BATHO-SPATIAL DISTRIBUTION PATTERN AND BIOMASS ESTIMATE OF THE MAJOR DEMERSAL FISHES IN LAKE VICTORIA

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ABSTRACT

A generalized bottom trawl exploratory survey was carried out on Lake Victoria to: (i) define the distributional pattern and magnitude of the lakewide demersal stocks, (ii) determine the commercial potential of *Haplochromis* spp. and (iii) evaluate trawling as a commercial fishing technique for Lake Victoria fisheries.

Preliminary results suggest that: (i) bottom trawl catches are more representative of the stocks, (ii) species diversification and fish density decrease with increasing mean depth and (iii) at least 80% of the catchable demersal ichthyomass is *Haplochromis*.

Though bottom trawling is a much more efficient fishing technique for the Lake Victoria fisheries, bio-socio-economic consideration impose that mechanization of the fishery should better proceed in graded steps. Besides, demographic and nutritional considerations indicate the necessity for rational management and increased direct human utilization of the fishery resource.

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INTRODUCTION

Lake Victoria as a fishery resource has experienced recognisable trends for the last seventy years or so. Though no one knows exactly when and how fishing began, it is certain that in the early stages of the Lake Victoria fishery adequate supplies were obtained with little effort, from inshore areas alone, and with simple fishing gear (such as the static fence-like "osageru" or the mobile seine-like "ngongo"). In the absence of convenient transport facilities to dispose of the fish quickly (under a tropical climate) to far inland areas, fresh fish supply was geographically limited and the fishing intensity was almost negligible. The lake, being held second in the size hierarchy of freshwater bodies, tantalizingly appeared a limitless resource.

The chimaera of an unlimited resource began to lose its illusion when fishing pressure was increased due to several developments. The use of gill-nets, first introduced in Nyanza (Kavirondo) Gulf in 1905 (GRAHAM 1929), made fishing more profitable as the gear proved more efficient, particularly in catching the highly prized *Tilapia;* and, the arrival of the railway to the Gulf at Kisumu in 1908 opened up more inland

BERGSTRAND and CORDONE (1971), giving a total of 52 sampling strata. Bottom trawling was conducted with the 180 H.P. research vessel, *IBIS*, which is 17m long, is fully rigged for a variety of fishing gear and is fitted with modern navigational devices. It is equipped with two electronic echo-sounders for recording both the depth and "biological targets" within the water column beneath the keel and has a 2-ton capacity hydraulic winch for deploying and retrieving the gear. Several types of otter trawls were used but two standard nets (of 2-seam design)—one with 24m and the other with 19m headrope lengths—were used more often. Different codends, which varied mostly in the mesh sizes (including stretched measures of 83, 76, 64, 57, 51, 38 and 19m), were fished with although the 64, 38 and 19m mesh size codends were used most frequently. For further details see BERSTRAND and CORDONE (*op. cit.*,).

Bottom trawling was possible only in waters deeper than 4m because of restrictions imposed by the draught of the *IBIS*. Towing speed was maintained at an average of 3 knots and the actual fishing duration was mostly 60 min. Shorter and longer drags were adusted to hourly catches for subsequent analyses. Trawling was performed during both day and night but, due to reversed diel vertical movements of certain species, mean catch rates and biomass estimates have been derived from drags made during the day (0700–1900 hours) only. However, species whose demersal catch rates tended to be higher during the night (1900–0700 hrs) than during the day may have been underestimated. Further, hauls believed to have been atypical in other respects (such as codend opened, net torn, etc. during the tow) were also not used for deriving the estimates. Thus, of the 1141 hauls made over the whole lake 772 (67.7%) were subsequently used for the analyses. The spatial distribution of all the hauls made (n_1) and those subsequently used (n_2) is shown in Table 1.

Table 1. The Spatial Distribution of Sampling Effort by Country Section of Lake Victoria and by Depth Interval.

Section of Lake Victoria		Depth interval (m)								
		4–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79	Total
KENYA	n_1	59	42	12	6	22	18	8	[1]	162
	n_2	41	37	12	6	14	10	8	[1]	128
TANZANIA	n_1	90	115	76	38	35	22	17	5	398
	n_2	55	95	66	32	31	20	14	5	318
UGANDA	n_1	207	167	68	38	24	28	37	12	581
	n_2	55	96	52	33	23	27	29	11	326
Whole Lake	n_1	351	324	156	82	81	68	62	17	1141
	n_2	151	228	130	71	68	57	51	16	772
% of Total Hauls	n_1	30.8	28.4	13.7	7.2	7.1	6.0	5.4	1.5	100.1
	n_2	19.6	29.5	16.8	9.2	8.8	7.4	6.6	2.1	100.0
% of total Area of Lake		9.3	9.2	8.5	7.5	9.3	17.7	20.2	18.4	100.1

[1] No Kenya Section of the Lake has this depth

Although, as it appears from the table, systematic sampling (in terms of a real proportionality in the distribution of sampling effort) was not realized, broad coverage of the lake was achieved and we have considered the data suitable for generalized considerations. Lack of knowledge of the absolute fishing performance of our gear (i. e. the ratio of the fish caught to the number actually present in the zone, and at the time, swept by the gear) inevitably limited our analyses and interpretations. But, by making certain assumptions, we have derived estimates of "ichthyomass" for the various species and "potential yield" for the *Haplochromis* taxon. These estimates are merely tentative and can be used for designing more systematic and advanced studies. If they are used for the expansion or technological improvement of the fishery, the intial mode of the development should be experimental in magnitude and outlook.

RESULTS AND OBSERVATIONS:

Most of the lake was found to be convenient for bottom trawling. The lake is generally shallow with mean and maximum depths of 40m and 79m, respectively. It is almost flat-bottomed and the few areas with rocky bottoms or floating "papyrus islands" could easily be detected and avoided. Other under-water obstructions in some areas could be tolerated, though the efficiency of the gear would be reduced. Most of the fishes of the lake appear more demersal than pelagic, and, trawling was found to be superior, in harvesting particularly the *Haplochromis* spp, over the existing commercial gear. The following are the major trends in the distribution and relative abundance of the fishes in the lake as reflected from our bottom trawl data.

Composition of the Demersal Fishes of Lake Victoria

The composition of the demersal fishes encountered during the survey is comprised of 24 species excluding those belonging to the *Haplochromis* taxon. They are systematised into 21 genera which fall into 11 families as tabulated by BERGSTRAND and CORDONE (*op. cit.*,). The *Haplochromis* taxon alone consists of 4 monospecific genera and the more important polytypic genus, *Haplochromis* itself, made up of probably more than 120 species some of which have not yet been described. Since most of the species encountered (120 species of the *Haplochromis* taxon and 5 species of *Tilapia*) belong to the family Cichlidae, Lake Victoria is rightly considered a "cichlid lake" (GREENWOOD, 1966). However, the taxa encountered were fewer than the number known in the lake as listed by Greenwood. This is because *Xenoclarias* was identified only to generic level, *Engraulicypris* and small *Barbus* spp were not sorted out from the bulk *Haplochromis* whenever encountered and waters shallower than 4m, where several other species would be expected to occur, were not sampled during our survey.

Only 20 of these taxa were used in the the present analyses and are listed in Table 2. Although there were temporal and spatial variations in catch rates and frequency of occurrence, most of these taxa were encountered in all the 13 sub-areas except areas (IV, VII and XII) which are deeper than 50m. Thus, depth (directly or indirectly) is certainly one of the ecological factors determining the distribution pattern of the fishes in Lake Victoria.

Batho-spatial and temporal distribution of species as implied by their mean catch rates

There appears a well defined trend in the number of species by depth with maximum species diversification occurring in the shallow inshore waters of the lake. Data presented in Table 2 show that species diversity progressively decreases with depth. Excepting the *Haplochromis* spp, 19 species

Table 2. Bottom Trawl Mean Catch Rates (Weighted by Depth Interval) of the Various Fishes in Lake Victoria (in Kg/Hr).

Depth (m)	0–9 [2]	10–19	20–29	30–39	40–49	50–59	60–69	70–79
Number of hauls	151	228	131	71	68	56	51	16
Species:								
Haplochromis spp[1]	493.8	800.2	639.5	507.5	448.0	486 3	196 3	29.6
Tilapia esculenta	54.1	28.3	4.4	0.5	0.0	—	—	—
T. variabilis	3.2	0.2	0.0	0.0	—	—	—	—
T. nilotica	10.0	0.9	0.0	—	—	—	—	—
T. zillii	0.4	0.0	0.0	—	—	—	—	—
T. leucosticta	0.2	—	—	—	—	—	—	—
Bagrus docmac	18.0	39.9	39.3	36.8	34.4	38.8	27.6	0.2
Clarias mossambicus	26.7	37.1	31.6	20.7	15.1	14.5	14.8	7.1
Xenoclarias spp	0.0	0.1	0.1	0.3	0.4	0.6	0.3	0.3
Proptopterus aethiopicus	33.3	23.1	7.3	5.5	1.6	0 5	—	—
Lates niloticus	2.0	0.6	0.4	—	—	—	—	—
Synodontis victoriae	0.4	1.7	7.0	9.0	11.2	26.5	29.4	14.9
S. afroficsheri	0.1	0.1	0.1	0.0	0.0	0.0	0.0	—
Barbus altianalis	0.4	0.5	0.3	0.2	0.2	—	—	—
Labeo victorianus	0.1	0.4	0.0	—	—	—	—	—
Mormyrus kannume	0.4	0.4	0.3	0.4	0.9	0.1	0.0	—
Schilbe mystus	0.9	1.8	1.3	0.6	0.3	0.1	0.0	—
Alestes spp	0.0	—	—	—	—	—	—	—
Mastacembelus frenatus	0.0	0.0	0.0	0.0	—	—	—	—
Gnathonamus longibarbis	0 0	0.0	—	—	—	—	—	—
Total	644 0	935.3	731.6	581.5	512.1	567.4	268.4	52.1
No. of species encountered (excluding *Haplochromis* spp)	19	17	16	11	10	8	7	4

[1] For *Haplochromis* spp only data from small mesh codends (19 and 38 mm) were used.
[2] Though the *IBIS* operated in waters deeper than 4m, mean catch rates were weighted by the area of the whole depth zone (i.e. 0–9 m).

occurred in the shallowest zone (4–9m) and only 4 were represented up to the deepest zone (70–79m). Four of the major commercial taxa (*Haplochromis* spp, *Bagrus docmac*, *Clarias mossambicus* and *Synodontis victoriae*) and one minor genus (*Xenoclarias*) were found to be eurybathic. On the other hand, *Tilapia* spp, *Protopterus aethiopicus* and most of the commercially minor categories were found to be more or less oligobathic. Among the *Tilapia* spp, *T. esculenta* has the widest, and *T. leucosticta* the narrowest, depth range of distribution. The depth zone limits of these species seem to be as follows: *Protopterus* (50–59 m), *T. esculenta* (40–49 m), *T. variabilis* (30–39m), *T. nilotica* and T. *zillii* (20–29 m) and *T. leucosticta* is confined to waters not more than 10 m deep.

In terms of mean catch rates and frequency of occurrence, the relative abundance also varies with depth for most of the fishes in the lake and could be divided into two broad groups: those whose catch rates tend to progressively increase with depth and those whose catch rates progressively decrease with depth. Among the latter group are the *Tilapia* spp, *Protopterus aethiopicus* and *Lates niloticus* (See Table 2), while the former

group comprises *S. victoriae*, *Xenoclarias* spp and to a certain extent, *Haplochromis* spp and *B. docmac*. Other species which are relatively more abundant in shallow waters, are sometimes found in waters of intermediate depths, but disappear completely in deeper waters. Five of the species with the best trends in distribution by depth can be summarized as follows:

S. victoriae and *Xenoclarias* spp catch rates significantly increase in waters deeper than 30 m. The mean size of these fish, like that of *Haplochromis*, is also directly related to mean depth as shown below:

Depth zone (m)	*Haplochromis* Sample Size	*Haplochromis* Mean Length, L_t	*Synodontis victoriae* Sample Size	*Synodontis victoriae* Mean Length, L	*Xenoclarias* Sample Size	*Xenoclarias* Mean Length, L_t
4– 9	3187	90.9 mm	172	10.8 cm	—	—
10–19	4434	87.2 mm	432	13.3 cm	—	—
20–29	2275	105.0 mm	415	14.6 cm	—	—
30–39	1766	106.9 mm	453	15.3 cm	73	16.7
40–49	1441	108.0 mm	685	15.6 cm	90	17.0
50–59	841	116.4 mm	629	17.4 cm	319	17.1
60–69	264	120.4 mm	557	21.4 cm	413	17.1
70–79	413	107.8 mm	227	22.8 cm	110	17.3

— Not enough samples were measured
L_t — Total length
L_f — Fork Length

However, further study is needed for sound interpretation of the apparent size-range segregation by depth among these fishes. Catch rates for *Haplochromis* and *B. docmac* are generally high in many depth zones but appear best in the 10–50 m depth range and very poor in deeper waters. All size ranges of *B. docmac* were often encountered on the same grounds. It is interesting to note that *Bagrus* follows *Haplochromis* more closely than does any other species in terms of relative abundance, diel vertical movements (see below) and depth preference which, together, strongly emphasize a closer *Bagrus*/*Haplochromis* association in the ecological predator/prey relationship.

Clarias mossambicus is almost equally ubiquitous throughout the depth range of the lake. Its frequency of occurrence was higher than 90% in each depth zone though catch rates by weight were generally higher in waters less than 40 m deep. The hardy nature of this fish, its accessory, suprabranchial, aborescent breathing organs and catholic feeding tendencies contribute, at least in part, to its eurybathic distribution.

Besides depth, there are other ecological variables (e.g. dissovled 0_2—concentration near the bottom, bottom type, open versus closed waters, etc.) that contribute to difference in distribution patterns, but analysis of detailed habitat types is outside the purview of our present consideration and only a broad picture of catch rates by the three territorial sections of the lake, though they are not spatially delimited, *per se*, is presented in Tables 3 and 4. Data seem to suggest that mean total catch rates are slightly higher in the Kenya section of the lake than the other two regions. But this is because the catch figures were first weighted by the surface area of each depth stratum and because the Kenya section has a very small proportion of the deep waters (where