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The past, present and projected scenarios in the Lake Albert and Albert Nile fisheries: Implications for sustainable management

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Abstract

Lake Albert is one of the largest lakes in Uganda that still supports a multi-species fishery which as a result of variable adult sizes of the species, causes management challenges especially in relation to gear mesh size enforcement. Prior to the 1980s, commercial species were 17 large-sized fishes especiall*y Githarinus, Citharinus, Distichodus, niloticus* and *Lates* spp that were confined to inshore habitats of the lake and were thus rapidly over fished. Frame and catch assessment surveys conducted in this study revealed a >80% dominance of small size fish species (*Neobola_bredoi* and *Brycinus nurse*) and a 40 – 60% decrease in the contribution of the large commercial species. Sustainability of small size fish species is uncertain due to seasonal fluctuations and low beach value. At about 150,000 tons of fish recorded from Lake Albert and Albert Nile, the beach value was estimated at 55.3 million USD. Despite the noted decline in catches of the large sized fishes their contribution was more than 50% of total beach value. Therefore, management measures should couple value addition for the small sized species and maintain effort regulation targeting recovery of the large previously commercial species

Key words: CPUE, fishing effort, multi-species fishery, pelagic species

Introduction

Lake Albert is located between latitude $0^0 15^1$ and $1^0 00^1$ N; longitude $30^0 21^1$ and $31^0 25^0$ E with a surface area of about 5300 km^2 (ILEC, 2006). It is shared between Uganda (54%) and the Democratic Republic of Congo (46%); from the south. Lake Albert is fed mainly by Semliki River and several streams flowing from the northern slopes of the Rwenzori, and to the north by the Victoria Nile. The Albert Nile leaves the northern end of the lake, flows through northern Uganda up to the Sudan border and after which it is referred to as the Mountain Nile or Bahr al Jabal (Holden, 1963).

Accurate and time specific information on trends in fisheries catch and fishing effort of any production system is a necessary component to facilitate sustainable fisheries management (McCluskey and Lewison, 2008). It is a common practice World over for fisheries managers working to maximize sustainable profits to employ measurement of effort to limit fishing activity to the level of maximum economic yield (Puga *et al.*, 2005). Continuous assessment of fishing effort has remained an important means of estimating trends in stock abundance when independent abundance data are not available. Ideally, index of stock abundance should be based on fishery-independent data collection methods such as trawl, gillnet, and acoustic surveys, which are often extremely costly or difficult to routinely implement leaving fishery-dependent data capture methods as the only viable alternative (Maunder and Punt, 2004).

Common fisheries dependent methods used to assess production of most fisheries are catch rates or catch per unit of effort (CPUE), and total effort surveys. The basic assumption is that as CPUE changes; it may reflect a change in stock abundance (McCluskey and Lewison, 2008). Despite the fact that, the assumption of a linear relationship between CPUE and stock abundance has come under much scrutiny (Harley *et al*., 2001), it still remains a useful index of abundance to project possible scenarios in stock dynamics especially in poor data inland artisanal fisheries (Moses *et al.*, 2002) such as Lake Albert in Uganda.

Lake Albert is one of the few large lakes in Uganda that supports a fishery based on a diverse population of native fish species. The lake provides employment, food and income to approximately 3 million people living in the surrounding districts (UBOS, 2002). It is the second largest fishery in Uganda, after Lake Victoria and exploited fish species vary in size from the small pelagic cyprinid *Neobolabredoi* (Poll, 1945) (Muziri) whose maximum adult size is 45 mm in total length (Lévêqueand Daget, 1984; Howes, 1984) to the large centropomidae *Lates spp* which can grow to more than two metres in length (Schofield, 2012), This size diversity causes difficulty in determining and enforcing size limits of fishing gears and consequent control over CPUE. Increasing fishing pressure has led to “fishing-down” of the stocks with some larger species having been driven to near-extinction while large individuals of others have disappeared (Hecky, 2007). In the 1950s, for example, large fishes such as *L. niloticus* and *Alestes baremose* (Boulenger, 1901) (Angara) made up 63% of the catch, while our data show that currently, small fishes such as the characidae *Brycinus nurse* (Rüppell 1832) (Ragoogi) and *N. bredoi* make up almost 80% of the catch.

There is little or no information on fish biomass in the lake but there is some data on fishing intensity collected sporadically through Frame surveys (FS) and Catch Assessment Surveys (CAS). Frame surveys are a direct enumeration of all fishing inputs including landing sites on a regular or *ad hoc* basis and provide information on their location as well as the numbers, types, sizes and mode of propulsion of fishing boats, and the number, types and sizes of fishing gear. Frame survey information also helps in identifying the primary and secondary sampling sites and appropriate sampling strata for the Catch Assessment. By the close of the 1920s the traditional fishery used simple locally made fishing gears such as harpoons, open baskets, basket traps and hand lines and fishing pressure was low (Worthington, 1929). At the time, the only commercial fishery was run by Greek fishermen on the Congo side of the lake that used beach seines and flax gill nets. Few native fishermen used these gears because of their prohibitive cost. Fishing was confined to inshore probably because the inshore fish stocks could provide an inadequate supply of fish.

The first official assessment of fishing effort on the Ugandan side of the lake was done in 1950 when the licensing of fishing vessels began and followed by estimation of fish catches in 1953 that coincided with recruitment of trained fisheries at landing sites. The commercial fish catches then, comprised of 17 fish species dominated by the moon fish; citharinidae *Citharinus citharus* (Geoffroy, 1809), distichodontidae *Distichodus niloticus* (Hasselquist, 1762), and *Lates spp* i.e. *L. niloticus* and *L. macrophalmus* (Worthington 1929). The others included cichlidae *Oreochromis niloticus* (Linnaeus, 1758), bagridae *Bagrus bajad* (Forsskål, 1775), *A. baremose*, characidae *Hydrocynus forskahlii (Cuvier, 1819*) (Ngasia), mochokidae *Synodontis schall* (Bloch & Schneider, 1801) and momyridae *Mormyrus caschive* (Linnaeus, 1758). Drastic decline of *C. citharus* catches was reported around 1942 coinciding with extensive use of beach seines (Cadwalladr and Stoneman, 1966).

The collapse of the *C. citharus* fishery, persistent decline of the other large sized commercial species and emergency of fisheries of small sized species suggests unsustainability of the lake and riverine fisheries of the Albert system possibly resulting from unsustainable fishing regimes. The study therefore, specifically, examined the changes in fishing effort and exploitation levels of the commercial fish species aimed at understanding the changes in dynamics of fisheries required for balanced harvesting, control of illegal gears and methods, and institution of species specific management measures.

Materials and methods

Study area

The Study was conducted on the Uganda portion of Lake Albert and Albert Nile between 2001 and 2012 (Figure 1).

Field sampling and data capture

Fishing capacity

Two frame surveys on the Ugandan part of Lake Albert were carried out in 2007 and 2012. The surveys were a complete census of all fishing inputs (fish landing sites, fisheries facilities available at landing sites, fishers, fishing crafts and fishing gears by type, size and mode of operation). The main fish species targeted by each fishing craft and gear recorded following Standard Procedures (LVFO, 2007a). The numbers of the main indicators of fishing capacity and effort, i.e. landing sites, fishers, fishing crafts, and gears were disaggregated by water body and region based on habitat characteristics of the location of the landing site. The GPS positions for fish landing sites on the Lake were plotted on the digital map of the lake using ArcGIS 10. Results of the NaFIRRI surveys of 2002 - 2012 were compared with earlier records of fishing effort (e.g. Holden, 1963; Cadwelladr and Stoneman, 1966; Walker, 1972; Nyeko and Coenen; 1991).

Fish species composition, CPUE, fish catches and value

The catch per unit of effort (CPUE) was determined from catch assessment surveys (CASs) carried out in the Ugandan waters of Lake Albert in 2002 - 2012. Additional data were obtained from baseline surveys conducted for oil

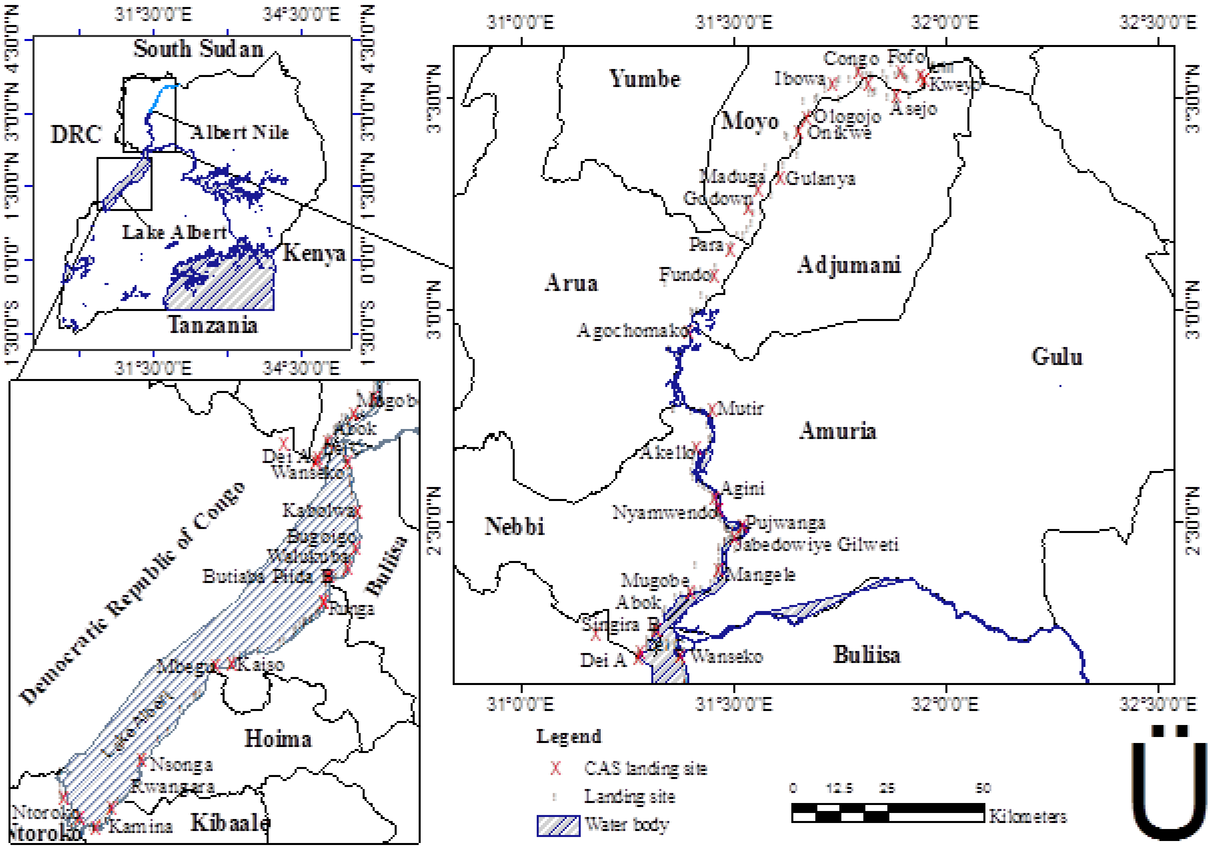

Figure 1. The two study sites (Lake Albert and Albert Nile) with an in set map of Uganda showing their location, the named landing sites are marked with X and indicate where sampling for Fish Catch Assessments' was done during NaFIRRI surveys (2007 – 2012).

exploration activities in Hoima and Buliisa districts in 2007 (Tullow; unpublished Report). Sample landing sites for CAS marked X (Figure 1) were selected from every riparian district using a two-stage stratified sampling design whereby: within each district, a sample of primary sampling units (PSUs) i.e. the fish landing sites were first selected according to protocols provided in LVFO (2007b). A total of 17 landing sites representing 22% of all the landing sites on the Ugandan part of the lake and 26 representing 21% of all the landing sites along Albert Nile were sampled. The fishing boats were then segregated into effort groups (Boat-gear combinations) and the CAS indicators estimated for each effort group. The CAS indicators included CPUE (kg/boat/day), the mean prices (shs/kg), the total fish catches (t) and value (USD), estimated for each effort group by species as given in LVFO (2007b). The catch rates of the main fisheries were compared with the data collected in 2002 in Buliisa and Hoima districts.

The proportions of *N. bredoi* and *B. nurse* in the mixed catches of light fishery within small seines were ascertained by randomly removing one full basin (about 25 kg) from at least three boats at the sampled landing site, sorted and weighed. The weight ratios of the constituent species were applied to the whole catch of every boat in the effort group.

Data analysis and interpretation

The total fish catches were estimated using mean fish catch rates in the January 2007 frame survey for CAS data 2007/2008 and May 2012 frame surveys. The beach value of the catch was estimated by raising the estimated total catch in each effort group by the mean unit price of each species landed. The analyses were categorized into four zones based on fisheries and habitat characteristics:

(i) Northern zone - (Nebbi and Buliisa Districts)
(ii) The central zone - (Hoima District)
(iii) The southern zone - (Ntoroko and Kibaale Districts) and
(iv) The Albert Nile

Results

Fishing capacity

In comparison to earlier surveys, the January 2007 and May 2012 census of fishing inputs on the Uganda side of Lake Albert revealed a more stable state in the number of boats, fishers and landing sites (Table 1). As in the 2007 survey, the number of landing sites was lower than those estimated in earlier frame surveys of 1970s to 1990s (Table 2). The most reliable indicator of trends in fishing effort on the lake was the number of fishing boats that increased from less than 2000 in 1991 to almost 5800 in 2007; a nearly threefold increase in fishing effort over 16 years and remained relatively stable in 2012 while Albert Nile recorded about 2700 (Table 1) which is the first recorded comprehensive estimate.

Out of the 6,000 fishing boats operating on the Uganda part of Lake Albert, 97% were the flat bottomed boats locally known as “*Congo barque*”. Other types of boats included Sesse boats, dugouts, and others that are often used extensively elsewhere but were of negligible importance on Lake Albert. However, on Albert Nile 60% of the 2700 fishing canoes were Dugout, the remaining 40% shared between Parachutes and small sized “*Congo barque*” in equal proportions. The most frequently used gears were the multifilament gillnets (used by 40% of the

Table 1. Fishing capacity on the Uganda side of Lake Albert and Albert Nile. Data from frame surveys carried out in January 2007 and 2012. The numbers of fishers are rounded off to the nearest 10s (Note: Some boats had no gear and others used more than one fishing gear)

Water body/period	Lake Albert		% change	Albert Nile
	2007	2012		2012
Number of landing sites	72	78	8	126
Number of fishers	15,360	15,420	0	4500
Fishing boat type				
Congo bargue	5,598	6,037	8	569
Dugout types	6	10	67	1,543
Foot fishers	0	18	1,800	0
Parachute	4	0	-100	545
Ssesse boats	157	151	-4	24
Fishing boats				
Using engine	416	311	-25	3
Using paddles	5,350	5887	10	2,678
Using Multifilament gillnets	2,033	2532	25	1,439
Monofilament gillnets	161	519	222	59
Long lines	1,533	527	-66	661
Beach/Boat seine	47	22	-53	46
Cast net	81	116	43	303
Hand line	13	14	8	14
Traps	53	56	6	141
Small seines	1,619	2303	42	13
Other gears	32	33	3	2
Total number of fishing boats	5,766	6179	7	2681
Fishing gears				
Multifilament gillnets	96,655	126,575	31	30,769
Monofilament gillnets	1,049	3,774	260	386
Long line hooks	1,978,224	745,706	-62	145,338
Beach/boat seines	47	22	-53	46
Cast nets	81	125	54	303
Hand lines	246	447	82	275
Traps	655	745	14	935
Scoop nets	30	0	-100	2
Small seines for light fishery	1,619	2,297	42	13

Table 2. Annual changes in estimated fish catch (t x 1000) and the gross value (USD) on the Uganda side of Lake Albert in 2007-2012

Water body	Lake Albert				Albert Nile	
Period	2007/2008		2012		2012	
Species/parameter	Catch	Value	Catch	Value	Catch	Value
Brycinus nurse	87.0	12.4	51.0	7.1	0.8	0.4
Neobola bredoi	29.4	3.5	78.0	11.4	-	-
Lates spp.	13.3	9.1	8.6	16.8	0.2	0.3
Bagrus bajad	6.2	2.4	0.9	0.8	0.4	0.4
Oreochromis niloticus	3.4	1.8	3.2	4.1	0.9	0.7
Alestes baremose	1.9	1.2	1.7	1.7	0.2	0.3
Hydrocynus forskahlii	1.5	0.7	6.7	6.4	0.2	0.2
Barbus bynni	0.9	0.4	0.2	0.2	0.6	0.5
Clarias gariepinus	0.3	0.1	0.07	0.1	0.7	1.0
Protopterus eathiopicus	-	-	0.03	0.0	0.5	0.7
Others	1.1	0.5	1.3	1.1	1.3	1.1
Total	144.9	32.2	151.6	49.7	5.9	5.6

boats), followed by small seines for the light fishery (37%) and long lines (8.5%) in 2012 (Table 1). Distribution of boats on Albert Nile by gear was: Gillnets (54%), long line hooks (25%), Cast nets (11%), and Basket traps (5%).

Changes in fishing capacity on Lake Albert, 1951-2012

Prior to systematic licensing, less than 500 fishing boats were recorded on the extreme north-west end of the lake in 1951. Subsequently, the number of fishing boats lake-wide had risen to more than 6,000 in 2012 along with spatial changes in landing sites (Figure 2).

The number of fishing boats used by illegal fishing gears generally increased for example, those of monofilament gillnets increased by over 200% largely in the tilapia fishery. Other notable increases between 2007 and 2012were also evident in boats using Cast nets (43%). There was however a reduction in boats using multifilament gill nets and boat seines by 66% and 53% respectively, in the same period.

Almost 160,000 multifilament gillnets and over 4,000 monofilament gillnets were recorded in May 2012 and < 127 mm mesh sized nets (minimum recommended size on large lakes) were the most common, constituting over 80% of multifilament gillnets dominated by 63.5 and 101.6 mm mesh sizes (Table 1; Figure 3b).

Catch per unit of effort (CPUE)

Brycinus nurse dominated the catches of the small pelagic fishery of Lake Albert with a higher catch per unit of effort in all parts of the lake in 2007 and 2008 while *N. bredoi* dominated the catches in 2012 (Figure 4). There was however an increase in CPUE in both species in the Southern part of the lake in 2012 with a sharp rise in *N. bredoi* from < 10 to > 250

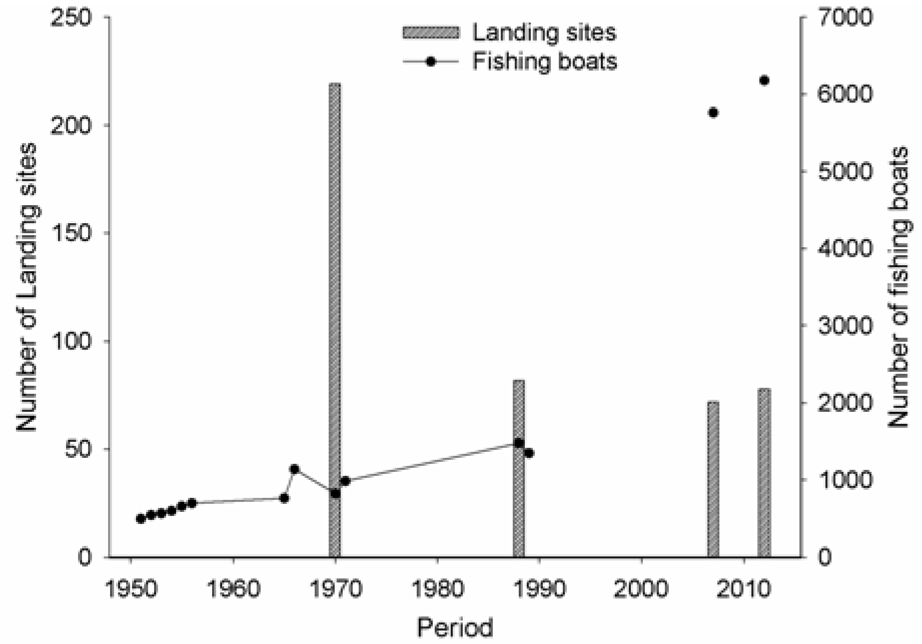

Figure 2. The Trends in number of landing sites and fishing boats on Lake Albert (1951-2012). (Data sources: 1950-1956 (Cadwalladr and Stoneman, 1966); 1965-1989 (Uganda Fisheries Department and Wildlife Services' Limited, Ministry of Agriculture, Animal Industry and Fisheries), 2007-2012 (National Fisheries Resources Research Institute, Frame surveys; 2007; 2012).

kg/boat/day from 2008 to 2012 respectively (Figure 4).

Both the gillnet and cast net fisheries CPUE of Nile tilapia were relatively stable at about < 10 kg/boat/day except in the in 2012 where the northern and central parts of the lake recorded CPUE > 10 kg/boat/day (Figure 5a). Generally, cast nets recorded considerably higher CPUE than the multifilament gillnets except in 2012 where the CPUE were comparable to those of gill nets (Figure 5a).

In both the gillnet and long line fisheries, CPUE of the Nile perch decreased to the lowest ever recorded (<10 kg $boat^{-1}day^{1}$) in most parts of the lake and Albert Nile in 2012 (Figure 5b) except for a slight increase from about 30 to 40 kg $boat^{-1}$ day^{-1} that was recorded in the central region around the same period, but still lower than what was recorded in 2002 (Figure 5b).

The CPUE of *B. bajad* in gillnets was consistently low (<5kg $boat^{-1}day^{-1}$) in all years except for a high CPUE of about 15 kg/boat/day recorded in the central part of the lake in 2007 (Figure 6a). The confidence intervals in this case were very wide and it reflects the few exceptionally large catches sampled (Figure 3). In contrast, the CPUE in the long line fishery increased considerably in the central part of Lake Albert over the years but declined in2012 and similar trends were common in the entire study area. A persistent decrease in CPUE was noted over the years in the North of Lake Albert (Figure 6a).

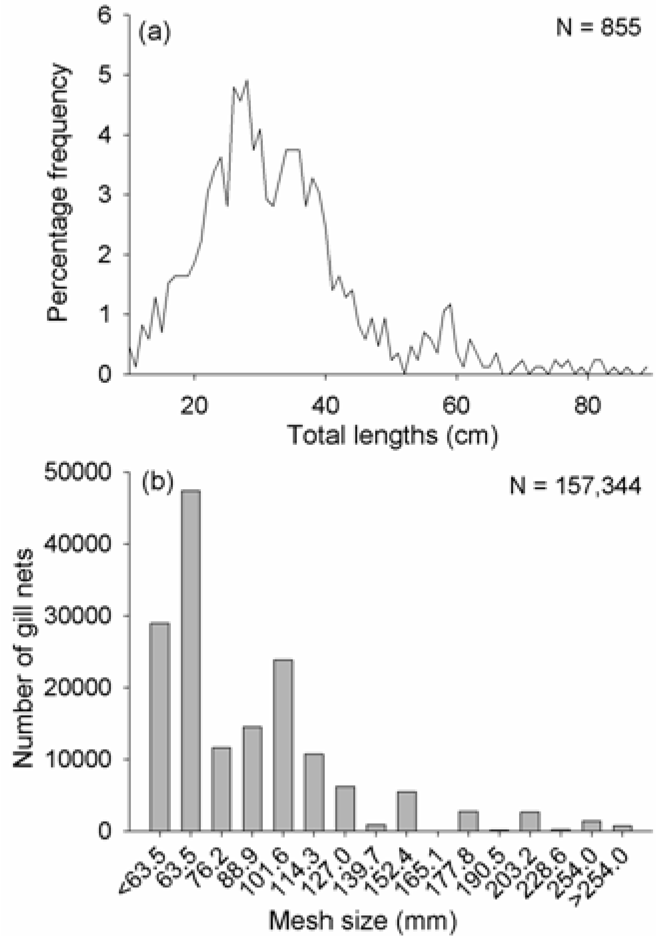

Figure 3. The comparison (a) length distribution of Nile perch (*Lates Macropthalmus* and *L. niloticus*) and (b) mesh size of multifilament gillnets on Lake Albert 2012 from the July CAS and May Frame Survey respectively (NaFIRRI surveys 2012).

Alestes baremose and *H. forskahlii* were mostly caught in gillnets and the CPUE of both species exhibited a similar pattern, but the catches of *A. baremose* were 3-4 times higher than those of *H. forskahlii* especially in the northern part of Lake Albert (Figure 6 b and c) but decreased sharply in 2008. The CPUE of *H. forskahlii* was consistently < 5kg/boat/ day over the years except in Central of Lake Albert where a notable sharp increase (> 10 kg/boat/day) was recorded.

Fish species composition, catch and beach value

In the two most recent surveys, the estimated total fish catch on the Ugandan side of the lake increased from an average of 145,000 t in 2007 / 2008 to about 151,069 t in 2012 while the Albert Nile recorded an additional catch of almost 6000 t (Table 3). In both surveys on Lake Albert > 80% comprised of *B. nurse and N. bredoi* caught in the light fishery while *B. bynni* dominated the Albert Nile

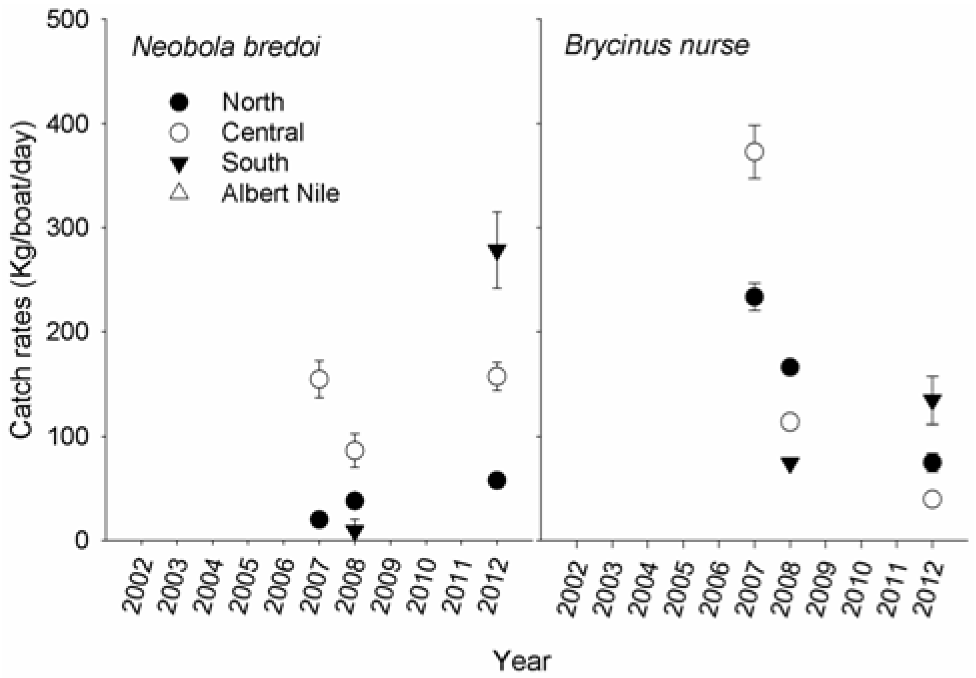

Figure 4. Changes in catch rates (kg/boat/day ± SE) of the two dominant fish species in the light fishery on Lake Albert, 2002 - 2012 (NaFIRRI, surveys).

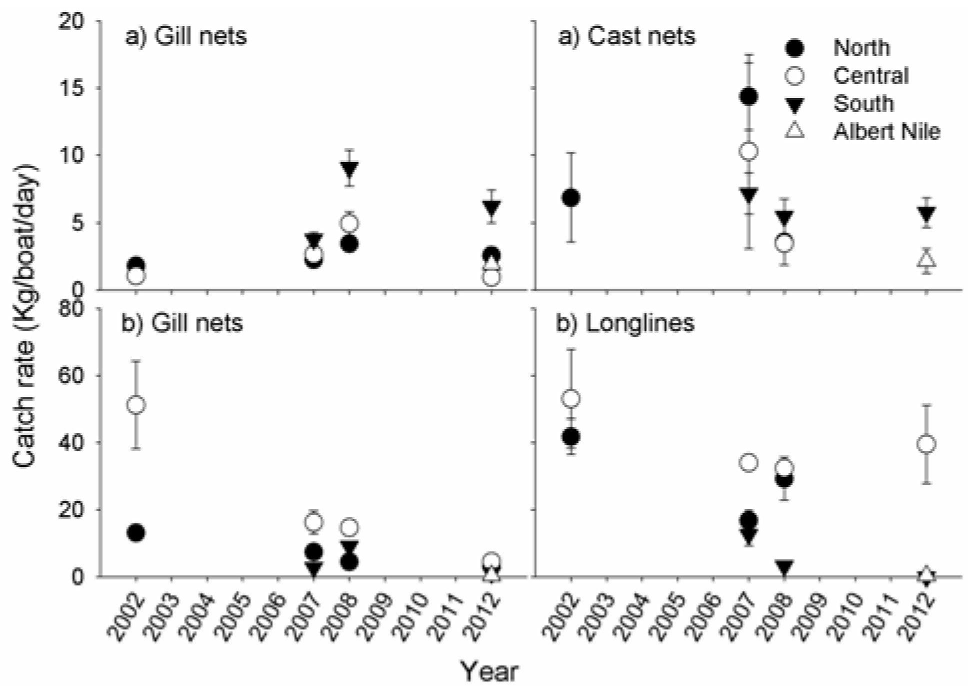

Figure 5. Changes in (a) Nile tilapia (*Oreochromis niloticus)* and (b) Nile perch (*Lates macropthalmus and L. niloticus*) catch rates (kg/boat/day ± SE) in different fishing gears on Lake Albert and Albert Nile, 2002 - 2012 (NaFIRRI, surveys).

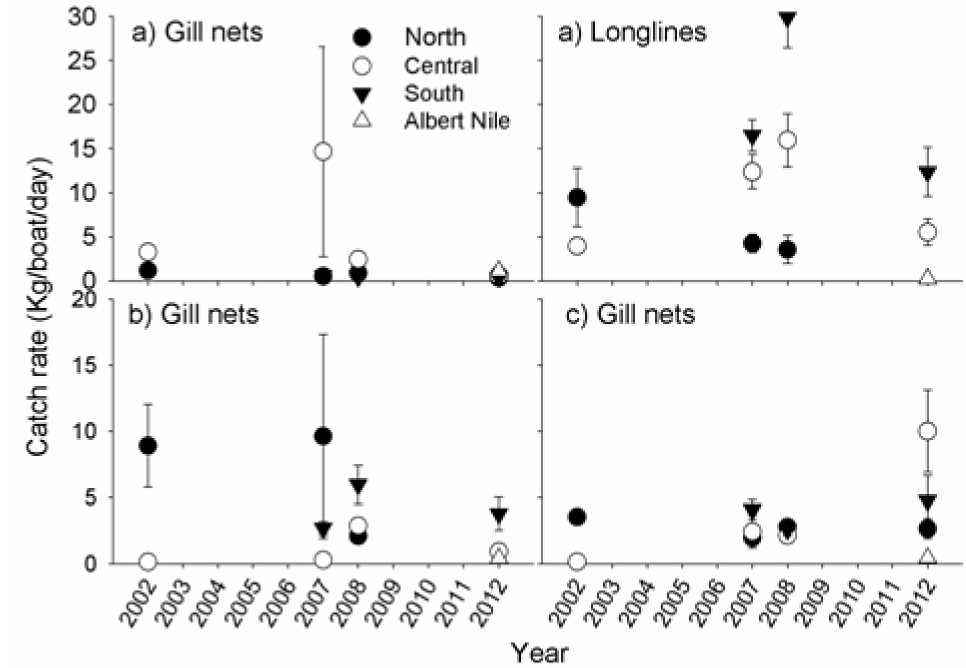

Figure 6. C hanges in (a) *Bagrus bajad*, (b) *Alestes baremose and Hydrocynus forskahli* catch rates (kg/boat/day ± SE) in different fishing gears on Lake Albert and Albert Nile, 2002 - 2012 (NaFIRRI, surveys).

Table 3. The composition (% by weight) of the Lake Albert fish catches from the 1950s. The symbol + indicates that the species was caught but made up <1% of the catchCadwalladr and Stoneman, 1966; Sentongo, 1992; 2007/2008/2012; 2008)

	1950s	1960s	1970s	1980s	1990s	2007/8	20012
Alestes baremose	39	74	20	11	7	1	1
Lates spp.	24	13	24	17	18	9	2
Hydrocynus forskahlii	10	6	32	26	33	1	3
Tilapiines	7	2	13	25	20	2	2
Brycinus nurse					+	60	35
Neobola bredoi						20	44
Labeo horie	4	1	+	1	2	+	+
Distichodus niloticus	4	1	1	1	1	+	+
Clarias gariepinus	+	1	1	3	4	+	+
Protopterus aethiopicus	+	+	+	3	1	+	+
Mormyrids	+	+	1	1	+	+	+
Synodontis schall	4	1	1	2	3	+	+
Citharinus citharus	2	+					
Bagrus bajad	3	2	5	8	8	4	+
Auchenoglanis occidentalis		+	1	1	2	+	+
Barbus bynni	1	+	+	2	2	+	+

fisheries (22%), followed by *O. niloticus* (18%) and *B. bajad* (12%) and the light fishery was completely absent (Table 3). The overall landed annual value of these fish catches on Lake Albert and Albert Nile was estimated to be around 60 million USD (Table 3). The most valuable species on the lake were the large sized ones such as; *Lates spp* and *Bagrus spp* and *O. niloticus* compared to the fish taken by the light fishery (Table 3).

Changes in fish species composition and catch on Lake Albert (1950-2012)

Fish catches in Lake Albert declined over the last five decades from 20,600 t in 1978 to the lowest at 2,300 t in 1985 (Sentongo, 1992) but recently increased to more than five-fold, the maximum catch ever attained due to the light fishery (Figure 7). The number of exploited fish species has remained relatively constant but the proportion of each in the catch has changed over time (Table 3). Apart from the complete absence of *C. citharus,* the most recent surveys in 2007; 2008 and 2012 indicated that most species were still being caught but the fishery was now dominated by light fishery comprising of the small pelagic species; *B. nurse* and *N. bredoi* which together make up 80% of the catch (Table 3; Figure 7).

Discussion

The changes in fishing effort on Lake Albert and Albert Nile have not been well documented, the consistency and comparability of historical data are uncertain. The major concern being disparity in the methods of data collection prior to the improved and standardized protocols provided in LVFO 2007a and 2007b. Some of the earlier studies employed aerial surveys whilst others concentrated on physical counts, precision of the two approaches is by no doubt different. However, the results coming from such surveys are useful in providing indicative trends to guide formulation of management plans.

The *"Congo barque,"* remains a popular boat on the lake since its introduction in the 1950s (Cadwelladr and Stoneman, 1966) perhaps it is well suited to the rough weather conditions common on Lake Albert unlike of the Albert Nile where the Dugout boats were the most popular mainly due to cost and easy maneuverability in lotic environments. In addition, the dominance of dugout canoes on Albert Nile is an indication of less development in the fisheries of the system. Our results revealed changes from developed (such as Sese type and Congo burque) to the primitive boats (dugouts and paracutes) increased northwards along the river. The implication is that the fishery is less developed further north than at the lake river interphase.

The fishery was however, clearly, dominated by use of small sized mesh gill nets 63.5-88.9 mm and below i.e. less than 101.6 mm the legally acceptable mesh size for gill net fishery in Lake Albert and Albert Nile (the Fish (Fishing) Rules, 2010), which reflects absence of large fish in the stock. The use of such small mesh sized nets is not a new phenomenon on the lake. Cadwalladr and Stoneman (1966) noted that the proportion of the catch caught in nets with a mesh size <106.6 mm rose from 20% in 1954 to >80% from 1963-65 following an increase in the demand for small fish an indication that the larger sized fish species had already started becoming scarce (Worthington, 1929; Holden, 1963). However the notable decline in use of each/boat seines was not due to a positive response of the fishers to protection of

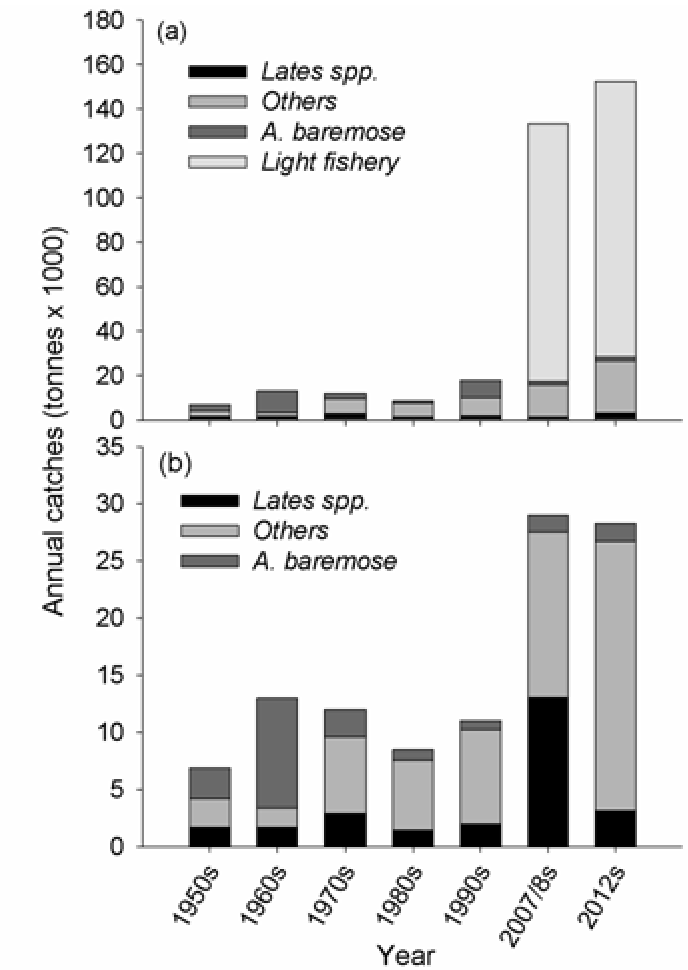

Figure 7. Estimates of total catch of (a) Nile perch, *Alestes baremose* and the light fishery (*Brycinus nurse* and *Neobola bredoi*), and (b) Nile perch, *Alestes baremose* and without the light fishery (*Brycinus nurse* and *Neobola bredoi*), with the rest being "others" in both, generated from (Tables 2 and 3).

Table 4. Changes in estimated annual fish catch and species/size composition of commercial catch for the 1970s and 2007/12 of Lake Albert

Period	Size structure of fish	Annual total catch (t)	Increase in fish catch
1970s	100% medium size to large species	<20,000	
2007/8	20% medium size to large species and 80% small sized fish	~145,000	7 times
2012	20% medium size to large species and 80% small sized fish	~150,000	Stable

Figure 8. Selected photographs of a few commercial fish species from Lake Albert and Albert Nile (2007-2012). ***PLATE 1Late niloticus*(Linnaeus, 1758) and *Lates macropthalmus* (Worthington, 1929) respectively; *PLATE 2Distichodus niloticus* (Hasselquist, 1762); *PLATE 3 Bagrus bajad* (Forsskål, 1775) and *Bagrus docmak* (Forsskål, 1775) respectively; *PLATE 4 Labeo horie* (Heckel, 1847); *PLATE 5 Hydrocynus forskahlii* (Cuvier, 1819); *PLATE 6* A catch of mainly Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) and a few African cat fish, *Clarias gariepinus* (Burchell, 1822); *PLATE 7* A catch of *Brycinus nurse* (Rüppell, 1832) and *Neobola bredoi* (Poll, 1945); PLA*TE 8* A catch of *Mormyrus spp.***

fisheries but rather than the concurrent lake wide enforcement patrols that were ongoing at the time of the survey.

The light fishery is a new development on the lake over the last decade and targets two small species *B. nurse* and *N. bredoi* but was completely absent on the Albert Nile. Despite the dominancy of the light fishery *B. nurse* and *N. bredoi,* their CPUE were highly variable. Often, the populations of small fish like these can fluctuate from year to year, depending on climatic and other factors as have been observed in lakes Kariba and Chivero in Zimbabwe (Songore, 2002). Such large changes over a short time result into challenges on sustainability of high productivity of these relatively new fisheries.

Worthington (1929) mentions that 17 fish species were caught in the lake with *C. citharus* being the dominant species, but by 1965 *C. citharus* had fallen to 11th position and *A. baremose* had become the most important fish species (Cadwalladr and Stoneman, 1966). The most important species now are *B. nurse* and *N. bredoi,* which are caught in the light fishery of small pelagic species. The collapse of the *C. citharus* stock, the decreased catches of other large fishes, and the emergence of fisheries based on small fish (*B. nurse* and *N. bredoi*) reflect the impact of the fishery.

Catch composition from a recent survey of (2012) showed that 16 species on Albert Nile recorded more that 1% by weight of the total catch compared to only 6% on the main lake. This could therefore suggest a decline in the multispecies nature of the lake as a result of dominance of the small pelagic species. There is however, continued multiplicity of species on the river compared to the main lake. The development of the fishery on the main lake has increased effort and in some cases introduced destructive fishing techniques such as beach seines, “sarasio” and small sized nets and hooks. Although the primitive nature of the canoes on the river still limit effort, introduction of beach seines and make shift fishing camps (comparable to *sarasio* on the main lake) noted in some places is likely to drive the fishery in the same direction as the main lake.

Are the fish resources of Lake Albert and Albert Nile overexploited?

The overall annual caches are currently approximately seven times those of the pre-1980 maximum (Table 4), although individual catch rates have declined because of increased population and number of fishing boats and most likely fishers have outstripped the increase in catch. In most fisheries, fishers perceive decrease in catch rates as overfishing but in fisheries science, overfishing refers to a situation whereby the same amount of or more fish could be taken by fishing less and usually applies to a particular species (Van Zalinge *et al.*, 1999*)*. Multi-species systems like Lake Albert cannot easily be exploited without loss of larger elements of the fish population, which are usually less abundant and reproduce slowly. As the fishing effort increases, the pressure on the large and medium sized fish species may be above that which provides maximum sustainable yield of these species, but the yield from other species and the total fisheries may be still increasing. Apart from the moon fish, *C. citharus* that appears to be extinct in Lake Albert is still present in Albert Nile. Species do not usually become extinct and the potential for fish productivity does not diminish as long as the natural habitats remain intact and in healthy states.

In the current review, the overall tonnage of fish is still increasing but a number of larger species are overfished while the smaller species are still abundant. However, a fluctuation in catch of the smaller species observed in Lake Albert between 2007 -2012 could be indicative of uncertainty of sustainability of their fisheries. Small species such as *N.bredoi* and *B. nurse* that have short regeneration/turnover time are more susceptible to environmentally driven stressors such as harvest, changes in water environment and climatic conditions. If the fishery of the system transforms itself into dependency on these small species under the continuously changing environment, its long time economic yield is in Jeopardy and needs concerted efforts for its management. Lake Albert supports important and highly productive fisheries about 150,000 t of fish per year, equivalent to about 25 t km^{-2} compared to Lake Victoria that produces about 1,000,000 t, which is equivalent to about 15 t km^{-2}. Although the biggest production of Lake Victoria is mainly from another small cyprinid *Rastrineobla argentea*, its contribution to annual catch is still about 50 - 60% compared to Lake Albert's > 80% contribution of the small pelagic species.

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Conclusions and recommendations

This paper gives an insight into the current status of the fisheries on Lake Albert suggesting the annual production is now comprising > 80% small pelagic species which earn lower market value. The contribution of the large sized and lucrative fisheries is lower than 20%. It is therefore, recommended that efforts aimed at managing the fisheries of the system incorporate post-harvest handling means to add value to the small fish products to increase their market value and efforts to reverse declining trend of large species.

It has been shown that whereas the river effort is still low and generally primitive, the proportion of the large fishes in the catch is still high and the multispecies nature (over 16 species commercially exploited) evident while the lake has only about 6 species. Increase and development in fishing gears and methods has continued to impact the Lake Albert fisheries. Reduction of fishing effort to the level of the 1980s could be a step towards rejuvenation of the stocks. Indiscriminate and more destructive gears such as beach/boat seines that already outlawed need to be monitored and completely eliminated from the fishery.

Some species, such as *C. citharus* are almost extinct in the main lake and *Polypterus senegalis* still available in the lake but most common in lagoons and the river suggesting their populations could be sustained under less fishing. In addition, efforts could be put in place to conserve genetic banks of these endangered species under aquaculture and aquarium setting.

The estimated production from Lake Albert is only from the Ugandan side that appear to be currently comprised by relatively small sized fish and have high regeneration or turnover rates and often highly dynamic and calls for reasonable investment in regular monitoring to provide adequate information to inform management decisions.

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