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Managing Nile perch using slot size: is it possible?*

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Abstract
The fishery of Lake Victoria became a major commercial fishery with the introduction of Nile perch in 1950s and 1960s. Biological and population characteristics point to a fishery under intense fishing pressure attributed to increased capacity and use of illegal fishing gears. Studies conducted between 1998 to 2000 suggested capture of fish between slot size of 50 to 85 cm TL to sustain the fishery. Samples from Kenya and Uganda factories in 2008 showed that 50% and 71% of individuals processed were below the slot size respectively. This study revealed that fish below and above the slot has continued being caught and processed. This confirms that the slot size is hardly adhered to by both the fishers and the processors. The paper explores why the slot size has not been a successful tool in management of Nile perch and suggests strategies to sustain the fishery.

Key words: Lake Victoria, Nile perch, exploitation, management, slot size.

Introduction

The Nile perch, *Lates niloticus* (L.), is a predatory fish highly valued in both commercial and recreational fisheries which can grow to 2 m in length and weigh over 200 kg (Ogutu-Ohwayo, 2004). It is widely distributed in Africa, occurring in the Congo, Niger, Volta and Senegal Rivers, and in Lakes Chad and Turkana, and throughout the Nile system as far as Lake Albert but was prevented from reaching Lake Victoria by the Murchison Falls. It was introduced into Lake Victoria from Lake Albert during the 1950's and early 1960's (Pringle, 2005) in order to convert the small and bony but abundant haplochromine cichlids to suitable table fish (Anderson, 1961). Opponents of the introduction feared that Nile perch might deplete the stocks of native fish species as well as its own numbers, through cannibalism, which would cause the fisheries to collapse (Fryer, 1960). It took about two decades for Nile perch to establish itself in the lake but its numbers increased rapidly in the late 1970s, leading to a dramatic increase in fisheries productivity (Ogutu-Ohwayo, 1990). At the same time, predation by Nile perch brought about a reduction in the numbers of many native species with haplochromines falling from >80% of the biomass during the 1970's to <1% by the mid-1980's, and it was feared that many species had become extinct (Ogutu-Ohwayo, 1990; Njiru *et al*., 2008).

The growth of the fishery and increasing fishing intensity led to a decline in catches of Nile perch creating fears that the fishery might not be sustainable without appropriate management measures (Matsuishi *et al*., 2006; Njiru *et al*., 2007). Studies carried out between 1998 and 2000 suggested that the capture of fish between 50 and 85 cm TL could be permitted and slot sizes of 50 to 85 cm TL were gazetted by the countries around the lake with enforcement starting in mid-2000s. This paper examines the extent to which fishermen and the processing factories adhere to the slot sizes, using information collected at landing beaches, processing factories, as well as published and unpublished literature. Factors that could have led to the decline in Nile perch in Lake Victoria are discussed and possible management strategies suggested.

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Genesis of the slot size

Catches

Annual catches of Nile perch in Lake Victoria increased from 30,000 t in the late 1970s to a peak of 560,000 t in 1999. In Kenya, for example, the Nile perch catch increased from 146 t in 1973 to 115,000 t in 1999 but then declined to 30,000 t in 2007 (Figure 1). The Ugandan catch increased from 11,000 t in 1977 to 120,000 t in the early 1990s but fragmentary data from the 1990s makes it difficult to determine trends, except that by 2000 the catch was around 175,000 t. In Tanzania, the catch increased from 72,000 t in 1983 to 231,000 t in 1990 but the poor catch assessment data in that country means that trends cannot be identified (Matsuishi *et al*., 2006; Njiru *et al*., 2007). Recent data suggest that the monthly catches of Nile perch have not declined significantly over the short term, except in Kenya (Figure 2) where the total catch fell from 290,000 t in 2005 to 260,000 t in 2006 and 230,000 t in 2007 (Lake Victoria Fisheries Organization, unpublished data).

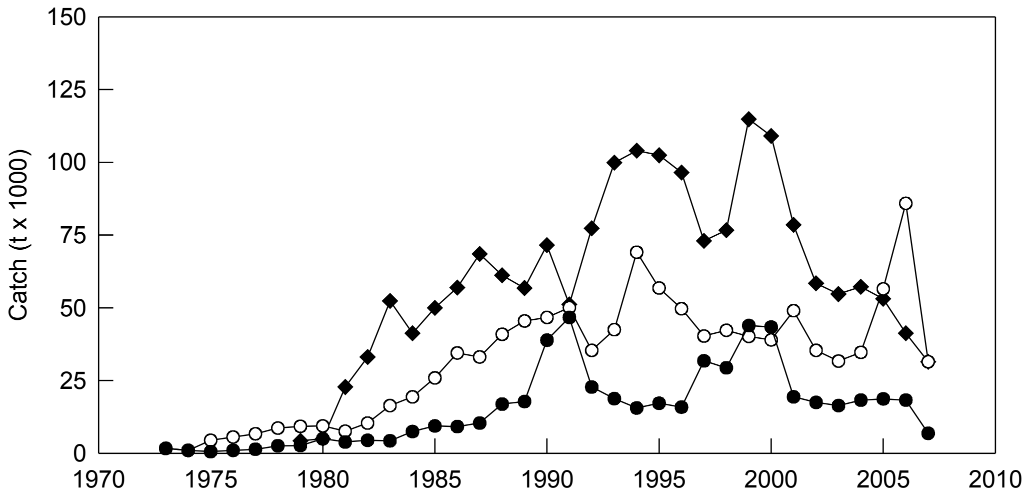

Figure 1. Fish catches from the Kenyan sector of Lake Victoria, 1973-2007. ♦ = *Lates niloticus*, ○ = *Rastrineobola argentea*, ● = tilapias (mostly *Oreochromis niloticus*). Source: unpublished data from Kenya Marine and Fisheries Research Institute, Kisumu.

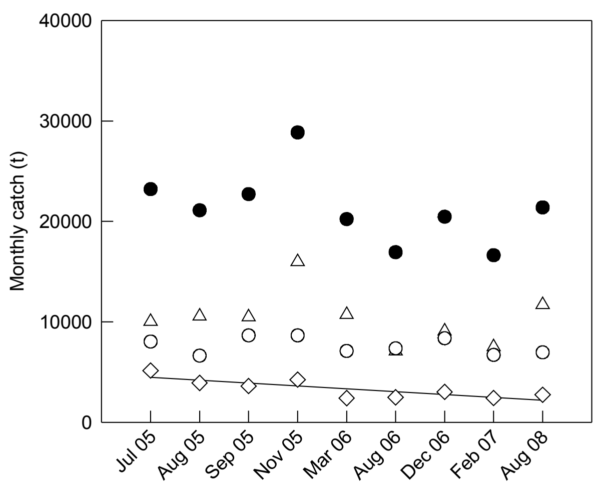

Figure 2. Estimated monthly catches of Nile perch in Lake Victoria, 2005-2008. ● = total catch, ◊ = Kenyan catch, △ = Tanzanian catch, ○ = Ugandan catch. The only significant trend was for the Kenyan catch (y = 4465.5 - 284.6x, r = 0.810, p < 0.01). Source: LVFO unpublished data.

Population and biological characteristics

The slot size is based on the premise that Nile perch ≤ 50 cm TL feed predominantly on the shrimp *Caridina nilotica* (Roux), thus converting invertebrates into fish flesh while larger fish are predominantly piscivorous, feeding mainly on the cyprinid *Rastrineobola argentea* (Pellegrin), juvenile Nile perch, Nile tilapia, *Oreochromis niloticus* (L.) and haplochromines (Figure 3), which is both destructive to the lake's biodiversity and energetically wasteful. Harvesting Nile perch ≥ 50 cm TL could also lead to the recovery of the haplochromines, thus enhancing the productivity of the fisheries, especially in deep waters where only the pelagic *R. argentea* occurs at present. Female Nile perch grow to a larger size and mature later than males and up to 2006 males and females reached 50% maturity at 54-64 and 62-85 cm TL respectively (Table 1). The sex ratio changed with size because males were smaller than females and most fish > 80 cm were females (Hughes, 1992) but the removal of large fish by the fishery has resulted in a more or less equal sex ratio in the 40-60 size class (LVFO, unpublished data). Thus, the slot size of 50 to 85 cm TL sought to protect immature fish, harvest mature individuals and at the same time protect the larger females which would be expected to replenish the stocks.

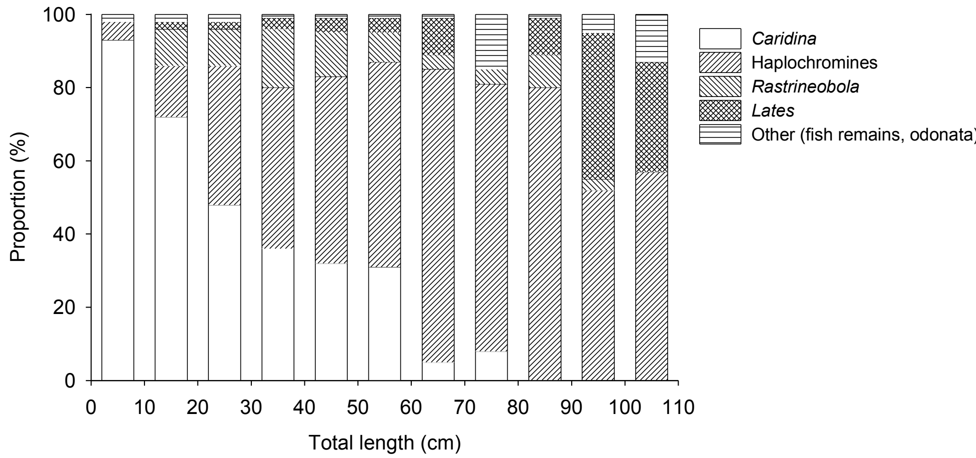

Figure 3. The prey eaten by *Lates niloticus* in relation to size in Lake Victoria, Tanzania, from 1997 to 2001 (adapted from Mkumbo, 2002).

Table 1. Changes in the length at 50% maturity (cm TL) in male and female Nile perch from Lake Victoria. Adapted from Njiru *et al.* (2007, 2008)

Area	Year	L_{m50} (males)	L_{m50} (females)
Kenya	1988	74	102
	2002	55	78
	2006	55	62
Tanzania	1985	54	68
	2002	64	73
	2003	57	76
	2006	58	70
Uganda	1990	60	110
	2002	54	77
	2006	60	85

Factors that may be hindering the effectiveness of the slot size

Factories and markets

The continued capture of immature Nile perch may be a consequence of the increased demand for fish. The number of factories processing Nile perch increased from 32 in 2000 to 35 in 2005 before falling to 27 in 2008 (Table 2) and their capacity exceeds the quantity of fish they are able to obtain (SEDAWOG, 1999; Abila, 2000). The factories once processed Nile perch with a minimum weight of 2 to 3 kg but as a result of increased competition for fish and the reduced numbers of large ones they now accept smaller fish, sometimes only weighing 1 kg. Some export markets prefer fillets from 0.5-kg fish (or smaller) owing to their low fat content while the local and regional markets accept fish of any size (Muhoozi, 2002). This market demand has encouraged use of small gillnets (<127 mm mesh), beach seines and small hooks which target small Nile perch. A recent survey showed that most Nile perch landed at beaches were below the length at first maturity (Lm_{50}) while most fish sent to the factories and filleted were also below the slot size (Figure 4).

Table 2. Changes in the number of Nile perch processing factories around Lake Victoria (LVFO, unpublished data).

	2000	2005	2008
Kenya	11	6	6
Tanzania	9	17	10
Uganda	9	12	11
Total	31	35	27

Ownership

Fish processing factories control the Nile perch fishing industry and have marginalized local fishers because there is intense competition for fish to meet the demand of the processing plants (SEDAWOG, 1999). The prominent fishers also compete to harvest more, factories to buy more than a nearby factory or in another country. The fish processing factories or prominent fishers can register any number of canoes without limit, and pay a fishing license (≈ $US 5 per boat) while there is no limit to the numbers of nets being used as long as the vessel can carry them. There is no system of ensuring that fishers use legal gear apart from what is reported during registration. The factory processors have an association where they strategise and dictate terms in the industry, whereas fishers do not have such a forum and are therefore unable to take a common stand. Fishers are totally at the mercy of the fish processing factories and with the loss of control to ‘‘foreign investors’’, local fishers have been deprived of ownership, which traditionally has been in the community (Geheb and Crean 2000), leading them to resort to irresponsible fishing practices (Yongo *et al.,* 2005).

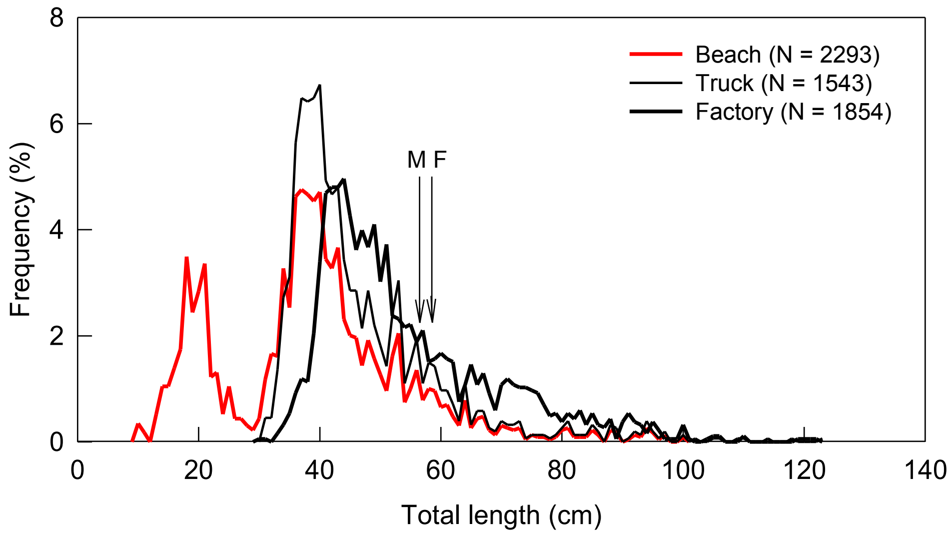

Figure 4. Length frequency distribution of Nile perch landed in beaches, loaded in trucks and in fish processing factories in Kenya in September 2007. The lines marked M and F denotes the length at first maturity of males (56.5 cm) and females (58.5 cm), respectively (data from LVFO, 2007a).

Open access

The Lake Victoria fishery is an open-access without any limitation on the total number of fishers, boats and gears used. The demand for fish from Lake Victoria has continued to increase over the years (Abila, 2000) and so fishing effort has also increased (Cowx *et al*., 2003; Njiru *et al.,* 2008). Fishers are using more efficient illegal fishing gears and methods to get more fish irrespective of their sizes (Cowx *et al*., 2003). The recommended gill mesh size for the lake fishery is 5 inches (127 mm), but gill nets <5 inches are still prevalent while banned gears such as beach seines, cast nets and monofilaments are still being used (Njiru *et al*., 2008) and when used in shallow areas all of them capture immature Nile perch.

The declining catch per unit effort (CPUE) has made fishing with legal fishing gears unprofitable without costly investments such as larger boats, outboard motors, or large quantities of gillnets (Muhoozi, 2002). The majority of fishers in lake cannot afford such investments and consequently resort to illegal fishing practices such as joining small-meshed gillnets (< 5 inches) together so a fleet of 80 nominal nets in one canoe is actually 240 nets, which may extend spread up to 3 km and are drifted by boats with outboard engines. This fishing method is more efficient but is also a source of conflict between fishers because it destroys passively set nets (SEDAWOG, 1999; Muhoozi, 2002). Although, the active operation of gillnets is illegal in Uganda 85% of boats fishing in the inshore areas operated gillnets actively (Muhoozi, 2002). These fishing methods probably enable fishers to maintain reasonably high catches of Nile perch, many of them undersized, at a time when the stocks are declining.

Security

Theft of gears and piracy has become a problem on Lake Victoria and has influenced the way fishers conduct their fishing activities (SEDAWOG, 1999). In addition, the high cost of the legal fishing gears has led to the use illegal fishing gears and methods (Muhoozi, 2002) such as cast nets and beach seines which are less easily stolen as they are under the control of fishers at all times. It has been argued that the Kenyan part of the lake is highly productive because it is shallow, has numerous river mouths and high nutrient loads, and is therefore the major breeding and nursery area of Nile perch and so fishing should be restricted to deeper waters (Njiru *et al.,* 2007). This has led to conflicts with Kenyan fishers being imprisoned in Uganda and Tanzania in pursuit of "their adult fish" but this view is unverified and it will remain so until investigations into fish migration have been carried out. Fishers who do not venture into the deeper waters of the lake and run the risk of being detained remain in the shallow waters where they target juvenile perch with illegal fishing methods.

Fishing for Rastrineobola *and* Caridina

The decline of Nile perch stocks in Lake Victoria, has led a shift towards the more abundant *Rastrineobola* which could have some adverse effects on the Nile perch stock because of its mode of fishing. Fishing for *Rastrineobola* is supposed to be carried out in deeper waters during dark nights by light attraction using 10-mm mesh nets. This is not the case in shallow areas < 5 m deep, where fishing goes throughout the year without light attraction and with 5-mm mesh nets (Muhoozi, 2002). Fishers sometimes join several of these nets vertically and horizontally so that they are up to 500 m in length. They are then used as beach seines, and this method is unselective, capturing juvenile fish of all species and so endangering recruitment.

The shrimp *Caridina* is harvested for poultry meal production in Nairobi and Dar es Salaam, and as it is the most important prey item for smaller Nile perch (Figure 2) this could result in a scarcity of food for fish < 60 cm TL (Budeba, 2003). This might eventually have an adverse effect on the Nile perch stock but, despite the importance of *Caridina* little is known about its ecology in Lake Victoria. In Tanzania, *Caridina* is neglected during recording of catches (Budeba, 2003) and there is a need for more information on this fishery.

Policies and enforcement

Policies and regulations governing Lake Victoria's resources which are different in each country (Ntiba *et al*., 2001), but substantial efforts towards harmonisation have been made by the Lake Victoria Fisheries Organisation (LVFO, 2007b). For, example, the use of monofilaments was banned in Tanzania and Kenya and allowed in Uganda, but during the LVFO Council of Ministers Session in February 2009, a joint communiqué was signed to ban monofilament in the three Partner States**.** The same session set the minimum mesh size for *R. argentea* at 10 mm instead of 5 mm nets. However, fishing for *R. argentea* is prohibited only in Kenya between 1 April and 31 August. Where some regulations are similar, the penalties are different. There is therefore an urgent need to harmonise all the regulations and penalties in the Lake Victoria fishery and treat the lake as one system.

Management strategies

Capacity and enforcement

The Nile perch population is dominated by small individuals (<40 cm TL) which suggests successful recruitment (Figure 4). These small fish occur mostly in water < 10 m deep which appears to be the most heavily fished area (Ligtvoet *et al*., 1995; Njiru *et al,*. 2008). Illegal fishing gears and methods in the shallow zones of the lake can lead to growth over-fishing resulting in depletion of the stock as few mature individuals are given a chance to replenishment it (Mkumbo, 2002). To sustain the fishery, the recommended slot sizes should be enforced, entry into the fishery should be limited through licensing, and illegal fishing gears and methods eradicated.

Funding

Lake Victoria's fisheries generate up to US $500 million annually mostly from Nile perch export (Yongo *et al.,* 2005) but no substantial funds are ploughed back for research and management. Instead, fishery management agencies rely heavily on donor funds and donors whose objectives might not be of immediate concern to management of the lake. Consequently, there is a need to source money locally, perhaps from taxes levied on the fishing industry to support research and management needed to maintain the fishery resources. In such a situation, research would have to be demand-driven and aim to answer specific issues raised by stakeholders.

Alternative livelihoods

Even with the best management systems in place, the supply of fish from the lake will be insufficient to meet the ever growing demand (Abila, 2000; Yongo *et al.,* 2005) because with a population growing at 3% the demand for fish outstrips the catch. Aquaculture, which is poorly developed around Lake Victoria, could be a viable option but much needs to be done since the combined production from. Kenya, Uganda and Tanzania is less than 10 000 t (< 0.02% of global production) (Mushi *et al*., 2005). The contribution from aquaculture should be greater because East Africa region has an adequate year-round photoperiod, extensive water bodies and wetlands, and suitable native species aquaculture suitable for fish farming Development of aquaculture, and other activities like ecotourism or horticulture might reduce pressure on the Victoria fisheries provided they could provide adequate livelihoods to a sufficiently large number of people.

Co-management

Properly implemented monitoring, control and surveillance schemes should be linked to community-based management approaches because government enforcement has been successful up to now (Ntiba *et al.,* 2002). The study by SEDAWOG (1999) found that beach communities formed for patrol and monitoring of their fishing grounds to deter thieves and control illegal gears were very effective. Since Beach Management units (BMUs), of which all fishermen must be members, have been established to coordinate fishing activities at all landing beaches around the lake. Co-management will transfer responsibilities and privileges to the stakeholders giving them a sense of ownership of the resource and if this approach succeeds illegal gears and the capture of undersized fish will be much reduced or, hopefully, eliminated. Security is a major problem but this could be strengthened by integrating communities into the management of the fishery resource through the BMUs, but their success will depend on local commitment the one hand and strong political support on the other.

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