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Challenges for Management of the Fisheries Resources, Biodiversity and Environment of Lake Victoria

Editors:
J. S. Balirwa,
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Fisheries Resources Research Institute

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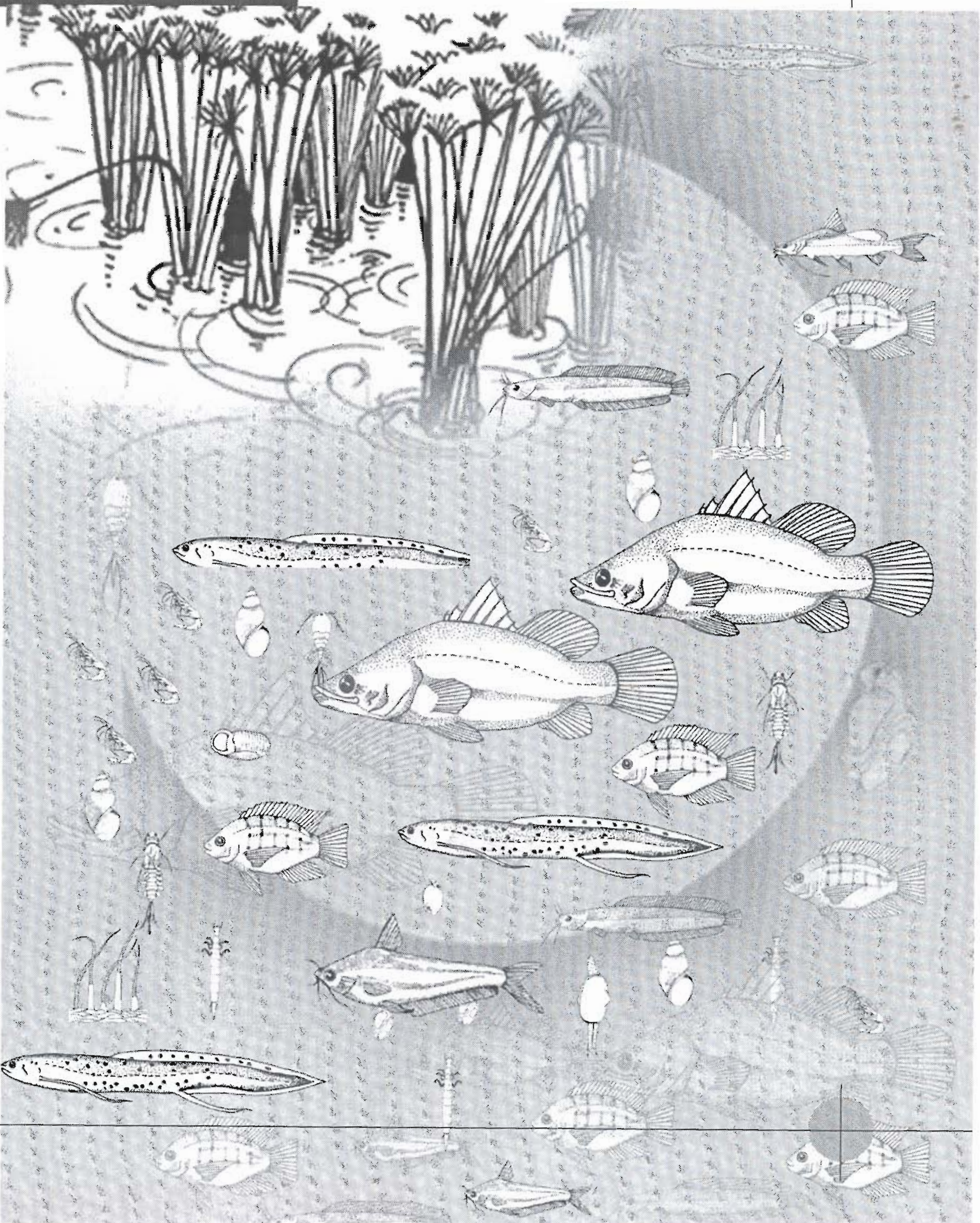
CHAPTER FIVE 5

Biodiversity conservation and Enhancement



5.1. Distribution of endangered native fish fauna and their conservation in Lake Victoria

G. Namulemo

Introduction

Lake Victoria, in East Africa, supports socio-economically important fisheries for more than 30 million inhabitants in the lake basin. The lake had, until the 1970's, a diverse fish assemblage dominated by haplochromines species, which formed at least 83% of the fish biomass (Kudhongania & Cordone 1974). The more than 500 haplochromine species in Lake Victoria, over 99% of them endemic, exploited virtually all the food sources in the lake (Witte and van Oijen 1990). Each species had its own unique combination of food and habitat preference (Goldschmidt *et al.,* 1990).

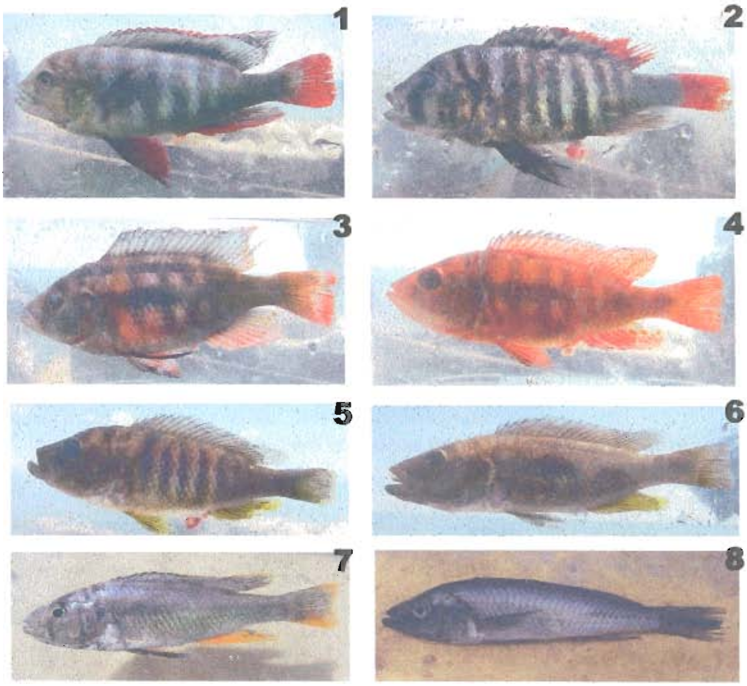


Plate: 5.1.1. Different forms and trophic groups of haplochromine cichlids in Lake Victoria

1 - *Neochromis omnicaeruleus*
2 - *Pundamilia pundamilia*
3 - *Paralabidochromis rockkribensis*
4 - *Pundamilia* 'bright red'
5 - *Lipochromis nelanopterus*
6 - *Harpagochromis serranus*
7 - *Yssichromis* sp
8 - *Yssichromis fusiformis*

Up to eleven trophic groups of haplochromine cichlids were identified from the Mwanza Gulf alone (Witte & van Oijen, 1990). They occupied all trophic levels and played an important role in the flow of energy in these ecosystems. Haplochromines were also popular as food for fish and as medicine against measles (Kaufman 1992).

Two tilapiine species, *Oreochromis esculentus* and *Oreochromis variabilis,* were the most important commercial species in these lakes and were found no where else except in the Victoria and Kyoga lake basins. The non-cichlid fish species (Plate 5.1.2) comprised of 17 cyprinid species, 10 catfishes and 18 other fish species all divided into five families (Witte *et al.,* 1992a, b). The commercially important non-cichlid fish species included *Bagrus docmac*, *Clarias gariepinus, Protopterus aethiopicus*, *Labeo victorianus, Synodontis afrofischeri, Barbus altianalis, Mormyrus kannume* and *Schilbe intermedius*. These fish species were an important source of protein and income to the people around the lake.

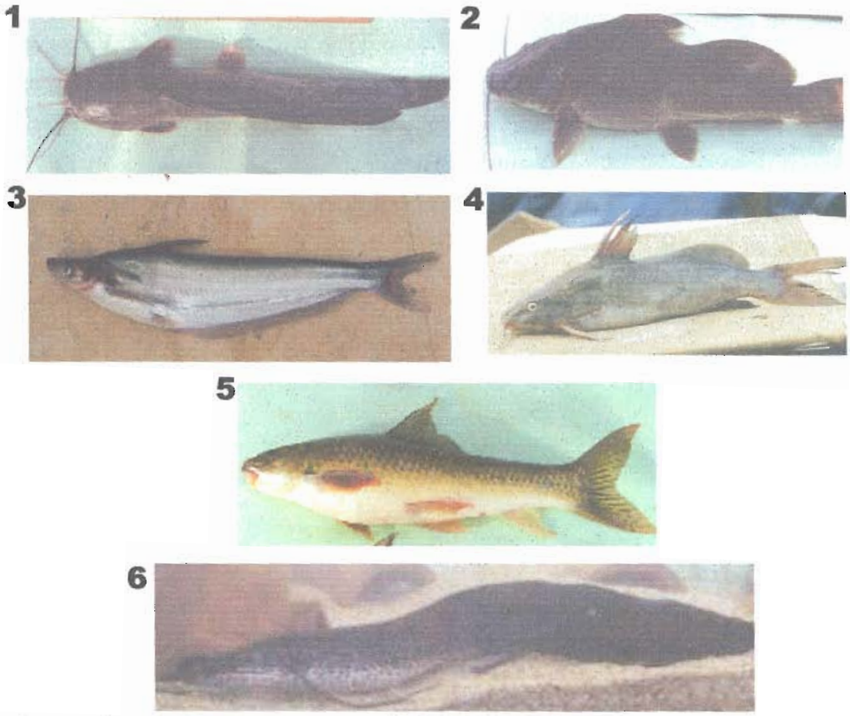


Plate: 5.1.2. Some native non-cichlid fish species of the Lake Victoria Basin

1 - *Clarias gariepinus*,
2 - *Bagrus docmak*,
3 - *Schilbe intermedius*,
4 - *Synodontis victoriae*,
5 - *Labeo victorianus*,
6 - *Protopterus aethiopicus*.

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, *Rastrineobola argentea* and several other small fishes preyed mainly on zooplankton while the major invertebrate/benthos feeders were *Clarias* spp, *S. intermedius, Synodontis* spp, *P. aethiopicus, L. victorianus* and several mormyrids (Twongo 1988). The major predator then was *B. docmac*.

Decline in fish species diversity

Stocks of the originally most important commercial species *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-bodied species, four exotic tilapiine species; *Oreochromis niloticus, Oreochromis leucostictus, Tilapia zillii* and *Tilapia rendalli* were introduced into Lakes Victoria and Kyoga from 1953 onwards. Later, the predatory Nile perch. *Lates niloticus* was introduced first into Lake Kyoga in 1955 and, later into Lake Victoria towards the end of 1950s, to feed on the then abundant small haplochromine cichlids and convert them into larger table fish, and also to develop a sport fishery (Ogutu-Ohwayo, 1990).

The introduced species rapidly upset the original ecological balance of the lakes and caused changes in species diversity, the fishery and the environment of these lakes. In the early 1980s an explosive increase in Nile perch catches was observed. Simultaneously, a decline in the stocks of the native fish species was reported (Witte *et al.*, 1992a,b). Over 50% of the endemic fishes disappeared from catches in Lake Victoria between 1980 and 1986 and many are presumed extinct (Kaufman 1992). Most dramatic was the lakewide decline of the haplochromines, which were the dominant prey of the Nile perch (Ogutu-Ohwayo 1990). The contribution of haplochromines to fish biomass in the lake decreased from 83% during the 1970s (Kudhongania & Cordone, 1974) to less than 1% by the late 1980s (Okaronon *et al.,* 1985). About 60% of the haplochromine species are thought to have become extinct from Lake 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 in the two lakes.

The introduced predatory Nile perch is believed to have been the major contributor to the mass extinction since the decline in endemic haplochromines was almost reciprocal with the increase in Nile perch population (Ogutu-Ohwayo 1990). Until their densities in the habitats where they coexisted with the Nile perch became low, the haplochromines constituted a dominant part of the Nile perch diet (Witte *et al.,* 1999). In the offshore waters a decline was also observed for other fish groups, such as the catfishes (Ogutu-Ohwayo 1990). The disappearance of their main prey species, the haplochromines, may also have contributed to the decline of *B. docmac* and *C. gariepinus* (Witte *et al.,* 1999). Recent surveys have shown that populations of two zooplanktivorous haplochromines *Yssichromis laparograma* and *Yssichromis fusiformis* are recovering in the offshore waters of Lake Victoria (Tumwebaze 1997).

Besides changes in species diversity patterns, algal biomass in Lake Victoria increased four to five times, phytoplankton production, dominated by blue-green algae, doubled and water transparency decreased (Mugidde 1993). Depletion of the detritivorous/phytoplanktivorous haplochromines, which previously constituted about 50% of the total haplochromine biomass in Lake Victoria, reduced grazing pressure and left much of the algae produced in the 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). 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 overall ecological efficiency of the lakes.

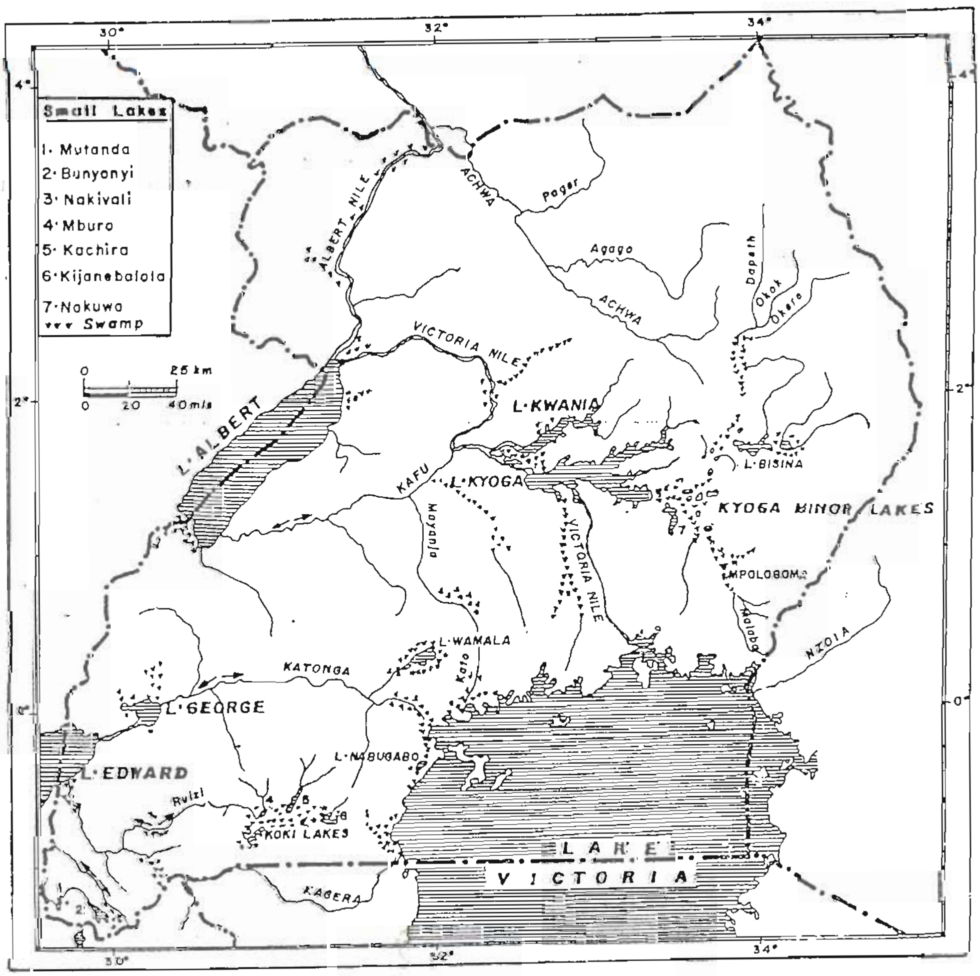


Fig. 5.1.1. A Map of Uganda showing various water bodies that comprise fish production systems

Fish faunal refugia

Loss of fish species diversity in the main lakes Victoria and Kyoga has led to a series of studies directed at the identification of faunal refugia (Kaufman 1992). Satellite lakes, shallow inshore vegetated habitats and rocky outcrops have been identified as the major refugia for the endangered native fish species in the Lake Victoria basin. In the 1989-1992 survey, it was also found that marginal swamps and rocky reefs were important refugia for indigenous species in Lake Victoria (Kaufman and Ochumba 1993). Rivers within the lake basin are also an important reservoirs for the endangered native fish species. *L. victorianus* and *B. docmac* whose populations in the main lake have declined were also recorded in rivers Nile and Sio. This chapter aims at describing the different types of faunal refugia for the endangered native fish species in the Lake Victoria basin.

a) Vegetated littoral habitats

Shallow inshore habitats with fringing macrophyte cover have been found to be important refugia for the endangered native fish species in lakes Victoria and Kyoga. In all the areas sampled, the number of fish species was higher in nearshore habitats with macrophytes cover as compared to open water habitats (Fig. 5.1.2.). Papyrus swamps fringing the northern shore of Lake Victoria provide a refuge for fish species native to the lake but face extinction as they become the food supply for the predacious Nile perch. In Lake Victoria the endangered native tilapiine *Oreochromis variabilis* still occurs in inshore habitats with fringing macrophyte cover especially the papyrus reeds, *Cyperus papyrus*. Fish faunal surveys in Lake Nabugabo have also shown that inshore habitats act as refugia for the endangered native fish species in the lake especially the haplochromines (Ogutu-Ohwayo, 1993).

Inshore areas with aquatic macrophytes may serve as both structural and in some cases low-oxygen refugia for prey species from Nile perch. Nile perch are very sensitive to low-oxygen conditions, which may limit their interaction with prey species in hypoxic habitats (Fish 1956). 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. The value of structural refugia has also been observed in satellite lakes with Nile perch. In lakes Nabugabo and Nakuwa where Nile perch was also introduced, most of the haplochromine cichlids live among submerged macrophytes especially water lilies where they are probably able to evade predation by Nile perch.

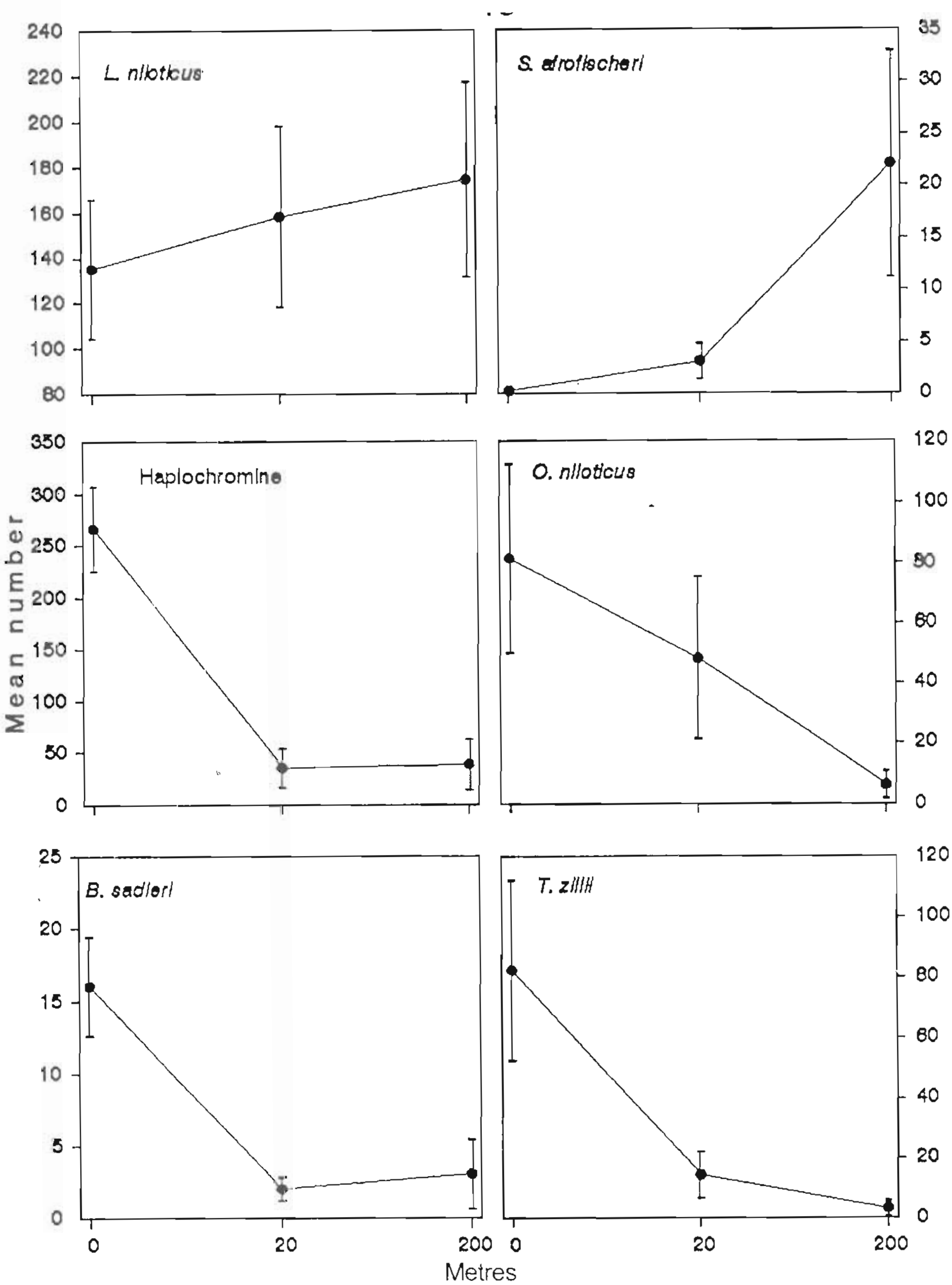


Fig. 5.1.2. Overall distribution of dominant fish taxa in Lake Victoria

Littoral macrophyte habitats are under threat from invasive weeds and drainage of surrounding wetlands for agriculture. Infestation by water hyacinth since the late 1980s has been a threat to survival of fish species diversity especially in the inshore areas. Weed mats destroyed rooted and floating macrophytes leading to destruction of breeding and nursery grounds of most fish species. Hyacinth mats also caused local deoxygenation that resulted in periodic mass kills of fish and other organisms. Drainage and clearance of marginal wetlands for agriculture also deprives fish of their breeding and nursery grounds.

b) Rocky habitats

Rocky shores and islands are important refugia for indigenous fishes in Lake Victoria. They harbour the highest densities and diversity of cichlid species in the lake. Their complex spatial structure provides a large number of ecological niches and allows complex food webs to build up. They also provide protection against predation. It was noted in the Mwanza Gulf of Lake Victoria that it is the rock-dwelling fish species that were least affected by Nile perch predation (Witte *et al.*, 1992a,b). A number of species critically low in numbers or originally believed to have been eliminated from Lake Victoria have been recorded now living in rocks. Such species include *Paralabidochromis victoriae, Xystichromis phytophagus* and *Pyxichromis para-orthostoma* among the haplochromines; *Oreochromis variabilis* and *L. victorianus* and *B. docmac.* A completely new group of haplochromines, the rock dwelling "*mbipi*" species has been identified and many species have been described (Seehausen, 1996, Seehausen, *et al.,* 1997).

More than 170 haplochromine species have been recorded from rocky substrates in the southeastern region of Lake Victoria (Seehausen, 1996). In the northern region of the lake more than 180 haplochromine species have so far been recorded from the rocky habitats (Wandera pers.com). Rocks also play an important role in the life history of several non-cichlids, and for some they may be the most important places of retreat from high predation pressure in more open water habitats.

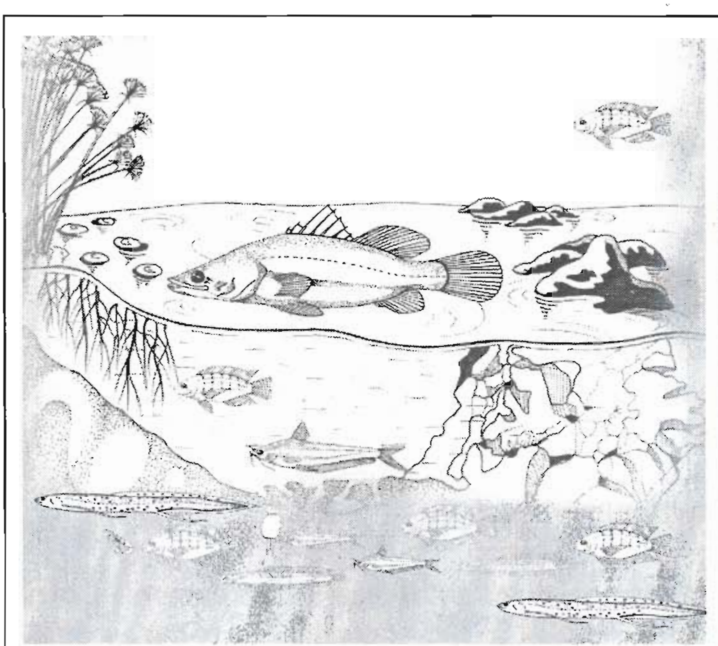


Fig. 5.1.3. Fish habitats (Refugia)

Several non-cichlid fish species have been recorded from the rocky habitats in the northern portion of Lake Victoria. Contrary to earlier belief that Nile perch would not live among rocks (Witte *et. al.*, 1992a, b), recent research has shown that the species is a frequent member of the rock-dwelling fish communities. While the juveniles of Nile perch may live together with other rock-dwelling fishes, the adults are often found hovering near these rocky habitats in search of prey that may stray out of their rock-protected habitats (Seehausen *et. al.,* 1997). The above observations indicate that rocky habitats can serve as refugia for some haplochromines and other endangered native fish species. A recent development that adds considerable stress to the rocky shore system is the heavy exploitation of rocky shore cichlid populations as bait in the Nile perch fishery.

c) Satellite lakes

Fish faunal surveys have been carried out in various satellite lakes in the Victoria and Kyoga Lake basins. Some of these lakes did not undergo introduction of exotic fish species and are spatially separated from the main lakes in which Nile perch was introduced. Many of the satellite lakes are also surrounded by extensive swamps, which provide a barrier to Nile perch invasion and human impacts. Results have indicated that most of the indigenous species depleted from the main lakes due to Nile perch predation pressure are still present in these satellite lakes (Ogutu-Ohwayo *et al.,* 1998). This is probably due to the absence of Nile perch in most of the satellite lakes. Satellite lakes and dams have played an important role in conserving endangered fish species of the Lake Victoria basin. They are said to be acting as "living museums" of East African ecological history (Mwanja *et al.,* 2001). The structural heterogeneity of macrophyte cover surrounding these lakes has made it difficult to access them. This has kept much of the biodiversity intact. Many fish species, especially the haplochromines, considered to have been eliminated from or whose numbers are very low in the main Lake Victoria, are still found in these satellite lakes. The predatory Nile perch, believed to have been responsible for the disappearance of many haplochromine species in the main lakes has failed to gain access to many of these lakes. Because of the physical and chemical conditions in some of the lakes, the predator could not survive even when directly introduced by man. In some lakes with dense underwater macrophytes cover, for example Lake Nawampasa, oxygen concentration becomes too low to support the Nile perch at night although the water is supersaturated with oxygen during daylight hours.

Fish communities of most of the satellite lakes are composed of native species. Among the tilapiines cichlids, significant populations of the two native tilapiines *O. variabilis* and *O. esculentus* remain in satellite lakes although they have been displaced from the main lakes Victoria and Kyoga. *O. esculentus*, survive as both native and introduced populations in satellite lakes within the Victoria and Kyoga lake basins. The species was recorded from Lakes Nawampasa, Gigati, Kawi and Lemwa among the Kyoga minor lakes; Lakes Kayugi and Kayanja among the Nabugabo lakes; and lakes Mburo and Kachera among the Kooki. Lakes Kayanja and Kayugi are also important reservoirs of the haplochromine cichlid *Prognathochromis venator*, which was originally found in Lake Nabugabo but is now extinct. *O. variabilis* was recorded from all the Kyoga minor lakes except Lake Nakuwa as well as from lakes Kayanja and Kayugi in the Victoria basin. Relative abundance and distribution of fish species recorded from the various areas sampled is shown in Table 5.1.1.

Table 5.1.1. Relative abundance of fish species recorded from the various areas sampled

Species	Lake Victoria	L. Kyoga	Kyoga minor	Nabugabo lakes	Koki lakes	River Sio	River Nile
Lates niloticus	27.8	61.2	0.2	11.1	0	11.0	3.7
Oreochromis niloticus	4.2	7.0	0.3	4.1	1.8	0.2	2.1
Haplochromines	44.9	10.6	50.7	42.0	79.8	0.8	2.0
Ctenopoma murieri	0	0	+	0	0	0	0
Afromastacembelus frenatus	0.1	0.1	+	0	0	0.5	0
Barbus paludinosus	0	0	+	0	0	0	0
Schilbe intermedius	0	0.3	+	1.5	0	9.2	0
Protopterus aethiopicus	0.9	1.5	3.5	+	1.8	0.1	0
Petrocephalus catostoma	0	0	5.0	6.7	0	0.6	0
Gnathonemus victoriae	0	+	0.3	10.4	0	0.8	0
Gnathonemus longibarbis	0	+	+	+	0	0.6	0
Marcusenius nigricans	0	0	+	0	0	0	0
Marcusenius grahami	0	+	0	+	0	15.5	0
Mormyrus macrocephalus	0	0.3	0	0	0	0	0.6
Mormyrus kannume	0.5	0	+	0	0	0	7.9
Clarias liocephalus	0	0	+	+	0.6	0	0
Clarias gariepinus	0.1	2.6	0.4	+	3.2	1.2	+
Brycinus jacksonii	0.1	0	0	0	0	0.1	0
Brycinus sadleri	12.8	0.1	35.3	5.3	0	28.6	3.1
Labeo victorianus	0	0	0	0	0	0.8	0
Barbus altianalis	0.1	+	+	0	0	0.1	7.3
Barbus trispidopleura	0.1	0	+	0	0	0	0
Bagrus docmac	0	0	0	0	0	0	0.6
Synodontis victoriae	0.1	6.7	0.4	0	0	16.1	+
Synodontis afrofischeri	1.7	4.9	0.7	7.3	0	13.3	+
Oreochromis esculentus	0	0	0.3	5.5	8.4	0	0
Oreochromis leucostictus	0.1	0.1	0.7	+	4.5	0	0
Oreochromis variabilis	0.8	0	+	0	0	0	1.8
Tilapia zillii	5.1	0.1	0.3	1.0	+	0	0.5
Barbus kersteni	0	0	+	3.7	0	0	0
Tilapia rendalii	0	0	0	+	0	0	0
Total No. of species	16	17	5	18	8	17	13

Key: + recorded in small numbers

The Kyoga minor lakes have the highest fish species diversity especially of the haplochromines. Most of the haplochromine species that have disappeared from Lakes Victoria and Kyoga were found to occur in most of the Kyoga minor lakes. This may be due to habitat diversity since most of the Kyoga minor lakes are separated from each other by dense stands of papyrus. They are also characterized by dense mats of water lilies and other submerged waterweeds. Lake Nawampasa for instance is separated from Lake Kyoga, where Nile perch occurs, by a dense swamp that acts as a barrier to the entry of Nile perch into the lake. In all the satellite lakes, shoreline habitats with macrophytes cover had higher fish species diversity as compared to open-water habitats. Vegetated habitats are important nursery areas for the young and juveniles of fish. Vegetation exerts an additional effect in that it supports the numerous epiphytic organisms that comprise the majority of the food of young tilapia and other herbivorous fish species (Welcomme , 1964).

The satellite lakes are suitable for conservation of native fish species since, due to their small size, they can be easily monitored. Many of these lakes can also be closed to fishing since many of them are near bigger water bodies that can provide alternative sources of fish protein. The major threats to satellite lakes include drainage of surrounding wetlands for agriculture and collection of ornamental fish for aquarium trade. Invasion by water hyacinth is also a threat especially in Lake Nawampasa.

Conclusions

Satellite lakes and rivers in the Victoria and Kyoga lake basins provide a sanctuary for endangered native fish species. Rocky and shallow inshore habitats with fringing macrophyte cover were also found to be important refugia for the endangered native fish species of the Lakes Victoria and Kyoga. However, the continued survival of these species in these lakes and habitats is threatened by human impacts such as drainage of fringing swamps for agriculture, deforestation, use of destructive fishing gears and collection of ornamental fish for aquarium trade. The rock-dwelling haplochromines are especially threatened by the fishers who use them as bait in the Nile perch fishery.

Recommendations

Satellite lakes, rivers and special habitats that provide sanctuary to endangered native fish fauna should be conserved to reduce further decline in fish species diversity. The emphasis should be on management strategies that ensure sustainable utilization of the resources. This will make it possible to get cooperation of the communities in conserving the fisheries and biodiversity in these water bodies. Reclamation of swamps and clearing of macrophytes surrounding the lakes and rivers for agriculture should be avoided to stop the spread of Nile perch and other human impacts. Culturing of haplochromines for aquarium trade and as bait should be encouraged in order to reduce on the fishing pressure exerted on them in their natural environments. Use of destructive fishing gears especially beach seines, which are operated along shorelines that are important breeding and nursery grounds for most of the fish species, should be prohibited.