FISHERIES RESEARCH COMPONENT

REPORT ON SCIENTIFIC FINDINGS

JULY 1997 TO JUNE, 2002

1.1 EXECUTIVE SUMMARY

The Fisheries Research Component is being implemented under three sub-components namely Fisheries Biology and Biodiversity Conservation, Socio-economics, Aquaculture and Information and Database. The overall objective of the component is to generate a information for sustainable exploitation and management of the fisheries, conservation of aquatic biodiversity, integration of Lake productivity processes into fisheries management, reduction in degradation of fish habitats, involvement of communities and creation of an information center for dissemination.

During the reporting period, the component produced the two regional books on fish biology (list in Appendix A), a Bibliography on Lake Victoria, and a Directory of TAFIRI scientists working under the Project. A total of 27 papers were also produced on various disciplines, these were prepared for the national and regional scientific conferences held in Mwanza and Kisumu respectively. Three more papers were published elsewhere (list in Appendix B). The book on Aquaculture potential Lake Victoria is also ready except for the final Ugandan input. A total of 30 technical reports were also produced by the component during this period (list in Appendix C).

In fish biology and biodiversity, various disciplines were covered under surveys in trawlable areas using R/V *TAFIRI II*, in non-trawlable areas and in satellite lakes using various gears and methods. Aspects covered included fisheries biology and diversity, phytoplankton and zooplankton ecology, macro-invertebrates, physical-chemical characteristics, heavy metal analyses, etc. A special study on macrophytes was also undertaken in satellite lakes and in the main lake.

In Aquaculture, experiments were performed as a collaborative study with SUA to determine the nutritive values of fish, on the effects of stocking density on growth performance of the tilapia *Oreochromis variabilis* (L.) fry under aquaculture conditions, on nutrition of juveniles of *Oreochromis variabilis* and the catfish *Clarias gariepinus* using locally available feed ingredients, and on the life history of the parasite *Diplostomum mashonense* (a parasite of fish and birds) in the Mwanza Gulf of Lake Victoria. . A culture-based conservation strategy for the endangered tilapia *Oreaochromis variabilis* in the Lake Victoria basin was also developed.

A comprehensive aquaculture resource assessment survey involving TAFIRI and Fisheries Management Component was undertaken in 2000 with the objective of establishing the industry's state of the art and recommend efficient pond management strategies to fish farmers for greater pond fish production. Recommendations were given regarding aquaculture viability and extension services, pond siting and development, coordinating NGOs and CBOs, quality seed production and distribution circuits to farmers, and pond management & chemistry. The recommended way forward covered such aspects as establishment of community and institutional hatcheries, community workshops, delivery facilities, fertilization regimes, and cost-effective feeds.

In socio-economics, four major studies were completed. These were on literature review of socio-economic dimensions of lake Victoria, on the impact of fishing activities on resource and

environmental degradation, on examining community involvement in harvesting, processing and marketing of fish, and on examining the contribution of fisheries activities to the national economy. Also, a joint survey with Fisheries Management Component was undertaken on making BMUs more effective, while a pilot study on community nutritional status, health and social amenities was also carried out in Mwanza region

Technically, the Information and Database Sub-component is an information provider, enabling availability and ease of accessibility of information to scientists and other stakeholders. Hence the subcomponent is not expected to produce any scientific findings. To achieve this, the subcomponent produced a library Management Information System, a Bibliography on Lake Victoria, a Directory of TAFIRI scientists working under the Project, and developed a sample databases for storage of selected information collected through field surveys.

1.2 MAJOR SCIENTIFIC FINDINGS RECORDED

1.2.1 Fish Biology and Biodiversity Conservation Sub-component

1.2.1.1 Research Results

TRAWL SURVEYS

Research in trawlable areas included studies on phytoplankton, zooplankton, macro invertebrates and fish. In the case of fish, species compositions, diversities compositions, sex ratios, gonadal maturity, feeding and fecundity for a number of fishes were studied and documented. Physical factors affecting zooplankton were also studied.

Species composition by number

Speke Gulf

Species diversity was recorded with numbers in all sampling sites (Bukumba, Bunda Hills, Magu Bay and Lamadi) within Speke Gulf, however, *Lates niloticus* was the most dominant (70.4%). Probably, this is a result of recovery of haplochromines that forms a favourable food. Recovery of *Schilbe intermedius, Brycinus sadleri, Bagrus docmac, Labeo victorianus, Protopterus aethiopicus* and *Clarias gariepinus* was recorded.

Mara Bay

The catch in the four sampling sites (Mori bay, Shirati Bay and Baumann's Gulf) was dominated by *Lates niloticus* whereby Baumann's had the highest % (87.5%). Another important species was *Oreochromis niloticus* at Shirati Bay (43.3%). The species was recorded at high frequently at Shirati Bay.

Emin Pasha Gulf

The percentage of *Lates niloticus* is still high in the three sampling sites which were sampled. Chato Bay recorded the highest (94.8% by number). However, *Oreochromis niloticus* shows high catch by number at Nyamirembe (34.4%). A new species (*Anguilla spp)* which reported for the first time in 1996 at Speke Gulf was also recorded at this sampling station constituting 0.7 % by number.

Mwanza Gulf

Though *Lates niloticus* contributed the highest proportion by number (87.8%), Mwanza Gulf is reported to be a poor zone in species composition *Protopterus aethiopicus* and *Oreochromis niloticus* were also recorded in which each contributed 1.1%. This situation was probably a result of over-exploitation and fishing using small mesh sized nets and competition.

Haplochromines were not included because of their taxonomic complexity. However, recent studies on the group have included molecular genetics to separate the closely related siblings.

Sex ratio and gonadal maturity

The skewed sex ratio in favour of males continues to exist for a number of fish species.

- 145 individuals of *Lates niloticus* were males while 79 were females giving a sex ratio (M: F) of 1.8:1 in favour of males.
- 37 individuals of *Oreochromis niloticus* were males and 31 were females giving a ratio (M: F) of 1.2:1 in favour of males.
- The sex ratio for other species were 1.9:1 in favour of males (*Brycinus sadleri*) and
- 0.3:1 in favour of females for *Schilbe intermedius.*

Length at first maturity

Males attain maturity for the first time at a size of 63.0cm (TL) and maturity females at 85.5 cm (TL).

Fecundity

It was found that fecundity differ according to fish species and size of the fish. For instance, *Lates niloticus* ranging from 94.5 to 153.0 cm TL produced eggs ranging from 1,136,000 to 17,336,000. *Oreochromis niloticus* of 26.8 – 56.0 cm TL had eggs ranging from 1,240 to 6,600 while *Schilbe intermedius* of 11.0 – 34.0 cm produced eggs ranging between 2,770 and 10,500. *Brycinus sadleri* of 12.6 – 18.0cm produced eggs ranging between 901 and 6,150. The extremely high fecundity for *L. niloticus* being a result of lack of parental care.

Food and feeding habits

Generally, the most dominant food item in individual stomach of *Lates niloticus* was *Haplochromis* species which constituted 37.0%, followed by *Caridina* (34.4%), fish remains (16.1%). Other food items were *Brycinus sadleri* and *Oreochromis niloticus* in which each constituted 0.2%. *Schilbe intermedius* and *Brycinus sadleri* were also gutted and examined. The food composition showed that fish species and *Caridina nilotica* are the main food items for all fish species which were examined.

Growth

The results show that there was a high correlation between length and weight for both males and females of *Lates niloticus*. The slopes for regression lines for both males and females were greater than 3 but insignificantly different. This implies that there is were no sexual differences which infer that male and females have same growth patterns, both males and females become heavier for their lengths as they grow larger.

Size structure and recruitment

It was found that in all sampling stations/zones *Lates niloticus* was first recruited into the trawl fishery at a size class of 15.5cm.

Abundance and distribution

The highest catch rate of *L. niloticus* was 138.5kg/hr at Bulamba while the least was recorded as 35.5kg/hr at Chato Bay. *O. niloticus* was highly abundant at Nyamirembe with catch rates of 65.3kg/hr followed by Baumann's Gulf (29.4kg/hr). The highest catch rates for *P. aethiopicus* was recorded in Mwanza Gulf (84.5kg/hr) followed by Baumann's Gulf (19.0kg/hr) and Bulamba (0.8kg/hr).

Diversity and Distribution of Zooplankton

Species composition

The zooplankton distributions in the main lake at various sampling stations comprised of Cyclopoida (50 - 80%), Calanoida (6 – 34%), Nauplii (5 – 18%), Rotifera (0.4 – 8%), and Cladocera (0.2 – 4.96%).

- The highest species diversity (16 species) was recorded at Shirati Bay while the lowest number (7) was recorded at Baumann's Gulf.
- Cyclopoida constituted the largest numerical proportion of crustacean zooplankton in all sampling stations followed by Calanoida, Nauplii, Rotifera and lastly Cladocera.
- From 11 sampling stations, 12 species of Rotifera, 6 of Cyclopoida, 6 of Clodocera and only 1 of Calanoida were recorded.

The cyclopoids, *Thermocyclops emini* and *Thermocyclops neglectus* were the most common and abundant species in almost all stations followed by *Tropocyclops confinnis* and *Tropocyclops tenellus.* The rare ones were *Thermocyclops incisus* and *Mesocyclops* spp. *Clodoceran* taxa were rare as reported in earlier studies of 1990's.

Rotiferas constituted the largest number of species (12) and widely distributed. The common species were *Asplanchna* spp., *Brachionus calyciflorus* and *Brachionus angularis.*

The calanoids were next to the cyclopoids in terms of abundance (No/m^2) but very important in terms of biomass.

Thermodiapomus galeboides was widely distributed in all stations and is reported to be raising very fast. Rotifers contributed the lowest biomass almost in all stations. The abundance and biomass of the copepod nauplii was higher than that of rotifers and cladocerans in all stations.

Vertical distribution of Zooplakton

At three stations, Mwanza Gulf, Bulamba and Luchiri, high number of zooplankton were found at 5m depth while in Chato and Mori Bays the Zooplakton concentrated at the bottom layers. The copepodid nauplius larvae composed the largest numerical abundance at all depth and were dispersed along the water column.

Abiotic factors

Water temperature considered as one of the physical parameter affecting the zooplankton abundance and distribution. It was found that at different depths temperature varied up to the range of 3^oC. The difference in water temperature between the surface and the bottom layers was small (this could be attributed to the depths of the sampling areas which were shallow.

Diversity and Distribution of phytoplankton

A total of four classes of algae including Cyanophyta, Bacillariophyta, Chlorophyta, and Dinophyta was reported were encountered in the main lake. High number of species of Chlorophyta class compared to the rest of classes. Mara Bay has shown to be the most diversified sampling zone in terms of algae species followed by Speke Gulf and Emin Pasha , while, Mwanza Gulf recorded as the poorest in diversity.

Macro-invertebrate species diversity and distribution.

Species composition

The macro-invertebrates were sampled in Mara Bay, Speke, Mwanza and Emin Pasha gulfs from sediments and macrophyte habitats

The results were as tabulated below (Table 1):

Table 1. Diversity and distribution of macro-invertebrates in Lake Victoria, Tanzania

Sampling zone	Abundant macro-invertebrates		
	Sediments	Macrophytes	
		Water hyacinth	Water lilies
Mara Bay	▪ Bivalves* ▪ Gastropods ▪ Diptera ▪ Worms ▪ Crustacea	▪ Worms* ▪ Insect larva ▪ Gastropods ▪ Crustacea ▪ Bivalves	
Speke Gulf	▪ Molluscs* ▪ Gastropods ▪ Bivalves ▪ Worms ▪ Diptera		
Mwanza Gulf	▪ Bivalves* ▪ Gastropods* ▪ Diptera ▪ Worms ▪ Crustacea	▪ Insect larva/nymph* ▪ Crustacea ▪ Worms ▪ Gastropods ▪ Bivalves	▪ Insect larva/nymph* ▪ Gastropods ▪ Crustacea
Emin Pasha Gulf	▪ Gastropods* ▪ Diptera* ▪ Worms ▪ Bivalves	▪ Insect larva/nymph* ▪ Crustacea ▪ Worms ▪ Gastropods	▪ Insect larva/nymph* ▪ Gastropods ▪ Crustacea

* - Dominant groups

Species Diversity

The species diversity in the sediments was 10 for Mara Region, 8 for Speke Gulf and 7 and 8 from Mwanza and Emin Pasha Gulfs respectively. From Macrophytes, water hyacinth and water lilies diversity was 26 and 12 respectively. The trend showed that macroinvertebrate species diversity decrease in number from North (Mara Region) towards the South (Emin Pasha Gulf).

Density and Distribution

The total number of taxa recorded in the main lake was 32. In the sediment the total number of species in the four sampling zone was 15 while the number of species recorded from water hyacinth and water lilies was 26 and 12 respectively.

- The common gastropods represented in all sampling zones from sediments were *Bellamya* spp and *Melanoides* spp. while from macrophytes were *Biomphalaria* and *Bellamya*
- *Corbicula* spp. and *Caelatura* spp. were the common Bivalve recorded from the sediments of Mara Bay, Speke Gulf, Mwanza Gulf and Emin Pasha Gulf sampling zones. From water hyacinth, *Byssanodonta* and *Sphaerium* were recovered from Mara Bay and Nyegezi sampling stations respectively.

- Crustacean (*C. nilotica*) was recorded only in Mara region from sediment while *Caridina nilotica* were reported from water hyacinth of Mara Bay and Ostracods from three sampling zones with high organisms from Nyamirembe.
- In the sediments oligochaetes were the only worms which were recorded in all sampling zones.

Within insects and insect larvae/nymph, Diptera, Eplemeroptera, Hemiptera and Coleoptera were represented in all four zones.

Water hyacinth in majority of sampling stations were reported to accommodate large number of insects and insects larvae/nymph as compared with number of organisms found from water lilies.

NON-TRAWLABLE AREA SURVEYS

This study was restricted to the littoral areas of the lake, which are not accessible by trawlers and this is not only due to the shallow nature of the area but also due to alluvial deposits, submerged or inshore rocky bottoms and occurrence of different forms of wetland vegetation. Such areas are fairly extensive and common in bays and gulfs, which are characterized by inflowing rivers.

The survey deployed different fishing gears/materials and methods so as to collect as much information as possible. These included beach seining, gillnetting, electrical fishing and light fishing method.

Beach – seine survey

Species composition (by weight).

The results showed that *Lates niloticus* dominated by 78.97% followed by *Oreochromis niloticus* (8.94%), Haplochromines (6.94%) and *Oreochromis leucostictes* (1.38%). Other species which were recorded in very low percentage by weight were *Tilapia zillii, Protopterus aethiopicus, Tilapia rendalli, Brycinus sadleri, Clarias gariepinus, Labeo victorianus, Brycinus jaacksonii, Synodontis afrofischeri, Barbus spp. Marcusenius victoriae* and *Rastrineobola argentea*.

The results show that the highest number of species (11 in number) was encountered in Mwanza Gulf followed by Emin Pasha Gulf with 10 species. Rubafu Bay, Mori Bay and Mara Bay constituted with 9 species each. Grants Bay, Speke Gulf and Shirati Bay had 8, 7 and 4 species respectively.

L. niloticus, O. niloticus and Haplochromines were the only species obtained in all the sampling station with high proportional percentage by weight and also by number.

Species abundance and Distribution.

Emin Pasha Gulf and Rubafu Bay have the highest catch rate of 39.5kg/haul and 38.6kg/haul respectively. Grants Bay, Mwanza Gulf, Mori Bay, Mara bay, Shirati Bay and Speke Gulf exhibited catch rates of 10.5kg/haul, 7.7kg/haul, 7.1kg/haul, 4.4kg/haul, 3.5kg/haul and 1.0kg/haul respectively. The low catch rates for fish species which were recorded at very low percentage by weight were *Marcubenius victoriae, Barbus* spp., *Brycinus jacksonii, Brycinus sadleri, Synodontis afrofischeri, Protopterus aethiopicus* and *Clarias gariepinus* were recorded which were linked to the direct ecological threats like predation over exploitation and competition.

Fish species abundance also differed significantly with respect to habitat type. However, *Lates niloticus, Oreochromis niloticus* and Haplochromine species were recorded in all habitats (Sandy, Muddy and vegetated).

Sex ratio
The M: F ratio of *L. niloticus* caught by beach seine in non-trawlable areas is 5:1 in favour of males and 1:1 for *O. niloticus*.

Gillnet Survey
Gillnets collections show a trend of increasing diversity in species or species count from Shirati Bay to Rubafu Bay. River Kagera also reported to be rich in fish diversity where *Labeo victorianus* was the dominant species. Lates niloticus was the dominant species in Mwanza Gulf (73.01%) and Speke Gulf (66.07%), while *Bryccinus sadleri* was the dominant species in Grant Bay (42.73%) In Mara Bay, Mara River, Mori Bay, Shirati Bay and Mori River the dominant species were *Protopterus aethiopicus*, *O. leucostictus*, *Synodontis afrofischery*, *Lates niloticus* and the *Clarias garipinus* respectively.

In general, Littoral non-trawlable areas had higher diversity in species than what has been reported for trawlable areas. This may be contributed by diversity in habitats and micro-habitats which support a diversity of species.

Mesh performance.
Results on gillnets performance indicates that small meshed nets (1", 1.5", 2" and 3") are best for diversity studies as they select many individual and species. Gillnet selectivity must be established with respect to size at first maturity and specific fish species.

Light fishing (Rastrineobola argentea)

Catch population structure:
Modal length for Shirati Bay, Mori Bay, Mara Bay, Grants Bay, Emin Pasha Gulf and Rubafu Bay were 5cm, 4cm, 5cm, 5cm, 6cm and 5cm respectively. This showed that *R. argentea* within different areas have somewhat similar frequency distributions' with many individuals appearing in the size range of 4 – 6cm.

Fish Condition and Growth:
The condition factor (K) was ranging from 0.32 to 0.56 in different sampling station with exception of Grants Bay which had K value of 0.89.

This reflects an environment with abundant or adequate food items for nourishment. The difference in condition factors in different areas implies that Lake Victoria experiences nutrient fluctuations at different times of the year.

Electrical fishing survey:
Both the established population structure in the areas and the extremely low diversity indices established for each electrified sampling site do not only suggest the ecological importance of the area for spawning and nursery but also the territoriality behaviour and parental care for some species.

Chemical pollution

Aspect of chemical pollution in the main lake has been done as among other factors which might contribute on biodiversity decline or disappearance. Further, pollution aspect was done purposely in order to assess the extent of pollution and its likely negative impact on the well being of the associate biota.

The results have shown that fish (*O. niloticus)* tissues were contaminated with heavy metals (Cd, Cr, Pb, Hg, Zn and Cu) though it was within the permissible levels. Heavy metals in sediments and suspended particulate matter were higher areas closer to urban/industrial than rural areas (Tables 2-4),. Moreover, the concentrations of the analysed metals were reported to decrease with increasing distance from the shore.

This implies that, industries and other municipal activities are the main sources of chemical pollutants in the lake. It was also observed that, samples from river mouth which drains from mining areas contained relatively high level of mercury as compared to all other sampling stations. This indicates that, heavy metal pollution in Lake Victoria is mainly from industrial and domestic effluents from Mwanza urban area as well as anthropogenic activities in rural areas including agriculture and artisanal gold mining.

There is a great need of such studies in other areas of the lake and other dominant fish species. Aquatic flora in the lake Victoria basin must also be investigated for chemical pollutants. Other water bodies including rivers and satellite lakes in lake Victoria basin are in a list of fish habitats to be examined for chemical pollution.

Table 2: Heavy metal concentration in fish tissues (*O. niloticus)* collected at Mwanza Gulf of Lake Victoria

Metal	Concentration (mean ± SEM) ppm		
	Gills	Muscle	Scales
Cadmium	<0.001	0.3 ± 0.1	<0.001
Chromium	4.1 ± 1.1	1.5 ± 0.5	2.0 ± 0.01.
Copper	3.6 ± 0.3	1.9 ± 0.6	2.3 ± 0.3
Mercury	<0.1	0.03 ± 0.01	<0.1
Zinc	77.3 ± 5.8	29.77 ± 4.4	77.6 ± 5.3

Table 3: Heavy metal concentrations (ppm) (mean ± SEM) in sediment samples Collected from Mwanza Gulf of Lake Victoria (n = 93)

Chemical elements	Location Categories			Distance from shoreline (m)		
	CA	FB	RM	25	500	2000
Cd	0.2 ± 0.1	3.0 ± 1.1	7.0 ± 2.1	4.3 ± 1.5	3.6 ± 1.4	2.6 ± 1.2
Cr	11.2 ± 1.2	12.3 ± 1.0	12.9 ± 1.0	10.6 ± 1.7	11.4 ± 2.1	12.8 ± 0.8
Cu	17.9 ± 2.3	22.3 ± 3.0	22.5 ± 2.9	26.1 ± 4.8	18.9 ± 2.1	19.7 ± 1.2
Hg	0.1 ± 0.03	0.1 ± 0.03	2.8 ± 0.6	0.2 ± 0.02	0.1 ± 0.04	0.1 ± 0.02
Pb	54.6 ± 11.1	23.0 ± 1.2	26.5 ± 1.5	30.7 ± 5.6	30.5 ± 6.0	27.6 ± 1.3
Zn	83.7 ± 19.0	22.0 ± 0.7	27.1 ± 2.5	45.4 ± 13.1	36.4 ± 9.5	28.2 ± 1.9

Note: CA – City area sampling station; FB – Landing beaches sampling station; RM – River mouth sampling station

Table 4: Heavy metal concentrations (ppm) (mean ±SEM) in suspended matter samples collected from Mwanza Gulf of Lake Victoria (n = 93)

Chemical elements	Location Categories			Distance from shoreline (m)		
	CA	FB	RM	25	500	2000
Cd	0.1 ± 0.01	0.3 ± 0.1	0.2 ± 0.02	0.3 ± 0.04	0.2 ± 0.03	0.1 ± 0.03
Cr	53.0 ± 7.5	22.5 ± 4.5	21.0 ± 4.3	35.3 ± 6.5	17.9 ± 2.7	27.7 ± 6.1
Cu	0.9 ± 0.2	1.7 ± 0.5	2.9 ± 1.4	3.0 ± 1.3	1.8 ± 0.9	1.0 ± 0.1
Pb	4.0 ± 0.3	2.4 ± 0.3	3.8 ± 0.7	4.5 ± 0.7	3.5 ± 0.4	3.1 ± 0.3
Zn	6.4 ± 1.0	2.6 ± 0.3	5.9 ± 1.4	7.2 ± 1.7	4.5 ± 1.1	5.1 ± 0.8

Note: CA – City area sampling station
FB – Landing beaches sampling station
RM – River mouth sampling station

SATELLITE LAKES

Satellite Studies
Satellite and other small water bodies had been neglected for quite sometime. The importance of the minor waters come up after discovery of the fish species now known to be either missing or very low levels in the main lake.

Although these species exist in the satellite lakes, their size ranges are extremely small compared to their counterparts in the main lake. For example, at the time of extinction in Lake Victoria, the size of mature *O. esculentus* varied between 25-26 cm total length and a modal size of 30-32cm with cases reaching 40-50cm. Currently, the exploitable size range is between 17 – 20cm and maturity sizes falling between 16 – 18cm TL long.

The extent of exploitation of fish resources in Satellite lakes is not under management control, thereby deploying destructive fishing methods. This has brought into action the formation of conservation management units. The CMU, establishment was a pilot exercise, instituted on few selected satellite lakes, but will extend to some other places. The units are formed on the same basis as the Beach management Units in the main Lake.

Other studies like phytoplankton, zooplankton, and Physico-chemical parameters of the waters have been studied. For instance, five classes of algae Cyanophyta, Bacillariophyta, Euglenophyta and Dinophyta have been recorded in the satellite lakes. *Aulocoseira* which in the most important food item of Tilapines had universal occurrence. This was the same for *Cylotella, Surirella* and *Nitzshia*. In general, the class Cynophyta is the most abundant followed by Bacillariophy to a Dinophyta is found in very limited locations. It is recorded only at Kirumi.

Studies on zooplankton indicated cyclopoid to be the most dominant. Cladocerans have been found to be vulnerable to predation. This is probably due to their large sizes. In general, similar zooplankton species are found in both satellite lakes and Lake Victoria, although the densities are higher in the latter.

Eutrophication is currently not a very big problem in satellite lakes. However, there are certain places where the impact has started showing up. For instance, in Lake Malimbe level of up 0.55 mg/l of ammonia is a big source of Nitrogen that in large quantities can cause undesirable algae

and other forms of plant growth thereby overloading the natural system and hence causing eutrophication and pollution.

- Oxygen has been found not to be limiting in satellite lakes. Even at Buswahili where the Oxygen concentration is thought to be lowest 6.4mg/l, still fish could be caught. The minimum threshold is thought to be 4mg/l.
- The permissible levels of pH in natural waters range between 5.0 to 8.5 (Renn, 1970) The range of values obtained for waters in satellite lakes falls with the drinking water quality standards. But the activities currently done in these waters need to be viewed with caution as the levels may raise up.
- The amount of phosphates found in most lakes never exceeds 0.1 ppm. Except for Lake Burigi where the value reaches 0.72mg/l at the bottom waters. This is likely to cause eutrophication.
- At Lake Burigi, high levels of alkalinity were recorded 289.0 ohms. Possibly caused as a result of natural water system as it passes through the soil and rock containing calcium carbonate.
- There is little danger of zinc contamination in satellite lakes. All values recorded were below 5.0 ppm which is permissible for domestic use.
- In general eutrophication in satellite lakes is very low compared to what is seen in the Lake Victoria.

MACROPHYTES

A macrophytes study was conducted in lake Victoria, its surrounding satellite lakes and wetlands with a view of exploring their macrophytic vegetation and the relationship between macrophytes and the distribution of fish species. It was found that the abundance and distribution of fish is heavily dependent on macrophytic vegetation. Various macrophytes of economic and biodiversity importance in Lake Victoria were identified. These include *Cyperus papyrus*, *Phragmites mauritianus* and *Typha capensis*, which are used extensively for construction, matting, basketry, granaries, fish traps, construction of rafters and other domestic uses. A considerable number of plants with medicinal uses and some used as food by human being and fodder for livestock were recorded.

1.2.1.2 Management Implications from Fish Biology Research Results

Trawl survey data still reveal high percentage compositions of *Lates niloticus* in many areas of the Lake. Particular areas have been identified where recovery of the Haplochromine and other indigenous species continue to increase in catches. The shallow protected bays, river mouths and vegetated inshore areas have indicated high diversities of fish species.

Effort is still targeting *Lates niloticus* for export market. Management options ought to concentrate on the enforcement of the existing regulations involving stakeholders from the grassroots. Currently, the Nile perch fishery is undergoing transition as a result of excess exploitation and ecosystem change. There are obvious signs of overexploitation that are manifested through reduction in age/length at maturity, higher fishing mortality, reduced catch rates and continual reduction of mesh sizes. The impacts are known to occur as a result of increasing fishing effort, unrestricted access to the fishery and weak enforcement and surveillance mechanisms. It is important to ensure the implementation of the existing regulations in order to safeguard this important fishery.

The current minimum mesh of 5" still catches immature Nile perch. Fishermen should be encouraged to use larger meshes. Complete removal of beach seines and other illegal gears will also provide opportunity for the fishes to grow to maturity. There is also need to update the

existing closed areas and seasons as a result of current scientific information. This is particularly the case for the catadromous and small inshore species. For the Nile perch, the option of imposing closed seasons and closed areas becomes difficult due to scarce knowledge on the spawning behaviour, breeding and nursery areas. Further monitoring is recommended.

In the Satellite lakes, alien introductions have not been possible. Management options should be directed at minimizing effort and have control over the gears in use. There is extremely low enforcement of the existing regulations. The free access to the fishery, and high demand for fish protein has harnessed the growth of the species particularly the tilapiines.

The common gear in use i.e. gill-nets range from 2 ½ " – 3". The range needs to be gradually extended to higher meshes. Recent information from Lakes Burigi, Katwe and Kirumi where local enforcement units conservation management units (CMU) have been installed, have indicated slight increase in modal classes of the exploited species. It is further recommended that CMU's must be given support and the local communities sensitized on the participatory programme.

It is in the Satellite lakes, where the indigenous tilapiine and other species native to Lake Victoria can be found, size structure and other biological features of these fishes have been reduced as a result of excess exploitation. Many species like *Oreochromis esculentus, O. variabilis, O. niloticus* and *O. leucostictus* mature at very small sizes compared to their counterparts in the main lake. It is important to increase the mesh size and moderate the effort to reduce pressure on the stocks.

Although little has been done on pollution and land drainage into the satellite lakes, measures ought to be taken to safeguard these landlocked water bodies. For a large part, satellite lakes are surrounded by heavy covers of *Cyprus* and other vegetation that buffers off land based pollutants. Cropping of these should be cautiously made to avoid erosion and direct deposition of land based nutrients.

Current results on fisheries biology and diversity in non-trawlable areas of Lake Victoria indicate that Mori Bay and Mwanza Gulf provide spawning habitats and both have high population and species values. The two areas have specific sites which should be protected. It is recommended that the sites in Mori bay be protected as an aquatic reserve where no exploitation will be allowed. Sites in Mwanza gulf, however, should form an aquatic park. In order to implement conservation actions, the following should be done.

- Local residents should be sensitized on the initiatives in place and encouraged to participate actively.
- The Government jointly with the Marine/Aquatic Park Dept should play the role of gazzetting the areas and financing some of the activities.
- In case the proposed aquatic reserve in Mori is to be established as a pilot area for co-management, then the caretaker and the government should sign the memorandum of understanding (MU) specifying the responsibilities of each of the two parties.

Spawning grounds both gazzetted and those identified under this project should be protected by proper enforcement of the relevant regulations under the Fisheries Act. The Act provides for closed areas from July 1st to Dec 30th in order to improve the fishery by increasing survival rate and recruitment.

Land-use plans in the vicinity should be revisited so that cultivation along the beach and encroachment of the wetlands for agriculture, etc. be avoided. This will minimize pollution in the non-trawlable areas and destruction of the wetlands.

Exploitation of the inshore areas should be avoided and appropriate minimum mesh size for both riverine and inshore fishery should be established.

1.2.2 Aquaculture Sub-component

An integrated farming of chicken and fish (fish-cum chicken culture) experiment was conducted in one of the 10 ponds constructed by the Project in Mwanza. The chicken provides fertilizer into the pond through droppings, which eventually enables the natural food for fish (phytoplankton) to grow. This was particularly for *Oreochromis niloticus*. This fish species being more herbivores it feeds on the phytoplankton, which eventually improved the growth performance of the fish. This pond has played a great role in the production of quality fingerlings for the fish farmers. The fingerlings that were produced from this pond were distributed to fish farmers in the regions of Kagera (1,641 fingerlings), Mara (3,199 fingerlings) and Mwanza (340 fingerlings). These fingerlings are doing well.

The hatchery has been used for a variety of investigations particularly feeding experiments, stocking density experiments and spawning experiments. The results of the feeding experiments showed that cotton seed cakes give high growth performance followed by Soya beans where as the stocking density experiment showed that stocking fish at low stocking density (1 fish per litre) gave high growth performance than high stocking densities (3 fish per litre). Research work on technologies for breeding *C. gariepinus* was conducted by using the artificial spawning. More than 600,000 fingerlings of *C. gariapinus* were produced in the hatchery through artificial propagation of the species.

Results from the twenty-four hours sampling to investigate feeding habit of *Oreochromis variabilis* was showed that the fish prefers feeding late in the morning and early in the afternoon. Also, it was established that diets containing cotton seed cakes could serve as an alternative diet in feeding the fish species. The observation was based on the fact that growth performance of the species on cotton seed cake was better than other diets and also cheaper than fishmeal. A culture-based conservation strategy for the endangered tilapia *Oreaochromis variabilis* in the Lake Victoria basin was also developed.

The survey of aquaculture status and management of fishponds, in lake Victoria basin Tanzanian side was conducted in collaboration with Fisheries Management Component. The survey results indicate that fish farmers in the catchment area are not keen in manuring their fishponds on regular basis. Animal manure particularly cattle manure is plentiful in Mara, Mwanza and Kagera in that order, even though Kagera with least supply of manure leads in manure application to fishponds.

Preliminary results to investigate biological development of *Diplostomum mashonense* (a parasite of fish and birds) in Mwanza gulf of the lake indicated that, of the four clarias fish species investigated (*C. gariepinus, C. liocephalus, C. werneri and C. allaudi*), only *Clarias gariepinus* was infected with the parasite.

AQUACULTURE RESOURCE ASSESSMENT SURVEY

A comprehensive aquaculture resource assessment survey involving TAFIRI and Fisheries Management Component was undertaken in 2000 with the objective of establishing the industry's

state of the art and recommend efficient pond management strategies to fish farmers for greater pond fish production. Recommendations of the survey were as follows:

Aquaculture Viability and Extension Services

- The Government and other development agents must support the fast increasing number of fish farmers of the lake Victoria basin to attain realistic and sustainable production targets.
- The decision whether aquaculture in Tanzanian lake Victoria basin communities is economically viable, socially acceptable, and culturally compatible must bear in mind that aquaculture as a farming system is a spontaneous process rather than a happenstance.

Extension Services

- It was recommended that the few Government extension staff be educated on basic aquaculture principles and practice.
- Districts should emulate examples from Bukoba, Muleba, Biharamulo by appointing one permanent staff to specifically deal with fish culture extension services.

Pond Siting and Development

- It was recommended to develop pond culture in Mara (Tarime and Serengeti districts) and Kagera regions as the two have relatively good supply of water.
- In Mwanza region and the drier part of Mara, fish should be stocked in the many big dams. This will ensure that fish are available even during the dry season.
- The implementing institution should respect the scientific advice especially in regard to the siting and the type of seed to be cultured.

Coordinating NGOs and CBOs

- The Aquaculture sub-component must play a coordinating role in bringing together extension staff, NGOs and CBOs and any other aquaculture development agents to define goals, set out common targets and chart out the cause for the sub sector's development strategy in lake Victoria basin.
- Aquaculture development agents may consider adopting with improvement the Mennonite Church Extension Strategy Model for use elsewhere in Lake Victoria basin.

Quality Seed Production and Distribution Circuits to Farmers

- Pond stocking must be done professionally and must respect farmers' choices of species for culture. Where wild seed is the only alternative, fingerlings must be professionally sorted out to minimize mixed stocking in ponds.
- Trained aquaculture personnel must closely supervise seed production and farmer-to-farmer seed delivery mechanisms particularly during the early development stages of the mechanisms. These have often been a source of mixed fish stocking in many areas the team visited.
- TAFIRI in collaboration with District Fisheries Officers, NGOs and CBOs as collaborators should play a leading role in establishing community – based hatcheries (guided by a central hatchery at the institute's Mwanza centre) and start mass seed production. The process could start by TAFIRI supplying quality brood stock of choice fish especially *O. niloticus* and *Clarias gariepinus* to those hatcheries, supervise their initial rearing, nutrition and management and finally define seed supply circuits within lake Victoria basin-Tanzania.
- It is recommended to establish a mini hatchery at Tarime to supply the growing demand for fingerlings
- Seminars, workshops, short course training programmes aiming at educating farmers and stakeholders on simple hatchery management principles and practice have to be organised

within a wider framework of imparting knowledge and skills on fish culture and environment management

- It is strongly recommended that scientific advice be respected when stocking fish ponds as this may help in keeping quality fish in the ponds and consequently encouraging more farmers to go aquaculture

Pond Feeding.

- It is recommended that a culture of feeding fish on a regular (routine) basis be established among fish farmers in the catchment area of Lake Victoria.
- The team recommends that samples of potential fish feed ingredients be collected from selected farms within lake Victoria basin-Tanzania in order to determine their nutritive values. This will enable feed formulators come up with profiles of rich fish foods. Good net fish yields (NFY) can only be realised through proper pond feeding practice.

Pond Fertilization

- Since the survey has established that farmers are generally still ignorant of the role and rate of manure loading in ponds, the team recommends that these areas be covered during community workshops to be conducted in the future. Such workshops should consider manure mixing to increase the level of elemental phosphorus in pond water, as this will rapidly stimulate pond productivity.

Pond Chemistry

- Farmers across the basin in Tanzania are advised to observe pond water quality through regular water exchange. The rule should be the higher the level of management inputs e.g. manure and feeds; the higher is the water exchange rate.
- Pond preparation procedures to consider slight liming adjustments as to allow falling within 4.5-8.5 pH scale range that is suitable for fish culture.

Pond Harvesting & Catch Utilization

- The survey team recommends that fish farmers across the lake Victoria basin in Tanzania should initially be supplied with pond size seine nets with which to harvest their fish.
- Farmers in an area could contribute money to buy a pond size seine net for common use. The Area Chairperson of Fish Farmers (ACFF) within the Mennonite Church Model could organize this arrangement. In this context the (ACFF) would act as the custodian of the gear.
- Fish culture activities in the lake Victoria basin-Tanzania must be seen to metamorphose from the present pure subsistence level to the level of generating real income at household level.

Community hatcheries

Community hatcheries are constructed in selected areas under direct supervision of sub component scientists in collaboration with District Fisheries Officers and Church Agents whenever possible. We strongly recommend that LVEMP support financially the establishment of rural hatcheries. On the basis of findings from this survey the following sites are recommended for community hatcheries:

Institutional hatcheries

Strengthen institutional hatcheries at Nyegezi (TAFIRI and NFFTI) to supply seed to Mwanza City and to dams in Kwimba, and Missungwi.

Community workshops
Conduct community workshops on the establishment and management of rural hatcheries that includes broodstock , fry and fingerlings nutrition and farmer to farmer seed delivery techniques. The theme of the workshops to be 'Breeding and rearing fish in a conserved environment' (Uzalishaji, Ufugaji samaki na uhifadhi wa mazingira yetu).

Delivery Facilities
Purchase seed and broodstock delivery facilities such as O_2 cylinders, transportation bags and the like.

Fertilization Regimes
Define pond fertilization regimes and loading rates based on findings from the present survey

Cost - effective feeds
From proximate analysis results, work out a number of simple feeds and diets that are cost-effective from the farmers' perspectives.

1.2.3 Socio-economics Sub-component

Literature review
Research gaps have been identified as; Use of poison and other illegal methods in fish capture, Indigenous knowledge in conservation and management of the lakes resources, Socio-economic viability of fisheries enterprises (fish farming and artisanal fishery). Socio-economic impact of water hyacinth, Riverine fisheries, Community level financing and utilization of revenue from fisheries activities among others.

A total of 116 pieces of literature on the socio-economic aspects of the fisheries by different socio-economic researchers and other scientists were reviewed. The literature were grouped into the following themes:

- The economic potential and/or impact of the Lake Victoria Fisheries for the riparian communities
- The evolution and/or changes of the fisheries of Lake Victoria i.e. the introduction and dominance of the Nile Perch which is claimed to have led to the disappearance of hitherto popular species including tilapia, *"ningu"* and several other economic species.
- The environmental degradation of the Lake Victoria Basin in the last five decades or so through basically *"anthropogenic"* factors.
- The negative socio-economic impacts of the last two named changes i.e. in terms of loss of employment, income and source of protein for the fisherfolk/riparian communities.
- Public awareness promotion activities being carried out by LVEMP components and Sub - components.
- Community Involvement/Participation

In order to bridge the gaps mentioned above, the following were recommended:

Capacity Building
This should be for LVEMP implementing institutions so as to arm them with the tools to effectively deal with the various socio-economic dimensions of the fisheries of Lake Victoria.

Socio-Economic Studies/Research and Publications
This should also include the following dimensions: Poverty and inequalities; Issues of indigenous knowledge and practice; Sociological and cultural aspects; Health and nutrition; Social Mobilization; More Community Involvement/Participation Studies and/or interventions; and Gender dimensions

Methodology
There is indeed dire need to adopt a holistic multi-disciplinary approach in the study of the various socio-economic aspects of the fisheries of the Lake Victoria water basin and catchment area.

Study on community involvement in fisheries from production to marketing
Significant factors that influence positively the community participation in FI are ability to fish and household size. However, factors that are significant but influence negatively community participation in fish production include tribe and number of dependents in the household. Educational level does not influence community participation and the reason for this outcome needs more investigation. Nevertheless, one can conclude that the present state of affaires in the fishing community is associated with the low education level among members of the community. It implies that educational level is not a factor that influences much participation in fishing. Other factors include; management of regulations, effective village leadership, adoption of improved fishing technologies (modern fishing gears, engine boats), and effective technical personnel (fisheries researches).

However, factors which decrease participation in fish production include; poor application of regulation, bye-laws, policy and ineffective village leadership, and long distance from beach to town.

The study also concluded that household size, processing ability and distance from beach to nearest town influence greatly community participation in fish processing. The most effective factor is household size, which is significant ($p< 0.10$). The age, dependency numbers and district location are also significant but influence participation inversely. The education level and tribe negatively influence participation, however are not correlated to fish processing.

Household size, distance from the beach to nearest town, gender, and marital status plays an important role on influencing community participation in fish trading. However, household size is significant ($p<0.05$) while other 3 factors are insignificant. Factors such as age, tribe, educational level, number of dependants and district location do discourage participation and all of them except education are significant.

Fishing is considered equally important, as other sectors of the economy like agriculture, livestock, and forestry research and non-fishing industries. Due to its significances, 90.9% of the respondents (N = 430) involve in fishing industry at full time and 8.1% engage on part time basis. Despite the importance of the fishing, a lot of constraints discourage communities in participating effectively in the industry. As consequence, the nature of involvement is absolutely based on traditional operation where as changes towards the use of modern equipment has been realized.

Gender imbalance exists in fishing industry. Overall analysis indicates that 86.6% of total respondents (N = 432) were men and 13.4% were women. This is a disproportional ratio in development. By activity, overwhelming (99.5%) respondents in fish production are men as compared to only 0.5% of women in total respondents (N = 195). Worse still, men exceed

(54.7%) women (45.3%) in the involvement of fish processing (N = 86). Similarly, men are more (88.1%) than women (11.9%) in fish trade (N = 151). Basing on this fact, gender imbalance is strong in fishing industry.

Welfare of the local communities participating in fish industry is extremely miserable. Most of fish participants live in a temporary poor shelters which are adjacent to the beaches. Besides the poor shelters, they face unhygienic and unhealthy environments, which are characterized with poor sanitation, filthy and polluted atmosphere.

Per capita expenditure.
Per capita expenditure on community participating in fishing industry (FI) is low. Over 95% of total respondents (N = 432) spend between Tshs.100/= and 5,000/= per day. The poor includes fish processors and traders. Fish producers are better off.

Fish trader gross profit.
About a third of fish traders earn gross profit ranging from losses to 10,000/= per week.

Fish processor gross profit
About 86% of total respondents who engage in fish processing earn gross profit per week between 0 and 100,000. Some experience a loss.

Migration practice
Three quarter of people migrate to another beach in order to get more fish. The migration has been happening due to low catch in beaches of origin.

Government based fisheries regulations and its effects.
Fisheries regulations, policies, laws and by-laws are used to control illegal activities, to increase efficiencies but effect of those instruments is not appealing. In some cases all people do not use the regulations. It discriminates the beneficiaries. This is a real weakness.

Moving to the Industry.
Analysis shows that a large proportion of people moved into F1. However, moving out is also observed but at a low proportion. Income is the major issue, which motivates movement.

The role played by the fishers and consumers on promotion of fishing industry.
Incorporating fishers and consumers in promotion of fishing industry will reduce cost of operation of monitoring regulations, laws, policy and others.

Some strategic plans to improve local community's welfare through socially sustainable fishing industry
Establish a Directorate of Extension Unit under the Ministry of Natural Resources and Tourism
An independent extension unit should be established in Tanzania. This unit should be formed as a Directorate under the Ministry of Natural Resources and Tourism. It should cater for the ministries, all departments and Institutions.

Mobilize fishermen to form fisher's organizations
A law should be enacted to induce all fishermen in Lake Victoria to belong to an association. Such an association should either be based on a district or regional level, not on beach level. It would be much easier to deal with fishers groups than to deal with them individually. The suggestion here is that fishermen, traders and processors should each form an association. The

three associations should combine to form an umbrella association either at the district or regional level

In collaboration with the Lake Victoria Fisheries Research Project (LVFRP), the results of a survey carried out (under LVFRP) indicates that: Lake Victoria meets certain basic conditions necessary for a co-management regime, there is a very weak development of fisheries based community institutions in the Tanzanian part of the lake, the current fisheries regulation is perceived as addressing the species decline in the lake.

Fisheries contribution to the national economy

Contribution to GDP

Results from this study indicate that Nile Perch Fishery contribution to GDP is quite significant. It has grown from from 0.4% in 1993 (data permitting) to 1.8% in 1998.

The proportion of Nile Perch Value to the Fisheries sector output value rose from 14.8% in 1993 to 75.7% in 1998 before falling to 45.3% in 1999 due to the EU import ban. Likewise the proportion of NP value to Division of Fisheries budget was 1769% in 1993 rising to 2882% in 1999 despite the fish import ban by EU. The comparison of NP value to the MNRT budget reveals that the NP value if all devoted to financing that budget it would meet 56% in 1993 but surpass the budget almost thrice in 1999!

Contribution to BOP

Results show that the proportion of Nile Perch export value to total exports also rose from 1.4% in 1993 to 12.7% of total exports in 1998 before dropping to 9.5% in 1999!

This is quite a significant proportion especially compared to the proportions represented by Gold exports to total exports. In 1993 Gold value proportion to total exports stood at 7.2% and went on to decline until 1999 when the proportion registered a 7.2%! Comparing the 1999 figures for Nile Perch and Gold.

Contribution to Government Revenue

This study found out a huge potential for improvement in tax revenue increase through three main avenues. First, the amount paid to local government as levy could increase if the amounts reported as purchases could be monitored so that cheating by the weighing scale could be contained. Secondly, innovative ways of levy collection as those already employed by some district councils could be adopted and implemented in a transparent and correct manner.

Thirdly, the declared prices by exporters could be adjusted upward to reflect the prices fetched in the world market or specific markets where the Nile Perch fillets are sold. Together with this, the differentiation between Frozen and Chilled (fresh) fillets should be made since this is no secret that chilled/fresh fillets fetch a higher price than frozen fillets.

Using data obtained from the Division of Fisheries on royalty and data from the National Bureau of Statistics publications on budgets, an interesting outcome is obtained. The results indicate that in 1993 the NP royalty could fund the Division of almost 12 times in 1998!

The survey found out that there are significant leakage of revenue due to cheating on the part of local government levy collectors, buying agents and exporters of NP fillets.

Levy Collection

On the local government revenue collection it was established in a couple of cases that revenue collected was far below the amount expected and collectable. At the Igabiro landing site for

instance, the amount which was collected monthly is Tshs 60,000/- compared to that which would be collected if Tshs 10/- were to be charged for the minimum kg 2,000/a day or Max 5,000/-/day. If we assume a worst scenario of only kg 1,000 only a day, then the amount to be collected would be Tshs 240,000/- for a 6 day week!.

In other places, the tendering system has been relatively successfully used. A case in point is Bunda district where previously fish levy could not fetch even 300,000/- per month now it fetches more than Tshs 4.6 million per month! The collection approach was initiated in May 2000 as a pilot and hopes to continue after 6 months of initial implementation. About half of the Tshs 4.6 million comes from buying companies which have to pay Tshs 700,000/- per month of which they have 3. With this new look, fisheries sector is now number 3 in terms of collections after livestock and agriculture (cotton).

The implication is thus fishery contribution is increasing at a faster rate than others and claiming a prominent position in the district sources of income. Fisheries prominence according to time series data available began its rise in 1994 when commercial Nile Perch fishing entered the scene.

Cheating through Weighing Scales
This is another way by which district levy leaks out to unscrupulous fish traders. Unfortunately, this phenomenon does not only deny districts higher income, but worse still they rob the poor fishermen of their hard-earned income.

If weighing scale were to measure correctly the weight of fish bought, obviously more kilograms will be reported and since the fish levy is based on weight, then we should expect more money to be collected and fishermen to get paid more even without a price increase!

Price Under- declaration
The third avenue of levy/royalty leakage is through exporters under-declaring of export prices. Officially exporters are known to report F.O.B prices of US $ 2.50/kgm of both frozen and chilled fillet exports without exception! Going through the green export documents, it has been found out that even the US $2.50/kgm is high compared to the average price actually declared! If one divides the declared invoice value with the net weight of NP exported, one will get the result ranging from US $ 1.75 for the Netherlands, Germany, Spain and Japan among others for Frozen and Chilled, US $ 2.2 for chilled fillets to the Netherlands. These computations have been done using TRA export documents for September 2000. Comparing the declared prices with cost of procurement of fresh fish for processing, processing costs and also the reported market prices in International media publications. It is easy to see that the prices are not correct!

According to the *INFOPECHE* Trade news, African edition No. 23 of 22/12/1997, Frozen Nile Perch from Kenya at New York Gate was bought for US $ 2.20 per pound or US $ 4.85 per kilogram. The latest INFOPECHE Trade news (African edition No. 21 of 22/11/2000), reports Frozen Nile Perch from Tanzania and Kenya ex-warehouse,

Community nutritional status, health and social amenities, results of a pilot/baseline survey carried out in Mwanza region
Prevalence of malnutrition
Using the weight for age index (W/A), it was found that 15.8% (N=203) of the children in the three villages were underweight Out of these 3.4% could be ranked under the –3SD indicating severe underweight and 15.8% were ranked under less than –2SD, however 84.2% (N=203) were normal weight. These figures were also compared with national figures and the results indicate that underweight prevalent in all the three villages were below the national underweight figures.

The height for age (H/A) index revealed that stunting was prevalent in all the three villages with Igombe and Nyamililo showing the highest percentages of over 30% (N= 203). The children who were found to be in the category of less than –2SD were 30.5% (Table ii). Severe stunting was found only in Igombe and Nyamililo. Nyamililo had the highest percent of children severely stunted (15.8% N=76). This was also compared to national figures. Although they are lower than the national stunting figures, it can be noted that, these percentages are quite high in the country.

The weight for height (W/H) index showed that wasting was within the national prevalence, which is 5.5% (N=2992). In all the three villages there was no severe wasting recorded, however there were cases of wasting found below –2SD in Mirongo and Igombe at 3.1% (N=64) and 4.5% (N=63) respectively (Table iii). On average 2.5% (N= 203) were wasted.

The anthropometry indices confirmed that Protein Energy Malnutrition (PEM) was prevalent in the three villages. It is however roughly three quarters of the national prevalence. The results indicate that PEM is favourable although much above the reference level of 2.5% expected for a population which is not afflicted by malnutrition.

A. Health status

Diseases/symptoms found were Urinary Tract Infection (UTI), stomach problems, diarrhoea, eye infection, fever, cough, vomiting and skin rash. Conditions such as diarrhoea, vomiting, measles and respiratory infections can reduce appetite while increasing nutrient and energy requirement demand and this can lead to malnutrition conditions in the patient. Out of these diseases, the most common were fever not associated with other conditions, cough, diarrhoea and respiratory infections (Table vii)**.** Of all the diseases, fever recorded on average the highest number of cases (51.0% N=144), this was followed by cough (18.1% N=144) and diarrhoea (15.9% N=144).

Socio-cultural factors related to feeding.

The dominant tribe living in these villages is the sukuma. Their main staple foods consumed are ugali (hardened porridge made from maize or cassava or a mixture of the two), rice and sweet potatoes (Table v). They consume these staples in large quantities. Within this community, it is typical to see heads of households or mothers carry home one piece of fish or some small quantity of protein giving food for the family's next meal. The meals are sometimes nicely prepared and serving is done in one bowl for the protein food and one plate of a mountainous ugali or rice or sweet potatoes (actually sweet potatoes are either taken with porridge or in rare occasions with milk) for the staple. All the men and boys eat from one plate and bowl, while girls and their mothers eat from another, a form of communal eating. Men are served first and they are normally served the 'best' of the prepared food.

If for instance the men were six and cows meat and ugali was prepared for that meal, then the men would be served with six pieces of meat cut to the size of a babies fist. Each man holds a piece of meat in his hands and eats it slowly until they finish the mountainous ugali**.** Through FGD's it was discovered that on average the piece of meat would weigh between 20-50g while the ugali would weigh between 3-5kg. This eating habit is highly preferred because it is believed that it teaches the children not to develop an overeating habit, which would be embarrassing whenever they visit other places or others visit them. Although the quality of the foods as well as a detailed assessment of this factor was not undertaken, it may be assumed that this eating style may have contributed to the PEM discovered. In other words the foods eaten did not provide adequate energy.

Fish exports and malnutrition

During the 1990's there was adequate fish left even after the exports for the local riparian communities. It was found out that there was a high correlation between fish eating and stunting and a very low correlation to underweight and wasting. It was difficult to make conclusions at this stage with these results because it was surprising to note that in Mirongo where fish eating was lower than Igombe, the children were taller than those in Igombe, thus this was to be investigated further in the next nutrition survey of the project. Thus, malnutrition found to be prevalent in these three villages must be explained by other factors other than what is believed to be low supply of fish resulting from fish exports. The following section presents some factors the survey could associate with PEM.

Variables associated with malnutrition prevalence

B. Inadequate dietary intake/Low feeding frequency.

Children under five years need adequate food taken at least four times daily to meet their daily nutritional needs. This is especially necessary during the weaning (4-24 months) and post weaning period. From the survey, it was discovered that most families feed their children three times a day (57.4% N=157) (Table iv), 16.2% N=157 feed their children less than three times a day, this could explain the underweight and stunting reported. On average, only 26.4% N=157 feed their children four times a day as required. The fact that not all children are fed as required is a first indication that feeding frequency is low. There was a significant correlation between number of times children were fed and stunting and underweight prevalence. In fact 70% of the stunted children were fed only twice a day while 60% of the underweight were fed less than three times. In Mirongo where children were a bit taller, over 50% were fed four times a day. This quickly showed that there was a relationship between feeding frequency and PEM.

Poor child feeding practices by their mothers /caretakers.

Children between 0-4 months need exclusive breastfeeding including being allowed to suck colostrum milk (the yellow breast milk at birth). This is mandatory for a child as this milk is rich in boosting the immune system of the child. However, from the survey a very high percentage of children 24.9% were not suckled on colostrum. The mothers of these children attributed this behaviour to cultural beliefs, which views the milk as bad or dirty. The children who were not suckled on colostrum milk constituted 56% of the children who suffered from fever and cough/flue. These children constituted 53.2% of the underweight children. The consequence here is that most children got exposed to attack by various diseases, which reduced their appetite for eating and thus leading to underweight.

High demand on women's workload.

In the rural areas women are food producers as well as domestic workers. They work in the garden and then in their houses. In the morning women on average wake up at six am and many of them start the day in their gardens. Those with children under five leave their children at home still sleeping. At about ten in the morning they come back home and in many cases find the children already awake. They prepare porridge for the family and part of it is given to the child. The child is then bathed and in some cases the mother would take it along with her to the garden or it would be left in the home under the care of an older brother or sister of the child. Normally this baby sitter would be of school going age but he/she would not go to school in order to help the mother with the child. She would come back home at about midday, hurriedly prepares food for the family even if it is not adequate or nutritious.

At Mirongo, mothers trade in products such as bananas, fresh and fried fish, and fruits. These mothers sell their products by the roadside either within the village or within the city. They leave in the morning to look for these products from wholesalers who bring them from upcountry to the city. A quarter of the day is spent looking for products and the remaining daytime is spent selling.

An analysis of the responsibilities of the women reveal that women do not list child caring as part of their daily responsibilities. Child caring is traditionally a woman's activity and it does not affect her daily program. In fact some women go back to their mothers home during pregnancy just because the load of work they are expected to do in their own houses even during her pregnancy is too much. This is reflected by the prevalence of low birth weight (Table xii). Mirongo had the highest low birth weight because mothers spent most of their time looking for incomes. As such women's workload is a contributing factor to low birth weight. Most of the children who were born with weights below 2.5kg showed a very high incidence of diseases.

This study revealed that Malnutrition exists in the region. This was manifested in the forms of wasting, stunting and underweight. The causes of this malnutrition can be attributed to poor child feeding, non-sucking of colostrum milk at birth and mothers workload. In Kenya a similar survey indicates that theirs is a prevalence of water borne diseases, lack of proper infrastructure at the landing beaches, a list of economic important flora and fauna and how changes in the fishery consumption and exports has affected the nutritional status of the riparian communities.

Impact of fishing activities on resource and environmental degradation

Major findings from this study are as follows:

- There has been a significant increase in the level of wood utilization, which is, among others, linked to the growth of the fishing industry.

- There is a growing demand for timber for boat building in response to the growth of fishing activities (artisanal and industrial) and lake transport.

- The life span and quality of most fishing vessels, has become short and low, this implies that there is a growing frequency of repair and construction of new boats.

- The growth and proliferation of lakeside settlements, has also led to a growing demand for construction materials for housing/shelter, shops and numerous other socioeconomic activities.

- The population growth in this area stems not only from natural increase, but also from high in-migration rates.

- Land, water (rainfall), and grazing shortages in the outer rims of the lake basin in recent years have also attracted livestock keepers towards the lake and especially towards what are perceived as marginal areas, such as wetlands.

- All wetlands are under severe threat, stemming from land pressure emanating from agriculture and grazing needs. Other pressures on wetland resources are a result of demands for building materials and production of various weaving products.

- Although the attitudes of most local communities reflect poorly on wetlands and other biotic resources, it was also realized that even some local officials, especially at village and ward

levels, also lack awareness and appreciation of the functions and importance of wetlands and other biotic resources.

- Due to haphazard settlement arrangements, space for sanitary facilities such as toilets are limited or are not taken into account. The incidence and frequency of waterborne diseases of gastro-enteritis, dysentery and other stomach illnesses in these areas are extremely high and widespread.

- The beliefs and norms of various ethnic groups are still strong. One of the most disturbing taboos is the one that does not consent to certain members of the family to share a toilet. Moreover, the construction of toilets is expensive, thus to have two or more toilets is a significant investment. Moreover, many homesteads do not have even a single toilet and all ablutions and defecations are done in the lake.

- Many homesteads do not have toilets due to the geology of the area. Much of the geology of the area is comprised of hard rock that are very close to the surface of shore and thus if one digs a pit latrine, they will have to contend with breaking up the rock, which is a tedious task.

- There is also a widespread attitude by most individuals that their existence is only for a short time, and therefore they see no reason for undertaking any long-term investments such as construction of toilets.

1.3 WAY FORWARD

- Update the information currently available and continue monitoring both the main lake and aquatic habitats in the basin and advice accordingly. Data collected will also be used in preparation of manuscripts in the 21 identified topics (Appendix D) to be published in a special supplement of the *Tanzania Journal of Science* in early 2003. Fully-fledged research proposals for the identified topics are already in place, and these were chosen to fill in existing knowledge gaps.
- Assessment of the ecological status and effectiveness of the fish breeding and spawning areas in Lake Victoria
- Conduct a special study of the impact on heavy use of native species as bait in the long-line fishery and recommend management actions
- Conduct study to determine sources of financing of the community level fisheries enterprises and utilization of revenue generated. This study is also important to contribute immensely to LVEMP 2.
- Design strategies of sustainable fishermen cooperative societies, and initiate pilot beaches to demonstrate management and operation of fishermen associations/cooperative societies.
- Development of a National Strategy for Aquaculture in Tanzania
- Conduct post implementation assessment of cultured fish after provision of fingerlings, training and advice to local communities to ascertain the performance and profitability of fish farming.
- Study on cost effective pond size, proper feeding rate of the stocked fish, and proper locally available organic fertilizers that will increase the growth performance of the fish and the cost effective pond size.
- Designing a formal credit systems based on an understanding of the socio-economic conditions and unique needs of small-scale fishers, traders and processors.

- Development of an employment creation guideline for the riparian communities. The component will develop medium-term employment targets, including monitorable indicators of main employment objectives that can be achieved within one to ten years.
- A study of riverine ecology is very important in elucidating the importance of rivers in fish breeding, nurseries and refugia.
- Systematics of the haplochromines is yet to be undertaken with a view to exploring genetic diversity and their role as favoured food items for the Nile Perch and demonstrators of adaptive radiation.
- Limnology of Lake Victoria remains unknown for a greater part, being subjected to perturbation over time. The dynamics of primary production of Lake Victoria is important in predicting the direction of change. Also, the Physico- chemical parameters need to be related to the distribution of fishes. The nutrient cycle and eutrophication processes and their impact on biodiversity need to be given more emphasis as few people have worked in this area. Chemical pollution and coliforms in the lake waters, fishes, suspended and bottom sediments, aquatic plants particularly water hyacinth need to be given more emphasis as far as their impact to biodiversity is concerned.
- In socio-economics it will be necessary to undertake research activities which were not undertaken during the previous period: Community health, nutrition and social amenities, socio-economic characteristics of fishers, and perceptions on fisheries legislation.
- Conducting studies on indigenous knowledge on conservation and management; and assessment of the socio-economic impact of HIV/AIDS on the social structure of fishing communities and the performance of the fishing industry.

APPENDIX A: CHAPTERS OF THE TWO FISH BIOLOGY BOOKS

BOOK 1- *Biodiversity of Lake Victoria: Its Conservation and Sustainable Use*		
Chapters	**Author(s)**	**Institutional Affiliation**
1. Biodiversity conservation and its relationship to aquatic ecosystems	J.D.R. Bayona and H.A. Mhitu	TAFIRI
2. Major aquatic ecosystems of the Lake Victoria basin (including lakes, rivers and dams)	E.F.B. Katunzi and J.D.R. Bayona	TAFIRI
3. Human activities and interests within and around the lakes of Lake Victoria basin and their consequences to sustainable fish production	G.L.K. Jambiya[1] & S.B. Mahongo[2]	[1]Geography Department, University of Dar es Salaam; [2]TAFIRI
4. The influence of physico-chemical characteristics on biodiversity in aquatic eco-ecosystems of the Lake Victoria basin	J. Kulekana and M. Kishe	TAFIRI
5. The diversity of algae in the major aquatic systems of the Lake Victoria basin and their relationship to ecosystem functioning and fisheries	T. Lyimo[1] and B. Sekadende[2]	[1]TAFIRI; [2]Botany Department, University of Dar es Salaam
6. The diversity of aquatic macrophytes in selected ecosystems of the Lake Victoria basin and their importance in biodiversity conservation	H.V.M. Lyaruu and S. Eliapenda	Botany Department, University of Dar es Salaam
7. The diversity of zooplankton in the Lake Victoria basin and their relationships to ecosystem functioning and fish production.	R.K. Waya	TAFIRI
8. The diversity of macro-invertebrates in the Lake Victoria basin and their relationship to ecosystem functioning and fish production	J. Mwambungu	TAFIRI
9. Fish species diversity in the Lake Victoria basin, their conservation and sustainable use	A.I. Chande and H. Mhitu	TAFIRI
10. Genetic status of selected fish species in relation to conservation of genetic and species diversity in the Lake Victoria basin	H.D.J. Mrosso & S.P. Mwaiko	TAFIRI
11. Biodiversity values of different aquatic eco-systems, habitats and organisms in relation to restoration and sustaining of fish species diversity	J.D.R. Bayona	TAFIRI

BOOK 2- *The Biology And Ecology of Lake Victoria Fishes: Their Development And Management*		
Chapters	**Author(s)**	**Institutional Affiliation**
12. Fishes and fisheries of the Lake Victoria basin	A.I. Chande	TAFIRI
13. The biology, ecology and fishery of *Rastrineobola argentea*	S. Mzighani	TAFIRI
14. The biology, ecology and impact of Nile perch, *Lates niloticus* and the future of the fishery in Lake Victoria	M. Kishe & O. Mkumbo	TAFIRI
15. The biology, ecology and impact of the introduced tilapiines especially the Nile tilapia, *Oreochromis niloticus* in Lake Victoria	B. Msuku	TAFIRI
16. The biology and ecology of native non-cichlids in the Lake Victoria basin	A. Chande and H. Mhitu	TAFIRI
17. The biology, ecology and population characteristics of the *Oreochromis esculentus* in the Lake Victoria basin in relation to conservation and restoration of the species	E.F.B. Katunzi	TAFIRI
18. The biology, ecology and population characteristics of the *Oreochromis variabilis* in the Lake Victoria basin in relation to conservation and restoration of the species	A. Shoko	TAFIRI
19. The biology and ecology of surviving haplochromines in aquatic ecosystems of the Lake Victoria basin	E.F.B. Katunzi	TAFIRI
20. Trophic interrelationships and food –webs among fishes in the Victoria basin	H. Mhitu[1], R. Waya[1], B. Sekadende[1] and T. Lyimo[2]	[1]TAFIRI; [2]Department of Botany, University of Dar es Salaam
21. The consequences of using different mesh sizes of gillnets on the fisheries and on biodiversity of Lake Victoria fishes	J.D.R. Bayona	TAFIRI
22. Management of the fishes and fisheries of the Lake Victoria basin	P.O.J. Bwathondi	TAFIRI

APPENDIX B: SCIENTIFIC PAPERS PRODUCED

Mwanza LVEMP National Conference: 6-10 August 2001

1. Satellite lakes, rivers and dams as refugia for the endangered fish species of Lake Victoria by E.F.B. Katunzi.

2. Food and feeding habits and trophic relationship of selected fish species of Tanzania waters of Lake Victoria by A. I.Chande and H.A. Mhitu.

3. The effects of stocking density on growth performance of Tilapia *Oreochromis variabilis* (Boul. 1906) fry under Aquaculture conditions. By A.P.A. Shoko, Urasa F.M. and S.G.M. Ndaro.

4. Zooplankton species composition and diversity in satellite lakes of the Lake Victoria by R. K. Waya.

5. A survey of phytoplankton communities in the lake and satellite lakes of Lake Victoria by T.J. Lyimo and B. Sekadende.

6. Assessment of Macro-invertebrates species in Tanzania waters of Lake Victoria by J.A. Mwambungu.

7. Heavy metal contents of fish (*Oreochromis niloticus)* from Mwanza gulf of Lake Victoria Tanzania by M.A. Kishe.

8. The physical-chemical parameters in some satellite lakes within the Lake Victoria catchment by J.J. Kulekana.

9. Study of macrophytes with medicinal potential in Lake Victoria and its surrounding wetlands by H.V.M. Lyaruu and S. Eliapenda.

10. Malnutrition prevalence in Lake Victoria catchment area, Tanzania: is fish export the root cause by P.O. Onyango.

11. Fish biology and diversity conservation in Lake Victoria, Tanzania during the period of 1997 – 2000 by A. I. Chande & H.A. Mhitu.

12. The surveys of littoral non-trawlable waters of Lake Victoria (Tanzania): Observed status of fish biodiversity and emerging issues by J.D.R. Bayona

Kisumu LVEMP Regional Conference: 3-7 December 2001

13. The biology, ecology and fishery of *Oreochromis esculentus* in the Lake Victoria basin by E.F.B. Katunzi

14. The role of reproductive strategies in recovery and success of selected fish species of Lake Victoria, Tanzania by A.I. Chande & H.A. Mhitu

15. Applicability and effectiveness of some fishing gears in assessing fish diversity and richness in non-trawlable areas of Lake Victoria (Tanzania) by J.D.R. Bayona, S. Mzighani, J.D. Komakoma & J.D. Bipa

16. Benthic macro-invertebrates of the Tanzania side of Lake Victoria and their role in fish production by J.A. Mwambungu, H.A. Mhitu & A.I Chande

17. A survey of the zooplankton structure and composition of some Tanzanian Lake Victoria basin waters by R.K. Waya

18. A study on the effects of different diets on the growth performance of Tilapia *Oreochromis variabilis* (Boul. 1906) under Aquaculture conditions. By A.P.A. Shoko, Urasa F.M. and S.G.M. Ndaro.

19. The dynamics of energy budgets for communities in Lake Victoria by H.A. Mhitu & A.I. Chande

20. Factors influencing involvement of local communities in the fishing industry in Lake Victoria: From production to marketing by R.W. Kisusu & P.O. Onyango

21. Potential strategies to address problems in Lake Victoria, Tanzania by P.O. Onyango, T.D. Haule & M. Salehe

22. Effectiveness of current used regulations, policies on management of fishing industry: Evidence from local communities in Mara, Kagera and Mwanza regions, Tanzania by R.W. Kisusu & P.O. Onyango

23. Distribution of heavy metals in sediments of Mwanza gulf of Lake Victoria, Tanzania by M.A. Kishe & J.F. Machiwa

24. The anthropogenic inputs in aquatic systems: A case of Lake Victoria satellite lakes by J.J. Kulekana

25. The contribution of Lake Victoria fisheries to the national economy by K. Kulindwa

26. Information Technology (IT) tools deployed in fisheries research under Lake Victoria Environmental Management Project in Tanzania by R. Kayanda

27. Some aspects of the population ecology of *Oreochromis esculentus* in satellite lake Malimbe, Lake Victoria basin by B.S. Msuku

People and the Sea international conference, Amsterdam: 29th August – 3rd September 2001

28. Co-management: a solution or an alternative management for Lake Victoria fisheries? By P.O. Onyango

LVEMP *Nyanza Review* Newsletter Issue 5 of 2001

29. Fish diversity in Lake Victoria: The natural heritage calling for conservation by A. I. Chande

30. Food and feeding strategies used by the Nile Perch (*Lates niloticus*) In Tanzania waters of LV by H.A. Mhitu

APPENDIX C: TECHNICAL REPORTS

1. Preliminary lake-wide surveys to explore the biodiversity and limnology of Lake Victoria. April 1997.
2. Proceedings of the workshop to harmonize fisheries research activities 27th – 29th November 1997, Tarime.
3. A report on preliminary survey to explore pilot zones I-V for establishing sampling frame for fisheries biology and biodiversity conservation. April 1998.ries biology and biodiversity conservation. Tarime, 28th – 29th May 1998.
4. A report on the national technical workshop for fish biology and biodiversity conservation
5. Lake Victoria fisheries: Its impact on nutrition, health and social amenities in Mwanza region. May 1998.
6. A report on the survey of fisheries biology, ecology and biodiversity in Lake Victoria basin and satellite lakes. October 1998.
7. Cruise survey report. June 1999.
8. A report on the survey of fisheries biology, ecology and biodiversity in Lake Victoria. April 2000.
9. An integrated study of selected satellite lakes. June/July 2000.
10. A report on the survey of fisheries biology, ecology and biodiversity in Lake Victoria. August 2000.
11. Experimental fishing surveys in the non-trawlable areas of Mwanza gulf to establish fish species diversity and some biological parameters. October 2000.
12. Study on the distribution, diversity and composition of macrophytes in Lake Victoria and its environment in relation to fish diversity. November 2000.
13. Satellite lakes survey report September 2000.
14. Report on fish biology and status of biodiversity within the non-trawlable areas of Lake Victoria. November/December 2000.
15. A report on the survey of fisheries biology, ecology and biodiversity in Lake Victoria. December 2000.
16. Report on fish biology and status of biodiversity within the non-trawlable areas of Lake Victoria. March/April 2001.
17. A report on the survey of fisheries biology, ecology and biodiversity in Lake Victoria. April 2001.
18. Report on fish biology and status of biodiversity within the non-trawlable areas of Lake Victoria. July/August 2001.
19. Socio-economic literature and dimension of the fisheries sector of Lake Victoria. August 2001.
20. Community participation in the fishing industry from production to marketing: Overview of factors influencing involvement in the fishing industry of Lake Victoria, Tanzania. September 2001.
21. The contribution of fisheries of Lake Victoria to the national economy. October 2001.
22. Community participation in fishing industry from production to marketing. A pilot survey by Onyango 1999
23. Nutritional status, community health and social amenities by Onyango 1998.
24. Preliminary Literature review on socio-economic dimensions of Lake Victoria. By Onyango 1998
25. Fisheries contribution to National economy of Tanzania a pilot survey report. By Onyango 1998
26. A report o the documentation survey for fish biology and biodiversity conservation.

27. A study on the potential of Aquaculture in the catchment area of Lake Victoria, Tanzania side. Bwathondi *et al*., 2000.
28. The status of Aquaculture practices in the catchment area of Lake Victoria Tanzania side. A report. By Bwathondi *et al*., 2000
29. The Status of Aquaculture development in the Lake Victoria Catchment Area. A book by Bwathondi *et al.*, 2001
30. A report on the impacts of economic activities along the shores of Lake Victoria

APPENDIX D
TOPICS FOR PUBLICATION IN A SPECIAL ISSUE OF THE *TANZANIA JOURNAL OF SCIENCE*

S/N	AUTHORS	PROJECTS	SPECIFIC THEMES
1	E.F.B. Katunzi	Energy channels in minor water bodies of Lake Victoria basin	1. Analysis of food of all the species commonly encountered in satellite lakes. This will later be compared with the relative abundances of the relevant food types in the environment 2. Looking at the effectiveness of the CMUs through evaluation of the 3 – 31/2"mesh in the exploitation of the tilapiines
2	J.D.R. Bayona	Research in non-trawlable areas of Lake Victoria	3. Exploitation of Catadromous Species and their Spawning Behaviour in Transboundary Rivers/Bays 4. Challenges in Establishing Aquatic Conservation Sites in Non-trawlable Areas of Lake Victoria and Monitoring of Fish Diversity 5. Establishment of Gill-net Selectivity of the Dominant Fish Species and Assess Impact of the Current Exploitation
3	A.I. Chande & H.A. Mhitu	*Fish biology and diversity research in trawlable areas of Lake Victoria*	6. Variations in the distribution of fish species and size structure according to depths and geographical areas in Lake Victoria, Tanzania 7. Studies on the diurnal feeding habits of different fish species and variations of their prey items in the environment in Lake Victoria, Tanzania
4	S.B. Mahongo	C. Heat energy budget	8. Computations of climatological fluxes of heat and moisture over Lake Victoria
5	T.J. Lyimo, A. Mbonde & S. Shayo	Phytoplankton Research	9. Phytoplankton species diversity and abundance in Lake Victoria (Tanzania)
6	J.J. Kulekana	Environmental pollution arising from limnological investigations in satellite lakes	10. Investigation of nutrients in water and sediments some rivers and lakes in the Lake Victoria catchment 11. Investigation of heavy metals in fish and sediments in some rivers and lakes in the Lake Victoria catchment

7	R.K. Waya	Zooplankton research	12. Diel Vertical Migrations of Zooplankton in Lake Victoria 13. Species composition and biomass estimates of zooplankton in some water bodies in Lake Victoria basin. 14. Seasonal abundance of Zooplankton in Lake Victoria
8	J.A. Mwambungu	Macro-invertebrates research	15. Comparative studies on the diversity of molluscs between the main lake and other water bodies of Lake Victoria basin
9	M.A. Kishe & J.F. Machiwa	Heavy metal pollution	16. Levels of heavy metals in selected aquatic organisms in Lake Victoria, Tanzania
10	M.A. Kishe	Physico-chemical characteristics	17. The influence of physico-chemical characteristics on the biodiversity of Lake Victoria, Tanzania
11	B.S. Msuku	Haplochromine taxonomy	18. The biology and ecology of surviving haplochromines in aquatic ecosystems of the Lake Victoria basin
12	A.P.A. Shoko	*Oreochromis variabilis* (RARE SPECIES)	19. The fishery of Tilapia *Oreochromis variabilis* in the selected satellite lakes within the Lake Victoria catchment area, Tanzania. 20. Food and feeding habits of Tilapia *Oreochromis variabilis* in the selected satellite lakes within the Lake Victoria catchment area, Tanzania.
13	S. Mzighani	*Rastreonobola argentea* (dagaa)	21. Distribution of a cestode, *Ligula intestinalis* and its effect to the host, *Rastrineobola argentea* in Lake victories, Tanzania