APPENDIX E

EXPLORATORY BOTTOM TRAWLING IN LAKE VICTORIA

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INTRODUCTION

When the Lake Victoria Fisheries Research Project began, the background information necessary for the successful application of quantitative stock assessment was lacking. For this reason and also due to the size of Lake Victoria, the complexity and variety of its many habitats, and its multi-species fishery, it was decided that initial stock assessment studies should consist of a lake wide survey using a variety of exploratory fishing methods.

The first phase of this survey has been completed. This involved widespread bottom trawling over various depths and lake areas from the research vessel 'IBIS'. Experimentation with various types of trawls, codends, towing speeds, warp lengths, etc., began in September 1968 and was essentially completed towards the end of 1968. Full-scale exploratory fishing began in January 1969 and contniued until mid-March 1970 when the bottom trawling phase was terminated. (Data from a short cruise made in May 1970 are not included in the report). Besides the usual interval between cruises, however, there was a three-month period of inactivity from July through September, 1969. We assumed that for this technique adequate coverage for survey purposes had been achieved.

This is one of a series of reports to present detailed results of exploratory bottom trawling in Lake Victoria. It will review some of the methods used, describe the coverage attained, and briefly summarize the results.

MATERIALS AND METHODS

All trawling was carried out on the research vessel 'IBIS'. It is 56-foot long with a 16-foot beam and a 7-foot draught and displaces about 50 tons. It is powered by a 200 h.p. diesel engine and attains a maximum speed of 9 knots. A two-ton capacity hydraulic winch supplies the power needed to set and retrieve the gear. The ratio of warp length to depth fished approximated 6 to 1 except in water shallower than 10 metres where the ratio used was about 10 to 1.

The two trawls used were of standard design with headropes of 78 and 65 feet. The 78-foot trawl was fished much more frequently (96.3 per cent of all hauls) than the 65-footer. The effective fishing height was about 2 metres. Trawling speed was maintained at approximately 3 knots for all hauls and regardless of codend size. Fishing time approximated the period that the trawl was actually on the bottom. Most hauls were of one hour duration, but longer and shorter hauls were common. Catches were adjusted to one hour, however, for most subsequent analyses.

Lake Victoria was divided into 12 areas and eight 10-metre depth intervals. However, since the draught of the 'IBIS' precluded trawling at depths under

4 metres, the shallowest depth interval ranged only from 4 to 9 metres. The areas are listed in Table E1. Because it is virtually flat and very largely free of obstructions, Lake Victoria is ideally suited to bottom trawling. Only rarely were snags encountered.

Fifteen cruises were made from the 'IBIS' to various areas of Lake Victoria. To obtain widespread coverage of this enormous body of water, we attempted to sample systematically by trawling in a set direction and at set distances between hauls. We had hoped to sample the various depths in proportion to their abundance. Very often this goal could not be attained, particularly when turning was required to avoid commercial gill-nets and when limited by shoreline irregularities. Except for hauls made in shallow bays, the location of each haul was determined by radar or sextant. An echo-sounder provided important supplementary navigational aid, besides its chief function of depth determination.

Immediately after the trawl, contents were released on the deck, the catch was sorted into taxonomic units. See Table E2 for a list of all species encountered. What is shown as *"Haplochromis* spp.," not only dominated the catch, but presented the most difficult taxonomic problem. This group represents about 90 known species, probably between 30 and 50 underscribed species, and four monotypic genera closely allied to *Haplochromis (Platytaeniodus, Astatoreochromis, Macropleurodus* and *Hoplotilapia*). This entire complex was treated as a single unit and a total weight obtained. In virtually all remaining instances, the fishes caught in each haul were identified to species, counted and weighed. *Xenoclarias* was taken only to the generic level. It was impractical to sort the small *Barbus* species and *Engraulicypris argenteus* from the large bulk of *Haplochromis*. They were often absent but even when present were too few to significantly influence the weight of *Haplochromis*.

When time permitted, the entire catch of a given species or a subsample of it was measured and, at times, weighed and sexed. Less frequently, food habits of certain species were ascertained. To derive an index of *Haplochromis* size and to estimate numbers caught, a "weight-count" was made from a sample from virtually all hauls beginning in October 1969. To do this the *Haplochromis* catch was mixed with shovels, and then a 5 to 10 kilogram sample was taken with a shovel or a specially designed scoop. These were counted and the number per kilogram determined. This "weight-count" was used as an index of size and, when multiplied by the total weight of *Haplochromis* caught, provided an estimate of the number caught. To check on the accuracy of these estimates, four complete counts of *Haplochromis* were made from four separate hauls. The actual counts of 2,642, 1,496, 684 and 296 compared favourably with estimated value of 2,543, 1,419, 679 and 288 respectively. In each case the predicted values underestimated the actual values, but since the percentage difference was in all instances less than 5 per cent, the method was judged suitable. Of course, accuracy would tend to vary with the size range encountered and probably with other factors as well. Visual observations of many hauls, however, indicated that the weight-counts adequately reflected the general size composition of the *Haplochromis* catch.

TABLE E1

Description of Areas Established for Exploratory Bottom Trawling Operations in Lake Victoria

UGANDA :

Area I : Tanzania - Uganda Border to Bugoma Channel in depth less than 50 metres.

Area II : Bugoma - Salisbury Channels to Rosebery Channel in depths less than 50 metres.

Area III : Rosebery Channel to Uganda - Kenya Border in depths less than 50 metres.

Area IV : Deepwaters 50 metres and over.

KENYA :

Area V : Nyanza Gulf.

Area VI : Uganda - Kenya Border to Kenya - Tanzania Border in depths less than 50 metres.

Area VII : Deepwaters 50 metres and over.

TANZANIA :

Area VIII : Kenya - Tanzania Border to Ukerewe Island in depths less than 50 metres.

Area IX : Speke and Mwanza Gulfs.

Area X: Between Mwanza Gulf and Igusa Channel in depths less than 50 metres.

Area XI : Igusa Channel to Tanzania - Uganda Border in depths less than 50 metres.

Area XII : Deepwaters 50 metres and over.

TABLE E2

Fishes Caught in Bottom Trawls in Lake Victoria

Families and Species	**Families and Species**
Lepidosirenidae	Clariidae
Protopterus aethiopicus	*Clarias mossambicus*
Mormyridae	*Clarias* spp.
Mormyrus kannume	*Xenoclarias* spp.
Marcusenius grahami	Mochokidae
Gnathonemus longibarbis	*Synodontis victoriae*
Characidae	*Synodontis afrofischeri*
Alestes jacksonii	Centropomidae
Cyprinidae	*Lates niloticus*
Labeo victorianus	Cichlidae
Engraulicypris argenteus	*Tilapia esculenta*
Barbus altianalis	*Tilapia variabilis*
Barbus spp.	*Tilapia nilotica*
Bagridae	*Tilapia leucosticta*
Bagrus docmac	*Tilapia zillii*
Schilbeidae	*Haplochromis* spp.
Schilbe mystus	Mastacembelidae
	Mastacembelus frenatus

SUMMARY OF BOTTOM TRAWLING:

From January 1969 to March 1970, 806 botom trawl samples were made in Lake Victoria. Actual trawling time was 1,084 hours and the total catch was about 257,000 kiiograms. In Table E3 these data are given for Tanzania, Uganda and Kenya and the number of hauls made are shown both by country and by depth interval. Fishing effort was concentrated in Uganda waters. Low effort in Kenya waters largely reflects the small fraction Kenya's portion constitutes of the total surface area

TABLE E3 – Summary of Exploratory Bottom Trawling in Lake Victoria by Depth Interval

Depth interval (metres)	Number of hauls made in each depth interval by country			Totals
	Uganda	Tanzania	Kenya	
4– 9	164	65	15	244
10–19	113	77	29	219
20–29	51	49	8	108
30–39	30	22	2	54
40–49	21	17	13	51
50–59	26	20	15	61
60–69	35	17	4	56
70–79	8	5	–	13
Totals	448*	272ø	86	806
Trawling time in hours	610.3	349.0	125.1	1084.4
Total catch in Kilograms	146,035	87,860	22,974	256,869
Mean Kilograms per hour	239	252	184	237
Distance covered by trawl, in nautical miles	1831	1047	375	3253

*Eleven trial hauls using 80, 90 and 108–foot trawls were excluded. Only hauls made with 65 and 78–foot trawls are shown.

øOne haul made in Speke Gulf was excluded. It was hung up and no fish were caught.

A variety of codend mesh sizes were used. These are listed by the three countries in Table E4. The number of hauls, trawling time, total catch, and mean rates are given for each of the seven codend sizes. The 2½ and 1½ inch codends were employed for a high percentage of the hauls, and thereby accounted for similarly high percentages of the effort and catch. Significantly higher catch rates were recorded for the three smallest codend sizes than the remaining four. This is directly related to the large yields of *Haplochromis* in the small mesh codends.

TABLE E4 – Summary of Exploratory Bottom Trawling in Lake Victoria by Codend Mesh Size

	Codend mesh size (inches)	¾	1½	2	2¼	2½	3	3¼	Totals
Number of Hauls	Uganda	5	129	2	5	286	6	15	448
	Tanzania	–	58	14	–	170	–	30	272
	Kenya	–	30	–	12	44	–	–	86
	Totals	5	217	16	17	500	6	45	806
Trawling time in hours	Uganda	5.0	142.3	1.8	7.5	418.3	11.8	23.6	610.3
	Tanzania	–	57.0	19.2	–	228.2	–	44.6	349.0
	Uganda	–	46.6	–	14.7	63.8	–	–	125.1
	Totals	5.0	245.9	21.0	22.2	710.3	11.8	68.2	1,084.4
Total catch in Kilograms	Uganda	6,401	61,433	74	955	74,690	812	1,670	146,035
	Tanzania	–	26,044	5,069	–	49,650	–	7,097	87,860
	Uganda	–	12,993	–	1,340	8,641	–	–	22,974
	Totals	6,401	100,470	5,143	2,295	132,981	812	8,767	256,869
Mean Kilograms per hour	Uganda	1,280	432	42	127	179	69	48	239
	Tanzania	–	761	263	–	218	–	156	252
	Kenya	–	279	–	91	136	–	–	184
	Totals	1,280	409	245	103	187	69	129	237

The basic effort and catch data are also presented for each of the 12 major lake area (Table E5). Although in some instances there are considerable differences in catch rates among the areas, too much significance should not be accorded them. The data shown in this Table and also those in Tables E3 and E4 are summaries only and have not been stratified by time of day, the proportions of different-sized codends used, or other factors. This must be done before meaningful catch rate comparison can be made.

The overall species composition of the trawl catch is given in Table E6. The *Haplochromis* dominated and formed, 50 per cent of the total catch. The catch of *Haplochromis* caught depends to a great extent on the size of codend used and increases with decreasing mesh size. As a 2½ inch codend was used in 62 per cent of the hauls, the percentage is low compared with the dominance of *Haplochromis* at all depths given in Table E7 where the catch is adjusted to assumed 1½ inch level. *Bagrus docmac, Clarias mossambicus* and *Protopterus aethiopicus* formed about 10 per cent each of the catch and were next in importance, followed by *Tilapia asculenta* (7 per cent), *T. nilotica* (3 per cent) and *Synodontis* species (2 per cent). The composition of the catch also depends on depth zone and the data in Table E6 are not adjusted for this factor.

The result of 396 bottom trawl hauls were used to describe the depth distribution of the major commercial fishes for the eight 10 metre depth intervals (Table E7). Only daylight hauls (0700 to 1900 hours) were included since during the night hours, *Haplochromis*, and to a ceratin extent other genera as well, moved very largely off the bottom. Also, a number of hauls were deleted when sufficient causes was judged to exist: i.e., hung-up, torn net, codend not fully closed, etc. For all but *Haplochromis*, the possible influence of codend size on catch rate was ignored. Results of trials using different codends fished under controlled conditions demonstrated the adequacy of this treatment, at least for the major commercial species. *Haplochromis* catches, however, increased substantially with decreasing mesh size. Where necessary, therefore, catches made with codends greater than 1½ inch were adjusted to assumed 1½ inch levels. Finally, variations by season and area were ignored and the hourly catch rates for individual hauls were merely totalled and then averaged.

TABLE E5 – Summary of Exploratory Bottom Trawling in Lake Victoria by Area

Country	Area	Number of hauls	Time in hours	Total catch in Kilograms	Mean Kilograms per hour
Uganda	I	75	85.3	18,832	218
	II	126	224.5	54,088	201
	III	178	224.6	63,134	281
	IV	69	74.8	18,981	254
	Totals	448	610.3	146,035	239
Kenya	V	37	53.5	8,379	157
	VI	30	42.5	9,439	222
	VII	19	29.1	5,156	167
	Totals	86	125.1	22,974	184
Tanzania	VIII	61	69.2	17,646	255
	IX	122	173.1	37,640	217
	X	22	31.8	9,134	288
	XI	25	31.5	8,078	256
	XII	20	43.4	15,362	354
	Totals	272	349.0	87,860	252

TABLE E6 – Species Composition from Bottom Trawl Catches from 806 Hauls Made from January, 1969 to March, 1970

Species	Weight in Kilograms	Percentage of total
Haplochromis spp.	133,838	52.9
Bagrus docmac v	30,600	11.9
Clarias mossambicus ..	27,510	10.7
Protopterus aethiopicus ..	26,344	10.3
Tilapia esculenta	19,100	7.4
Synodontis spp.	6,239	2.4
Other species	2,092	0.8
Tilpia variabilis	1,727	0.7
Other *Tilapia*	100	0.0
Total	256,869	99.9

Mean hourly catch rates in kilograms for the major commercial fishes are shown in Table E7. The dominant influence of the *Haplochromis* group is clearly demonstrated. In the five depth intervals from 10 to 59 metres, the *Haplochromis* catch averaged about 500 kilograms per hour and comprised from 75 to 90 per cent of the total catch. It was somewhat less than this in the shallowest zone averaging 320 kilograms per hour and 67 per cent of the total. The mean catch in the deepest water, however, decreased substantially to 185 kilograms in the 60 to 69 metre zone and then to 29 kilograms in he 70 to 79 metre zone.

A series of hauls made in the three shallowest depth zones with a ¼ inch codend yielded substantially higher catches of *Haplochromis*. Hourly catch rates commonly varied from 1200 to 1800 kilograms. Thus, the true mean catch rates for *Haplochromis* are probably three or more times those shown in Table E7, at least in relatively shallow water.

The take of remaining fishes was much reduced compared with *Haplochromis* (Table E7). In order of decreasing catch. the species taken were *Bagrus docmac*, *Clarias mossambicus*, *Synodontis victoriae*, *Tilapia esculenta* and *Protopterus aethiopicus*. *Bagrus* yields were fairly uniform at depths from 10 to 59 metres with an apparent concentration in 10 to 29 metres. A moderate decline in catch occurred in the 4 to 9 and 60 to 69 metre depth zones, and an abrupt decline to negligible levels in the deepest zone.

The depth distribution of *Clarias mossambicus* was perhaps the most uniform of any of the species. It was not characterized by any extremes, although there was a pronounced peak in density in the 10 to 19 metre zone (42 Kg/hr.). Concentrations in the remaining zones, except for the deepest. ranged from about 15 to 30 kilograms per hour. The catch rate in the 70 to 79 metre zone declined to an average of about 8 kilograms per hour, much less of a decrease than that for other species with one exception. This exception is *Synodontis* which was much more abundant in deeper waters. Highest average catch rates were recorded in 50 to 59 metres (27 Kg/hr). with a slight drop in 60 to 69 metres (24 Kg/hr.); and a further decrease in 70 to 79 metres (17 Kg/hr.). By weight it was the second most important species in the deepest zone. With the exception of the 30 to 39 metre zone, there was a progressive decline of *Synodontis* in water shallower than 50 metres.

As expected, the catches of *Tilapia* species were confined to shallower depth zones, although this was much less pronounced for *Tilapia esculenta* than the others *(T. nilotica, T. variabilis, T. zillii* and *T. leucosticta)*. Significant yields of *T. esculenta* were obtained only in 4 to 9 metres (53 Kg/hr.) and in 10 to 19 metres (32 Kg/hr).

For the remaining species of *Tilapia* combined, the only substantial catches were recorded in the 4 to 9 metre zone (15 Kg/hr.). The mean catch rates of *Protopterus* declined progressively with depth: from 40 to 25 to 8 to 4 kilograms per hour in the four 10 metre depth intervals from 4 to 39 metres. Only occasional *Protopterus* were caught at depths between 40 and 59 metres and none in deeper water.

Another measure of species distribution, which is independent of the weight or number taken, is the percentage frequency of occurrence. This is found by dividing the number of hauls in which a given species is found

TABLE E7 – Mean Kilograms of Fishes Caught Per Hour of Exploratory Bottom Trawling in Lake Victoria

Species	Depth in metres (number of hauls)															
	4–9 (61)		10–19 (93)		20–29 (66)		30–39 (38)		40–49 (37)		50–59 (47)		60–69 (42)		70–79 (12)	
	Kg.	%	Kg.	%	Kg.	%	Kg.	%	Kg.	%	Kg.	%	Kg.	%	Kg.	%
Haplochromis spp. ..	320.4	67.0	524.8	78.3	462.8	83.1	524.0	87.6	465.9	88.9	496.7	85.5	185.2	74.9	28.8	52.8
Tilapia esculenta ..	52.6	11.0	31.7	4.7	3.5	0.6	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other *Tilapia* spp. ..	15.0	3.1	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bagrus docmac ..	24.6	5.1	42.3	6.3	45.1	8.1	35.5	5.9	31.3	6.0	38.6	6.6	21.9	8.9	0.3	0.6
Clarias mossambicus ..	22.4	4.7	41.5	6.2	31.7	5.7	22.5	3.8	15.1	2.9	17.9	3.1	15.8	6.4	7.9	14.5
Protopterus aethiopicus	40.4	8.4	24.8	3.7	7.8	1.4	4.4	0.7	1.9	0.4	0.3	0.1	0.0	0.0	0.0	0.0
Synodontis victoriae ..	0.6	0.1	1.6	0.2	4.3	0.8	10.3	1.7	6.9	1.3	27.1	4.7	23.9	9.7	17.3	31.7
Other species	2.3	0.5	3.0	0.4	1.7	0.3	1.3	0.2	2.6	0.5	0.4	0.1	0.3	0.1	0.2	0.4
Totals	478.3	99.9	670.6	99.9	556.9	100.0	598.3	100.0	523.8	100.0	581.0	100.1	247.1	100.0	54.2	100.0

by the total number of hauls and converting to per cent. These data are found in Table E8 for the major commercial species for each depth interval. The widespread distribution of species of *Haplichromis* and *Clarias mossambicus* is immediately apparent. *Bagrus* is ubiquitous in Lake Victoria in depths less than 60 metres, whereas *Synodontis* is particularly common in depths over 20 metres. *Protopterus* is taken in virtually all hauls made at depths from 4 to 20 metres.

What has been presented here is merely a brief and general picture of the distribution and relative abundance of the important commercial fishes of Lake Victoria. Catch rates vary greatly from one area to another and even from one location to another within an area. Such information will be the subject of future reports, and it will be expanded to include all species caught and not just those of commercial significance. In addition, a considerable body of information has been collected which includes: (1) the number and weight of each species taken in every haul (or of each genus where identification is difficult), (2) measurements of lengths and weights and determination of sex and state of sexual maturity for various samples of the catch, (3) data on diel movements based on day and night trawling, (4) data on seasonal movements based on periodic trawling in the same area, and (5) information on the influence of codend mesh size of characteristics of the catch. Analysis and publication of these data would significantly contribute to our understanding of the ecology of the Lake Victoria fish fauna.

TABLE E8 – Percentage Frequency of Occurrence of Fishes Caught During Exploratory Bottom Trawling in Lake Victoria

Species	Depth in metres								All depths
	4–9	10–19	20–29	30–39	40–49	50–59	60–69	70–79	
Haplochromis spp. ..	100.0	100.0	100.0	100.0	100.0	100.0	100.0	91.7	99.7
Tilapia esculenta ..	100.0	88.3	73.8	36.8	16.7	0.0	0.0	0.0	53.4
Other *Tilapia*	71.2	36.2	7.7	5.3	0.0	0.0	0.0	0.0	21.1
Bagrus docmac ..	94.9	97.9	100.0	100.0	100.0	85.1	47.6	16.7	88.8
Clarias mossambicus	89.8	100.0	90.8	94.7	91.7	100.0	97.6	100.0	95.4
Protopterus aethiopicus	91.5	95.7	58.5	47.4	19.4	4.3	0.0	0.0	53.2
Synodontis victoriae ..	35.6	62.8	84.6	94.8	100.0	100.0	100.0	100.0	78.4
Other species	64.4	74.5	83.1	84.2	86.1	85.1	85.7	83.3	79.1