The status of the light fishery, distribution and selected population parameters of the main species of the fishery in Uganda

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Introduction

The light fishery in Uganda is mainly based on three fish species namely Mukene, *Rastrineobola argentea* from lake Victoria, Nabugabo, Kayanja, Kyoga main and a series of Kyoga small lakes e.g. Omuno, Gigati, Bisina, Nawamapasa, Meito, Nakuwa etc. (Sharpe et al., 2012); *Neobola bredoli* -Muziri and *Bycinus nurse*-Ragoogi/Ndolo from Lake Albert and Albert Nile (NaFIRRI, 2008). Despite the wide distribution of these small sized pelagic species in Uganda the fisheries are only developed in lakes Victoria, Kyoga main, Nabugabo and Albert/Albert Nile. In Lake Victoria the fishery started in early 80s on the Tanzanian part of the lake and in Uganda in late 80s, Lake Kyoga main in early 1990s and most recently on Lake Albert/Albert Nile while in most of the other Kyoga small lakes and Kayanja the fishery remains untapped.

This fishery is currently the dominant fishery under exploitation in most lake in Uganda (Lakes Albert, Victoria and Kyoga). In Lake Victoria Mukene has been on average comprising more than 40% of the catch in the last half decade

(Figure

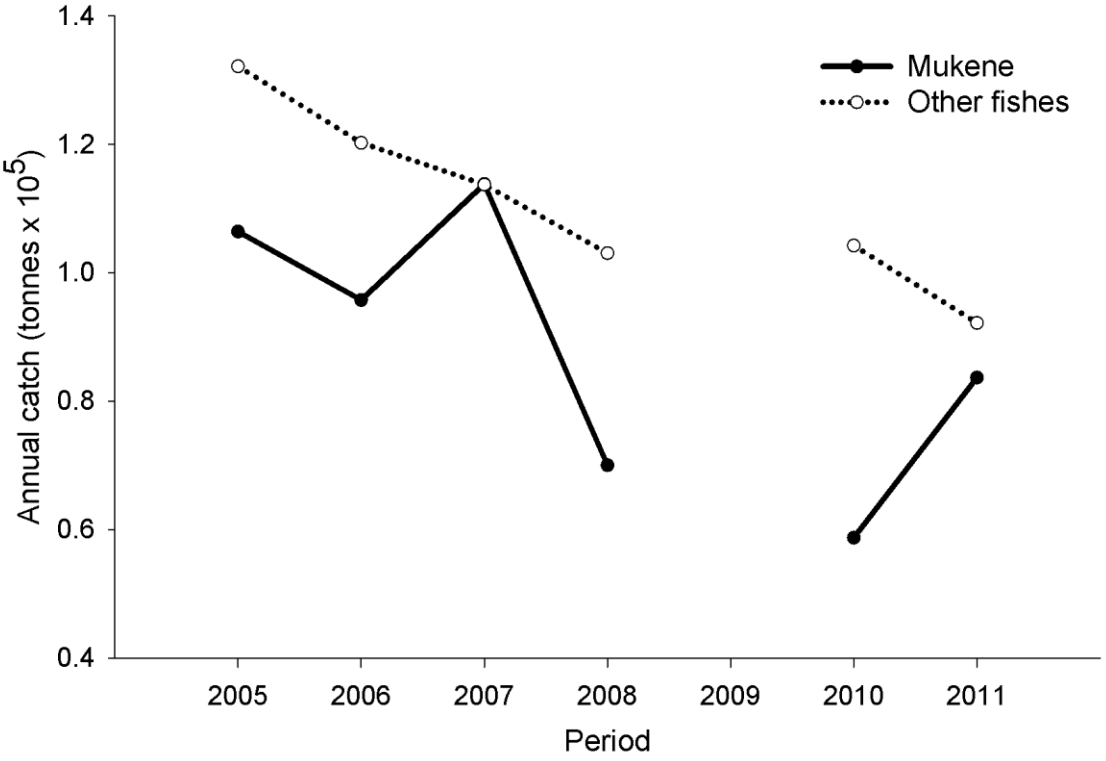


Figure 1. The trends in contribution of Mukene to the total catch with respect to other species in Lake Victoria between 2005 and 2011

In Lake Albert fish catches had declined over the last five decades, falling from 20,600 t in 1978 to the lowest at 2300 t in 1985 (Sentongo, 1992) however, NaFIRRI surveys of 2007/08 revealed an increase to about 160,000 t due to the light fishery dominated by the small pelagic species namely *B. nurse* and *N. bredoli* (Figure 2).

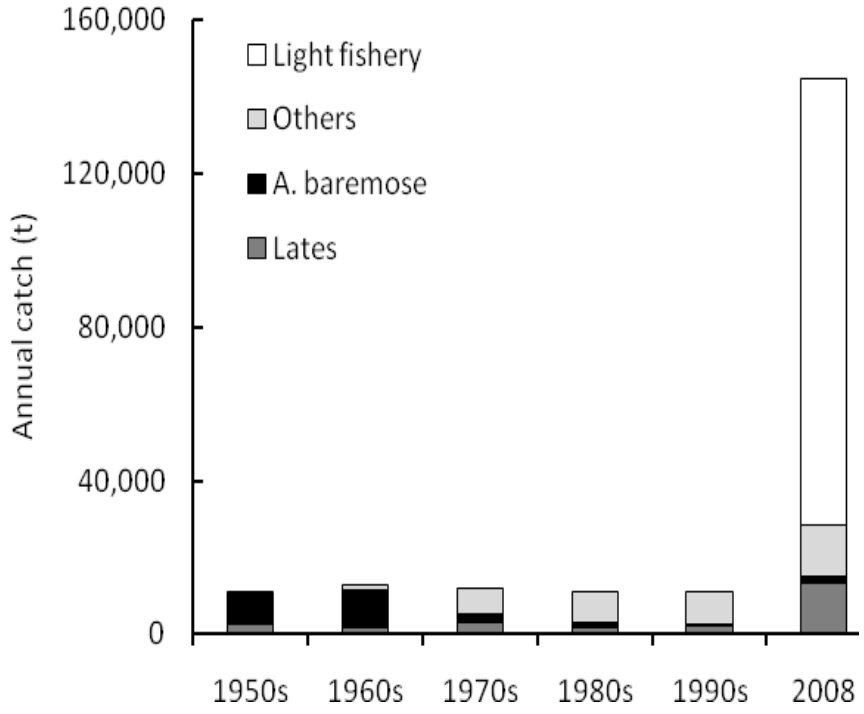


Figure 2. Estimates in trends in total catch of Nile perch, *Alestes baremose* and the light fishery (*Brycinus nurse* and *Neobola bredoli*), with the rest being "others" on Lake Albert (1950s to 2000s).

Apart from the complete absence of *Citharinus citharus the* most recent surveys in 2007 and 2008 in Lake Albert indicated that most species were still being caught but the fishery was now dominated by *Brycinus nurse* and *Neobola bredoli* which together make up 80% of the catch (Figure 2).

In lakes Kyoga and Kwania 0ut of the 2008/9 annual fish catch 0f 30889 and 6564 tonnes in 17% and 13% respectively comprised Mukene (NaFIRRI, 2009) despite the lakes shallowness and besides the unexploited stocks of the other small lakes in the basin (Sharpe *et al.*, 2012). The relative abundant highly valuable Tilapia catches could also explain the small contribution of Mukene to the total catch.

Due to the continuous decline in the highly valuable large sized fish species e.g. Nile perch, Nile tilapia, *Bagrus spp*, *Barbus spp*, *Citharinus citharus*, *Alestes spp* and *Hydrocynuss spp* against the increasing small sized pelagic fisheries e.g. contribution of Mukene and its associated standing stocks of over 600tonns in Uganda water of Lake Victoria and over 80% *B. nurse* and *N, bredoi* contribution to the total catch of Lake Albert. With financial support from the United Nations, Food and Agricultural Organization (FAO), Rome, the Department of Fisheries Resources (DFR) has embarked on sensitizing and assisting fisher folks to adopt

the most efficient gear e.g. the catamaran technology to exploit the emerging fisheries in Ugandan lakes. Most fishermen in Uganda use inefficient fishing crafts and methods to exploit the fishery and only harvest < 20% of the lake's fisheries producing less than 200 tons worth 25 b Uganda shillings. The common current harvesting methods concentrate around in shore breeding. Nursery grounds resulting in capture of keystone species juveniles in the bycatch of those who are fishing the fishes using single boats. The catamaran lift net technology is known to have been effective in harvesting such fishery on the Tanzanian part of Lake Victoria and if adopted could be tested and adopted for the Ugandan situation for improving and development of the light fishery as a hole. This review also looks at some of the results from the described trials.

The Catamaran method can be used and operated in deep offshore waters and even on rough conditions of the lake. This unit consists of two canoes joined into a plat form, one outboard engine, and a lift net (8 and 10 mm), up to five pressure lamps and it is operated by a minimum of 5 fishers.

With this method it is hoped that up to a tone of Mukene can be fished per fishing night. Now that the small pelagic fishery is commercially important and their fisheries are fast expanding in Ugandan lakes, it has become urgent to provide information on the fisheries to guide management in theses important fisheries. Preliminary information and observations from commercial catches show many juveniles of both Nile perch and Nile tilapia as by catch therefore fisher men are encouraged to operate in more open offshore waters, this can be possible with the catamaran technology of fishing. This small pelagic fish species of the great lakes region though known had not attracted much attention as being part of economic importance. The earliest known such fishery being clupeid fishery of Lake Tanganyika (Wandera, 1990). It is really after the decline in catches of the preferred keystone species that the potential of pelagic fisheries as useful resources has been realized. This fish is also known to be playing an important role in the energy flow since they form a main link in the trophic chain.

This paper examines the status of the light fishery, distribution and selected population parameters with a view of identifying the most appropriate harvesting gear for immense emerging fisheries in Ugandan lakes adding a catamaran lift net technology to our already existing ones to guide sustainable harvesting of these fisheries.

Approach, scope and Methodology

The study was mainly based on extensive desk reviews for on the existing light fishery based mainly on the single boats and lampara nets that is commonly deployed in capturing pelagic fish species in the major water bodies in Uganda and the experimental catamaran lift net technology of Mukene fishing done at

Kiyindi landing site on the North-Western shores on Lake Victoria, Buikwe District between January and March 2011, where monthly samples were taken. Experimental fishing was done using lift nets of 8mm and 10mm inches mainly set in the open waters to obtain ecological and biological information on the species. These boats were operated from Kiyindi landing site and on each sampling trip a sample of the catch was obtained from the boats, preserved in 5% formaldehyde solution and appropriately labeled for later laboratory analysis at NaFIRRI.

Laboratory procedure and data analysis

In the laboratory samples were soaked in water to remove excess formaldehyde, sorted to species level where possible. The weight and standard length (SL) measured to the nearest 0.1 grams and 0.1 mm respectively. (FL). Specimens were measure and allocated to different length categories/groups from which individual fish were counted and weighed forming a pattern of length frequencies. Bye-catch fish species were sorted out, identified, their lengths, numbers and total weights were taken. A minimum of 10 specimens were randomly selected from each length group and dissected for biometric analyses. The fish were cut open to determine the sex and gonad maturity stages. Gonad maturity stages for both males and females were determined using Kesteven's gonad maturity index as modified in Witte and Van Densen (1995). The population structure was determined from length frequency distribution according to Peter (1987). The size at first maturity was defined as the size at which 50% males and females become mature (L_{50}) and was estimated using specimens which were gonadal stage IV and above. The percentage mature by length class and sex were fitted to algorithm function using the Newton algorithm from ® Microsoft Excel Solver routine.

$$P(l) = 1/1+e^{-(a + b\,l)}$$

Where P (l) is the proportion of mature fish at length l, and a and b the parameters of the logistic equation (e.g. Piñeiro & Saínza, 2003; Fontoura *et al.*, 2010). However the L_{50} of females was used for comparative analyses because earlier studies were mainly based on females.

Results and discussion

Temporal variation

Length at 50% Maturity (L_{50})

This parameter was only possible for Lake Victoria because that is where time series data existed and indicated that the length at 50% maturity of female *R.*

argentea in Lake Victoria relatively steady at approximately 46 mm SL from 1966 until the 1990s when it slightly declined to about 45bmm SL with the boom of the introduced Nile perch. The rate of decline in L_{50} accelerated even further between 2000 and 2010 from 44 to about 36 coinciding with intensification of the *R. argentea* fishery in the Ugandan waters of Lake Victoria. Overall, the length at maturity of *female R. argentea* has declined by about 16% in the past 44 years (Sharpe *et al.*, 2012). Previously published values for L_{50} of *R. argentea* from the Northern waters of Lake Victoria also decline from 43 to 44 mm SL in 1988
(Wandera 1992), to 42 mm SL in 1996–97 (Wandera 1999), 41 mm in 2001–2002 (Taabu 2004), to 40 mm SL in 2004–2005 (NaFIRRI, 2005), 37 mm SL in 2010 (Sharpe *et al.,* 2012). The 2011 estimates from the catamaran lift net technology are the same to the 2010 value from the 5 mm mesh size of about 37 mm SL for females in the 8 and 10 mm mesh sizes deployed, indicating some stability of the stocks. These series of studies are consistent with early trends constitute an important factor on deciding the appropriate harvesting gear for the emerging pelagic small fish species in Uganda.

Reproductive trait

Table. 1 Mean size-adjusted trait values for *Rastrineobola argentea* from Lake Victoria at the beginning (Z_0) and end (Z_1) of the time-series along with % change (1966-2008-10) adopted from (Sharpe *et al.*, 2012).

Trait	Time period	Z_0	Z_1	% Change
L_{50} overall	1966 to 2008–10	46.54	39.07	-6-05
L_{50} fishing	1991 to 2008–10	46.90	39.07	-16.70
Relative fecundity	1966 to 2008–10	590	837	+41.91
Egg volume mm^3	1966 to 2008–10	0.046	0.078	+68.11
Clutch volume mm^3	1966 to 2008–10	26.05	51.42	+97.39
Ovary weight mg	1966 to 2008–10	74.44	100.48	+34.99

All egg traits (egg volume, clutch volume and ovary weight) in Napoleon Gulf of lake Victoria showed indications of increase between 1966 to 2008-10, but the increase in fecundity was only up observed after the Nile perch boom in 1992 followed by no additional increase after almost two decades of commercial fishing, in either Lake Victoria or Lake Kyoga.

Spatial Variations

Length at 50% Maturity (L_{50})

Length at 50% maturity was lowest in lakes with Nile perch only, whereas in the temporal analysis, L_{50} was lowest in years with Nile perch and fishing. The greatest increase in fecundity was observed in lakes with Nile perch and fishing, whereas in the temporal analysis, the greatest increase in fecundity was observed after the Nile perch introduction (1992) and there was no additional increase in fecundity after almost two decades of commercial fishing, in either Lake Victoria or Lake Kyoga. Overall, introduced Nile perch and fishing tended to be associated with a range of life history responses in *R. argentea*, including decreased body size, maturation at smaller sizes, and increased reproductive effort (larger eggs; and higher relative fecundity, clutch volume, and ovary weight). Probably adaptation responses that enable *R. argentea* survive in a stressiful environments characterized by both predation and intensive fishing. An understanding of related information will go a long way in developing appropriate policy that will guide sustainable harvesting technology for the emerging fisheries in Uganda.

Table 2 Length at 50% maturity(mm SL) of *R. argentea* in lakes that are at different levels of perturbation in the Victoria and Kyoga basin lakes 2008-2010. Estimates derived from (Sharpe et al., 2012)

Lakes	No Nile perch with little or no fishing	Nile perch only	Nile perch and commercial fishing
Omuno	46	-	-
Gigati	44	-	-
Nawampasa	-	37	-
Bisina	-	30	-
Meito	-	36	-
Nabugabo	-	38	-
Kyoga	-	-	42
Victoria	-	-	39

In Lake Albert in *Brycinus nurse* **the length** at 50% maturity was 60 mm Forkal length FL. A high proportion (77%) all specimens examined in breeding condition and ripe males and females were recorded throughout the year with no noticeable breeding peaks. The highest proportion of breeding individuals was recorded from sandy shores and river mouths while most immature fish were found on sandy shores (NaFIRRI, 2007). In *Neobola bredoi* a species related to *R. argentea* in lakes Victoria and Kyoga matured at relatively smaller of L_{50} 29 mm SL (Namboozo, 2008) compared to similar systems of Lake Kyoga and Victoria (L_{50} 42 and 39 mm SL respectively with similar impacts of Nile perch and commercial fisheries. The main by catch in this fishery were B. nurse and *Barilius niloticus* which are part of the fishery. Te other larger sized fish species (Nile perch and *Alestes baremose*) captured comprised <0.1%.

Size structure of *R. argentea* from the 8 and 10 mm catamaran lift net in open waters of Lake Victoria (January –March 2011)

Based on 3,902 specimens obtained from the sampling with 2,434 from the 8mm net and 1,468 from the 10mm net the population structure of mukene showed a normal distribution in both mesh sizes with 10mm having slightly larger individuals mean SL 36.4 mm SL compared to the 8mm net individuals 34.5mm SL. However in both mesh size the sizes were slightly below the length at 50% maturity at 37 mm SL. (Figure3).

This normal distribution indicates that the population of *R. argentea* is stable (Mathew, 1998). From this graph (Figure 3) the larger specimens in the 10mm and could be attributed to the fact that the larger nets could be allowing the bulk of juveniles of Mukene to escape capture.

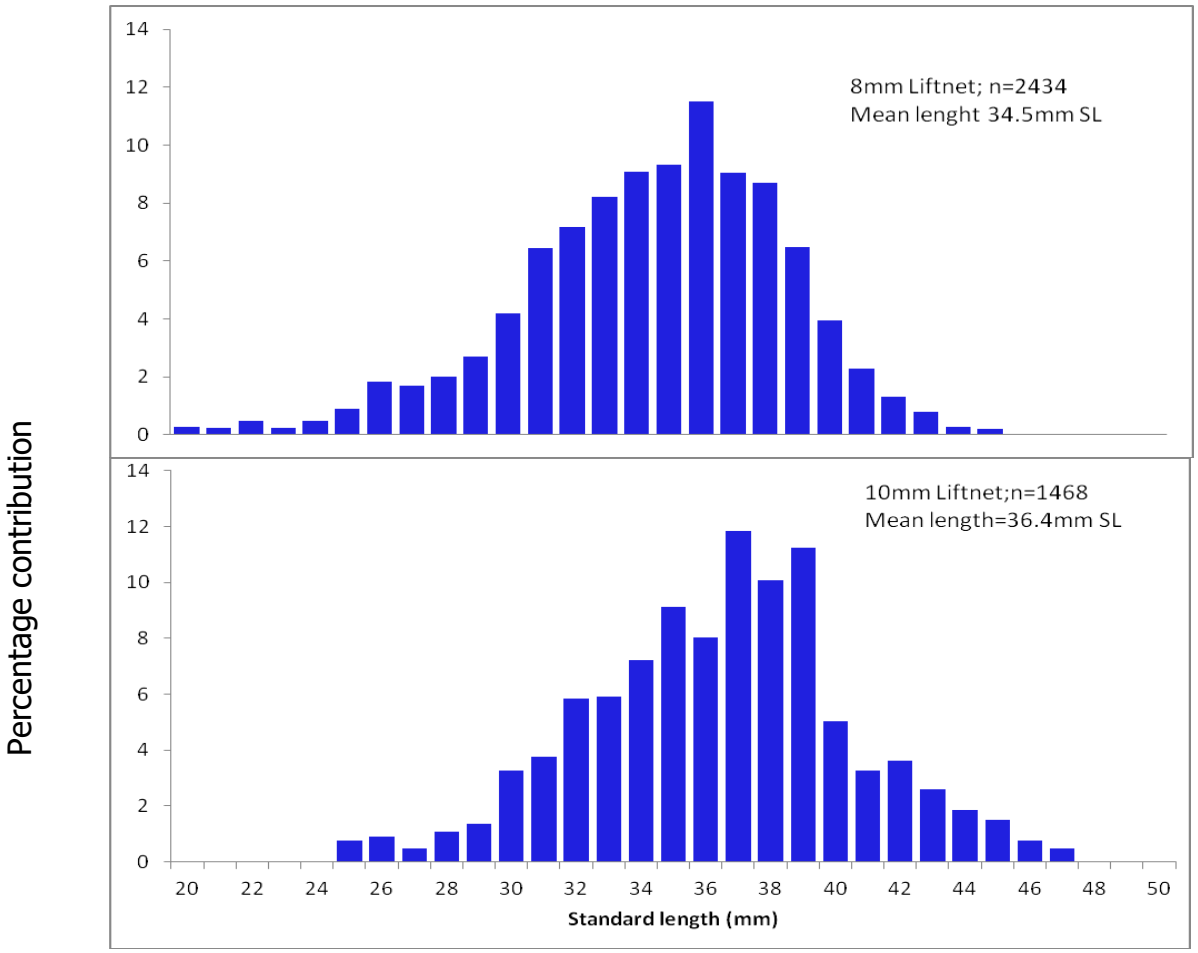


Figure 3: Length frequency distribution of *Rasterineobola argentea* from the experimental lifts nets of 8 and 19 mm mesh sizes (January –March 2011).

By catch composition

A total of 685 individual were caught as bycatch. These comprised of mainly haplochromines, Nile perch juvenile and Caridina. The contribution varied between the two nets, there were 420 and 265 individuals obtained in 8mm net and 10mm nets respectively.

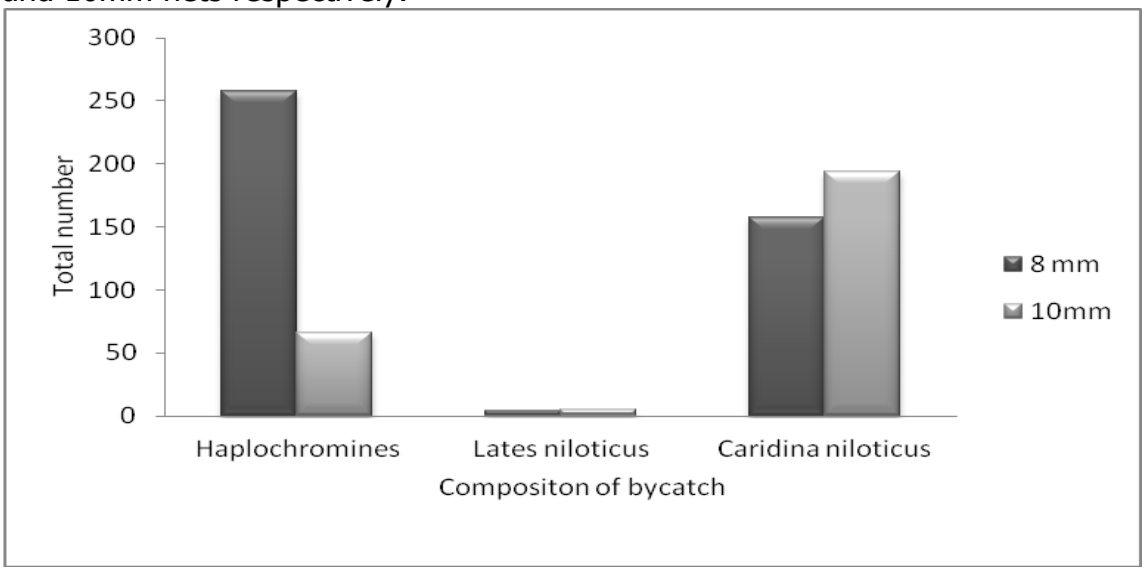


Figure 4: Bycatch composition from the experimental surveys.

From all the bycatch there were so many haplochromines in the 8mm lift net followed by *Caridina nilotica* and the juvenile Nile perch were least caught. This means that these nets operated in far way from breeding and nursery grounds for fish. Despite the fact that the 8mm net caught many bycatch there were few juveniles of fish since they comprised mainly the freshwater prawns and haplochromines (Nkejjes).

Conclusion and recommendation

At present most of the light fishery is restricted to the inshore areas due to the small sized vessels with low stability. The review shows that the most important factor to consider in the light fishery may not necessarily be the mesh sizes but rather the distance from the shore and this directly supports the catamaran lift net technology that is operated and difficult to use in resolving the associated uncertainties about the species in this fishery especially the balance between the predatory demands of the predatory species like the Nile perch and fishing. There is therefore need for targeted studies to monitor the impacts of the fisheries as it develops to guide policy development and sustainable harvesting of the fisheries in the light fishery.

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