Key elements of fisheries management on Lake Victoria

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The fisheries of Lake Victoria have always been dynamic and the relevant authorities have continually tried to manage them. During the second half of the last century, numerous changes took place and fisheries managers had to cope with influences other than exploitation, including species introductions, invasive weeds, lake level rise, changes in water quality, and illegal fishing practices. These have influenced the way the fisheries have been managed.

In the 1920s, measures existed to manage the fisheries of Lake Victoria. In those days, a minimum net mesh size of one inch was in place, as well as certain restrictions for trawling and other fishing methods. Over the years, certain fishing gears and methods have been banned; some bans were lifted and then reimposed; minimum mesh sizes have shifted as a result of changing species compositions and changing needs to protect components of the stock. More recently, the fishery has been subjected to a series of bans on export to the European Union because of outbreaks of cholera and fish poisoning practices.

This article presents an overview of fisheries management on Lake Victoria, the successes and failures, impacts of fish exploitation and invasive weeds on species diversity, results of a major research project on the lake to assess the status of the fisheries, and the way forward.

Keywords: management, Nile perch, overexploitation, regulations

Introduction

Fisheries collaboration in East Africa, particularly among Kenya, Uganda and Tanzania, is perhaps one of the oldest on the continent. As early as 1928 it was recommended that a collaborative lake-wide authority for regulation and collection of fisheries statistics be established (Graham, 1929). With the establishment of the East African Freshwater Fisheries Research Organisation in 1947, a consolidated collaboration was established and further intensified with the formation of the East African Community (EAC) in 1967.

In the early 1970s, Kenya, Uganda, and Tanzania became members of the FAO Committee for Inland Fisheries of Africa (CIFA). Some of the objectives of CIFA are: a) to assist member countries to establish the scientific basis for regulatory and other management measures for the conservation and sustainability of inland fisheries resources; b) to formulate such measures through subsidiary fisheries bodies or sub-committees as required; and c) to make appropriate recommendations for adoption and implementation by member states. In the case of Lake Victoria, implementation of fisheries and environmental measures was fairly well facilitated by the East African Community.

With the collapse of the East African Community in 1977, this important regional coordinating mechanism crumbled. The riparian countries, however, felt the need to continue collaborating in the development and management of the fisheries of Lake Victoria and, subsequently, a CIFA Sub-Committee for Lake Victoria was formed in December 1980. This sub-committee

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continued providing a unique forum for regional collaboration in the development and management of Lake Victoria's fisheries after the collapse of the EAC.

Between 1991 and 1995 a number of meetings were held in the Lake Victoria region, under the auspices of the FAO-CIFA Sub-Committee for Lake Victoria to discuss management issues, options, and strategies for each of the riparian states. These led to a regional meeting for the management of Lake Victoria and the creation of the Lake Victoria Fisheries Commission. The latter was later changed to the Lake Victoria Fisheries Organization, which was inaugurated in June 1994 (LVFO, 1999).

Recent changes in the Lake Victoria fishery

Lake Victoria has traditionally supported valuable fisheries, which are an important source of protein for the indigenous peoples. However, the fishery has exhibited considerable change over the last 80 years. Evidence of a decline in catches started as early as the 1920s (Graham, 1929) and resulted in the introduction of *Tilapia melanopleura, Tilapia zillii, Oreochromis leucostictus*, and *Oreochromis niloticus* in the 1950s (Welcomme, 1988). Overfishing was confirmed as early as 1972 (Worthington and Lowe-McConnell, 1994). Haplochromines, which contributed 80% of the demersal fish stocks (Kudhongania and Cordone, 1974) were not utilized until late 1970s when fish meal processing factories were established. The introduction of Nile perch (*Lates niloticus*, L.) in the late 1950s and early 1960s altered the fishery and, with other factors, resulted in changes in the lake's ecosystem and the food web (Ogutu-Ohwayo, 1990, 1995; Ligtvoet and Mkumbo, 1992; Witte et al., 1992). Increased pollution and clearing of the peripheral wetlands (Kaufman, 1992; Hecky, 1993; Muggide, 1993), which served as fish nursery grounds, may have seriously affected the fisheries and the lake resources in general.

Despite a continuous decline in many endemic food species such as *Oreochromis esculentus* Graham, *Bagrus docmak* Forsskall, *Clarias gariepinus* (Burchell) and *Labeo victorianus* Boulenger, there has been a rapid increase in total landings from early 1980 to a peak in the early 1990s (Figure 1). Catches increased five times from 85 914 t to 567 660 t and Nile perch contributed over 70% of the total landings, and up to 97% in trawl catches (Bwathondi, 1990; Ligtvoet et al., 1995). Catches for other fish species decreased even further and species groups like the haplochromines almost disappeared in bottom trawls (Ligtvoet and Mkumbo, 1992). With increased fishing pressure, predation, and competition among species, the multispecies fishery of Lake Victoria fishery changed to only three species: Nile perch (*Lates niloticus*), the pelagic cyprinid—dagaa (*Rastrineobola argentea* Pellegrin), and the introduced tilapiine (*Oreochromis niloticus* L.) (Figure 2).

In the mid-1990s, Nile perch, the dominant species in the fishery, showed signs of decline. Changes in

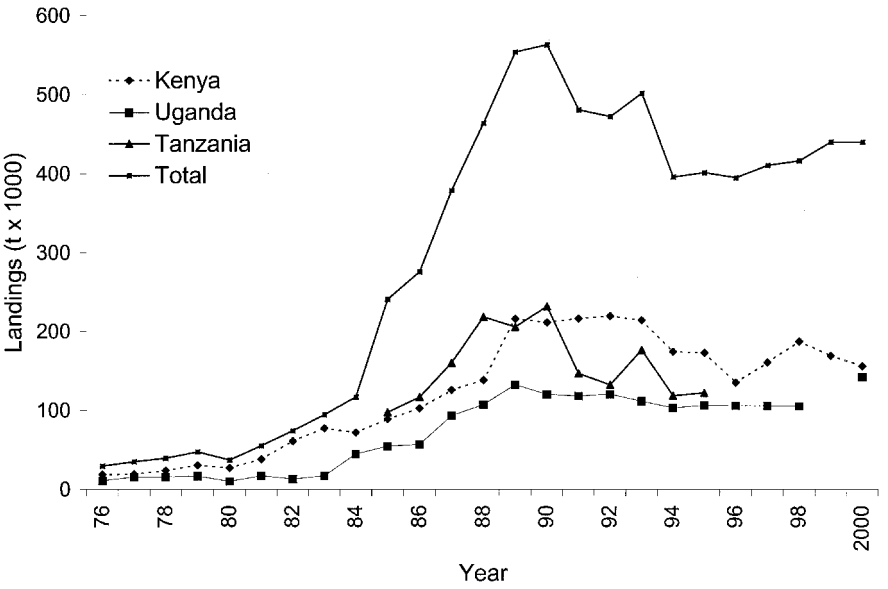

Figure 1. Total landings (t) of fish in the three riparian countries of Lake Victoria.

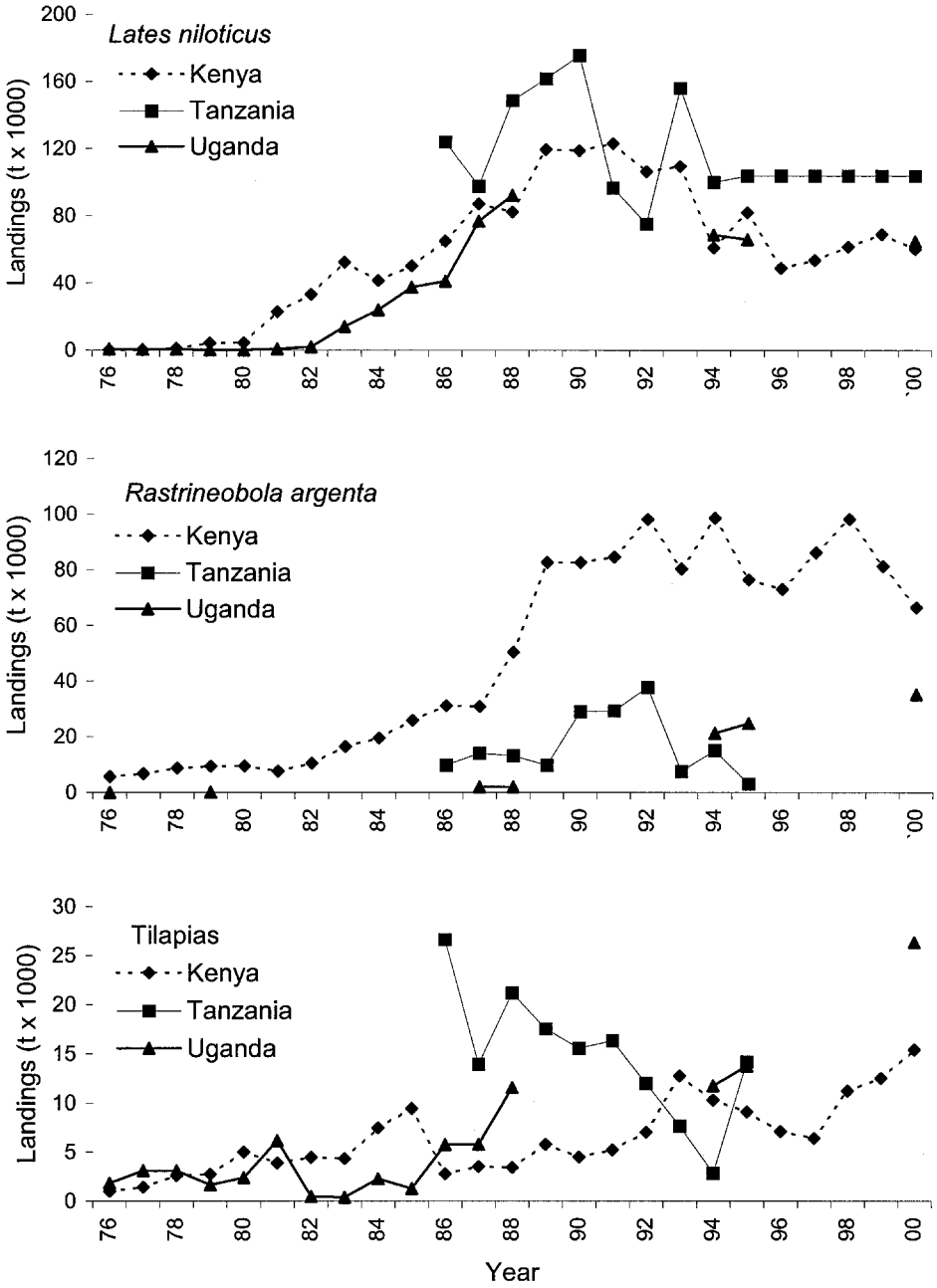

Figure 2. Trends in landings (t) of the major commercial fish species in the riparian countries of Lake Victoria.

the efficiency of fishing gears, motorization of canoes and increase of total fishing effort to maintain the yield have been observed (LVFO, in press). Extension of fishing grounds is also evident, but all against a continued decrease in catch per unit effort and mean size of fish caught (Mkumbo and Cowx, 1999; Othina, 1999).

History of fisheries management in Lake Victoria

In the 1920s, a minimum mesh size was in place, as well as certain restrictions for trawling and other fishing methods. The first colonial legislation to cover Lake Victoria was the Fish Protection Ordinance, 1908

Table 1. Management measures for Lake Victoria (after HEST, 1989).

Management Measure	Kenya	Uganda	Tanzania
Gillnet mesh for catching			
Nile perch	152 mm	127 mm	
Tilapia	102	127 mm	76 mm in bays
Rastrineobola (dagaa)	10 mm	10 mm	
Minimum fish size landed			
Nile perch	50 cm	48 cm	30 cm
Tilapia	25 cm	28 cm	15 cm
Rastrineobola (dagaa)	4.0 cm	4.5 cm	
Seine net for dagaa		Total ban	
Beach seines		Total ban	
Trawling			No trawling in bays
Gillnets		No monofilament gillnets	No monofilament gillnets
Closed areas	Kisumu Bay for dagaa	Recommended	24 Closed areas gazetted
Close season	For dagaa from 21 May–1 August	Recommended	Exists from 1 January–30 June

(Cap.s 163 Laws of Kenya), which prohibited the use of mesh-sizes of below one square inch (Dobbs, 1927). The Ordinance also introduced licensing and boat registration rules for "non-native Africans" (Dobbs, 1927). Over the years, certain fishing gears and methods have been banned, and some bans were lifted and then reimposed; minimum mesh sizes have shifted as a result of changing species compositions and changing needs to protect components of the stock.

The introduction of Nile perch and the sudden upsurge of this species led to an expansion of the fishery and the need to manage the stocks more effectively. The initial recommendations for managing the Nile perch stocks (HEST, 1989) are summarized in Table 1.

In response to the changes in fishery exploitation patterns resulting from the Nile perch boom, more appropriate management measures (CIFA, 1994; summarized in Table 2) were proposed by the various riparian countries in the mid 1990s. These measures have never been fully enforced and, more recently (LVFO, 2000), a call has been made to promulgate these regulations. Furthermore, in view of the clear

Table 2. Management measures for Lake Victoria (after CIFA, 1994).

Management Measure	Kenya	Uganda	Tanzania
Gillnet mesh for catching			
Nile perch	127 mm	127 mm	127 mm
Tilapia	127 mm	127 mm	
Rastrineobola (dagaa)	10 mm	10 mm	10 mm
Bagrus/Clarias/Protopterus		127 mm	
Seine net for dagaa	>200 m from shore	Total ban	Total ban
Beach seines	Total ban	Total ban	Total ban
Trawling	Total ban	Total ban	Permitted beyond 20 m depth
Longlines for Nile perch		Encouraged	
Traps and weirs on rivers	Total ban	Total ban	
Cast nets		Recommended ban	
Closed areas	Recommended	Recommended	24 Close areas gazetted
Closed season	Recommended	Recommended	Exists from 1 January to 30 June
Water hyacinth control		Recommended	Recommended

evidence of over-exploitation prevalent in the lake fishery (Mkumbo et al., 2002), attention is now focusing on reducing fishing pressure. This is primarily directed at invoking comanagement initiatives to regular effort at the community level and restricting the size of fish that can be handled by the fish processing factories to between 50–85 cm total length for Nile perch. There is also a recognized need to harmonize fiscal measures, for example, taxes, levies, and non-taxable revenues, between countries and link to individual countries' macro-economic policies.

External factors influencing management

Invasion of water hyacinth

The water hyacinth, *Eichhornia crassipes* Solms (Mart.), invaded Lake Victoria in 1989 and within a few years around 6,000 ha of water surface was covered (Twongo et al., 1995). Fish landing sites became inaccessible, water intake became cumbersome, ferry services were hampered, and other means of transport became virtually impossible at many locations. Working groups were formed to discuss the control of the weed, either biologically, mechanically, or chemically (or any combination of these methods). Mechanical control combined with the impact of a biological control in the form of a weevil appeared to be very effective in Uganda, where the problem was (temporarily) resolved in 1999. The hyacinth more or less disappeared from Tanzanian and Kenyan waters by the end of 2000, but large hyacinth mats are again evident in certain regions of the lake. Proliferation of the water hyacinth in terms of the distribution and movement of large mats of vegetation is now being monitored using RADARSAT imagery to provide advanced warning of any problems (Schouten et al., 1999). It should be noted that the proposal to shred the weed without removal was observed not to be the right solution in Kenya. Water intake pipes continued to clog up with plant debris.

One positive aspect of the prolific weed growth was the resurgence in abundance of many fish species whose catches had collapsed following the explosion in Nile perch stocks (Njiru et al., 2002). The conditions under or near the mats of floating vegetation became favourable for lungfish, catfish, haplochromines, and other tilapines, to avoid predation and competition pressures from Nile perch.

Events in Burundi

During tribal clashes in Burundi in 1994 thousands of dead bodies entered the Lake via the Kagera River. This phenomenon had an immediate effect on fish exports to Europe and the consumption of lake fish was seriously affected. Fish prices plummeted, resulting in a considerable impact on the socio-economic conditions of fisherfolk in the affected area.

EU-import bans for fish from Lake Victoria

More than once the import of fish and fishery products from Lake Victoria into the European Union has been banned. The initial bans were imposed due to poor hygiene conditions and, later, due to illegal and irresponsible fishing methods. The chronology and reasons for the European Union to impose bans on fishery products from East Africa can be described as follows:

1) *Salmonella* bacteria were detected by the Spanish Veterinary Authorities in February 1997. All member states imposed a compulsory and systematic check on Nile perch fillets for *Salmonella*. The *Salmonella* report triggered a series of EU-inspection visits in the three countries around the lake.

2) A cholera-outbreak which occurred in 1997 led to a six-month ban from January–June 1998. This ban was considered unjustified in the region as cholera should not be a reason to impose an import/export ban because fish products are expected to be further processed at their destination.

3) A number of deaths were reported among fish consumers on the lake because of illegal poisoning to catch the fish. Consequently, the Ugandan Government self-imposed a ban on fishing, consumption of fish from the lake, and export in March 1999 which was eventually lifted in November 2000. Considerable efforts were made to resolve the situation in Uganda and Kenya to reduce the severe consequences for the fishing communities, especially those specialized for Nile perch production. Tanzania was allowed to resume the export of perch products from Lake Victoria to the European Union in January 2000, followed by Uganda and Kenya in August and December 2000, respectively.

Lessons learned from the fish bans

The import bans imposed by the EU could be compared to a closed season, an ultimate management measure, from outside the region. The bans led to an initial reduction in fishing effort on the lake. Fish and fishery products from Lake Victoria were no longer

absorbed by European markets. Consequently, new markets were explored and found: Israel, Japan, Australia, South America, and the United States of America became the destinations of perch from the lake. The fish was sold, however, at much lower prices than before, which again had an impact on the fishing communities and processing sector. The reduced fishing effort during the period of the ban was expected to lead to a recovery in the stocks by the fisheries organizations. However, little evidence of this was found, nor were adequate data collected to show the quantities of fish exported during the most recent EU-import ban. It should be noted that the production and export of fish products increased exponentially when the ban was lifted in the Tanzanian part of the lake.

Gold mining

Gold mining is expanding in the region, especially in Tanzania, and it may have a considerable impact on the lake environment. Modern techniques to extract gold from ore leave considerable toxic waste, especially in the form of heavy metals. There are fears that these heavy metals will eventually end up in the lake water and ultimately in the food web. Recent research (Campbell, 2001) indicated that Nile perch <5 kg contain very low quantities of mercury and are acceptable for export. However, continuous monitoring of the mercury content of fish products should be given high priority to alleviate fears of contamination.

Recommended action and follow-up

Many documents exist nowadays which can be categorized as "grey literature." Useful and superfluous recommendations appear everywhere and it seems difficult to streamline them. International conferences are ideal for summarizing recommendations and preparing action plans. Numerous recommendations can be formulated, but, without a time frame and the finances for implementation, they just remain interesting documents. The following presents an overview of recommendations from two important international conferences, which were held in 1992 and 2000.

The *Workshop on People, Fisheries, Biodiversity and the Future of Lake Victoria* held in 1992 (Anonymous, 1992) concluded that the environment of Lake Victoria was changing rapidly and that the fishery was unsustainable at the level of production at that time. It was also concluded that, due to overfishing and development of an export market, the amount of fish protein for local consumption was inadequate and that the changing condition of the fishery would affect the social and economic welfare of millions of people in the lake basin. The workshop produced numerous resolutions and recommendations, of which the most important are summarized in Appendix 1 (Anonymous, 1992).

The second conference, *Lake Victoria 2000, Options for the Future*, held in May 2000, similarly produced a set of conclusions (LVFO, 2000). These were extremely detailed and far-reaching (summarized in Appendix 2). The annex also presents the recommended actions and/or activities. It should be noted that the recommendations are much more detailed than those of the 1992 workshop as nine years of research had been carried out on the issues raised in 1992. Furthermore, the regional character of the proposed interventions is recognized.

Fish sizes at factories

Numerous discussions have been held on the average size of fish processed by the factories for the export market. No hard data exist and sampling programs are largely absent. Random sampling of fish delivered to the factories indicates that small-sized fishes are being processed. This arises because the recommended 5 inch mesh size gillnets catch fish of about 1 kg or a mean total length (TL) of 53 cm, which is below the length of first maturity (around 65 cm TL for females; Mkumbo et al., 2002) of the current stock. It is assumed that the hanging ratio is between 0.8 and 1.0, but, if this ratio is smaller, then even smaller fish are exploited. It may be concluded that, at the present level of exploitation, practically all fish caught by gill nets with mesh sizes smaller than 5 inch (which is a significant proportion of the nets used on the lake) are immature.

Lake Victoria Fisheries Research Project

Stock assessment research has been carried out on the lake by the three riparian fisheries research institutes (Fisheries Resources Research Institute, Jinja, Uganda, Kenya Marine Fisheries Research Institute, Kisumu, Kenya, and Tanzania Fisheries Research Institute, Mwanza, Tanzania) with financial assistance from the European Development Fund. Preliminary results, presented below, will form the basis of a fuller picture on the lake's resources.

Stock assessment

Experimental trawl data for the last few years with standardized gears will result in a detailed picture of the spatial and temporal distribution of the trawlable bottom fishery resources and in quantitative assessments of the stocks of Nile perch and Nile tilapia. In areas where trawls cannot be used, multi-mesh gillnet fleets are operated to collect additional data. Studies on the relationship between fish catches and limnological parameters are also carried out. Trawl surveys, using the swept area method adjusted for distribution of fish in the water column indicated that the standing stock index of Nile perch was in the region of 650,000 t (UNECIA, 2002).

Acoustics

Regular lakewide hydro-acoustic surveys indicate the highest densities of fish are in the eastern part of the lake (Tumwebaze et al., 2002). The vertical distribution of fish and other organisms during seasons of mixed and stratified water columns has been obtained. Biomass estimates will be obtained once the target strength experiments have determined the relevant specific parameters to convert the acoustic signals into values. Continuing research will eventually lead to recognizable trends in relative abundance of fishery resources.

Biology

Recent gillnetting experiments have shed new light on the feeding behavior of the Nile perch. Significant differences were found between the number of fish with full stomachs and empty ones and suggest Nile perch feeds mainly around noon (A. Asila, Kenya Marine and Fisheries Research Institute, Kisumu, Kenya, unpubl. data). Feeding studies show diet changes with size of fish and diet has shifted during the period the lake underwent many physical changes. Plankton compositions in the lake and diet have shown that Nile perch are selective in the size of *Caridina* they consume. Many other biological parameters, relevant for stock assessment, have been determined for the various commercial fish species.

Catch/effort

Ongoing research aims to investigate trends in catch rates of the different fisheries on the lake. Such information is crucial for production estimates based on frame survey results. The relationship between changing catch rates and varying average mesh sizes is being established.

Socio-economic research

Marketing surveys and comanagement studies have been carried out in the region; currently, a study is being implemented to look into the possibility of power sharing. Recently a radio program was launched, by and for the fishing communities, to allow the various stakeholders the opportunity to express opinion and debate issues relating to the fishery resources.

Fisheries management plan for Lake Victoria

The present setup of fisheries management measures is geared towards managing a status quo situation. Fisheries managers (except for Tanzania) generally do not have access to sufficient funds to react to external events. No deviation from work plans is allowed in projects financed by donors; there is often an inflexibility with respect to the use of contingency funds. For instance, studies on tembea (driftgillnets), beach seining, fish poisoning, impact of invasive weeds, effect of numerous corpses on water quality, and the appearance of huge eels in catches cannot be financed easily. By the time the funds have been allocated, the impact has worsened or the damage has been done, without proper scientific investigation. The Lake Victoria 2000 conference made a number of recommendations, which should be followed up for immediate and long-term implementation for the sustainable management of the environment and fisheries resources (LVFO, 2000). If retention schemes and royalties on exports (at the present stage) cannot cater to financing the proposed activities, then outside funding should be sought, assuring continuous implementation of research and management activities. Fisheries management plans, which are currently being drafted, should be based on joint action with a high degree of collaboration between the various interventions (projects), and, at the same time, a high degree of flexibility.

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Appendix 1: Workshop on People, Fisheries, Biodiversity and the Future of Lake Victoria (1992)—Summary of major resolutions and recommendations.

Limnology and environment	Status (2000)
1 Models to be developed to predict lake productivity	Ongoing
2 Controls on oxygen distribution and levels to be elucidated	Ongoing
3 Determination of flow of nutrients into the lake ecosystem	Ongoing
4 Determination of energy flow through the two major trophic pathways	Ongoing
5 Special attention to water hyacinth to be given	Done
Fish biology	
1 Quantify interactions among food web structures, water quality and life history characteristics of fishes	Ongoing
2 Need for stock assessment	Almost completed
3 Refuge areas to be established to protect diversity of native species and	Partly complete
4 Study possible contribution of aquaculture to fishery and stock recovery	Partly complete
5 Proposals for exotic species to be properly evaluated	Done
Policy, management and socio-economics	
1 Water quality requirements of the fishery to be determined	Ongoing
2 Planning and development plans to be submitted to LV Commission for social and environmental impact assessment	In preparation
3 Development of information systems encompassing regional social and economic and biological data for fisheries planning	Started
4 Assistance to be given to groups affected by predicted decline in fishery	To be identified

Appendix 2: Lake Victoria 2000 Conference, a New Beginning—Summary of major resolutions and recommendations.

A Multiple resource use and ecosystem health of LV Basin	Status (2000)
1 Population stabilisation	
2 Effective land use and urban planning	
3 Widespread soil erosion control programs	Ongoing
4 Improve fertility of land through increased use of fertilisers	
5 Soil and water conservation at watershed scale (wetland conservation)	Ongoing
6 Economic development to reduce dependence on small scale farming	
B Role of science, politics and economics in fisheries management	
1 Management of fisheries within framework of the FAO *Code of Conduct for Responsible Fisheries*	Started
2 Management to be directed towards human ecosystem of multiple scales	
3 Facilitate and foster participation of communities by education, development training and participatory research	Ongoing
4 Socio-economic research capacity to be strengthened	Ongoing
5 Organise specialised workshops for senior fisheries managers	Programmed
6 Gender issues to be addressed in resource management projects	
7 Assess benefits and disadvantages of systems of tenure, custodianship and proprietorship	Initiated
8 Determine impact of management measures on various interest groups	Ongoing
C Development of the fisheries sector in Lake Victoria	
1 Establish regional database and improve access to datasets	Ongoing
2 Quarterly stock assessment and biannual frame surveys to be executed	Ongoing

(Continued on next page)

Appendix 2: Lake Victoria 2000 conference, a new beginning—Summary of major resolutions and recommendations. *(Continued)*

3 Stock assessment of indigenous species, food web analysis, etc	To be resumed
4 Development of business plan, including a retention scheme (Tanzania), to fund monitoring and research activities	Started
5 Number of processing plants not to be increased	To be implemented
6 Overcapitalisation to be avoided	
7 Scientists and policy makers to be in regular contact	
8 Aquaculture options for Nile tilapia and catfish; others to be discouraged	Ongoing
9 Conservation of food fishes	Ongoing
10 Zoning system for management of human activities to be established	
11 Investigate possibility of eco-labelling and fair trade associations	
D Role of conservation in biodiversity and fisheries sustainability	
1 An overall policy for biodiversity conservation to be developed	
2 Integration of conservation policies into wider planning of activities	
3 Conservation strategy to be linked to control of fishing effort to prevent collapse of stocks	
4 Typical refugia to be preserved through protected area status	
5 Setting up of typical reserves for various specific habitats	
6 Cautious approach to be taken towards large aquaculture development	Continuing
7 Conservation of genetic biodiversity as regards movement, introduction and stocking of fish into the lake and satellite water-bodies	
8 Placing a financial and social value on resources to be protected	
E Integrated lake basin management	
1 States to adopt appropriate policy, legal and institutional framework	
2 All stakeholder to be consulted in decision-making processes	To be implemented
3 Conflicts between fisheries resource users to be avoided	Continuing
4 Creation of public awareness	To be expanded
5 When allocating LV basin resources, their value to be assessed	
6 States are to cooperate for sustainable use of LV basin's resources	
7 In case of adverse effects upon environment affected states to be notified	
8 Strengthen regional mechanisms for better co-operation and co-ordination regarding planning, development and management of the LV Basin	Continuing
9 LVFO to facilitate collaboration and co-operation	Ongoing