THE BIOLOGY AND ECOLOGY OF LAKE VICTORIA FISHES:

THEIR DEVELOPMENT AND MANAGEMENT

(UGANDAN VERSION)

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Chapter 1

The Fishes and Fisheries of the Victoria and Kyoga Lake Basins

Overall fish production

Most fish in Uganda comes from lakes Victoria, Albert, Kyoga, Edward, George, about 160 minor lakes and rivers. Fish production of most lakes in Uganda has changed considerably since development of most of the fisheries started during the first half of the 20th century. Analysis of the changes that have taken place in these fisheries provides useful information on the potential and management issues associated with fisheries in Uganda.

Total national fish catch statistics are not available for the period prior to 1960. The trends in total fish production from the different water bodies between 1961 and 1995 are illustrated in Figure 3. Total fish catches were 60,000 to 71,000 metric tonnes between 1961 and 1965 and increased after 1965 reaching a peak of245,000 metric tonnes in 1990. The increase from 1965 to the late 1970s followed establishment of introduced Nile perch and Tilapiines to Lake Kyoga which reached a peak in 1978 and then declined. The second peak followed establishment of the same introduced species in Lake Victoria. This too peaked in 1990 after which catches declined. During 1970s, most of the fish came from Lake Kyoga while during the 1980s it was from lake Victoria. Although the above trend show an increase in total fish catches, historical trends in fisheries have been of decreasing catches especially of more desirable species. This impression can only be appreciated through examination of historical changes in individual fish production systems. The trends in total catches from major water bodies is illustrated in Figure 4. A brief analysis of the fish stocks and fish production from the different water and the efforts to manage the fisheries of the major lakes is given below.

Lake Victoria

Lake Victoria is the largest tropical lake and the second largest lake in the world. It has a surface area of 68,800 km^2, a shoreline 3,450 km tong, a catchment area of 193,000 km^2, a mean depth of 40 m and a maximum depth of 79m. The lake is shared between Kenya (6%), Uganda (43%) and Tanzania (51%).

Originally, Lake Victoria had a diverse fish fauna (Graham 1929, Greewood 1965). About 12 taxa comprised the commercial catches. The lake contained more than 300 species of haplochromines (Witte *et al* 1992a, b). 0. *esculentus* and 0. *variabilis* were the most important commercial fish species. Other taxa, especially *P. aethiopicus, B. docmac,* C. *gariepinus, L. victorianus, Barbus* spp, Mormyrids, *Synodontis* species and S. *intermedius* were also commercially exploited.

The original fishing methods consisted of basket traps, hooks, seine nets of papyrus and basket traps. These had little impact on the fish stocks. The pressure on Lake Victoria started to increase with introduction of more efficient flax gill nets in 1905. This resulted into an increase in fishing effort. Initially it was possible to catch as much as 50 to 100 0. *esculentus* per net of

about 50 m each night (Jackson 1971) but this catch decreased rapidly over time. A fishery survey carried out in 1928 (Graham 1929) showed that 0. *esculentus* were being overfished and recommended that minimum gill net mesh size limit of 127 mm should be imposed. This was imposed in 193 I. However, there was no limit to the fishing effort especially the number of nets, boats and fishermen on the lake. As a result, the catch of O. esculentus continued to decrease and was 1.6 fish per net by the 1950s. As the catch in the larger mesh nets decreased, the fishermen shifted to smaller mesh gill nets. The catch in the smaller mesh gill nets were better than those in the 127 mm mesh nets and this made the mesh size limit so difficult to enforce that it was repealed.

As the larger species became scarce, fishermen shifted to smaller originally less preferred haplochromines and *R. argentea.* A fish stock survey of Lake Victoria from 1969 to 1971 showed that haplochromines were the most abundant fish in Lake Victoria and comprised up to 80% of the demersal fish stocks (Kudhongania and Cordone 1974) and remained so up to 1981 (Okaronon *et aI1984).*

L. niloticus and four tilapiine species; 0. *niloticlls,* 0. *leucostictus, T. zillii* and *T. melanopleura* were introduced into Lake Victoria in 1950s to improve declining stocks of large species. Stocks of Nile perch increased rapidly between 1971 and 1983. This was followed by a decline and in some cases total disappearance of some of the native species. About 200 out of an estimated 300 species of haplochromines disappeared. The fishery changed from a multi-species to a three species fishery comprising Nile perch, Nile ti1apia and Mukene. There were, however rapid increases in commercial catches. In the Ugandan portion of the lake fish catches had decreased from 41,670 metric tonnes in 1970 to about 10,000 metric tonnes in 1980. However, as the introduced species increased fish catches increased from 17,000 metric tonnes in 1981 to 132,382 metric tonnes in 1981 due to an increase in the contribution of Nile perch. Fish catches lake-wide increased five fold from about 100,000 to over 500,000 metric tonnes following establishment of introduced species especially Nile perch.

The increase of fish catches following establishment of Nile perch was followed by increased establishment of fish processing plants, which fillet Nile perch mainly for export. This stimulated increases in fishing efforts. Fishing effort more than doubled from 3,200 canoes in 1972 to 8,000 canoes in 1990. These factors need to be controlled if the fishery is to remain sustainable. There are indications that maximum sustainable yield (MSY) has been exceeded. Fish catches which had increased from 10,000 metric tonnes in 1980 to 132,000 tonnes in 1989 decreased to 120,000 tones in 1991 to 103,000 tones in 1994 (Figure 4). There is therefore need to control further expansion of the fishery until adequate scientific data is available to guide on optimal levels of exploitation.

Some of the interventions required on Lake Victoria include: controlling of fishing effort; controlling the use of destructive fishing gears and methods especially beach seines, gill nets of less than 5 inches and mosquito seines of less than 5 mm; and protection of refugia. Uganda, Kenya and Tanzania have formed the Lake Victoria Fisheries Research Organisation (LVFO) to co-ordinate uniform management of the fisheries of Lake Victoria. LVFO should spearhead these interventions.

Lakes Kyoga and Kwania

Lakes Kyoga and Kwania are located wholly within Uganda between longitude 32°E to 34°E and latitude 1°N and 2°N. It is at an altitude of 1037 m above sea level and covers an area of 2047 km^2 The lake is shallow with an average depth of 3 m to 4.5 m.

The most important commercial fish species at the time that the first fishery survey of these lakes was done by Worthington (1929) to the early 1950s were O. *variabilis.* 0. *esculentus, P. aethiopicus. B. docmac.* C. *mossambicus,* S. *intermedius, Barbus* spp and Mormyrids. Haplochromines were abundant in the lake but as in Lake Victoria, were not commercially exploited.

Introduction of more efficient fishing gears, especially gill nets without having a mechanism to control them had effects similar to those of Lake Victoria. Unlike Victoria, there was no control on the size of nets used on Lake Kyoga. Consequently, nets of 2.5 inches to 4 inches were freely used. The small mesh gill nets were harmful to the native tilapiines. This contributed to a fall in catch rates from about 30 fish per net in I940s to only 7 fish per net in 1950.

Tilapiine species and Nile perch were, as in the case of Lake Victoria, introduced in Lake Kyoga to improve the fishery. Total fishery yield increased form 18,261 metric tonnes in 1964 to a peak of 167,200 tonnes in 1978, due to the contribution of the two introduced species, Nile perch and Nile tilapia. However, total fishery yield decreased to 54,706 metric tonnes by 1989 and have remained low since then. This suggests that Lakes Kyoga and Victoria might not sustain the very high catches realised after establishment of introduced species, especially Nile perch. The very high catches were, in both lakes supported by the haplochromine prey which were abundant in these lakes but which have since been depleted by Nile perch predation.

As in the case of Lake Victoria, stocks of the native species declined and others completely disappeared following establishment of the Nile perch again showing that introduction of predatory fishes have negative impacts on stock of native species. However, stocks of some haplochromine species have started to increase apparently due to a reduction in predation pressure arising from over-fishing of the Nile perch and increase in the macrophyte cover following the spread of water hyacinth. The factors that are causing decline in total fishery yield and the recovery in indigenous fishes especially haplochromines should be examined.

Fishery surveys carried out in 1991 and 1997 suggested that the fishery of lakes Kyoga and Kwania could collapse if no action was taken to control use of destructive fishing gears and methods and control the number of fishing boats. The fishing effort increased very fast from 4045 boats in 1991 to 6500 boats in 1997. The size of gill nets decreased from 4½ inches stretched mesh in 1991 to as low as 2½ inches by 1997. Boat seines are rampant and are operated allover the lake and using very small mesh size nets of 2½ inches to catch Nile tilapia and Nile perch. Many juvenile Nile perch and Nile tilapia are caught as bye catch of the Mukene fishery. There is need to develop mechanisms of reducing this.

The management interventions on Lake Kyoga are similar to those for Lake Victoria. However, in addition to controlling fishing effort on Lake Kyoga, there is need to prohibit use of open water seines and to develop mechanisms to avoid the Mukene fishery from harming the fisheries of Nile perch and Nile tilapia.

Lake Wamala

Lake Wamala is located in Mubende District. Its area varies from 100 to 180 km^2 depending on the amount of rainfall.

The lake originally had a native fishery consisting of *P. aethiopicus* and C. *gariepinus*. In 1956, the fishery was improved by stocking tilapiines, 0. *niloticus* and 0. *leucostictus.*

Lake Wamala was opened to commercial fishing in 1960 under controlled exploitation. Only 250 boats using gill nets of 5 inches (127 mm) stretched mesh size were permitted to operate on the lake. However, fishing effort increased rapidly to about 1000 boats by 1967.

Fish catches increased from about 1000 metric tonnes in 1960 to a peak of 7100 metric tonnes in 1967 and remained between 4000 to 6000 metric tonnes annually from 1965 to 1976 (Figure 3). Thereafter the catches declined to about 1000 metric tonnes and have remained below this level since then.

During the 1970s, the catches were dominated by Nile tilapia (67%) followed by C. *gariepinus* (17%) and *P. aethiopicus* (15.1 %). The maximum size of Nile tilapia in the lake decreased from 32 cm in 1970s to 22 cm by 1990s and the size at first maturity decreased from 21 cm to **14** cm during the same period. As the size of the exploited stocks decreased, there was a shift in the mesh size of gill nets used on the lake from 5 inches during the 1970s to 2.5 inches by the 1990s.

The volume and area of the lake also decreased. The shoreline of the lake receded by about 0.5 krn in some places and the depth decreased from about 4.3 min 1970s to about 1.7 m in 1997.

The decrease in the size of Nile tilapia may be partly due to the shift in the mesh size of gill nets used on the lake from larger to smaller meshes. However, stunting of the fish seems to have been caused by environmental stress especially shrinking of the area and volume of the lake resulting into over-crowding and thus stunting of fish as is sometimes the case in over-crowded aquaculture ponds. Nile tilapia in the lake are also heavily infested by nematode parasites. The shrinking in the lake's volume and area could have been due to poor land use practices. Sustainability and improvement in the fishery of the lake will depend on adjustment of fishing effort - fishing gears and methods, number of boats and number of nets per boat, and curtailing environmental stress.

Some of the management interventions on Lake Wamala require revision of the gill net mesh size limit for the lake. Research is also required to establish the causes of stunting of Nile tilapia in the lake.

Nabugabo lakes

Nabugabo lakes include five satellite lakes (Nabugabo, Manywa, Kayugi, Kayanja and Kitunda) located near the western shore of Lake Victoria. The first fishery surveys of Lake Nabugabo showed that the most important commercial fish species in this lake were *P. aethiopicus, B. docmac*, S. *intermedius*, C. *gariepinus*. 0. *esculentus* and 0. *variabilis*. The lake also contained 21 other fish species of which eight were haplochromines. Of the eight haplochromines species, five were endemic and are believed to have evolved within the lake in a period of only 4,000 years. As in the case of lakes Victoria and Kyoga, Nile perch and several tilapiines species were introduced into Lake Nabugabo. This was accompanied by disappearance of many of the native species. Lakes Kayanja, Kayugi and Manywa which are adjacent to Lake Nabugabo but separated from it by extensive swamps contain 0. *esculentus* and two haplochromine species previously found only in Lake Nabugabo. These three lakes need to be protected to conserve these species. Swamps around the lakes should be protected to prevent Nile perch from spreading into the three lakes.

Studies on lakes Nabugabo, Kyoga and Victoria (Ogutu-Ohwayo 1993, 1994, Chapman *et al* 1995) have shown that some of the species which have been depleted from open waters of these lakes survive among marginal macrophytes and rocky outcrops found within or along the lake margin and in small satellite lakes which are separated from the main lakes. In order to conserve and restore some of the endangered species, it will be necessary to avoid destroying rocky outcrops and clearing aquatic macrophytes which are not weeds.

The Kyoga **minor** lakes

The Kyoga minor lakes complex consists of over 24 small lakes all of which are joined by an extensive swamps (Figure 1). Like the Nabugabo lakes, the Kyoga minor lakes contain endemic species whose stocks have been decimated by over-exploitation and Nile perch from lakes Victoria, Kyoga and Nabugabo. They are therefore valuable in conservation of the biodiversity lost from lakes Victoria, Kyoga and Nabugabo. Surveys carried out on these lakes since 1995 show that 0. *esculentus* and many native species which have been depleted from lakes Victoria and Kyoga still survive in these lakes. They would, therefore, be useful sources of restocking the main lakes should this become necessary. The Kyoga minor lakes also contain beautiful ornamental fish species that have sometimes been collected directly from the wild for export.

The Koki lakes

The Koki lakes consist of Lakes Kijanebalola, Kachera, Mburo, Nakivali plus about 14 smaller lakes. They are located in south-western Uganda (Figure I). They are 3 to 4 m deep and are associated with extensive swamps. They are the single largest fishery of the *P. aethiopicus*. The original endemic tilapia 0. *esculentus* of the Victoria and Kyoga lake basins is also abundant in some of the lakes. They have an important haplochromine fishery.

Rivers

Uganda has extensive river systems and is the source of African longest river the Nile. Other rivers include Aswa, Dopoth-Okot, Paget, Katonga, Mayanja-Kato, Mpologoma. The lengths of these rivers is given in Table 2. These rivers are important sources of fish. Some of the originally cherished riverine food fishes such as *L. victorianus* have been decimated by destructive fishing gears and methods. Rivers are also important breeding areas for migratory specIes.

Conclusions

It is clear from the above account that fish stocks and fish species diversity of most of the lake including those which are under controlled exploitation have declined. These declines seem to largely due over-exploitation, use of destructive fishing gears and methods, introduction caused by inadequate or total absence of effective management regimes. For the stocks to be sustainable, it is necessary to control the fishing effort and use of destructive fishing gears and methods. On the Ugandan and indeed all the African Great lakes, controlling the number of fishermen, boats, or nets posses a great challenge because historically, most of these fisheries have been open for all. The open access policy needs to be evaluated and the fishing effort controlled on all the lakes. The number of fishermen, boats and fishing gears on all the lakes has been increasing rapidly. In many of the cases, more efficient fishing gears and methods have been introduced without having a means of regulating their deployment. It appears that management of fishery resources through regulation made and enforced by government machinery has not been successful. Mechanisms which involve user communities in development and management of fishery resources need to be developed and tried. The satellite lakes contain some of species whose population have been depleted from the large lakes and are important in conserving these species.

Table I. The major lakes in Uganda

Name of lake	Total Area (km^2)	Area in Uganda (km^2)	Depth(m)
Victoria	68457	28655	82
Albert	5335	2913	51
Kyoga & Kwania	2047	2047	7
Edward	2203	645	117
George	246	246	3
Bisina	308	308	

Table 2. The major rivers of Uganda

Name of river	Length (km)
Victoria Nile	426
Albert Nile	257
Aswa	357
Dopoth-Okot	314
Paget	232
Katonga	182
Mayanja-Kato	175
Mpologoma	173

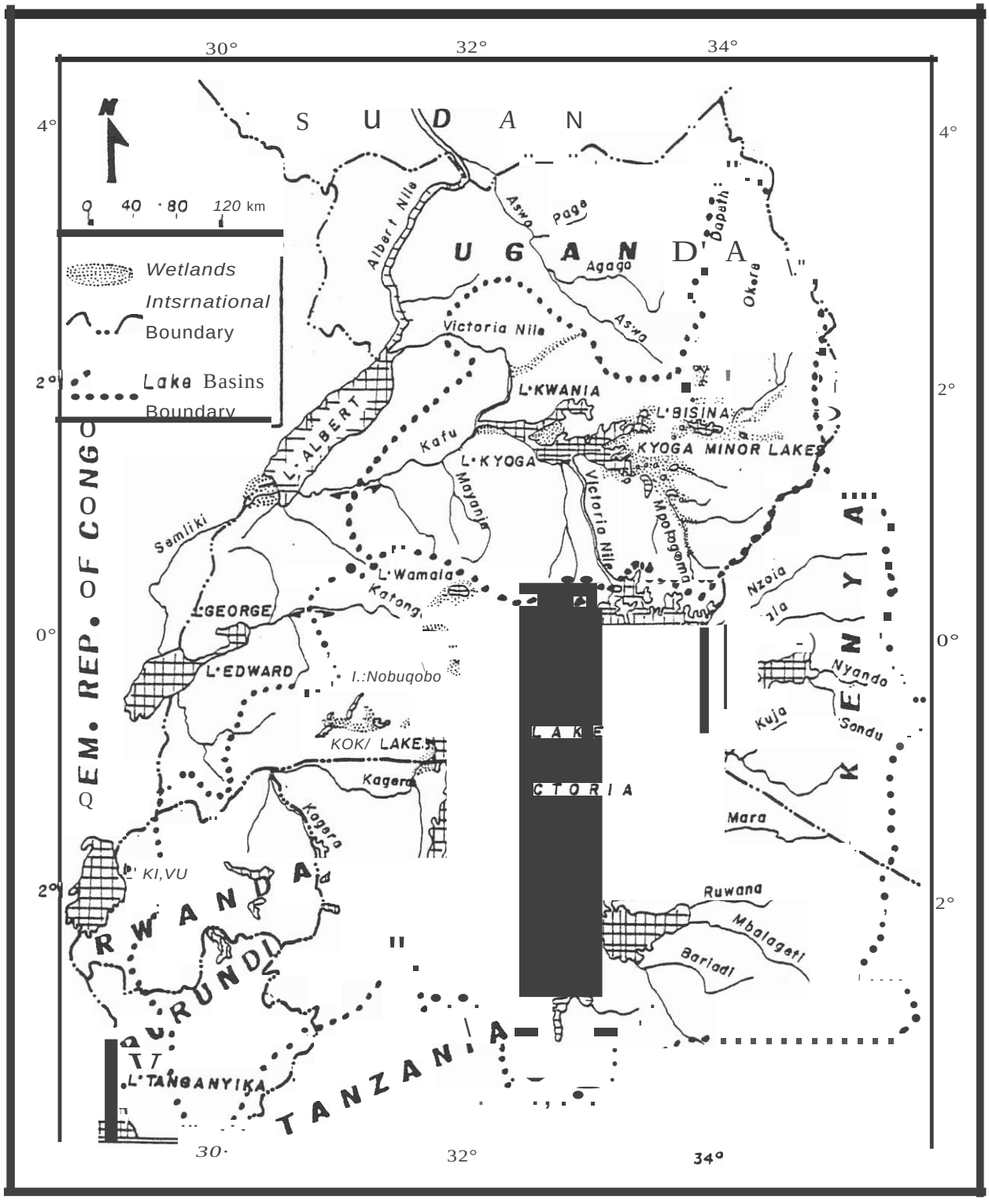
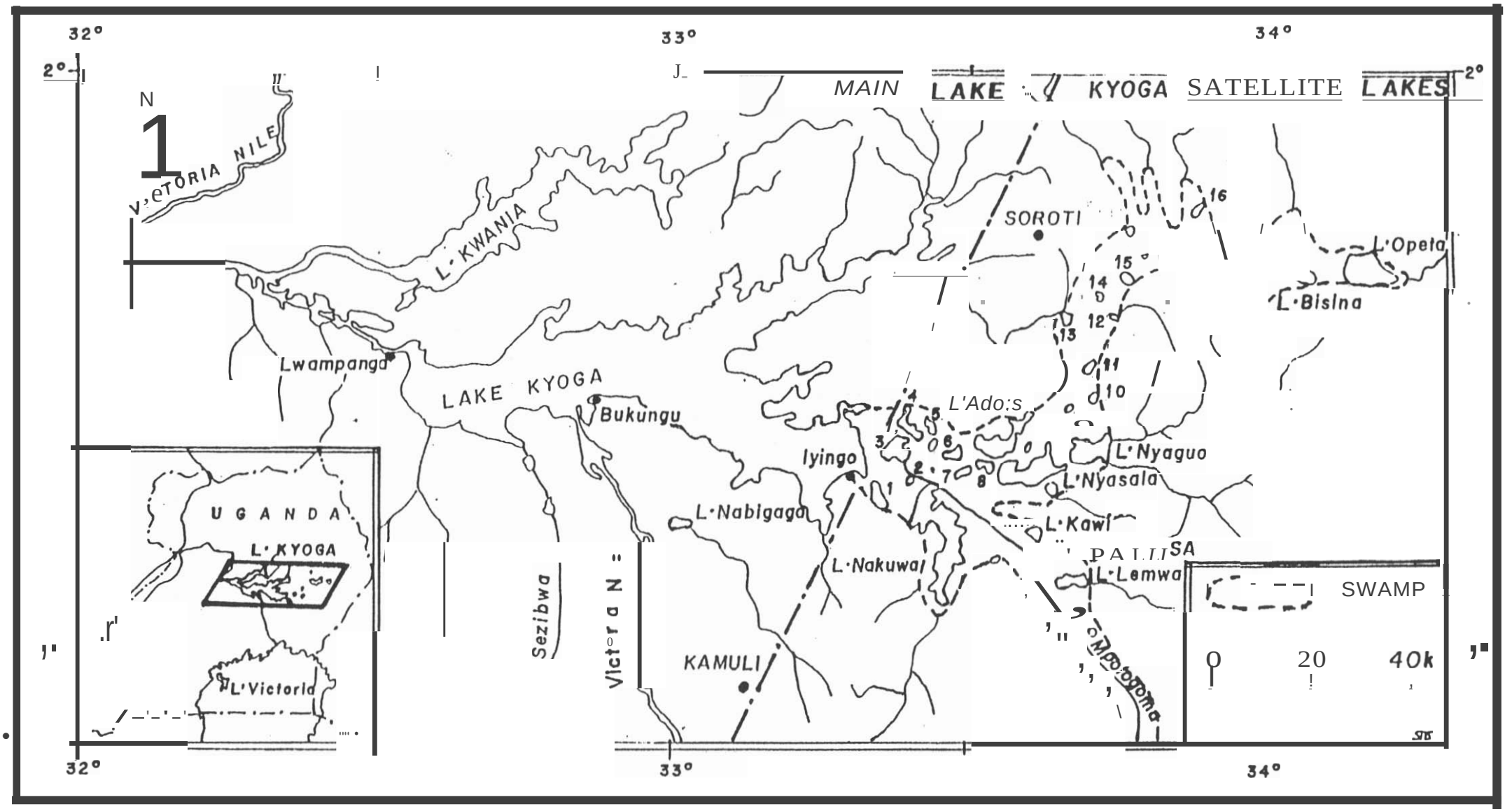


Fig.1 The Map of Uganda showing the Victoria and Kyoga lake basins


MAIN LAKE KYOGA SATELLITE LAKES
32°
33°
34°
2°
N
1
V,eTORIA NILE
L·KWANIA
SOROTI
L·Opeta
L·Bisina
Lwampanga
LAKE KYOGA
Bukungu
L'Ado:s
Iyingo
L·Nyaguo
L·Nyasala
L·Kawi
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L·Nakuwal
PALISA
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UGANDA
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Figure 2

Contribution of different water bodies to national fish catch (1961-1995)

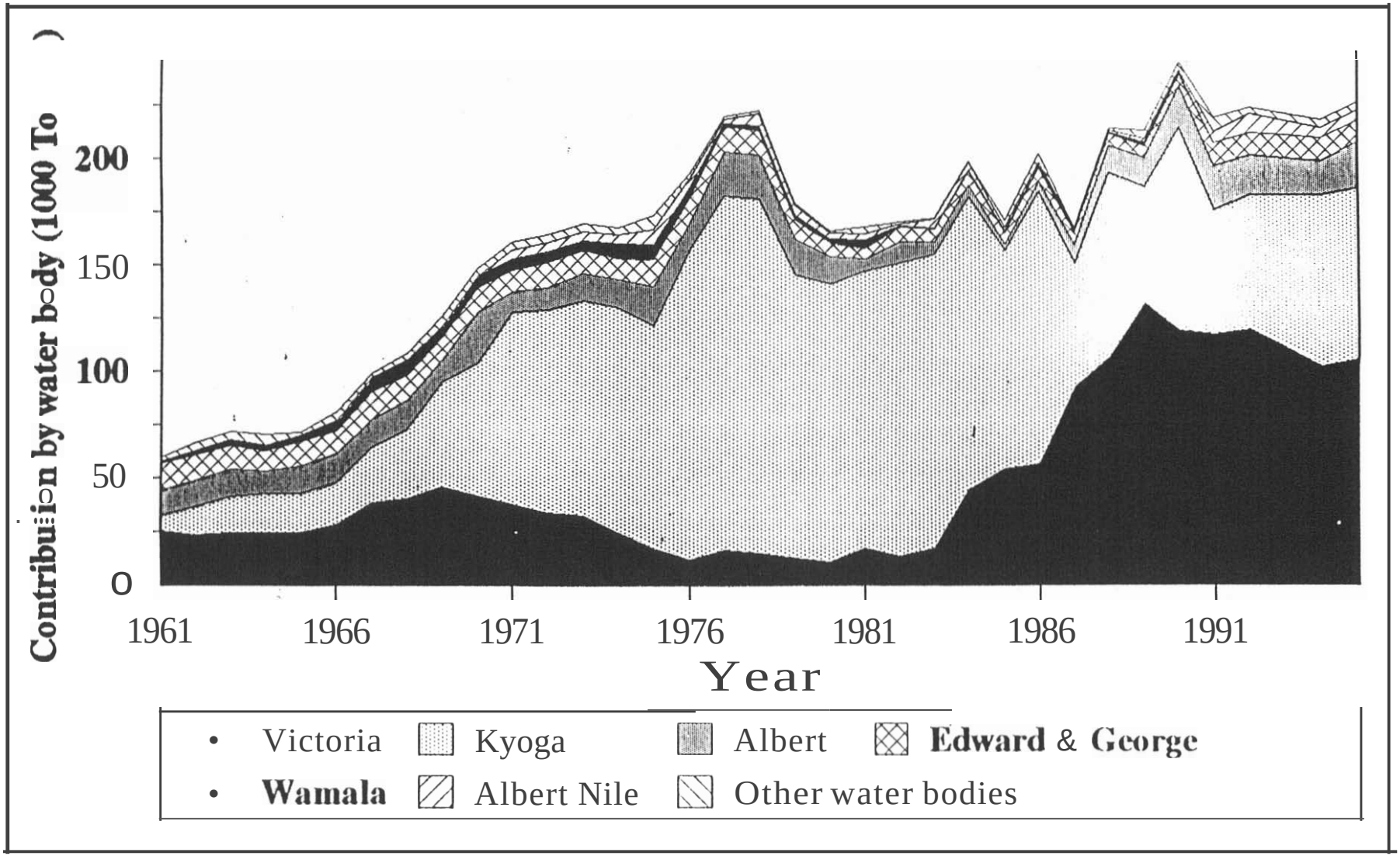

Fig. 2

Relative importance of major commercial fishes in different water bodies
(Based on catch statistics data for 1991)

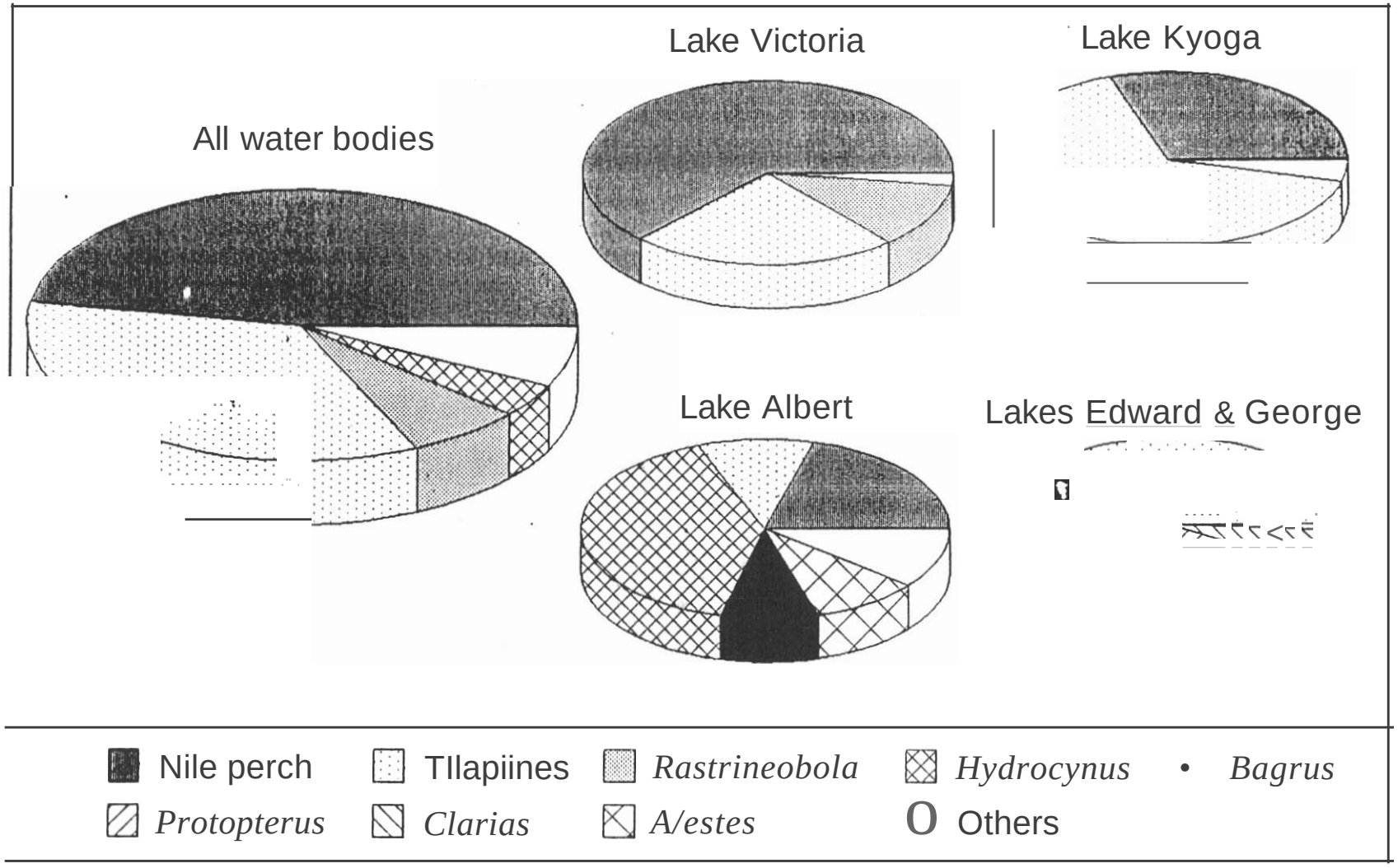

Fig. 4