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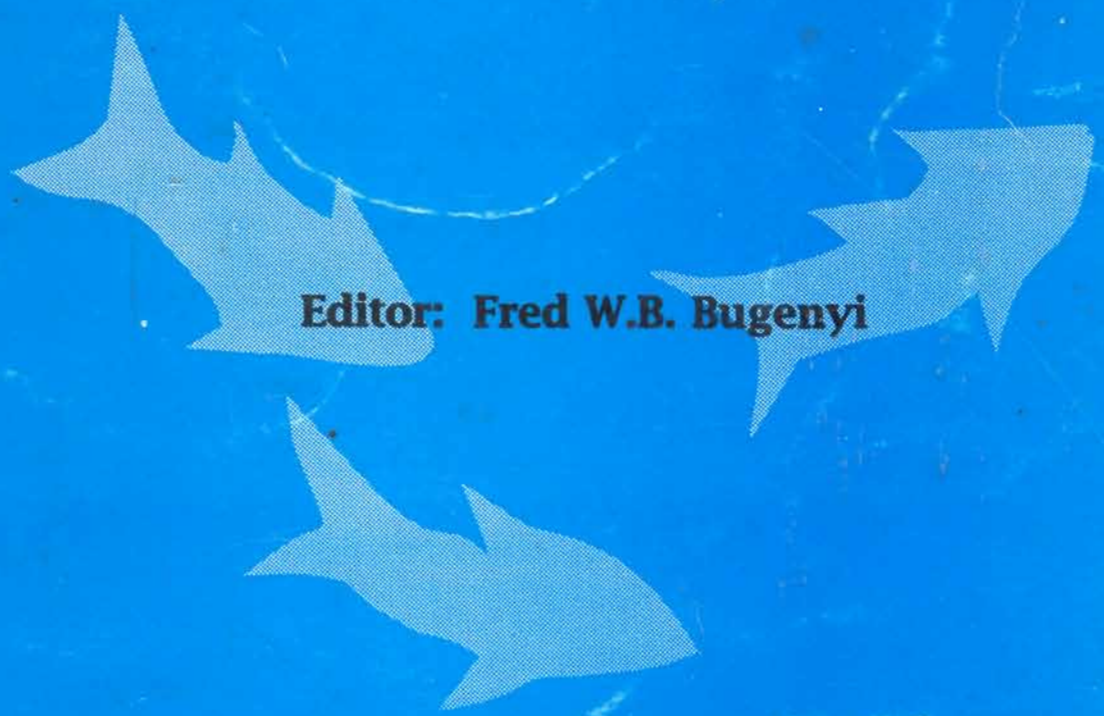

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Fishery resources and some economic aspects of four fishing villages on lakes George and Edward in the Queen Elizabeth National Park, Uganda

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ABSTRACT

The fishery resources of Lake George and Ugandan waters of Lake Edward are described. The main fish species currently observed in the commercial catches were determined and the reasons of changes in species composition of the catches, that occurred in the recent years, are explained. The fishing activity and some economic and nutritional aspects of four fishing villages, selected among the ten present within the Queen Elizabeth National Park boundaries, are analyzed. In the end some suggestions are given for management of the fishery resources of these lakes.

INTRODUCTION

The aim of this work is to investigate some biological aspects of the commercial fish species present in the two lakes and the aspects related to the management and exploitation of these resources by the local populations. At the same time, a socio-economic investigation on the economy and dietary habits of the people of this area was performed.

This research has been carried out collecting data in the field during a period of six months, from April to September in 1990, in the Queen Elizabeth National Park (Q.E.N.P.), Uganda and processing these, once back in Italy.

The Queen Elizabeth National Park was created in 1952 and covers an area of 1978 sq. km. It is located in the western side of the African Rift Valley (Fig.1). Lake George is connected to Lake Edward by the Kazinga Channel which is 33 km long and has a maximum width of less than 1 km. Lake Edward has an area of some 2240 sq. km, 71% of its waters is located in Zaire, while 29% in Uganda; the average depth is 34m. Lake George lies totally within Uganda and has a surface area of some 290 sq. km with a depth that is nowhere more than about 3m. The area of the National Park is crossed by the equator; there are two wet seasons from March to May and from September to November and two dry seasons in the remaining months.

Resources of the lakes of the East African Rift Valley have a great nutritional and economical importance not only for the fishing communities

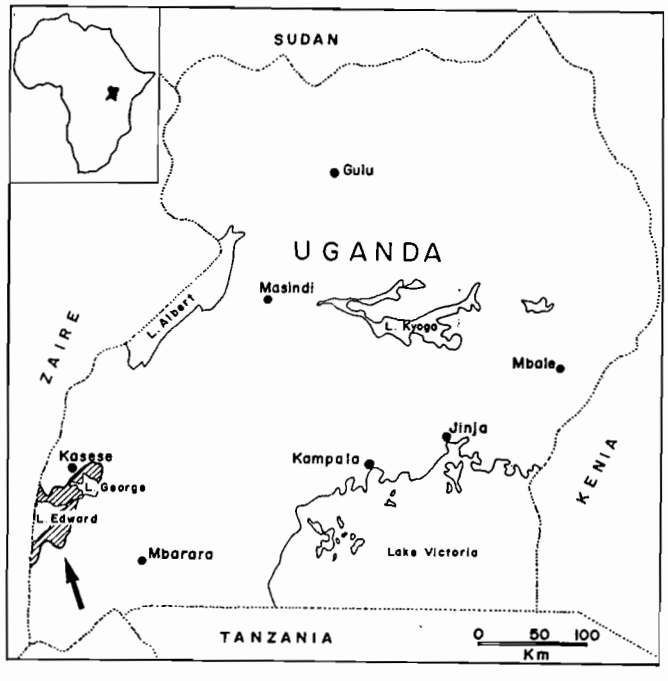


Fig. 1. The Queen Elizabeth National Park (Uganda).

but also for the whole population of the countries where lacustrine basins of a certain size are present. Because the main biological and ecological characteristics of the eastern African lakes are the high productivity and the big adaptive radiation of some families of fish. These features underline the importance of investigating subjects concerning the fisheries resources of these lakes and their exploitation by the local populations. For these reasons, management of these ecosystems that warrant either the keeping of the existing ecological balances or the optimization of the exploita-

tion of such resources, so important for the welfare of local populations, is very important.

There are many researches previously carried out in this area; many studies have been made on lakes George and Edward. Lake George has been studied more intensively than any other tropical lake, as production processes were investigated here throughout a six-year (from 1967 to 1972) International Biological Programme project by he Royal Society of London.

Many studies have been carried out on Lake Edward: the research expeditions of TREWAVAS, 1933 and WORTHINGTON and RICARDO, 1936; and the recent researches by DUNN, 1989: "Fisheries management study in the Q.E.N.P., Uganda", VAKILY, 1989: Etude du Potentiel halieutique du lac Idi Amin". Some socio-economic investigations have been carried out on the fishing villages present in the area of the National Park (ETOORI, 1986 and INFIELD, 1989).

METHODS

The study area is represented by four fishing villages chosen among ten villages present within the National Park boundaries (Fig.2). Three of these, Katwe, Kazinga and Rwenshama are located on Lake Edward, the fourth, Hamukungu, on Lake George. These four villages were chosen because they seem to be the most representative of the area for the high number of inhabitants, number of boats and different fishing gears used. The study of fish species in the lakes was carried

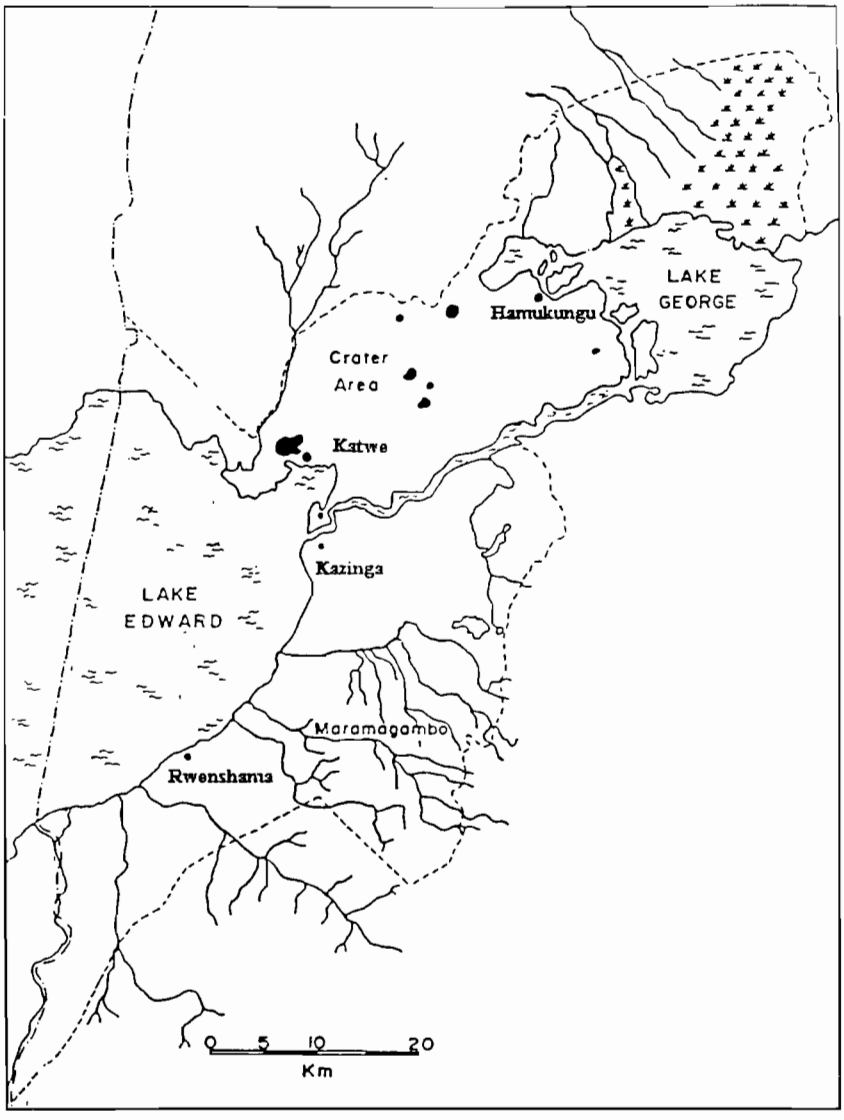


Fig. 2. Study area: fishing villages analysed in the Queen Elizabeth National Park.

out with a daily analysis of commercial catches at the landings of fishing villages chosen. The principal fish species were identified, and weight and length data of the specimens of the different species were collected; this allows the definition of the age structure of the fish populations studied. In the six months of the present study, the fishing activity of 183 canoes (present in the four fishing villages selected) was recorded and over 14,000 fish specimens were analyzed. Throughout the six months spent in the area many interviews with fishermen, with canoe owners and with various members of villages were carried out, to collect more detailed information on marketing, the economy of the fishing villages and their food availability and habits. Much information was obtained through direct experience and observation, during the daily excursions in the villages.

RESULTS

Main fish species

The most important commercially valuable species are: the tilapias *Oreochromis niloticus* and *Oreochromis leucostictus*, of the family Cichlidae. The catfishes *Bagrus docmac* and *Clarias lazera* of the Sub-order Siluroidea. The lungfish *Protopterus aethiopicus* is the only representative of the Order of Dipnoi in these lakes. Other species of lesser importance are *Barbus altianalis*; *Mormyrus kannume*; *Labeo forskalii*.

Number, type of canoes and number of fishermen

The canoes are wooden and locally made. Canoes with a total length of about 8 m, are especially common on Lake Edward and smaller canoes 5 - 6 m length, are more common on Lake George and in the illegal fishery on Lake Edward. In the Ugandan waters of Lake Edward 203 canoes and about 1300 fishermen were counted. In the village of Hamukungu, on Lake George, there were 80 canoes, 40 of which were from other villages of the lake, and there were 320 fishermen. All villages analyzed have a remarkable number of illegal canoes, whose catches are not included in the statistical data of the Uganda Fisheries Department (UFD).

Gears and fishing methods

Three major fishing gears are employed on lakes George and Edward:

(i) single filament gillnets; each canoe has a number of nets varying from 10 to 50 (from 500 to 5000 m of total length), with mesh sizes varying from 102 mm to 177 mm. A very common fishing method is the "beating method" which, although illegal, predominates on Lake George, in the Kazinga Channel and is used by the illegal canoes on Lake Edward. This method uses three or four nets of 102 mm mesh size which are laid in an arc. The water is beaten with sticks to drive the fish into the net (DUNN, 1989).

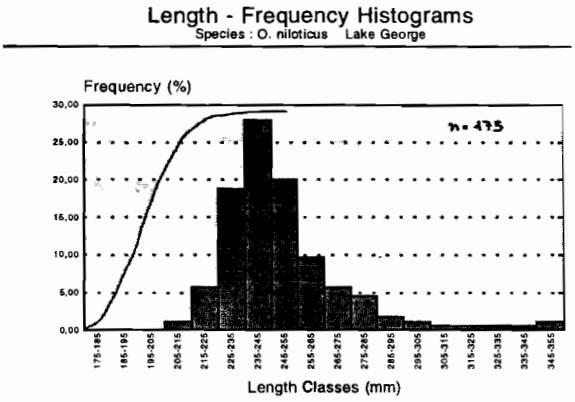
(ii) Long-lines are used on both lakes, with hooks of 35 mm length, each canoe has a number of hooks varying from 100 to 1000.

(iii) The basket nets are hand made by twining dried stems of papyrus. It represents the oldest fishing method and is not much used on both lakes. There are 3 or 7 basket nets per canoe; they are set along the shorelines of the lakes or rivers among the vegetation in the water with a depth of around one meter.

Aspects of population structure of the main fish species

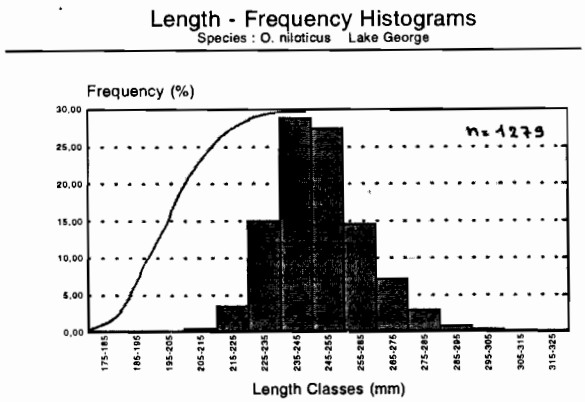
The population structure of main fish species during both the wet and dry seasons was analyzed. From the analysis of each population structure it is also possible to assess the grade of selectivity, on single species, of the fishing methods and gears used in the lakes. Figure 3, for example, shows the length frequency distributions of the *O. niloticus* population in Lake George. Since in the present study data on the size at first maturity of the fish species analyzed, were not collected, the only data available, and represented by the GWAHABA and RINNE studies published in the early 1970s, was used.

The curves drawn, obtained from an earlier study of the biology of this species GWAHABA (1973), represent the trend in maturation size as compared to the distribution of length classes. From Figure 3, it is evident that the percentage of unripe specimens caught by the fishing methods used on these lakes was low. The flex point, of



Wet Season

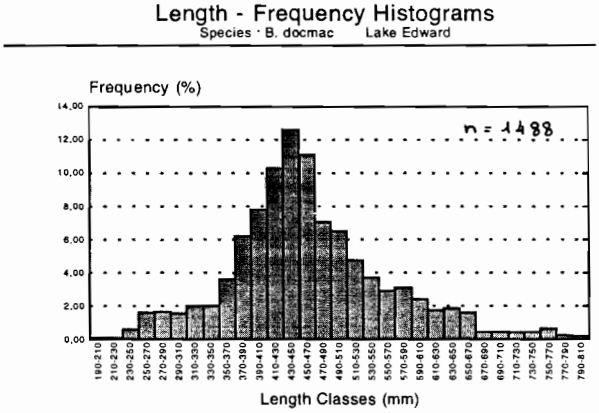
The curves show the parcentage of *Oreochromis niloticus* ripe specimens in relation to the distribution of length classes.



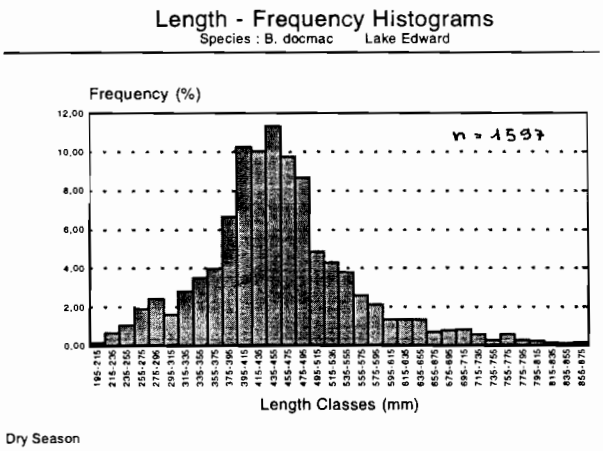
Dry Season

around 20 cm length, represents the 50% of fishes which have reached maturity. The average size, during the two seasons, is about 24.5 cm (TL) and is composed of ripe specimens, because *O. niloticus* in this lake, reaches the size of first maturity around 18 cm length (GWAHABA, 1973). The population structure of *B. docmac,* the fish species most commonly caught on Lake Edward, is presented in Figure 4. This species reaches the size of first maturity of around 30 cm (TL), at the end of the second or at the beginning of third year of age (RINNE, 1974-75). From the figure it is possible to see that the percentage of fish caught around that length is rather low; that means that juvenile, immature fish, are not caught by the fishing methods currently used. The average size of this species in the catch is about 44 cm, at this length all the specimens have certainly reached maturity. The wide range of length classes shown by this species is due to the fact that it is caught by all fishing gears used by fishermen.

The other two important fish species are *P. aethiopicus* and *C. lazera* which are fished mainly by longlines in the deep waters of Lake Edward. The analysis of the population structure of these species shows that this is a very selective fishing



Wet Season



Dry Season

method, because only large mature fish are caught. For this reason the fishing mortality on their populations is not harmful.

Fish catches composition

The most important commercial species, by total weight (kg) on Lake Edward, is the catfish *B. docmac*, followed by tilapia (*O. niloticus*) and the other species (Table. 1). *Protopterus aethiopicus* and *C. lazera,* even if present in smaller proportions, make a large contribution to total catch. Other species (*B. altianalis, O. leucostictus, M. kannume and L. forskalii*) contribute only a small proportion to the total catches, not only because they have lower commercial importance, but also are distributed geographically in specific habitats.

Table. 1- Catch composition (in kg) in the fishing villages analyzed on Lake Edward (Uganda).

SPECIES	WET SEASON	DRY SEASON	TOTAL
O. niloticus	1603.8	3366.9	4970.7
B. docmac	4824.7	4237.7	9062.4
P. aethiopicus	650.3	629.3	1279.6
C. lazera	563.1	465.5	1028.6
B. altianalis	61.0	32.5	93.5
O. leucostictus	1.4	43.9	45.3
M. kannume	5.8	4.3	10.1
L. forskalii	0.4	0.1	0.5
TOTAL	7710.5	8780.2	16490.7

The situation in Lake George is very different (Table 2). Here tilapia (*O. niloticus*) represent about 90% of the total catch, because lines of gill-nets and the "beating method" are the only fishing methods used. In Fig. 5 the percentage by species, of the catches on Lake Edward obtained in this study (pie chart B), were compared to those obtained by the Uganda Fisheries Department in 1950 (pie chart A). It is clear that there has been remarkable change in species composition of the catches from 1950 up to present. *Oreochromis niloticus* which formed 70% of total catches in 1950 has gone down to 30%. At the same time the catches of *B. docmac* have increased from 20% to 55%, and *P. aethiopicus* and *C. lazera*, which in 1950 formed with the lesser commercial value species only 10% of total catches, now constitute 8% and 6% of the catch respectively.

Table 2 Catch composition (in kg) in the fishing villages analyzed on Lake George (Uganda).

SPECIES	WET SEASON	DRY SEASON	TOTAL
O. niloticus	330.5	648.9	979.4
B. docmac	24.3	48.3	72.6
P. aethiopicus	0	22.7	22.7
C. lazera	2.6	4.9	7.5
B. altianalis	0	0.4	0.4
O. leucosticta	9.8	0.3	10.1
TOTAL	367.2	725.5	1092.7

The other species, *B. altianalis, O. leucostictus, M. kannume* and *L. forskalii* form just 1% of the total catches. The reason for this change in the composition of the catch is probably due to market and economic factors. Another important reason is the increase in the number of canoes using long-lines, which were not used in the past and with which these species are caught.

Fig. 6 shows how the average fresh-weight of *O. niloticus* landed on Lake George has decreased from 1950 (DUNN, 1973) up to present. This value reduced over the first 20 years (between 1950 and 1970) from 0. 9 kg to 0. 4 kg and by 1990, (this study), had fallen to 0.287 kg. The progressive reduction in fresh-weight is due to the steady decrease of the mesh size of gill-nets used

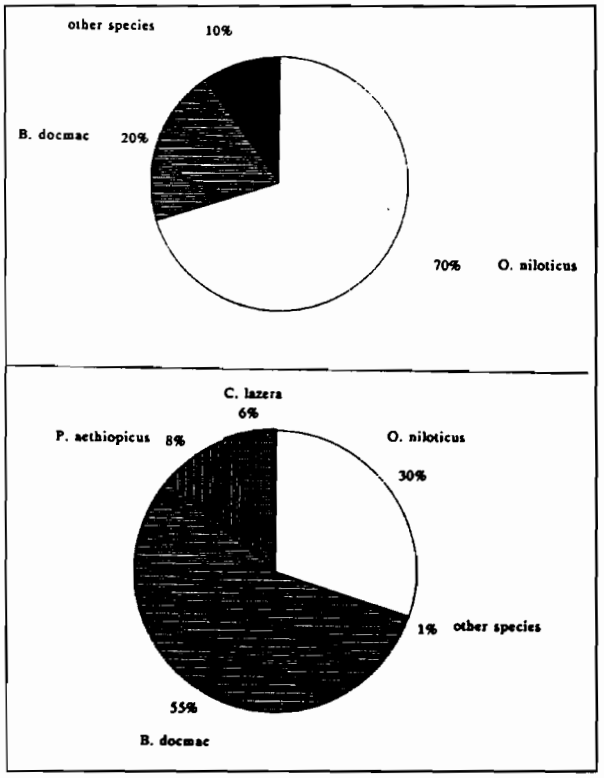


Fig. 5: Catch percentages on Lake Edward in 1950 (A) and 1990 (B).

by the fishermen, as a result of an increase of the fishing effort (numbers of fishermen and their time) that has produced a gradual impoverishment of the larger size specimens.

In Tables 3 and 4 the average catches per canoe per day (CPUE: Catch Per Unit Effort) were calculated for the two seasons, for all fishing villages analyzed on Lake Edward and for the one on Lake George. The high values of standard deviations are due to the great variability found in the total catches (in kg) of the canoes sampled in each village, due to the high variation in the number of fishing gear per canoe. The values of the daily catches, besides confirming which are the most important species, also give an idea of the high productivity of the water of these lakes. This value shows seasonal changes; in fact in

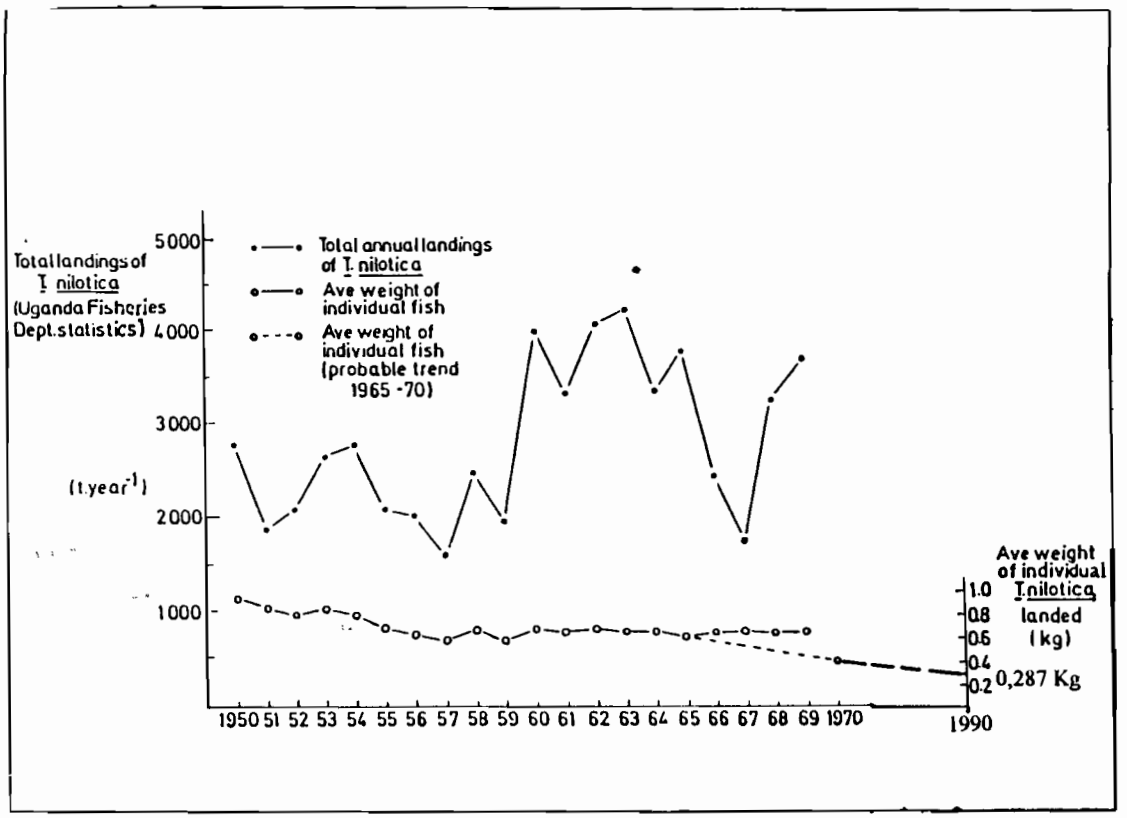


Fig.6 Average fresh-weight and total landed, of *Oreochromis niloticus* on Lake George, 1950-1969 (data from Dunn, 1973) and value of average fresh-weight found in this study of 1990.

Table. 3- Average catches/canoe/day (in Kg) of the villages analysed on Lake George (Uganda).

SPECIES	WET SEASON	±SD	DRY SEASON	±SD
O. niloticus	20.6	14.12	28.5	16.39
B. docmac	62.2	24.43	34	2.93
P. aethiopicus	7.47	6.20	4.6	3.56
C. lazera	6.67	4.96	3.4	2.69
B. altianalis	0.73	0.32	0.23	0.12
O. leucosticta	0.02	0.01	0.36	0.31
M. kannume	0.05	0.05	0.036	0.06
L. forskalii	0.003	0.005	0.0006	0.001
Total	97.7		71.1	

Table 3 it is possible to see a greater fish harvest during the wet season than the dry one. These seasonal differences are due to the biology of the species fished, in fact many of them, especially tilapias and catfishes, during the wet season, show a peak in reproductive activity that produces an increase in the size of ripe specimens due to the presence of gametes; this makes these species more vulnerable to the gill-nets.

Table 4, concerning Hamukungu (Lake George), shows that the most fished species during the two seasons is *O. niloticus*. The average catches per canoe are lower compared to those observed in Lake Edward. This is probably partly due to the smaller sizes of the canoes used on Lake George and especially to the lesser number of nets per

canoe and fishing trip. The main reason, however, is the lower harvest of the larger *B. docmac, P. aethiopicus* and *C. lazera* normally fished by long-lines, which are not used in this village.

In Table 5 total annual catches (in tonnes) for all canoes (203) present in the Uganda fishing villages of Lake Edward were assessed. These values were obtained by multiplying the total number of canoes by the average catches/canoes/day (CPUE) and by the number of annual fishing days. The result obtained, 5844.2 tonnes/year can be compared with historical catch data, from 1961 to 1988 (DUNN, 1989), and from data collected by the Uganda Fisheries Department (Figure 7).

Table 4. Average catches/canoe/day (in kg) in the village analysed on Lake George (Uganda)

SPECIES	WET SEASON	± SD	DRY SEASON	± SD
O. niloticus	20.6	11.89	23.1	14.67
B. docmac	1.5	1.95	1.7	3.67
P. aethiopicus	0	0	0.8	6.81
C. lazera	0.1	0.46	0.1	1.29
B. altianalis	0	0	0.01	0
O. leucosticta	0.6	0.57	0.01	0
Total	22.8		25.7	

Table 5. Total annual catches (in tonnes) for all canoes of the Ugandan fishing villages of Lake George (Uganda)

SPECIES	WET SEASON	DRY SEASON	Total
O. niloticus	713	986.4	1699.4
B. docmac	2152.8	1176.7	3329.5
P. aethiopicus	258.5	159.2	417.7
C. lazera	230.8	117.7	348.5
B. altianalis	25.2	7.9	33.1
O. leucosticta	0.6	12.4	13
M. kannume	1.7	1.2	2.9
L, forskalii	0.1	0.02	0.12
Total	3382.7	2461.5	5844.2

Present level of exploitation

The data in Figure 7 are from 1961 to 1988 and the dotted line represents years in which the catch data was not collected by the Uganda Fisheries Department. The trend in catches follows very closely the historical events of the country, which gave rise to a decrease of market demand, during crisis periods, while during periods of economic and social stability, demand increased. The lake's productivity has remained always constant during the past years (DUNN, 1989).

After 1985 it is possible to see a progressive increase in total catches in the Ugandan waters of Lake Edward due mainly to the political and economic stability of the country, after the years of civil war. This stable condition is still continuing and has determined an increase in demand for fish (especially the larger fish species) from human populations of the entire area. This has caused an increase in fishing effort: numbers of fishermen, canoes and fishing gears.

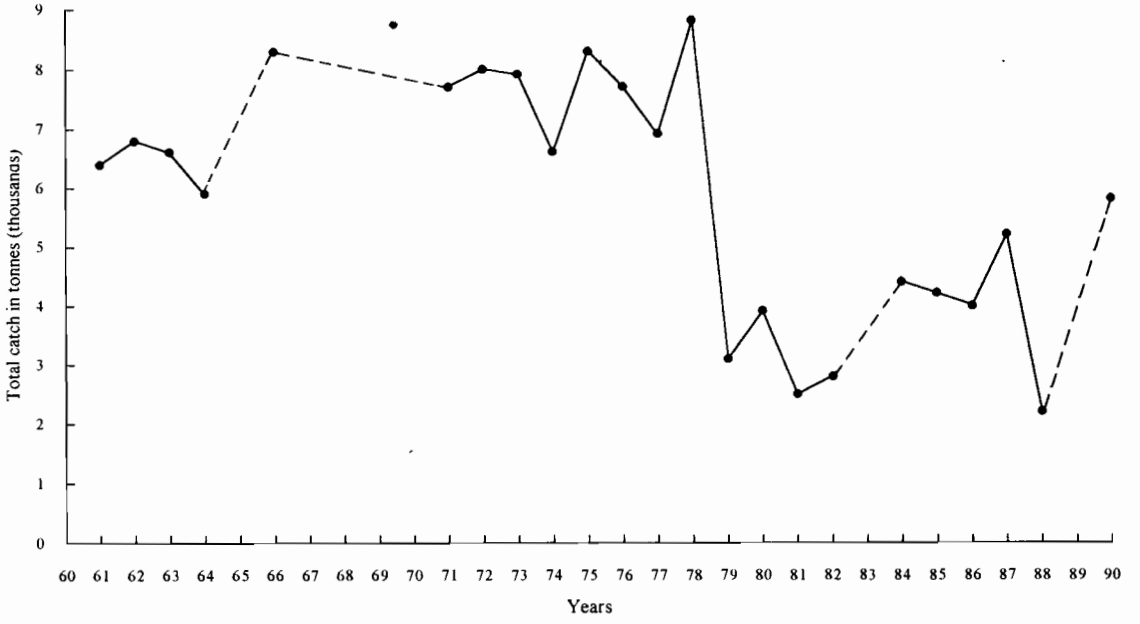


Fig. 7. Total catches in the Uganda waters of Lake Edward (1960-90).

Socio-economic aspects

In the whole area of the park there are about 20,000 inhabitants distributed among 10 villages. Within the park boundaries there are no cultivated lands and the fishery resources of the lakes represent the most important economic and nutritional product for this population. Fish is the only source of income and is used as an important item of exchange with the villages located outside the park boundaries, ensuring a continuous contribution of animal proteins in exchange for all other food products.

INFIELD's study of 1989 shows a low number of persons per family in the villages of this area, compared to other regions of Africa. That is because in many cases, some members of the family cultivate land outside the park area, while only a few people live in the fishing villages around lakes. The domestic food economy of fishermen populations living on these lakes can avail itself on several resources for maintenance:

(i) that coming from the sale of fish caught in the lakes; and

(ii) that coming from family members who cultivate a range of agricultural products outside the park. The most commonly consumed food products are green bananas (*Musa paradisiaca*) (39% of total imported goods in the fishing villages of the lakes) (OLIVIER, 1990) and fish which is the main source of protein in the diet of the local population. Other foodstuffs constitute 29% of total imported goods.

These populations are sustained directly and indirectly by an annual fish catch estimated at 5,000 tonnes for Lake George and 4,000 tonnes for Lake Edward, together valued at some US $ 5.0 million (=2.63 billion U. Shs.) (DUNN, 1989). This divided among all the inhabitants, constitute an average income of 250 US $/year per person. Subtracting the yearly auto-consumption from the yearly harvest, amounting to 2,190 tonnes/year (0.3 Kg fish/day/person), 6,810 tonnes/year is obtained which constitutes the portion of the catch available for sale to the sub-urban markets outside the park boundaries. This portion of the catch represents the monetary income of the entire population of the area, that is, the profit share which is available to improve the living conditions of the individuals. The economical value of 6,810 tonnes/year is equal to 3,783,000 US$/year (1.99 billion U. Shs./year), that divided among all inhabitants gives a monetary income per person of 189 US $/year. This value is rather high compared to the national average of Ugandan gross domestic product (280 US$/year/person, FAO, 1988), as well as to that of many other African countries. Considering that in developing countries the income distribution within the population is such that 60-70% have an income which is less than half of the gross domestic product (FAO, 1988).

Probably even if the standard of living is relatively good from an economical and nutritional point of view, it is not possible to say the same for hygiene and health; in fact the high rate of parasitism, characteristic of African lake habitats, leads one to believe that this relationship does not exist.

DISCUSSION AND CONCLUSION

This study establishes that the main species, by numbers observed in the commercial catches are *Bagrus docmac* and *Oreochromis niloticus*. The analysis of population structure of the main species shows that the high selectivity of fishing gears and the methods currently used in the lakes do not cause harm to the juvenile stages of fish populations exploited.

In Lake George, the progressive decrease of mesh size of nets over time, in response to the increase of fishing effort (number of fishermen and their time), caused a reduction in size of *O. niloticus* landed.

The economic balance of the study area allowed an analysis of the main consumer products for the local populations (fish and green bananas) and shows the close connection between the fish resources of the lakes and local economy.

During recent years considerable changes in the composition of the catch took place to the advantage of larger fish species with high market value (*B. docmac*, *Protopterus aethiopicus* and *Clarias lazera*), and the disadvantage of tilapia *O. niloticus*. This is due to a progressive improvement of the economic conditions of the country, which

has determined a change in the market demand and an increase in the long-line fishery, which targets these species. This shows the high capacity of adaptation of the artisanal fishery to environmental and market changes.

According to DUNN (1989) the present level of exploitation of fish resources of the lakes appears to be close to the optimum. In fact DUNN in his study, has estimated the MSY (maximum sustainable yield) of fish populations equal to 3,000 tonnes/year for Lake George and some 7,000 tonnes/year for Lake Edward. For this reason, any development strategies should have, as their first goal, the maintenance of this stable condition. An important function in this is to monitor the fishery so as to avoid an increasing use of nets with too small a mesh size. This could cause an excessive exploitation of the juvenile stages of fish populations of the lakes.

It is clear that the economic and nutritional importance of fishery resources of the lakes for the human populations of the basin of the surrounding area is very high. The relatively high income per person, explains the high demographic pressure observed in the lake villages. There is a corresponding need to manage the fishery in the face of this pressure so as to optimize exploitation without the risk of overfishing.

This study shows that there is an economic and food interdependency between villages outside and inside the park boundaries; in fact the former depends on the latter for animal proteins (fish), while the fishing villages depend on the villages outside the park for other foodstuffs, especially agricultural products.

The presence of the lakes in this area ensures a good standard of living, from the economic point of view, when compared with the rest of Uganda and with many other African countries.

SUMMARY

The aim of this work was to investigate some biological aspects of the commercial fish species present in the two lakes and the aspects related to the management and exploitation of these resources by the local populations.

Four fishing villages were selected as a sample, one on Lake George and three on Lake Edward to identify which were the principal fish species present in the catches and to study some aspects of their biology and population dynamics.

At the same time, a socio-economic investigation of the economy and dietary habits of the inhabitants was performed. In the six months of the present study, the fishing activity of 183 canoes (present in the four fishing villages selected) was recorded and over 14,000 fish specimens were analyzed.

The most important commercially valuable species are *Oreochromis* (Tilapia) *niloticus*, the catfishes *Bagrus docmac* and *Clarias lazera*, and the lung fish *Protopterus aethiopicus*. Seasonally important at specific locations is the barbel *Barbus altianalis*. Of lesser importance are *Labeo forskalii*, *Mormyrus kannume* and *Oreochromis leucostictus*.

For the analysis of the data collected it is possible to say that the optimum policy for the development of the fisheries of Lakes Edward and George should be to manage the fishery so that it may produce the maximum sustainable yield commensurate with the maintenance of the best standards of economic and social well-being of the fishing communities.

An assessment of the present fisheries of the lakes indicates that they are presently being exploited at near optimum levels; any development strategies should have the goal of maintaining this stable condition.

Our economic analysis of the fishing units shows that this is a very profitable activity for the canoes owners and provides a reasonable living wage for the fishermen employed.
The fisheries resources of lakes Edward and George provide a continuous and fundamental protein supply to the local populations and a relatively high pro-capita income.

ACKNOWLEDGEMENTS

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