:\gillnet99

THE PRESENT STATUS OF THE FISH STOCKS IN THE EXPERIMENTAL AND COMMERCIALIARTISANAL GILLNET FISHERIES IN SELECTED WATERS OF LAKE VICTORIA, UGANDA

J.O.Okaronon

J. Akumu

S.Bassa

Fisheries Resources Research Institute,

P.O. Box 343, Jinja, Uganda

April 2001

BACKGROUND

Lake Victoria had a multi-species fishery dominated until the 1970s by the tilapiine and the haplochromine cichlids, but with important subsidiary fisheries of more than 20 genera of non-cichlid fishes such as *Bagrus, Barbus, C/arias, Mormyrus, Protopterus, Synodontis,* etc (Kudhongania & Cordone 1974). From about 1930 to 1960, the fisheries of Lake Victoria were managed by controlling the mesh size of gill nets (Graham 1929). Gill nets of mesh sizes less than 127 mm (5 inches) stretched mesh had been prohibited on Lake Victoria because they cropped immature *Oreochromis esculentus* (Ngege) which were at that time the most important commercial species on the lake (Graham 1929). The catch in the legal 127 mm mesh nets per night was over 30 fish of *Oreochromis esculentus* prior to 1921; this dropped to 6 and 1.6 fish in 1928 and 1954, respectively, (Beauchamp1955), indicating overfishing of the stocks

When the mesh size restriction was repealed in Uganda and Tanzania in 1956 and in Kenya in 1961, there was a shift to smaller meshes that cropped immature tilapia and other large species and led to a collapse in the fishery. Most probably as an effort to boost the fish production in the lake, four tilapiine species (Oreochromis *niloticus,* O. *leucostictus, Tilapia rendalli* and *T. zillil)* were introduced into Lake Victoria in the 1950s and the Nile perch *(Lates niloticus)* was introduced in the 1960s. Stocks of most of the native fish species further declined following these introductions.

"

The demand on the fish stocks of Lakes Victoria and Kyoga has increased tremendously. Fish landings increased rapidly following establishment of the introduced Nile perch and Nile tilapia. The number of fish processing plants targeted to process Nile perch has increased from zero to eight in Uganda and to about 22 in Kenya in 1991. The incentive created by the availability of ready market has caused rapid increases in fishing pressure. The total number of fishing canoes in the Uganda region has increased from 3264 in 1971 to 8674 in 1990 (Weatherall 1972, Tummwebaze & Coenen 1991). Since the entry into the fishery is not controlled, this rapid increase in fishing effort may lead to a decline in catch per unit effort and cause a collapse in the fishery.

There is currently very little control in the fisheries of Lakes Victoria and Kyoga. Both are open fisheries where any national has the freedom to catch fish to their capacity. The law on the management of fisheries in Uganda is in the Fish and Crocodiles act of 1964 and its statutory amendments. This law prohibits catching "Ngege" of less than 28 cm (11 inches) and Nile perch of less than 46 cm (18 inches) total length but does not limit the type and mesh size of nets to be used in catching fish.

There is already evidence that the high fishing pressure has resulted in a decrease of the size of Nile perch and Nile tilapia and R. *argentea* landed by the

commercial fishery especially on Lake Kyoga and the trend is spreading to Lake Victoria.

Against the above background of change, there is considerable uncertainty about the dynamics of the fisheries resource base of the lake. The continuing uncertainty concerning the ultimate fate of the Nile perch stocks, which have been predicted to collapse, coupled with the uncertainties about the size and degree of utilization of the many other fish species make it necessary that the fish stocks and fish landings be monitored in order to guarantee continued livelihoods for the estimated one million people directly or indirectly involved in the fishery.

THE PROBLEMS AND QUESTIONS OF THE RESEARCH.

Consequent on the continuing uncertainty about the dynamics of the fisheries resource base of the lake, especially concerning the ultimate fate of the Nile perch stocks - the major fishery in Lake Victoria -, the work being reported on was started to address some of these uncertainties. The research was to follow up and relate the exploitation of the fish stocks to available stocks. The questions at the time were:.

- Which fish species is the commercial/artisanal fishery is targeting?
- What sizes of fish does the commercial/artisanal fishery target?
- What are the catch levels in the commercial/artisanal fishery?

- Which gears are used to exploit the fish stocks?

These will all be related to the available stocks.

OBJECTIVES OF THE STUDY

The overall aim of the study was to assess the exploitation of the fish stocks in relation to the available fish stocks.

The specific objectives included the following:

- To determine the species composition of the experimental (i.e. available stocks) and commercial/artisanal (i.e. exploited stocks) catches.
- To assess the size structure of the fish caught in both the experimental and commercial/artisanal fishery.
- To determine the catch levels in both the experimental and commercial/artisanal fishery.
- To assess the gears used in the exploitation of the fishery.

STUDY AREAS

The areas of study were Lake Victoria Central (Entebbe waters) and Lake Victoria West (Masaka and Kalangala Districts) (Fig. 1). The selection of these areas was based on the anticipated difference in fifing pressure. The Entebbe waters were anticipated to have higher fishing pressure than the Masaka and

Kalangala waters, considering the high demands of the nearby urban population of Entebbe.

The Entebbe waters studied covered an area of approximately 320 Km^2 and located between 32°20'-32°40'E and 005'N-005'S. These waters are generally shallow (4 metres) along the shores becoming deeper (20-30 metres) offshore.

In Lake Victoria West, the study area covered approximately 200 Km^2 and was located between 31°55'-32°5'E and 005'-Oo20'S. Unlike the Entebbe area, the waters in this area were generally shallow, not exceeding 15 metres depth.

MATERIALS AND METHODS

Experimental gill netting was carried out during the period 1991 to 1999 during the following months (Table1):-.

Table 1. Sampling period for experimental gillnetting surveys.

Year	Lake Victoria West	Lake Victoria Central
1991	November	October
1992	February	January, May
1993	April	April, July
1994	June, September, November	January, August, September, October, December
1995	February, April	March, June, September
1996	August, October	November
1997	March, May, July, September, October	March, April, May, July, September, October, December
1998	January, March, April, July, September, December	February, March, August
1999	February, June, September, October	January, May, July, October, November

Fleets of 15 nylon gill nets each were used; the nets were of the following mesh sizes (Table 2).

Table 2. The range of gillnets used in experimental gillnet surveys.

mm	25.4	38.1	50.4	63.5	76.2	88.9	101.6	114.3	127.0	139.7	152.4
inches	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6

mm	165.1	177.8	203.2	228.8
inches	6.5	7	8	9

This selection of nets was used because the 127.0-228.6 mm mesh nets were being legally used in the commercial/artisanal fishery while the 25.4-114.3 mm mesh nets were used in experimental fishing to determine the status of the stocks that were supposedly not to be exploited by commercial/artisanal fishery.

The nets were set in selected sites (Fig. 1) in areas where commercial/artisanal fishermen operate. The sampling sites had the following general characteristics (Table 3)

Table 3. The sampling sites for experimental gillnet surveys.:

Area	Sampling sites	Characteristic features
Lake Victoria West	AlB	• Shallow « 11 metres) • Near Luyo Light House
	C	• Shallow <15 metres • Near rocky island • Off Lambu Fishing village
Lake Victoria Central	D	• Shallow «10 metres) • Near rocky islands • Off Entebbe airport
	E	• Deep (20-30 metres) offshore • Near Bulago and Nsadzi islands

The nets were set during the day around 14:00 hrs, left set overnight and retrieved the following morning at around 08:00 hrs. Each sampling site was fished for two nights during each visit. The 25.4 and 38.1 mm mesh nets were not used during the period 1991-1994. The fish retained was sorted by species and by gill net mesh size. The fish was weighed individually and the total length and other biometric parameters taken and recorded.

In the sampling area of Lake Victoria Central, commercial/artisanal fishing operations were studied/monitored in Bugonga Fish Landing site with respect to the landed fish catches. Bugonga was selected because the research team was based (during the surveys) and was able to monitor the fishing canoes, some of which landed very early in the morning (before 07:00 hrs). **It** was not possible to this in Lake Victoria West because the research team was based in Masaka town

(about 50 km from the study area) and was able to reach the area around 07:00 hrs after most of the fishing canoes had landed. The landed catches in each canoe were recorded by species and individual weights taken and recorded. The canoe operator was interviewed to obtain the relevant information regarding the landed catch particularly the number and mesh sizes of gill nets used and the fishing ground.

ANALYSIS OF OATA

The data collected was analyzed for fish species composition, size structure (kg), and catch rates - kg per net per night for experimental catch and kg per boat per day for commercial/artisanallandings. The data on fishing gears was analyzed for changes in the number of fishing canoes carrying them over the period. Most of the analysis was carried out using the EXCEL program. Standard error and 95% Confidence levels are some of the descriptive statistics obtained in relation to means.

The above parameters were analyzed and presented by year and by month - all by area. The size structure (kg of wet weight) was based on the individual fish species. The catch rates were based on total catches/landings for individual experimental gillnets and fishing canoes.

RESULTS

1. Fish species composition

1.1 Experimental gillnetting

A total of 14 fish taxa (belonging to 12 genera) were retained in the experimental gillnets during 1991-1999. These were *Aethiomastacembelus* sp, *Barbus* sp, *Brycinus* sp, *Clarias gariepinus, Gnathonemus* sp, *Haplochromis* spp, *Labeo victorianus, Lates niloticus, Mormyrus kannume, Oreochromis leucostictus,* O. *niloticus, Synodontis afrofischeri,* S. *victoriae* and *Tilapia zillii* (Table 4). All these taxa but one -, *Brycinus* sp, - were recorded in Lake Victoria West while six fish taxa - *Aethiomastacembelus* sp, *Barbus* sp, *Clarias gariepinus, Gnathonemus* sp, O. *leucostictus* and *Tilapia zillii* were not recorded in Lake Victoria Central.

The catches were dominated by *L. niloticus* in both Lake Victoria West (Table 4a; Fig.2) and Central (Table 4b; Fig.2). The diversity of fish retained increased over the period, rising from 3 species in 1991 to 8 species in 1997 in Lake Victoria West (Table 5a) and from 1 species in 1991 to 6 and 7 species in 1997 and 1999, respectively, in Lake Victoria Central (Table 5b).

The dominance of *L. niloticus* decreased considerably from 99.8% in 1991 down to 78.6% and 55.3% in 1998 and1999, respectively, in Lake Victoria West as other fish species, mainly, O. *niloticus*, appeared in the catches (Table 4a).

Lates niloticus contributed more than 95% of the catches in Lake Victoria Central except for 1997 and 1999 when it contributed 78.6% and 89%, respectively; this was the period when 0. *niloticus* made significant appearance in the catches (Table 4b).

1.2. Commercial/Artisanallandings

A total of 16 fish taxa (belonging to 14 genera) were landed at Bugonga Fish Landing site during 1991-1999. These were *Aethiomastacembelus* sp, *Bagrus docmak, Barbus* sp, *Brycinus* sp, *Clarias gariepinus, Gnathonemus* sp, *Haplochromis* spp, *Labeo victorianus, Lates niloticus, Mormyrus kannume, Oreochromis leucostictus,* 0. *niloticus, Protopterus aethiopicus, Synodontis afrofischeri,* S. *victoriae* and *Tilapia zillii* (Table 6). The fish landings were dominated by *L. niloticus* (>96%) followed by O. *niloticus.* The diversity of fish landed increased over the period, rising from 1 species in 1991 to 9 species in 1996 (Table 7).

2. Size structure of the fish retained and/or landed

2.1 Experimental gillnetting

The mean size of *L. niloticus* retained by the experimental gillnets declined over the period (Table 5 and Fig. 3). In Lake Victoria West the mean size declined

from 1.29±0.11 kg in 1991 to 0.14±0.02 kg in 1998 before indicating a rise to 0.27±0.02 kg during 1999. Similarly, the mean size of the fish retained in Lake Victoria Central declined from 0.99±0.20 kg in 1991 to 0.11±0.02 kg in 1997, then started to rise to 0.20±0.06 kg and 0.21±0.03 kg during 1998 and 1999, respectively (Table 8 and Fig. 3).

2.2. Commercial/Artisanal landings

The mean size of *L. niloticus* - the major fishery - landed by the commercial/artisanal canoes at Bugonga Fish Landing site declined over the period of study (Table 9 and Fig.3). The mean size of the landed fish declined from 2.54±0.37 kg in 1991 to 0.60±0.03 kg in 1998 then increased slightly to 0.76±0.01 kg in 1999. The proportion of landed fish *(L. niloticus)* of less than 2 kg fresh weight increased from about 3% in 1991 to about 50% by 1996; this proportion was about 90% in 1999 (Table 10).

3. Fish catch and landing levels

3.1. Experimental gillnetting

Peak catches in the experimental gillnets were generally obtained in decreasing mesh sizes over the period of the survey (Tables 11a & 11band Figs4a & 4b).

In Lake Victoria West, peak mean catch of 13.17±15.16 kg/net/night was obtained in the *152A* mm mesh gillnets during 1991 while peak catches of 6.76±6.90, 6.62±3.26 and *2.86±2A2* kg/net/night were retained in the 114.3 mm mesh nets during 1992, 1993 and 1994, respectively (table 11a & FigAa). During 1995, 1996 and 1997 peak catches of 2.92±2.00, 2.24±1.95 and 1.17±1.11 kg/net/night were obtained from the 88.9,114.3 and 50.8 mm mesh nets, respectively. Peak catches of 1.69±0.93 and *2.68±1AO* kg/net/night were recorded in the 101.6 and 114.3 mm mesh nets, respectively, during 1998 and 1999, respectively.

In Lake Victoria Central, peak mean catches of 6.96±53.37 and 2.54±1.69 kg/net/night were obtained in the 127.0 mm mesh nets during 1991 and 1992 while peak catches of 3.20±2.20, 2.21±2.29 and *2.37±1A7* kg/net/night were retained in the 101.6, 114.3 and 38.1 mm mesh nets, respectively, during 1993, 1994 and 1995, respectively (table 11b & FigAb). During 1996 and 1997 peak catches of 2.28±0.61 and *1AO±0.71* kg/net/night were obtained from the 114.3 and *25A* mm mesh nets, respectively. Peak catches of 1.26±2.17 and 1.81±1.09 kg/net/night were recorded in the 127.0 and 88.9 mm mesh nets, respectively, during 1998 and 1999, respectively.

The catches were generally poor during 1996 and 1997 in Lake Victoria West, picking up again in 1998 (Table 12a). Similarly, poor catches were obtained in Lake Victoria central from 1996 to 1998 with an indication of a rise during 1999

(Table 12b). In both areas, the catches were generally better from April to June (Tables 12a & 12b)

3.2. Commercial/artisanal fishery

Fish landings at Bugonga Fish Landing site by commercial/artisanal canoes declined rapidly from 54.2±16.5 kg per canoe per day during 1992 down to 22.7±2.8 kg/canoe/day during 1995, and then showed a rise thereafter to 37.4±12.7 kg/canoe/day during 1999 (Table 13).

The landings per canoe per day varied from 68.8±27.4 kg in May 1992 to 12.8±4.3 kg in July 1998 (Table 14).

4.. Commercial/artisanal fishing vessels and gears

During the period 1991 to 1999 an average of 10 landed and fish in them sampled daily during the survey (Table 15). The number of canoes landing and sampled daily increased from 3 in 1991 to 16 in 1997 and then decreased to 11 in 1999.

Table 15. Commercial/artisanal canoes landing fish at Bugonga Fish Landing site.

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	1991/99
Number of days sampled	3	7	7	13	14	13	16	14	11	98
Daily average number of canoes	3	8	10	14	12	12	10	6	6	10

The use of nets of less than 127.0 mm mesh in fishing canoes landing fish at Bugonga became noticeable and rampant during 1996. The proportion of these small size nets « 127 mm mesh) increased from 15.9% in 1996 to over 50% by 1998 (Table 16). Use of nets of 76.2 mm (3 inches) mesh increased from about 5% in 1996 to 17% in 1998 (Table 16)

DISCUSSION

During the survey period, the available stocks - as determined through experimental gill net surveys - were dominated by *L. niloticus* followed by O. *niloticus.* The fish landings at Bugonga Fish landing sites by the commercial/artisanal canoes were also dominated by *L. niloticus* followed by O. *niloticus.* This indicates that the commercial/artisanal gill net fishery was targeting the most available fish stocks.

Catch of fish per standard 127 mm (5 inches) gill net - the minimum mesh gill net legally permitted on Lake Victoria - hung overnight is a good measure of the state of the fishery (Beauchamp 1955). Changes in the value of the average catch per gill net provide an empirical method for determining changes in the numbers of catchable fish contained in the fishing grounds as catch per net will depend on the density of this population. The original major commercial species, the tilapiines, were abundant only in the sheltered inshore waters of less than 20 m deep and a distance of about one kilometer from the shoreline whereas other cichlids and non-cichlid fish had a wider distribution (Graham 1929). The virgin fishery provided excellent catches that satisfied the demand of the local markets around the lake. The initial catch rates in 127 mm mesh size of gillnets of 45 m length ranged between 50 and 100 tilapia *(Oreochromis esculentus)* per net per night but by 1968 the catch rates had declined to 0.35 fish per net per night (Jackson 1971).

During the survey of 1991 to 1999, the catch rates of fish declined over the period in both the experimental and commercial/artisanal gill net fisheries. The catches in the standard 127 mm mesh experimental nets declined from about 7 kg per net per night in 1991 to less than 1 kg per net per night by 1997. Peak catches in the 127 mm mesh experimental nets were only obtained in 1991 and 1992, thereafter the peak catches were obtained experimental nets of mesh sizes less than 127 mm. By 1995 the peak catches of 2.9 and 2.4 kg per net per night were being obtained in 88.9 mm mesh nets (Lake Victoria West) and 38.1

mm mesh nets (Lake Victoria Central), respectively. This indicates that the abundant sizes of the available stocks kept shifting to smaller sizes over the period, thus a shift in peak catch rates to smaller mesh experimental nets over the period. In the commercial/artisanal fishery, meanwhile, the fish landings at Bugonga Fish Landing site declined considerably from 54.2 kg per canoe per day 1i 1992 to about 23 kg per canoe pr day. This decline in commercial/artisanal landings could have been due to the decline of the stocks retainable by the gears in use - the nets of mesh sizes of 127 mm and larger.

The decline in fish catch rates on Lake Victoria prompted the first fisheries survey in 1927 (Graham 1929) after which a minimum gill net mesh size of 127 mm was recommended and imposed in 1931. By 1955, catch rates had fallen to an extent that it was unprofitable to use 127 mm mesh size nets, most of the fishermen began using smaller meshes to catch the then un-exploited length ranges of fish. From this time onwards, the fishermen continued shifting to smaller meshes whenever the catches in the larger meshes decreased.

Use of gill nets of mesh sizes less than 127 mm was noticeably rampant during 1996 in the areas fished by the canoes landing at Bugonga Fish Landing site. During the period of the survey, the proportion of nets of mesh size less than 127 mm increased from 16% in 1996 to more than 50% by 1998. The 76.2 mm (3 inches) mesh nets, in particular, went up from about 5% in 1996 to 17% in 1998. this may have resulted from the experience that the fish retainable by the larger

mesh gill nets had become scarce. The fish landed at Bugonga during 1996 to 1998 averaged less than 1 kg fresh weight for *L. niloticus.* In the experimental gillnet fishery during the period 1996 to 1998, the average size of *L. niloticus*- the dominant fish species in the catches - was about 0.2 kg fresh weight; this is about the average size (28 cm total length and 255 g) of *L. niloticus* retainable in the 76.2 mm mesh nets (Ogutu-Ohwayo, *et a/1991).* These catches were from the experimental nets of meshes 114.3, 101.6, 50.8 and 25.4 mm that produced peak catches during the period 1996 to 1998. It is, therefore, evident that the decline in the average size of *L. niloticus* landed by the commercial/artisanal canoes at Bugonga Fish Landing site was due to the use of small size mesh «127 mm) gill nets as a result of the decline in the abundance of fish retainable by the larger mesh nets.

Okaronon (1995) observed that 0. *niloticus* larger than 20 cm total length and retainable by the 127 mm mesh gillnets were rarely retained by the experimental nets in fished in Lake Wamala during 1988/92, thus the common use of the 51 mm and 64 mm mesh gill nets during the period. This shift to the smaller mesh nets resulted in the collapse of the Lake Wamala fishery.

CONCLUSIONS

On the basis of the data collected during the surveys of 1991 to 1999, the following conclusions are drawn:

- The commercial/artisanal fishery in the study area was targeting *L. niloticus* and 0. *niloticus*, the two fish species found to be dominant in the experimental gill net surveys aimed at determining the status of the fish stocks in the area of study.
- The average size of *L. niloticus* targeted and landed by the commercial/artisanal fishery continued to decline over the period along side the decline in mean size of the available stocks as determined by the experimental gill net surveys.
- The fish catch and fish landing levels declined over the period in both the experimental and commercial/artisanal gill net fisheries. There was, have, an indication that the catches and landings were showing some recovery during 1998 and 1999.
- The commercial/artisanal fishery continued to shift to smaller mesh size nets in an effort to exploit the un-exploited and seemingly abundant smaller length ranges of fish.

RECOMMENDATIONS

- Based on the indication that the fishery was recovering during 1998 and 1999, and also considering that there has been some sentisization of the

stakeholders on the negative effects of the use of bad fishing methods, this paper recommends further surveys of this fishery.

- Some measures should be put in place to minimize the use of illegal fishing methods. These could include the involvement and/or empowerment of the communities in the management of the resource.

ACKNOWLEDGEMENT

REFERENCES