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Conservation of fish species diversity in the Victoria and Kyoga lake basins

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Abstract

Fish species diversity in lakes Victoria and Kyoga has declined and some species, especially of haplochromines and *Oreochromis esculentus* are believed to be extinct. A survey was carried out in a number of satellite lakes and an inventory made of the existing fish species, their relative abundance and distribution. The lakes studied included the Kyoga minor lakes, Nabugabo lakes, the Koki lakes and L. Wamala. Various habitats within the main lakes Victoria and Kyoga were also surveyed. Various stations along rivers Nile and Sio were also sampled. A total of twenty-one fish taxa were recorded from Kyoga minor lakes as compared to eighteen recorded from Lake Kyoga. Lake Nyaguo had the highest number of fish taxa (14), followed by lakes Nakuwa (12), Nawampasa (11), Lemwa (10), Agu (9), Kawi (8), and Gigati (7). The number of haplochromine species was highest in L. Nawampasa (23) followed by lakes Gigati (18), Agu (11), Nyaguo (10), Lemwa (8) and Nakuwa (2). Fourteen fish taxa were recorded from the Nabugabo lakes, the highest number being from L. Nabugabo (13) followed by lakes Kayanja (11) and Kayugi (7). Four haplochromine species were recorded from Nabugabo lakes From Koki lakes eight fish taxa were recorded, Lake Kachera having a higher number of species (8) than L. Mburo (6). A total of 9 fish taxa were recorded from L. Wamala, with only two haplochromine species Overall, twelve fish taxa were recorded from L. Victoria. Twenty-two haplochromine species were recorded from the lake. The habitats with rocky outcrops and macrophyte cover were found to have the highest number of fish taxa. River Sio had a higher number of fish taxa (17) than R. Nile (7). Results show that some of the fish species that have disappeared from lakes Victoria and Kyoga are present in the satellite lakes and rivers surveyed. Inshore areas with aquatic macrophytes and rocky habitats were also found to be important refugia for the endangered fish species. Some of the satellite lakes and the selected habitats within the main lakes should therefore be protected for conservation of fish species diversity

Key words: Conservation, introductions, refugia, satellite lakes, extinct

Introduction

Fish species diversity in capture fisheries is very important as it provides choice for consumers and plasticity in employment opportunities. It is also important in the ecological functioning of the aquatic ecosystems. However, human activities such as over-fishing and species introductions have caused rapid reduction in fish species diversity. Loss of fish species diversity is a threat to the food supply, income and health of the people and to the maintenance of ecological functioning in the aquatic ecosystems.

Lakes Victoria and Kyoga had high species diversity with many species in common. Haplochromines were the most abundant group of fishes in these lakes and formed at least 83% of the fish biomass in L. Victoria before the 1980s (Kudhongania & Cordone, 1974). They were important as human food and in evolutionary studies. L. Victoria alone had over 300 haplochromine species, more than 99% of them endemic (Witte et al., 1992a). The original fish fauna had evolved into a trophic diversity that promoted efficient utilization of most of the available energy resources. Tilapiine cichlids and phytoplanktivorous haplochromines were the primary converters, *R. argentea* and several other small fishes preyed mainly on zooplankton while the major invertebrate/benthos feeders were *Clarias* spp, *Schilbe intermedius, Synodontis* spp, *Protopterus aethiopicus, Labeo victorianus* and several mormyrids (Twongo 1988). The major predator was *Bagrus* *docmac*. Two tilapiine species, *O. esculentus* and *Oreochromis. variabilis*, were the most important commercial species in these lakes. The rivers in the two lake basins had a number of riverine species the commercially important of which was *L. victorianus*.

Stocks of the originally most important commercial species especially *O. esculentus*, *O. variabilis* and *L. victorianus* were depleted by human exploitation during the first half of the 20th century (Graham, 1929). Thereafter the fishery shifted to the smaller originally less preferred species, the haplochromines and *R.. argentea*.

In an effort to sustain the declining fishery of the large species, four exotic tilapiine species *Oreochromis niloticus*, *O. leucostictus*, *Tilapia zillii* and *Tilapia melanopleura* were introduced into lakes Victoria and Kyoga from 1953 onwards. Later, the predatory Nile perch. *Lates niloticus* was introduced into L. Kyoga in 1955 and into L. Victoria towards the end of 1950s, to feed on the haplochromine cichlids and convert them into a larger table fish, and also to develop a sport fishery (Ogutu-Ohwayo, 1990).

The introduced species upset the original ecological balance of the lake and caused changes in species diversity, the fishery and the environment of these lakes. As the stocks of Nile perch increased, fish species diversity, especially of the haplochromines, decreased rapidly. The contribution of haplochromines to fish biomass in the lake decreased from 83% recorded during the 1970s to the early 1980s to less than 1% from the late 1980s onwards (Okaronon et al 1985). About 60% of the haplochromine species are thought to have become extinct from L. Victoria alone (Witte et al 1992). Thereafter, the two introduced species, Nile perch and Nile tilapia dominated the fishery of lakes Victoria and Kyoga. The pelagic cyprinid *R. argentea*, a major prey species for juvenile Nile perch, is the only indigenous fish species of commercial importance. Recent surveys have shown that populations of two zooplanktivores haplochromines *Yissichromis laparograma* and *Yssichromis fusiformis* are recovering in the offshore waters of L. Victoria (Tumwebaze, 1997).

The disruption and reduction in stocks of the trophically diverse haplochromine community by Nile perch changed the food web of the lakes and this seems to have reduced their overall ecological efficiency. Algal biomass in L. Victoria increased four to five times, phytoplankton production doubled and water transparency decreased (Mugidde, 1993). Depletion of the detritivorous/phytoplanktivorous haplochromines, which previously constituted about 50% of the total haplochromine biomass in L. Victoria, reduced grazing pressure and left much of the algae produced in lake unconsumed. Decay of the excess organic matter depleted the water column of oxygen leading to hypoxic conditions in waters deeper than 40 m especially during periods of stratification. This reduced habitable space for many aerobic organisms and is thought to have forced deepwater haplochromines into shallower waters where they fell easy prey to Nile perch (Hecky, 1993).

Loss of fish species diversity in the Lake Victoria has led to a series of studies directed at identification of faunal refugia. Fish faunal surveys have been carried out in various satellite lakes within the lakes Victoria and Kyoga lake basins, and selected habitats within the main lake to make an inventory of existing fish species, their distribution and relative abundance.

Objectives

The objective of the study was to make an inventory of the fish species in the various satellite lakes and selected habitats in lakes Victoria and Kyoga and assess their value in conservation of fish species diversity.

Study Area, Material and Methods

The study was based on the Napoleon Gulf of Lake Victoria, Lake Kyoga, Kyoga minor lakes, Koki lakes, Nabugabo lakes and Lake Wamala. The areas sampled are shown in Figure. In the Napoleon Gulf sampling was carried out at five stations namely Kiryowa, Kikondo, Kirinya, Rwamafuta and Cliff. Rwamafuta and Kikondo sites are characterised with rocky outcrops, Kiryowa and Kirinya have shorelines with dense macrophyte cover while Cliff site has a steep shoreline without macrophyte cover except for occasional Water hyacinth mats. The Kyoga minor lakes were Nawampasa, Nakuwa, Gigate, Kawi, Lemwa, Nyaguo and Agu. The Nabugabo lakes included lakes Nabugabo, Kayanja and Kayugi. The Koki lakes included lakes Kachera and Mburo. . Some sites along River Nile and River Sio were also sampled. Sampling was carried out between 1997 and 2001.

Fish specimen were obtained from experimental gillnets and basket traps. Three graded fleets of gillnets were used on each lake. Each fleet consisted of 8 panels of mesh sizes 1, 1.5, 2, 2.5, 3, 4, 5,6,7 and 8 inches stretched mesh. The first fleet of nets was set along the shoreline; a second series was set 20 m and a third 200 m away and parallel to the shoreline. Rivers Nile and Sio were also sampled as above.

The nets were set at dusk, left overnight and retrieved the following morning. On retrieval, fish were sorted into taxonomic groups to species level whenever possible and the number and weight of each taxa in each mesh size of net recorded. The fish that could not be identified in the field were preserved in 10% Formalin, labelled with date, habitat and time of capture and transported to laboratory for species identification. Identification of fish to species level was based on Greenwood, 1974 and 1981.

Results

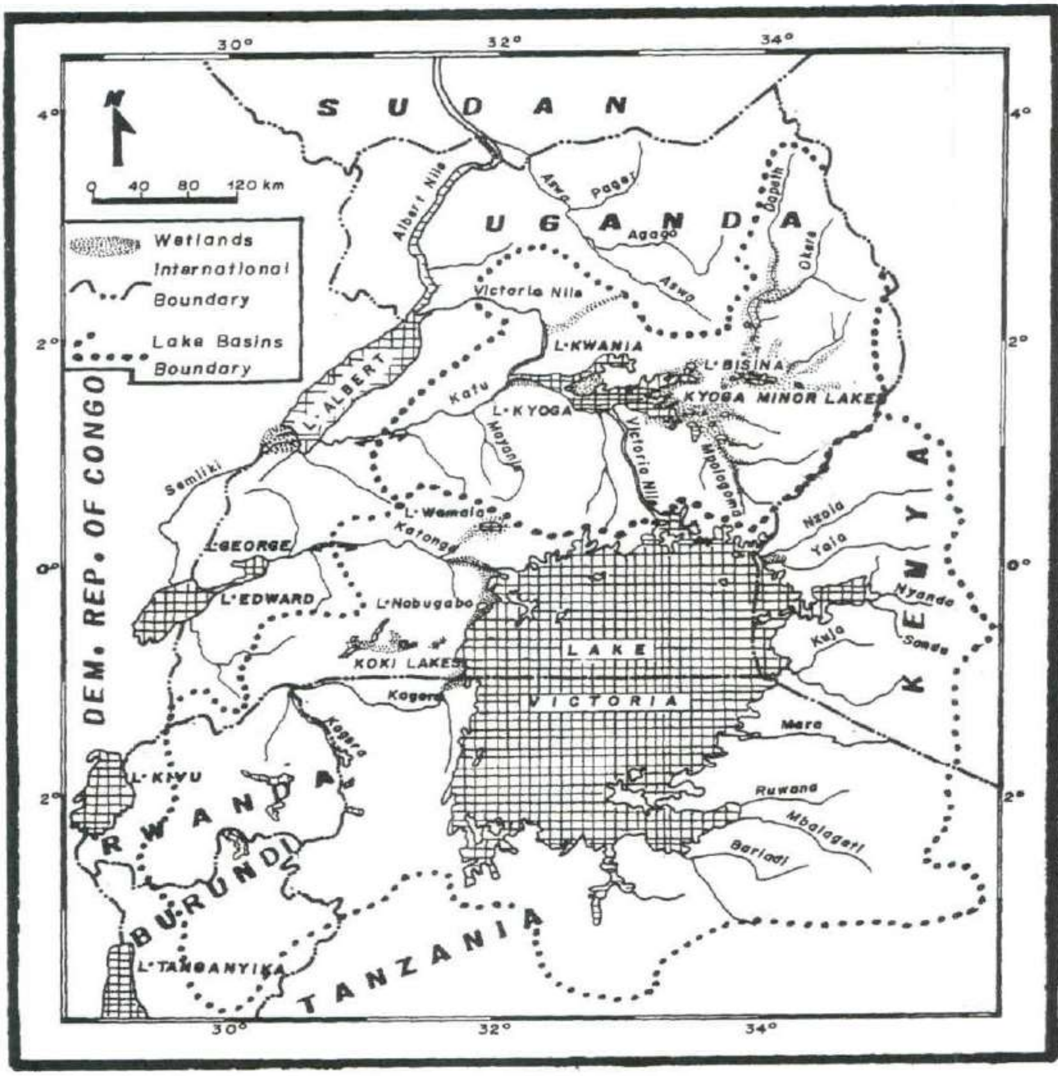
Lake Victoria

Sampling was carried out at five sites namely Kiryowa, Cliff, Kikondo, Kirinya and Rwamafuta. The fish species recorded from Lake Victoria and their relative abundances is shown in Table 1. Overall, twelve fish taxa were recorded. Numerically, Nile perch was the most dominant (42.3%) followed by haplochromines (30.7%), *Oreochromis niloticus* (12.2%), *T.zillii* (8.9%), *Synodontis afrofischeri* (2.3 %) and *Brycinus sadleri* (1.9%). Other species recorded in small numbers included *Mormyrus kannume*, *Oreochromis leucostictus*, *Synodontis victoriae*, *Clarias gariepinus*, *Oreochromis variabilis*, and *Protopterus aethiopicus*. Fish species distribution varied with species as shown in Figure 2. Generally the highest number of fish was recorded from the inshore fleet followed by the middle and the offshore fleets. The average number of Nile perch, *Synodontis* spp. and *M. kannume* increased from inshore to offshore while that of haplochromines, O.

Table 1. Percent composition, by number, of fish taxa from different pilot zones

Species	L.Victoria (N. Gulf)	Lake Kyoga	Kyoga minor	River Sio	Nabugabo lakes	Koki lakes	Lake Wamala
Lates niloticus	42.3	15.4	0.2	11.0	3.9	0	0
Oreochromis niloticus	12.2	2.5	0.3	0.2	7.8	1.1	1.7
Haplochromine	30.7	46	50.7	0.8	61.6	92.8	94.8
Ctenopoma murieri	0	0	0.2	0	0	0	1.1
Afromastacembelus frenatus	0	0	0.1	0.5	0	0	0
Barbus paludinosus	0	0	0.2	0	0	0	0
Schilbe intermedius	0	0.3	0.1	9.2	0.4	0	0
Protopterus aethiopicus	+	0.3	3.5	0.1	0.2	0.2	0.6
Petrocephalus catastoma	0	0.1	5.0	0.6	1.7	0	0
Gnathonemus victoriae	0	14.7	0.3	0.8	0	0	0
Gnathonemus .longibarbis	0	0.1	0.2	0.6	0.1	0	0
Marcusenius nigricans	0	0	0.5	0	0	0	0
Marcusenius grahami	0	0	0	15.5	12.0	0	0
Mormyrus macrocephalus	0	0.6	0	0	0	0	0
Mormyrus kannume	+	+	+	0	0	0	0
Clarias liocephalus	0	0	0.1	0	0.1	0.6	0.1
Clarias gariepinus	+	0.2	0.4	1.2	0.1	0.4	2.1
Brycinus jacksonii	+	0	0	0.1	0	0	0
Brycinus sadleri	1.9	15	35.3	28.6	4.3	0	0
Labeo victorianus	0	0.1	0	0.8	0	0	0
Barbus altianalis	0	0.1	0.2	0.1	0	0	0
Barbus trispido	0	0	+	0	0	0	0
Barbus sp.	+	0	0.1	0	0	0	0
Synodontis victoriae	+	1.7	0.4	16.1	0	0	0
Synodontis afrofischeri	2.3	0.7	0.7	13.3	1.0	0	0
Oreochromis esculentus	0	0	0.3	0	2.7	3.7	0
Oreochromis leucostictus	+	1.0	0.7	0	0.4	1.1	0.5
Oreochromis variabilis	+	0	0.1	0	0	0	0
Tilapia zillii	8.9	1.1	0.3	0	1.2	+	0.02
Barbus kersteni	0	0	0	0	2.4	0	0
Oreochromis rendalii	0	0	0	0	0.1	0	0
Total number of species	**12**	**18**	**25**	**17**	**17**	**8**	**8**

Figure 1. A map of Uganda showing the Victoria and Kyoga lake basins



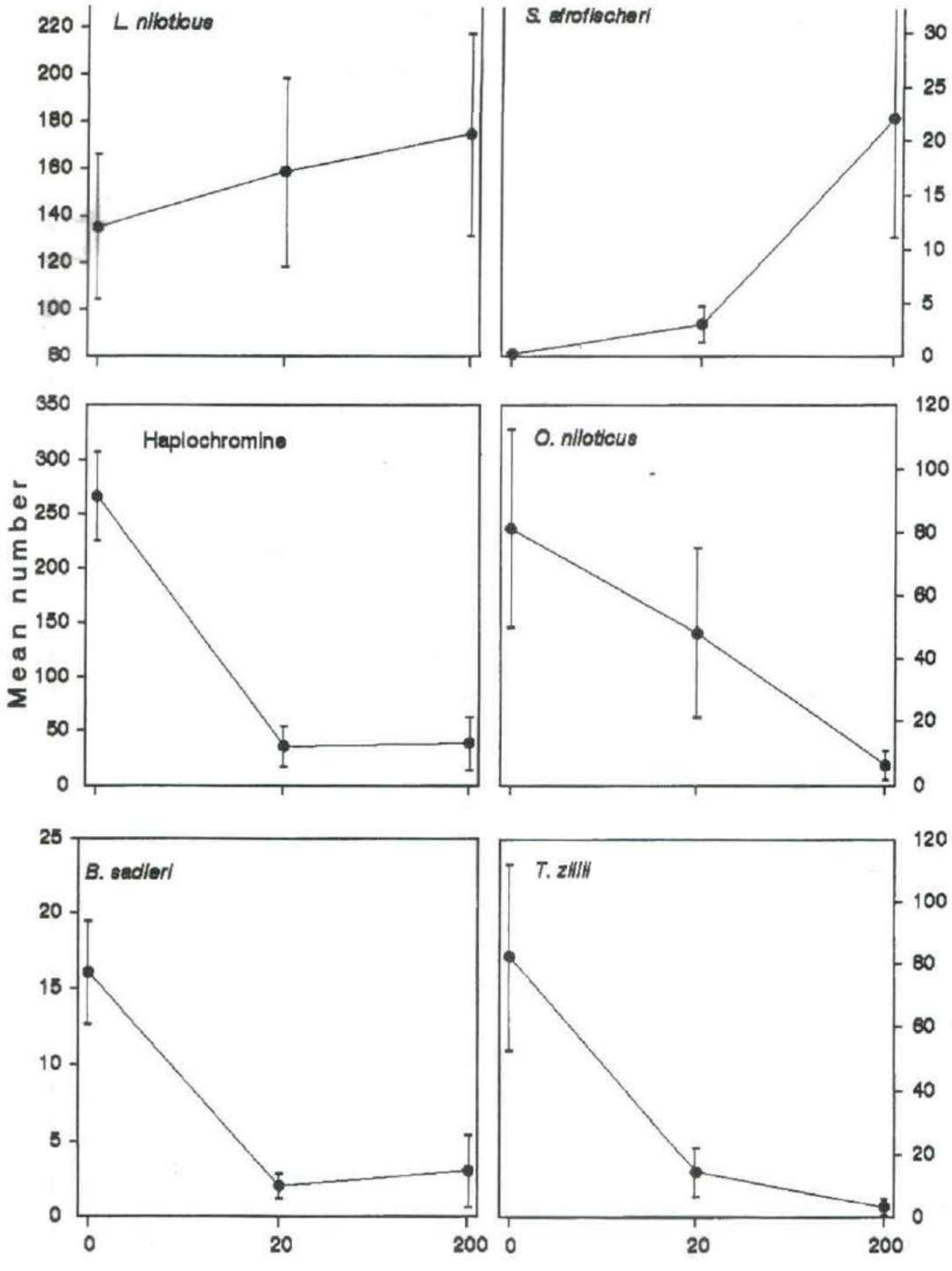
niloticus, T. zillii, B. sadleri, O.leucostictus, C. gariepinus, and *P. aethiopicus* decreased from inshore to offshore. *O. variabilis* was recorded only from the inshore nets. Number of fish species was highest at Rwamafuta (12) and Kikondo (12) each, followed by Kiryowa (11), Kirinya (10) and Cliff (8). Twenty-two haplochromine species were recorded from the five stations.

Lake Kyoga

Eighteen taxa species were recorded and these included haplochromines, *L. niloticus, Brycinus sadleri, Gnathonemus victoriae, O. niloticus, Synodontis victoriae, Synodontis afrofischeri, Mormyrus macrocephalus, T. zillii, O. leucostictus, Schilbe intermedius, Protopterus aethiopicus, C. gariepinus, Labeo victorianus, Gnathonemus longibarbis, Barbus altianalis, Petrocephalus catastoma,* and *M. kannume.* The highest number of species occurred in inshore (13) followed by offshore (11) and middle fleets (8). Fourteen haplochromine species were recorded as shown in Table 1. Their distribution varied with species but the highest number occurred inshore.

Kyoga Minor lakes

Overall twenty-seven fish species were recorded from Kyoga minor. Fish species composition and relative abundance of fish species recorded from the different lakes is shown in Table 2. These included haplochromines *B. sadleri, T.zillii, O. esculentus, S. victoriae, S. afrofischeri, O. variabilis, Afromastacembalus frenatus, Ctenopoma murieri, Barbus paludinosus, Barbus altianalis, S. intermedius, Barbus trispidopleura, Barbus* sp., *P. catostoma, C.*



Distance in metres from the shore
Figure 2. Overall distribution of dominant fish taxa in the Napoleon Gulf

Table 2. Percent composition, by number, of fish taxa from the Kyoga minor lakes

Species	Nawampasa	Nakuwa	Lemwa	Kawi	Gigate	Nyaguo	Agu
L.niloticus	0	12.8	0	0	0	0	0
O. niloticus	0.1	3.7	0.3	0.1	0.3	0	0
Haplochromines	67.5	11.0	89.3	69.4	67.3	5.9	80.8
C.murieri	0	0	1.0	0	0	0	7.1
A. frenatus	0	0	0	0	0	0.1	0
B.palludinosus	0	0	0	0	0	0.7	0
S.intermedius	0	3.7	0	0	0	0	0
P. aethiopicus	0.3	2.7	0	29.3	0.03	0.1	0.5
P.catastoma	0	0	0	0	0	21.4	1.0
G.victoriae	0	1.8	0	0	0	1.1	0
G.longibarbis	0	0	0	0	0	0.5	4.5
M.nigricans	0	0	0	0	0	2.1	1.0
M.grahami	0	0	0	0	0	0	0
M.macrocephalus	0	0	0	0	0	0.1	0
M.kannume	0	0	0	0	0	0	0
C.liocephalus	0	4.6	0	0	0	0	0
C.gariepinus	0.5	0.9	2.9	0.4	0.3	0.1	0
B.sadleri	26.0	0	0	0	31.1	67.4	0
B.altianalis	0	12.8	0	0	0	0	0
B.trispidopleura	0	0	0.3	0	0	0	0
Barbus sp.	0	0	2.3	0.1	0	0	0
S.victoriae	0.8	14.7	1.0	0	0	0.1	0
S.afrofischeri	0.7	32.1	0.3	0.2	0.03	0	1.0
O.esculentus	1.4	0	0.3	0.2	0	0.4	0
O.leucostictus	0.3	1.8	2.3	0.4	0.8	0.1	0.5
O.variabilis	0.7	0	0	0	0	0	0
T.zillii	1.5	0	0	0	0	0	3.5
Total umber of species	**11**	**12**	**10**	**8**	**7**	**14**	**9**

gariepinus, M. grahami, C. liocephalus, G. victoriae, G. longibarbis, O. leucostictus, P. aethiopicus, Mormyrus kannume, Mormyrus macrocephalus and O. niloticus. Fish species distribution varied within each lake but generally the inshore habitats with macrophyte cover had the highest fish species *diversity*.

Nabugabo lakes

Three lakes were sampled namely, Nabugabo, Kayanja, and Kayugi. Overall thirteen fish taxa were recorded from L. Nabugabo and they included haplochromines (48.8%), *B. sadleri* (11.3%), *Barbus* spp (0.4%)., *G. longibarbis* (0.2%), *L. niloticus* (11.0%), *M. grahami* (0.1%), *O. rendalii* (0.3%), *O. leucostictus* (0.9%), *O. niloticus* (22.2%), *P. aethiopicus* (0.1%), *S. intermedius* (1.0%), *S. afrofischeri* (2.8%) and *T. zillii* (0.9%). Four species of haplochromine cichlids were recorded from L. Nabugabo *and they included Astatotilapia velifer, Gaurochromis simpsoni, Paralabidochromis beadlei* and *A. alluaudi*

Eleven fish taxa were recorded from L. Kayanja namely; *haplochromines* (58.9%), *B. kersterni* (4.2%), *B. sadleri* (0.3%), *C. gariepinus* (0.3%), *C. liocephalus* (0.1%), *G. victoriae* (5.3%), *M. grahami* (23.7%), *O. esculentus* (5.1%), *O. leucostictus* (0.2%), *P. aethiopicus* (0.2%), and *T. zillii* (1.7%). The haplochromine species included *A. alluaudi, A. nubila, Aststotilapia* ssp. and *Prognathochromis venator*.

From Lake Kayugi seven fish taxa were recorded and they included haplochromines (82.2%), *B. sadleri* (1.3%), *B. kersterni* (0.8%), *G. victoriae* (4.9%), *O. esculentus* (1.1%), *P. catostoma* (9.7%) and *P. aethiopicus* (0.2%). The haplochromine cichlids inclueded *A. velifer, A. nubila, G. simpsoni, A. alluadi* and *P. venator.* Overall seventeen fish taxa were recorded from the Nabugabo lakes as shown in Table 1.

Koki Lakes

Experimental fishing was carried out in lakes Mburo and Kachera. From Lake Mburo 6 fish taxa were recorded. These were haplochromines (95.5%), O. esculentus (3.2%), *O. niloticus* (0.8%), *O. leucostictus* (0.3%), *C. gariepinus* (0.1%), and *P. aethiopicus* (0.1%). *The haplochromine cichlids belonged to four species namely Astatotilapia aeneocolor, Astatotilapia nubila, Astatoreochromis alluaudi* and *Harpagochromis squamipinnis. Generally, the inshore sites had the highest number of fish although distribution varied with individual species. Numbers of O. esculentus, C. gariepinus* and *P. aethiopicus were highest in the inshore fleets while O. niloticus was most abundant in the middle fleets. Among the haplochromines, H. squamipinnis* and *A. aeneocolor were most abundant in the offshore fleets while A. alluaudi and A. nubila were most abundant in the inshore fleet.*

Eight fish taxa were recorded from Lake Kachera. The most abundant were haplochromines (90.6%), *O. esculentus (4.2%), O. leucosticus (1.7%), O. niloticus (1.4%), C. liocephalus (1.1%), C. gariepinus (0.6%), P. aethiopicus (0.4%) and T. zillii. The haplochromine cichlids included* H. squamipinnis, A.aeneocolor, A. alluaudi *and* A. nubile. *Fish species distribution was as for Lake Mburo*

Lake Wamala

Overall, 9 fish taxa were recorded from L. Wamala as shown in Table 1. Numerically the most abundant species was *O. niloticus, haplochromines, O. leucostictus, C. gariepinus, Ctenopoma murueri , C. liocephalus, P. aethiopicus, C. carsoni, T. zillii. C. gariepinus* was most abundant in the offshore while the other species occurred mostly in the inshore fleet. There were two species of haplochromines namely *A. nubila* and *Pseudocrenilabrus multicolor.*

River Sio

Seventeen fish taxa were recorded and they included *B. sadleri* (28.6%), *M. grahami* (15.5%), *S. victoriae* ((16.1%), *S. afrofischeri* (13.5%), *L. niloticus* (11.0%), Haplochromines (0.8%), *C. gariepinus* (1.2%), *P. catastoma* (0.6%), *G. longibarbis* (0.6%), *S. intermedius* (9.2%), *L. victorianus* (0.8%), *G. victoriae* (0.8%), *O. niloticus* (0.2%), *Brycinus jacksonii* (0.1%), *B. altianalis* (0.1%), *A. frenatus* (0.3%) and *P. aethiopicus* (0.1%). The nearshore habitat had the highest number of species (15) followed by the middlefleet (10) and the offshore fleet (8).

River Nile

Seven fish taxa were recorded and they included, in order of abundance, Mormyrus kannume (37.9%), L. niloticus (23.7%), haplochromines (22.0%), Barbus altianalis (7.3%), B.sadleri (3.1%), O. niloticus (2.1%), O. variabilis (1.8%), M. macrocephalus (0.6%), Bagrus *docmac (0.6%), T. zillii (0.5%) and crabs (0.5%).*

Discussion

Fish species diversity decreased with increasing distance from the shoreline, which at all the sites sampled, was fringed with aquatic macrophytes. Sites that are sites, both of which are characterized with rocky shorelines, notably Rwamafuta and Kikondo had high species diversity. Fish species diversity in the satellite lakes and rivers was also found to be highest in habitats with submerged and fringing macrophytes. Studies carried out in Lake Victoria in the early 1990s showed that marginal swamps and rocky reefs were important refugia for indigenous species in Lake Victoria (Kaufman and Ochumba, 1993; Namulemo, 1997). Ogutu-Ohwayo (1993) noted that many surviving species, especially haplochromines, in Lake Nabugabo were confined to macrophytes along the lake margin.

Inshore areas with aquatic macrophytes may serve as both structural and in some cases low-oxygen refugia for prey species from Nile perch. Chapman et al (1995) demonstrated that some of the cichlids from Lake Victoria could tolerate extremely low levels of oxygen, which may permit these fishes to use structural inshore habitats as refugia.

In the present study, the value of structural refugia has also been observed in satellite lakes with Nile perch. For instance in lakes Nabugabo and Nakuwa where Nile perch was introduced, most of the haplochromine cichlids live among submerged macrophytes especially water lilies where they are probably able to evade predation by Nile perch. Submerged and fringing macrophytes also act as barriers to the spread of the Nile perch since the species cannot survive under low oxygen conditions. For instance, L. Nawampasa is separated from L. Kyoga, where Nile perch occurs, by dense macrophytes that act as a barrier to the entry of Nile perch into the lake.

It was noted in the Mwanza Gulf of Lake Victoria that it is the rock dwelling fish species that have been least affected by Nile perch predation (Witte et al, *1992).* This suggests that rocky areas can serve as refugia for some haplochromines and other rock dwelling fish species.

Conclusion and recommendations

The information gathered so far indicates that marginal macrophytes and rocky habitats provide both structural and physiological refugia for the endangered native fish species in L. Victoria and may be valuable in conservation of fish species diversity in the lake. It has also been observed that the satellite lakes of the Victoria and Kyoga lake basins provide a sanctuary for *O. esculentus* and many haplochromine species which are believed to be extinct from L. Victoria. Some of these lakes should therefore be protected for conservation of fish species diversity and as a source of brood stock for fish farming. Rivers Sio and Nile were also found to be rich in fish species diversity and important sources of *L.victorianus* as brood stock in fish farming. These rivers should also be protected for conservation of fish species diversity. Some of the measures to conserve fish species diversity should include

- Avoid clearing the papyrus swamps and marginal vegetation along the lakes in order to stop the spread of exotic fish species and also to avoid other anthropogenic impacts on the lakes
- Declare some satellite lakes and special habitats within the main lake Victoria as conservation areas and set up marine parks
- Avoid use of destructive fishing gears especially beach seines which are
- operated along shorelines which are important breeding and nursery grounds for most of the fish species

References

Graham, M., 1929. The Victoria Nyanza, and its fisheries.

A report on the fishery survey of Lake Victoria, (1927-29). Crown Agents Colonies, London.

Hecky, R.E., 1993. Peter Kilham Memorial Lecture. The eutrophication of Lake Victoria. Verh. Int. Verein. Limnol. 25: 39-48

Kudhongania, A.W. & Cordone, A.J., 1974. Bathiospatioal distribution pattern and biomass estimate of the major demersal fishes in Lake Victoria. Afr. J. Trip. Hydrobiol. Fish. 3: 15-31

Mugidde, R., 1993. The increase in phytoplankton production and biomass in Lake Victoria (Uganda). Verh. Int. Verein. Limnol. 25: 846-849

Namulemo, G. 1997. Distribution, relative abundance and food of the surviving haplochromine cichlids in the littoral areas of Napoleon Gulf (Lake Victoria). Msc. Thesis Makerere University, Kampala. 89pp

Ogutu-Ohwayo, R., 1990. The decline of native fish species diversity in lakes Victoria and Kyoga (East Africa) and the impact of introduced species, especially the Nile perch, Lates niloticus, and the Nile tilapia, Oreochromis niloticus. Env. Biol. Fish. 27: 81-96

Okaronon, J. O., Acere, T.O & Ocenodongo, D.L., 1985. The current state of the fisheries in the northern portion of Lake Victoria. pp. 89-98.1:CIFA. Report of the third session of the sub-committee for the development and management of the fisheries of Lake Victoria. 4-5 October 1984. Jinja, Uganda. FAO Fish. Rep. 335. FAO, Rome

Tumwebaze, R., 1997. Application of hydroacoustics in fish stock assessment of Lake Victoria. MPhil Thesis. Department of Fisheries & Marine Biology. University of Bergen, Norway. 134 pp.

Twongo, T., 1998. Recent trends in the Fisheries of Lake Kioga. pp. 140-151. 1:CIFA. Report of the third session of the sub-committee for the development and management of the fisheries of Lake Victoria. 4-5 October 1984. Jinja, Uganda. FAO Fish. Rep. 335. FAO, Rome

Witte, F., Goldschmidt, T., Goudswaard, P.C., Ligtvoet, W., Oijen. M.J.P. van & Wanink, T.H., 1992a. Species extinction and concomittant ecological changes in Lake Victoria. Neth. J. Zool. 42: 214-232

Witte, F. Goldschmidt, T., Goudswaard, P.C., Ligtvoet, W., Oijen, M.J.P. van & Wanink, J.H., 1992b. The destruction of an endemic species flock: quantitative data on the decline of the haplochromine cichlids of Lake Victoria. Env. Biol. Fish. 34: 1-28