

CHANGES IN POPULATION STRUCTURES OF THE MAJOR FISH SPECIES IN SELECTED SATELLITE LAKES AROUND LAKE VICTORIA FOLLOWING CHANGES IN FISHING EFFORT

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ABSTRACT

This paper evaluates the impacts of reduction in effort, increase in mesh sizes, and prohibition of illegal fishing gears in selected satellite lakes around Lake Victoria. The study was carried out in six satellite lakes by making investigations on fish collected from experimental and artisanal fisheries. The fishes were analysed for length frequencies, weight and numbers caught to determine the population structure of the fishes. Indiscriminate fishing by deploying illegal gears and increased fishing effort due to open access policy, the catch and diversity of the species in these lakes has declined. Establishment of Conservation Management Units (CMUs) as an enforcement measure in some satellite lakes seems to succeed in controlling the illegal practices and a positive sign of recovery of some species and size increase of the exploitable fish species was noted in lakes Ikimba and Kirumi where enforcement has been effected. From March 2002 to January 2003 the maximum size of Oreochromis niloticus and O. esculentus had increased from 28 cm to 33 cm and 25 cm to 27 cm in Lake Kirumi and Lake Ikimba, respectively. Nevertheless, fish species diversity in these lakes is still low. Recommendations on the way forward are given

INTRODUCTION

Satellite lakes have not only served as natural species reservoirs (Katonzi 2003) but also have influenced the socio-economic outlook of the indigenous populations of human being in the Lake Victoria basin (Harris 1998). Apart from *Lates niloticus* and *Rastrineobola argentea*, data collected for the last five years has confirmed the presence of fish species in satellite lakes to be similar to those indigenous to Lake Victoria (Katonzi and Msuku 2001). Recent attempts to study biodiversity in satellite lakes (Lyimo and Sekadende 2003, Katonzi 2003) have also paved way for the resolution of the intricacies within these isolated water bodies. The available data so far indicate that the fisheries within satellite lakes are declining (Katonzi and Msuku 2001, Katonzi and Kishe 2002, Katonzi 2003) while little is known on the ecosystems and population structures. Heavy fishing pressure, free access to the fisheries,

continual use of illegal fishing gear have greatly affected the commonly exploited species.

To keep the biological entity while preserving the aesthetics, there is need to address the fisheries management issues so as to minimize possible changes that could lead to species extinction. Until recently, there has not been any initiative to involve the fishers and communities in supporting and applying biological findings. This has resulted in over-exploitation of fisheries resources manifested as reduced age and size at first maturity of fish species, as well as high fishing mortalities and decline in catch rates and fish diversities in these minor water bodies (Katonzi 2003). As a measure to combat further declines, Conservation Management Units (CMUs) were established to participate in the management process.

Over the last two years, a positive sign of species recovery and size increment of some

fish species in the satellite lakes has been noted (Katunzi and Msuku 2001, Katunzi and Kishe 2002, Katunzi 2003). The common species in satellite lakes are *Oreochromis* species (i.e. *O. niloticus*, *O. esculentus* and *O. leucostictus*), *Clarias gariepinus* and *Protopterus aethiopicus* (opp. cited). This paper speculates on the reasons behind these recoveries, changes in fish population structures following changes in fishing effort and suggests appropriate measures that will help to sustain the fish species in the satellite lakes.

MATERIALS AND METHODS

The study was carried out in March 2002, September 2002 and January 2003 in lakes

Burigi, Malimbe, Ikimba, Kirumi, Kubigena, and Katwe (Fig. 1). Fishery data was collected from the satellite lakes using data from the fishermen (dependent) and experimental fishing (independent). Independent fishing was carried out using multi-mesh gillnets whose panels had mesh sizes ranging from 2.5 cm to 12.5 cm at 1.25 cm interval. The nets were set in the evening, left overnight and hauled early the next morning. Collected fish samples were identified to species level, grouped into size classes per gillnet mesh size basing on total length (cm) measurements. Data was analysed for length frequency distribution and percentage species compositions.

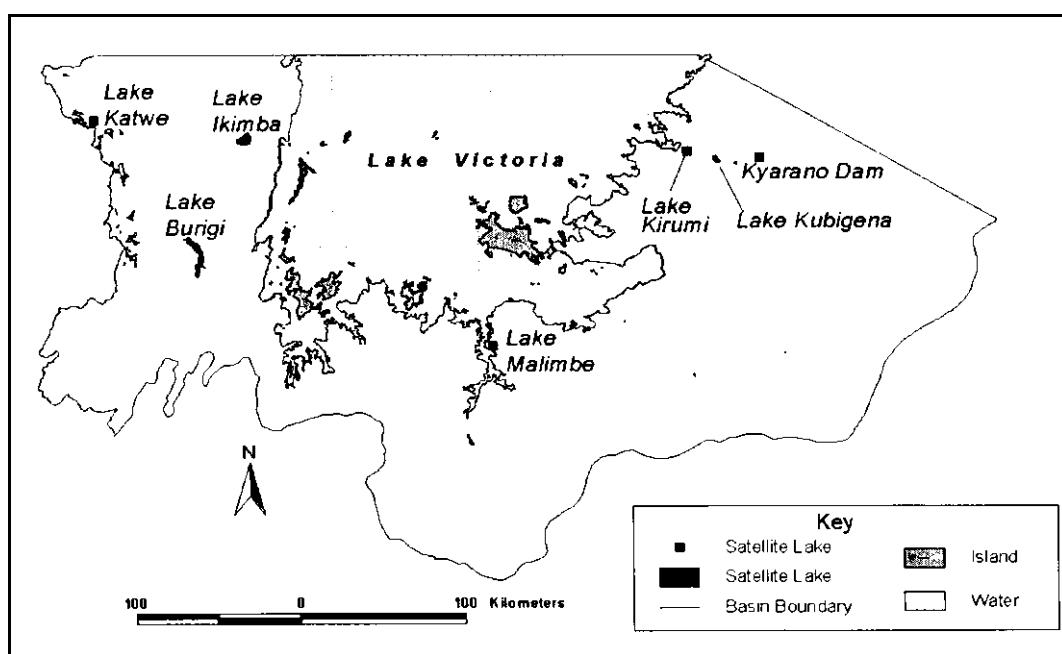


Figure 1: Map of Lake Victoria showing sampling stations

Data from dependent fishery was analysed by taking length frequencies and weights of the landed fishes per boat at lakes Burigi and Kubigena. Fishermen were using gillnets of mesh sizes 5.0 cm, 7.5 cm and 8.5 cm in both lakes while in Lake

Kubigena hooks of size 9 and 10 were also in use. The length modes from the catch data were reported and discussed with relation to lengths at 50% maturity as per Katunzi and Msuku (2001) to establish the level of exploitation for *O. esculentus* from lakes Burigi, Malimbe and Ikimba.

RESULTS

The majority of the fish species reported missing, for example, *Oreochromis esculentus*, *O. leucostictus*, *Momurus* species in Lake Victoria were found in these satellite lakes.

Lake Burigi

Lake Burigi was characterised by an artisanal fishery based on *Oreochromis esculentus*, *O. niloticus*, *O. variabilis*, *Clarias gariepinus* and *Protopterus aethiopicus*. The three *Oreochromis* species coexist but *O.*

esculentus was captured from further offshore waters. Catches from both independent fishery (Table 1) and dependent fishery (pers. observ.) were dominated by *O. esculentus* in terms of weights and numbers. Other fish species that were found but at low percentages include *Clarias gariepinus*, *Tilapia zillii*, *Barbus profundus*, *Astatoreochromis alluaudi* and three phytoplanktivorous haplochromines (Table 1).

Table 1. Percentages composition by number and weight (kg) of fish species in Lake Burigi

Fish species	March 2002		September 2002		January 2003	
	Weight	Number	Weight	Number	Weight	Number
<i>O. variabilis</i>	7.1	14.0	5.1	0.3	24.9	14.5
<i>O. esculentus</i>	22.1	33.1	78.4	90.5	20.2	38.2
<i>O. niloticus</i>	10.7	9.9	2.4	5.1	30.7	11.6
<i>T. zillii</i>	0.2	0.4	-	-	1.1	0.3
<i>B. profundus</i>	0.1	4.6	-	-	0.0	0.8
<i>C. gariepinus</i>	59.8	9.1	13.7	1.7	23.1	1.8
<i>P. aethiopicus</i>	-	-	-	-	0.01	0.1
Haplochromines	0.04	29.1	0.3	2.4	0.01	32.7

From the independent fishery data in March 2002, the maximum lengths of *Oreochromis esculentus* caught was 22 cm TL (Fig. 2a) whereas in September 2002, the biggest size was 35 cm TL (Fig. 2b). However, the January 2003 survey indicated a size decrease to 29 cm TL (Fig. 2c). In the latter two surveys, larger fishes were caught compared to the March 2002 catch.

The dependent fishery data indicate that the mode of the exploited population was 17 cm TL (Figs 3a & b).

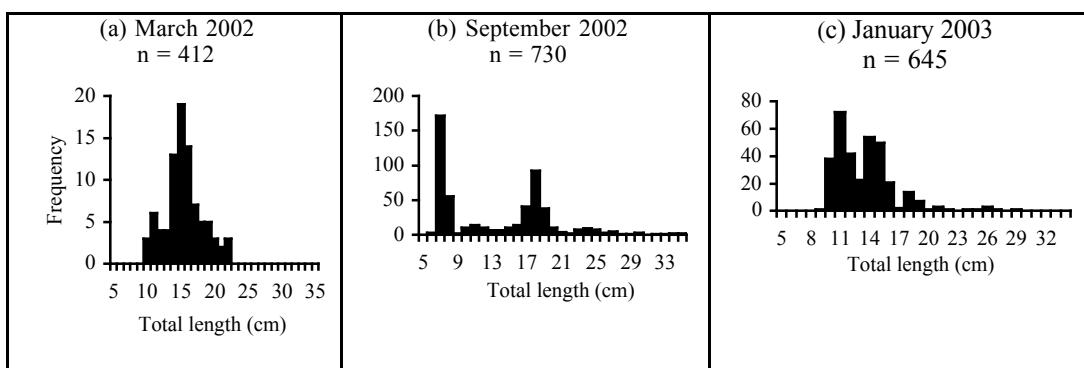


Figure 2: Length frequency distribution of *O. esculentus* catches in Lake Burigi (experimental/independent fishery)

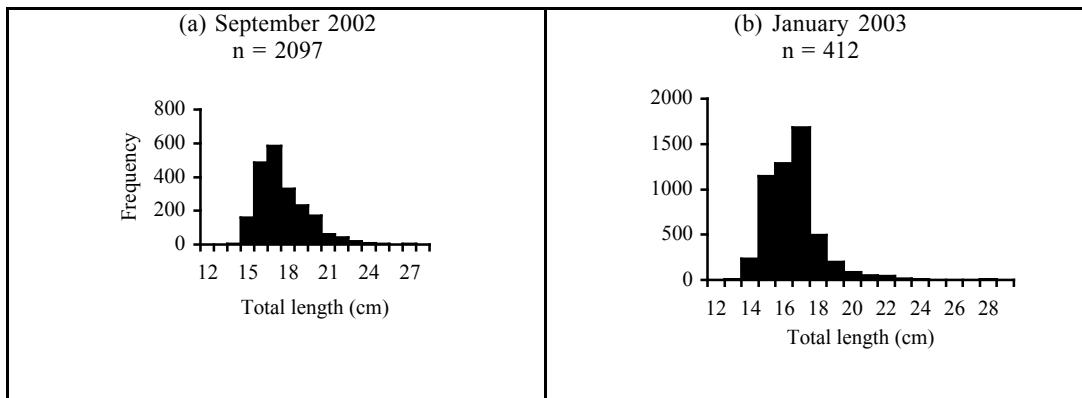


Figure 3: Length frequency distribution for *O. esculentus* in Lake Burigi showing a range of exploited population (dependent fishery)

Table 2. Percentages composition by number and weight (kg) of fish species caught by gillnets in Lake Ikimba

Fish species	March 2002		September 2002		January 2003	
	Weight	Number	Weight	Number	Weight	Number
<i>B. sadleri</i>	3.6	12.6	-	-	2.8	13.3
<i>O. esculentus</i>	35.9	77.2	13.8	45.8	11.3	8.3
<i>B. profundus</i>	0.4	4.6	-	-	0.2	0.7
<i>C. gariepinus</i>	50.0	2.8	61.9	22.1	39.6	1.7
<i>P. aethiopicus</i>	-	-	-	-	36.9	8.0
Haplochromines	10.0	2.8	22.9	31.7	5.8	48.7
<i>O. variabilis</i>	-	-	1.4	0.4	-	-
<i>M. rheni</i>	-	-	-	-	3.4	19.3

Lake Ikimba

Oreochromis esculentus continued to dominate the gillnet fishery of Lake Ikimba for three different sampling periods (Table 2). Among the haplochromines caught were *Prognathochromis venator*, *Astatotilapia velifer*, *A. lacrimosa* and *Astatoreochromis alluaudi*. There was an increase in the number of fish species from 5 (March 2002 survey) to 7 species (January 2003 survey). Fish species that were not caught in previous surveys are *Protopterus aethiopicus* and *M. rheni*.

The modal length of fish in September 2002 (Fig. 4a) and January 2003 (Fig. 4b) was the same ranging from 8 - 11 cm TL. However, the 2003 data indicated a high number of bigger size categories of fish (Fig. 4b).

Lake Katwe

Though Lake Katwe had the highest number of fish species (Table 3), the number decreased from 15 (March 2002) to 13 (September 2002) and then to 11 (January 2003) (Table 3). The haplochromine group was dominated by an unidentified algal scraper and *Astatoreochromis alluaudi*. Other species identified include *Xystichromis* sp., *Gaurochromis simpsoni* and *Psamochromis* sp. All the four tilapiine species were exploited from this lake with *O. niloticus* and *O. leucostictus* dominating compared to *O. esculentus* and *O. variabilis*. *Brycinus jacksonii*, *O. variabilis*, *G. longibarbis*, *S. intermedius*, *P. catastoma*, *T. zillii* and *P. aethiopicus* that were collected during March

2002 were not recorded in the catch of January 2003 survey. The lake has been exploited heavily without any management

measures. The catch rates had declined from 22.2 (in 2002) to 16.4 kg/boat (in 2003).

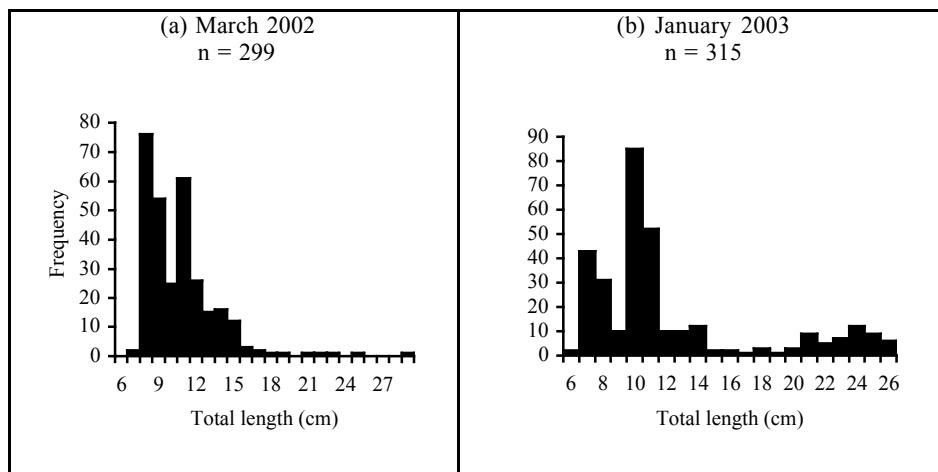


Figure 4. Length frequency distribution of exploited *O. esculentus* caught by gillnet-Lake Ikimba

Table 3. Percentages composition by number and weight (kg) of fish species in Lake Katwe

Fish species	March 2002		September 2002		January 2003	
	Weight	Number	Weight	Number	Weight	Number
<i>B. sadlieri</i>	0.1	0.4	0.2	0.3	2.3	1.5
<i>B. jacksonii</i>			0.1	0.3	-	-
<i>O. leucostictus</i>	4.6	5.5	9.5	11.6	28.9	11.6
<i>O. variabilis</i>	6.0	5.9	4.1	2.8	-	-
<i>S. intermedius</i>	1.3	0.8	0.9	0.8	1.1	0.6
<i>L. victorianus</i>	0.5	0.4	2.1	1.9	4.1	1.1
<i>O. esculentus</i>	13.8	37.1	-	-	2.5	1.1
<i>O. niloticus</i>	27.1	33.7	9.2	8.6	4.1	0.5
<i>S. victoriae</i>	0.2	0.5	-	-	0.6	0.8
<i>B. altianalis</i>			0.3	1.9	1.6	3.2
<i>C. gariepinus</i>	39.8	7.6	6.5	1.1	17.1	0.9
Haplochromines	0.9	2.5	54.2	30.7	37.7	78.8
<i>S. afrofischeri</i>	1.0	1.3	12.5	38.5	-	-
<i>G. longibarbis</i>	0.1	0.8	-	-	-	-
<i>P. catastoma</i>	0.1	0.4	0.2	0.6	-	-
<i>T. zillii</i>	3.9	2.1	-	-	-	-
<i>C. alluaudii</i>	-	-	-	-	0.1	0.2
<i>P. aethiopicus</i>	0.6	0.4	-	-	-	-
<i>M. rheni</i>	0.1	0.4	1.4	0.6		

Lake Kirumi

The species composition at Lake Kirumi observed in January 2003 had changed compared to earlier studies results (Table 4). Phytoplanktivorous haplochromines, *O. niloticus*, *P. aethiopicus* and *B. altianalis* made up the highest percentages both in terms of numbers and weights (Table 4). *Barbus altianalis* was now dominating the Lake Kirumi catches. Also, haplochromines and *O. niloticus* were contributing high

percentages both by numbers and weights (Table 4). Though the maximum size of *O. niloticus* caught in September 2002 and January 2003 remained at 33 cm TL, the modal length had shifted from 19 cm TL (Fig. 5a) to 27-30 cm TL (Fig. 5b) respectively. However, the catch per net was still low.

Table 4. Percentages composition by number and weight (kg) of fish species in Lake Kirumi

Fish species	March 2002		September 2002		January 2003	
	Weight	Number	Weight	Number	Weight	Number
<i>B. sadleri</i>					2.9	13.0
<i>O. esculentus</i>					5.2	6.3
<i>O. niloticus</i>	21.2	14.3	34.6	3.0	53.5	8.7
<i>O. leucostictus</i>			6.9	1.2		
<i>B. altianalis</i>			5.4	6.3	12.7	42.3
<i>C. gariepinus</i>	43.9	4.8	23.5	0.3	1.1	0.3
<i>P. aethiopicus</i>	26.0	23.8	3.4	0.2	18.5	1.7
Haplochromines			49.7	89.4	5.6	26.3
<i>S. afrofischeri</i>	8.9	57.1	4.8	4.0		
<i>C. alluadi</i>					0.5	1.3

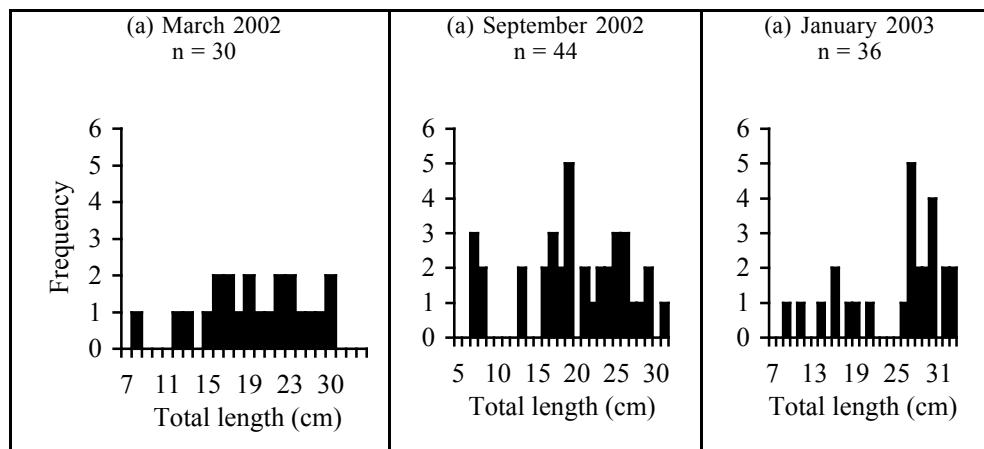


Figure 5. Length frequency distribution of *O. niloticus* catches in Lake Kirumi

Lake Malimbe

Lake Malimbe has an important small-scale fishery based on *Oreochromis esculentus*. The 2002 and 2003 surveys revealed a

decline in modes at 11 cm (Fig. 6a) and 7 cm TL (Fig. 6b) respectively. Other fish species e.g. *P. aethiopicus*, *C. gariepinus*

and haplochromines were also found but in very small quantities (Table 5).

Table 5. Percentages composition by number and weight (kg) of fish species in Lake Malimbe

Fish species	March 2002		September 2002		January 2003	
	Weight	Number	Weight	Number	Weight	Number
<i>O. esculentus</i>	40.8	1.0	44.0	74.0	90.2	79.2
<i>C. gariepinus</i>	22.6	1.0	32.0	21.2	-	-
<i>P. aethiopicus</i>	29.1	78.7	-	-	4.1	19.3
Haplochromines	6.0	8.2	5.8	5.4	5.8	20.6
<i>T. rendalli</i>	1.6	1.0	-	-	-	-

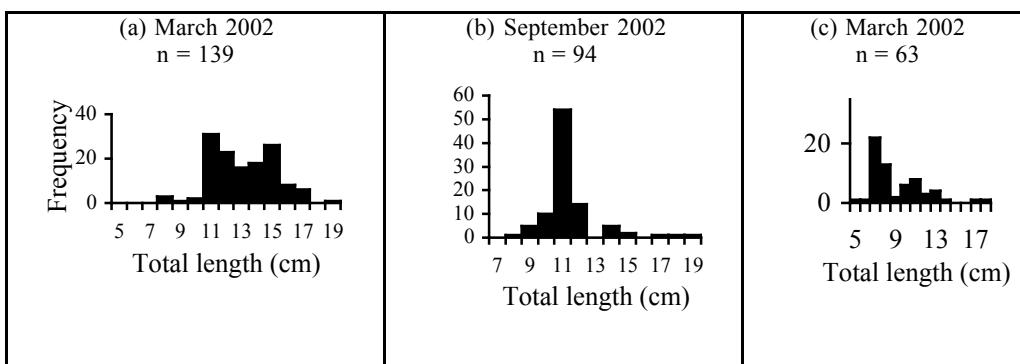


Figure 6. Length frequency distribution of *O. esculentus* caught by gillnet in Lake Malimbe

Lake Kubigena

The lake supports a fishery based on *Oreochromis leucostictus*, *O. niloticus*, *Clarias gariepinus* and *Protopterus aethiopicus* (Table 6). Due to open access the fishery and continued use of illegal fishing gears and methods (e.g. spears), the species are exploited before reaching maturity as recorded by Mossile and Mainoya (1988). *Protopterus aethiopicus* and *C. gariepinus* dominated the catch in terms of numbers and weights for the three surveys (March 2002, September 2002 and

January 2003) (Table 6). The collected *C. gariepinus* had size ranges of 24-67 cm TL (September 2002) (Fig. 7a) and 22-70 cm TL (January 2003) (Fig. 7b) with modal length of 37 cm TL and 32 cm TL respectively. *Protopterus aethiopicus* caught in Lake Kubigena in September 2002 and January 2003 had respective sizes of 34 - 125 cm TL (Fig. 8a) and 37 - 114 cm TL (Fig. 8b). Respective modal length are 48 cm TL and 51 - 53 cm TL

Table 6. Percentages composition by number and weight (kg) of fish species caught by gillnet in Lake Kubigena

Fish species	March 2002		September 2002		January 2003	
	Weight	Number	Weight	Number	Weight	Number
<i>O. leucostictus</i>	41.5	1.3	9.0	11.6	8.3	11.6
<i>O. variabilis</i>	1.5	0.1	-	-	-	-
<i>L. victorianus</i>	0.3	0.0	-	-	-	-
<i>O. niloticus</i>	3.8	0.3	-	-	-	-
<i>C. gariepinus</i>	18.2	77.4	16.7	16.1	36.7	53.3
<i>P. aethiopicus</i>	34.6	20.9	74.3	71.4	55.0	35.1

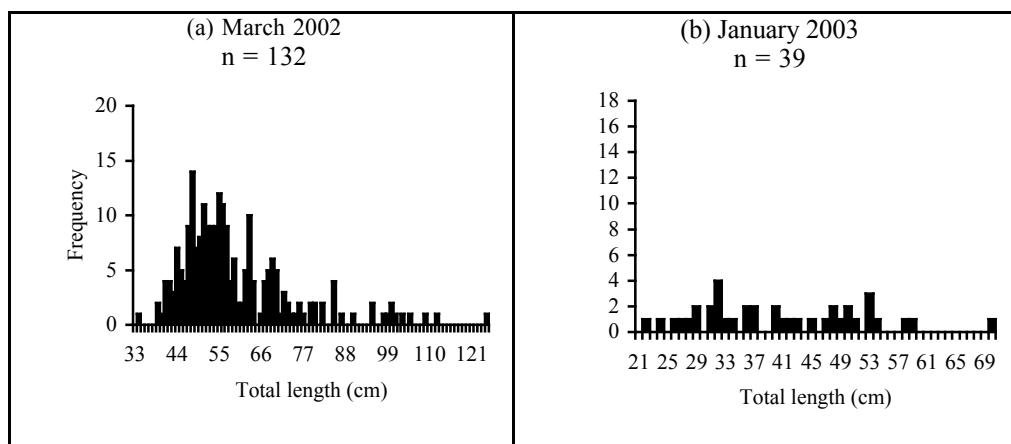


Figure 7. Length frequency distribution of exploited *C. gariepinus* in Lake Kubigena caught by gillnet and hooks (dependent fishery)

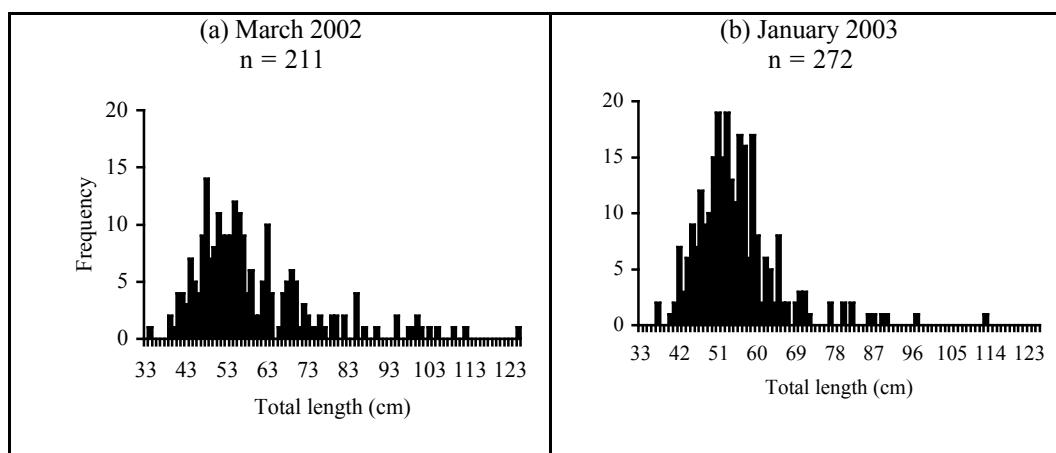


Figure 8. Length frequency distribution of *P. aethiopicus* in Lake Kubigena showing the range of exploitation population caught by gillnets and hooks (dependent fishery)

DISCUSSION

The increase in diversity in the month of September was probably a result of increase in food items (phytoplankton and zooplankton species) in the environment as a result of the rains. The level of species diversity in each lake does not however guarantee unrestricted harvesting. At Lakes Ikimba and Kirumi, where the communities positively responded to the initiative of establishing Conservation Management Units (CMUs) (pers. obs), an increase in sizes of fish and number of species has been registered. At Lake Ikimba, the increase is also due to an effective enforcement of increased mesh size and prohibiting of bad fishing practices. On the other hand, a slight recovery of some fish species e.g. *Barbus altianalis*, *O. niloticus* at Lake Kirumi was because no fishing was taking place. Also, haplochromines were observed though in small numbers.

The apparent size increase of *O. esculentus* at Lake Burigi (during September 2002 survey) was probably a result of reduced fishing effort since fishing was stopped for three months due to lack of security within the area. The slight drop of size observed during January 2003 survey suggests that the resources are sensitive to fishing pressure. Currently, the size of *O. esculentus* exploited coincides with L_{m50} of 16.6 cm TL for females and 16.5 cm TL for males (Katuunzi and Msuku 2001). This suggests that by further reducing the fishing effort, fishes at Lake Burigi could grow to bigger sizes. Increase in mesh size to 7.5–10 cm is recommended, so as to give chance to many fishes to reproduce before they are caught.

Lake Malimbe stands out as an example of a unmanaged fishery. Due to socio-economic reasons and lack of proper sensitization of the CMUs, the fishers have continued to exploit fish using under sized gillnets. This, combined with the splashing water method locally known as “katuli”, has caused a decrease in the modal class of the exploited population (*O. esculentus*) from 11 cm TL (March and September 2002) to 7 cm TL

(January 2003). Despite the low modal lengths, the exploited fishes were mature. Also the lengths at 50% maturity were low compared to those in the main lake (Witte and Van Densen 1995).

The fishery at Lake Kubigena exploits both *Protopterus aethiopicus* and *Clarias gariepinus*. However, the exploitation rate was very high and the catch was dominated by immature fish because the mode for *P. aethiopicus* was 47–56 cm TL during September 2002 survey, and 36–37 cm TL in January 2003, while in Lake Victoria, the length at first maturity for *P. aethiopicus* had been found to be 66–76 cm TL for males and 76–86 cm TL for females respectively (Mossile and Mainoya 1988). *Clarias gariepinus* matures at size of 40 cm TL for both males and females (Witte and Van Densen 1995). The establishment of conservation strategies eg CMUs would help to conserve the fish resources. There is thus, need for co-management initiatives in this lake. Disappearance of some species during September 2002 and January 2003 was noted and was mainly attributed to overfishing. However, the disappearance of *Labeo victorianus* was due to reproductive behaviour of the fish which normally spawn during the rainy seasons at the margins of the rivers 15 to 30 km upstream (Witte and Van Densen 1995). September and January is a long and short rainy seasons and it is possible that during these periods fishes move upstream for spawning as Lake Kubigena connects with River Mara.

Lake Katwe is a nursery and refugia for a variety of species endemic to Lake Victoria (Katuunzi and Kishe 2002, Katuunzi 2003). Several other lakes in the Kagera River system (i.e. Lakes Mitoma, Kalenge, Rushwa and Rwakajunju) have similar roles and will be of importance to the replacement of Lake Victoria fish biodiversity if attention is paid to conserve and manage them. The four major tilapiine species in Lake Katwe (i.e. *Oreochromis niloticus*, *O. variabilis*, *O. esculentus* and *O. leucostictus*) should be regarded as buffer

stocks in Lake Victoria natural restocking programmes.

These minor fisheries in the satellite lakes have the potential to provide opportunities for income generation and improvement of nutrition. Local communities depend on these lakes for other livelihood resources. Hence they need to be properly managed for sustainability. The CMUs were envisaged to increase the effectiveness of regulating the fishery and minimizing user conflicts, because most of the satellite lakes are in very remote areas where the government can not adequately monitor and enforce the existing fisheries regulations. Therefore, such initiatives are considered as effective measures to enhance law enforcement (Panayotou 1982), because they become part of the decision making process, sharing responsibilities and possess legal rights in the management for ensuring the sustainability of the fishery (Mc Cay 1993, Cacand 1999).

Fish resources in the satellite lakes are continually declining because of the open access policy to the resources and the continued use of illegal fishing gears and methods. This continual decline of the fisheries have enormous implications on the consumers and those dependent on the fishery for their income. In order to arrest continual decline of fisheries resources found in the satellite lakes, it is recommended to establish surveillance units in places where they are lacking, and offer them some logistical support to enable them undertake the surveillance responsibilities effectively.

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