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## **PREFACE**

During the last 20 years, a great deal of attention has been paid to the Lake Victoria fisheries. Both national and international organisations have been conducting research on the development trends in the fisheries resources of the lake. More recently, two large development programs supported by the World Bank and the European Union have been launched to promote policies to encourage a more sustainable exploitation of the lake's fisheries resources.

Much of the attention on the Lake Victoria fisheries is linked to the introduction of the Nile perch in the 1950s and the effects this caused two to three decades later. A major effect was the transformation of the fisheries from a broadly based multispecies fishery to one based on three dominant species; a small sardine



Although the wetland around Lake Victoria is today under human pressure and conflict as its biological resources continue to be over-exploited, socio-economic research in progress on the apparent changing status, uses and value of this valuable ecosystem is limited. Further research should be conducted on views and attitudes of indigenous peoples on biodiversity within fisheries in the wetland and open waters of Lake Victoria, to enhance conservation efforts.

In Kenya, there is a large amount of gray and preliminary data on biodiversity and socio-economics collected independently by different organizations. These should be examined, evaluated as to their significance and accuracy, analyzed and published. Despite the new efforts on the establishment of the East African Community, there are still gaps that hinder free flow of research information and networking between the different institutions and individuals working on biodiversity and socio-economics of Lake Victoria.

It may be concluded that although substantial research work has been done on Lake Victoria fisheries and socio-economics, there remains knowledge gaps in the research that aim to understand the linkages between social and economic development, biodiversity conservation and the sustainable use of natural resources.

## **ACKNOWLEDGMENTS**

I wish to acknowledge the International Union for Conservation of Nature (IUCN) who commissioned this work and funded it. In particular I am grateful to Dr. Eirik G. Jansen and Dr. Geoffrey Howard of IUCN for their initial input and contributions into this report. I also wish to thank Ms Mine Pabari for her assistance with logistics and encouragement during the work. This work would not have been well done without the input of my research assistant, Mr. Zack Otieno Ayayo, whose assistance in gathering the necessary data for this report I sincerely acknowledge. Both Mr. J.O. Manyala and Mr. P.O. Raburu of Fisheries Department, Moi University, assisted in giving various scientific information and literature and I wish to thank them all. I thank all the individuals and institutions who voluntarily gave information to me. In particular I wish to acknowledge the contribution of Kenya Marine and Fisheries Research Institute (KMFRI) and its scientists for all the scientific assistance I got during my various visits and at the Socio-economics and Biodiversity seminar held in Rongo (27-30 July 1998), where I got substantial amount of information.

*Fishermen display their catch of Nile perch. The fish catch per boat is on the decline*

## **1. INTRODUCTION**

The African Great Lakes are considered to be dynamically fragile ecosystems that are relatively resistant to minor changes with which they have co-evolved but vulnerable to major perturbations such as overfishing, the introduction of alien species and pollution. Lake Victoria is the second largest fresh water lake in the world and the largest of its kind in Africa. The lake is rich in biodiversity, of which fisheries is a major resource for the riparian communities and for export. During the last two decades the lake has encountered numerous problems and extensive resource exploitation which has constrained its productivity resulting in the drastic decline of biodiversity in general and fisheries in particular.

Since 1920s the lake has undergone successive dramatic changes. Intensive non-selective fisheries, extreme changes in the drainage basin vegetation, industrialization, agricultural developments, dams and the introduction and invasion of exotic species are among the factors that have led to the destruction of the native and endemic components of the lake. These have been followed by a progressive build-up of physical and chemical changes in Lake Victoria. For instance, to date there are substantial increases in the chlorophyll concentration and primary productivity as well as decreases in silica and sulphur concentrations compared to values measured 30 years ago (Hecky,

community towards dominance of blue-greens and an enhancement of algal blooms. In some shallow depths of the lake anoxic waters have recently been found suggesting significant increases of oxygen demand in the seasonally formed hypolimnion, (Ochumba, 1990). This situation has increasingly resulted in the impoverishment of the lake. The lakes ecosystem has also been particularly affected by the introduction of the Nile perch, *Lates niloticus* during 1950s and the water hyacinth, *Eichhornia crassipes* in 1990s, the consequence of which are detrimental to the lake's biodiversity, especially fish; leading to a shift in the fishery from a multi-species to only two major exotic species, *Lates niloticus* and *Oreochromis niloticus* and the endemic species *Rastrineobola argentea* (Ochumba *et al* 1991).

The endemic species fish and bird flocks found in Lake Victoria are today threatened by a variety of human activities. The 1988 World Conservation Union Red Book of Endangered Species listed hundreds of endemic fishes of Lake Victoria as endangered. Scientists, fishermen, and environmentalists have decried the loss of Lake Victoria's native species, while others have praised the introduction of Nile perch, some even referring to it as a 'savior'(Gibbon, 1997). Now the savior threatens to destroy itself, the lake ecosystem, and a major source of protein in the midst of the world's fastest-growing human population. More than thirty million people who depend on the lake are feeling the consequences of these changes in the biota and

lake environment. In Lake Victoria, as elsewhere, human welfare is intimately linked to concerns for species conservation and ecosystem integrity (Kaufman *et al* 1992). At the moment many fish communities of Lake Victoria are being intensively exploited to meet escalating needs for animal protein, the requirement of which is rising exponentially with the rapidly accelerating increase in human populations. However, there is sometimes only partial appreciation of the very important role which fisheries economics as a discipline can play in the unraveling of the internal workings of fishery systems.

O'Riordan (1996) argued that management of Lake Victoria's fishery resources is in need of reform to prevent a collapse in fisheries, local economies and environmental degradation. This role extends to the formulation of management, development and research strategies, the assessment of the impact of intervention measures and so on. In a review of fresh water biodiversity Stiasny (1996) observed that as the twentieth century draws to a close, the management of freshwater usage and aquatic conservation is perhaps more urgent than development effort in the world. He argued that as human populations continue to increase, the limits of the earth's freshwater resources are revealed more and more in the increasingly intense conflicts between human consumptive usage and the maintenance of aquatic health and biodiversity. However, it is increasingly evident that the pending "crisis of freshwater" will set the agenda regarding future development (Stiasny 1996). The Lake Victoria situation is already on the worse side of environmental degradation and biodiversity loss and has attracted substantial international attention.

## **2. OBJECTIVE**

The overall objective of this study was to evaluate, analyze and report on the past, present and future biodiversity research in relation to fisheries in Lake

valuable information for this review.

## **4. BIODIVERSITY RESEARCH ON LAKE VICTORIA**

### **4.1.**



the dominant non-cichlid species in the landings. Ogutu-Ohwayo (1992) reported that Lakes Victoria and Kyoga formerly had similar fish faunas of high species diversity. About 15 species or species groups occurred regularly among commercial catches and one group, the haplochromine cichlids had more than 300 spp in Lake Victoria. By the 1960s, stocks of the native tilapiines and other large species had been reduced by selective fishing. Therefore, the Nile perch, *Lates niloticus*, and 4 tilapiine spp, Nile tilapia, *O. niloticus*, *O. leucostictus*, *Tilapia zilli*, and *T. melanopleura*, were introduced to improve the poor state of fisheries in Lake Victoria.

Miller (1989) and Bruton (1990) reported that the East African lakes are inhabited by cichlid fishes which are characterized by a complex structure of interaction both between and within species, as is typical of mature ecosystems. This has produced species "flocks" that are unique to each lake in species numbers and diversity. According to Greenwood (1994) and following other recent investigations and taxonomic revisions of the species flock of cichlids in Lake Victoria and other African Great Lakes there is clear evidence that the cichlids of Lake Victoria, Edward and Kivu are components of a closely interrelated superflock, phylogenetically distinct from that of Lakes Malawi, Albert and Turkana. This and other related studies show that there are many similarities between the fish faunas and striking examples between-basin parallelism based on morphological, genetic and phylogenetic analyses may be cited; but little attention has been paid to ecological comparisons except for speculative comparisons between lakes due to lack of data. Miller (1989) reported that most of the cichlid species in Lake Victoria are facing extinction as a result of the introduction of an exotic component.

commercial fisheries and their survival is vital to local people. In recent years the population of

destruction of about 65% of the endemic haplochromine cichlids. They lamented that this represents eradication of approximately two hundred vertebrate species in less than a decade, which may well represent the largest extinction event among vertebrate during this century, resulting into far-reaching changes in the food web currently taking place in the lake. The bottom dwelling detritivores contributed most to the demersal ichthyomass. An analysis of the pelagic community in the sub-littoral area of the Mwanza Gulf revealed that the phytoplanktivores formed 17.7% of the biomass of the total haplochromine community. These studies show how the lake's collapsed ecosystem serve as a negative example of how easily a complex ecosystem can be irreversibly destroyed if no conservation efforts are put in place to reverse or even halt this trend.

The current anthropogenic activities such as overfishing and pollution have also been partly held responsible for the decline of the multispecies fishery and adversely affected the ecosystem of Lake Victoria (Craig 1992). Changes in the water quality, especially its hydrology and chemistry in the lake, were reported by Hecky and Bugenyi (1992). Talling (1966) reported on the annual cycle of stratification and growth in Lake Victoria. Other ecological changes in Lake Victoria have been reported by Marten (1979); Ligtvoet and Witte (1991); Lowe-McConnell (1994); Kaufman (1992); Reinthal and Kling (1994); Ochumba *et al* (1992); Mwebaza-Ndawuli (1994); Ochumba and Kibaara (1989). Gophen *et al* (1995) also reported on some aspects of perturbation in the structure and biodiversity of Lake Victoria ecosystem and observed that the dramatic ecological changes occurred after the introduction of the Nile perch in the 1950s as a result of which an extraordinary spectrum of endemic haplochromine fish suffered massive reductions. Originally, the massive species flock comprised nearly 400 species encompassing a wide trophic spectrum and made up 83% of the

*Tilapia zillii* and *O. leucostictus* were abundant.

Amongst the recently introduced fish species in Lake Victoria Ogotu-Ohwayo (1992) reported that stocks of *L. niloticus* started to increase rapidly followed by the Nile tilapia. As these introduced spp flourished, stocks of most of the native spp declined rapidly and some completely disappeared; of all the native spp, only *R. argentea* was still abundant by 1988. Abiotic and biotic factors affecting the diversity of the native fish fauna were also discussed by Ogotu-Ohwayo (1992) in Uganda. In Jinja, Uganda Basasibwaki (1992) reported that the gillnetting and beach seining operations in Napoleon Gulf of Lake Victoria indicated considerable decline in haplochromine abundance and species diversity as compared with the situation in the same gulf twenty years ago. There was differential disappearance among the five trophic groups examined. He observed that since Lake Victoria ecosystem was unstable, it was difficult to predict future trends of the surviving haplochromines in the lake. Other studies in Uganda by Okaromon (1994) found that the fisheries in Lake Victoria are changing rapidly: haplochromids, lungfish (*Protopterus aethiopicus*) and catfishes (*Clarias mossambicus* and *Bagrus docmac*) are disappearing fast from the catches; two introduced species (*Lates niloticus* and *Oreochromis niloticus*), together with the indigenous *Rastrineobola argentea*, are now the only important species.

In Kenya, Asila (1994) reported that changes in the species composition of the fisheries have been influenced by an array of factors, namely the establishment of 2 of the 6 introduced species, changing exploitation patterns of the fishery necessitated by the increase in population, disappearance and re-appearance of some fish species, political and socio-economic development of the riparian states, introduction of more complex fishing gear into the lake, interspecies competition and an insatiable external market. Ogari (1992) observed that the decline and succession of species is due to over-fishing over the years. According to Ogari (1992), originally fishing depended on the two tilapiine species namely *O. esculentus*, and *O. variabilis* but the recent over-fishing of the tilapiine created a decline in catches resulting in succession of the dominant non-cichlid species in the landings. He observed that the management measures applied to improve the fishing in 1950s and early 1960s such as introduction of *L. niloticus* and *O. niloticus* into the Kenyan waters has impacted negatively on the diversity and abundance of the indigenous species as they became established. Recent massive fish mortalities in Lake Victoria have been reported by Ochumba (1992) and Kaufman and Ochumba (1995)

and drastic ecological changes due to human perturbation of the lake's ecosystem has been implicated as the cause. Wandera (1992) discussed the possible causes of occasional massive fish death in Lake Victoria.

Studies in Tanzania by Witte *et al* (1992) revealed some vital information on the dynamics of the haplochromine cichlid fauna and ecological changes in the Mwanza Gulf of Lake Victoria. Witte *et al* (1990) also reported on reproductive strategies of zooplanktivorous haplochromine cichlids from Lake Victoria before the Nile perch boom. Further work by Dawes (1986) revealed that Lake Victoria indigenous fish species, especially cichlids, face extinction.

The fisheries of Lake Victoria have undergone substantial changes in recent years owing, in particular, to the rapid proliferation of the introduced *L. niloticus* (Reynolds and Greboval 1988). There has been intense controversy over its impact on the fisheries of the lake, especially with respect to the ecological disruption of endemic species and its possibly adverse socio-economic/advantageous consequences. Studies on the aspects of the evolution of the Nile perch fishery shows the impact of Nile perch to have been both profound and ambiguous. Globally, the Nile perch fishery has been so far an exceedingly positive development from an economic benefit and food resource viewpoint (Reynolds and Greboval 1988).

However, ecological implications of Nile perch in the lake has caused a lot of cony5giia93 TPrce\* -1.76 0.36 Tw ( )

which preyed upon them, which included two endemic tilapiine cichlids and 38 species of non-cichlids, no longer exists. It has been replaced by a community dominated by *L. niloticus* which now accounts for well over 80% of the fish biomass in the Nyanza Gulf. The only other species regularly encountered are *O. niloticus* and *R. argenteus* (Hughes 1986).

Comparing developments in areas with and without a haplochromine fishery reveals that the impact of *L. niloticus* on the haplochromine stock in order of magnitude is larger than that of other fishes. In most regions the majority of the fishermen have turned to fish on *L. niloticus*, sometimes hampered by the lack of suitable material (Goudswaard and Ligetvoet, 1988). In an *FAO fisheries report* (1987) the impact of *L. niloticus* on the fish ecology in the Kenyan waters is discussed with respect to predation on other fish species and competition for food. Changes in the diet of *Lates* was found to decrease, with respect to the abundance of target prey being the major factor affecting the changes in food organisms. *L. niloticus* has thus had a direct impact on other fish species in the lake (*FAO fisheries report* 1987).

According to Ogutu-Ohwayo and Hecky, (1991) *L. niloticus* in the lake has virtually eliminated a number of endemic species resulting into the loss of genetic diversity accompanied by a loss of trophic diversity; the transformation of the fish community coincided with profound eutrophication (algal blooms, fish kills, hypolimnetic anoxia) which might be related to alterations of the lake's food-web structure. Riedmiller (1994) observed that introduction of the Nile perch into Lake Victoria has dramatically altered the fishery in that lake and contributed to the decline of the fishery for indigenous tilapias. Hoza (1990) analyzed the evolution of fisheries systems of Lake Victoria between 1979-1989, taking into consideration the major changes which have occurred in the fisheries before and after the introduction of Nile perch and reported significant ecological and species diversity alterations.

However, according to Getabu (1988), the major fisheries started to decline long before the introduction of the Nile perch (*L. niloticus*), therefore it is questionable whether this predatory species is the sole cause of decline in the stocks of tilapia and anadromous fish. Acere (1988) argued that the introduction of *L. niloticus* was conducted mainly to increase fish populations for the ever increasing human population following the collapse of the endemic tilapia fisheries. He reviewed the events which have taken place in the lake regarding its fisheries in order to understand better the

controversy which currently exists. He observed that the decline of the haplochromines of the lake is most probably due to overfishing and to some extent as a result of the piscivorous habits of adult Nile perch. Reynolds and Ssali *et al.* (1990) also argue that the decline of the haplochromines is as a result of predation pressure in combination with fishing mortality and environmental change. They go on to argue that although the Nile perch has been highly valued as a "producer of food and wealth", this has resulted in massive ecological upheaval, which has made it difficult to evaluate the costs and benefits involved. However, Ogari (1988) observed that prior to the introduction of *L. niloticus*, a balance between predators and prey species had evolved in Lake Victoria. Adaptations by both predators and prey had ensured that extermination of a species would not occur as a result of predation. In Lake Victoria, as in other lakes where this species has been introduced, many endemic prey-species have been almost eliminated and the *L. niloticus* population is now largely cannibalistic (Ogari 1988). The view of Ogari (1988) is supported by other authors such as Reynolds and Greboval (1988), Moreau, *et al* (1993), Achieng' (1990), Mkumbo and Ligetvoet (1992) and Asila (1994). Okaronon (1994) conducted a bottom trawl survey in Uganda sector of Lake Victoria during the period May 1993 through May 1995 to establish the current composition, distribution and abundance of the fish stocks. Fourteen fish taxa (excluding the Haplochromis) were recorded, with *L. niloticus* making up the bulk of the fish retained. Turner (1994) observed that despite the vulnerability of individual species, Lake Malawi's haplochromine cichlid communities have been shown to be capable of sustaining high yields at high levels of exploitation, suggesting that the replacement of the haplochromine cichlids by Nile Perch in Lake Victoria is unlikely to have been a consequence of fishing.

#### **4.4. Other vertebrates**

Lake Victoria, especially its wetland ecosystems, is rich in vertebrate species other than fish, most of



pumping station was associated with periods of

fluctuations in Lake Victoria and other lakes and discussed their deepwater habitats, evolution and habitat type, and rates of speciation. He examined the relationships between fluctuations in the lake environments and modes of their evolution.

#### **4.8. Biodiversity Conservation in Lake Victoria**

At the moment the *biological integrity* of the Lake Victoria and its biodiversity are in a precarious condition. Biological integrity was defined by Angmeier and Karr (1994) as being “a system's wholeness, including the presence of all appropriate elements and occurrences of all processes at an appropriate rates”. This definition is based on ecological principles and may also be referred to as the Index of Biotic Integrity (IBI). According to Karr (1991), the IBI is based on an array of indicators combined into one or more simple indices and may be used to detect degradation, identify its cause and







from the lake. Thus, in Kenya, there is already much concern on the current over-exploitation trends of the lake's fishery resources amongst the local communities, fish processors and the government as more and more juveniles which cannot be filleted are landed (Abila and Jansen 1997). These observations lead to the conclusion on the need to control the type of fisheries and expansion of the fish processing and export industry to ensure food security and sustainable exploitation of the fisheries. In recent socio-economic studies Yongo (1998) reported on the impact of changing fish species on nutrition and health of lakeside communities while Gutwa (1998) reported on the marketing of fish and fish by-products and their impact on Lake Victoria lakeside communities. Abila (1998) reviewed the socio-economics of Lake Victoria fisheries in relation to the Lake Victoria Environmental Management Program (LVEMP).

Some socio-economic changes in Lake Victoria have been reported especially in relation to commercial Nile perch fisheries in Tanzania. Katunzi (1990) observed that the lake is a vast fisheries resource and therefore attracts the riparian states to explore the possible ways of identifying the optimal use of its resources. His paper analyses the research and development activities along the Tanzanian side of Lake Victoria and summarizes the major programmes and results. In addition he made an evaluation of the socio-economic effects of these activities and concludes with future recommendations. Mkisi (1991) conducted socio-economic surveys in the Mwanza region on fishermen, processors, traders and consumers with special emphasis on living conditions, division of ownership, characteristics of fishing units, fishing operations, costs and earnings, and income generation. From their research, conducted mostly in Tanzania, Wilson and his colleagues from PLEA have given a series of reports discussing several socio-economic issues related to Lake Victoria fisheries. Such include:

- Lake Victo53 on

problems facing the region.

## **6. INSTITUTIONS WORKING ON LAKE VICTORIA FISHERIES**

In recent times a number of national, international and non governmental institutions have turned their attention into conducting research and conservation on Lake Victoria. In Kenya the following governmental institutions continue to conduct research on different aspects of Lake Victoria some of which are only remotely related to biodiversity and socio-economic issues of the lake's fisheries resources.

### **6.1. Governmental institutions**

#### **6.1.1. Kenya Marine Fisheries Research Institute (KMFRI):**

KMFRI has become the key player in Lake Victoria in Kenya research especially targeting fisheries sub-sector. With its station and staff based on the shores of Lake Victoria, KMFRI coordinates and conducts research on fisheries biology, mortalities, stock assessment, aspects of aquatic macro- and micro-fauna and flora as well as some aspects of water quality, pollution and biodiversity degradation. KMFRI also works in collaboration with a number of international research or donor organizations. Biodiversity and socio-economic research work in KMFRI is at an early stage but some valuable preliminary data has been generated, especially on changes of fisheries diversity as related to species introduction, over fishing and pollution. KMFRI continues to conduct some magnificent work on the socio-economics of Lake Victoria, some of which were presented at the recent seminar on biodiversity and socio-economics held at Rongo, Kenya (27 July-5 August 1998). There is need to focus this work on the changing status the lake's biodiversity. Of particular interest in this review is the KMFRI's work on stock assessment being supported by EEC and the biodiversity and related research supported by the GEF/World Bank LVEMP.

#### **6.1.2. Kenya Medical Research Institute (KEMRI)**

KEMRI's station based in Kisumu is mainly concerned with water related diseases in Lake Victoria. Although KEMRI has not targeted its programmes to fisheries biodiversity, it is of interest that some efforts are being placed on changes of biodiversity in disease vectors, their prevalence and disease epidemiology as they affect the health and activities of communities around the lake. Data on these aspects will be of great value if synchronized with the socio-economic studies and biodiversity in

the lake.

#### **6.1.3. Lake Basin Development Authority (LBDA)**

Although much of the data from this organization is rarely published, the work that the authority continues to do in relation to water quality, fisheries and water related diseases in the Lake Basin region can not be ignored. The authority has particularly compiled a lot of raw data on water quality and aquaculture that if analyzed will provide an insight into the management of Lake Victoria fisheries.

Other activities of the Authorities that should be examined in relation to their effect on Lake Victoria biodiversity and socio-economic implications include agriculture/horticulture (especially

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individual work done by university scientists, this review considers them not as part of the university's or institutional efforts towards conservation of the lake's biodiversity. Furthermore, past work at the universities are mainly in the form of student thesis outputs, with limited follow up and continuity. In recent times some Kenyan universities have started institutional research on Lake Victoria especially fisheries. Considerable data is available on work done by scientists from Nairobi University, Department of Zoology. In Moi University, research work is in progress at the Department of Fisheries and School of Environmental Studies. In addition to its contributions in capacity building and research in environmental issues of the lake, Moi University has established a research presence on the shores of Lake Victoria, through its Homa Hills Environmental Research Station, where a full team of researchers and postgraduate scholars conduct research on various aspects of environmental and socio-economic issues. Of particular interest in this program is that this would be one of the rare occasions when university research seeks to involve community in environmental research and conservation. A typical example is the Nyando wetland Conservation Program (NWP) being conducted by the School of Environmental Studies in collaboration with the Kenya Wild Life Service, Lake Basin Development Authority, OSIENALA and the Nyando Wetland Community. Based on this successful pilot project the School's Research Station at Homa Hills will play a key role towards research and conservation of Lake Victoria biodiversity with a strong socio-economic base. According to a report by Okoth (1996), Maseno University College is also establishing a strong base for studies on Lake Victoria, through its recently established Center for the Study of Lake Victoria and its Environs (CSOLVE).

#### **6.1.6. National Museums of Kenya**

This has become a major national and regional research facility in biodiversity. With its major biodiversity activities based in Nairobi, the NMK is making good strides towards biodiversity studies in Lake Victoria. The institute is a regional repository of biological specimens in the region both as materials for conservation/preservation, taxonomy and scientific research. Additionally, the NMK collaborates with other national and international institutions in biodiversity research. Biodiversity research on Lake Victoria at the NMK is still at its infant stage and mostly emphasizing generation of basic scientific data especially on species and genetic diversity for fish and related fauna. At the floral level the NMK has participated on collection, identification and preservation of different indigenous flora in Kenya including aquatic and

terrestrial plant species in the lake region. Such studies also have some socio-economic interests which the NMK is yet to address. In terms of Lake Victoria fisheries, the NMK has little scientific input except for the current preliminary thesis study on genetic diversity of tilapia in species.

#### **6.1.7. Kenya Wildlife Service**

Kenya Wildlife Service is a governmental parastatal with the mandate to conserve the country's wildlife resources including those within the Lake Victoria and its basin. KWS has currently established a biodiversity program for western Kenya. KWS collaborates in and supports programmes on the biodiversity rich wetlands. Other area around the lake where KWS is active is the Ruma National Park, the Ndere Island Natural Reserve, the Kakamega Forest, the Got Ramogi Sacred Forest Project and other areas of ornithological interest. KWS has also supported several biodiversity conservation initiatives in and around Lake Victoria. Of particular interest to this review is the Nyando Wetland Conservation Program, a community based research and conservation program in Nyando River Wetland area. In this project KWS, through its biodiversity and partnership offices in western Kenya, are part of a team conducting community awareness creation, research and demonstration of conservation techniques at the grassroot levels in Nyando District. KWS also has the mandate to control the human-wildlife conflicts in areas outside official gazetted parks. For wetlands in this category, KWS offers advise and protection, especially to the farming communities by controlling the marauding hippos through scaring them back into their wetland habitats. The KWS and indeed the Kenya Government values the lake and its rich biodiversity and places every effort in their conservation. Even with these efforts KWS does not seem to be directly involved with fisheries resources in the lake as much as it does on terrestrial species. Furthermore, there is still no effort to conduct socio-economic research in this area.

#### **6.1.8. Lake Victoria Environmental Management Program (LVEMP)**

This regional program being implemented by the three riparian countries around Lake Victoria is one of the largest forms of environmental conservation interventions in and around the lake. The program was initiated in response to the eminent ecological collapse of the lake resulting from a number of adverse effects on the water quality and fisheries biodiversity. With its several research, capacity demonstration of tiated

organizations in Kenya, Uganda and Tanzania. Details of the program are in the project document but it is worth mentioning here that the program will need to target more efforts on research on biodiversity degradation, conservation and related socio-economic situations in the lake and its basin.

#### **6.1.9. Other National organizations**

These exist in Uganda and Tanzania especially TAFIRI in Tanzania and FIRI in Uganda but are not reviewed, though they may be mentioned in this text in relation to regional collaboration efforts on Lake Victoria fisheries research. The recently formed Lake Victoria Fisheries Organization (LVFO) will hopefully greatly enhance conservation, research and sustainable management of fisheries resources in the lake. LVFO was established in 1980 to provide a forum for regional collaboration in the development and management of the fisheries of Lake Victoria. The organization is an independent inter-governmental organization that aims to harmonize national measures for the sustainable utilization of the living resources of the Lake and provide a forum for discussion of the impacts of initiatives dealing with the environmental and water quality in the Lake basin.

### **6.2. Non-Governmental and international Organizations**

#### **6.2.1. Lake Victoria Fisherfolk Association**

This organization has just been registered by the Kenya Government. Its main objective is not to conduct research but to form a strong partnership of the Lake Victoria local fisherfolk with other institutions (or on their own) in decision making, planning, implementation and evaluation process of fishery policy, management and conservation. Furthermore, the association aims at effectively lobbying and advocating on behalf of the fisherfolk for a positive change of events especially in respect to conservation and sustainable use of the lake's fisheries resources. The formation of this organization is seen by the patrons as a means of averting both environmental and economic crisis's now facing the fishing communities along the Nyanza Gulf. From biodiversity research stand, this institution comes in at the right time when there is need to involve the fisherfolk in community based research, conservation and sustainable use of Lake Victoria fishery resources.

#### **6.2.2. Friends of Lake Victoria (OSIENALA) Environmental Program**

This is a Kenyan based organization registered in 1993 to fight the environmental degradation of Lake Victoria and its environs. Since its inception

OSIENALA has carried out projects such as the implementation of the UNDP/GEF supported Lake Kanyaboli rehabilitation program and Sondu Miriu/Nyando wetland conservation project. It has also been conducting numerous local and regional training and workshops on the conservation of lake's fisheries resources. Through these efforts OSIENALA has also put into place a number of valuable publications concerning the lake conservation and has been lobbying for participation in the regional Lake Victoria Environmental Management Program (LVEMP), (OSIENALA 1995). A lot of OSIENALA's work has been associated with socio-economic issues and biodiversity loss in Lake Victoria without necessarily linking the two. In Eastern Africa OSIENALA remains a grassroot institution concerned with community based environmental conservation activities around Lake Victoria. There



lake and around the lake. Research work is needed to ascertain the socio-economic and biodiversity implications of these changes in order to plan for conserving the rich avian diversity in the basin. For instance, it would be useful to study the changing perching behavior and resting sites of birds as the trees are being cut for fuelwood and wetland are being reclaimed or as some rivers such as Sondu/Miriu are being dammed for production of hydro-electric power. Research is required on the changes in the aquatic birds feeding behavior and types of fish species being fed on.

3. Changes in the Nile perch feeding behavior and those of other fish species appear to occur in relation to the changing ecosystems in the lake. There is need to start monitoring the changes in prey species diversity by gut analysis. This will help in suggesting to what extent such changes are affecting the diversity of prey and their sizes. As yet there is no evidence that sufficient baseline data exists on this important area.
4. Changes in population structure of the Nile perch fisheries need to be intensified as the fishing pressure increases and the consequent impact on the diet of the Nile perch and the fisheries biodiversity, with special emphasis on regional relationships in time and space.
5. Due to the changing fisheries in the lake, the riparian communities are becoming more dependent on fish processed products especially their by-products for their income and subsistence. Socio-economic research in this is still inadequate, particularly with respect to affordable sources of protein and income generation.
6. It is well known that Lake Victoria and its catchment is rich in biodiversity and that this rich resource is fast declining. The problem is that to date there is no authoritative catalogue on the indigenous biodiversity of the lake and associated wetlands that would assist in continued evaluation, monitoring and up

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significance, accuracy and reliability as base line information for future research. It is suggested that further consultancy work will greatly assist in compiling this information and presenting them as publications.

10. To date there is much proliferation of Non-governmental Organizations (NGOs) and programmes seeking to contribute to the conservation of lake Victoria or just gambling to benefit from the donor support targeted for conservation of the lake. There is need to evaluate the contribution of such institutions so as to consolidate their efforts. While in Kenya, OSIENALA poses a strong presence in the

## **8. CONCLUSIONS**

Certainly, substantial research work has been done on Lake Victoria fisheries and socio-economics. Most of this has targeted the exploitation of the fisheries resources in the lake. Some recent work has been done on the biodiversity of the lake but a lot remains to be done. Of particular interest would be the relationships between the lake's biodiversity and socio-economic studies, which is still wanting. The great pressure placed on the lake's resources by the heavy populations around the lake calls for investigations on the coping strategies of the riparian communities and conservation plans for the future. Despite the recent establishment of LVEMP, which by nature of its implementation excludes many stake holders, there is need to forge strong linkages between the riparian communities to help facilitate data gathering. For instance there is need to form comparable NGOs in Uganda and Tanzania to complement the efforts of OSIENALA in Kenya. There is also need to form stronger research linkages and exchange visits between the different institutions working on Lake Victoria. From this study it may be concluded that there is still much scope for socio-economic and biodiversity research in Lake Victoria and its catchment basin.

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**Annex 2. INDIVIDUALS ASSOCIATED WITH BIODIVERSITY AND SOCIO-ECONOMICS RESEARCH ON LAKE VICTORIA**

**1. Persons and Contacts in Kenya**

Abila, Richard - Socio-Economics of Lake Victoria fisheries, KMFRI, Kisumu, Kenya.

Asila, A. (1992) [KMFRI, Kisumu]; M.Phil. candidate, Currently working on Selectivity of gill nets on Nile Perch in L. Victoria (KMFRI/Moi Univ.).

Gutwa, G.K. (1998) Marketing of fish and fish by-products and their impact on Lake Victoria lakeside communities, KMFRI, Kisumu, Kenya.

Olulu H. O. -Managing fisherfolk union with cold storage facilities for Nile perch. Suba District Co-operative Union. P.O. Box 205, Homa Bay.

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Oyieke, Hilda, PhD. Lake Victoria Biodiversity Research, National Museums of Kenya, Nairobi.

Raburu, O P. M.Sc. D.Phil (scholar). Drp. of Fisheries, Moi University, P.O. Box 3900, Eldoret. Biodiversity of fish in Nyando Wetland.

Rasowo, Joseph Ouma, PhD, wants to enterprise rice/fish farming in the Nyando Plains (Funding from Support Africa). Moi University Fisheries Dept. P.O. Box 3900 Eldoret.

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Wangila, B.C. PhD. Fish Geneticist. Starting to look at the effect of water hyacinth on the abundance of fish in L. Victoria.

Yongo, Ernest (1998) The impact of changing fish species on nutrition and health of lakeside communities. KMFRI, Kisumu, Kenya.

## **2. Persons and Contacts in Tanzania:**

2.1. Tanzania Fisheries Research Institute P.O. Box 475, Mwanza;

- a. E.F.B. Katunzi, M.Sc. Centre Director, Tanzania Fisheries Research Institute (TAFIRI) Mwanza Station.
- b. Mahongo, B.Sc. Oceanographer, (TAFIRI, Mwanza) .
- c. Mary Kishe, B.Sc.
- d. Mukumbo, M.Sc. Stock Assessment (TAFIRI, Mwanza).
- e. Nsinda, B.Sc. Stock Assessment (TAFIRI, Mwanza).
- f. Yohana Budeba, M.Sc, Limnologist (TAFIRI, Mwanza).

## **3. Persons and contacts in Uganda:**

Basasibwaki, P. Uganda Fisheries and Forestry Research Organization (UFFRO), Jinja. Research on abundance and species composition of haplochromines in Lake Victoria.

Byarujali, S.M. Dept. Bot. Makerere, P.O. Box 7062 , Kampala - Diatom species diversity.

Katonda. K.I. Deputy Executive Secretary. Lake Victoria Fisheries Organization (LVFO). Jinja, Uganda.

Kateyo, E.M. Institute Environment & Natural Res48 5Es. Mwkerere, UnTD 039, P. C. Box 015761, Bz 21011, BvM (LVFO)

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**Annex 4. Institutions involved in supporting research on Lake Victoria Fisheries**

1. European Union (EEC) Lake Victoria Fisheries Project Stock Assessment.
2. FAO - Improved Utilization of Nile Perch.
3. FAO/Inland Fisheries Planning Project Pelagic Fisheries (*Rastrineobola argentina*).
4. Haplochromine Ecology Survey Team (HEST) & University of Leiden (Tanzania) Haplochromine.
5. IDRC - Fish systems (Uganda/Tanzania).
6. IFAD- Uganda: Project.
7. IUCN-EARO; regional project on the “Socio-economics of the Nile perch Fishery in Lake Victoria”
8. Kenya Belgium Joint in Fisheries Ecology Water quality.
9. Kenya Marine Fisheries Research Institute Haplochromine.
10. UNDP/ Belgium survival Fund. - Development of Small Scale Fish Farming Program: Lake Basin Development Authority.
11. New England Aquarium (Kenya Uganda and Tanzania). Cichlids, Limnology, aquaculture.
12. UNDP - Lake Kanyaboli/Project Yala Swamp.-OSIENALA.
13. University of Michigan Socio-Economics: FLEA (Dr. D.C. Wilson).
14. USAID/ILOR -Israeli Limnological & Oceanography Research Limited Cichlids & Limnology.
15. Wetland Ecologist National Environment Management Council (NEMC).
16. Kenya Wildlife Service (KWS) - Nyando Wetland Biodiversity Conservation Research Program.
17. Kinneret Limnological Lab-Israel and Harvard University respectively] Changes in oxygen availability in the Kenyan portion of Lake Victoria: Effects on fisheries and biodiversity.