The trap size may vary, both in length and circumference, but is typically about 70cm long and with a diameter at the "fat" end of about 50cm.

Figure 20 A large trap from Malagarasi delta, Tanzania.

Wire non return traps are also found in the lake. These are made from chain link fencing (Burundi), chicken wire (Burundi), or a mesh of wire recovered from steel hawsers (used by crews of Congolese cargo boats in Mpulungu Harbour). Reeds are used in the (Kalambo River region of Zambia/Tanzania) and Rattan woven traps also exist (usually without non return device and probably not actually in the Lake itself).

Variations in individual construction abound. Whilst most fishermen make their own there exists in the northern part of the lake a cottage industry making traps for sale to fishermen.

Although these traps are usually set in reed beds, swamps and lakes adjoining Lake Tanganyika the traps can also be used in open water up to 50m deep (Burundi).

The entrance to the commonest type of non return trap is not central. The fish have to swim upwards, into the funnel of the non return device, and then once they have passed through the funnel, drop down into the body of the trap. They then do not swim up, to the entrance of the trap which is near the top, to try and escape. When the time comes to remove the fish the fisherman lifts the trap from the water, turns the trap upside down and removes the fish by hand. The wire traps made by Congolese in Mpulungu have a central entrance.

The traps are usually, but by no means always, checked every 24 hours. They can be left for days, since the fish do not escape and do not die and spoil. The target species are catfish and large tilapine fishes. Catch rates measured by the Department of Fisheries in Burundi in the first 6 months of 1999 were 6.3kg per lift. FPSS in Gatumba, Burundi in November and December 1999 found a catch rate of 4.1kg per lift from 33 lifts, and in 2000 an average catch of 3.3kg was measured from 3 hauls, and in Tanzania FPSS measured the catch from only one trap which contained 17 kilos of fish. (See Appendix 6, Part C).

The species recorded in traps in Tanzania were:

Lates mariae *Oreochromis tanganicae*
Tilapia rendalli *Tilapia spp.*

While in Burundi, the species recorded were:

Clarias gariepinus *Oreochromis tanganicae*
Oreochromis niloticus

Small fishes can escape one of these traps, as the mesh size is typically 45 – 50mm.

Bait is often used. In streams where there is one approach, and the trap fills this approach, then bait is not necessary. In reedy areas and swamps balls of cooked manioc or maize flour are used. Where it is available, brewing waste is preferred, while fish itself is rarely used.

Fish fences may be used in conjunction with these non-return traps, to concentrate the fish into the trap. These traps are made and operated by men only. A man may have up to 100 traps stationed in the field and a selection at home under repair or new ones for replacement. Typically one trap fisherman owns 30-50 traps.

Figure 21 A Congolese fisher collecting his traps in the shadow of a freighter in Mpulungu Harbour, Zambia.

The catch is alive when collected and is also very saleable, because of its freshness and size. Despite this, much of the catch in remote areas is smoked, merely because there is inadequate transport. There is apparently some problem of theft from traps, as they are left unattended. Old traps are often seen in villages placed over young trees to protect them from the depredations of goats.

In that the smaller fishes of key interest to biodiversity are not trapped, and only large adult fish caught, unless there are very large numbers then there should be little problem with their effect on lakewide biodiversity. However, in the Rusizi Delta area, particularly in the swampy lands adjoining the lake in that region where there are more than 3000[25] traps being operated in the wet season, it would seem that this practice poses a serious threat to biodiversity. If each trap catches 4kg every lift and each lift is weekly, then the annual catch from traps alone in the Rusizi Delta area is more than 600 tonnes[26].

5.4.14 Mid-water non-return fish traps

Near Kabyolwe village, on the border of Nsumbu Game Reserve in Zambia, approx 2km east of the village; the FPSS found a mid-water fish trap. This was situated about 120m offshore from a rocky shore in a small bay. Under a very large float made of about 20 sticks (~9-12cm Ø and 1.4m long) was strung 4 yards (3.68m) under water, by two ropes of liana, a large three chambered trap. The trap was attached to the bottom, this being in 45 yards (41.4m) of water depth, the weight being a large stone, and the rope being further lengths of liana.

The trap was made of bamboo lattice work bound with bark lashings, with square meshes of about 10cm x 15 cm. The whole made of 3 baskets woven together with the mouths of each basket joined in the middle. Thus the trap was three chambered. Each chamber was approximately 1.6m long by 85cm round. One end of each chamber was woven over in the manner of a basket.

Figure 22 A pelagic fish trap in Zambia. Float and one of the 3 chambers visible.

[25] FPSS 1999/2000 did not count traps inland of the Lake, merely those in the villages adjoining the Lake which also border the swampland adjoining the lake. There may be many more in inland villages fishing the same waters and swamps adjoining the lake.

[26] In late 1999/ early 2000 in Burundi, fishing in the lake was restricted for security reasons. Many trap fishermen increased their effort in an attempt to cash in on the resultant high prices for fish.

Where the three baskets were connected together, the triangular gap in the uppermost side had been woven over and there was attached to the middle a bunch of grass and the liana ropes to the float. On the underside the entrance is woven so as to be circular. The rope to the weight is attached to the side of the entrance.

Inside the "foyer" of the trap are three non return entrances, made of sharpened sticks, one for each of the three chambers (or baskets) of the trap. Inside the trap were 9 large *Dinotopterus cunningtoni*, a large catfish, eight in one chamber and one in another. The third chamber had been broken into and the fish stolen. The trap had been there from Sunday to Tuesday, two days soak time.

A boat is needed to set and check the trap. The target fish, despite being catfish, and bottom lovers who usually live amongst big stones, swim up the rope to the trap, and enter it. The fisherman supposed that this was because they liked the shade created by the trap and the grass laid specifically to increase the shade.

The fish are removed from the three discrete chambers through a small patch in the wickerwork at the top of each chamber, which has to be undone each time for the purpose. The fisherman uses a spear to remove the fish, though the spear was not available for inspection.

The fisherman reported that there used to be a lot of this type of trap in Zambia, but only a few people now knew how to make them and they were dying out. Two others in addition to the one at Kabyolwe were recorded [27]in the water off Chisanza village in the southeastern arm in January 2000. The traps last 6 months and the rainy season is the best time to use them.

These traps are very rare, but seem to be very efficient at catching adult *Dinotopterus cunningtoni*. Were there a large number of them, they may pose a threat to this species, but given that the practice is so rare, they are more a curiosity than a threat to biodiversity.

These traps (two-chambered but otherwise similar) are described in a report by the Game and Fisheries Department of Zambia in 1965[28] as such:-

> *The Chisowe is a basket trap with three sections. A central hall section, easily entered by fish, leads off by funnels into two side sections which are said not the be baited. The trap operates either on the bottom or in mid water. Fish are said to swim up the anchor rope for an unknown reason and enter the trap. This trap catches Dinotopterus exclusively.*
>
> *This method of fishing also has a tradition of fishing attached to it. Persons using this method are apparently unable to shake hands for if they do the victim will die and will thereafter drive fish into the trap for the fisherman.*

Most unfortunate for the FPSS team, who all greeted the trap owner they met in Kabolywe Village in December 1999 with a warm handshake.

5.4.15 Tubular traps

Tubular traps restrain the catch by the pressure of the water flow restricting the fishes ability to swim out of the trap.

This type of trap is very common in rivers throughout Africa, however in the streams and rivers flowing into Lake Tanganyika they are not common, because most of these streams

[27] By the FPSS facilitator, whilst on a boat tip to confirm the existence of the Lake Tanganyika Ichthyosaur

[28] Republic of Zambia. Ministry of Lands and Natural Resources. Game and Fisheries Department (1965) Fisheries Research Bulletin 1963-64.

either not permanent or are slow flowing rivers when they get near the lake. The method requires quite a strong current or a fish weir to increase the current.

One tubular was set in one of the side streams of the river in the valley of the Kalambo, approx 2km upstream from the lake. A barrier of stones, as a fence, rather than as a weir, was placed across the stream and in the middle was placed a tubular trap. The fish are thus directed down the trap. The fish enter and cannot return or escape due to the strength of the flow of water into the trap.

Figure 23 A tubular trap in the Kalambo River, (Zambian side).

The trap is conical, 1.60cm long and 40cm wide at the mouth. The trap tapers down to the other "thin" end where the reeds of which it is made are tied together. The reeds are fastened to a circular wooden hoop (of Ø 2cm wood) at the open end with strips of bark. There is only one hoop, about 5cm from the entrance. The reeds are fastened together further down the net 6 further times with bark lashings, though there are no further supporting hoops. Through the base of the trap, 10cm back from the entrance, is thrust a 105cm pole of wood, 35cm sticking out each side of the trap. This is used to jam the trap into the stones that make up the guide/barrier in the stream.

During the dry season the fish migrate down the river towards the lake and are caught in the trap facing upstream. Several others examples of this kind of trap (some with non-return devices) were observed by the FPSS in 1999/2000, but never *in situ*. They were always being used as decorations in Hotels and Lodges.

In itself, as in the example given above, this gear does not pose a threat to biodiversity, but when associated with fish weirs, it seems to be more destructive, in that few fish choosing to travel downstream can escape.

5.4.16 Labyrinth traps

A barrier/labyrinth trap catches fish by them entering the trap voluntarily and then not being able to find their way out. The fish are guided into the trap by the sides of the trap which often have fences attached to them (not in Lake Tanganyika).

Figure 24 A 'V' shaped labyrinth trap in the mouth of the Kalambo River

A simple labyrinth trap was found in the reed beds at the mouth of the Kalambo river in Zambia. This is a wet season gear and, typically, 6 or 8 of these would be constructed in the wet season. The trap was V-shaped, made of reeds and with each arm of the V 308cm long on the outside. The entrance was 6cm wide at the base of the 'V' (see Gear Plan 8, Part C).

Another labyrinth trap, a heart shaped one, was observed in Kapata village, Chituta Bay, Zambia. It was reported that in the middle of the wet season, about 6 were built in the village. The trap is built in a channel in a reed bed. It is made of a sheet of reeds, held together with rubberised nylon multifilament twine of approx 1.0mm Ø removed from worn out car tyres. The reed wall is supported by 9 wooden posts driven into the mud of the reed bed, and attached to the reed wall with further lengths of rubberised nylon from car tyres. From above, in plan view, the trap is heart-shaped (♥) with the entrance to the trap being in the bottom of the 'V' of the top of the heart shape. The opening is restricted to the bottom 10cm of the reed wall, and is relatively small, being about 5cm across at the widest. The trap is built so that the entrance faces towards the main body of the lake, so the trap catches fish entering the reed bed from

the lake. The reeds used for the reed wall are approximately 1.8m long (including the sections under the water and stuck in the mud), and the posts used to hold the structure up are 1-1.20m long. The trap itself is 1.6m long and 1.2 m wide.

These traps are wet season traps, particularly effective when the water level has risen from its dry season low. The target species are *Clarias sp* and Tilapine species. Ten kilos in 24 hours is a good catch. The fish are removed from the trap using a small scoop net. Some theft of fish from these traps is reported.

There are not very many of these traps and they are located only in the southern part of the Lake.

5.4.17 Fish fences and fish weirs

Fish fences and fish weirs are usually associated with fish traps, or some method of restraining the fish once it has passed over or through the weir, or been herded by the fish fence.

Figure 25 A fish fence in Malagarasi Delta. To be used in conjunction with a non-return trap

Four fish fences and weirs have been noted by FPSS in 1999/2000, as follows:

- A fish fence on the Lunzua river, at Simumbele village upstream from Kapata village near Mpulungu in Zambia. This was seen in the dry season[29], (October 1999), when the stream was low, and was a remnant of the fence built in the wet season of 1998/1999. Exactly how this fence worked is hazy, but it presumably is used in association with woven rattan type tubular traps, common in the interior of Zambia.
- A similar type of weir was reported (early Jan 2000) to be placed on the upstream Lufubu ("where the water runs fast") several miles upstream from Kabyolwe village. The weir blocks the river completely, and raises the level of the water upstream of the weir by (in this case) about 15cm above the downstream side. The water flow is directed through three sluices, each of which is blocked with a tubular trap, (which filters all but the smallest fishes). This weir/trap construction was said to be the cause of a complete absence of fish from the upper reaches of the Lufubu, and was destroyed in late January 2000 by the National Parks Authority, as it was operating in the Nsumbu National Park.
- In the Kalambo a tubular trap in conjunction with a "fence" of stones was noted and is described above.
- In the Malagarasi delta fish fences are used to direct fish into bottom set non return fish traps. The fences are made of reeds, set in the mud of the shallows of the delta, in a cross-hatch pattern, forming a support, which with the addition of further reeds, large fish cannot pass. The fence extends across a shallow (<20cm deep) creek and at one end of the fence is set a bottom set non return trap. Essentially the creek is blocked off with the only exit being the opening with the trap in it.

The weirs on the Zambian part of the lake are said to target *Alestes sp* and *Clarias spp*. The fences in the Malagarasi delta target *Oreochromis tanganicae*.

[29] By the FPSS facilitator whilst dragonfly collecting.

Where fish weirs block off the whole water flow, and filter all the fish passing down the river into traps, they pose a serious threat to the populations of fish in the rivers where they are placed. Several species travel up rivers to breed, or travel from rivers to the lake at various times of the year. All of these would be filtered by the weirs and traps on their journeys down the river to the lake. In any legislation that may be enacted in response to concerns on overfishing or biodiversity, the use of fish weirs in conjunction with traps should be included.

There are no data on catch quantities or seasonalities.

5.5 Bag nets

Bag nets include scoop nets which are one of the mainstays of the traditional fisheries of the northern part of the lake. The principle of a scoop net is that the fish are filtered from the water in a bag of netting kept open by a frame, which is moved through the water by the fisherman.

There are four types of bag net being operated on the lake. Note that many gears employ bag/scoop nets as an ancillary to the main catching gear, usually to remove the fish from the net.

Ancillary scoop nets are used in:

- The industrial purse seine fishery as brails.
- The lift net (Artisanal) fishery.
- Chirimila seines (Ring nets) in Zambia.
- Subsurface seine (the Aquarium fish trade).

Figure 26 Ancillary scoop net. Lift net fishery.

5.5.1 Lusenga

A lusenga is a large scoop net for immature sardines, with a wooden frame and a bag made of what is locally called “mosquito netting”. The principle is that the fish are filtered from the water by the mesh of the net, which they enter more or less voluntarily, or at least do not make much effort to escape.

Figure 27 A scoop net for sardines in north Tanzania.

The scoop net frame is kept on the beach and the bag kept rolled up in the house. The bag being relatively expensive to make and liable to theft if left about. The diameter of the opening of a lusenga is typically less than 3m; 2.5m – 2.75m being common. The opening is not quite circular, being slightly taller than wide. The depth of a lusenga bag varies but is typically about 3.5m. The handle is of variable length, commensurate with the size of the opening (larger nets have larger handles), but typically 5-7m.

Before fishing, the fisherman attaches the net to his frame on the beach, using 210d/45 twine or similar. He uses a two-man paddle canoe with a pressure kerosene lamp on a holder in the bows and attracts sardines in waters close to the beach. These are led by the boat into shallower water which tends to concentrate the fish since they keep clear of the bottom. The fish are then scooped out of the water using the net on a pivot on the side of the boat.

Larger sardines are absent from the catch, as they evade the net, and tend not to be in the lake margins most of the time anyway. Most other species are not attracted to the lights. The catch thus tends to consist of small sardines. It should be emphasised that this kind of gear operated in this way cannot catch large fish as they swim out of the way of the net. A forced increase in the size of the mesh would make the fishing gear inoperable, because

then the target fish, small pelagics, would get through the mesh and almost nothing would be caught.

Most nets round the lake are in fact made of mosquito netting but in Burundi the netting for these bag nets is sold in Bujumbura in the Asiatic Quarter as curtain material. The mesh size for this product is 6mm so is in fact legal in Burundi and greater than that of "mosquito netting", which is really tiny (about 1.5mm stretched mesh), and is often stated as being the material for a lusenga bag in Burundi. The mesh of the curtain material is knotless braided and octagonal shaped. In Tanzania and Congo true mosquito netting is used for the bag of the net.

Bags for these nets are really tatty, and are made from numerous pieces of netting, sewn together to form a bag shape. Some of the netting pieces are coloured or have ornamental designs and even words embroidered on them.

Lusenga fishing is dependent on lights. At the period of the full moon, when the moonlight intensity is highest, the lamps used to attract the fish do not work and fishing is suspended. Thus lusenga fishing works only about 75% of the time.

The numbers of Lusenga nets seems to be decline. For example, lusenga are no longer operational in Zambia, where in the early 1950's, lusengas were the commonest form of sardine fishing gear on the Zambian part of the lake. They are reported to "not work any more". In Tanzania, where there are suitable sloping beaches, lusengas can still be found, and in Burundi near Bujumbura and northern Congo they are quite common.

The Burundian Department of Fisheries sampled 36 Lusenga catches between January and June 1999 and found an average catch of 15.8 kg per night. In northern Tanzania, FPSS measured the catch of two lusengas and the average catch per night was 18.33kg, from an average of 1.33 scoops per night (13.75kg/scoop). The LTR survey of the lakeside in 1995 found thirty seven lusengas in Burundi, two hundred and seventy one in Tanzania and eight in Zaire (DR Congo).

As few large adult fish of any species, and relatively few juveniles of benthic and littoral fish are caught by this method, it is not considered to be a threat to biodiversity. It would be beneficial if the fishermen did put back any juveniles of other species, but they are unlikely to do this until serious environmental education has been implemented, and it becomes socially unacceptable to catch the fry of juvenile littoral species. If this was achieved it would probably be, by that stage, unacceptable to take the fry of sardines.

5.5.2 Large meshed lusenga

This lusenga is used only in the south of Burundi and is not found elsewhere. This gear has a mesh of 8-10cm and is operated in a similar manner to a mosquito meshed lusenga. Due to the security situation the FPSS 1999/2000 was unable to visit south Burundi and make a thorough assessment of numbers, catch composition or effectiveness. It is assumed to be an uncommon gear.

5.5.3 Scoop net (hand-operated)

These scoop nets are used in reedy areas to catch catfish and tilapine fishes. The net used in Burundi is basically the same shape as a lusenga, except that it is smaller (1.2m x 1.5m) and the frame is made of steel (see Gear Plan 9, Part C). The mesh size is 25.4mm (1 inch) and this enables it to be drawn through the water at a speed fast enough to catch the fish.

The fisherman rolls up the net on the frame for storage and transport, and removes the pole from the net frame. When going fishing, he carries the gear to the fishing area and reassembles it, attaching the mesh to the loop of the net with some twine. A restricted area, such as channel or reed margin is then then swept rapidly with the scoop net, the fish are not seen before sweeping.

This is not a common gear, there being none at all recorded in the beach surveys of LTR, Bellemans or FPSS, but two were observed by coincidence in the Rusizi Nature Reserve in Burundi.[30]. Since this gear does not involve using a boat, and is not dependent on a beach it is perhaps not surprising that past beach surveys have failed to record it.

Other scoop nets are used in the reed beds of Zambia. The principle of this is the same as for the preceding scoop net from Burundi, except that the gear is much smaller, and used in the wet season for the capture of *Clarias sp*. In this practice, the fish are seen before capture. The FPSS in 1999 found one example, in Chituta bay, which because of the dry season was not in use.

In Tanzania small scoop nets have been found (Petit 1997) used in conjunction with lights in a drive in fishery at night, where a sleeping fish is located using lights. The scoop net is placed behind the fish and a paddle is struck onto the water, frightening the fish into the net.

Given the small scale of operation, none of these three variations of scoop nets are presumed to present a threat to biodiversity.

5.5.4 Dragged bag net (Mousquitaire)

The principle of dragged gear is that the passive fish are filtered by the active net which does not necessarily have to have a frame. The Mousquitaire, is a dragged gear made of genuine mosquito netting (mesh size about 1.5mm) with a rectangular entrance and a long bag behind (see figure below). Although some of these nets are made from sewn sheets of mosquito netting, which is available in the larger towns, many are made from Chinese made mosquito nets that can be bought in most street-side markets and town stores round the lake (see Gear Plan 10, Part C).

Figure 28 A Chinese made mosquito net used for fishing in Zashe, Tanzania.

The two sides of the net are fastened to poles by which the mouth of the net is held open. One fisherman takes each pole and the bag net is dragged along in the margins of the lake (in water less than the depth of the mouth of the net).

The gear is very portable, and usually carried rolled up on the poles used to drag the net and keep the mouth open. Fishermen patrol the beach margins and when a school of fry is sighted they unfurl the net and proceed to drag it through the fish school.

Figure 29 The catch (~300 gms) of a Mousquitaire in Zashe, Tanzania.

The catch is almost exclusively immature sardines, though some immature fish of other species are also taken. May and June are particularly productive as the fry of *L. miodon* are in the margins.

Subsistence fishermen tend to fish until they have caught a predetermined amount of fish. When the bucket, casserole or plastic bag or other receptacle is suitably full they roll up the gear and go home. They are generally fishing for the pot rather than for commercial purposes. Artisanal fishermen fish for sales and catch considerably more. In Zambia at Mpulungu sardine fry are considered a delicacy, and are much sought after by consumers. Fishermen

[30] When the 1999/2000 FPSS facilitator was crocodile watching

therefore fish as many as they can in the season. They apparently make a flavoursome omelette, and are equally delicious fried.

The average catch of these nets as observed by FPSS in northern Tanzania and Congo (Uvira) in late 1999 was rather less than 2 kg/day, and this must be presumed to be for subsistence rather than sales. This provides an important adjunct to the diet for some lacustrine families.

Petit (1997) comments that mosquito nets can catch up to 10kg/day which is confirmed by the Burundi Fisheries Department's measurements of 9.7 kg/day in early and mid 1999. This is a lot of individual fish, given that there must be many hundreds of sardines per kilo. These catches would be for sale.

It should also be said that since the mortality of young sardines is so vast, and relatively few [31] are killed in this manner the gear should also pose little threat to the pelagic sardine populations on which the artisanal fisheries of the area depend. The method is illegal in all 4 countries round the lake as it violates mesh size regulations.

Therefore, this method is not considered a direct threat to biodiversity as the catch is almost all juvenile sardines, which are not supposed to be liable to extinction.

5.6 Seine nets

A seine net sweeps an area. The fish are typically herded into the path of the net by draw lines which increases the area affected by the seine. Beach seine nets concentrate the fish against a beach, and may have a bag into which the fish are further concentrated. Open water seines usually have a bag and are operated from a boat.

There are four basic designs used in the lake:

- A beach seine for sandy beaches.
- A small "beach" seine for muddy swamps and river mouths.
- A beach seine for use exclusively with lamps at night.
- A seine net with bag developed from an encircling gill net, operated from a boat and using a frightening device, at night.

5.6.1 Beach seine (day)

Figure 30 Hauling a beach seine in Musende Bay, near Mpulungu, Zambia.

An area of the lake off the beach is enclosed by the net and the draw lines, which are paid out from a boat. The boat returns to the beach and the draw lines on each side are then hauled in by manpower which concentrates the fish in the path of the net section in a herding action. Eventually the draw lines are completely hauled in and only the net is left in the water, with the fish concentrated in it. Then the two wings of the seine are hauled and the fish are further concentrated into the centre of the net. This central section of the net is then pulled up onto the beach and the fish removed[32].

[31] Compared to the total mortality of this age class.
[32] Note that with a beach seine an **area** of shallow water is swept, unlike purse seines which sweep a **volume** of water.

Sometimes the boat is used to provide extra floatation to the bunt of the net, particularly if a bag is incorporated in the net design. In many areas the seine is not operated on one beach only, but is very mobile, the boat and haulers moving from beach to beach, up and down the coastline, fishing wherever possible.

On Lake Tanganyika there is no mechanisation of the hauling and manpower has to be collected in sufficient numbers to operate the gear. A minimum of 6 people are needed on the small seines, but some of the larger seines may require up to 20 men. In urban or village settings there is nearly always a large crowd looking on and willing to assist for the chance of a few free fish.

The beach seines on the lake are very basic pieces of equipment. But, they are very large catch a lot of fish. Typically they are about 80m long and have rope draw lines of about 200m each side. Large ones may be 250m with up to 1.5 km of draw line on each side[33]. In the extreme northern end of the lake the seines have no "bag" as such, except that the central section of the net, where the fish are finally concentrated, has a smaller mesh size than the two wings. A typical beach seine from Burundi is given in Net Plan 11 (Part C). Further south in the lake the presence of bags in the nets becomes more common and a typical example from Zambia is illustrated in Net Plan 12 (Part C).

A beach seine can only be operated from a beach or over mud, as the groundrope slides over the bottom and hitches on any obstruction. They are habitually used in the littoral and sub-littoral, as this is the area nearest to the beach. They are used all year round, and day and night, but usually during the day.

Ownership of a beach seine is usually by an individual; they are in principle expensive to make. The owner may not even be active in the fishery, rather a business man who hires the crew to operate his seine net. Sometimes families or co-operating groups of people (usually related) own a seine collectively and it is operated by a larger group, the extra hands being either close relatives, friends or passers by. The ownership and operation of a beach seine in Zambia is described in Petit (1997).

In Burundi, the mesh and other bits and pieces needed to make a beach seine are all available in Bujumbura, but the high cost of netting and rope is putting them out of reach for most fishermen. Indeed no "new" seine was encountered by FPSS in 1999/2000, nor any seine that showed any sign of being seriously repaired, with large amounts of new netting, within the last 3 or 4 years. In Congo reports were received of beach seines being abandoned due to the costs of repair. Further south in Kigoma in Tanzania there are shops which sell sheet netting for liftnets of 8 and 12mm stretched mesh (this is knotless). Some pieces of large mesh netting come from towns around Lake Victoria, where beach seining has been banned. Similarly with Burundi and Congo new seines are not common in Tanzania. In Zambia the nets are really tatty, as there are very few sources of net; the operators of beach seines rely on the industrial fishing companies for all their supplies of netting. The companies sell off old nets or surplus nets, sometimes by the kilo, and these are bought and used to make and repair the Zambian beach seines. Since the fishermen cannot control what netting is available, they take what they can and shoot panels into the net when and where appropriate. The Zambian beach seines, with different mesh sizes and colours of netting, come to look like a patchwork quilt.

The catch from the beach seines is comprised of littoral fish reflecting the fishing grounds in which they operate. Any fish that gets in the way of a seine is caught; since the bunt or bag is usually 8 or 10mm mesh little escapes. The net is towed over the bottom all the way in from the position where it is shot.

Catches vary considerably depending on the amount of fishing that has been going on, on the beach being used. More beach seining means fewer fish (as would be expected) and virgin grounds (such as encountered by poachers in the National Parks) can yield up to 600

[33] Petit (1997) reports a beach seine net in Zambia with 2 km draw lines.

kilos in one haul (with many mature fish). By contrast the Burundian Department of Fisheries in 1999 sampled 5 catches of beach seines in the Bujumbura area and found an average catch of 13.8 kilos per haul. The 29 Tanzanian catches measured by FPSS in 1998 and 1999 showed an average of 39.82kg per day, though this was a result of two shoots of the net, with a resultant 19.75kg average catch per shoot.

In Bujumbura in 1993 – 1995 (Paffen *et al* 1998), LTR found that from the records of 65 beach seine units, the nets were shot on average 3.2 times per day with an average catch of 20.1 kg/haul.

The species in the catch are many and varied. Appendix 6 (Part C) gives lists of the species from the FPSS Burundi and Tanzanian data. In Burundi only two species make up more than 10% of the catch by weight (*Auchenoglanis occidentalis* and *Limnochromis auritus*) and *Limnochromis auritus* is the only fish species to make up more than 10% of the catch by numbers. 22 species make up more than 1% of the catch by weight, and 45 species are recorded in the catch from Burundi.

In Tanzania, beach seines are banned, by a law that came into effect in January 1998. In 2000, though everyone knows about the ban, it is not being enforced and beach seines can be seen throughout the Tanzanian zone of the lake. In Zambia beach seines are banned everywhere except on Lake Tanganyika.

There has been a lot of concern about beach seining. This is because the gear is supposed to:

- Catch everything of every size.
- Destroy the nest of Tilapine fishes on the substrate of sand.
- Destroy the habitat, particularly where this is weed, in that the weed is pulled up by the net.

Studies by the BIOSS of LTBP[34] have shown that on beaches that are heavily fished there are less fish; though local depletion is not surprising.

Despite this the FPSS has not found that this gear is necessarily a threat to Lake Tanganyika's biodiversity, except locally.

The reasoning for this is:

- Not all the habitat is affected. Large areas of pebble and sandy beaches cannot be fished due to obstructions. Areas of large rocks and mixed reed and rocks are never beach seined.
- Other areas away from the sandy beaches contain most of the affected species and their nesting areas
- The places where a beach seine is most able to operate are those which are the least biodiverse. Sandy beaches are less diverse, although recognising such habitat hosts species of importance, than rocky/boulder shores, similarly rocky areas with weed or reeds are diverse and not suitable for seining.
- The areas where there are many beach seines are also those with the largest populations. In these areas fishing effort is very high, and the effects of other gears are also great.
- There seems to have been an attempt to single out beach seines, and blame an unmeasured decline in fish catches exclusively on their use. This is a simplistic response to overfishing and ignores the important point that overfishing is caused by too much fishing effort; rarely if ever, in a multi-habitat and multi-species fishery, by one gear only.
- The logic for the ban appears to come from the marine zone of Tanzania (where coral reefs and flats are destroyed) and Lake Victoria (which is a large shallow lake most of which is susceptible to beach seining). Neither of these have the same

34 Richard Paley. Regional Facilitator BIOSS Pers comm.

habitat profile as Lake Tanganyika, which is a deep lake with predominantly rocky shores which cannot be seined.

The FPSS therefore sees little point in banning beach seines **in the absence of comprehensive management regimes** to control other gears and the total fishing effort on the littoral zone. The situation in Tanzania where a ban has been imposed and not enforced is detrimental, as it highlights the inadequacies of the enforcement of the legislation and the lack of capabilities (for whatever reason) of the department charged with its implementation. In addition, it becomes impossible to collect data on the seine fishery, as to collect data, or even license the gears, would indicate that the ban is not functioning.

5.6.2 Swamp beach seine

In the Gatumba area of northern Burundi, inside the Rusizi Nature reserve, are two small lakes, Archimedes and Angola. They are very shallow, nowhere exceeding 2 metres in depth. They are surrounded by further swamp.

Fishermen in Gatumba have developed a seine net specifically for fishing in these two lakes, (though they report also using it in the shallow creeks that pass through the nearby reedy areas of the lake). Due to the small size of the net restricted waters are essential for its operation.

The seine is very simple, consisting of one sheet of uniform netting attached to a headrope and footrope, with the ends gathered together simply with a rope and length of wood. The netting is only 20m long and of 6mm mesh size. The seines have short draw lines of mixed ropes with a length of only 40 or 50m. There appear to be only 4 of these seines in the area.

The catch is mixed fish[35], but with *Oreochromis spp.* predominating.

5.6.3 Light assisted beach seine

Whilst in theory any seine can be used at night, using lamps to attract the fish to the area to be swept and into the path of the net as it is pulled in, is a distinct method and there are seines specially developed to do this. The target fish are sardines, prawns and immature sardine, and the mesh of the wings of the nets are correspondingly low (~6-8mm), as compared to a standard "day" beach seine (~20-35mm).

In Zambia according to Petit (1997):-

> *Light boats leave the shore at dusk, gather fish and come back to the inshore zone where the beach seine is cast. They aim at catching Clupeids. The nets are made of stretched meshes of 10 and 8mm mostly, the one used widely round the Lake for the lift-net. The difference is the intensive use of mosquito nets for the pocket or even for the net. In Chituta, one seine was nearly made only of mosquito net. A second difference is the great use of these Kapenta seines as an inshore beach seine, during night or daytime.*

Figure 31 A light assisted beach seine at Kasisi in Zambia. Stacked for the evenings fishing.

In Zambia in 1999, at a village called Kasisi near Mpulungu the nets observed by FPSS were constructed of a variety of mesh sizes and mesh type, including "Moji" circular mesh netting. Many panels of irregular shapes are stitched together. In the wings the mesh sizes are larger, of 45mm and 35mm stretched mesh nylon knotless netting. The mesh sizes reduce

[35] Weiler (1992) lists only 11 species caught in these lakes, eight susceptible to gill nets 8mm - 40mm stretched mesh.

towards the central bunt, with panels of 10mm, 8mm and 6mm being employed. In the bunt itself mosquito netting is used, with some panels of sheet nylon, probably nylon bed sheets from the local second hand clothes stores, of "0" mm mesh size[36]. There are no gaps, and even phytoplankton would be caught. All the other netting was knotless except the 35mm and 45mm in the wings. All the netting except the nylon sheets and mosquito netting was sourced from the Purse Seine companies who sell off old nets. Headropes were a variety of sizes, 12 – 14mm polypropylene being the dominant type in this seine. This is also sourced from purse seine companies. Floats were of various sizes, plastic doughnut shape with hole larger than headline. Weights were irregular shaped rocks (~750gms) from the nearby hill (thus prismatic as this is the crystalline structure in the region) attached to the footrope by a 15cm dropper of bark rope. The draw lines were polypropylene rope of 12mm, 90m and 80m long. No wooden wing spreader is used on this net. (The other two seines in the village had spreaders). The net floats and only touches the bottom when it gets near to the shore and a by-catch of littoral species are caught then.

These seines are sometimes used during the day if a sardine shoal is observed passing by and are on occasion used during the day (though not in Kasisi village) to catch mixed littoral fishes in shallow water. Of course with these small mesh nets little escapes when used in this way.

Figure 32 Floats and lights for light assisted beach seines. Nsumbu, Zambia

One owner employs others to assist with the hauling, for a small monetary reward (detailed in Petit 1997 for Nsumbu area of Zambia). Fish is sold fresh (or dried if a large amount) locally. The catch, as evidenced by what is laid out drying in Kasisi (Feb 2000), is immature sardines and small prawns. The nets in this village are very poor quality and made up of so many panels and different sizes of mesh that a proper net plan could not be attempted.

The catch varies considerably, with moon phase, season, and turbidity. Recently in some southern areas of the lake catches from light assisted beach seines have been so low that the owners have given up and gone into farming and trading. Petit (1997) reports catches of 2-5kg/haul in Zambia. Not enough to cover the kerosene used in the lights.

LTR Catch assessment data (Paffen *et al* 1998) from 1993, 1994 and 1995 gave catch rates in Tanzania of 50.4, 51.4 and 47.9kg/night. In Mpulungu, LTR monitored (1993-6) 307 light assisted beach seine hauls and found that average catch to be 54.2kg per night, with each net being shot 1.3 times per night on average, with a catch per haul of 41.4kg. Of this 91.8% was clupeids. The catch of the light assisted beach seines is generally of sub-adult sardines and the work of the LTR would indicate that where light assisted beach seine activity is widespread the gear may well pose a threat to the populations of sardines – particularly *L. miodon*, which tends to be the target species.

The lamps used by fishermen are not all on boats, and many are just kerosene pressure lamps on floats. This enables a light boat to have more than one set of lights, and this increases the light boats' effectiveness.

In Zambia, when the fish do not follow the light boats into the shallow water, which happens quite often, the fishermen cannot seine the light-attracted sardines. When this happens frequently the fishermen will modify their beach seine to make a small shallow water purse seine, so as to be able to reach their prey. This modified beach seine is called a "mutobi" in Zambia and is described later on in this report.

[36] Netting less than 8mm is illegal in seines in Zambia. This seine was less than 400m from Fisheries Department Mpulungu.

Petit (1997) identified the following “inshore” species in the catch of night beach seines in Mtanga village north of Kigoma in Tanzania:

Callochromis melanostigma
Cardiopharynx schoutedeni
Chelaethiops minutus
Chrysichthys ? brachynema
Chrysichthys graueri
Ectodus descampsi
Grammatotria lemur
Lamprologus sp
Lates mariae
Lepidiolamprologus ?attenuatus
Lepidiolamprologus cunningtoni
Lepidiolamprologus elongatus
Limnothrissa miodon
Limnotilapia dardennii
Malapterurus electricus
Neolamprologus ?
Neolamprologus ? callipterus
Neolamprologus ? niger
Neolamprologus ? tetracanthus
Neolamprologus savoryi
Simochromis babaulti
Simochromis diagramma
Synodontus multipunctatus
Telmatochromis temporalis
Trematocara nigrifrons
Trematocara spp
Unidentified cichlids
Xenochromis hecqui
Xenotilapia ochrogenys
Xenotilapia spp

Figure 33 ZK2000 worth of dried shrimp in Kasisi, Zambia

Unfortunately the weight of the catch by species was not recorded.

Since this method targets sardines, and only has a secondary effect on the littoral, the FPSS did not undertake much study of the fishery using this gear in 1999/2000. There are however, detailed accounts in Petit (1997) on the fishery at Mtanga in Tanzania, and in Zambia. Similarly the socio-economics of light assisted beach seining were covered by the joint PRAs with SESS in Zambia and Tanzania in 1997.

5.6.4 Open water seine

The open water seine has a bag and the fish are caught in the bag rather than the net (hence it is a seine not a gill net). This gear is used during the night.

This net is very similar to an encircling gillnet, being operated in the same way, using a boat and a frightening device. The major difference is the use of a small meshed bag in the net, which catches the fish. The catch is also very similiar of the encircling gill net. The details of the net are given in Gear Plan 13 (Part C).

Only one of these seines was seen by FPSS in 1999, near the Malagarasi Delta in Tanzania, being operated by Congolese refugees.. This is locally known also as a “mtimbo” by the local fishermen though it is not the same as a classic mtimbo which is an encircling gill net (see below) and uses a different principle for the capture of the fish.

5.7 Surrounding Nets

5.7.1 Industrial purse seine

The industrial fishery is, in theory at least, of no direct interest to the LTBP FPSS as it specifically targets the less diverse pelagic zone. It should be noted however, that this fishery is very important commercially, employing many people in the region. In addition, FPSS recognises that the sustainability of this fishery is of great importance to the future protection of littoral biodiversity. Any loss of capacity in the pelagic fishery would increase pressure on the littoral zone and land surrounding the lake. As a result FPSS recommended that management of the pelagic zone was of strategic importance to the future conservation of biodiversity and maintenance of livelihoods in the region.

Figure 34 An Mpulungu purse seiner towing light boats to the fishing grounds

Industrial purse seining has been much studied by the Research for the Management of the Fisheries on Lake Tanganyika, an FINNIDA/FAO project. A serious student of the industry would be best advised to study their reports.

A simple description of the industrial fishery method and gear, with a net plan, is given by Andrianos, E (1976). Not much has changed, the fishing operators being rather conservative. If anything the net designs have become simpler, though many of the vessels have now been equipped with power blocks to assist hauling the net.

For the benefit of completeness and very briefly: in Mpulungu the boats, towing between 2 and 6 light boats, leave port in the late afternoon and steam to the fishing grounds (which in late 1999 were about 30 miles North West of Mpulungu). The lights are illuminated and the fishing operation begins if any fish are aggregated (the boat moving on if fish are not observed). Once fish are found then the light boats are released and start up their own attraction lights (generator powered). The seiner continues to illuminate its lights. After a period, dependant on the moon and the whim of the captain, two of the light boats move to the seiner. The seiner turns off its main lights and the fish attracted to the seiners lights remain with the light boats. The seiner then shoots the purse seine round the two light boats, purses it and retrieves the net using a hydraulic power block and electric winches. Some older boats without power blocks used a two boat system and extensive manpower to haul the net.

Figure 35 The hydraulic power block on a purse seine boat based in Mpulungu

The catch is between nothing and 4 tonnes, typically 200-400 kg, and is bought aboard using a brail. The operation is then repeated with the other light boats. Up to 4 hauls can be made in a night, particularly by the boats equipped with a net hauler, though usually only two are made. Just before dawn the boats head home, arriving in port sometime after 8.00am. In 1999 the boats averaged less than 750kg per trip over the year.

The boats stop operating for 4-6 days over the full moon period, as the fish are not aggregated adequately. (Interestingly in the West of the Zambian part of the lake, the

Chirimila Seine fishermen do aggregate fish during the full moon using kerosene pressure lamps).

The Burundian purse seine fleet built up in the late 1970's and 1980's to about 30 vessels and operated until the early 1990's, when the fishery became unprofitable. The vessels began to move south to Zambia. Although the decline in the industry in Burundi has been attributed to a sharp fish biomass and stock decline, and this probably had its effects, the unprofitability of the operation in the Burundi was also closely related to usurious taxes imposed on the industry, which they could not avoid or evade. Whether the reported decline in the stock was due to overfishing, limnological changes or changing predator prey relationships, has not been satisfactorily determined. A Congolese fleet, described in early LTR reports, had completely stopped operating by 2000 due to the lack of security on the Congolese coast.

By 1997 the industrial fleet had almost completely departed to the southern part of the lake, industrial fishing all but having ceased in the north. A single vessel was in Kigoma in 2000 but never appeared to operate. A single vessel remained in Bujumbura in 2000 and could not operate most of the time due to the security problems there at that time.

In December 1999 29 vessels were registered in Zambia, with thirteen operating regularly in Zambian waters from Mpulungu. A further 6 vessels operated by two companies were based near Nsumbu village in the SW arm. Some vessels were registered to fish in Congolese waters at the south of the lake, a license costing US$1,000 per company, regardless of how many boats were being employed. This payment appears to be more of a 'sweetener' to the individuals in authority than a true licensing system.

Figure 36 Lake Fisheries. An Mpulungu purse seine company. Purser Boats on left. Shed. Red light boats on right. (2 boat method)

This fishery, originally targeted the pelagic sardines, *Limnothrissa miodon* and *Stolothrissa tanganicae*. The sardines made up nearly 78% of the catch, with the majority of the balance being *Lates stappersii*, a predator on the sardines which presumably preying at night and was also attracted to lights. Less than 1% of the industrial catch in Burundi was "mixed fish" [Bellemans 1990], his sobriquet for littoral and bathy-benthic fishes.

In Zambian waters the catch in the industrial fishery in the southeastern arm is now (early 2000) 99.52% *Lates stappersii*, and 0.25% sardines *Limnothrissa miodon* and *Stolothrissa tanganicae*. The balance are "others" and *Lates mariae* and *L angustifrons*. In the southwestern arm of the lake, the catch is 23% *S tanganicae* and 75% *L Stappersii*. There has thus been a dramatic drop in the sardine catch, as a proportion of the whole catch, and also in gross weight.

It is reported (Republic of Zambia DoF 1981) that the *Lates stappersii* sustain themselves mainly on mid water pelagic shrimps, *Palamon moorei* and *Limnocaridina parvula,* instead of sardines for most of the year in Zambian waters. Indeed quite large amounts of mid-water pelagic shrimps are caught in light assisted beach seines in Zambia in the wet season. The *L. stappersii* that feed on the *S. tanganicae* for at least some of the year used to be predated on by the larger *Lates* species. These larger predators have just about disappeared from the catch, and it may be that the lack of predation has allowed the *L. stappersii* to proliferate and their predation has reduced the sardines.

There are two further theories (Dorr 1999) regarding the cause of the decline in numbers of Stolothrissa in the Southern part of the lake:

- *Lates stappersii* feeds on *Stolothrissa* larvae and fry and has been increasing in numbers since the 1970s; the combination of fishing pressure on *Stolothrissa* plus predation by *Lates* caused the decline; and,
- *Stolothrissa* is an offshore, cool-water species during adult life, average lake water temperature has risen a degree (from 23 to 24^{o}C) in the last 20 years, therefore, temperature increases may have also contributed to its decline

Exactly what has occurred over the last 8-12 years in Zambia regarding the relative abundance and the predator prey relationships between *Lates stappersii* and the sardines and prawns is unclear. However it is obvious that a fundamental change has occurred. Generally observations made by FPSS (Petit 1997), and during travel of the 1999/2000 FPSS teams, have shown that the further south one goes in the lake the more *L stappersii* appear in the lift net catch. South of Kapili in Tanzania the catches become more and more dominated by *L stappersii*. If this subjective observation is a reflection of the truth, the decline in *S tanganicae* may be far more widespread than suspected, and may have nothing at all to do with purse seining.

Figure 37 Beamy purse seiners in port, Mpulungu

Of note also is the fact that the purse seine fleet in Mpulungu in the SE arm has not caught any significant amount of sardines for nearly 7 years. One would expect that the sardine stocks would have recovered to some extent in the meantime, but this seems not to have occurred.

Local fishermen still catch significant amounts of *Stolothrissa tanganicae* using Chirimila seines[37] in inshore waters near Nsumbu in the SW arm of the Southern lake, and one fishing operator using a lift net also targets the species near Mpulungu. This may be because the *L. stappersii* avoid nearshore waters due to their turbidity, whilst the sardines seek them out for the same reason and are thus susceptible to these gears.

In addition to changes in catch composition the industrial catch has declined from about 6000 tonnes per year in 1992 to 4,000 tonnes per year in 1998.

Mpulungu is regarded by the Zambian public as a fishing port on Lake Tanganyika - justifiably so as the purse seine industry is the major employer in Mpulungu. Each vessel has a crew of 12-15 and there are 13 -15 operating nightly – more than 150 employees directly employed in the catching operation. No less than a hundred and fifty more are employed as workers and casual labour by the companies, in the freezing and processing of the catch, its marketing and transport. In addition, more than 200 men and women rely on the fishing companies to sell them surplus catch for resale, or for the crew share to provide income to the households through sales. For a lacustrine town of 16,000 people to have nearly 500 wage earners (3% of the total population, and possibly up to 20% of those with earnings of any sort) in the purse seine fishing industry makes it a most important industry and employer in the town, and a backbone of the urban economy. This immense contribution to the economic well being of this remote and underdeveloped region should not be overlooked in the haste to condemn the industry for supposed, but by no means proven, overfishing of the sardines.

5.7.2 Shallow water purse seine

The shallow water purse seine is found in Zambia only. It is a beach seine for sardines, modified for use in shallow water when the fish do not follow the light boats to the shore, and so cannot be trapped by a conventional beach seine. It is called “Mutobi” in the local

[37] Ring nets.

Zambian language. The fish will not come in close to the shore if they can see the bottom is close, which occurs when there is a combination of effects: the moon providing light and the water being particularly clear.

In essence the net is the same as a light-assisted beach seine for sardines. The net is modified by the addition of rings along the footrope and a line of the beach seine is used as a pursing line through these rings. The net is then shot in water away from the beach and pursed as in a purse seine, round the light boats that have aggregated the fish. The water that this can be used in is not deep, as the net is relatively small, both in depth and length, so cannot be used in open water.

The method catches the same target fish as a night operated beach seine targeting sardines.

5.7.3 Open water artisanal purse seine

Artisanal purse seines, not to be confused with the ring net used in Zambia – a "Chirimila Seine", have been reported[38] to be used on the lake. The artisanal fisherman is supposed to have adopted seining techniques and moved out to the open water; copying the industrial purse seine operators of Burundi (passim) and Zambia.

Unfortunately the FPSS enquiries round the lake in 1999 and 2000 did not find any of these gears anywhere on the lake, despite making pointed efforts to inquire after them. It seems therefore that artisanal open water purse seines must join the Lake Tanganyika Ichthyosaur[39] and the Mpulungu Electric Snake (reported 1961[40]) in the lacustrine mythology, until confirmed to exist.

5.7.4 Ring nets

A Chirimila seine is a ring net - a hybrid between a lampara net and a purse seine. The net is pictured in the FAO Catalogue of Small Scale Fishing Gears and described in Coulter (1992). There is confusion over the name, with various authors calling it a seine or a purse seine, however it is most accurately described as a ring net. It is only used in Zambia, and targets sardines in open water.

Figure 38 A ring-netter with light boats returning to Nsumbu in

Petit (1997) describes its use as follows:

> *Light boats leave the shore with dusk and their owners generally work with one precise net. Generally after 22.00, the boat carrying the crew and the net (often a boat formally used to carry a purse seine is reconverted into a Chilimira fishing unit) leaves the shore and roams among the light boats until the captain chooses one to make the haul, then the next one, etc. Net pullers are generally 12-14, so more than for Kapenta seines (8-10) as the Chirimila net is bigger and heavier than a Kapenta seine. The catch is shared half for the net owner and half for the owner of the light boat. Agreements between the net owner and the net puller vary but generally, once deducted the costs (Chilimira boats have an outboard engine), half the profit remaining is due to the crew. Crew members reported that they were*

[38] G Hanek, Pers comm.
[39] Frequently reported to FPSS by fishermen in Tanzania, Congo and Zambia.
[40] Whiteford Chumba Pers comm.

happy with the income "in the past" but those have decreased to very low shares following several years of bad catches.

In Nsumbu or Kasakalawe, most of the Chilimira were belonging to traders and not to farmers, as they are expensive. The SS have shown that Chilimira and light boats owners make considerable profits during good years but crew members are among the lowest labourers in the fishing community.

Raw data for 9 months in 1999 from Nsumbu in the SW arm (unpublished from DoF in Mpulungu) shows:

- Boats fish 266 days per year (Extrapolated figure).
- Average catch 359 kg/day.
- Average 3.76 light boats each. Range 2 – 7.
- Average 3.6 draws per night. Range 2 – 6.
- Average catch per draw ~ 100kg.
- Extrapolated catch per unit per year. 95.5 tonnes.
- ~16 nets = annual catch of ~ 1500 tonnes/year.

This fishery makes a significant contribution to the economy of Nsumbu region of the Zambian coastline. The fishery is not presumed to affect the biodiverse littoral zone.

5.7.5 Double-stick net

A double-stick net is a net held open between two sticks, with no bag, with which the fish are surrounded and removed from the water.

Only one double-stick net was noted by the FPSS 1999/2000 team. This was in Burundi in Bujumbura, South of the Port. This was a "no-go" area for LTBP personnel at that time, as a result observations had to be made by the FPSS facilitator from the vehicle at long range; and details are consequently sketchy.

The net was a sheet of mosquito netting strung between two vertical poles of about 1m length. It was approximately 5m long and 60cm deep. The headrope and footrope appeared to be nylon multifilament of approx 210d/48 (?) onto which the sheet netting seemed to have been roughly stitched.

In the knee high shallows of a sandy and reedy area two pre-teen children held the sticks, keeping the netting stretched between them, and two other children ran about splashing the water and driving the prey towards and into the net. The sticks were then bought together, forming a bag, and the fish were removed from the water using the netting and placed in a plastic bag for storage.

Although this gear seems similar to a Mousquitaire, the differences are that the net has no bag, and the net is not dragged through the water in the manner of a dragged bag net. Due to the distance from the fishing gear, it was impossible to identify the fish, but given the area they were probably sardines.

In itself it seems to pose no threat to Biodiversity, but in the context of fishing in highly populated areas of the lake, it is just another of the cornucopia of gears used to target littoral stocks.

5.7.6 Underwater seine (aquarium fish trade)

This net is a vary simple piece of 4mm knotless netting which is used only in the Aquarium fish trade in Zambia. The width and length of the net were not recorded by FPSS as no nets were available to be measured. The net is set under water at a depth of 40m in a curved form. Two divers or more go down and drive the fish into the net. The fish are trapped

against the net and removed with a scoop net. When the fish is captured it is kept in a 200 litre plastic container which has small holes drilled in it and is covered with a piece of 10mm netting on the mouth. This (blue on the RHS in the photo) container is used to store the fish in deep water and to decompress them on the way to the surface.

The species targeted are:

Cyphotilapia frontosa
Benthochromis tricot
Greenwoodochromis spp
Gnathochromis spp
and other related species

Divers usually fish at about 40m deep. They do sometimes go down to 70m deep, and given that there are no decompression facilities anywhere near Lake Tanganyika, mortalities amongst divers are to be expected.

Figure 39 Decompression container (blue), framed storage net (buff), scoop net (red) and gill net(white) as used in the aquarium trade. Mpulungu,

This is really a very minor activity in the scheme of things. The aquarium fish trade does not seem to be flourishing, and the numbers of fish being extracted are very small compared to what is being removed by other fishermen using other gears. However, the potential for the aquarium trade to target very rare species requires close monitoring.

There are rumours of the breeding programmes of Lake Tanganyika ciclids in the USA, which would seriously reduce the profitability of live fish exports from the region, as the breeding programmes are aimed at those fish with the highest value. Similarly advances in cloning technology may soon completely obviate the need to catch significant numbers of wild fish for aquariums.

5.8 Drive in gear

Many gears use frightening or drive-in devices to enhance the catch. Small children may frighten fish into the double stick net, or in encircling gillnets, divers, “TamTams” or paddles may be used to drive the fish into the net. These are accessories to the main gear. It is rare to find a gear that uses the frightening or drive in effect as the primary engine in the capture of the fish.

5.8.1 Frightening line

This is a very uncommon fishing method, noted in only one village in NE Congo. The fish are driven to the beach with a frightening line of a bark rope with leaves and branches attached which is extended out by boat in an arc over shallow water from the beach, (<1m depth). The line is then retrieved at both ends and the fish are frightened and driven to the margins where they are removed by hand or with simple gears.

It was not possible for FPSS enumerators to witness this method in operation, nor measure the gear, as it is made specially for each fishing occasion, so the remarks on its operation and effectiveness are brief, and details of the catch are unknown.

5.9 Lift nets

A lift net is a sheet of netting, or shaped bag of netting, placed under the water and lifted up when fish swim voluntarily between the net and the surface. In Lake Tanganyika lights are used at night to attract the fish to come between the lift net and the surface.

5.9.1 Single boat, catamaran and trimaran lift nets

Figure 40 Lift net catamaran at Kasanga, South Tanzania

Though this is the most important gears used on the lake, it is not covered in detail here as it is a gear targeting pelagic species in the pelagic zone; and has been the subject of much research by the Research for the Management of the Fisheries on Lake Tanganyika a FINNIDA/FAO project, and various FAO development projects.

In Lake Tanganyika there are varying degrees of development of this gear, from a simple sheet of netting, utilised at night by only one boat with poles acting as spreaders in water of less than 20m with 2 or 3 lamps to attract the fish; to sophisticated 'Apollo' nets, with the vessels of the catamaran further apart and with bigger and better nets and more lights, and accompanying light boats to enhance the attraction of the fish. 3 boat "Apollos" have also been developed as the catch from a lift net increases disproportionately quickly with any increase in the size of the net. These various gears are described in detail by Petit (1995) in his PhD thesis.

FAO has, over the years, done a lot of work improving lift net fishing in the north of the lake and introduced the word "artisanal" to cover those lift net boats "improved" as a result of their works, which has subsequently caused much confusion.

The gear is described well in a series of documents, notably the FAO Catalogue of Small Scale Fishing Gears, where a two boat catamaran with its net is impeccably illustrated. Similarly it is covered in Petit (1997), Petit (1995) in the reports of the LTR project, and in FAO reports from the early 1970s.

The economics and some of the trade in sardines, and an analysis of the operation have been covered in Petit (1995), and the whole trade in sardines, the majority from lift net fishing, by LTR in its numerous reports. The catch from the lift net fishery is probably between 165,000 and 200,000 tonnes per year, making it the largest fishery on the lake by far.

Figure 41 A Burundian lift net being repaired in Mwongongo, N Tanzania.

Despite this it seems that many observers still think of lift nets as a "small scale method". The literature emphasises the catch and the economics and the importance of the lift net industry but seems not to emphasise the sheer size of the gear in use in the sophisticated two and three boat fishery. This gear is staggeringly expensive for poverty stricken lacustrine peoples, and the fish produced is the mainstay of the economy in many villages. A look at the picture shows a lift net being repaired by 8 people in Mwongongo in northern Tanzania. Not a small scale fishing gear by most standards.

As a result of this gear not affecting the littoral at all, and even the simplest and smallest lift nets operating in relatively deep water away from the shore, where the fish are concentrated with lights, the gear does not catch littoral fish except for the occasional unfortunate specimen. It is not considered to be a direct threat to biodiversity.

5.10 Falling Gear

The fish is covered by the gear from above so that it cannot escape.

5.10.1 Cast nets

A cast net is thrown out in a circle by the fisherman, covering the fish with netting. This is done in shallow water so that the fish is held between the bottom and the net.

Figure 42 A cast net being deployed from a dugout in the Malagarasi Delta, Tanzania

Despite cast nets being common in most parts of Africa, their use in Lake Tanganyika is most limited. Indeed only one was found on Lake Tanganyika by FPSS in 1999/2000. This was in the Malagarasi delta, south of Kigoma in Tanzania. It was home made by the fisherman using nylon multifilament (See Gear Plan 14, Part C). The desired shape had been achieved by increasing the size of the meshes of the net from the top to the bottom from about 22mm stretched mesh to about 55mm stretched mesh (though the mesh sizes in the net were not regular).

The net was fished from a small dugout canoe in the lesser creeks of the delta. The target was *Labeo sp* and *Oreochromis tanganicae* which was later smoked and wholesaled to buyers from Kigoma. The fisherman was very happy with his fishing operation, catches and the method.

This gear is not common and does not appear to pose any threat to biodiversity.

5.11 Gill nets

The principle of the gill net is that the fish swims into the net and is caught by its head, in a mesh. There are a variety of types, but in all the catching principle is the same. Even those gill nets typically called “encircling” rely on the fish getting trapped in the mesh of the net. (Some large fish are also caught incidentally in encircling gill nets, and are not gilled, but these are the minority of the catch). In general therefore the size of the fish that will be caught is related to the size of the mesh of the net, in that a fish with a big head will not be able to get its head and gills stuck in a small mesh; and a small fish will merely swim through a large mesh.

Figure 43 Sorting a gill net after retrieving it in the morning. Ujiji,

In Burundi and NE Congo all gill nets are either made by hand or are bought in the Asiatic Quarter of Bujumbura. Most are bought. In Tanzania and Zambia, most gillnets are bought in local markets and stores. The main source of origin is China.

Gill nets are nearly always set from boats. The preferred substrate is flat, either rock, shingle, sand, or mud. The edges of reed beds are preferred if available. Gill nets are also used in rice paddies, swamps and feeder streams. Anywhere where the net is likely to be caught

up and damaged is avoided. Areas of cut reed are particularly damaging to encircling gill nets. In general, the further south one goes on the lake, away from the Rusizi delta fan area of sand and mud, the less gill nets are found. The slopes of the lake margins get steeper and there are less and less suitable fishing grounds for gill net usage. In the south of the lake, or on delta fans such as Luiche and Malagarasi, the use of gill nets goes up again considerably. In suitable substrates in Zambia, such as Chituta Bay, they are again very common.

All gill nets observed in use are made from nylon multifilament, usually 210d/2 210d/4 or 210d/6. The headropes and footropes are usually the same material as the net, though some have 210d/15 (See net plans 15, 16, 17 and 18, Part C). A variety of float materials are used, depending on mesh size (and hence depth of net). Larger nets tend to have cork or plastic floats, whereas very small nets use squares of "flip flop" sandal material or bark. The weights are nearly always variously sized stones attached with inner tube or bark lashings. Floatline[41] weights are usually pieces of vehicle, gearbox parts predominating, or larger stones. Lashings are universally strips of inner tube. Ropes are usually a sennit of recycled old netting, plaited or tied in with a series of half hitches using 210d/6 multifilament, their diameter related to the task they are to do.

5.11.1 Bottom set gill nets

There are a series of mesh sizes for set gillnets. The nets are targeting two distinct zones: the littoral demersal from the depth of the net to about 45m depth; and, the deeper demersal waters offshore above the anoxic zone. The pelagic water column in the lake is not generally targeted by gill nets. In the littoral demersal the target fishes are ciclids and tilapine fishes, whereas off shore the targets are larger catfish and nile perch. The common mesh sizes used are:

In the littoral –	1, 1.5, 2, 2.5, and 3 inches
In the shelf areas -	5, 7, 8 and up to 11 inches

The lengths of the nets in use can be quite dramatic. Nets of 500 to 600 metres are typical and others of more than a kilometre are not infrequently found (see net plan 16, Part C). In front of some of the villages round the lake up to 12km of net might typically be set every night. The height of these particularly long nets is very small, a 1 inch net being only 25 meshes deep (approximately 45cm when hung in). This shows that the target species of these nets are expected to be swimming on or very close to the bottom. Further gillnet plans are given in Net Plan 15 and 17 (Part C).

The nets are set from a paddled planked canoe, or occasionally dugout canoes, with two to three fishermen. With few exceptions the net is left to soak overnight, the net and the catch being collected in the morning. If there are fish merchants on the beach wishing to buy the fish then the fisherman may clean his net on the beach and sell the catch immediately (taking some for himself and his family). Alternatively, if the village is some way from the landing beach, the net and the catch may be returned to the village of the fisherman, both being fairly light, and the net cleaned there. The fisherman will also tend to mend his net at home in the village, rather than on the beach. There is no tradition of setting a net in a place and then returning at set intervals to check the catch and remove the fish. The net is always retrieved to be cleaned.

Figure 44 Sorting a gill net at home. Kasisi, Zambia. Note the woman assisting.

The choice of fishing area is typically described by the fishermen as "at random". At random it may be, but within boundaries and limits set by the tenacity of the fisherman to paddle, depth, habitat and shipping lanes. Observation in the field reveals that small mesh (<50mm

[41] Floatline runs from the net to the surface float.

stretched mesh) gill netting is usually undertaken within a few hundred metres of the shore (otherwise it gets too deep in most places); and not more than three kilometres along the coast from the beach where the fisherman is based. The larger mesh nets are set straight out from the village, and the fishermen, from experience, have discovered the appropriate depth for their quarry, and where to find this depth. Nevertheless they paddle the minimum distance possible, the float usually still being visible in the distance from the shore. It all depends on the topography of the lake bottom at that particular village.

Catch rates vary. The Burundian Department of Fisheries in the first half of 1999 sampled 5 nets and found an average catch (soak time = overnight) of 14.54kg. This compares with the FPSS investigations in Gatumba, Burundi in November and December 1999 with revealed an average catch of only 3.1 kg per set from 39 sets measured. In January and February 2000 FPSS in Burundi measured the catch from 8 further nets with an average catch of 13.78 kg per set. Unfortunately none of these figures is all that useful as the length of the net in use was not recorded, and that is a vital part of the estimation of effort in gill nets. The Burundian figures from 2000 show 44 species in the gill net catch, with three species contributing more than 10% to the catch. These are *Chrysichthys sianenna* (13.88%), *Auchenoglanis occidentalis* (11.75%) and *Lophiobagrus cyclurus* (11.45%) (see Appendices 6-9, Part C).

Lacustrian trading vessels are reported to cause serious damage to set nets, with the nets floatline entangling with the propeller of the these rare and ponderous craft. Similarly hippos and crocodiles can become entangled in the nets and completely destroy them. However many of the trading vessels and “aquatic beasts” that cause the disappearance of nets turn out to be two-footed with a canoe!

In Ujiji in November 1999 FPSS found the following gill nets, all of which were set every night except during celebratory times or times of sickness; (~260 days/year).

Table 5.3 Gill net measurements, Ujiji, Tanzania

No	Mesh size	Mesh size (mm)	No. pieces	Length stretched (yards)	Length hung (yards)	Length hung (m)	Comment
1	5	127	30	1500	990	900.9	
2	6	152.4	15	750	495	450.45	
3	5	127	20	1000	660	600.6	
4	3	76.2	15	750	495	450.45	
5	4	101.6	15	750	495	450.45	
6	3	76.2	15	750	495	450.45	
7	1	25.4	20	1000	660	600.6	
8	2	50.8	10	500	330	300.3	
9	3	76.2	20	1000	660	600.6	
10	6	152.4	20	1000	660	600.6	
11	2.5	63.5	13	650	429	390.39	
12	2	50.8	15	750	495	450.45	
13	3	76.2	20	1000	660	600.6	
14	3	76.2	20	1000	660	600.6	
15	3	76.2	20	1000	660	600.6	
16	2.5	63.5	20	1000	660	600.6	
1	Not surveyed but present in village				594	540.54	Estimate
2			"		594	540.54	Estimate
3			"		594	540.54	Estimate
4			"		594	540.54	Estimate
5			"		594	540.54	Estimate
				Total length in Yards	12474		
				Total length in metres	**11351.34**	**11351.34**	

The results of experimental gill net fishing has shown that catches in 1999 in the area of the Rusizi delta in Burundi have dropped to about 25% of the catch in 1995[42]. Now that the reserve in Rusizi is effectively destroyed, FPSS was able to find 13km of nets at this fishing camp.

Table 5.4 Length of gill nets by mesh size in Rusizi fishing camp, near Gatumba.

Mesh Size	Number	Length	Total Length
1.5 inch	3	1200	3,600
2 inch	1	800	800
5 inch	10	500	5,000
5-7 inch	9	400	3,600
Total length employed from that landing beach			**13,000**

These nets pose a very real risk to biodiversity, in that they target the biodiverse littoral, and bathy-benthic zones, where the fish biodiversity of the lake is concentrated. They can be used in nearly all habitats, unlike beach seines. The range of mesh sizes employed indicates that all sizes of ciclids and tilapine fishes above about 10cm length (those caught by the smallest nets employed, the 1 inch nets) are being targeted. It is not so much that the fishing gear is in itself dangerous to biodiversity, but that the sheer size of the gill net fishery, the **kilometres** of net placed nightly and the wide range of mesh sizes employed is such that all fishes apart from the very smallest in the littoral are being very heavily fished.

These gears, when placed in a box and carried home, appear very small and insignificant. One kilometre of one inch gill net will fit into a sack or fish box and can be carried off by a small child. This may be partly why they have seldom excited interest in researchers and statisticians. All the reports cited that mention the traditional fisheries of the lake, have tended to almost ignore this method, and concentrate on labelling beach seining as a

[42] Gaspard Ntakimazi pers comm.

destructive fishing method. Beach seining is of course a very exciting daytime method, with much huffing and puffing as the net is hauled by well muscled men, an excited crowd baying for fish, and a satisfyingly large number of small immature fish to be critical of with each haul. Meanwhile the insidious gill nets continue meshing away, kilometre after kilometre, night after night throughout the littoral. Difficult to observe, but very effective and a considerable threat to biodiversity.

In addition, studies tend to be skewed towards beach seines, in that visiting consultants and their local counterparts can have a good breakfast, and then drive out to the study site, measure the beach seine nets and catch, and be back in the hotel before lunchtime: a much more comfortable regime than getting up in the dark and finding the gill net fishermen at first light before they disappear into the villages with their gear and fish!

5.11.2 Floating Gill Net

This is not a common gear, FPSS observed two types of floating gill net in 1999/2000. It is used in swamps and rivers associated with the lake rather than in the lake itself.

In November 1999 in the Luiche Delta in Tanzania one floating gill net (2" x 26md, length ~ 35m) was observed in the swamp, threaded between the weed clumps. The net had no weights on the footrope which was 210d/2 nylon multifilament, and the floats were bark, attached to the headline by loops in the headline itself. The headline was 210d/2 nylon monofilament. One tilapia-like fish was observed in the net. The net was not attended and the owner was not in the swamp at the time, so further enquiries could not be made.

In November 1999 in the Lufubu the FPSS Zambia team found a drifting and floating gillnet. Locally called Sensenta. Constructed from locally manufactured (Nkwazi) multifilament gill nets ranging from 210d/9 to 210d/6 twine with a variety of mesh sizes in the same net. The mesh sizes found on the "Sensenta" drift net are 76mm, 89mm and 104mm. There are a maximum of 80 meshes vertical (depth), the drift net goes up to 90m in length. Floats are set at 4 metres apart with sinkers (stones) at 2m apart. The materials used as floaters are Polystyrene packaging for refrigerators and other electronic equipment.

It is a top set net drifting with the water current during the rainy season when there are high flows. The net is set across the river with one person in a boat moving from one end to another keeping the net in position as it drifts. The net can drift many hundreds of meters down the river before being retrieved. The fish species caught are mainly Characids, which live in tributaries and marshes.

Only one drifting/floating net was recorded at Masansa fishing camp. A return visit to Masansa fishing camp to accurately measure this gear in December 1999 was unsuccessful as the National Parks Authorities had burnt down the fishing camp, since the Lufubu River is part of Nsumbu National Park, and the fishermen living there were naturally assumed to be fishing in the river.

The latter of the two gears described above, the floating and drifting gill net, would appear to be a serious threat to biodiversity in the river where it is used, to those fish travelling up or down the river for breeding purposes, or other inhabitants of the habitat. The net sweeps the whole water column in the river for a considerable distance, presumably catching many of the target fish in its path, since it has a variety of mesh sizes.

5.11.3 Encircling gill net (with boat and frightening device)

An encircling gill net is a gill net with draw lines, shot round an area and then retrieved. The draw lines frighten fish inwards which allows them to be encircled and then gilled in the net. Some fish larger than can be gilled in the mesh are sometimes caught. The gear thus has some of the characteristics of a seine net. However as the fish are generally caught by gilling, it is classified as a gill net.

The FPSS in 1997 conducted a study on the "Mtimbo" fishery in Lugunga camp south of Kigoma in Tanzania. The report on this was produced in 1997 (Petit, ed, 1997) and should be referred to for a very detailed description of this gear and its use, and the Lugunga village area.

This gear is mistakenly referred to by Petit (1995, 1997) as a ring net. It does not have rings on the footrope, nor is it used in open water. One of these nets, from Kilomoni in N Congo, is detailed in Net Plan 18 (Part C).

There are two types:

- For use by day, mesh size of 1½"
- For use by night, mesh size of 2-2½"

Figure 45 Hauling an encircling gill net with frightening device in the Malagarasi Delta, Tanzania

These are banned throughout the lake. They are used everywhere except in Zambia, where there is community resistance to them.

The catch rate recorded by the Burundian Fisheries department in the first half of 1999 was 11.9kg/day from 6 observations. FPSS in November and December 1999 from 22 observations recorded 19.3kg per day. On average the net was shot 15 times per day, so the catch from each shot of the net was 1.28kg. Fishing is supposed to be better in the wet season that the dry season. Later observations in Burundi, in 2000, showed an average catch of 13.81kg/day, with the catch dominated by *Oreochromis tanganicae and Trematocara variabile* which between them made up nearly 40% of the catch by weight (see Appendix 8, Part C).

The LTR survey of the lake did not differentiate gill nets adequately for an estimate of the numbers of encircling gill nets in the 4 countries of the lake to be estimated.

FPSS in 1999 found 269 in northern Congo and 32 in north Burundi (See Appendix 9, Part C). In both cases the numbers include all types of encircling gill nets and only refer to a very small part of the lake shore. Remembering that these gears can only be used in unobstructed sandy substrates, it is likely that these figures **cannot** be reliably extrapolated for the whole coastline of the two countries, since the substrates of the coastline in the southern areas are more rocky.

Encircling gillnets are generally perceived to be a "bad" gear. This is because they are used in conjunction with a frightening device and they are presumed to catch more than ordinary gill nets. The lack of knowledge on the actual effects of using encircling nets is acknowledged by Petit (1997) , and no research has been done in the intervening years. The FPSS then (1997) opined that the small mesh encircling nets were more damaging than the large mesh ones as they are used in shallower water where there was presumed to be more biodiversity and more juveniles.

5.11.4 Encircling gill net (with boat and divers)

This gear is a gill net set in a circle and is used with a paddle canoe, with two fishermen. Divers then swim down with eye goggles on (but not aqua-lung gear), and bang rocks together to drive the fish into the net. Once the fish are gilled, the net is retrieved and the fish removed. The net does not have to be very high since the fish targeted are demersal and stay close to the bottom. The mesh size varies with the wishes of the fisherman.

The method is common in the Congo, but nowhere else, and events conspired to stop the FPSS team there measuring the gear, or photographing it.

The same method is used in shallow water by the aquarium trade in Zambia and elsewhere. A monofilament gill net is used in shallow water. It has half inch mesh size, 9m in length and 1.5m in depth. When an area rich in fish is found the net is set round the area and divers with aqualungs drive the fish out of their hiding places and they are gilled in the net

The species targeted are:

- *Tropheus moorii*
- *Eretmodus sp*
- and just about anything else

Wire framed fish cages covered with 10mm netting is used to store the fish in shallow water. Plastic bags are also used for storage to avoid bruising and loss of scales.

5.11.5 Encircling gill net (without boat)

In Bujumbura, north of the Cirque Nautique, is a long shallow area of weeds and reeds, and a beach. This is a favoured area for sporting activity at weekends, and the population of Bujumbura also exploit the areas fisheries resources. It is also an area that was off limits to FPSS staff in 1999.

It was possible however to observe there from afar. Two children using a gill net of approx 12m length, 1.20m deep and half inch mesh size were seen encircling areas of the weedy margins there. The net had orange hard PE floats and a lead cored footrope. The net was monofilament. It had been bought complete, but where from is unknown, probably originating in China or Taiwan.

The depth of the water was approximately 35-50cm only (much less than the net depth). The catch was not ascertained but probably consisted of small littoral ciclids.

A similar net being used for encircling fish in the shallows was observed in Musende bay near Mpulungu in Zambia. It appeared to be longer than the Bujumbura example and was also half inch mesh size. It was very similar to the nets used in the aquarium trade underwater with divers (indeed it may have been one). It was impossible to measure this as the operators were extremely hostile once they realised that an interest was being taken in the net.

This is a rare gear, but its use in the littoral could be a cause of concern, due to its small mesh size and the already high fishing pressure on the shallow littoral zone.

5.11.6 Reed floated gillnet for Tilapia

In the Malagarasi delta in Tanzania, at Mwambani Fishing Camp, the FPSS in 1999 found a fisherman who had (reportedly x 100) small nets for fishing tilapia nests. These were unweighted, made of a piece of 210d/2 white PA nylon 3" gill net, 15 meshes by 26 meshes. The 15 mesh sides (top and bottom) being double selvedged. A piece of netting cut from a Chinese made commercially sold gill net as available throughout Tanzania. On the headline were 5 reeds as floats/spikes, the outer two being used as spikes to hold the net in place and the inner three as floats to keep the top of the net at the surface. Reed Ø = 7mm (see gear plan 19, Part C).

The net is placed next to tilapia nests. The end reeds are spiked into clumps of vegetation or the muddy bottom substrate, and the mesh stretched between them, with the three inner floats holding the net from sinking. The bottom,

Figure 46 A fisherman with a tilapia nest net. Tanzania

unweighted edge of the net is pushed into the mud/vegetation substrate using another reed so that it reaches the bottom.

Male tilapia return to the nest after the disturbance and are meshed. Female tilapia visiting the nests are meshed. Male tilapia will take over an empty nest, so the fishermen can continue to use a nest, even when he has caught the male and the female, since the nest replenishes. The method is called “Matela” in the local language.

A description of this method is given by Petit (ed) 1997 in a report on a joint BIOSS/FPSS visit to Luiche delta, though the description of the gear employed is at variance with the account given here, in that there are only two reed floats, and that the name is “Butela“.

These nets are not widespread. The man interviewed by FPSS in 1999 appeared to be the only person using this method in the lakeside part of the Malagarasi delta. Petit mentions that there may be 5 people doing this in the Luiche in 1997.

Whilst meshing adult breeding tilapine fish can hardly be called environmentally friendly, one person doing so in Malagarasi is hardly a great threat to biodiversity.

5.11.7 Dragged gill net with listening device

This is a Zambian fishing gear that seems to be no longer used on Lake Tanganyika. It is included here merely for interest should it be observed later. It was impossible to find any of these gears in use, so an exact description is not given here.

The fisherman goes out in a one-man paddling canoe, and using his paddle as a “sonar” device, locates a shoal of *Limnotilapia dardennii*. *Limnotilapia dardennii* apparently grunt in a characteristic way when in shoals, and it is this sound listened for. Using his knowledge of the species’ habits, and the information from the sound of the shoal gathered by his paddle, he can work out which way the shoal is moving.

He then paddles his boat in front of the shoal, and lowers a gillnet with its footrope attached to a weighted (with 3 stones) wooden pole (~5m long) to the bottom. From each end of the pole there is a bark rope strung to a central towing point, forming a triangle of the pole and the two ropes. This triangle is about 1.5m high at its apex and the net is slung inside this triangle with the apex of the triangle attached to the boat by a rope. The fisherman then drags the framed gill net in the direction of the moving fish, and the fish are gilled.

The practice of listening for fish with a paddle is seemingly well known among traditional fishermen; usually aged ones.

5.11.8 Drive in gill nets

This is a gill net into which the fish are driven, though the net is static, unlike an encircling gill net.

One of these was observed in the Luiche delta in Tanzania by FPSS in 1999. It was 2½” mesh size, 210d/2 multifilament and 26mesh deep. (This netting is available in local stores in Kigoma and Ujiji). Reeds are used as floats. The reeds are about 60m long, a reed being attached to the headline of 210d/6 every 1.2m. Each reed float is juxtapositioned with a D size torch/radio battery, attached to the 210d/6 footrope with rubber inner tube bindings.

Figure 47 A drive in gill net with reed floats in Malagarasi, Tanzania

The method involves setting the net parallel with the reed bed edge, approximately 1 metre from the reeds. The boat is then paddled along the line of the net about 10m into the lake, and the paddle beaten on the water to frighten the fish into the net. The net is then retrieved, and the gilled fish removed. The net is deep enough to cover the whole water column from bottom to surface.

The catch was observed, one small *Oreochromis tanganicae*. No estimate of the days catch was made.

The same drive in fishery apparently also exists in reverse, with the fish being frightened out of the reed beds by people splashing and jumping about in the reeds, into a similar gill net set by boat or on foot along the outside margin of the reed bed.

It has been reported to FPSS that in Zambia a night-time drive in gill net fishery has started near Chisanza to the NE of Mpulungu. The gear is a bottom set gillnet, set in shallow water, and the fish are frightened into the net by lights. The net is set in the dark and then the light lit. The canoe with the light passes down the net about 10m from the net. The fish are frightened by the light, swim away from it, and become meshed in the gill net. FPSS was unable to locate any of these gears so was unable to measure them or interview the fishermen involved.

In Burundi a drive in fishery using fires lit in reed beds coupled with gill nets has been reported by FPSS though the practice was not observed. This would be naturally opportunistic as the reeds take a considerable time to grow to a size when they can be torched.

In Tanzania, at Kigoma bay, a night time drive in fishery exists whereby a bottom set gillnet is placed in shallow water about 15m from the shore. A paddling canoe then passes very close to the shore, with the two fishermen inside rhythmically banging their paddles on the canoe sides, chanting and singing, the noise produced being either melodic or chaotic, depending on the musical abilities of the fishermen and the opinion of the listener. This cacophony drives the fish, who presumably slumber at night in the shallows, into the set net offshore as they attempt to escape.

None of these drive in methods are very common, and for fish seem to present no more of a threat than other gill nets. The burning of reeds to drive fish into nets presents other problems of conservation and should probably not be encouraged.

5.11.9 Seined gill net

Using the principle of a gill net, the seined gillnet is an attempt to get round the enforcement of the local bans on the use of encircling gillnets in Zambia.

This is a truly unusual method, not mentioned in von Brandt (1972), nor in the FAO Catalogue of Small Scale Fishing Gear (1975). It appears to be relatively new in Zambia, and the Fisheries Department staff had not until recently seen the gear, though they knew that it exists. The fish are gilled so the method is still correctly classified as a gill net, though the manner of operation is like a seine. The method is only applicable in areas of shallow water, with a sandy, unobstructed bottom. Chituta Bay being a very appropriate place.

The gear consists of a gill net, with draw lines, like a seine, and is illustrated in Gear Plan 20 (Part C). An example measured in Kapata village, Chituta Bay, near Mpulungu, was made up of 5 x 50 yards sections of 3" stretched mesh net connected together and hung in at approximately 66%, giving an operating length of 150 metres of net. The net was 26 meshes deep, and at each end there was a spreader of 65m, made of wood, weighted at the bottom with a stone.. (This sheet netting is available from many stores in the nearby Mpulungu market). The headline and footrope are made up of 380d/15 3 strand polyethylene twine, interspersed with sections of 210d/36 nylon three strand. (The nylon is preferred as it is easier to work with and stronger, though is more expensive).

The floats are cork/bark, conical, 6cm deep and 7 cm across the wide end. At the sharp end a hole is drilled through which the headline is threaded. One is attached to the net every 3 metres. The weights are stone, prismatic shaped, attached with rubber inner tube lashings. 120-200 gms. A typical stone was 14 x 3.4 x 1.8cm. Similarly with the floats one is attached every 3m. The size of the weights compared to the floatation provided by the floats indicates that the net is very definitely meant to stick to the bottom.

Draw lines are attached to the spreaders at each end of the net. These are made of bark rope of 8.5-9.5cm Ø, two strand. This is very cheap being only KW 4500 per 100m, and manufacturers of this rope (men) bring it to the village to sell. One draw line is 200m and the other 150m. The difference in lengths is explained by the fact that when the net and draw line is paid out from the boat (see description of method below) the float is attached to the 150m draw line. This is paid out, then the net and the boat returns to the float, paying out the 200m draw line as it goes, to pick up the end of the first (150m) draw line. Since, in the words of one antediluvian fisherman, *"it is very difficult to paddle a straight line at night"* an extra 50m of draw line is allowed to ensure that there is enough for the boat to reach the float, and the start of the first draw line, to begin the retrieve of the gear.

The gear is used at night with two fishermen operating the gear from a paddling canoe. The substrate must be fine sand/mud and unobstructed. The boat travels to an appropriate area of depth 8-10m. One draw line is attached to a float with a small lamp on it (not to attract fish, merely to indicate the float). The boat then heads off paying out the draw line in a rough circular fashion. After the draw line is shot the net follows and then the draw line on the other side, the boat meanwhile continuing in its circular path, eventually ending up back at the float which is the start of the first draw line. The two fishermen then pull in the draw lines and the net to the boat. Fish are frightened by the draw lines into the path of the net and, if of an appropriate size, are gilled. The boat is not anchored during the operation. The procedure is repeated until a suitable amount of fish has been caught, 10 to 15 times, yielding 20 – 25kg (FPSS did not measure the catch, this figure is derived from interviewing the fisherman and seems optimistic). Target species are reported to be *Boulengerocromis microlepis* and *Limnotilapia dardennei*, among others.

15 of these gears were reported in the Kapata village and there would presumably be more in the other villages round Chituta Bay. It does however seem that these gears are restricted to the Chituta Bay area and areas north with suitable substrate, as no others were found by FPSS near Mpulungu or in the Western arm.

The gears are locally a threat to biodiversity in that gill nets are identified as one of the major contributors to excessive fishing effort round the lake.

5.11.10 Staked Gill nets

The FPSS survey in Zambia in 1999 did not find any of these nets, but they are described in a report by the Game and Fisheries Department of Zambia in 1965 as such:

> *The "Mbwa" and "Itapi" nets are very similar but are named differently in different areas …….. They are made up of a heavy grade nylon with an 8" stretched mesh and are normally about 50 yards long. The net has no corks or leads but is fence like in that bottom and foot ropes are held apart by poles at 4 foot intervals. The two end poles are very long and these are pushed into the mud from the surface and hold the net upright. It is a moderately successful net usually catching large Nshinga (Dinotopterus cunningtoni) and Poloko (Auchenoglanis occidentalis). Traditionally only chosen people may use the net and there is a great deal of prescribed ceremony in its use. It is said that any pregnant woman seeing the net is liable to abort.*

It was also generally acknowledged that any menstruating woman stepping on these nets during construction will bleed to death, though this belief seems to have now died out; with

the nets perhaps? Apparently[43] there are just not enough large fish left in this bit of the lake to justify their use.

5.11.11 Single wall (monofilament) tangle nets

The principle of tangle net gear is that the fish swim into the net and get tangled up, so that they cannot escape. It is particularly effective for spiny fish. The only tangle nets found were in Burundi.

Monofilament gill nets are very effective and not commonly seen on Lake Tanganyika. It is a commonly held opinion that they are illegal. No laws seem to exist in any country bordering the lake specifically banning their use though there are mesh size regulations. Those few that have been seen have been either drive in gill nets in the aquarium trade or have been stolen from projects. These latter nets, in a village near to Bujumbura in Burundi, were then reused by the fishermen who had acquired them as tangle nets in deep water, targeting *Auchenoglanis occidentalis* and *Clarias sp*. The nets were very low diameter monofilament nylon, with a floatline with integral floats and a lead cored footrope, and since they had been used for biological sampling, of a variety of mesh sizes. According to the same fishermen the gears were not favoured, as the fish tangled up too much, and were extremely difficult to remove. They also caught too many small fish of low value, which were very difficult to remove also, and slowed the operation too much. As a result the gears were stored and the intention seemed to be to remove the floatline and lead cored footrope and hang in a traditional multifilament gill net.

In that the supply of monofilament nets suitable to be used for tangle netting has dried up (LTBP has stopped fishing with low diameter monofilament gill nets) and the fishermen who experimented with the gear found it unworkable, it seems that the stolen gear poses little threat to biodiversity.

[43] Martin Pierce Pers comm

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