TRENDS IN EXPLOITATION OF THE LAKE VICTORIA FISHES

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Description of Lake Victoria

Lake Victoria is the second largest lake in the world and is the largest fresh water body in the tropics lying across the equator (0021'N - 3°0'S, 31°39' - 34°53'E) at an altitude of 1116 m above sea level. It is shared between Tanzania (51%), Uganda (43%) and Kenya (6%). Its greatest length and breadth are 400 and 320 km, respectively; surface area is 68680 km^2; mean depth is 40 m and the deepest zone is 60-79 m. The lake's shoreline is extremely irregular and totals some 3 300 km in length. There are a number of large islands (3.7% of the lake's area) especially in the northern half, whose shorelines are as varied as those of the mainland area. It has large expanses of open water, which during rough weather can be difficult to navigate especially by small boats.

A. Fishing techniques and fishing operations

(i) The original fishery of Lake Victoria

The major commercial species, the tilapiines, were abundant only in sheltered inshore waters of depth less than 20 m and a distance of about one kilometre from the shoreline whereas other cichlids and non-cichlid fish had a wider distribution (Graham 1929). These waters were easily accessible to traditional fishermen who used small fishing boats that varied from simple rafts to canoes of reed bundles and dugout canoes all propelled by hand and using simple locally made fishing gears that consisted of hooks and lines, harpoons and lances, non-return traps, basket traps and seines made of papYfUs. Under conditions of a virgin fishery excellent catches of fish were obtained which satisfied the geographically limited market of the subsistence requirements of people living near the lake. Fishing for mainly tilapiines was thus limited to inshore waters. Near-shore areas are also breeding grounds and fishing in these areas can be detrimental to the fishery.

The trend of the fishery over 1900 - 1970s was of increasing fishing intensity, expansion to more offshore waters and decreasing fish catch rates. Fishing started to intensify with the introduction of efficient cotton flux gill nets In 1905 (Worthington & Worthington 1933); improved communication like extension of the railway line to Kisumu in 1908 which facilitated the importation of modem fishing gear and supply of fish products to distant markets; the increased demand of fish due to development of urban centres and increasing human population around the lake (Graham 1929, Jackson 1971, Ogutu-Ohwayo 1990a).

The Initial catch rates in 127 mm mesh size gill nets of about 45 m length ranged between 50 and 100 tilapia *(O. esculentus)* nef]night-[1] but by 1968 the catch rates had declined to 0.35 tilapia nef]nighr[1] (Jackson 1971). The decline in fish catch rates prompted the first fisheries survey of Lake Victoria 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 such an extent that it became unprofitable to use 127 mm mesh size nets and some fishermen began using smaller meshes to catch un-exploited length ranges. From this time onwards the fishermen adopted the habit of shifting to smaller meshes whenever the catches in the larger meshes decreased. This made the 127 mm mesh regulation so difficult to enforce that it was repealed in Uganda and Tanzania in 1956 and in Kenya in 1961 (Jackson 1971). The removal of the mesh size limit resulted in lack of uniform management policy for the whole lake. The subsequent trend of uncontrolled fishing effort and the continuously declining gill net mesh size led to the collapse of the native tilapia fishery. During the 1950s the fishing pressure was further increased when synthetic fibre gill nets with greater fish catching efficiency and a longer life span than the cotton flux gill nets were introduced in 1951 and communication on the open lake were further improved with the introduction of the out board engine in 1953 (Mann 1969).

(ii) <u>A shift to smaller species fishery</u>

While the catch rates of the larger species declined there was a gradual shift to smaller, originally less preferred fish species particularly the haplochromine cichlids and *R. argentea.* The need for changes in fishing strategy so that the harvest would quantitatively and qualitatively represent available stocks prompted the UNDP/FAO and EAFFRO lake-wide fish stock assessment survey of Lake Victoria in 1969 to 1971. This survey showed that although many fish species were confined to the shallow inshore waters, there were considerable quantities of fish all over the lake and at all depths. The survey showed that 83% of the demersal ichthyomass in the lake consisted of haplochromine cichlilds with a potential yield of 200 000 metric tons which could be obtained from the relatively lightly fIShed deep water areas (depth >20 m) and anticipated even higher yields because haplochromines whose catches had remained relatively low due to selective properties of the commercial fishing gears and the limitation of fishing to inshore waters which had deviated the commercial catches from the available biomass (Kudhongania & Cordone 1974). Fishery yield from the lake could therefore be improved by developing appropriate technologies to fish over the entire lake.

In 1973 a small industrial trawl fishery was started in the Mwanza area of Lake Victoria using small trawlers (10 – 15 m long, 80 - 170 lIP) and trawl nets with a 19 mm mesh size codend (Witte & Oijen 1990). During the second half of the 1970s haplochromines were also increasingly becoming the target of artisanal fishermen mainly using gill nets of mesh size 38 - 51 mm (Sculley 1975). Beach seines of 19 - 25 mm mesh size codend and mosquito seines of 8 - 13 mm mesh size codend were also in use especially in the Kavirondo Gulf (Marten 1979). However, before the mechanisms of exploiting the haplochromine based fishery were fully developed rapid changes started to occur in the fishery due to impacts of an introduced predator, Nile perch *(Lates niloticus).*

(iii) The current fishery of Lake Victoria

The current fisheries of Lake Victoria in the Ugandan sector are dominated by the artisanal fishermen using a large number of traditional "Ssese" planked canoes 5758 fishing and 674 transport and 2242 dugout fishing canoes; the fishermen operate from 715 landing sites (Tumwebaze and Coenen 1991). A variety of fishing gear is utilized.

Gillnets were the major fishing gear used by fishermen in the uganda sector of the lake during the Catch Assessment Survey (CAS) in January-March 1989 (Okaronon and Kamanyi 1989). Other gears generally used were seine nets (prohibited in Uganda), cast bets and hooks on long lines. Gillnets of mesh sizes ranging from 101.6 mm (4 inches) to 304.8 mm (12 inches) were in common use during January-March 1989 (Okaronon and Kamanyi 1989).

The most popular nets in use were 203.2 nun (8 inches) mesh (45.5% of the total number and in 32.4% of the fIShing canoes sampled) and 127 mm (5 inches) mesh (22.8% of the total number and in 32.4% of the fishing canoes sampled); these nets were used for catching the Nile perch and Nile tilapia. The 127 mm mesh nets retained Nile perch of 53 cm mean total length (TL) and Nile tilapia of 31 cm mean TL. Considering that Nile perch and Nile tilapia attain first maturity at 50 cm TL (95-110 cm TL for females) and 26 cm TL for Nile tilapia, respectively (Ogutu-Ohwayo 1988), the nets below 127 mm mesh nets were retaining mostly immature fish; even the 127 mm mesh nets popularly used during the CAS (January-March 1989) were harvesting heavily on the immature females of Nile perch.

Mukene *(Rastrineobola argentea)* fishing employs the use of the 10 mm and 5 mm mesh nets. Over 70% of the Mukene caught by the 5 mm mesh nets are immature but the 10 mm mesh nets crop mature individuals (Ogutu-Ohwayo *et al.* 1989, Wandera 1988). The 5 mm mesh nets catch fish ranging from 19 mm standard length (SL) while the 10 mm mesh nets catch those ranging from 26 mm SL to about 60 mm TL. The size at flIst maturity for Mukene, i.e. the size at which 50% of the fish are mature is 42 mm SL for males and 44 mm for females; and males of more than 45 mm SL and females of more than 47 mm SL are 100% mature (Wandera 1988). In the capture of Mukene these nets are often used as beach seines and may capture many juveniles of Nile perch, Nile tilapia and other fish species. These nets (10 mm and 5 mm mesh) are also used as Lampara lift nets in offshore fishing. In the Lampara fishing method minimal effect on juveniles of other fish has been recorded except at certain periods when these juveniles leave the inshore waters for offshore waters (Wandera, pers. comm.).

B. Spatiotemporal exploitation patterns

At the beginning of the 20th century the fish fauna of Lake Victoria was dominated by two indigenous tilapiine species *Oreochromis variabilis* Boulenger 1906 and *Oreochromis esculentus* Graham 1929 and about 300 species ofhaplochromines (Oijen, et at. 1981). There were only about 50 non-cichlid fish species in the lake (Lowe-McConnell 1987).

The native fishery depended on few predominantly near-shore fish taxa. O. *esculentus* was the most important commercial species followed by

O. *variabilis* (Graham 1929, Mann 1969, Jackson 1971, Ogutu-Ohwayo 1990a). Other important species included *Protopterus aethiopicus* Heckel 1851, *Bagrus docmak* Forskal1775, *Clarias gariepinus* Burchell 1822, *Barbus* sp., mormyfids and *Schilbe intermedius* Linnaeus 1758. *Labeo victorianus* Boulenger 1901 formed the most important commercial species in the affluent rivers of the lake's basin (Cadwalladr 1969). Haplochromine cichlids and *Rastrineobola argentea* Pellegrin 1904 were abundant but because of their small size and low market value were not originally exploited on a large scale.

The upsurge of the introduced fish species especially Nile perch has coincided with a phenomenal increase in total annual fish yield. For the Uganda sector of the lake, fish catches increased from 42 000 tons in 1970 to 120000 tons in 1990, fishing effort increased from 3200 fishing canoes in 1972 to 8000 canoes by 1990 (Okaronon 1994, Tumwebaze & Coenen 1991). The increase in exploitable fish stocks arising out of establishment of Nile perch has attracted major investments in the fishing industry transforming the fish markets from mainly local to broad sections of the East African region and overseas markets.

Large scale commercial and overseas fish export ventures have been established around the lake in Uganda, Kenya and Tanzania (Reynolds et al 1995). The rapid expansion of the fish filleting capacity around the lake has increased significantly export earnings to the extent that in 1996/97 fmancial year fish exports were next to coffee in overall national exports in Uganda fetching US$41.37 million (Ministry of Planning and Economic Development 1997).

The fishery of the Uganda sector of the lake is already showing symptoms of decline in annual yield from 132000 tons in 1989 to 120000 tons in 1991 and 103 000 tons in 1994 despite the increasing fIShing effort (Okaronon 1994). Basing on the biology of *L. niloticus,* O. *niloticus* and *R. argentea* (Balirwa 1989, Fryer & Iles 1972, Ogutu-Ohwayo 1988, Wandera 1990) exploitation would be the main process to influence sustainability of increased fish catch levels of the three major commercial fish species in the future fishery of the lake. The lake continues to have unlimited entry for the number of fishermen and fishing gears and there is gradual expansion of the fishing industry fuelled by establishment of fish factories which can lead to overfishing and collapse of the new fishery if there is no guidance of fishing effort.

The total catch from the Ugandan waters of Lake Victoria steadily increased between 1952 and 1969, then declined during the 1970s and early 1980s before beginning to pick up again in 1983 (Table 1). Lake Victoria was leading fish production up to 1968 during which period it was contributing between 30% and 50% of national fish production (Table 1, Fig. 1). After 1968, most of the fish production in Uganda came from Lake Kyoga before Lake Victoria fishery began to pick up and surpass that of Lake Kyoga in 1987 (Fig. 1). During 1990, fish production from Ugandan waters of Lake Victoria was estimated at 119900 tons (56% of national fish production) down from 132400 tons (62% of national production) during 1989.

Since 1987 the major fish species landed by the artisanallcommercial fishermen operating on the Uganda waters of Lake Victoria were Nile perch *(Lates niloticus)*, the tilapiines (mostly Nile tilapia, *Oreochromis niloticus)* and Mukene *(Rastrineobola argentea)*. The other fish species constituting about 3% of the total landed catch by weight in 1989 included *Bagrus, Barbus, Clarias, Mormyrus, Protopterus* and *Synodontis*. The landed artisanallcommercial catches of Nile perch in the Ugandan sector of the lake drastically increased during the 1980s from below 5% during the 1970s to about 86% of the total landed catch by weight in 1988 (Fig. 2).

During the 1989 CAS of the Uganda sector of Lake Victoria, a total of 8 fish species groups were recorded in the landed artisanallcommercial catches, namely *Bagrus* sp., *Barbus* spp, *Lates niloticus, Protopterus aethiopicus, Oreochromis leucostictus, O. niloticus, O. variabilis* and *Tilapia zillii* (Okaronon and Kamanyi 1989). During this survey the tilapiines and *Lates niloticus* contributed 49.3% and 49.1% of the total landed catch by weight, respectively (Okaronon and Kamanyi 1989) although a year earlier (1988) the contributions from the tilapiines and *Lates niloticus* to the landed artisanallcommercial catch was estimated at 11% and 86% by weight, respectively (Uganda Fisheries Department 1988).

C. The need for regulation

In fisheries management, the size limit of fish that should be cropped is normally set at flTst maturity that is, the size at which 50% of the members of that species are mature (Beverton & Holt 1957). This allows 50% of the individuals to breed before they are cropped.

The size at fITst maturity of Nile tilapia in Lake Victoria is around 26 cm total length (TL). This suggests that the minimum size of Nile Tilapia that should be permitted should be 26 cm TL. However, as noted earlier, the fishing effort and the fishing pressure on Lake Victoria are very high. It is, therefore, logical to set the gillnet limit for the Nile tilapia at 100% maturity to ensure that there is enough spawners in the population. In Lake Victoria, 100% maturity in Nile tilapia is at 28.5 cm TL. This would require a minimum gillnet mesh size of 127 cm (5 inches) (Fig. 3) and suggests that the minimum gillnet mesh size with respect to Nile tilapia on Lake Victoria should be set at 127 mm (5 inches).

The size at fITst maturity for Nile perch is 50 cm TL for males and 95-110 cm TL for females (Ogutu-Ohwayo 1988). This would mean that the minimum mesh size suggested above for the Nile perch would crop immature Nile perch (Fig. 1). However, biological and ecological considerations may justify setting the minimum mesh at 127 mm (5 inches). The Nile perch is a predator which during certain stages of its development becomes detrimental to the fishery by feeding on other commercially important fishes. On this basis, it has previously been recommended that fishing pressure on Nile perch of the size range which feeds on other commercially important fishes should be increased (Ogutu-Ohwayo 1985).

Nile perch up to 50 cm TL feeds predominantly on invertebrates especially the prawns, *Caridina nilotica,* and dragonfly nymphs. At this stage, it plays a beneficial role because it converts the invertebrates into a consumable commodity, fish. The Nile perch shifts to a virtually piscivorous diet comprising Mukene, members of its own kind and Nile tilapia after about 50 cm TL and fmally concentrates on the Nile tilapia after about 95 cm TL. It is, therefore, destructive to other commercially important fishes after 50 cm TL. Use of mesh sizes which crop Nile perch of more than 50 cm TL would, therefore, be beneficial to the fishery by reducing predation pressure on the only two other commercially important fish species *(0. niloticus* and *R. argentea)* in Lake Victoria. This size range of Nile perch given above coincides with the mesh size limit suggested for the Nile tilapia. This further suggests that the minimum size of Nile perch permitted should be set at 50 cm TL.

Use of beach seine nets, most of which are 51 mm to 102 mm (2 to 4 inches) mesh size has been rampant on Lake Victoria. From the catch curves for Nile perch (Fig. 1) and Nile tilapia (Fig. 3), it is clear that these nets mainly catchjuvenile Nile perch and Nile tilapia of a lower length than that permitted by law. The dragging of beach seines on the lake bottom and near the lake margins furthermore destroys nests and breeding ground and disrupts courtship of Nile tilapia. Use of these nets should be prohibited.

The small mesh sized seine nets used to catch Mukene *(Rastrineobola argentea)* also catch immature Nile perch and Nile tilapia (Fig. 8, 9). On Lake Tanganyika, fishing for clupeids using small mesh sized seine nets affected the stocks of larger species of *Lates* and *Luciolates* (Coulter 1970). The 5 mm and 10 mm mesh seine nets used to catch Mukene can catch immature Nile perch and Nile tilapia in breeding and nursery grounds. These nets are particularly destructive when operated inshore (Fig. 8). Fishing for Mukene should, therefore, be done using Lampara type shift nets operated offshore. Also over 70% ofMukene caught by the 5 mm mesh seines are immature (Fig. 7) and this is directly detrimental to the Mukene fishery. This size of net (5 mm mesh seine) is already in use on Lake Victoria and should be prohibited.

The improvement of fisheries management can only be successful if there is an established communication between all parties involved; these include the scientist, the administrator, decision makers and fishermen (Okemwa 1991). All of them should cooperate in measures to manage the resource. Administrators should consider scientific advice, for example, on the level of effort to be used in the fishery. On the other hand, scientists should consider socio-economic factors which sometimes take precedence over biological objectives. Fishermen should be made to understand that fisheries management is in their interest, so that they can harvest the resource more profitably and on a sustained basis. There should always be dialogue to promote better understanding among scientists, administrators, decision makers and fishermen (Larkin 1982). The lack of dialogue and communication between the different parties involved in fisheries is considered as one of those factors which led to disastrous effects on the fishery, for example, decline in fish production.

D. Current management of exploitation

In as much as its legal framework is concerned, Lake Victoria is still largely an open access fishery, such that very few restrictions apply to canoes and gear used.

The law instituted and implemented in 1933 prohibited gillnets with meshes less than 127 mm, but this was repealed by Uganda in 1956 (Okaronon 1990, Okaronon and Wadanya 1991). The removal of the restriction on gillnet mesh sizes left the fisheries administrators with few other tools for direct control of the fishing effort. The law as presently constituted stipulates that the only prohibited gear for the Uganda sector of Lake Victoria are gillnets with a stretched length greater than 90 metres and a depth exceeding 30 meshes. There is, however, no limitation on the number of nets that can be used when set separately. There are no restrictions placed on the number of fishing canoes allowed to operate on the Uganda sector of the lake; it is only required that each canoe be licensed by Uganda Department of Fisheries. Through the Statutory Instrument No. 15 of 1981, it was laid down that the legal minimum size of fish to be caught in the Uganda sector of Lake Victoria for Nile perch *(Lates niloticus)* be 440 mm (18 inches) total length and for Nile tilapia *(Oreochromis niloticus)* be 280 mm (11 inches) total length.

Through the above Statutory Instrument, provision therefore exists in law to discourage the possession of small-sized fish of Nile perch and Nile tilapia. However, given the various developments and threats to the future well-being of the Lake Victoria fisheries, and local and commercial interests of those who depend on these fisheries for sustenance and profit, it is now increasingly necessary that more concrete and clear-cut policy measures be formulated and implemented.

Government of Uganda has a precedence in the 1995 Constitution: protection of important resources is a preserve of government on behalf of the people of Uganda. Government has committed itself to have a stake in sustainable utilisation and management of the natural resources in such a way so as to prevent or minimise damage and destruction to resources.

Recent reviews of the 1964 Uganda Fish and Crocodile Act resulted in prohibition of use of seine nets and trawling, increasing fishing vessel licence fees, creating Industrial Fish Processing licences; this was in addition to limiting size of Nile perch and Nile tilapia to be caught. The reviews of the Act resulted in the separation of the extension from law-enforcement in 1992 leading to the existing Fishing Regulations and Control Unit (FRCD) (Kizza 1998).

The Local Government Act of 1997 has conferred to the decentralized line Ministry staff as extension staff. Out of the 53 staff in the Fisheries Department in 1998, 35 were for FRCD. Five of these (FRCD staff) are responsible for the five lake zones, one of which is Lake Victoria. These measures mandate FRCU, on behalf of Government, MAAIF (Ministry of Agriculture, Animal Industry and Fisheries) and the Fisheries Department, to effectively manage the optimal exploitation of the fisheries resources.

The concept of involving communities around the lake to participate in internalizing local fisheries related issues is becoming widely acceptable. Thus the Uganda fisheries industry is in partnership. The industry is now trying to nurture and foster stronger bonds between policy makers, researchers, extension workers and other stakeholders. The communities around Lake Victoria and elsewhere are being sensitized to respect the resources, have a sense of ownership and use them responsibly. This is being spearheaded by various donor agencies and projects which include Lake Victoria Environment Management Project (LVEMP), Lake Victoria Fisheries Research Project (LVFRP) and Lake Victoria Fisheries Organisation (LVFO). Water Hyacinth Control Dnit has a community participatory component. It is hoped that these communities will for example safe guard immature fish from exploitation, protect and scout closed areas and seasons; they are also expected to disseminate and impart precautionary messages on the utilisation of the resources. Through the formulation of democratic and credible organisational structures, community participation can successfully be undertaken.

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