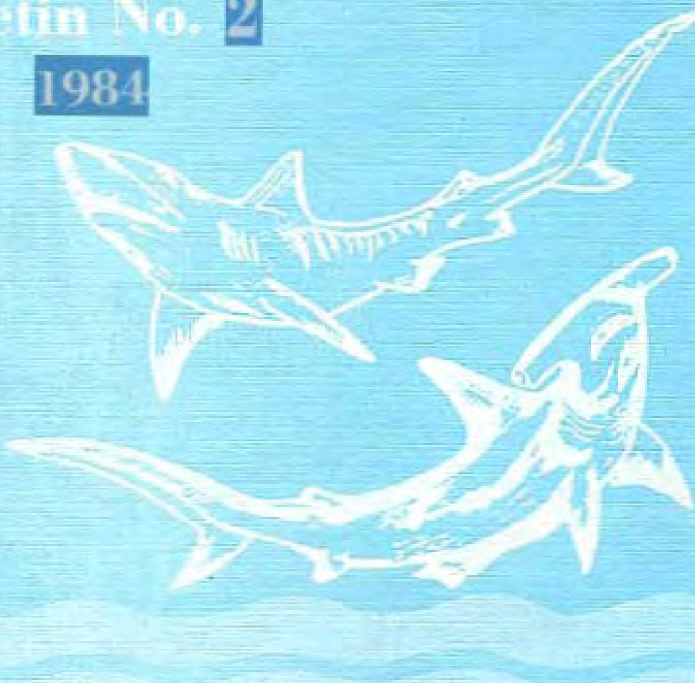
KENYA AQUATICA

Bulletin No. 2
May, 1984



A BULLETIN OF
KENYA MARINE & FISHERIES
RESEARCH INSTITUTE

CONTENTS

EDITORIAL NOTES:

This is the second issue of KENYA AQUATIC. The original idea was to publish the bulletin annually. The present issue has come after five months, because of our anxiety to release the accumulated material. The Kenya Aquatic aim is to treat Aquatic Science from a wider perspective and present compiled and well-documented information.

Efforts will be made to report activities related to Aquatic resources through KENYA AQUATIC. This will include scientific communications, critical reviews, seminar proceeding and other publications. This comprehensive coverage will be possible only through co-operative of various institutions, Departments, universities, societies and individuals who are concerned with aquatic resources.

KENYA AQUATICA is a technical and extension series for rapid dissemination of information on aquatic resources and allied information from Research Officers, Fisheries Officers and any individual for transfer of Technology to the fishermen and industry and any other relevant information needed for National Development.

The Editor wishes to invite comments and suggestions from readers with a view to improving the bulletin in the choice and arrangement of the articles, notes, summary, news briefs etc. It is our aim to see that this publication receives wide acceptance from the reading public and those interested in aquatic both within the country and abroad. It is hoped that this issue will stimulate further contributions from the readers.

We appeal to all concerned to send us regularly such Publications, at the following address:-

The Director,
Kenya Marine & Fisheries Research Institute,
P.O. Box 81651,
MOMBASA, Kenya, E. Africa.

EDITORIAL NOTES:

This is the second issue of KENYA AQUATIC. The original idea was to publish the bulletin annually. The present issue has come after five months, because of our anxiety to release the accumulated material. The Kenya Aquatic aim is to treat Aquatic Science from a wider perspective and present compiled and well-documented information.

Efforts will be made to report activities related to Aquatic resources through KENYA AQUATIC. This will include scientific communications, critical reviews, seminar proceeding and other publications. This comprehensive coverage will be possible only through co-operative of various institutions, Departments, universities, societies and individuals who are concerned with aquatic resources.

KENYA AQUATICA is a technical and extension series for rapid dissemination of information on aquatic resources and allied information from Research Officers, Fisheries Officers and any individual for transfer of Technology to the fishermen and industry and any other relevant information needed for National Development.

The Editor wishes to invite comments and suggestions from readers with a view to improving the bulletin in the choice and arrangement of the articles, notes, summary, news briefs etc. It is our aim to see that this publication receives wide acceptance from the reading public and those interested in aquatic both within the country and abroad. It is hoped that this issue will stimulate further contributions from the readers.

We appeal to all concerned to send us regularly such Publications, at the following address:-

The Director,
Kenya Marine & Fisheries Research Institute,
P.O. Box 81651,
MOMBASA, Kenya, E. Africa.

A REVIEW OF LAKE TURKANA FISHERIES.*

James Ogari, Kenya Marine and Fisheries Research Institute, Kisumu.

INTRODUCTION

Lake Turkana lies in an enclosed basin in the northern extension of the east branch of the great rift valley. Its approximate altitude is 400 m above sea level. The lake is nearly 260 km in length and varies from 14 km to 44 km in width, with a mean depth of about 30 m. The maximum depth already recorded is 115 m and the total surface area, estimated from an aerial survey is 8011 km.

Shorelines tend to shelve more steeply in the central sector than in the north and the inshore zones are correspondingly narrower. Shallow bays are found on the east coast, for example, Allia Bay.

Prior to the upper pleistocene period the lake level was higher and its waters overflowed to the northwest into the River Nile via the Sobat River (Worthington 1932). This past connection with the River Nile system is shown by the presence in the lake of a characteristic nilotic fauna. Since separation from the Nile the water of Lake Turkana has become increasingly alkaline. The conductivity was found to be in the region of 3,600 microhos over most of the lake. In the north it varied considerably during the year depending on the volume of freshwater entering the lake from the River Omo, the only permanent inflowing river.

ALGAE AND PRIMARY PRODUCTIVITY

Phytoplankton populations in the open water of Lake Turkana were dominated by blue-green algae and were characterized by a low species diversity. The algae were not uniformly distributed and there were marked differences in species composition between the north and the south. Primary productivity and algae biomass both showed a distinct gradient along the axis of the lake, from high values in the north to very low in the extreme south, as illustrated by the following values of gross production rate in g /m /day: northern sector 1315 - 6220; central sector 194 - 3936; and southern sector 259 - 293.

Daily rates of production varied considerably with location and with season. Primary productivity rose to a peak during the postflood season in the northern sector when Microcystis was the predominant species. This increase was due to the input of nutrients into the lake during the River Omo flood session.

** This paper is adapted from Proceedings of the Workshop of KMFRI on Aquatic Resources of Kenya, July 13-19, 1981*

The open water phytoplankton of Lake Turkana was almost entirely uncropped by either fish or crustacea. Postlarval Engraclicypris stellae of up to 9 mm which grazed Surirelia and similar diatoms, were the only habitual phytoplanktons in the open lake. When zooplankton populations were seasonally low in the northern sector Micralestes acutides switched to algae food and successfully assimilated Microstis. A very high proportion of the organic carbon produced by the photosynthetic activity or open water algae thus passed through a process of decomposition before it becomes available to the zooplankton in the form of detritus, and an extra step is thus added to the food chain.

Ferguson's Gulf in common with other similar inshore areas proved to have an algal flora which was quite distinct from that of the open lake. The phytoplankton was chiefly composed of blue green algae dominated by Anabaena circinalis. The gross rate of primary production was relatively high, averaging 4147 g /m /day and was thus similar to values observed in the northern sector of the main lake. However, in Ferguson's Gulf, Sarotherodon *niloticus* grazed the phytoplankton heavily, and as a result of this direct link with the primary producer, fish yields were phenomenally high.

On the sublitorial fringes of the lake rich communities of attached algae, often containing a wide diversity of species, occured on a variety of surfaces including mud, sand, rock and the leaves and stems of macrophtes. Although generally absent from loose substrates on high energy shorelines, epilithic algae grew profusely on rock surfaces subject to strong wave action. In the southern basin where phytoplankton densities were very low, attached littoral algae made a significant contribution to primary productivity and were grazed extensively by Sarotherodon and Tilapia.

The failure of fish to utilize phytoplankton in the open waters of the lake may be due to the relatively low algae concentrations. In deeper water, although primary production on an area basis is usually comparable with adjacent marginal situations, the algal cells are spread over a much greater vertical range. It seems likely that as a result of the diffusion of algal food resources in the open lake, concentrations fall below a threshold at which it is possible for phytoplanktivorous fish such as *Sarotherodon* species to feed efficiently. Results on study of anchovy larvae have revealed that, the larvae requirements include the phytoplankton density to be between 20 mg and 40 mg/l, sixe of phytoplankton species as food. The larvae could only do well in areas of high chlorophyll concentration, with no patches of phytoplankton. Unfavourable weather (Strong current) tends to disrupt the phytoplankton into patches. This may support the nonutilization of the phytoplankton within the open waters of Lake Turkana.

Zooplankton

In the absence of a well developed benthic fauna, the proportion of fish feeding on zooplankton in Lake Turkana is usually high. *Trophodiaptomous baforanus* a calanoid coppod, was the dominant species of secondary production. *Mesocyclops leuckarti* a cyclopoid copepod, was also common and ubiquitous.

Production rates of *T. banforanus* im mg dry wt/m /day for the three sectors of the lake were estimated as follows: north 13.5; central 6.2 and south 1.7. These results show that as with primary productivity there is a marked decrease from north to south. Although there was considerable regional and seasonal variation in zooplankton densities, there was general tendency for biomass to be lower in the southern sector as illustrated by mean concentration for *T. banforanus* in no/1: north 56 central 30 and south 31.

Pelagic fish densities were much higher in the central sector of the lake than in the south and it is clear that the observed level of zooplankton concentration in the central sector was the result of heavy predation. In the southern sector pelagic fish were scarce and the relatively high ratio of density to production in *T. banforanus* may be attributed to low predation rates. The results suggest that zooplankton densities in the south are close to a limiting level below which it becomes inefficient for pelagic fish to feed.

In the extreme north of the lake, population of zooplankton fell during the flood season. This may have been due to adverse effect caused by lowered salinity. However, exceptionally concentrations of zooplanktovorous fish, poarticularly *A. minutus* were noted in the area and the dearth of zooplankton may have been partly the result of overpredation. In the absence of normal food, many fish were found to have ingested scales.

The efficiency with which algal food is utilized by *Sarotherodon niloticus* in the gulf of the resultant extremely high rates of fish production were unmatched by any other area of comparable size in Lake Turkana. Thus in 1976 the production of *S. niloticus,* from an area of 10 Km in Ferguson's Gulf amounted to over 1600 tonnes.

The present studies prove conclusively that population of zooplankton over most of the lake are cropped heavily by fish and secondary producers to higher trophic levels.

Primary production in the southern sector was locally high in communities of attached algae which thrived in the littoral region down to depth of two to three metres. The algae occured ubiquitously on all shores in the southern basin, including precipitous coasts to the southwest of the lake, and were grazed extensively by *A. niloticus* and *T. zilii*

FISH SPECIES

Forty eight fish species have been identified in Lake Turkana. Twelve of these were riverine and confined to the region of the Omo River delta. The remaining 36 occur regularly within the actual lake.

The fauna is well adapted to the environmental conditions and all major trophic niches appear to be occupied, with the exception that no species of fish grazed regularly on the open water phytoplankton dominated by blue-green algae, S. niloticus which is capable of assimilating Microcystis species, the chief algal genus, is restricted to inshore areas of Lake Turkana.

Synodontis schall occured as a demersal species both inshore and offshore and fed on benthic organisms such as ostracods and molluscs. The results indicate that it was principally pelagic in distribution. The dominant demersal fish in the deeper areas of the lake was *Bagrus bayad* a species widespread in shallow riverine situation elsewhere. *A. minutus* and *A. ferox* formed the midwater scattering layer and the depth or the layer below the surface varied from one to two metre in extremely turbid water to over 30 m in the clear water of the southern sector. *Alestes baremose* and *Hydricynus foskalii* predominated in the surface waters, and *Lates longisponus* and *Schilbe uranoscope* were the principal species in a zone below the scattering layer. Further offshore, the water column between the communities describe above and the bottom was populated mainly by well dispersed adult *Engraulicypris stellae* and mature prawns, *Macrobranchium niloticus* and *Caridina nilotica*. In terms of biomass A minutus proved to be the predominant species of fish in the lake and formed an important link in the pelagic food chain between the zooplankton and predatory fish such as *Synodontis schall, Hydrocyrius forskalii* and *Lates longisponus*. The acoustic survey indicated a mean stock density of approximately 37 tonnes/km for pelagic fish in open lake at depths greater than 10 m. Estimates of the standing stock of small crustacea of the zooplankton in Lake Turkana which range with locality from 80 to 200 tonnes/km, with a mean of 120 tonnes/k^2.

Fish production and biomass varied considerably from area to area within the lake. There was an obvious tendency for stock density to decrease from north to south, which clearly parallels similar falls in primary and secondary production. The indications are that high rate of primary and secondary production led to significantly greater areas densities of fish in the northern sector than in more southerly areas, particularly inshore demersal forms such as *Labeo horie* and adult *Barbus, bynni*

Pelagic fish, which predominated in the central sector, were chiefly concentrated in the western half of the lake between the 10 m and 30 m contours. Off shore demersal populations, with *Bagrus bayad* contributed throughout the deeper waters.

Overall densities of fish were generally low in the southern sector of the lake chiefly as a result of dearth of pelagic species.

Four main communities of fish have been recognized in the main lake:

1. Littoral;
2. Inshore demersal;
3. Offshore demersal;
4. Pelagic.

Their boundaries shift seasonally and are determined chiefly by amount of illumination. A reduction in underwater illumination during the turbid flood season stimulates fish living in the subsurface layers to move near to the surface and closer inshore. Communities of littoral and inshore demersal fish are subdivisible on the basis of substrate.

1. Littoral community are restricted to an inshore belt between the lake margin and the four metre contour. *Sarotherodon niloticus, Clarias lazera* occur throughout. *Tilapia zillii* prefer rocky or stony shores. *Sarotherodon galilaeus* prefer soft sunstrate.

2. Inshore demersal community are bottom living fish restricted to inshore areas of the lake between the four metre contour and a depth of between 10 and 15 metres. *Labeo horie Citharinus citharus, Distichodus niloticus* Within this community the fishery involves mainly bottom set gillnets. The principal species are *Hydrocynus forskalii, Citharinus cithanus. Distichodus niloticus, Labeo, horie, Barbus bynni* and *Lates niloticus* The area of the lake is between Rivers Kerio and Todenyang; it extends offshore to the 1.5 metre contour and lies chiefly on the west coast of the lake. This is due to the prevailing southeasterly winds which has resulted in high concentrations of a small pelagic fish *Alestes minutus* and *Alestes ferox* together with their predators. There is a continual replenish supply of zooplanktonic food. It seems likely that such concentration of prey, as a result of wind action, has enabled stock densities of pelagic fish in Lake Turkana to be maintained well above levels which an evenly distributed zooplankton would support. The distribution of littoral fish was also influenced by the direction of the prevailing winds and high energy beaches on the west coast which support much smaller populations than the sheltered east coast where sublittoral beds of potamogeton developed. Although fluctuations of annual catches varied between 2,800 tonnes and 3,800 tonnes during the period 1970 - 1975 they indicated relatively stability although species composition of the catch has changed considerably. Thus the proportion of the total yield formed by *Citharinus citharus* fell from 80 in 1970 to 0.3% in 1975. This decline is attributed partly to exploitation and partly to

environmental changes in the River Omo where the spawning grounds are situated. The reduction in the discharge of the River Omo which had led to the recent net fall in lake level, is believed to have had an adverse effect on the recruitment of *C. citharus* during present decade. It seems likely that nursery grounds on the flood plains of the river have shrunk considerably as a result of the diminished flow.

In Lake Turkana total catch has been maintained at its current high level due to expansion into new areas, but chiefly by reduction in mesh size which has tended to increase the species diversity of the catch (table 1). Thus in 1974 Labeo horie and Bagrus bynni caught mainly in five and six inches nets, together contributed 41% of the total catch. With the attraction of unusually high catches in Ferguson's Gulf, fishermen began to move into the area from communities throughout the entire inshore fishery. By mid-1975 over 75% of all Lake Turakana fishermen had concentrated in Ferguson's Gulf as a result, fishing effort fell considerably in the inshore gillnet fishery. Future developments clearly depend on the stability of the *Sarotherodon* fishery in Ferguson's Gulf, but if it fails, fishermen will return to the inshore fisheries of the main lake. It is considered that the effects of the current reduction of efforts will be beneficial to the inshore gillnet fishery. As recommended below legislation should be introduced to limit stretched mesh size to a minimum of six inches.

Tilapia Fishery

Since early 1975 an exceptionally important gillnet fishery for *Tilapia*, (*Sarotherodon nilotics*) have developed in the Ferguson's Gulf area which has attracted a high proportion of the total fishermen in the lake. Thus by August 1976 a total of 121 canoes and 420 rafts were operating an estimated total of 6,332 gillnets within the confines of the gulf. Catches increased considerably with a total of 1,966 tonnes in 1975 increasing to an estimated 16,100 tonnes in 1976. Since the fish are concentrated in an area of approximately 10 sq. km this represents a yield of 16,610 tonnes/sq, km. During 1975 a variety of stretched mesh sizes principally from three to five inches, were in use, but during early 1976 legislation was introduced which limited mesh sizes to a minimum of five inches.

This was largely due to the annual increase in water level of approximately one metre which occured between late July and October within the marginal areas of the lake as a result of the Omo River floods. On shorelines where flat terrain fringed the lake as at Ferguson's Gulf and at Kerio, a zone upto 800 metres wide was thus inundated annually. In certain years, when the lake shores were lightly grazed by domestic stock, extensive areas of grassland were covered into shallow temporary marshes by the rising water and provided a source of shelter for fish particularly young *niloticus*

During 1974 it was estimated that a total of 304 tonnes of large cichlids were caught in seine nets on the east coast. A minimum mesh of five inches stretched mesh should be employed.

Table 1. Annual fish catches in Lake Turkana

Year	Metric tonnes
1974	5731
1975	4236
1976	17044
1977	15473
1978	15560
1979	13731

REFERENCES

1. A.J. Hopson (1975). Bottom trawling in Lake Turkana. Symposium on the hydrobiology and fisheries of Lake Rudolf. Molo 25th - 29th May, 1975.

2. E.B. Worthington (1932). Scientific results of the Cambridge expedition to the East African lakes 1930 -1931. Introduction and station list, J. Linn. Soc. Zool.

Table 3. Mean of 30 monthly samples in kg/hr by fish species in Outer Nyanza Gulf for the period January 1979 - December 1981.

Location	Outer Nyanza Gulf						
Year	1979		1980		1981		
Number of months	10		10		10		
Number of hauls	122		132		152		
	Mean	S.D	Mean	S.D	Mean	S.D	F-test
Bagrus docmac	9.2	8.3	4.7	8.0	4.1	4.5	0.68
Clarias mossambicus	0.4	0.5	0.2	0.3	8.4	3.1	10.94*
Haplochromis spp.	57.4	27.6	10.2	14.4	9.5	15.8	4.92
Labeo victorianus	1.9	0.7	0.8	0.8	0.4	0.2	0.62
Lates niloticus	0.4	0.1	0.1	0.1	63.9	78.7	1.09
Protopterus aethiopicus	0.0	0.0	0.1	0.1	0.0	0.0	1.88
Synodontis afrofischeri	0.2	0.1	0.1	0.1	0.1	0.1	0.49
Synodontis victoriae	1.4	2.0	0.8	1.2	0.6	0.5	0.37
Oreochromis niloticus	0.2	0.1	17.3	22.6	4.4	7.5	1.22
Sarotherodon variabilis	3.0	3.6	0.6	0.9	0.02	0.05	2.09
Tilapia zillii	0.0	0.0	1.9	2.5	0.0	0.0	0.00
Total mean catch in kg/hr	74.1	13.7	36.8	12.2	91.4	70.0	0.37

* Calculated F-values greater than tabulated F-values at α 0.05 (1)