Mara Swamp and Musoma Bay Fisheries Assessment Report

Mara River Basin, Tanzania

Integrated Management of Coastal and Freshwater Systems Program

Baseline Survey of Fisheries Resources in the Mara Swamp and Musoma Bay

Mara River Basin, Tanzania

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Front and Rear cover: Papyrus swamp along Mara River, Tanzania (Deonatus B.R. Chitamwebwa)

Preface: About GLOWS

The Global Water for Sustainability (GLOWS) program is a consortium financed by the United States Agency for International Development (USAID) working to increase social, economic, and environmental benefits to people through clean water, healthy aquatic ecosystems and sustainable water resources management. Launched in early 2005, GLOWS works on-the-ground to implement improved practices, build local capacity through multi-level training activities, and share lessons learned and advancements in the practice of Integrated Water Resources Management.

Because water resources touch so many elements of human systems and ecosystems, management must be integrated across water use sectors, across scales of governance, across space in a river basin context, and across time. Many current water problems stem from the fragmented, single-issue and single-sector approaches that have characterized water resources management in the past. GLOWS works to integrate the environmental, technical, governmental, and management elements of IWRM. The basic goal is to manage the human and environmental elements of IWRM to ensure that abundant quantities of sufficiently clean freshwater are available in the correct place at the correct time. This requires a governance and management system that integrates science-based understanding of the natural controls on water abundance and quality with appropriate and effective human technologies and actions.

Working at a basin, watershed or aquifer scale, the GLOWS partner organizations provide expertise across the policy, governance, institutional, educational, and technical dimensions of IWRM. Approaches combine advanced analytical techniques, innovative mechanisms for sustainable resource management and biodiversity conservation, community-based programs in poverty alleviation, improved sanitation and potable water supply, and global networking of local NGOs to achieve IWRM objectives.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Acronyms

BMU	Beach Management Unit
CAS	Catch Assessment Survey
IFMP	Implementation of a Fisheries Management Plan
TAFIRI	Tanzania Fisheries Research Institute
TZS	Tanzanian Shillings
USAID	United States Agency for International Development
WWF	World Wildlife Fund

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Executive Summary

1. Musoma Bay is part of Lake Victoria and it stretches in an easterly direction for about 20 km in length with an average width of about five kilometers. Its end forms the mouth of Mara River. Mara Swamp is within the lower part of Mara River; it extends from about a kilometer behind the river mouth to some kilometers up the river, covering an area not less than 50 km^{2}. Both the Bay and river have a rich assortment of floral and faunal biodiversity, some being of economic importance.

2. Present fish resources in Musoma Bay include the Nile tilapia, the catfish, lungfish, Nile perch and some resurging species which, previously, had almost disappeared through predation, heavy exploitation, and environmental and ecological changes brought about by exceptionally heavy rains of early 1960s. Those rains also were the source of the growth and expansion of the swamp that bears riverine species, some of which ascend the river during the wet season (November-May) to spawn. Also, the flood-pools and ox-bow lakes contain fish species that have almost disappeared from the main lake. Presently, the important fish species are the lungfish and catfishes.

3. Legal gears used in Musoma Bay and Mara Swamp fisheries are nylon gillnets and hooks (in the form of longlines and handlines). The minimum gillnet mesh size allowed is 5” (127 mm). The commonly used hook sizes are numbers 7-12. Monofilament gillnets, undersized gillnets, beach seines, fixed stake traps and poisons are banned gears, but some are still illegally used.

Gillnets are set as passive gear such that fish are “gilled” only when swimming through the meshes which are kept open by opposing action of the upper float line and the lower sinker line. A fleet of nets is kept in position by fixing the two ends to the anchor ropes. Longlines consist of long main lines to which short branch lines bearing hooks are attached at regular intervals. The hooks are suitably baited to attract the target species. The gear is kept at a desired depth range by attaching floats at intervals to the main line. Handlines carry a few hooks and are lowered vertically to suitable depths in the water column while held in the hand. The hooks are also baited. In Musoma Bay, plank canoes are used as fishing craft. They are propelled by paddles, sails or by outboard engines. In the Swamp, the dugout canoes are the chief fishing craft.

4. Most species found in Musoma Bay and Mara Swamp are of conservation significance because they are economically important. Some are rare and seasonal and have re-appeared after almost disappearing from the main lake for reasons mentioned earlier.

5. In the rainy season the waters are enriched with nutrients from wash-offs and precipitation. Hence more food is available. During this period, fish tend to concentrate for feeding and breeding such that their catch is high. In the cool, dry, season (June-October) the fish are less active and their catches become low. This is reflected by the low prices in the wet season and correspondingly high prices in the dry season, although accurate data to support this observation are lacking.

6. Fish market survey shows that both men and women are engaged in fish trade in almost equal proportions. Both had gone through primary education. The majority were part time traders, being active during the dry season. The chief source of capital at the start of the trade was through the sale of farm produce. They traded fish mainly from Musoma Bay followed by fish from Mara Swamp. Fish from elsewhere were fewer. The fish was sold primarily in the fresh state. Most women relied on the head as their means of transporting fish while men used bicycles. The fish was sold within the villages around the Bay and Swamp. Income generated from the trade was enough to support the family only half of the traders. Others had to supplement with income from other sources. The chief constraints were unreliable supply of fish, lack of enough capital and unreliable fish markets. In addition, lack of organizational skill in the trade could be one of the major setbacks.

7.1 In Mara Swamp environmental changes resulting from climate changes, e.g., droughts, pose as the major threats to fish loss and reduction as these influence the size of the swamp. In the wet period the swamp increases in size and avails more space for swamp adapted fish. Droughts reduce its size and tend to tempt the local communities to clear it for cultivation of suitable crops to survive on during the drought period. Fires, which are more destructive to the swamp, could be applied for vegetation clearing, causing more damage to the swamp and its inhabitants. Also flood pools and ox-bow lakes become prone to drying out, forcing the fish to retreat to the river or die altogether.

7.2 Measures for reducing losses and reduction of fish populations involve taking steps that enhance climate modification that reduces the occurrence of droughts such as reforestation and avoidance of further deforestation. Proper land use to reduce sedimentation and wise use of agro-chemicals, that have direct deleterious effects on fish, should be practiced.

8. It is advised that local communities become the owners of the resources within their area of jurisdiction and stop common access to those resources so that the communities feel the responsibility of managing the resources of which they are the major if not the sole beneficiaries. This would end the current altitude of most community members of regarding the natural resources of belonging to the government and not theirs. So, monitoring, control and surveillance would be more effective.

9. In order to have a sustainable fishery, overcapacity has to be avoided through activity diversification. Communities around Musoma Bay and Mara Swamp should not only focus on fishing as the only income generating activity. Activities such as dairy cattle keeping, rice growing, aquaculture, horticulture, tree nurseries and craft making using swamp craft materials are among the potential alternatives which can generate income. Such activity diversification, coupled with capacity building in terms of capital, equipment and training in managing the projects, would possibly lead to sustainable fisheries in the target areas.

1. Introduction

Musoma Bay is part of Lake Victoria (Fig. 1.1); it stretches in an easterly direction between latitudes 1° 25'-1° 33' and longitudes 33° 40'-33° 57', that is, from Lukuba Island to the mouth of Mara river, about 20 km long with an average width of about five kilometers. Water depth is generally shallow with an average depth of about 5 m. The deepest part is at its entrance, being about 25 m. Shores around the entrance are rocky but toward the river mouth, they are fringed with aquatic vegetation (macrophytes), mainly papyrus swamps, bulrushes, and the invasive water hyacinth.

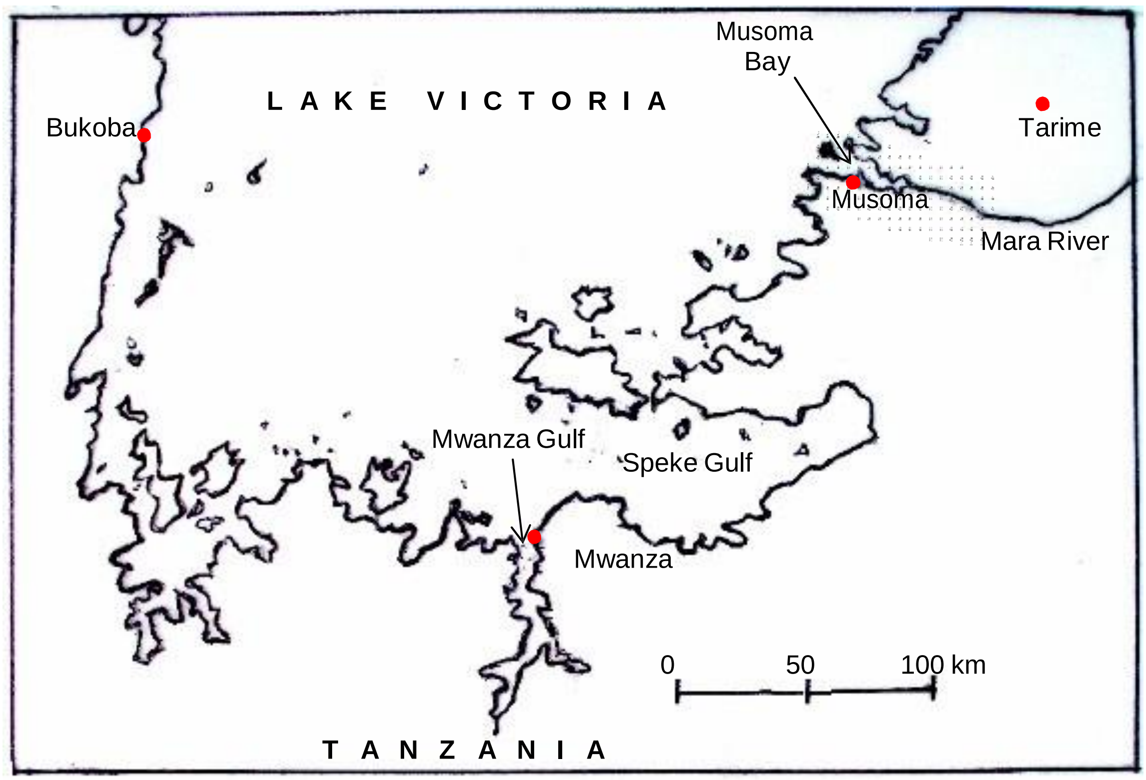

Fig. 1.1 Tanzania part of Lake Victoria showing the study area.

Mara swamp is situated in the lower part of Mara river. It extends from about a kilometre behind the river mouth to tens of kilometers upstream within Tanzania, bordering Musoma Rural, Tarime and Serengeti Districts. It is more than 50 km^2 in area. The swamp is heavily chocked by papyrus reeds (whose cover is increasing in size), swamp grass, water hyacinth and other water loving aquatic plants, including *Sesbania* sp. on the outer edges. The swamp also harbours a variety of fauna, including animals, such as hippos, crocodiles, antelopes, and water fowl. A variety of riverine and swamp fish species are also found there, some of which are of economic importance, for example, the lungfish and catfish (Appendix 3 attached).

2. The fisheries resources in Musoma Bay and Mara Swamp

The fisheries in Musoma Bay and Mara Swamp are essentially the same as those in the main lake- Victoria. Up to the 1950s the most commercially important species included the two tilapiine species *Oreochromis esculentus* (ngege/sato) and *O. variabilis* (sato) the first being the far more numerous. Other important species were the mormyrids (domodomo) especially *Mormyrus kannume*; others still were *Labeo victorianus* (ningu); the catfishes *Schilbe intermedius* (nembe), *Bagrus docmac* (hongwe) and *Clarias gariepinus* (kambale); the lungfish *Protopterus aethiopicu*s (kamongo/kambale mamba) and *Barbus* spp. (kuyu) (Beauchamp 1956). The most numerous but less important commercially because of their small sizes were the haplochromines that formed a "species flock" comprising hundreds of species (Greenwood 1956). Nearly all the above species were largely caught with gillnets of appropriate mesh sizes, except *Protopterus* and *Clarias* whose principal types of gear were hooks and local stake traps. In the 1950s some alien species were introduced into the lake. They included four tilapiine species: *Oreochromis niloticus* (the Nile tilapia), *O. leucostictus*, *Tilapia zillii* and *T. rendalli*. The reasons for the introductions were for improving the fishery of the lake.

In the early 1960s, the level of Lake Victoria increased by about two meters during the exceptionally heavy rains that fell between 1961 and 1964 (Beadle 1981). The sudden rise of the lake level affected the macrophytes (aquatic vegetation) that fringed most parts of the lake, especially bays. Rooted macrophytes were drowned while floating or partly floating ones, like the papyrus swamps were drifted away and later destroyed through wave action in exposed beaches. In short, the great loss in macrophytes contributed to the changes of Lake Victoria's ecology (Kudhongania and Chitamwebwa 1995).

During the 1960s, a number of factors were operating in the lake. Firstly, the fishing effort was increasing through the increasing fish demand by the expanding riparian population. Secondly, the introduced species were establishing themselves in the lake at the expense of the indigenous fish species. Thirdly, environmental changes continued to take place. And fourthly, the number of the destructive beach-seine gear was also increasing. The gear is very destructive in that it harvests fish of all sorts and sizes-juveniles and adults alike. On top, it scrapes the bottom of the lake, tearing off rooted macrophytes and destroying nests for breeding. It therefore interferes with breeding activities of inshore species, including that of the tilapias.

Consequently, the decline of the species of economic importance took place. The indigenous fish species declined to very low level while others went missing. Eventually, the Nile perch increased suddenly in the lake on the expense of preying on indigenous species, especially the most numerous haplochromines. By the late 1970s and early 1980s the dominant species became the Nile perch, followed by the Nile tilapia. By mid 1980s, nearly all the indigenous species had disappeared from catches, except the small cyprinid *Rastrineobola argentea* (dagaa/omena/mukene) which, because of its short turn-over time, withstood the predation pressure to become the second in commercial importance. There followed hue and cry over the changing fisheries attributed largely to the effect of predation (Barel *et al*. 1985, Witte *et al*. 1992). The Nile perch stock increased tremendously causing fish production in Lake Victoria to reach a peak of over 200,000 metric tones in early 1990s. Currently, fish stocks are declining, calling for immediate management interventions (Okedi 2005). The fisheries of the lake are still in a state of flux.

So like in the main lake, previously the fisheries in Musoma Bay were based on the Nile perch, Nile tilapia and *R. argentea,* though not exactly in the same order of importance. During the visit to the bay, the most important fish species noted were *O. niloticus*, *Clarias* and *Protopterus*.

On the other hand, the fishery in the Mara Swamp became important after the heavy rains of the 1960s when the river was heavily flooded and the level of the lake rose. This caused large flood pools to remain permanently with water. This resulted in the "spill over" of some species from the river and lake. Possibly, this is the reason why later on some indigenous species of Lake Victoria have been reported to exist in these lakes while missing in the main lake (Katunzi and Msuku 2002, Katunzi 2005). Therefore, the fishery in the swamp which includes that of the satellite lakes has been based on *Protopterus, Clarias,* and small catches of *O. niloticus, O. leucostictus, O. esculentus* and some haplochromines. Recently some lost species have begun being occasionally caught in the bay and river especially during their ascent up the river to breed, in the rainy season (November to May). Two surveys done in Mara River and its swamp in August, 2001 and June, 2002 have revealed the presence of about twenty fish species mostly living in the river and its tributary- Thigithe (Sobo 2002). Table 2.1 presents the species identified.

Table 2.1. Species found in Mara River, the tributary Thigithe and the swamp during 2001 and 2002 surveys (modified from Sobo 2002).

Family	Species	Present status
Anabantidae	*Ctenopoma muriei*	Rare**
Bagridae	*Bagrus docmac*	Rare
Characidae	*Brycinus jacksonii*	Rare
Cichlidae	*Oreochromis leucostictus*	Very common
	O. niloticus	Common
	*Haplochromines**	Common
	Pseudocrenilabrus multicolor	
	Tilapia zillii	Common
Claridae	*Clarias alluaudi*	Common
	C. gariepinus	Very common
Cyprinidae	*Barbus altianalis*	Rare and seasonal
	B paradinosus	Common
	Labeo victorianus	Rare and seasonal
Mochokidae	*Synodontis afrofischeri*	Rare and seasonal
	S. victoriae	Rare and seasonal
Mormyridae	*Hippopotamyrus grahami*	Rare and seasonal
	Gnathonemus longibarbis	Rare and seasonal
	Moymyrus kannume	Rare and seasonal
	Protocephala catastoma	Rare and seasponal
Protopteridae	*Protopterus aethiopicus*	Very common
Schilbeidae	*Schilbe intermedius*	Rare and seasonal

* Probably, there were several of these species but were difficult to identify
** The term is used to denote the present very low catches of the fish which was abundant in the past.

During our visit in the swamp area the satellite lakes (Kirumi and Kubigena) had just been refilled with a little water after going completely dry mid last year because of the long droughts, of 2005 and 2006, which culminated in the recession of Lake Victoria's level. Most probably, the food sensitive *O. esculentus* could have gone missing since it is rather difficult for the fish to penetrate the mass of papyrus mat into the river water and it is even unlikely that its preferred food, the diatom *Aulacoseira* (previously *Melosira*) (Fish 1955) is abundant in the river. At present the main fisheries in the Mara swamp are those of *Protopterus* and *Clarias* which are caught by long lines. Also there is an illegal fishery on the juveniles of Clarias using traps. These juveniles of Clarias are sold to longline fishers for use as bait in the Nile perch longline fishery on the main lake.

3. Fishing gear and techniques used in Musoma Bay and Mara Swamp

The main gear used in Musoma Bay and Mara Swamp are gillnets, longlines and handlines, while monofilament gillnets, undersized gillnets, beach seines, fixed stake-traps and poison (mainly insecticides and herbicides) have been banned. They are, however, used illegally and their control is currently the most challenging issue in implementing the management plans for sustainable fisheries in the Lake Victoria Basin.

The legal minimum mesh size of gillnets is 5″ (127 mm). The nets are set at the bottom (bottom set) in batches of up to 30 pieces of 90 m stretch, which reduce to about 60 m after being hanged on the float and sinker lines. They are set passively as a wall in the water column for the fish to entangle themselves when swimming across the nets. Sometimes gillnets are used to encircle fish, and then frighten the fish so that they can run onto the circling nets. This is the active use of gillnets which is illegal because the fish are forced into the nets. Gillnets can also be used as beach seines by dragging the ends to the shore, but this is illegal too.

Long lines consist of short branches of twine attached to a long line of twine (thread) at regular intervals of 3 to 10 m, each branch carrying a hook. The gear is carefully arranged in a basket and the hooks sequentially hanged on the rim. During setting, the hooks are released one by one and bait attached to them. The bait used in the Nile perch fishery is live fish- juveniles or dwarf type of *Clarias*.spp. The small haprochromines are also used live or cut in pieces.

Hand lines consist of one or several (up to 4) hooks attached at one end (at small intervals of 30-40 cm). The end of the line is held in the hand and lowered at appropriate depth after attaching bait consisting of pieces of earthworms, suitable insects, or filamentous algae. The fisher jerks his hand upwards on feeling the bite of the fish on the hook(s) so as to get the fish hooked. The hand lines are targeted at the Nile tilapia and sometimes on the Nile perch. Also, rod and lines are used to catch the haplochromines. The bait used is earthworm or the shrimp, *Caridina nilotica*. This is one of the methods of catching live bait for the Nile perch hook fishery in the bay. All types of gear are fixed in the water column by attaching their ends to anchored ropes bearing buoys as landmarks. With the exception of the hand line and rod and line, which can be operated from the edge of the lake, all other gears in the bay are set by using Sesse (plank) canoes, propelled mainly by sails and paddles. A few canoes use outboard engines. In the swamp the craft used is the dug-out canoe which is ideal for manoeuvring along the narrow channels among the papyrus reeds but rather requiring extra care in balancing in order to avoid capsizing.

4. Fish species of conservation significance and their abundance

In co-management of resources, which takes into account the interests of every stakeholder (Ntara, 2001), a species becomes of conservation significance if it is important to the stakeholders. And for local communities, they would pay attention to the conservation of a given species if it is profitable to them either as food or as an income earner. Thus all currently exploited species from the bay and swamp are of conservation significance since they are of value to the communities. As already mentioned elsewhere, the species include *O. niloticus*, *L. niloticus*, *C. gariepinus*, *P. aethiopicus* and some of the previously feared extinct species which are gradually resurging, e.g., *B. docmac*, *L. victorianus*, *S. intermedius*, *Synodontis victoriae*, and *S. afrofisher*i, mormyrids which are, apparently, more easily caught in Mara River than in

Musoma Bay (Sobo 2002), and the haplochromines. Most of these rare species are potamodromous; that is, they migrate from freshwater bodies to upper reaches of rivers to spawn (McKeown 1984). They are therefore sensitive and vulnerable to capture as they congregate at the river mouth ready to ascend to the breeding grounds. Although occasionally or seasonally caught, their conservation significance stems from the fact that they are a delicacy to the local communities; they fetch exceptionally high prices at the market. For example, two pieces of *Labeo* weighing about 150 g each were being sold at TZS 1,000/- in Musoma Central Market during the survey. Economically, *O. niloticus* is the most important in the bay while *P. aethiopicus* leads in the swamp.

5. Seasonal variations and abundance of fishes

Generally, fish abundance increases during the rainy season (November-May) because it is the peak of their breeding activities. All potamodromous species (McKeown 1984) become more available in Musoma Bay and Mara River during the rainy season because they congregate and pass there on their upward migration to upper reaches of Mara River. And resident fish within the Bay also have their breeding activities increased during this season. The Nile tilapia and other tilapiine species, for example, migrate into shallow waters at this time for breeding (Lowe-McConnell 1956). For this, the protected Musoma Bay is quite ideal to the ecology of the tilapias that prefer shallow and protected bays for breeding and rearing their young, especially where the shoreline is fringed by emergent and submersed aquatic vegetation. Information from the fisheries officers puts the number of canoes fishing in the bay at around 60. Assuming that the number of active canoes are 50 on each fishing day and, from the approximate data given by fishers that the average catch per canoe per night is about 5 kg contributed mainly by *O. niloticus*, and assuming further that active fishing days in a year are 250, then the annual yield from the bay could be estimated at 125,000 kg or 125 m t per annum. By valuing a kilo of fish at TZS 500/-, the fish would be worth TZS 62,500,000/-. Assuming the same conditions in the swamp but the catch per night being put at an average of 2 kg of fish composed mostly of *P. aethiopicus*, the yield would be 25,000 kg or 25 m t per annum. At the same price per kilo the value of the fish would be TZS 12,500,000/-. However, these values are likely to be underestimates.

Official data are presently assessed by the catch assessment survey (CAS) method. Sampling is done twice in a given month and at selected landing sites. Estimates are done for each riparian district using the data collected in that way. Unfortunately, no data are taken from the studied bay and swamp. The recent fish catch estimates of the three most important species caught in Musoma District are shown in Tables 5.1a-c below:

Table 5.1a. Recent CAS estimates of catch and value of *L. niloticus* for Musoma District.

Month	Catch in metric tonnes	Value in millions of TZS
July 2005	1666.4	1.815.1
August 2005	1718.3	1,910.7
September 2005	1,886.3	2,097.5
November 2005	1,881.9	2,104.0
March 2006	844.0	746.3
August 2006	1199	859.2

Source: CAS National Working Group, IFMP TAFIRI, Mwanza,Tanzania

Table 5.1b. Recent CAS estimates of catch and value of *R. argentea* for Musoma District.

Month	Catch in metric tonnes	Value in millions of TZS
July 2005	1,289.2	1,934.0
August 2005	884.1	1,308.0
September 2005	1,824.4	2,7000
November 2005	920.2	1.068.0
March 2006	3,930	4,681.0
August 2006	1,510.0	2.30.0

Source: CAS National Working Group, IFMP TAFIRI, Mwanza, Tanzania

Table 5.1c. Recent CAS estimates of catch and value of *O. niloticus* for Musoma District.

Month	Catch in metric tonnes	Value in millions of TZS
July 2005	241.9	118.1
August 2005	247.8	110.5
September 2005	268.1	119.6
November 2005	851.2	405.6
March 2006	329.0	166.2
August 2006	141.0	84.6

Source: CAS National Working Group, IFMP TAFIRI, Mwanza, Tanzania

Data for the above estimates are collected by officials of Beach Management Units (BMUs) which will be talked about later and are processed by fisheries officials. The data might not be depicting the exact situation of the fish abundance and seasonal variations in the bay and swamp but are given here to show rough contributions of the current species of economic importance in the lake. Both the Nile perch (*L. niloticus*) and dagaa (*R. argentea*) do not feature much in the fisheries of Musoma Bay and are almost absent in Mara Swamp. In Musoma Bay, the current major fishery is that of the Nile tilapia based on the gillnet fishery using the five-inch mesh size recommended as the minimum mesh size. Nets of up to 6” are also used. In the Mara Swamp the most important fish being caught there is the lungfish exploited with long lines bearing hooks of sizes 7 to 10. Note that the bigger the number, the smaller the hook size! A visit to Kyagata- the largest livestock market in the area- revealed that the lungfish dominated all other fresh fish being sold there and mainly was caught from the Mara Swamp.

6. Survey of fish market

During the visits to villages and landing sites, a questionnaire, (Appendices 1 and 2), was used to interview fish traders to assess their performance and constraints. Thirty-five traders were interviewed of whom 19 (54.3%) were men and 16 (45.7%) women. All had gone through primary education, except a single man. Only one of the traders had attended secondary school. Their age group distribution is as shown in Fig. 6.1. In terms of commitment to their trade, 25.1% were full time fish traders, 68.6% part-time traders and 5.7% were occasional ones.

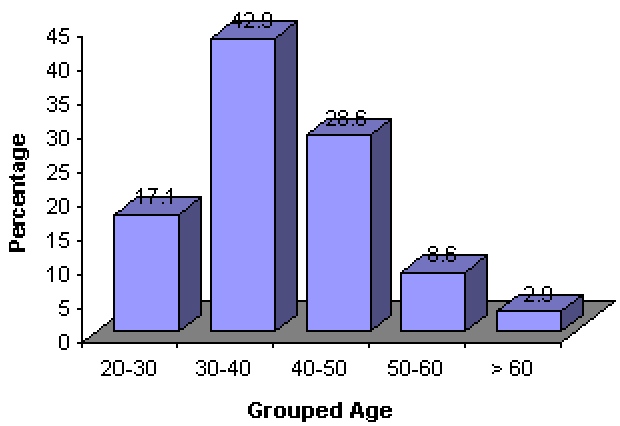

Figure 6.1. Age groups distribution of fish traders by percentages.

Fig. 6.2 indicates the source of capital at the start of the business. The majority got their capital through selling farm produce, including livestock. Fig. 6.3 shows the experience distribution among the traders by percentages. A substantial number (40%) had just entered the trade– they hardly had had 5 years of experience.

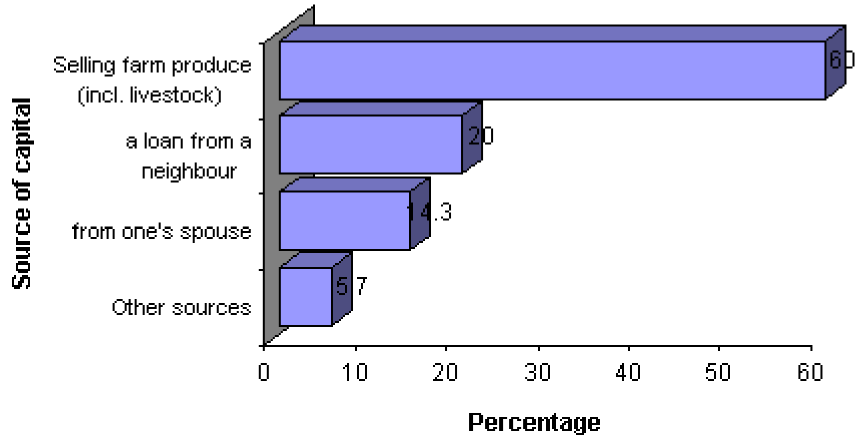

Figure 6.2. Source of capital at the start of the fish trade

Figure 6.3. Experience period in fish trading

Most traders (67.6%) dealt with fish got from Musoma Bay landing sites. Those who got the fish from Mara Swamp accounted for 23.5% and only 8.8% of the traders obtained fish from elsewhere. Fig. 6.4 presents the percentage frequency of the means of transport used in taking fish to the markets. Note that the dominant means were on head (done entirely by women) and on bicycle.

Fish species sold in fresh form are the Nile tilalpia (*O. niloticus*), the Catfish (*C. gariepinus*), the lung fish (*P. aethiopicus*) and more or less juvenile Nile perch (*L. niloticus*). But the big-sized Nile perch are sold directly by fishers to filleting plants for

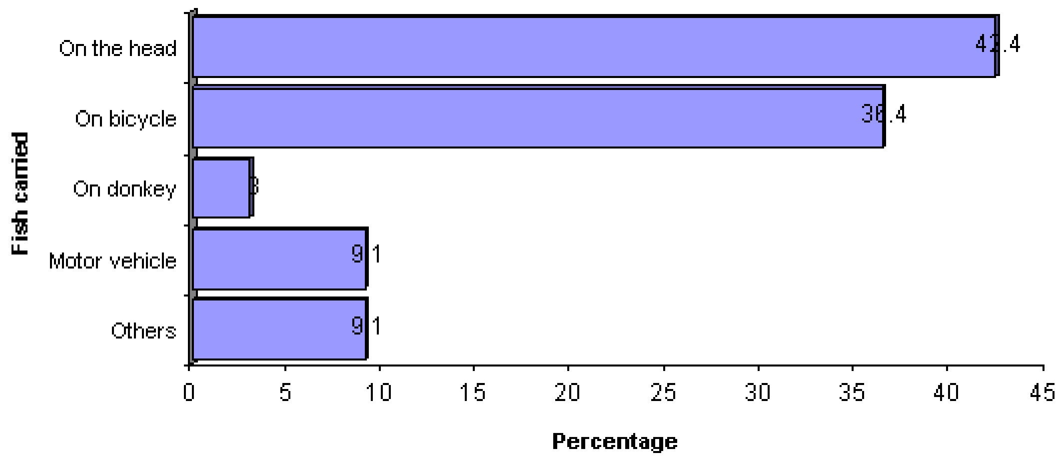

Figure 6.4. Percentage frequency of transport means used by fish traders.

the export markets. Species that is sold in the processed form is the small cyprinid, *R. argentea* (dagaa), but the unsold fresh fish are also processed. Processing methods include smoking, sun-drying and frying. Processing also entails the use of fuel wood which, for many traders, has to be bought. To avoid the necessity to process fish, some traders (48.4%) were forced to lower the price and sell at a lower and sometimes at give-away prices.

Fig. 6.5 depicts the percentage of traders with respect to the average value of fish traded per day. Most traders dealt with fish worth from less than TZS 10,000/= to 40,000/= that is less than USD 35. Only about a quarter of the traders sold fish worth more than T.shs. 40,000/=. About half of this last group could handle fish worth more than TSh. 200,000/=. One trader in particular was very well organized. He dealt with fresh Nile tilapia and his markets were as far as Mugumu (Serengeti), Tarime and Sirari at the Kenya/Tanzania border. He had agents there and liaised with them on how much fish he should send them with respect to the situation forecast each day and sent them fish by buses.

On the question of the profit got from the business whether it was sufficient for supporting the traders' daily needs, slightly more than half (51.4%) responded positively.

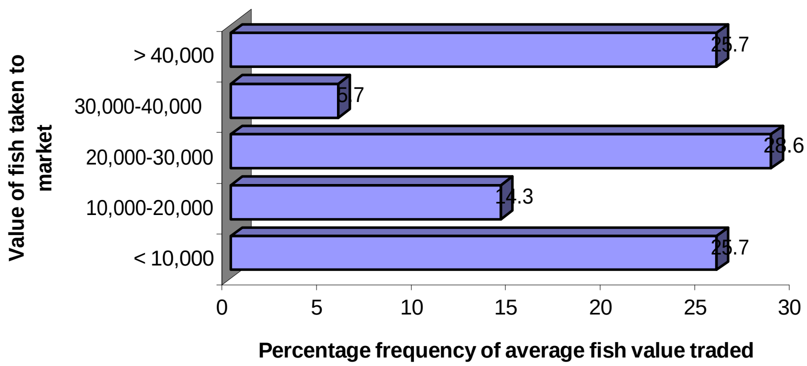

Figure 6.5. Percentage of traders according to the estimated average value of fish they trade per day.

The rest (48.6%) said they had to subsidize their income with money earned from other sources. Regarding the more favourable season for fish trade, majority of the traders (85.7%) said it was during the dry season (June-October) when fish trade was profitable because of the reasons summarized in Fig. 5.6. However, a few (14.3%) said they made profit during the wet season and argued that fish were more available then but because more people were engaged in farming activities and since roads were not good at the time, the few traders who managed to reach markets had less competition and the buying price at the landing sites was much lower so that one could buy as much as he/she could afford.

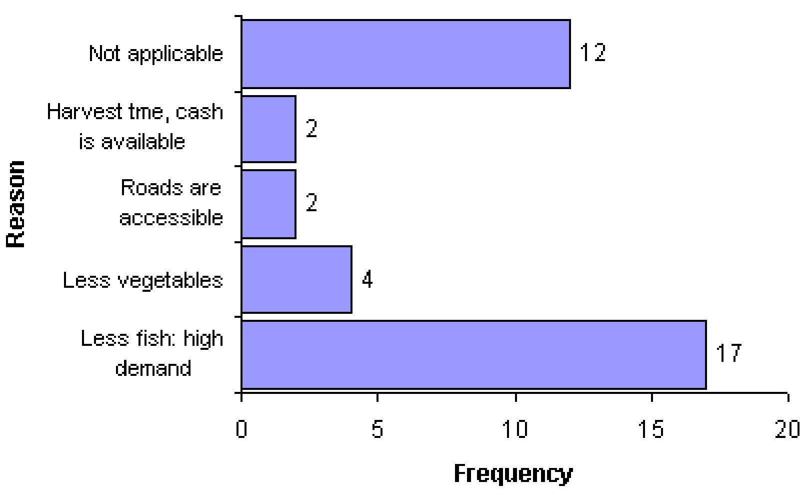

Figure 6.6 Reasons favouring high profit during the dry season

Fig. 6.7 shows the percentage frequency of common problem occurrence among the traders. It is noted that unreliable supply of fish and shortage of enough capital stand out as the most prominent constraints. If availed more capital, most traders (85%) said they would expand their fish trade by using more efficient transport to reach distant markets;

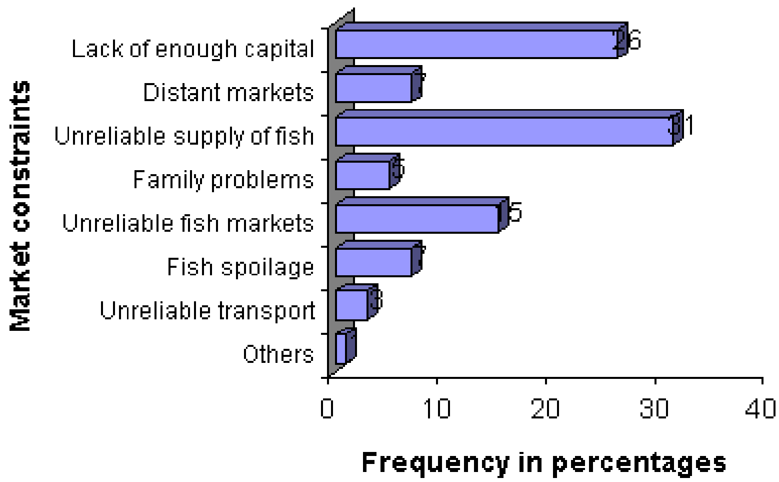

Figure 6.7. Different constraints faced by fish traders

they would also increase the volume of fish traded. The rest (15%) said they would venture into other more profitable activities such as cereal and fruit trade, shops, horticultural farming and even resort to the real fishing in the open lake waters.

So, apart from the problems listed above, lack of good organizational skills and instant communication cause some constraints in the fish trade.

7.1. Causes of loss and reduction of fish resources in Mara Swamp.

There are several reasons in which fish species can go extinct. If they become unable to reproduce, cannot find the appropriate food items for their nutrition and when adverse environmental conditions are prevalent, e.g. high temperatures that can occur in small pools, absence of enough dissolved oxygen and by drying up of the water medium in which the species are adapted to live. The loss could also occur through heavy predation by crocodiles and over-exploitation by man.

In the Mara Swamp, the flood-pools formed during the wet season become inhabited by fish. At the onset of drying, the fish in the pools, if they are not adapted to the dry conditions, they ultimately die. But fish like *P. aethiopicus* form a cocoon and estivate in that cocoon in the dry mud until when the pools are refilled with flood water again. *Clarias* may have the chance to wriggle on dry grass towards another pool or river water.

O. esculentus could possibly not survive in Lake Victoria when the diatom *Aulacoseira* went missing from the lake because of changing environmental variables. The diatom was the only food the fish could eat and digest (Fish 1955). It is now worrying if the fish still exists in the swamp after the satellite lakes/pools of Kirumi and Kubigena went dry last year. It is also likely that *Labeo* and *Barbus* spp which spawned up the river are very seldom observed in the river possibly due to increased sediment load taking place there such that, in one way or another it prohibits the incubation and eventual hatching of the eggs. Conversely, the deposition of sediment as the river water reaches the swamp slows the flow speed, causing the river to swell sideward thereby enhancing the spread of the papyrus swamp.

Incidentally, the papyrus swamp is an ideal breeding ground for the lungfish (Goudswaard *et al*. 2002, Greenwood 1958). Consequently, this has enhanced its population growth in the swamp. Perhaps, the swamp might be supporting the largest lungfish population in the Tanzania basin of Lake Victoria. In actual fact, *P. aethiopicus* and *C. gariepinus* are best adapted for survival in the poorly aerated swamp; their fishery there is, to a large extent, self-regulatory. The swamp cover protects the fish from exploitation by man and predation by crocodiles through limiting of the fishing activities and access which have to take place in the open waters or channels where the setting of gear and hunting are possible. So, the more the swamp coverage, the less the fishing activities and predation become and, vice versa. This means that only prolonged droughts have drastic potential for substantially reducing the populations of these species through marked water recession. Prolonged droughts tend to induce the adjacent local communities to clear the papyrus swamps in order to cultivate short-term crops, such as sweet potatoes, to survive on. Frequently, fires are set on the swamps as the easiest method in clearing the area for that purpose. But, in so doing, a big damage to both floral and faunal biodiversity may result directly from the fires and subsequent sediment loading during the onset of rains. Since these changes affect the environment they are likely to cause reduction of fish population in the swamp.

Losses and reduction of other species in the area (river water) could have resulted through over-exploitation at the mouth of the river and possibly by environmental degradation and toxicity brought about by wash-offs of agro-chemicals into the river.

7.2. Measures for reducing the losses and reduction of fish populations in the Mara swamp

The drying up of satellite lakes which, in a way, reduced or even caused the loss of fish from the swamp system was a result of prolonged droughts. This is a natural phenomenon which can partly be controlled through major reforestation, of the presently rather deforested villages, which can influence the rainfall regimes through environmental modification. On the question of the causes due to sedimentation, the control of human activities that lead to pronounced soil erosion could be curbed through the provision of education on better land management, including the use agro-chemicals. The latter have the potential of direct poisoning of the fishes or imposing other lethal effects connected with fish spawning activities.

8. Management opportunities giving incentives for sustainable fisheries

The fish resources of Lake Victoria (and other lakes in Tanzania) have, until recently, been managed by the central government and its instruments down to the district level, while their exploitation by resource users has always remained open to everyone (Onyango 2005). Such management approach makes the resource users feel irresponsible towards rational exploitation practices that entail observing certain rules and regulations imposed by the government for that purpose. Resource users have always the tendency to maximize profit even if it involves disobeying the laws (Geheb and Kamuturaki 2005) since the resource ownership is attributed to the government rather than to themselves. Therefore resource sustainability cannot be achieved and, instead the resource is over exploited. The rational approach is to give ownership to local resource users coupled with exclusion of open access (Onyango 2005). Ownership gives the local communities the incentive to monitoring, control and surveillance of the resource. They become automatically motivated to deal with trespassers so as to safeguard their property.

Incidentally, Beach management units (BMUs) have recently been formed all round Lake Victoria to take the responsibility of monitoring, control and surveillance of the fish resources at village level in response to the call for co-management of the lake’s fish stocks by the riparian authorities (Imende *et al.* 2005). It is, however, argued that these beach units could turn out to be the governments’ instruments if not given the ownership of the fish resource they harvest in their areas while limiting access by outside communities (Onyango 2005). In fact, more conflicts are likely to arise when the majority of resource users in the same village are not part of the decision makers and therefore the latter would still be looking at the fish resource as belonging to the government and the officials of BMUs who are, unfortunately, very familiar to ordinary members of the same community. This was observed in some of the surveyed communities. It was related that illegal fishers were a serious problem in Musoma Bay where they carried out their offenses intentionally for the sake of provoking confrontation between them and BMU officials who are still more or less incapacitated in their operations. Moreover, as the saying goes, ‘Familiarity breeds contempt.’ The BMUs cannot be effective without the support of the majority of the communities in which the BMUs are operating. The support can only be rendered through the incentive of community ownership of the fish resources and involvement of community members in decision-making with regard to the formulation of rules and regulations for managing the resources within their jurisdiction. In other words, government authorities have to work hand in hand with communities by providing education through seminars and other media to let them feel that they are being valued and their contributions recognized.

It is therefore recommended that villages, through their local leadership and BMU units, be given the ownership of the resources within their village jurisdiction and technical support necessary for monitoring, control and surveillance so that sustainable fisheries could be achieved.

9. Capacity building measures for local communities and other stakeholders regarding sustainable fisheries

Theoretically, a sustainable fish stock can be maintained if the rate of recruitment more or less equates the rate of natural mortality plus that of exploitation; if the rate of loss through natural mortality combined with exploitation exceeds that of recruitment, the stock declines, resulting in the collapse of the stock. To maintain sustainable fisheries in the area in question, there should be taken steps to reduce overcapacity, that is, reduce the number of fishers by creating or improving upon other income generating activities so that pressure on the fish stocks is reduced. Assuming the communities are given the suggested ownership status of the fish stocks in their areas, then for effective management, capacity should be given to the BMUs for monitoring control and surveillance of the stocks by providing patrol boats (which could be shared among villages for joint patrols), communication gear and other essential infrastructure and accessories.

Turning to other income generating activities, the villages can be given the capacity in rice farming along the swamp and other potential areas near the lake. Already there is a rice-growing scheme in Buswahili village along the southern part of the swamp in Musoma Rural District. There exist potential areas for aquaculture, so building capacity for raising fish for consumption and for bait use in the Nile perch hook fishery on Lake Victoria could be a useful alternative. *Clarias* juveniles fetch up to TZS 150/= per piece and it takes about 40 days to rear catfish fingerlings to attain 8-10 cm total length required for use as bait.

Most homesteads keep livestock and there is a problem of over grazing in some villages. Actually the swamp is the biggest pasture source used in the dry season. Convincing the communities to embark on dairy cattle rather than keeping large herds of livestock stand the chance to improve incomes and reduce land degradation.

The swamp has vast resources of papyrus reeds and other aquatic vegetation that are potential craft materials. Currently, the mats woven by mostly women in the villages around the swamp are crude. Further training to diversify and improve the craftsmanship on the mats could produce better value-added mats and various products for sale in towns and even for export markets. A variety of these craft products can be seen at Ahero Market near Kisumu, Kenya. So crafts-persons could be hired from there and elsewhere to come and teach the present communities. Still, tree nurseries could be started by creating and encouraging interested groups to raise seedlings for reforestation of the villages which are at various stages of deforestation; the aim being the provision of firewood, timber and fruit both for home consumption and for sale.

A good number of fishers were of the opinion that if given a loan, they would spend it on buying water pumps for use in horticulture. They were convinced it paid more than fishing especially in Mara swamp where they claimed fishing was very risky because of the occasional attacks by crocodiles and hippos and hostile environment full of mosquito bites and staying overnight in unstable dugout canoes. Opportunities in horticulture lie in growing tomatoes, water melon, cucumbers and other vegetables which, the communities believe, are hot cakes in town markets.

According to Ms Sylvia Chirwa (Nyegezi Freshwater Fisheries Training Institute), the lungfish (kamongo) produces very good and tasty fillets. In support for her assertion, I still recall the incidences of the 1970s when limited amount of lungfish fillets were occasionally served at the University of Dar es Salaam cafeterias and students used to literally fight over them, including female students from Lake Victoria basin where the eating of lungfish by females of most Bantu tribes there is a taboo (or natural dislike?) that still holds water and who, for certain, would not have dared even to taste the fish if it had not lost its identity through processing! The raw fillets can further be turned into fish balls, cakes, pie, sausages and samosas. Such processing would greatly add value to the lungfish currently caught in the Mara Swamp. It is thus strongly recommended that the fisher communities from the swamp area be convinced to form a co-operative society, followed by availing capital support to erect a small processing plant which would produce fillets that, by arrangement with hotels in Musoma and Tarime towns, could be used to prepare special dishes mentioned above. This would no doubt attract a good number of customers who would boost the market of the fish and bring in substantial income to the fishers and their families. Indeed, it could perhaps create lungfish eating tourism to the region such as is the case with crocodile meat at the Baobab Farm in Mombasa, Kenya and elsewhere.

In summary, all these activities require capital and some skills in their operation and management. These requirements ought to be considered for the suggested activity diversification in order to relieve fishing pressure on the stocks and thus remain with a manageable number of fishers who are necessary for the creation of sustainable fisheries.
It is also advised that group activities be encouraged rather than individual ones for cheaper and more effective service provision.

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Appendix 1

ITINERARY

Date	Town/Village visited	Persons met/consulted/interviewed
29th May, 2007	Musoma	Mr A. Makaja, District Fisheries Officer Musoma Rural District.
30th May, 2007	Musoma	Messrs F. Mhina and W. Kasanga
30th May, 2007	Kirumi	Village Chair man, Mr Charles Segeru and fishers from the village
31st May, 2007	Tarime	Mr A. Madundo, District Fisheries Officer, Tarime District; Mr Mukoyongi District Natural Resources Officer.
“ “ “	Bisarwi	Village Chairman, Mr A.C. Chogo and Village Executive Secretary, Mr. Y. Wambura, and uncompromising fishers.
“ “ “	Kembwi	Village Chairman, Mr F.V. Okello and unco-operative fishers
1st June, 2007	Ryamisanga	Village Executive Secretary Fishers and fish traders
2nd June, 2007	Kembwi	Village Chairman, and still uncooperative fishers
3rd June, 2007	Musoma	Vehicle engaged in some pressing issue
4th June, 2007	Musoma	Ms Sharon Murray, USA and Mr Kajuni, USAID, Dar es Salaam.
“ “ “	Kirumi-Mamu	Village Chairman, BMU Secretary, fishers and fish traders
“ “ “	Kyagata Market	Fish traders
5th June, 2007	Kuruya	District Fisheries Officer, Tarime Village Executive Officer Fishers and fish traders
6th June, 2007	Musoma	Return back to Mwanza

Date	Town/Village visited	Persons met/consulted/interviewed
26th June, 2007	Musoma	Mr F. Mhina, WWF Office District Fisheries Officer
27th June, 2007	Nyarusurya	Fisheries Assistants: Mr E. Magige and Ms S. Malima, BMU officials, fishers and fish traders
28th June, 2007	Kinesi	Village Chairman, Mr E. Obate; BMU Secretary, MrW. Chacha, fishers and fish traders.
29th June, 2007	Buswahili	Village Executive Officer, Mr J. Nyituga, fishers and fish traders
29th June, 2007	Musoma	Return to Mwanza

Appendix 2

Photo illustrations

Photo 1. View of one of the flood pools along Mara River. Note the dug out canoe used by fishers in the river and swamp fisheries. The river passes beyond the fringing papyrus swamp in sight.

Photo 2. Papyrus swamps fringing the Mara River just past Kirumi Bridge towards Lake Victoria. Note the bad practice of burning the swamp done especially in the dry season.

Photo 3. The survey team with WWF staff and his guests from USAID heading to Mamu Landing Site in Musoma Bay, near Mara River mouth.

Photo 4. Survey team talking to the fisher folk at Mamu Landing Site, Kirumi Village.

Photo 5. Fishers preparing their nets ready for evening setting in Musoma Bay. Note the gillnet float-line (head-rope) in the fisher's hands and the Sesse plank-canoe fishing craft.

Photo 6. The Nile tilapia (*Oreochromis niloticus*), currently the dominant species in Musoma Bay.

Photo 7. The lungfish (*Protopterus aethiopicus*), the leading fish in Mara Swamp. This specimen is about 10 kg in weight. The fish yields excellent fillets.

Photo 8. The catfish (*Clarias gariepinus*); it is an important catch in the Musoma Bay and Mara Swamp.

Photo 9. A mixture of *Labeo victorianus* (with the greenish tinge) and *Schilbe intermedius* (silvery in colour). They are seasonal; these were caught from the Speke Gulf

Photo 10. *Synodontis afrofischeri* (with brownish tinge) and *S. victoriae* (with black spots). They are also seasonal.

Notes

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