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The present status of the hook fishery and its impact on the fish stocks of Lake Victoria

D. Chitamwebwa,[1*] J. Kamanyi,[2] J. Kayungi,[3] H. Nabbongo,[4] A. Ogolla[5] and J. Ojuok[6]

[1]*Tanzania Fisheries Research Institute, P.O. Box 475 Mwanza, Tanzania.*
[2]*Fisheries Resources Research Institute, P.O. Box 343, Jinja, Uganda.*
[3]*Kagera Regional Secretariat, P.O. Box 299, Bukoba, Tanzania.*
[4]*Department of Fisheries Resources, P.O. Box 4, Entebbe, Uganda.*
[5]*District Fisheries Office, Mbita District, P.O Mbita, Kenya.*
[6]*Kenya Marine and Fisheries Research Institute, P.O. Box 1881, Kisumu, Kenya.*
*Corresponding author: dbrchita@yahoo.com

Abstract
Surveys on the hook fishery of Lake Victoria revealed that long lines are the most important gear used for catching Nile perch. Hand lines and hook and line are used to catch Nile tilapia and also Nile perch. Hooks are increasing because of their cheapness. They now total about 12 million lake-wide. Hooks are preferentially baited with live bait; they select the catch according to their sizes and bait type. Big range of fish sizes is caught. Hooks tend to reduce the size of the brood stock made up of big perch that carry millions of eggs. The use of live bait suppresses the recovery of resurging species with an adverse impact on the lake's biodiversity. Use of the recommended hook sizes 4-9 should be enforced and overcapacity reduced for sustenance of the fish stocks. The farming of bait fish should be encouraged for standardisation of bait size to target the right size of the catch and spare the recovering species.

Key words: hook fishery management, fish stocks, biodiversity, bait fish farming

Introduction

Long lines with baited hooks have become the most widely used fishing method for Nile perch *Lates niloticus* (L.) in Lake Victoria while Nile tilapia *Oreochromis niloticus* (L.) and haplochromines are caught by hand lines and by angling. The number of hooks has almost trebled over a period of eight years and it is estimated that about 12,000,000 hooks are presently in use on the lake with about half of them in the Tanzanian part (LVFO, 2008). The rapid development of this fishery is explained by the fact that it requires relatively little capital, especially compared to gill nets and therefore allows people with low income to enter the fishery. A regional working group on the hook fishery was established in September 2005 and it undertook a preliminary survey during October-December 2005 followed by other surveys from January-March 2006, while further surveys were carried out along with catch assessment surveys.

Live bait is the most effective type of bait for Nile perch and almost all species found in the lake are used for this purpose. Hooks are a highly selective form of fishing gear and the size of the hook and bait determines the minimum size of fish that can swallow it while the maximum size will be the biggest fish the hook can retain. Catches may therefore include juveniles as well as the largest adults of the target species. The Nile perch hook fishery therefore has the potential to fish out large individual perch which may produce several millions of eggs thereby causing a loss of reproductive potential. In addition, the fishery uses live bait mostly obtained from wild stocks in the lake and its basin thus threatening the recovery of native species and reducing stocks of species valuable in other fisheries.

This paper presents the results of the surveys carried out on the hook fisheries in all three countries around the lake together with observations from catch assessment surveys (CAS) in the Tanzania waters of Lake Victoria. The impact of the fishery on the stocks of the target and bait species is discussed.

Methods

Landing sites where the hook fishery was widespread were visited in Kenya (9 sites), Tanzania (4 sites), and Uganda (10 sites). The type of materials used in rigging hooks, the sizes and number of hooks per gear unit, the types of bait used, type of the types of canoes and their means of propulsion, and the methods of setting the gear were either directly observed or determined from interviews with fishers. The catch rates and size

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distribution were determined, especially in later surveys done during the catch assessment surveys (CAS). Additional information was obtained from fishers through questionnaires and informal discussions. The status of the fishery was assessed by observing trends of the number of fishing units counted during frame surveys carried out every two years between 2000 and 2008. The investigation also included visits to fish farmers where catfish *Clarias gariepinus* (Burchell) were being grown for sale as live bait.

Results

Gear Description

The hooks that were being used ranged from number 4 size (the largest) to number 20 (the smallest) but the most frequently-used were numbers 9-12. Long lines were the most commonly used form of gear, followed by hand lines while angling was the least frequent method. Long lines consist of 0.5-0.7-mm polyamide monofilament lines although multi-strand 15-36-ply nylon twine was occasionally used. They are rigged with snoods ranging from about 10-30 cm in length with snood intervals ranging from about 5 to 10 m. Long lines have, on average, a total of 400 and 1500 hooks for those operated on canoes propelled by sails and outboard engines, respectively, and they specifically target Nile perch.

Hand lines, which target large Nile perch and Nile tilapia, carry on average, about 10 large hooks (numbers 4-8) on 0.7-1.0-mm monofilament lines although number 7-8 hooks are preferred. In angling up to four hooks are attached to various sizes of monofilament lines attached to fishing rods or held in the hand and the hook size depends on the target species; numbers 7-8 for Nile perch, 9-15 for Nile tilapia and 15-20 for haplochromines.

Bait species, sources and storage

Almost all fish species that occur in Lake Victoria are used as bait but the most commonly used are the haplochromines (more than 60%), *Clarias* spp. (about 20%) and dead dagaa (less than 5%) since these are the most readily available. Baits used for tilapia include earthworms (over 80%), filamentous algae (about 10%), insects and their larvae, and the shrimp *Caridina nilotica* Roux and earthworms are used to catch haplochromines. *Clarias* needed for bait are caught from wetlands along the lakeshore and along river banks and flood plains, small beach small seines and angling with small hooks are used to catch haplochromines while in the swamps bait is caught by draining pools or using traps. The bait fish are kept alive in covered 20-litre containers with water that must constantly be renewed to prevent oxygen depletion; even so, the loss through asphyxiation is quite common.

Some bait fish are raised in ponds by a few farmers in Kenya, and in Uganda where a number of farmers are making serious efforts to raise fish for bait. All of them are raising the catfish, *C. gariepinus* but farmed fish account for less than 2% of all those used for bait.

Gear setting

Long lines are set at various depths from the surface to the bottom through the manipulation of floats and sinkers attached at intervals along the main lines, depending on the depth at which the target fish is expected to occur. Two types of setting are practised: day setting in which the gear is set early in the morning and retrieved in the evening the same day, and overnight setting where the gear is set in the afternoon or evening and retrieved in the following morning. Day setting is the most common method because it this minimises gear theft and reduces interference with gillnets which are normally set overnight.

Hand lines, set in inshore waters, are anchored at one end while the other end bears a few hooks baited with live bait. The gear may be operated actively by trolling in shallow waters and around rocky islets using outboard engines or paddles in an effort to catch large Nile perch; in this case artificial baits such as wooden fish dummies are used. Those fishermen targeting tilapia with hand lines fish in shallow water from canoes or rafts. Anglers mostly stand on rocky shores at the edge of the lake where they are most likely to catch tilapia and haplochromines.

Status of the hook fishery

The total number of hooks in use on the lake rose from about 3,500,000 in 2000 (98.5% in long lines) to over 11,000,000 in 2008 (99.4% in long lines). The number of long line hooks used in Kenya increased rapidly between 2000 and 2002 but remained relatively stable thereafter while they rose steadily in Tanzania with a sharp increase between 2006 and 2008 (Table 1). Relatively few hooks were used in Uganda in 2000 but they increased rapidly especially between 2004 and 2008 suggesting a major change in the fishing methods employed in that country. The number of hand line hooks did not change greatly, except in Uganda where there was a sharp increase in their numbers after 2004.

Table 1. The number of long line (LL) and hand line (HL) hooks (thousands) in use on Lake Victoria, 2000-2008. From LVFO (2009).

	Kenya		Tanzania		Uganda		Total	
Year	LL	HL	LL	HL	LL	HL	LL	HL
2000	1,040	34	2,202	14	254	5	3,496	53
2002	2,562	12	4,609	39	927	7	8,098	58
2004	2,046	13	3,082	19	969	8	6,096	41
2006	2,624	20	4,135	35	2,286	16	9,045	72
2008	2,502	16	6,002	30	2,764	20	11,268	66

Most hook fishers use Sesse canoes, pointed at both ends, and at some landing sites, e.g., Mchangani on Kome Island, Tanzania, almost all of the boats were engaged in the hook fishery. Overall, about 64% of all fishing boats in Kenya were using hooks, compared to 55% in Tanzania and 34% in Uganda. Most canoes were propelled by paddles in combination with sails but there is an increasing trend towards the use of outboard motors on canoes pointed at one end; in 2000 just under 10% of boats were propelled by motors but this had risen to just under 22% by 2008 (Table 2). Outboard engines enable fishers to reach offshore fishing grounds and they no longer have to rely on favourable winds, and they can therefore fish more frequently.

Table 2. The numbers of fishing craft (thousands) on Lake Victoria according to their mode of propulsion, 2000-2008. From LVFO (2008).

	Kenya		Tanzania		Uganda		Total	
Year	Motor	Paddle/sail	Motor	Paddle/sail	Motor	Paddle/sail	Motor	Paddle/sail
2000	0.64	10.87	1.53	13.95	2.03	13.51	4.20	38.34
2002	0.69	11.52	2.61	18.55	3.25	15.34	6.55	35.04
2004	0.86	11.42	5.58	17.06	3.17	13.01	9.61	41.49
2006	1.30	13.72	6.42	19.95	5.05	18.94	12.77	52.61
2008	1.18	12.85	6.93	18.89	5.60	17.66	13.71	49.40

Table 3. Catch rates of Nile perch (kg/canoe/day) from long lines at four landing sites in Tanzania, February/March, 2006.

Landing site	Catch rate
Kijiweni	31.1 ± 19.2
Kinagi	22.9 ± 17.9
Malehe	36.3 ± 31.1
Mchangani	26.9 ± 20.0

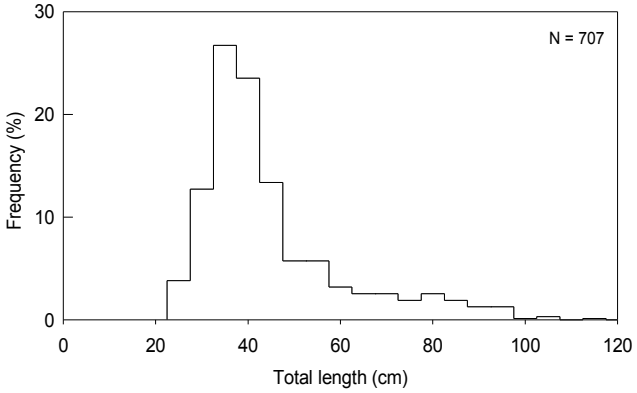

Figure 1. The length-frequency distribution of Nile perch caught in the long line fishery in Tanzanian waters, February/March, 2006.

Catch rates and structure of exploited stocks

The Nile perch hook fishery is most successful when live bait is used but dead dagaa are also used and, according to the fishers, it is most effective in May/July during the cool, windy, period when the lake is isothermal (Talling, 1966). Catch rates ranged between 30-40 kg/canoe/day in Kenya, 25-45 kg/canoe/day in Uganda and 22-36 kg/canoe/day in Tanzania (Table 3); the wide standard deviations of the latter indicate that catch rates are highly variable. In addition, fishers mentioned that on rare occasions as much as 100-200 kg/canoe/day of Nile perch could be caught. The modal length of Nile perch caught by long lines was around 35-40 cm in all three countries, which is below the minimum slot size of 50 cm TL (Figure 1).

The size of Nile perch in hook sizes 10-12, which are the most commonly used hooks in long lines, do not differ much in size and there is little size-selectivity in the catch by these three hook sizes (Figure 2). The mean size of the fish varied slightly according to hook size, with the largest hook (size 10) catching the largest fish (48.7 cm), compared to 46.9 cm for size 11 hooks and 44.3 cm for size 12 hooks. The differences were not significant (Kruskall-Wallis test, K = 1.47, $p > 0.05$) indicating that the three hook sizes are exploiting the same fish.

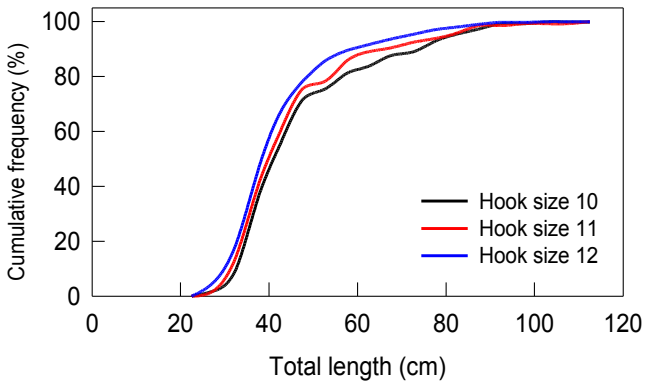

Figure 2. Cumulative length-frequencies of Nile perch caught by three commonly used hook sizes, numbers 10-12 (Note: no. 10 is the largest, no. 12 the smallest).

There was a degree of selectivity according to the type of bait that was used with smaller fish being caught with haplochromines and larger ones with *Clarias* as bait (Figure 3). The reason for this is that haplochromines used as bait were smaller (6-10 cm TL) than *Clarias* (10-20 cm TL) and therefore used on smaller hooks which tended to select the more numerous smaller Nile perch.

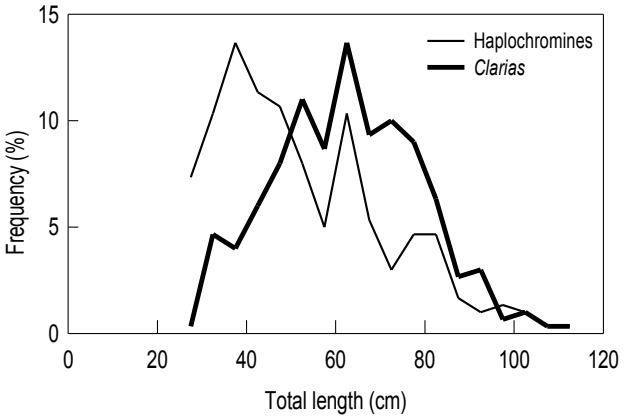

Figure 3. The length-frequency distribution of Nile perch caught in size 10-12 hooks using *Clarias* and haplochromines as bait.

The hook sizes used in the Nile tilapia fishery ranged from numbers 9-12 in Kenya, 9-11 in Uganda, and 10-15 in Tanzania. The catch of Nile tilapia with these hooks in Tanzania consisted mainly of 18-20 cm fish (Figure 4a) which is close to the length at first maturity in 2004-05 (Njiru *et al*., 2007). There was some variation in this distribution as in the case of a sample from one area in Tanzania where fish caught with size 11 hooks exhibited a bimodal distribution (Figure 4b). The first mode (16-18 cm TL) was made up of fish that were presumably juveniles whilst the second mode (28-30 cm TL) was composed of mature fish, which suggests that bigger hooks (e.g., sizes 9 and 10) would catch predominantly large and mature Nile tilapia.

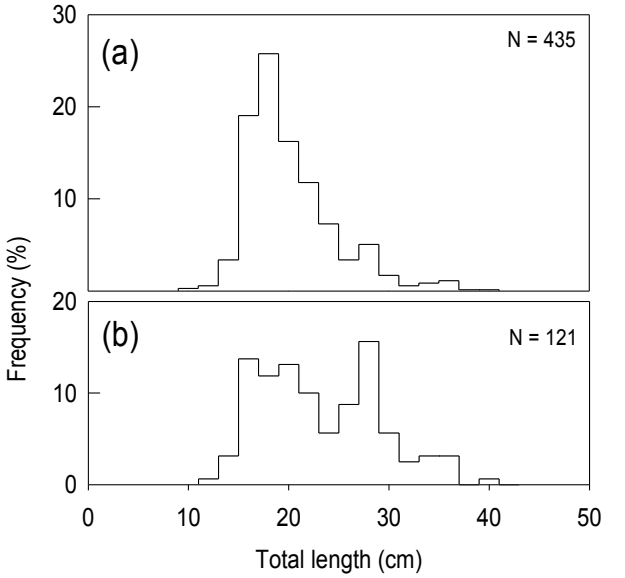

Figure 4. Length-frequency distribution of *Oreochromis niloticus* (a) caught with hook sizes 10-15 used in the fishery in Tanzania, February/March 2006 and (b) caught with hook size 11, at Mchangani Kome, Sengerema, March 2006.

Catfish culture

Culture of the catfish, *C. gariepinus* for bait was practised in Kenya and Uganda, while two people in Tanzania who intended to culture these fish experienced financial and technical difficulties which prevented them doing so. The major problems reported by farmers were the high mortality of fry, the high cost of feed, cannibalism and competition with cheaper bait obtained from the wild. The current production of bait fish from farms accounted for less than 2% of the bait requirement and there is obviously scope for expansion provided the difficulties can be overcome; this would probably be easier if more people were involved and could take advantage of the economies of scale.

Discussion

The long line fishery has grown on Lake Victoria because of the increasing cost of fishing gear, which is often stolen and although hooks are also stolen, the loss is much less than when gillnets are stolen. In the long line fishery, specifically targeting Nile perch, the importance of bait cannot be underrated; indeed, the fishery has evolved through its requirement for *live* bait. Selectivity seems to be more strongly influenced by the size of the bait than the size of hooks (Figures 2 and 3). Since smaller tends to catch smaller fish there is a demand for larger (> 30 cm) species such as *Mormyrus kannume* Forsskål and juvenile lungfish *Protopterus aethiopicus* Heckel, and the fishery uses both adults and juveniles of different species, some of which (e.g. catfish and lungfish) are taken from the wild. Mkumbo and Mlaponi (2007) estimated that about 7, 500 t of bait from the wild was needed each year on the Tanzanian side of Lake Victoria. This estimate was based on 4,000,000 hooks then in use there, half of which were considered to be baited each day. The number of hooks has now risen to slightly more than 11,000,000 (LVFO, 2008) suggesting that more than 22,000 t of bait would be required each year. At present, there are few alternative sources of bait and the problem is growing and apparently insoluble; the only possible solution, the culture of bait species, has yet to have any impact.

The demand for tilapia bait is unlikely to have such adverse impacts since the most commonly-used baits are earthworms and filamentous algae, both of which are plentiful around the lake shore and in its basin.

The modal size of Nile perch and Nile tilapia caught in the hook fishery are 35-40 cm TL and 18-20 cm TL, respectively while the minimum legal lengths (the "slot size") are 50 and 25 cm TL, respectively. Both fisheries therefore catch a high proportion of undersized fish although, in the case of Nile perch at least, the size of first maturity has decreased from 50-65 cm and 80-95 cm TL for males and females in the 1980s (Ogutu-Ohwayo, 1988; Hughes, 1992) to about 46 cm in males and 57 cm in females (LVFO, 2007). This suggests that the catches of both species consists mostly of juveniles which is a potential threat to the stocks as they might become too small to produce enough recruits to the fishable stock thus bringing about recruitment overfishing (Pitcher and Hart, 1982). That the stock now is composed of small fish is reflected by the shift towards use of smaller hooks (Table 5).

Table 5. Changes in the number of hooks of different sizes used in the hook fishery of Lake Victoria, 2006-2008 (from LVFO, 2008).

Hook size	2006	2008	% change
< 4	32,000	25,000	-22
4 to 7	406,000	395,000	-3
8 to 10	5,224,000	4,845,000	-7
> 10	3,383,000	6,002,000	77

The legally permitted hook size (4-9) in the Nile perch fishery should be strictly enforced, to protect both undersized fish and the very large females beyond (> 85 cm TL), which can produce millions of eggs and are not caught in gill nets. This might be achieved through the use standard-sized bait fish, but this would only be practical if the bait came from farm-raised fish.

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