The Fish Stocks in Uganda Aquatic Systems: Opportunities and Challenges for Transformation

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Introduction

The status of fish stocks in a water body at any one time is a function of several factors affecting the production of fish in that water body. These include: total number (abundance) and biomass (weight) present, growth (size and age), recruitment (the quantity of fish entering the fishery) including reproduction, mortality which is caused by fishing or natural causes,

Other indirect factors of major importance to the status of the stocks include production factors (water quality and availability of natural food for fish), the life history parameters of the different species making up the stocks (e.g. sex ratios, condition of the fish, reproductive potential (i.e. fecundity) etc), Changes in fish stocks do occur when any of the above listed factors directly influence aspects of growth, reproduction and mortality and therefore, numbers and standing stock (biomass). In the exploited fisheries, major research concerns regarding stocks relate to the listed factors especially: estimates of stock abundance/biomass, the quantity of fish being caught, where the fish are caught, which species are caught (relative abundance), when the fish are caught, how the fish are caught.

The balance between stock abundance and amount of fish caught provides the basis for intervention. Due to the diverse characteristics of the physical water environment, fishes are in general, not evenly distributed throughout a water body. Shallow and vegetated areas tend to support higher abundance and diversity of fish species. In addition, seasonal variations in fish abundance are so strong that fluctuations in catch have to be expected at fish landings.

Since capture fisheries are a renewable natural resource, sustainable capture depends on a level of fish abundance that replaces what is taken out. This is through reproduction and growth which in turn depend on successful breeding, nursery, feeding and growth. These can be ensured through manipulation of age (size structure) targeted fish capture through mesh size restrictions, the protection of the fish habitats and maintenance of desirable water quality for the fisheries, distinct from sanitation-related water quality provision.

Therefore, beyond the figures generated, a major aim of capture fisheries research is to find out the nature of interaction among production and fishing factors including the behaviour of the fishes.

Overview of the capture fish production systems in Uganda

With up to 18% of the surface area covered by lakes, streams and swamps, Uganda has a high potential for fish production (Fig. 1). There are five major lakes (Victoria, the Kyoga complex, Albert/Albert Nile, Edward and George) that are the most important fish production systems.

Lake Victoria (68,800 km^2) - is one of the African Great lakes and the second largest lake in the world. The lake is shared by Kenya (6%), Uganda (43%) and Tanzania (51%) has a 3450km long indented shoreline and its basin covers 193,000km^2 which extends into Rwanda and Burundi. Till 1980s, Lake Victoria had a commercial fishery based on the native tilapiine species (*Oreochromis esculentus* and *O. variabilis*), catfish (*Bagrus docmak* and *Clarias gariepinus*), lung fish (*Protopterus aethiopicus*) and riverine breeding stocks of *Labeo victorianus* (Ningu) and *Barbus alltianalis* (Kisinja). These fisheries have greatly declined and have been replaced by the establishment and expansion of the introduced species, *Lates niloticus* (Nile perch) and *Oreochromis niloticus* (Nile tilapia). The native species, *Rastrineobola argentea* (mukene) has also become important and is the basis of the light fishery that has spread to most parts of the lake.

Lakes Kyoga and Kwania (2047km^2) form the Lake Kyoga complex. These two lakes are shallow with an average depth of 3-7m. The Lake Kyoga fisheries have gone through cycles similar to those witnessed on Lake Victoria.

Lake Albert (5,335 km^2) is located in the western rift valley and is shared between Uganda (54%) and Democratic Republic of Congo (46%). The lake is the third most productive fishery in Uganda contributing about 9% of national commercial fish production. The lake is the source of Nile perch and Nile tilapia introduced into Lakes Victoria, Kyoga and several other smaller water bodies. There are two species of Nile perch that are in Lake Albert. These are *Lates niloticus* and *L. macrophthalmus* but it is *L. niloticus* that was introduced into Lakes Victoria and Kyoga. There are four species of tilapia in the lake. These are the Nile tilapia (*Oreochromis niloticus, O. leucostictus, Tilapia zillii* and *Tilapia* (*Sarotherodon*) *gallaens*.

Apart from Nile perch and Nile tilapia, the most important commercial species from Lake Albert are: *Alestes baremose* (Ngassia), *Bagrus bayad* (Semutundu) and *Clarias gariepinus* (Male). The moon fishes (*Citharinus* and *Distichodus*) were commercially important till the early 1960s but drastically declined due to overfishing. Currently 2000/2, a basket /scoop fishery for *Brycinus nurse* and a light-fishery for *Neobola bredoi* (similar to the Lake Victoria *mukene*) has developed. Lake Albert is the only remaining major multispecies fishery.

Lake Edward (2300 km^2) - situated in the western arm of the East African Rift valley at an altitude of 912m above sea level. It is shared between Uganda (29%) and the DRC (71%). The dominant commercial fish species are *Oreochromis niloticus, Protopterus aethiopicus, Bagrus docmak, Clarias gariepinus.*

Lake George at an altitude of 914m is joined to Lake Edward by a slow flowing 30km long Kazinga Channel. It is a shallow (mean depth 2.5m) productive lake covering an area of

250km^2. Most shorelines of Lakes Edward, George and Kazinga Channel boarder with the Queen Elizabeth National Park. Similar species like in Lake Edward occur in this lake.

Apart from the larger water bodies, there are also about 160 small lakes scattered in various parts of Uganda but are mainly concentrated in the district of Kabale, Kisoro, Kyotera, Mbarara, Masindi, Kabalole, Ntungamo, Rukungiri, Bushenyi in southern Uganda and Kamuli, Palisa, Bugiri, Kumi and Soroti in Eastern Uganda.

The smaller lakes fall into five major groups comprising Lake Wamala, Nabugabo lakes, Koki lakes, the minor lakes of western Uganda and the Kyoga minor lakes. Lake Wamala (about 180 km^2) is located in Mubende district. Its area varies depending on amount of rainfall. Nabugabo lakes include satellite lakes (Nabugabo, Manywa, Kayugi, Kayanja and Kitunda) located near the shores of Lake Victoria. The Kyoga basin small lakes complex consists of over 24 small lakes all of which lie within extensive swamps. The largest of these is Bisina. The Koki lakes are located in south-western Uganda and consist of lakes Kijanebalola, Kachera, Mburo, Nakivali in addition to about 14 smaller lakes all associated with extensive swamps.

The minor lakes of western Uganda include lakes Bunyonyi, Mutanda, Mulehe, Chahafi, Kayumbu and other numerous crater lakes in Bunyaruguru and Queen Elizabeth National Park Bushenyi district. These are mainly volcanic lakes and some of them are very deep. Uganda has extensive river systems and is the source of African longest river, the Nile. Other rivers include Aswa, Dopoth-okot, Paget, Katonga, Mayanja-kato and Mpologoma.

Fish production estimates

Uganda waters currently (2002) produce an estimated 220,000 metric tones (Table 1) of fresh fish annually using an estimated 18,450 fishing crafts. This production does not include the unrecorded catches that may find their way to neighbouring countries or miss recording. The production therefore, could be above 300,000mt annually.

Fish production in Uganda can be increased through exploitation of some less exploited species like in some minor lakes and swamps. The most important sources of fish are Lake Victoria about 61% in 2002, L. Kyoga (25%), L. Albert and Albert Nile (9%), Edward, George and Kazinga Channel (3%) and 2% for other minor lakes, rivers and swamps (Table 1). The annual fish production estimates of the upper Victoria Nile are not well known but a survey upstream of Upper Victoria Nile Buyala to Kikuba-mutwe and downstream at Namasagali to Bunyamira in 2000 indicated an estimated annual production of 285mt and 143mt respectively at these locations. This indicates that there is a potential of increased production beyond the 250,000mt if these fish catches were recorded.

Overall fish species composition in commercial catches

Up to 86% of commercial fish production from Uganda's lakes comprised of Nile perch, Nile tilapia and Mukene as at 1995 (Table 2). This trend has not changed much except that there is apparent recovery of haplochromines.

Table 2. Major commercial fish species in Uganda (1995)

Scientific name	Common name	% Contribution
Lates niloticus	Nile perch	42%
Oreochromis niloticus	Nile tilapia	38%
Rastrineobola argentea	Mukene	6%
Clarias	Male	1%
Hydrocynus	Ngassia	4%
Protopterus	Mamba	3.5%
Mormyrus	Kasulu	0.4%
Brycinus	Nsoga	1%
Labeo	Ningu	0.1%
Bagrus	Semutundu	2%
Others	Mostly Nkejje	2%

Of the 42% Nile perch production, 30% came from Lake Victoria and 11% from Lake Kyoga 1% from L. Albert. However, there are new fisheries which of recent are of economic importance on Lake Albert. Catch assessment survey conducted on the Masindi district portion of the lake, showed that *Brycinus nurse* contributed 52% and *Neobola bredoi* which is closely related to Mukene and is caught using light attraction devices contributed 4%. These are new fisheries of commercial importance.

Status of fish stocks

Lake Victoria

On Lake Victoria fish stocks have been fluctuating since the introduction of the Nile perch and tilapiines (*Oreochromis niloticus, O. leucostictus, Tilapia rendalli* and *T. zillii)* in the 1950s and 1960s. Until the 1970s, the indigenous tilapiines e.g *Oreochromis esculentus* and haplochromine cichlids dominated the catches and subsidiary fisheries included the non-cichlid fishes such as *Bagrus, Clarias, Synodontis, Schilbe, Protopterus* and *Labeo*. Stocks of most of these species declined and others disappeared following over-fishing and subsequent establishment of the introduced tilapiines and the Nile perch.

Trends in fish stocks of Lake Victoria (Uganda)

The first lake-wide fish stock assessment of Lake Victoria was carried out during 1969-1971 before major transformations in the fishery. That stock assessment survey revealed 24 species excluding haplochromines which were suspected to make up more than 120 species.

Other major findings describing the stocks are summarised below:

Table 3. Estimated catch rates (kg. hr $^{-1}$) of fish from trawl catches in the Uganda part of Lake Victoria from the 1969/1971 & Jan 1999 – Dec 2000 stock assessment survey.

Species	Catch rate 1969-1971 (kg.hr^{-1})	Jan 1999 – Dec 2000
Haplochromis spp.	327.38	8.2
Tilapia esculentus	2.59	
T. variabilis	0.60	
T. niloticus	0.85	23.6
T. zillii	0.08	0.02
T. leucostictus	0.05	
Bagrus docmac	23.51	
Clarias mossambicus	17.33	0.07
Xenoclarias spp.	0.38	
Protopterus aethiopicus	5.77	0.6
Lates niloticus	0.48	207.6
Synodontis victoriae	15.36	
S. afrofischeri	0.01	0.02
Barbus altianalis	0.18	0.02
Labeo victorianus	-	
Mormyrus kannume	0.29	
Shilbe mystus	0.08	
Total	**394.94**	**240.1**

At least 80% of the estimated biomass (1969/71) was composed of Haplochromis species with the relative abundance of the other major species as *Bagrus docmac* (5.8%), *Clarias gariepinus* (4.0%), *Synodontis victoriae* (3.4%), *Oreochromis esculentus* (~ 2.0%).

Most species in the lake were more bottom-dwelling than pelagic and species diversity and abundance decreased with increasing depth.

In the fish stock assessment survey carried out between 1997 and 2000, the biomass, composition and distribution of the major commercial species were determined (Table 3).

There were no trawl surveys from 1971 till recent assessments were made but based on the estimated quantity of fish from the Uganda part of Lake Victoria between 1967 and 1989 (Table 1), the following patterns can be discerned:

a) 1967-1973: Estimated landed catch fluctuated between 32,000mt and 46,000mt;
b) 1974-1984: There was a noticeable decline in catch over the years averaging around 15,000 mt until 1984 when it rose to about 45,000mt;
c) 1985 – 1989: A rapid increase over the years with the catch reading a maximum of 132,000mt in 1989, and thereafter, dropping to 104,000mt in 1999. Current estimates show that in 2002, the estimated catch was about 136,000mt.

Between 1997 and 2000, trawl surveys were conducted as part of fish stock assessment in Lake Victoria. Results of this most recent exercise provide an indication of the present status of the fish stocks in comparison to 1969/71.

Table 3. A comparison of the percentage species relative abundance between two stock assessment periods 1969/1971 and 1997/2000

1969/71		1997/2000	
Species	**% Relative abundance**	**Species**	**% Relative abundance**
Haplochromis spp	83	*Haplochromis spp*	3.4
Bagrus docmak	4.2		
Clarias gariepinus	4.1		
O. esculentus	3.8		
Protopterus	2.8		
O. niloticus	0.5	*O. niloticus*	9.3
Lates niloticus	<0.1	*Lates niloticus*	86.5

Fishing Effort:

Analysis of the fishing effort (number of fishing boats) in the Uganda part of Lake Victoria has been carried out to examine the validity of the observed trends from the stock assessment surveys and estimated quantities of fish landed.

Fishing boats increased from 3470 in 1988 to 8000 in 1990, 15,418 in 2000, 18,609 (2002) and 16,775 (2004). Over this period (1988-2000), increase in fishing effort resulted in a lake-wide decline in catch per unit effort (CPUE). The decline from 36mt boat $^{-1}$ yr $^{-1}$ in 1989 to 10 mt in 2000 was accompanied by a decrease in the average mesh size of gill nets used from 203.2mm and 177.8mm to 152.4mm and below. The use of the illegal gill nets of mesh below 127mm (<5") increased from 5% in 1990 to about 19% in 2000. The overall effort of these trends has been a reduction in the average size of Nile perch and Nile tilapia landed and an increase in the number of parachute boats, indicating fishing in shallow waters.

The tilapia and light fishery for Mukene in Lake Victoria

The Tilapia fishery

Following the sharp decline in catches of the native tilapiines (*Oreochromis esculentus* and *O. variabilis*) in the 1950s, the introduction and establishment of the Nile tilapia, *O. niloticus*, in Lake Victoria in the same period revived the tilapia fishery of the lake. Nile tilapia is currently the main fish for the local consumers but this fish is also increasingly becoming part of the export market.

The rapid decline in the native fishery which was caused by biological over-fishing may also lead to the same pattern in the Nile tilapia fishery in addition to other environmental (habitat) disruptions even though this species appears to be highly adapted to a wider ecological base than the native tilapiines. Since the 1970s, the tilapia fishery of Lake Victoria has been dominated by the introduced Nile tilapia that occupies all habitats previously containing native tilapiines. The highest densities of the Nile tilapia (65% of all the fish biomass) occur in shallow macrophytes-dominated habitats in less than 4m deep areas within 500m from the shoreline. In deeper (4-10m) habitats, Nile tilapia accounts for 13-32% of the fish biomass. Nile tilapia in Lake Victoria breeds through the year with two peak breeding periods (May – June and November to December).

The Mukene Fishery

Following the decline in catches of endemic fish species and the demand by the export market for the Nile perch, *Rastrineobola argentea* (mukene) has become an important commercial fish species in Lake Victoria. It is not only prey to the Nile perch, but is now a main source of fish protein available to the rural areas. Mukene is also an important commodity in feed formulations for poultry and could become part of fish feed combinations in aquaculture. The species is ranked third in importance after the Nile perch and Nile tilapia in Uganda.

Mesh sizes of nets used in the capture of *R. argentea* on Lake Victoria have reduced from 10mm stretched mesh to 5mm in several areas. Favourite grounds for mukene fishing especially the sheltered bays are also nurseries for other fish species which are as a result caught as by-catch in the mukene fishery. The biology, ecology and the performance of the fishery has been investigated over a period stretching back to 1970 before the establishment of the Nile perch and before and after expansion of the mukene fishery in the northern waters of Lake Victoria.

The average size of mukene from the inshore waters of Lake Victoria has dropped from a mean size of over 60mm standard length (SL) in the early 1970s to 37mm SL by 2000. The species now grows faster maturing after 8 months compared to 14 months in 1988. It also currently matures at a smaller size to 36mm SL compared to 52mm SL prior to 1980s. The species breeds throughout the year with two peak breeding periods during the months of August and December/January.

The decrease in mean size of the populations and size at first maturity of mukene and an increase in growth rate especially in closed bays inshore are signs of local over-fishing. Once the fishery shifts away from these bays, capture of juvenile fishes as by-catch can be reduced.

Inshore waters and closed bays are nurseries for mukene and many other fish species especially the tilapia. Fishing for mukene in these areas captures up to 50% of juvenile mukene and juveniles of Nile perch and tilapia as by-catch species. Open waters away from shores contain less than 2% of the by-catch due to mukene fishing. Therefore, fishing for mukene should be carried out in more open waters. Closed bays and shoreline areas (1,500m or less from the shoreline) should be avoided. Beach seines which can also be operated to capture mukene should be prohibited since they are operated from shoreline habitats that are also breeding and nursery areas for most species of fish.

The only method by which mukene can be exploited is through light attraction. The mesh size of mukene fishing nets is not yet provided for under current legislation.

The Lake Kyoga complex (Kyoga and Kwania)

Prior to the establishment of the introduced Nile perch and Nile tilapia in Lake Kyoga, the fishery comprises of the native tilapia (*oreochromis esculentus, O. variabilis*) and lung fish (Protopterus aethiopicus) that made up 95% of the landings up to the mid 1967.By 1990s, the native tilapias contributed less than 5% of the total landings of 26,300mt.

Currently, *Rastrineobola argentea* is a major fishery but analysis of the monthly catches at Bukungu, a major landing site on Lake Kyoga, suggests that the average number and size of fish have declined.

Kyoga Minor lakes

Seven minor lakes; Agu, Nyaguo, Gigate, Lemwa, Kawi, Nakuwa and Nawampasa were surveyed. Data was also collected from the eastern end of the main lake Kyoga at Iyingo where the extensive swamp within which the minor lakes are located begins. A total of 55 fish species were identified from these lakes. Cichlids contributed 67% of the fish caught of which 86% were haplochromines belonging to 13 genera. These covered all major tropic groups whcich once dominated lakes Victoria and Kyoga before the introduction of the Nile perch. A number of un described haplochromine species were collected. Of the haplochromines 87% were of types either extinct or almost extinct from lakes Victoria and Kyoga. The native tilapiine species of lakes Victoria and Kyoga, *Oreochromis esculentus* and *O. variabilis*, which had become very rare in the two lakes, still occur in these small lakes.

Lake Albert

Lake Albert is the third most important fishery in the country contributing up to 9% total national production. Four broad ecological zones can be recognized as influencing the type of fish species under exploitation on Lake Albert (Holden, 1993). These are:

a) **The Victoria Nile from the Nile delta at Wanseko/Panyamur to the Murchison Falls.**

Species caught in this zone consists mainly of river associated species such as *Alestes baremose*, the most important commercial species in the area, the cyprinids *Barbus bynni* and *Labeo horie* and *L. Coubie*, the mormyrids *Mormyrus caschive*, *M. kannume*, *Hyperopisus bebe*, and *Mormyrops anguilloides*. Large sized adult species like the Nile perch and *Distichodus niloticus* are also caught in this area. Much of this area lies in the Murchison Falls National Park and fishing is prohibited as the area forms an important breeding ground to many anadromous fish species within the main lake. Many fishermen however openly fish in this area.

b) **The shallow open water areas off Wanseko/Panyamur and off Ntoroko**

These are areas influenced by the rivers flowing into the lake, the Victoria Nile for Wanseko and the Semliki, Muzizi and Wassa rivers for the Ntoroko waters. Species caught are similar to those described in (a) above.

c) The lagoon

Large lagoons occur at Butiaba, Tonya, Kaiso and Buhuka. Minor lagoons also occur scattered along the shoreline as at Bugoigo and Kaboolwa. These shallow waters support mainly the shallow water dwelling cichlid species, the tilapiines, *Oreochromis niloticus*, *O. leucostictus*, *Tilapia zillii* and *Sarotherodon galilaeus* and the haplochromines *Thoracochromis* spp and mostly juvenile *Lates niloticus*.

d) The deep open water between the shallow waters in (b)

This region comprises the largest portion of the lake. Fish species of commercial importance include very large *Lates niloticus*, *L. macrophthalmus*, *Bagrus bayad* and *Hydrocynus forskahlii*. Worthington (1929) recorded 42 fish species belonging to 13 families from lake Albert. 17 species are recorded among the commonest. ***Citharinus citharus*, *Lates spp*, *Oreochromis niloticus*, *Bagrus spp*, *Alestes baremose*, *Hydrocynus forskahlii*.** *Synodontis schall* and *Mormyrus caschive* were the most important commercial species in that order. Up to 1965 almost the same number of species still formed the bulk of the artisanal fishery. Fish species now commonly encountered in commercial catches from the Northern half of the lake are shown in Table 5.

Catch statistics between 1978 and 1986 indicate a steady drop in commercial landings from an average of 20,600 to 4,900 tons.

Catches of the Nile perch (*Lates* spp)

Two species of the Nile perch occur in Lake Albert. *Lates niloticus*, which grows to a very large adult size, is associated with inshore waters and the River Nile while *Lates macropthalmus* a slightly smaller species is common in the open waters offshore.

For a long time *Lates* species have been among the top three fish species landed in the commercial catches from Lake Albert (Table 5).

Table 5. Percent contribution of fish species landed by the artisanal fishery of Lake Albert over the time.

Fish taxa	1950s	1960s	1970s	1980s	1990/91	2002
Alestes sp	38.5	73.6	20.0	10.8	7.3	5.8
Lates sp	24.1	13.3	24.1	17.2	17.6	25.0
Hydrocynus sp	9.5	5.6	32.0	25.7	32.7	2.7
Tilapias	7.0	1.9	13.3	24.9	20.1	5.2
Labeo sp	4.3	1.1	0.4	0.9	1.6	0.2
Distichodus sp.	4.3	0.8	1.1	1.1	0.5	0.1
Clarias sp.	0.4	0.6	0.7	3.2	4.0	0.4
Protopterus sp.	0.3	0.1	0.3	3.0	0.8	0.01
Mormyrids	0.4	0.1	0.7	0.5	0.3	0.6
Synodontis sp.	4.4	1.3	1.0	2.0	2.8	0.2
Citharinus sp.	2.0	0.2	0	0	0	0
Bagrus sp.	3.2	1.5	4.9	8.1	7.9	3.4
Auchenoglanis sp.	-	0.04	0.6	0.7	1.6	0.2
Brycinus nurse	0	0	0	0	0	48.4
Barbus sp.	1.3	0.1	0.4	1.7	2.8	2.6

With a fish diversity of only 53 species in comparison to >300 species once present in Lakes Victoria and Kyoga, lake Albert is the only multispecies fishery in Uganda exploiting up to 10 fish species. The backbone of the lake's commercial fishery has for long relied on large predatory fishes such as *Lates* sp, *Bagrus bayad* and *Hydrocynus forskahlii* in addition to the tilapias especially the Nile tilapia.

A recent population increase around the lake has led to an increase in the exploitation rates. Catches of the traditional table fishes (*Lates*, *Oreochromis*, *Bagrus*, *Hydrocynus* and *Alestes*) from the lake have dramatically declined and new fisheries targeting the pelagic fish species have sprung up. They include the basket perforated basin fishery for *Brycinus nurse* and the light fishery of *Neobola bredoi*.

Lake Edward

During the 1970s, the tilapiines were contributing about 78% of the landed catch but this declined to 43% in the late 1980s. In contrast, the catch of *Bagrus docmak* increased from 15% to 46% over the period. Other species of secondary importance were *Protopterus aethiopicus*, *Barbus bynni* and haplochromines.

Lake George

On Lake George, mature *Enterochromis nigripinnis* which is spatially segregated from the juveniles of other species and is a dominant haplochromine (86% by fresh weight) in experimental catches is found in 100m and above from the shoreline and could be harvested to boost the catches. It can be cropped using 1" mesh size gill nets, as the immature fish of the other species are not located in more than 100m from the shoreline.

Small water bodies, swamps and rivers

The numerous smaller lakes, extensive wetlands and network of rivers and streams are sources of fish for the communities around them. Production from these areas is estimated at 2% of the total estimated production from the country's fisheries. However, since most fish from the smaller systems is directly used by local residents, the current figure may be an under-estimate especially with reference to the seasonal riverine-stream-swamp fisheries in the east and to the north of the country.

For the most part, only limited data are available on the status of fish stocks in the smaller water bodies. However, most of them appear to have been over-fished while others, the fisheries are not known, others especially the riverine-swamp stocks have declined due to environmental degradation. In Kabaka's lake in Kampala for example, large Nile perch (>50cm in length) and *Clarias gariepinus* were found but no juveniles of these species were encountered despite extensive experimental fishing during 2000. It was concluded that reproduction in the two species is not occurring in Kabaka's lake as a result of intensive pollution. In an evaluation of two small southwestern lakes (Chahafi and Mulehe) following restocking, it was concluded that stocks had improved while a similar survey of Lake Nabisojjo during 2000 and lake Kimira stocked with 85,000 Nile Tilapia fry in 2002 revealed the opposite. Following restocking of this lake Nabisojjo with 18,000 Nile tilapia fry in 1999, the stocked fish were not part of the experimental catch, and, the fishery was still dominated (>80%) by the unexploited *O. esculentus*.

Production from Aquaculture

Fish production from Aquaculture presently (2004) contributes about 2.5% i.e. less than 5000mt of total fish production in Uganda. However, there is presently a strategy to supplement the over-stretched capture fisheries by increasing and diversifying fish farming and thereby catalyse transformation of the sector into viable commercial enterprise that will improve rural livelihood and nutrition. This would also bridge the large gap between capture fish production and production and demand.

Fish farming was established in Uganda in the 1950s and by 1968, there were 11,000 ponds covering 420ha and producing 800 – 900 mt of fish. By 1980, production had drastically declined to less than 100mt as ponds had been abandoned. Fish farming in Uganda is still dominated (80%) by subsistence farmers owning on average one pond. Over 50% of the ponds measured between 100 – 300 m^2. However, around 1997 some fish farmers took up polyculture (Nile Tilapia, catfish/common carp) as the target farmed fish species. Though not well known, there could be estimated 10,000 fish farmers (2005) operating about 25,000 ponds in Uganda presently using average ponds of 400 m^2. It is estimated that when Aquaculture is promoted through the market, production from fish farming can increase from the present estimated 5000mt annually to 20,000 mt by 2006 assuming that identified constraints to increasing Aquaculture production to desirable ranges are attended to.

Fish production challenges

There have been challenges in the fisheries, which threaten their sustainability. Catch rates of most important and desired species on all the lakes have decreased due to over fishing, predation by Nile perch, and habitat degradation among other factors. Fish species diversity has declined with over 60% of the species in Lake Victoria disappearing or being reduced to negligible quantities. The pressure to the fisheries has been exacerbated by increase in fish processing plants and export of fish, which have stimulated demand and caused an increase in fishing effort.

In general, the major challenges to increased but sustainable fish production are:

a) Open access to the fisheries.
b) Environmental degradation of water bodies and thus of fish habitat.
c) Decline in fish stocks and fish species diversity due to excessive fishing effort (over-fishing or over-capitalization of the fisheries).
d) Use of destructive fishing gears and methods.
e) Capture of immature fish and introduction of exotics.
f) The spread and impacts of exotic fish species (Nile perch).
g) Proliferation of invasive weeds, in particular, water hyacinth.
h) Post-harvest losses (10-30% of the catch) due to poor handling, processing and storage.
i) Ineffective management of the fisheries due to limited community participation.
j) Inadequate investment skills among fishers.
k) Inadequate access to information technologies and inefficient dissemination of technology.
l) Closed areas and seasons enforcement.
m) Unreliable fish catch statistics data where to base management.

Opportunities for transformation in capture fisheries

- Uganda has waters and extensive wetlands and rivers capable of producing large quantities of fish if properly managed.

- Over 160 lakes can be manipulated for enhancement of fish production through re-stocking, introduction of fish species like Black bass (*Macropterus salmoides*) which do well in very cold regions like Kabale, Kisoro etc. could improve on production of these lakes or initiation of cage culture in some of unproductive lakes.

- Reduction of fishing effort and use of destructive fishing gears and methods, and capture of immature fish.

- Reduction of post harvest loses presently at 20 – 30 % of the catch., due to poor handling, processing and storage.

- Effective management.

- Sensitise fishers on investment skills.

- Avail and disseminate appropriate technologies to fisher communities.

- Involve communities in resource management.

- Restrict entry to fishery.

- Protect aquatic environment and fish habitats for nursery and breeding grounds.

- Introduction of closed areas and seasons.

- Introduction of crafts and propulsion methods that exploit off shore deep waters.

- There are ready local and international markets for fish (fish processing plants. neighbouring Kenya, Democratic Republic of Congo, Sudan and fish consumption locally).

- Harvesting of un exploited species such as *Haplochromis nigripinus* on lake George. *Bricynus nurse. Neobola Bredoi* on lake Albert.

Aquaculture

Increasing aquaculture production is a realistic option to sustainable fisheries production in Uganda. Beyond addressing aquaculture production challenges, there is need to widely disseminate Aquaculture Guidelines. In particular, clear guidelines and instruments are required regarding:

a) The utilisation of wetlands/swamps for large-scale aquaculture;
b) The marketing of farmed fish which may be below the permitted size of fish from capture fisheries;
c) The use of streams (i.e. diversion canals) for aquaculture production Vs for other community uses;
d) Cage culture farming in water bodies (location, size, pollution control etc);
e) Ornamental fish farming that could rely on seed from wild stocks;
f) Commercial culture of some species with seed material from wild stocks (e.g. Nile perch, *Bagrus);*
g) The wide dissemination and transfer of cultured species leading to potential escapes into the wild (e.g. Mirror carp, Nile perch, Red tilapia, Eel, etc);
h) The licensing and certification of fry producers for quality control;
i) The use of genetically modified fish including the use of chemicals (hormones) by private farmers.

Aquaculture opportunities

- Extensive wetlands can support large areas for Aquaculture.

- Selective breeding for Nile tilapia is on going for production of improved high quality seed that would improve Aquaculture production.

- Small lakes, which are not productive, can be used for cage culture.
- Encourage fish farming and avail adequate technologies in improved high quality feeds and pond management.
- There is high demand for clarias bait in hook fishery. About 112 million bait fish per year on Uganda waters. Aquaculture supply is less than 20% of this. Encourage bait farming.
- High demand for fish in processing plants in the near future for export.
- Training of advisory services, farmers, managers, labourers in Aquaculture production e.g. through fisheries for sustainable harvest (FISH) Project sponsored by USAID in Uganda to promote commercial Aquaculture.

Aquaculture production challenges recommended for intervention:

a) Provision of advisory services
b) Production and supply of quality fry,
c) Pond management technologies,
d) Prolific breeding of tilapia,
e) Production-marketing chains (large-scale investors and out growers),
f) Quality fish feeds including live feeds and pellet feed,
g) Technical, socio-economic feasibility and environmental desirability of large-scale fish farming.
h) Profitability of fish farming not well understood, and lack of interest by would be fish farmers.
i) Appropriate fry size for stocking.

TABLE 1. Trends of estimated quantity of fish landed from Uganda waters 1961-2002
Wt. '000' tonnes

Year	Victoria	Albert	Kyoga	Ed/Ge	Wamala	Albert Nile	Others	Total
1961	25.5	11.8	6.8	12.5	1		1.8	59.40
1962	23.4	12.2	13.2	12.1	2		3.6	66.50
1963	24.4	12.5	17	12	2.1		3.9	71.90
1964	24.4	10.2	18.5	10.2	2.1		5.2	70.60
1965	24.4	12.4	18.4	12.6	2.1		1.6	71.50
1966	28	13.6	19.9	10.9	4.8		4.2	81.40
1967	38.2	13.2	26.3	12.9	6.6		1.9	99.10
1968	40.5	13.5	32.5	13	7.1		3.3	109.90
1969	46.3	10.4	48.9	11.8	5.6		4.3	127.30
1970	41.7	24.2	62.1	10.5	5.3		3.9	147.70
1971	38.1	9.5	89.7	11.7	5.2	4.2	3.9	162.30
1972	33.9	10.5	95.1	12.3	4.1	4.3	4	164.20
1973	32.5	13.0	100.5	11	4.3	4.2	4	169.50
1974	24.5	13.5	105	10.5	6.5	4.0	3.5	167.50
1975	16.9	18.7	104.2	13.2	6.3	7.1	6.8	173.20
1976	11.1	12.3	145.8	12.5	4.3	4.5	2.1	192.60
1977	15.7	20.6	167	12	1.1	1.8	1.3	219.50
1978	14.2	20.6	167	11.8	1.8	5.7	1.1	222.20
1979	12	17	133	9.6	2	4.5	1.8	179.90
1980	10	13	131	7	1	3.2	7	165.90
1981	17	6	130	5	3.8	3	3	167.80
1982	13	10	138	6.9	0.5	1	6	107.00
1983	17	6	138	6	0.5	4	6	172.10
1984	44.8	6	137	6.5	0.3	3.9	5	199.20
1985	54.6	2.3	102.7	6	0.5	1.8	3.4	171.10
1986	56.8	4.9	128	6.3	0.5	2.2	4.2	202.90
1987	93.2	8.9	57.7	6.2	0.4	1.1	0.24	167.84
1988	107.1	12.5	86.75	5.9	1.1	0.6	1	214.25
1989	132.4	13.9	54.71	5.6		1.9	4	213.61
1990	119.94	19.48	94.92	5.5		1.41	39.7	245.22
1991	118.04	20.53	58.45	10.93		5.28	63.4	219.57
1992	120.4	18.7	63	10.6		8.8	2.6	224.10
1993	111.5	17.55	71.5	10.7		6.8	6.3	224.35
1994	103.04	16.4	80.2	10.8		4.8	3.7	218.94
1995	103	16	90	9		5	4	227.00
1996	106	22	81	5		0.4	4	218.40
1997	106	19	80	6		3.4	4	218.40
1998	105.2	19.1	80.2	5.6		3.5	3.5	217.10
1999	104.2	29.06	81.12	7.43		3.5	4.2	229.51
2000	133.4	19.38	55.89	5.22	5.61			219.50
2001	101.8	19.6	58.42	6.4	4.5			220.72
2002	136.11	19.38	55.58	5.22	5.6			221.89

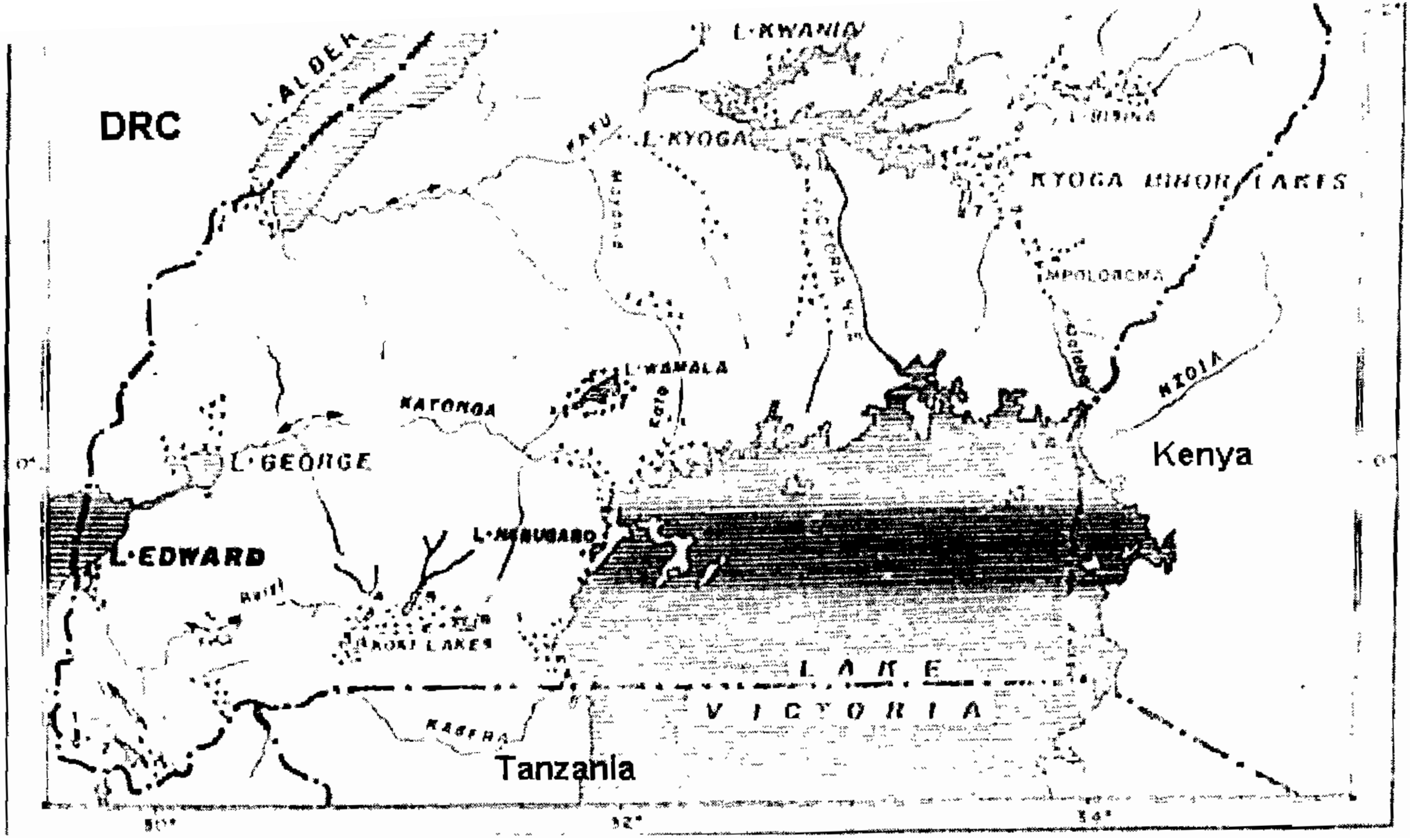

Fig. 1. The aquatic systems and wetlands associated with fish production in Uganda