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Fish species diversity and relative abundance in Lake Albert—Uganda

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*Lake Albert is located towards the tip of the western arm of the African Great Rift Valley, between Uganda and the Democratic Republic of Congo. Despite the presence of several predatory fishes, including the Nile perch (*Lates niloticus*), Lake Albert supports the most diverse commercial fisheries in Uganda with at least 55 species that vary markedly in size. The lake contributes at least 30% of the national fish production. Increased human activity around and within Lake Albert, especially oil and gas exploration, may pose threats to the well being of the lake, its diverse fish communities and its fishery. During 2007, fishery surveys were undertaken using gill-nets and seines in the Uganda part of the lake to identify existing fish species and their critical habitats and provide management recommendations for sustaining the fisheries. Six main habitat types for fishes were identified: shallow river-associated waters; open sandy shorelines; lagoons; large bays; rocky escarpments; and, open-water habitats. Together, these habitats harboured 40 fish species belonging to 12 families. Lagoons, large bays and rocky shores had higher numbers of fish species. Some species rare in most parts of the lake were recovered from the rocky habitats. The shoreline waters contained mostly juvenile fishes. These habitats were considered as natural refugia to fishes in the lake and effort should be made to protect them in order to sustain species diversity in the lake.*

Keywords: fish species composition, habitats, threats to diversity

Introduction

Lake Albert has a surface area of 5,500 km^2 and is located towards the tip of the western arm of the African Great Rift Valley. The lake is shared between Uganda (54%) and the Democratic Republic of Congo (46%). It is the third most productive lake in Uganda contributing about 180,000 tonnes per annum (30%) to national fish production. Despite the presence of several predatory fishes notably the Nile perch (*Lates niloticus and Lates macrophthalmus*), Lake Albert supports the most diverse commercial fisheries in Uganda. The lake is also the original source of the Nile perch and the Nile tilapia (*Oreochromis niloticus)*, the two species responsible for a booming fishery in the country's other lakes (Lake Victoria and Lake Kyoga), where they were introduced.

Increased human activities around Lake Albert have led to changes in the water quality that may influence the biota including fishes (NaFIRRI Report, 2007). For example, demand for fishes has led to introduction of more efficient fishing gears and methods that may be harmful to the fishery. Activities related to the recent discovery of oil in the Lake Albert basin are a potential threat to the well being of the lake, its diverse fish communities and its fishery (Hecky, 2007).

In the 1960s, Lake Albert contained at least 53 species, of which 17 were exploited commercially

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(Rene and Daniel, 1992). By the 1990s, the number of recorded species had dropped to 33 with 14 species being of commercial importance (Ssentongo, 1992). While many of the species may still occur in the lake, over-fishing and destruction of fish habitat could be taking their toll on stocks of these fishes. Already, some fish species such as the moonfish (*Citharinus citharus)* and a butterfish (*Eumopius niloticus)* are no longer recorded by the artisanal fishery. Between January, 2007 and February, 2008, several fishery surveys were undertaken in the Uganda part of the lake. The objectives of these surveys were to document existing fish species, determine their relative abundance, and establish habitats critical to their survival in order to provide options for sustainable management of the fisheries. Specifically, we sought to generate a checklist of fish species commonly encountered in the lake, determine distribution and relative abundance and assess their current catch rates.

Material and methods

Study area and Habitats

Worthington (1929) recognized three ecological habitats based on lake depth, as controlling the distribution of fish species on Lake Albert. These were:

- The deep water zones of more than 20 m depth,
- The intermediate waters (7 to 20 m), and,
- The shallow waters (<7 m) that included lagoons.

Holden (1963) however identified four zones based on ecological and physical characters of the lake. The zones were identified as:

- The Victoria Nile delta area up to the Murchison Falls;
- The shallow open lake influenced by the River Nile at the north eastern tip of the lake and by Semliki, Muzizi and Wassa Rivers at the southern end;

The lagoon areas comprising large lagoons at Butiaba, Tonya, Kaiso and Buhuka plus the smaller ones in the area of Bugoigo and Kaboolwa; and, the deep open lake waters.

Based on the two classifications above, the current survey identified six main habitats that influence the distribution of fish species in the lake and these were:

- River mouths: These are waters influenced by incoming rivers and included waters at the deltas of the Victoria Nile and Semliki rivers and at mouths of several rivers that empty into the lake such as River Waaki, R. Wambabya, R. Nkussi, and R. Muzizi;
- Lagoons: Closed or semi-closed lagoon occur at few places and are normally associated with sand spits at Butiaba, Tonya, Kaiso and Buhuka (Worthington 1929);
- Large Bays: These occur on the lee side of the spits that form lagoons. They are large bays, normally of calm waters supporting beds of aquatic submerged macrophytes. The shoreline may be sandy or marshy;
- Open sandy shores: The greater percentage of the lake's shoreline consists of the open sandy shore habitat. It is at this habitat that that beach seining, a common but illegal fishing method is carried out by the artisanal fishers;
- Rocky escarpments: These occur mostly in the D.R. Congo but on the Ugandan side, stretches are found between Kibiro and Hoimo and between Sebagoro and Songa; and,
- Deep open waters: These are deep open waters of more than 20 m depth. They cover the largest portion of the lake and are mostly exposed to rough weather common on the lake.

Experimental fishing was carried out at 16 stations shown in Figure 1, and whose habitat types are indicated in Table 1. At each inshore station, three sets of graded multifilament gillnets of mesh sizes 1 to 8 inches were used. While the very small meshed nets (1 to $1^1/_2$ inch) were 90 m long and 52 meshes deep, the rest of the nets were of standard dimension (90 m long and 26 meshes deep). All nets were mounted at 50% hanging ratio. In each set, the smaller nets of (1 to 5.5 inch) were graded at half-inch intervals while the larger meshed nets (6 to 8 inch) were at intervals of one-inch. The first set of nets was set within 50 m from the shoreline. The second and third sets were set 500 m and 1000 m, respectively, from the shoreline. The offshore nets were set at least three kilometers from the shoreline. These nets were set in the evening and retrieved the following morning.

An 8 mm mesh beach seine net measuring 14 m by 4 m was used in places suitable for seining, such as sandy shorelines, near rocks and close to river mouths. Fish specimens were identified to species using Greenwood (1966) and Greenwood (1981).

Table 1. Composition and relative abundance (% numbers) of fish species caught from various habitats in Lake Albert 2007.

Family	Species	Lagoon	River mouth	Large Bay	Open sandy shore	Rocky	Open water	Grand Total
Bagridae	*Auchenoglanis occidentalis*	0.06	0.06	0.01	0.09	0.02	0.00	0.25
	Bagrus bayad	0.16	0.19	0.28	0.59	0.23	0.04	1.47
	Bagrus docmak	0.00	0.00	0.00	0.00	0.05	0.01	0.05
Centropomidae	*Lates macrophthalmus*	0.00	0.22	0.85	0.44	0.71	1.49	3.71
	Lates niloticus	2.39	0.74	0.86	1.65	1.59	0.31	7.55
Characidae	*Alestes baremose*	0.22	0.50	0.26	0.67	0.51	0.08	2.23
	Alestes macrolepidotus	0.00	0.01	0.03	0.00	0.03	0.00	0.07
	Brycinus nurse	10.13	8.61	9.83	5.68	4.36	3.11	41.73
	Hydrocynus forskahlii	0.98	1.64	2.91	2.82	1.05	1.05	10.44
Cichlidae	*Neochromis "nigricans"*	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	Neochromis "zebra"	0.00	0.00	0.00	0.00	0.02	0.00	0.02
	Oreochromis leucostictus	2.00	0.03	0.04	0.00	0.65	0.00	2.72
	Oreochromis niloticus	1.40	0.29	0.12	0.12	0.02	0.04	2.00
	Sarotherodon galilaeus	0.49	0.01	0.03	0.07	0.00	0.00	0.60
	Thoracochromis avium	0.00	0.00	0.00	0.02	0.04	0.01	0.07
	Thoracochromis loati	0.00	0.04	0.01	0.05	0.01	0.00	0.11
	Thoracochromis mahagiensis	0.00	0.06	0.04	0.13	0.03	0.07	0.33
	Thoracochromis wingatii	0.00	0.01	0.18	1.61	0.19	0.06	2.05
	Tilapia zillii	1.73	0.24	0.61	0.76	0.70	0.03	4.08
Citharinidae	*Distichodus niloticus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clariidae	*Clarias gariepinus*	0.50	0.16	0.01	0.04	0.00	0.00	0.71
	Clarias liocephalus	0.04	0.00	0.00	0.00	0.00	0.00	0.04
Cyprinidae	*Barbus bynni*	0.00	0.33	0.05	0.12	0.08	0.04	0.62
	Barbus perince	2.52	1.97	0.05	0.02	0.00	0.01	4.58
	Barilius niloticus	0.00	0.19	0.03	0.02	0.00	0.00	0.24
	Labeo coubie	0.00	0.00	0.00	0.00	0.02	0.00	0.02
	Labeo horie	0.00	0.05	0.00	0.26	0.20	0.01	0.52
	Neobola bredoi	0.00	0.00	0.02	0.33	0.00	0.00	0.35
Lepidosirenidae	*Protopterus aethiopicus*	0.09	0.00	0.01	0.00	0.00	0.00	0.11
Mochockidae	*Synodontis frontosus*	0.00	1.93	0.00	0.00	0.00	0.00	1.93
	Synodontis schall	0.04	0.28	0.24	0.55	0.25	0.12	1.48
Mormyridae	*Gnathonemus cyprinoides*	0.09	0.50	0.00	0.00	0.00	0.00	0.59
	Hyperopisus bebe	0.00	0.01	0.00	0.00	0.00	0.00	0.01
	Marcusenius nigricans	0.00	0.25	0.00	0.00	0.00	0.00	0.25
	Marcusenius petherici	0.00	0.05	0.00	0.00	0.00	0.00	0.05
	Mormyropsis anguilloides	0.00	0.02	0.00	0.00	0.00	0.00	0.02
	Mormyrus caschive	0.00	0.08	0.00	0.00	0.00	0.00	0.08
	Mormyrus niloticus	0.00	0.01	0.00	0.00	0.00	0.00	0.01
Polypteridae	*Polypterus senegalus*	2.62	0.34	1.09	0.38	1.01	0.00	5.44
Schilbeidae	*Schilbe intermedius*	0.04	3.25	0.13	0.00	0.04	0.05	3.50
	Total	**25.50**	**22.05**	**17.69**	**16.44**	**11.79**	**6.53**	**100**
	No of Species	**18**	**33**	**24**	**22**	**24**	**18**	**40**
	Sample size	**660**	**2010**	**832**	**763**	**4340**	**876**	**9481**

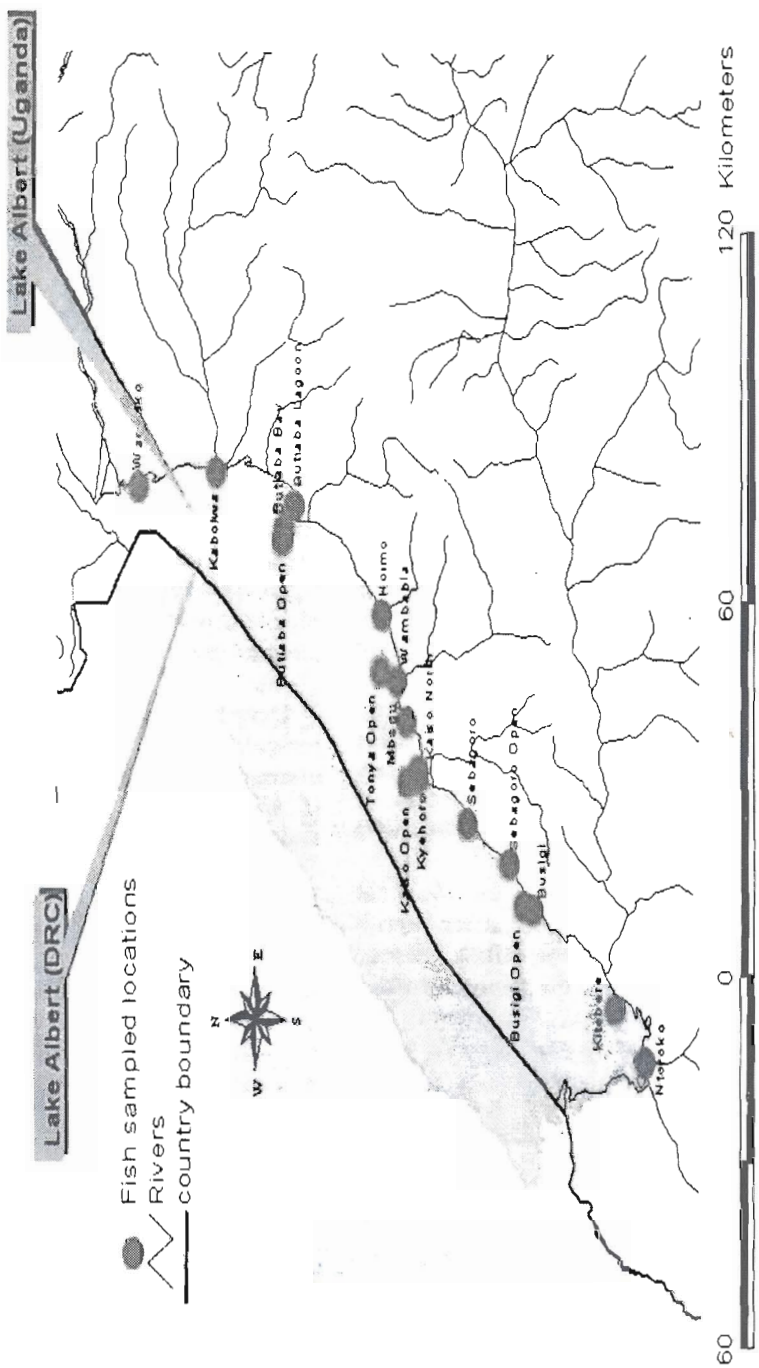

Figure 1. Stations sampled on Lake Albert during the survey 2007.

For each species, the number, total weight (g) and individual lengths (cm) were recorded. Fork length (FL) was measured for all species with forked caudal fins while Total Length (TL) was used for fishes with entire caudal fins.

Results

Fish species composition and distribution

A total of 40 fish species belonging to 26 genera in 12 families were recorded during the surveys (Table 2). The river mouth contributed the highest number of species (33) while the open water and lagoons contributed least species (18 each). By numbers, lagoons yielded most fishes (25.5% of all fishes caught) while the open water habitat yielded fewest fishes (6.53%). A small pelagic characid, locally known as Ragoge (*Brycinus nurse)*, was the most abundant fish species. Other species of numerical importance included the tiger fish Ngassa (*Hydrocynus forskahliii)*, the Nile perch and the bichir (*Polypterus senegalus)*.

By weight the lagoons still contributed the highest biomass (31.77%) while the open waters again yielded the least (7.18%). The tiger fish, Nile perch, B. nurse and the bichir yielded highest biomass, contributing 14.63, 13.61, 12.06 and 10.39 percent of the total catch, respectively.

Habitat-restricted fish species included the moonfish (*Distichodus niloticus)* and all mormyrids confined to the river mouths, the catfish (*Clarias liocephalus)* to lagoons, and the haplochromines (*Neochromis "nigricans"* and, *Neochromis "zebra"),* and a cyprinid (*Labeo coubie)* to the rocky habitat.

Catch rates

Catch rates (number/weight of fish per net per night) by gillnets were calculated based on total number of nets used at a particular habitat. Fish species were categorized as:

- Small (S): Fishes that grow to small adult size – Caught in nets up to $2^1/_2$" stretched mesh;
- Medium (M): Fishes growing to medium sized adults – Caught in nets up to $4^1/_2$"; and,
- Large (L): Fishes growing to large adult sizes – Caught by all nets deployed.

Catch rates were highest in lagoons and lowest in open sandy shores (Figure 2). Lagoons, large bays and river mouths yielded higher catch rates than rocky, open sandy and open water habitats. Trends in catch rates of fish species were similar to those in catch composition above (Table 3).

Discussion

Fish species composition

Fifty-five fish species (including the two new species recorded in this survey) have so far been recorded on Lake Albert, (Worthington 1929, Greenwood 1966, Greenwood 1981, Rene and Daniel 1992). While some fish species (e.g. *Citharinus citharus*) are almost extinct in the lake, a number of species among those not encountered during the survey are likely to be present but were simply not caught either as a result of inadequate sampling of their habitats or use of inappropriate gear (Table 3).

Despite the high number of fish species still present in the lake, the biomass especially of commercially important species such as the Nile perch (*L. niloticus* and *L. macrophthalmus)*, the tiger fish and Angara (*Alestes baremose)* is now quite low. The fish community of Lake Albert is dominated by predatory fish species such as *Lates*, *Hydrocynus* and *Bagrus*. The prey species mainly Ragoge (*Brycinus nurse),* Muziri *(Neobola bredoi)* and the haplochromines, therefore, need habitats that protect them from these predators. River mouths, lagoons and large bays harbour marginal vegetation in which prey species, especially the haplochromines, hide and breed. Likewise, the crevices and nooks in rocky habitats provide perfect refugia for these fishes as has been observed on Lake Victoria (Seehausen, 1996).

Overall, mean catch rates of 10 fishes or 773 g per net per night observed (Table 3) are quite low. Worthington (1929) records catch rates of 27 (equivalent to 5.2 kg) of *H. forskahlii* per net. This has fallen to as low as 2.8 fishes (196 g) during the current surveys. The increased fishing effort on this lake as a result of higher demand for fishes may be responsible for this decline in fish biomass (NaFIRRI Report, 2007).

Table 2. Catch rates (weight (g) per net per night) of fish caught by experimental gillnets in the different habitats of Lake Albert in 2007.

Family	Species	Category	Lagoon	River mouth	Large Bay	Open sandy shore	Rocky	Open water	Total
Bagridae	*Auchenoglanis occidentalis*	C	11.1	24.6	4.9	39.9	32.5		17.5
	Bagrus bayad	C	153.1	90.8	59.3	154.4	44.5	12.8	71.3
	Bagrus docmak	C					8.3	33.6	7.7
Centropomidae	*Lates macrophthalmus*	C		37.5	178.7	62.5	156.1	272.3	127.3
	Lates niloticus	C	852.6	146.4	135.0	342.2	255.5	32.2	184.3
Characidae	*Alestes baremose*	B	13.4	117.4	44.8	204.8	94.5	65.2	92.8
	Alestes macrolepidotus	B		8.4	21.6		63.7	18.1	18.3
	Brycinus nurse	A	390.0	224.9	404.0	291.2	179.7	73.5	239.6
	Hydrocynus forskahlii	B	83.7	223.3	391.6	640.1	304.2	252.7	297.9
Cichlidae	*Neochromis "nigricans"*	A					1.0		0.1
	Neochromis "zebra"	A				0.4			0.04
	Oreochromis leucostictus	B	259.6	2.2	3.6		38.9		17.2
	Oreochromis niloticus	C	336.5	127.0	36.5	32.3	4.5	22.0	74.7
	Sarotherodon galilaeus	B	76.4	2.3	2.4	8.5			5.3
	Thoracochromis avium	A				5.3	2.2	0.6	0.9
	Thoracochromis loati	A		0.8	0.4	2.3	0.4		0.6
	Thoracochromis mahagiensis	A		1.3	1.1	4.3	1.1	2.3	1.6
	Thoracochromis wingatii	A		0.2	6.7	59.4	7.2	0.8	8.2
	Tilapia zillii	B	215.7	21.8	95.1	99.0	76.5	2.2	52.7
Citharinidae	*Distichodus niloticus*	C		76.7					26.7

(Continued on next page)

Table 2. Catch rates (weight (g) per net per night) of fish caught by experimental gillnets in the different habitats of Lake Albert in 2007 *(Continued)*.

Family	Species	Category	Lagoon	River mouth	Large Bay	Open sandy shore	Rocky	Open water	Total
Clariidae	*Clarias gariepinus*	C	627.7	104.1	24.3	185.7			85.4
	Clarias liocephalus	A	1.8						0.1
Cyprinidae	*Barbus bynni*	B		215.6	13.8	8.3	54.9	20.9	93.3
	Barbus perince	A	61.0	45.2	1.1	0.4		0.2	18.1
	Barilius niloticus	A		0.4	0.1	0.1			0.2
	Labeo coubie	B					4.1		0.5
	Labeo horie	B		28.2		111.8	44.0	5.9	25.6
	Neobola bredoi	A			0.0	0.3			0.04
Lepidosirenidae	*Protopterus aethiopicus*	C	434.7	10.0	19.2				27.5
Mochockidae	*Synodontis frontosus*	A		109.2					36.5
	Synodontis schall	B	8.0	35.0	54.5	74.4	71.3	95.2	57.1
Mormyridae	*Gnathonemus cyprinoides*	B	14.4	50.0					19.0
	Hyperopisus bebe	B		1.6					0.6
	Marcusenius nigricans	A		2.8					0.9
	Marcusenius petherici	B		3.3					1.2
	Mormyropsis anguilloides	B		3.0					1.1
	Mormyrus caschive	B		18.4					6.8
	Mormyrus niloticus	B		4.0					1.5
Polypteridae	*Polypterus senegalus*	B	573.7	77.9	308.8	140.3	245.1		151.8
Schilbeidae	*Schilbe intermedius*	A	3.0	115.4	12.8		4.2	19.7	45.6
	Total		**1873**	**916**	**1216**	**374**	**577**	**416**	**734**

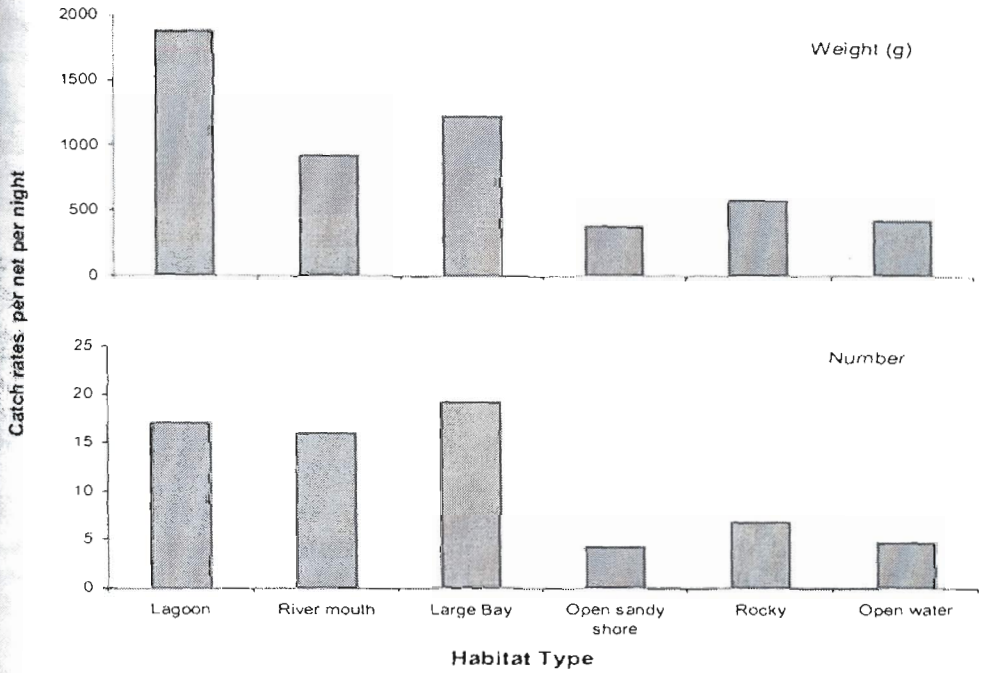

Figure 2. Catch rates of fish species in experimental nets set in different habitats of Lake Albert in the year 2007

Threats to fish abundance and diversity

Over exploitation

With increased demand for fishes in the region (NaFIRRI Report 2007), more effort is being exerted to the fishery to satisfy this demand. Catch studies indicate that the number of fishing units (canoes) on the Ugandan waters of the lake has increased from 764 in 1965, to 1479 in 1988 to 5700 in 2007 (Hecky, 2007; NaFIRRI Report, 2007). In an effort to catch as much of the little remaining fish as possible, a fishing method (locally known

Table 3. Fish species not encountered on Lake Albert during the 2007 survey.

Family	Species	Possible reason for not being caught
Characidae	*Hydrocynus vittatus*	Rare on the lake
	Alestes dentex	Extremely rare on the lake
Cichlidae	*Thoracochromis albertianus*	Taxonomic status not clear
Citharinidae	*Citharinus citharus*	Almost extinct in the lake
	C. latus	Almost extinct in the lake
	Distichodus rostratus	Extremely rare on the lake
Clariidae	*Clarias alluaudi*	Habitat not adequately sampled
Cyprinidae	*Barbus neglectus*	Habitat not adequately sampled
Cyprinodontidae	*Aplocheilichthys. kassenjiensis*	Too small for gears used
	A. mahagieinsis	Habitat not adequately sampled
Malapteruridae	*Malapterurus electricus*	Habitat not adequately sampled
Mochokidae	*Synodontis nigrita*	Extremely rare on the lake
Mormyridae	*Mormyrus macrocephalus*	Habitat not adequately sampled
	Mormyrus niloticus	Habitat not adequately sampled
Schilbeidae	*Eutrophius niloticus*	Extremely rare on the lake

as "*Sallacio*") that enables fishers to stay on water for prolonged periods of 2 to 3 weeks without landing has been introduced. Over this period, gillnets are left in the water and fishes caught are periodically removed without lifting the nets out. The catch is processed (salted and sun-dried) on the lake and collected by land-based business owners. This increases fishing effort and could, thus, affect the stocks. The increase in effort has resulted in a reduction in catch rates forcing introduction of new fisheries on the lake. *Brycinus nurse* and *Neobola bredoi*, previously not exploited (Wandera, 2000), now constitute the largest proportion of the commercial catch (NaFIRRI Report 2007).

Bad fishing methods and gears

Beach seining is rampant on Lake Albert. These nets are operated in shallow inshore waters and lagoons where fishes breed and brood their young. While seiners may be targeting adult fishes, immature fishes caught along are also taken. The beach seines also destroy fish breeding habitats (especially tilapia nests), and thus directly interfere with breeding (Welcomme, 1968). Waters where the beach seines are operated are areas of high species densities and diversity. Target species include haplochromines that are used as bait in the hook fishery. Sustained seining depletes species from an area and may lead to species loss.

Habitat degradation

Human activities in the lake's basin influence the lake environment. Although most of the immediate areas surrounding the lake are game reserves/park, the lake is drained by rivers that originate farther inland, in farmlands and human settlements. Products of activities in these areas eventually end up into the lake and may alter the lake's environment to the detriment of fish species in there. For example, brewing and distillation of a local liquor (locally known as Enguli) is common along the rivers and streams discharging brew waste and heat into the lake.

Oil and gas exploration and development

Commercial quantities of oil and gas have been discovered in the Lake Albert basin. Exploration on the shores and under the lake bed currently in progress, show the presence of exploitable quantities of hydrocarbons in the area. Commercial production of this oil is likely to cause increased human activities that may affect the lake's ecosystem and its biodiversity. An accidental oil spill, for example, is likely to be quite disastrous to the biota and could eventually affect the fishery. Habitats critical to survival of many fish species noted above, are likely to be affected and thus greatly influencing the animal life dependent on them. Lake Albert is the first inland freshwater waterbody of its size to be targeted for oil production in Africa. The effects of such a spill on the lake's biota are likely to be unique and not easily estimated.

Conclusions

Although a number of fish species are threatened in Lake Albert, the lake still harbors a majority of the species originally present. Only two species, the Mpoi (*Citharinus citharus*) and a butter fish (*Eutropius niloticus*) are on the verge of extirpation from the lake.

High fish species diversity occurs in shallow waters especially at lagoons, river mouths and large open bays. Lagoon and near-shore waters of the lake also harbor juveniles of most fish species; thus these habitats act as fish nursery grounds. Submerged aquatic macrophytes common in these shallow waters provide structural refugia for many small-sized prey species in the lake. These near-shore areas are, unfortunately, the waters most susceptible to the effects of human activities on the lake. Habitats critical to fish survival identified as river mouths, lagoons, near-shore waters of large bays and rocky areas should be mapped out and protected.

Catch rates are highest at river mouths and lagoons and lowest in the open waters. The catches are dominated by the Ngassa (*H. forskahlii*) and Ragoge (*Brycinus nurse*), the latter being from the newly introduced light fishery. Other fish species of importance include both species of the Nile perch and Angara (*Alestes baremose*).

Being a multi-species fishery that targets species of varying sizes, it is not realistic to fix the minimum mesh size at 5 inches as is the case at present. Fishers targeting species that grow to a large adult size such as the Nile tilapia (*O. niloticus*), the Nile perch and the catfish (*Bagrus* spp.) should be the only ones to adhere to the 5 inch mesh net rule. Future research should aim at determining suitable fishing methods and gears that exploit the smaller-sized fishes without harming the fisheries of the large species.

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References

Greenwood, P. H., 1966. *The fishes of Uganda. 2nd ed.* The Uganda Society, Kampala.

Greenwood, P. H., 1981. *The haplochromine fishes of the East African Lakes.* Collected papers on their taxonomy, biology and evolution with an introduction and species index. Kraus International Publications, Munich.

Hecky, R. E., 2007. Lake Albert Strategic Environmental and Social Overview Draft Report to Tullow Oil Plc (Tullow), by Environmental Resources Management, Southern Africa (Pty) Ltd. (ERM).

Holden, M. J., 1963. Report on the fisheries of Lake Albert. Fisheries Laboratory, Lowestoft.

NaFFIRI Report, 2007. A baseline survey of water and sediment quality, fisheries and invertebrates at Ngassa spit, Lake Albert. Prepared for Environmental Resources Management Southern Africa (Pty) Ltd (ERM) in association with Environmental Assessment Consult Ltd (EACL), August 2007.

Rene, F., Daniel, P., 1992. The fisheries resources of Lake Mobutu/Albert. p 1-6. In: G.W. Ssentongo (Ed.), Compilation of papers presented at the technical consultation on Lake Edward and Mobutu shared between Zaire and Uganda. UNDP/FAO Regional Project for Inland Fisheries Planning (IFIP), RAF/87/099-WP/10/92 (En).

Seehausen, O., 1996 *Lake Victoria rock cichlid: taxonomy, ecology and distribution.* Verduijn Cichlids, the Netherlands.

Ssentongo, G.W.,1992. Fisheries exploitation and management of Lakes Edward and Mobutu/Albert. p 7-20. In: G. W. Ssentongo (Ed.), Compilation of papers presented at the technical consultation on Lake Edward and Mobutu shared between Zaire and Uganda. UNDP/FAO Regional Project for Inland Fisheries Planning (IFIP), RAF/87/099-WP/10/92 (En).

Wandera, S. B., 2000. The fisheries of the Ugandan sector of Lake Albert. A report on the current state of the fishery of the Ugandan sector of Lake Albert. Prepared for FAO sub regional representative for Southern and Eastern Africa (SAFD). April 2000.

Welcomme, R. L., 1968. Observation on the biology of the introduced species Tilapia in Lake Victoria. Rev.Zool. Bot. Afr 76, 249–279.

Worthington, E. B., 1929. A report on the fishing survey of Lakes Albert and Kyoga. March–July 1928. Crown Agents for colonies, London.