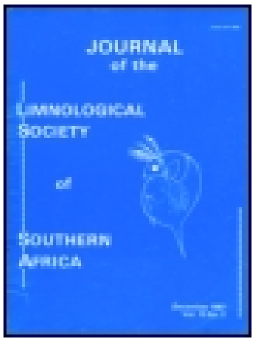

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ASPECTS OF THE FISHERIES OF LAKE LIAMBEZI, CAPRIVI

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SUMMARY

Lake Liambezi, situated in the Linyanti Swamp, Caprivi, is inhabited by 43 fish species. Population estimates with seine nets, rotenone and explosives gave values of 74 to 157 kg ha^{-1}. The composition of seine net catches differed markedly from gill net catches where non-Cichlids form a majority. Results of a fleet of gill nets show that best catches of 25 kg 50 m^{-1} net $night^{-1}$ can be made with 60 mm mesh nets, catching predominantly non-Cichlids (*Marcusenius macrolepidotus*, *Schilbe mystus*, *Synodontis* spp.). A small commercial fishery is established on the lake, with 60 active fishermen using large mesh (100 - 150 mm) gill nets. Their catch consists mainly of Cichlids (*Sarotherodon andersoni* and *S. macrochir*) and *Clarias* spp. Production figures dropped from 637 ton in 1973-74 to 115 ton in 1975-76. This drop is ascribed to reduced effort as well as a reduction in catch per unit effort. Recommendations are made to utilise the fishery potential of Lake Liambezi in a more balanced way by introducing small mesh gill nets to harvest non-Cichlid populations.

INTRODUCTION

Caprivi, in the north eastern corner of South West Africa (Namibia), borders on Zambia in the north, Botswana in the south and its eastern tip just reaches Zimbabwe (Figure 1). During flood periods the Zambezi River floods its banks and the whole eastern section of Caprivi becomes inundated. The Kwando-Linyanti River which forms the southern border, runs in a very shallow and wide bed, forming a wide belt of swamp land. Lake Liambezi (17°50', 18°00'S and 24°10', 24°28'E)(altitude 929 m) is situated at the end of this swamp system (Du Toit, 1926). The Chobe River originates in Lake Liambezi and drains into the Zambezi River.

Lake Liambezi forms the focus of a small gill net fishery amongst the local people. Apart from gill netting, the people of the Zambezi and Chobe flood plain, the Basubia, practice a variety of traditional fishing techniques during flood periods. A study of the fishery, initiated in 1973, is reported here.

Only 10 150 ha of the total surface of more than 30 000 ha is open water. Extensive *Phragmites* reed beds extend to the south, southwest, west and north and the open water can only be reached from the north eastern and eastern shores. This lake is relatively shallow with an average depth of only 3,5 m and a maximum depth of 5,0 m. The open water has a murky grey colour due to the presence of *Microcystis* while it is clear and peat-stained in the reed bed areas of the lake. It receives water from four sources. About 10% of the Kwando River water eventually percolates through the vast Linyanti Swamp and reaches the lake. A second important source is direct rainfall (average for Katima Mulilo 680 mm (1935 - 1946) (Curson, 1947)), as well as a considerable amount of run-off from an area north and north-east of the lake. During years of high Zambezi floods (about every third year) a link is established via the Bukalo Mulapo.

Generally the evapo-transpiration rate on the lake equals or exceeds inflow, but in good rain years

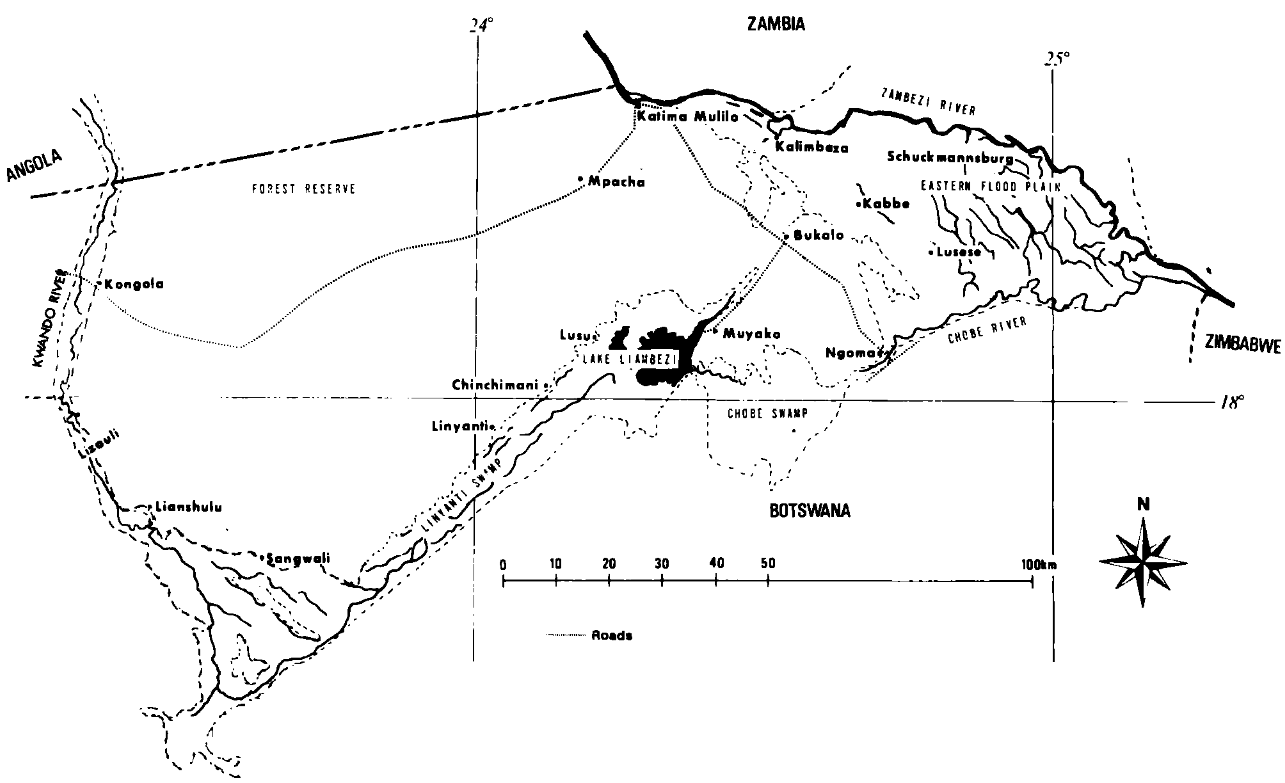

FIGURE 1. Map of Caprivi showing main water bodies.

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excess water drains from the lake via the Chobe Swamp to the Zambezi River. The water of Lake Liambezi is slightly alkaline and had a conductivity of 19,5 - 41,2 mS m^{-1}. Water temperatures ranged between 24 and 30°C, rarely dropping to as low as 16°C during July. The entire lake substrate consists of organic matter, which in some areas has a hard peaty nature.

METHODS

Collection of fishery statistics

The fishery was studied by making regular surveys at all the fishing camps around the lake excluding the south eastern side which falls in Botswana. Seven to ten recorders were trained and issued with forms on which the following data were collected daily for every active fisherman: name, village of origin, date, place of recording, number and mesh sizes of nets, number of each fish species caught (that could safely be distinguished), amount of money received from sale of fresh fish, ownership of dugout canoe. Surveys stretched over periods of seven or eight days at roughly six-weekly intervals.

Fish sampling

Seine nets are used for capture-recapture techniques where population studies are undertaken. Lake Liambezi affords only very limited opportunities for the use of seine nets. In a stretch of 500 m near Lizulu, four sites of 60 m each were cleared of marginal vegetation so that a beach was formed where a seine net could be hauled ashore. Two nets were used, measuring 50 x 3 m with 50 mm mesh and 40 x 3 m with 25 mm mesh, both with bags in the centre. Nets were laid out at a distance of 20 to 70 m from the shore.

On two occasions smaller reed beds in the lake were encircled with the seine nets and rotenone and explosives were used to collect all fish in such areas. A dipnet and fish shocker were used to collect fry and small species amongst weeds and marginal vegetation.

Mesh size, stretched (mm)	Twine thickness	Length of net (m)
25	210/3	10,0
50	/4	21,4
60	/4	27,3
80	/4	14,3
96	/6	32,0
100	/6	27,0 30,5
127	/6	34,0 42,0 26,7
140	/9	80,7
160	/9	88,3 90,3
190	/9	87,0

TABLE 1. Details of experimental gill nets.

A series of gill nets formed the main collection apparatus. Size selection by gill nets can be partially overcome by using a series of gill nets, if possible a geometric series so that consecutive mesh sizes overlay sufficiently in their selection curves (Regier and Robson, 1967). Unfortunately an ideal series of nets was not available and the nets summarised in Table 1 were used.

All nets were mounted at half the stretched length. Nets were supplied with a solid plastic bottom line and had large plastic floats or small floats built into the float line.

Collected fish were transported to a field laboratory at Lizulu and biological data collected.

Gill net collections were made monthly for a period of four to six nights in each of the major habitat types of the lake, i.e. in the wide channel at the fish laboratory, in the open lake, in channels a-

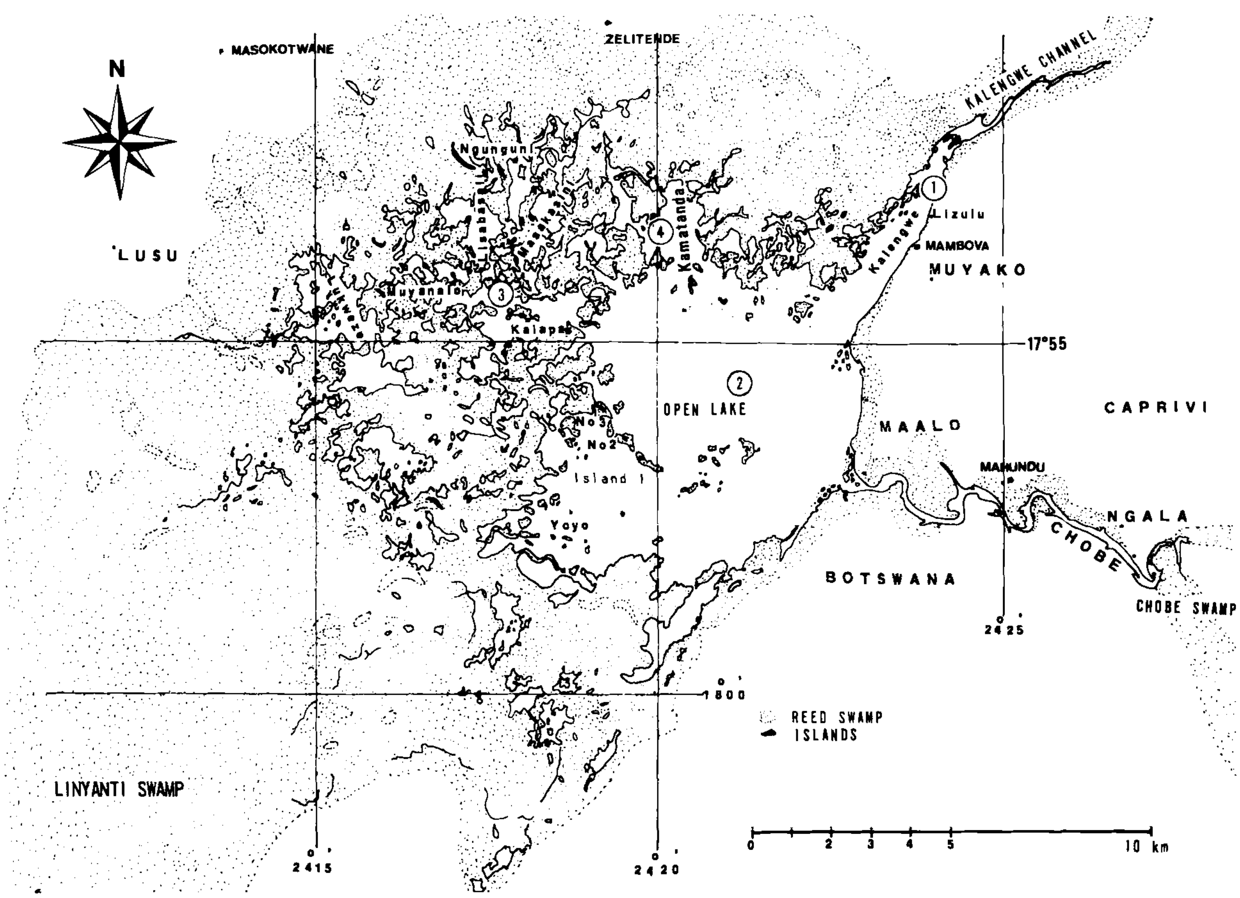

FIGURE 2. Position of collecting stations in Lake Liambezi.

mongst islands and in a bay with dense underwater vegetation consisting of especially *Lagarosiphon* (Figure 2).

RESULTS

Fishery activities on Lake Liambezi

The present fishery on Lake Liambezi came into existence in 1959. Nets were initially homemade from motor tyre cords, but were replaced with nylon nets when these became available in the sixties. No records of catches or fishery intensity exist, but evidence suggests that fish were caught on large scale and exported to Livingstone in Zambia (Beatty, 1969). Most fishermen do not fish throughout the year, but go to their villages in spring to prepare lands and plant crops, returning when rains subside. The is only one village, viz. Mambova, near Muyako (Figure 2) with permanent fishermen. Other villages around the lake where local tribesmen fish, are Kalengwe, Muyako and Mahunu in the east, Zelitende to the north and Masokotwane and Lusu to the west. Temporary fish camps are situated on small islands in the western and south western part of the lake as well as in Botswana. With the increase of *Salvinia molesta* mats on the lake, many islands could not be used after 1974. The most important islands on which fish camps were found every year include the more accessible islands No. 1,2 and 3, Malovu, Kalapa, Masakasini, Kamatanda and Lisabasali.

Fishing gear used by fishermen

No traditional fishing gear is used on Lake Liambezi except fish spears with which spawning *Clarias* are collected in shallow water. All nylon nets used are made of 210/6 twine in white, green or yellow green. Composition of net mesh sizes used in the study period is set out in Table 2. Fishermen seem to prefer 102 and 114 mm nets but as these were often not available, larger mesh nets were used. Nets were obtained from Botswana and Zambia until 1975 when nets became available in Caprivi. Nets were obtained unmounted, 20 or 24 meshes deep and in 91,4 m pieces. They were mounted by fishermen themselves to an average length of 44,5 m, roughly 1:2 which has also been found to be the most effective mounting for Southern African fishes (Jackson, 1961; Gaigher, 1975). A bottom rope made of barktwine or old hessian material is twisted into the meshes and bricks attached at irregular intervals to serve as weights. Folded leaf stems of a large *Cyperus* sp., fixed directly to the mesh at about 1 m intervals, serve as floats. These usually last only a few weeks since they absorb water. The nets do not reach right up to the surface and have to be dried or floats replaced regularly.

Nets are set in series diagonally over bays between reed beds and are left in position for 2 to 7 days before they are dried and set in a different spot. Nets are inspected every morning only as very few fish are caught during daylight hours.

Dugout canoes are used exclusively as craft in Caprivi.

Fishery intensity and fluctuations in catches

Results of surveys conducted from 1973 to 1976 are summarized in Table 3. Each survey represents a period of 7 - 8 days with all fishing villages and camps combined.

The number of active fishermen on the lake showed a seasonal variation (Figure 3) together with net efficiency. A negative correlation appears between number of active fishermen and lake level with seasonal increases in fishing activity in the June - October periods. A weak correlation can also be found between lake level and net efficiency; it is generally lower with high lake level, probably the result of dispersion of the fish, as an increase in lake level means an enormous increase in surface area. Figure 3 also clearly shows that two out of three times when there was a fast rise in level, higher than normal catches were made.

Composition of commercial catches

Table 4 shows that the bulk of the commercial catch

Sampling dates	Mesh size, inches and (mm)						Average number of nets per day
	3(76)	4(102)	4½(114)	5(127)	5½(140)	6(152)	
May 1973	-	-	31	53	13	3	626
June - July	-	1	32	54	10	3	854
August	-	2	22	65	9	2	634
October - November	-	2	27	61	7	3	937
November - December	-	1	30	65	2	2	889
January 1974	-	2	33	63	1	1	560
March	-	2	30	57	6	5	380
April - May	-	-	31	66	3	-	380
June	-	0,2	37	61	1	0,7	587
July - August	-	2	35	62	0,4	0,6	752
September	-	0,6	33	63	3	0,1	657
November	-	4	28	68	-	-	437
January 1975	-	3	31	65	1	-	169
February	-	0,3	27	72	-	-	334
April	-	2	25	73	-	-	243
May	-	-	18	82	-	-	220
June	-	1	19	79	1	-	237
August	-	2	21	76	-	1	277
September	0,2	3	41	51	4	0,2	360
October	0,5	6	17	76	-	-	184
December	1	-	36	63	-	-	108
January 1976	2	14	18	64	-	-	102
February	-	-	18	64	18	-	53
March - April	-	6	13	59	22	-	143
May 1973 - March 1974	-	1,5	28,7	61,1	6,3	2,4	697
May 1974 - April 1975	-	1,2	32,2	65,2	1,1	0,3	445
May 1975 - April 1976	0,2	3,1	20,3	72,6	3,3	0,5	187

TABLE 2. Percentage composition of mesh sizes of gill nets used in Lake Liambezi fishery from May 1973 to April 1976.

Month	Year	Average per day			Fish net^{-1} night^{-1}	Average mass (g)	Total mass caught (kg day^{-1})
		Fishermen	Nets	Fish			
May	1973	82	626	2580	4,1	-	1548
June - July		119	854	2919	3,4	-	1751
August		93	634	2568	4,1	618	1587
October - November		118	937	2952	3,2	-	1771
November - December		118	889	3086	3,5	588	1815
January	1974	69	560	3177	5,7	663	2106
March		85	380	2401	6,3	682	1637
April - May		51	380	1144	3,0	700	801
June		82	587	2372	4,0	650	1542
July - August		95	752	1197	1,6	600	718
September		78	657	1565	2,4	733	1147
November		50	437	980	2,2	807	849
January	1975	23	169	346	2,1	788	273
February		42	334	574	1,7	710	408
April		31	243	444	1,8	859	381
May		28	220	267	1,2	811	217
June		27	237	410	1,7	767	314
August		52	477	874	1,8	724	633
September		53	360	603	1,7	798	482
October		29	184	164	0,9	749	123
December		17	108	205	1,9	779	160
January	1976	20	102	238	2,3	714	170
February - March		13	53	152	2,9	-	122
March - April		30	143	744	5,2	841	626
May 1973 - March 1974		92	697	2812	4,0	638	1745
May 1974 - April 1975		57	445	1078	2,4	731	765
May 1975 - April 1976		30	187	406	2,2	773	316
Average		59	422	1332	2,9	714	942

TABLE 3. Fishery activities on Lake Liambezi from May 1973 to April 1976.

Date	*M. macrolepidotus*	*M. lacerda*	*H. vittatus*	*H. odoë*	*C. gariepinus*	*C. ngamensis*	*S. mystus*	*Synodontis* spp.	*S. macrochir*	*S. andersoni*	*T. r. rendalli*	*H. giardi* + *H. codringtoni*	*S. robustus* + *S. thumbergi*	*S. macrocephalus*	*S. angusticeps*
May 1973	-	2,5	0,2	2,3	13,9		0,1	1,2	19,7	29,7	11,0	5,0	2,8	5,0	6,7
June - July	-	4,6	0,5	4,9	6,2	3,2	1,4	2,4	22,2	24,8	9,0	4,3	2,8	4,7	8,9
August	0,1	1,8	1,3	2,0	3,9	2,0	1,1	1,1	35,9	32,0	7,4	3,0	2,2	2,7	3,6
October - November	0,5	2,2	1,0	3,1	5,6	2,8	1,8	1,6	24,9	31,8	10,3	2,9	2,5	3,9	5,2
November - December	0,3	1,1	1,1	2,0	3,9	1,3	0,9	0,9	35,9	34,0	8,6	2,8	1,7	2,0	3,6
January 1974	-	0,4	0,6	0,7	1,3	0,8	0,4	0,5	40,1	42,6	7,6	1,0	0,7	1,5	1,7
March	-	0,3	0,2	1,7	6,5	2,7	0,6	0,8	27,0	42,1	13,0	0,6	0,7	1,5	2,3
May	-	0,1	0,3	0,7	3,2	0,7	0,2	0,3	38,4	43,6	5,3	1,0	0,5	0,7	5,0
June	-	0,6	0,6	3,0	8,3	3,7	1,4	1,4	35,7	28,8	3,9	2,0	2,2	3,2	5,1
July - August	-	0,8	1,0	3,7	9,6	4,1	0,6	1,1	27,7	26,8	6,2	2,8	4,0	4,2	7,6
September	0,1	0,1	0,4	1,2	4,6	0,9	0,5	0,5	31,3	42,7	5,6	3,0	2,4	2,3	2,3
November	2,6	0,3	0,4	3,0	9,5	0,1	1,0	0,7	30,0	32,5	5,7	2,8	1,4	3,9	6,1
January 1975	-	1,5	0,04	1,1	2,3	0,1	1,0	0,9	34,1	45,7	0,9	2,8	1,6	4,4	4,0
February	-	0,2	0,1	0,3	2,3	0,1	0,3	0,3	22,5	58,0	2,2	3,7	0,6	2,7	6,8
April	-	0,4	-	0,2	2,2	-	-	0,1	4,5	86,6	0,1	0,5	0,2	3,2	2,1
May	-	0,4	0,05	0,2	8,9	-	0,5	0,4	6,1	43,5	1,1	25,1	2,1	2,4	9,2
June	-	0,8	0,03	0,6	5,9	-	0,2	0,4	15,2	51,5	2,5	12,4	1,6	5,0	3,9
August	0,1	0,5	0,06	0,7	4,6	0,06	0,04	0,04	37,9	44,6	1,8	4,2	1,0	2,0	2,6
September	-	0,4	0,2	0,5	3,4	0,04	0,1	0,2	34,4	47,6	2,0	4,9	0,6	2,2	3,5
October	3,0	0,5	0,5	1,9	6,7	0,09	1,7	2,2	16,4	46,8	1,2	7,5	1,5	5,1	5,0
December	7,0	0,9	0,1	1,1	4,0	0,07	0,8	0,3	23,1	46,5	1,2	9,2	0,1	1,8	3,7
January 1976	5,2	0,06	0,06	0,7	11,2	0,06	1,2	0,9	15,3	49,1	5,0	4,0	0,3	3,1	3,9
February - March	-	0,3	0,1	-	5,7	-	0,1	0,4	22,1	42,7	3,6	11,6	0,5	1,1	11,9
March - April	-	0,02	-	0,02	3,8	0,02	0,1	0,02	8,3	76,7	2,0	3,2	0,3	0,7	4,9
May 1973 - March 1974	0,1	1,8	0,7	2,4	5,3	2,4	0,9	1,2	29,4	33,9	9,6	2,8	1,9	3,0	4,6
May 1974 - April 1975	0,3	0,5	0,4	1,7	5,3	1,2	0,6	0,7	28,0	45,6	3,7	2,3	1,6	3,1	4,9
May 1975 - April 1976	1,7	0,4	0,1	0,6	6,0	0,04	0,5	0,5	19,9	49,9	2,3	9,1	0,9	2,6	5,4
Average	0,7	0,9	0,4	1,7	5,5	1,2	0,7	0,8	25,8	43,1	5,2	4,7	1,5	2,9	5,0

TABLE 4. Percentage composition of commercial catches in Lake Liambezi, May 1973 to April 1976.

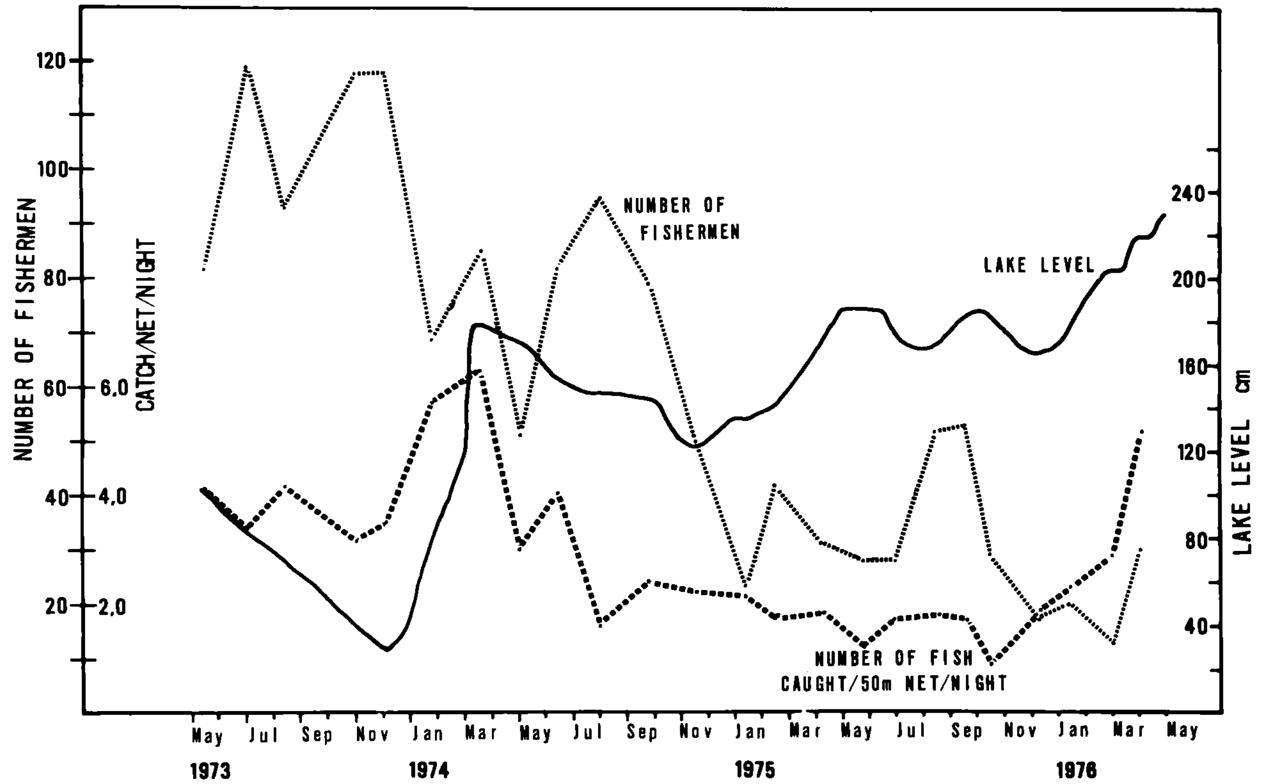

FIGURE 3. Net efficiency of commercial fishery compared with fluctuations in numbers of active fishermen and lake level.

consists of Cichlids, especially *S.andersoni* and *S. macrochir* while *Clarias* spp. make up 6,7 percent and all other fish of the families Mormyridae, Characidae, Schilbeidae and Mochokidae only 5,0 percent.

Year	Cichlids		Clarias		Mormyrids, Characids, Schilbeids and Mochochids	
	Numbers	Mass	Numbers	Mass	Numbers	Mass
May 1973 - March 1974	85,2	72,3	7,7	15,0	7,1	12,7
May 1974 - April 1975	89,3	83,5	6,5	10,7	4,2	5,9
May 1975 - April 1976	90,1	85,4	6,0	12,0	3,8	2,6
Average	88,2	80,4	6,7	12,6	5,0	7,1

TABLE 5. Percentage composition of commercial catches on Lake Liambezi from May 1973 to April 1976.

As pointed out in Table 5, there was an increase of the percentage of Cichlids in commercial catches, both in terms of numbers and mass, with a corresponding decrease for *Clarias* and especially other fish species over the study period. The average mass of fish caught by the fishermen over the three year period was not constant. There was a general decrease in the average mass of non-Cichlids with an increase in average mass in both *Clarias* species as well as in Cichlids (Table 6).

Production of Lake Liambezi

The total mass of fish removed from the lake by fishermen was computed from the regular fishery surveys (Table 7). If only the open water areas of the lake where nets could be set, are taken into account, an average production of 34,5 kg ha^{-1} was achieved. Taking all the adjacent reed swamps into consideration as well, this figure drops to 11,5 kg ha^{-1}. There is no clear boundary between the lake and the broad stretch of Linyanti Swamp to the south west of the

Fish species	*M. macrolepidotus*	*M. lacerda*	*H. vittatus*	*H. odoë*	*C. gariepinus*	*C. ngamensis*	*S. mystus*	*Synodontis* spp.	*S. macrochir*	*S. andersoni*	*T. r. rendalli*	*H. giardi* + *H. codringtoni*	*S. robustus* + *S. thumbergi*	*S. macrocephalus*	*S. angusticeps*
May 1973 - April 1974	213	768	5467	1013	1458	861	307	340	536	654	451	361	463	315	499
May 1974 - April 1975	300	784	4983	809	1279	837	350	300	618	783	476	478	477	456	585
May 1975 - April 1976	348	590	4907	780	1567	1133	289	254	685	825	595	629	659	531	638
Average for species	287	714	5119	867	1435	944	315	298	613	754	507	489	533	434	574

TABLE 6. Average mass (g) of fish species in commercial catches on Lake Liambezi from 1973 to 1976.

lake, making estimations even more difficult.

There are some indications however that the surrounding *Phragmites* swamp can be regarded as an entity of its own for the following reasons:

1 Nets set along the reeds normally yielded less fish than nets set over a bay.

2 Many predatory fish like *S. thumbergi* were collected by artificial lure in small open water patches in the reed swamps and feeding channels of the Linyanti Swamp. This fish species was seldomly collected in the open water areas of the lake.

According to Table 7 a steady drop in fish production was experienced over the study period. There are various reasons of which the decline in number of active fishermen and a drop in efficiency of gear can be singled out as the most important. It must also be remembered that in the last year only a quarter of the lake, that area nearest to Muyako, was heavily fished, as the western area could not be used due to *Salvinia* mats. In terms of production per surface

Year	Tonnage caught (ton a^{-1})	Crop (kg ha^{-1}) (open water)	Crop (kg ha^{-1}) (total lake)
May 1973 - April 1974	636,9	63,7	21
May 1974 - April 1975	279,2	27,9	9
May 1975 - April 1976	115,3	11,5	4
Average	343,8	34,5	11,5

TABLE 7. Tonnage of fish caught on Lake Liambezi from May 1973 to April 1976.

Water body	Author	Surface (km^2)	Average production (kg $ha^{-1}a^{-1}$)
Lake George	Henderson & Welcomme (1974)	270	157,1
Lake George	Dunn (1973)	250	138,4
Lake Mwadingusha	Henderson & Welcomme (1974)	393	127,2
Lake Edward	do.	2300	69,7
Lake Mweru	do	4580	67,7
Shire River	Welcomme (1974)	1400	64,1
Kainji Dam	Henderson & Welcomme (1974)	1270	56,7
Lake Chilwa	do	1750	56,0
Lake Malawi (Eastern arm)	FAO (1954)	?	50,0
Mweru-wa-Ntipa	Henderson & Welcomme (1974)	1520	38,2
Kafue Flood Plains	Welcomme (1974)	4340	14,0
Lake Liambezi		±300	11,5
Lake Bangweulu	Henderson & Welcomme (1974)	9850	9,1
Lake Malawi	do	30800	9,1
Kariba Dam	do	5364	7,6
Kariba Dam	Bowmaker (1975)	5364	5,7
Barotse Flood Plains	Welcomme (1974)	5120	4,7
Lake Victoria	FAO (1954)	68800	1,6
Okovango Swamps	Welcomme (1974)	16000	0,5
All lakes in the world (estimated)	Holt (1967)	-	5

TABLE 8. Production of some African lakes and swamps especially with gill nets.

area, it can therefore be assumed that production stayed more or less constant over this period at 30 kg $ha^{-1}a^{-1}$.

The results obtained in this study are compared in Table 8 with statistics of commercial fisheries on a number of African Lakes and Swamps. The average production of the whole of Lake Liambezi is used here to be comparable to the quoted figures which were computed in the same way. The figure obtained for Lake Liambezi is relatively low if compared with other Central African lakes.

According to Henderson and Welcomme (1974) the expected fish production of a lake is related to the Ryder Index which can be expressed as Conductivity/Average depth. A positive relationship was found by these two authors for a number of African lakes between real production and the so-called morpho-edaphic index as shown in Figure 4. All three figures for Lake Liambezi lie below the regression line, indicating that this lake as a whole might be underutilized.

Experimental catches

Fish species collected

Forty three different fish species were collected as set out in Table 9. Of these fishes, 29 were regularly collected, using appropriate gear. The fish of Lake Liambezi represent the more flood plain loving and widespread species found in Caprivi and in the Upper Zambezi System (Bell-Cross, 1972). Of the 77 species recorded from Caprivi (Skelton and Van der Waal, in prep.) nearly all species showing limited distributions and adaptations to rocky pluvial as well as densely vegetated swampy and ephemeral habitats, are absent in Lake Liambezi.

Composition of experimental fish sampling

Results of five different methods employed to obtain samples of the fish community of Lake Liambezi are represented in Table 10. Important differences in species composition are evident. Seine net catches are markedly different from either gill net catches or the other two collection methods, mainly in the dominance of Cichlids as well as virtual absence of Mormyrids, Schilbeids and Mochochids. In fact the

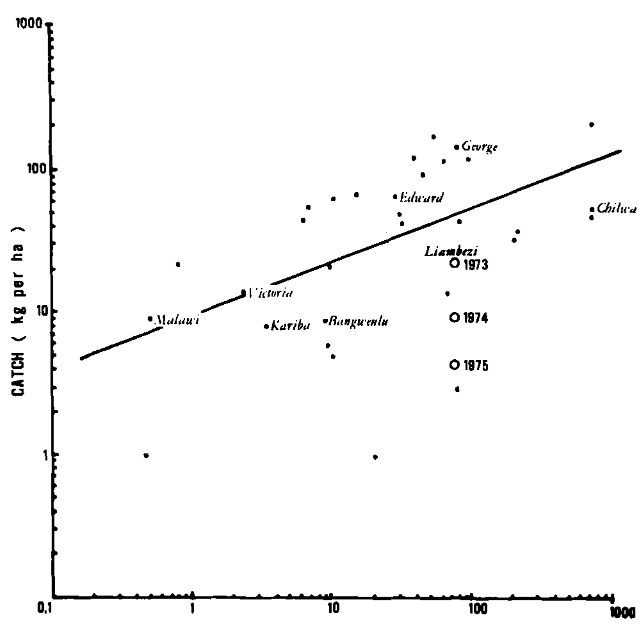

FIGURE 4. Morpho-edaphic indices and catches in kg ha^{-1} of a number of African lakes (from Henderson and Welcomme, 1974) and Lake Liambezi.

Mormyridae	
Petrocephalus catostoma (Günther, 1866)	churchill
Marcusenius macrolepidotus (Peters, 1852)	bulldog
Mormyrus lacerda (Castelnau, 1861)	western bottlenose
Characidae	
Hydrocynus vittatus (Castelnau, 1861)	tigerfish
Alestes lateralis (Boulenger, 1900)	striped robber
Rhabdalestes rhodesiensis (Ricardo, 1943)	slender robber
Hepsetidae	
Hepsetus odoë (Bloch, 1794)	African pike
Cyprinidae	
Barbus poechii (Steindachner, 1911)	dashtail barb
Barbus paludinosus (Peters, 1852)	straightfin barb
Barbus multilineatus (Worthington, 1933)	copperstripe barb
Barbus unitaeniatus (Günther, 1866)	longbeard barb
Barbus viviparus (Weber, 1897)	bowstripe barb
Barbus barotseensis (Pellegrin, 1920)	Barotse barb
Barbus barnardi (Jubb, 1965)	blackback barb
Barbus aurantiacus (Pellegrin, 1910)	Botswana barb
Coptostomabarbus wittei (David & Poll, 1937)	upjaw barb
Labeo lunatus (Jubb, 1963)	Upper Zambezi labeo
Clariidae	
Clarias gariepinus (Burchell, 1822)	sharptooth catfish
Clarias ngamensis (Castelnau, 1861)	blunttooth catfish
Clarias theodorae (Weber, 1897)	snake catfish
Schilbeidae	
Schilbe mystus (Linnaeus, 1762)	silver catfish
Mochokidae	
Synodontis nigromaculatus (Boulenger, 1905)	spotted squeaker
Synodontis woosnami (Boulenger, 1911)	Upper Zambezi squeaker
Synodontis macrostigma (Boulenger, 1911)	largespot squeaker
Synodontis leopardinus (Pellegrin, 1914)	leopard squeaker
Cyprinodontidae	
Aplocheilichthys johnstonii (Günther, 1893)	Johnston's topminnow
Aplocheilichthys hutereaui (Boulenger, 1913)	topminnow
Cichlidae	
Sarotherodon macrochir (Boulenger, 1912)	greenhead tilapia
Sarotherodon andersoni (Castelnau, 1861)	threespot tilapia
Tilapia sparrmanii (Smith, 1840)	banded tilapia
Tilapia rendallii rendallii (Boulenger, 1896)	Northern redbreast tilapia
Tilapia ruweti (Poll & Van den Audenarde, 1965)	Okovango tilapia
Haplochromis giardi (Pellegrin, 1904)	pink happy
Haplochromis codringtoni (Boulenger, 1908	green happy
Haplochromis carlottae (Boulenger, 1905)	rainbow happy
Haplochromis darlingi (Boulenger, 1911)	Zambezi happy
Serranochromis robustus jallae (Boulenger, 1896)	nembwe
Serranochromis macrocephalus (Boulenger, 1899)	purpleface largemouth
Serranochromis longimanus (Boulenger, 1911)	longfin largemouth
Serranochromis angusticeps (Boulenger, 1907)	thinface largemouth
Serranochromis thumbergi (Castelnau, 1861)	brownspot largemouth
Pseudocrenilabrus philander (Weber, 1897)	southern mouthbrooder
Anabantidae	
Ctenopoma multispinus (Peters, 1844)	manyspined climbing perch

TABLE 9. Checklist of fish species in Lake Liambezi.

few fish of these families that were collected with seine net results do not give a better representative picture of fish species composition in Lake Liambezi than a series of gill nets. But gill nets may be more selective towards spiny fish such as *Schilbe* and *Synodontis*.

Standing crop

The calculated standing crop by the different methods is summerised in Table 11.

The lower figures for seine catches show that a considerable portion of the fish escape under or over the net. Water plants sometimes caused the nets to roll up and many Cichlids and *Hepsetus odoë* escaped by jumping.

Composition of experimental gill net catches

Gill nets were found to be the most effective apparatus to collect fish samples as they could be used anywhere in the Lake. Percentage composition of catches made with different gill nets is shown in Table 12. All the gill net settings were used and all catches worked back to a standard gill net length of 50 m over a one night period before averages were computed.

Experimental gill net results show that catches in Lake Liambezi are dominated numerically by *Marcusenius macrolepidotus*, *Schilbe mystus*, *Synodontis* species and *Petrocephalus catostoma*.

In Table 13 a comparison is made with gill net catches on the Barotse Flood Plain, 150 km north of Caprivi, where a similar population composition was found (FAO, 1969). The 13 Cichlid species constituted only 12 percent of the total experimental gill net catches. In Table 14 these results are given in mass and numbers. The Cichlids together comprise 14,4 percent by weight.

Gill net selectivity

Selectivity for fish species of different mesh gill nets is illustrated in Tables 12 and 14. There is a great difference in the catch composition of small and large mesh gill nets, both in terms of numbers and mass.

Smaller mesh gill nets of 50 to 80 mm catch predominantly *M.macrolepidotus*, *S. mystus* and *Synodontis* while *Clarias* and *Sarotherodon* are caught more frequently in larger mesh gill nets of 96 to 190 mm mesh (Figure 5). It shows clearly that small fish species are predominantly caught in small mesh gill nets and the larger fish species are caught as expected in larger mesh gill nets. Young Cichlids and *Clarias* are however not caught in any large numbers in small mesh nets as might have been expected (Figure 5 and Table 14). The exceptions amongst Cichlids are only those

Fish species	Rotenone	Explosive	Seine net 25 mm mesh	Seine net 50 mm mesh	Average gill net catches 25 - 190 mm mesh
	Collection gear used				
N	168	230	2157	6725	15014
P. catostoma	-	-	-	-	11,6
M. macrolepidotus	4	4	-	0,01	19,3
M. lacerda	-	-	-	-	0,02
H. vittatus	-	-	-	0,02	0,02
H. odoë	13	1	1,4	3,6	2,9
A. lateralis	5	33	7,3	0,1	2,1
B. poechii	12	7	1,8	0,1	0,9
C. gariepinus	-	-	0,1	0,1	0,7
C. ngamensis	-	-	0,1	0,2	0,8
S. mystus	42	17	-	0,1	32,9
S. woosnami } *S. leopardinus*	1	3	-	0,1	13,9
S. macrostigma	-	-	-	0,04	2,6
S. nigromaculatus	-	-	-	-	1,1
S. macrochir	-	-	16,6	60,6	1,1
S. andersoni	-	1	3,9	6,6	1,3
T. sparrmanii	1	1	5,9	1,6	0,9
T. r. rendalli	5	-	15,3	7,1	0,8
H. giardi	-	-	0,6	0,3	0,3
H. codringtoni	-	-	2,2	3,4	0,9
H. carlottae	1	1	2,4	1,1	0,1
H. darlingi	13	29	35,2	4,8	2,2
S. robustus jallae	-	-	0,1	0,2	0,02
S. macrocephalus	1	-	3,1	3,5	2,7
S. longimanus	1	-	1,5	2,9	0,6
S. angusticeps	-	-	1,3	1,8	0,9
S. thumbergi	-	-	1,1	2,2	0,3
P. philander	-	1	0,1	-	-

TABLE 10. Comparison of percentage composition of fish species collected in Lake Liambezi with rotenone, explosives, seine nets and a fleet of experimental gill nets.

species that do not reach a large size: *Tilapia sparrmanii, Haplochromis darlingi* and *H. carlottae.*

The average mass of fishes caught by the gill nets is represented in Table 15 and although most Cichlids here show an increase in weight with larger mesh size it is not pronounced. Larger fish were often caught in smaller mesh nets that were not gilled but entangled themselves. This tendency is shown in many larger economic important fish species: *S. macrochir*, *T.r. rendalli* and *Clarias ngamensis*. Large overlap of length distribution is also found amongst catches of smaller fish species like *Synodontis* spp. *M. macrolepidotus* and *S. mystus*.

Gill net efficiency

In a commercial gill net fishery the efficiency of gear used is of utmost importance. An indication of efficiency of the various gill net mesh sizes can be obtained from Table 14. These results are summarised in Figure 6. As can be expected in a normal fish community, more small fish than large fish are collected when the efficiency of different mesh gill nets is comparable (e.g. twine thickness decreases proportionally with mesh size) with a high rate of decrease in numbers caught from 60 to 100 mm mesh. In terms of mass there is a build-up to 24,8 kg per 50 m of net per night from the 25 mm to 60 mm mesh net with

Collecting method	Mass of fish, kg ha^{-1}
Rotenone treatment	156,6
Explosive treatment	132,1
25 mm mesh seine	91,8
50 mm mesh seine	73,9

TABLE 11. Calculated standing crop of fish after the application of different collecting methods.

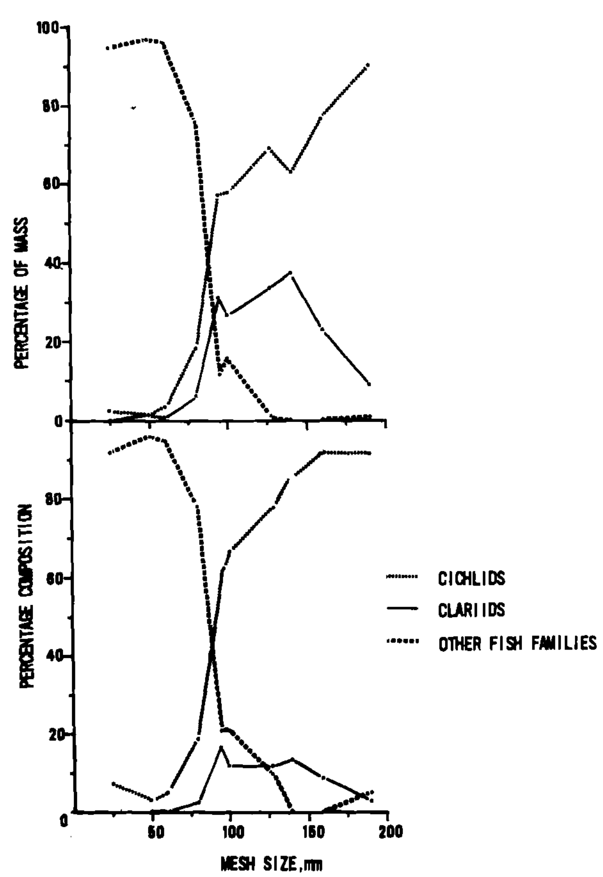

FIGURE 5. Selectivity of experimental gill net fleet for various fish groups in composition and mass.

Fish species	Mesh size (Stretched) (mm)										
	25	50	60	80	96	100	127	140	160	190	Average
P. catostoma	37,4	-	-	-	-	-	-	-	-	-	11,6
M. macrolepidotus	2,0	26,7	38,8	19,4	0,3	0,6	-	-	-	-	19,3
M. lacerda	-	-	-	-	0,2	0,6	-	-	-	-	0,02
H. vittatus	-	-	-	0,1	0,2	-	-	-	-	-	0,02
H. odoë	1,6	2,7	4,0	4,8	1,0	1,9	0,3	-	-	-	2,9
A. lateralis	6,7	-	-	-	-	-	-	-	-	-	2,1
B. poechii	2,9	-	-	-	-	-	-	-	-	-	0,9
C. gariepinus	0,1	0,1	0,2	1,2	5,8	7,4	12,7	12,3	6,8	3,6	0,7
C. ngamensis	0,1	0,1	0,1	2,6	11,6	4,7	0,3	1,8	1,1	-	0,8
S. mystus	36,9	48,5	26,1	19,1	3,5	3,7	-	-	-	3,6	32,2
S. leopardinus } *S. woosnami*	4,1	12,5	20,3	31,4	13,0	8,9	0,2	-	-	3,6	13,9
S. macrostigma	0,5	5,2	4,6	0,3	0,5	0,4	-	-	-	-	2,6
S. nigromaculatus	0,1	1,1	1,3	1,7	1,7	5,6	3,7	-	-	-	1,1
S. macrochir	0,4	0,2	0,1	0,2	9,1	9,7	45,3	7,0	1,1	7,1	1,1
S. andersoni	0,1	0,2	0,2	0,1	3,5	4,5	32,3	77,2	90,9	82,1	1,3
T. sparrmanii	-	0,9	2,3	0,5	-	-	-	-	-	-	0,9
T. r. rendalli	-	0,1	0,1	0,5	12,2	10,9	1,2	-	-	-	0,8
H. giardi	-	-	0,1	0,4	2,3	4,5	1,8	-	-	-	0,3
H. codringtoni	-	0,2	0,4	3,0	5,4	6,6	-	-	-	-	0,9
H. carlottae	-	0,2	0,2	0,1	-	0,2	-	-	-	-	0,1
H. darlingi	7,0	-	-	-	-	-	-	-	-	-	2,2
S. robustus jallae	-	-	0,1	-	0,2	1,2	-	-	-	-	0,02
S. macrocephalus	0,1	0,7	0,8	8,7	22,4	16,5	0,2	-	-	-	2,7
S. longimanus	-	0,6	0,5	1,7	1,2	1,7	-	-	-	-	0,6
S. angusticeps	-	0,1	0,2	3,2	5,4	10,3	2,0	-	-	-	0,9
S. thumbergi	0,1	0,2	0,4	1,1	0,7	0,4	-	1,8	-	-	0,3
n	2075	5106	4378	1560	606	516	600	57	88	28	

TABLE 12. Composition of experimental gill net catches in Liambezi in percentages

Fish species	Locality and type of net	
	Barotse Flood Plains 37 - 150 mm mesh*	Lake Liambezi 25 - 190 mm mesh
P. catostoma	-	6,8
M. macrolepidotus	23,6	11,3
M. lacerda	-	0,01
H. vittatus	5,5	0,01
H. odoë	1,3	1,7
A. lateralis	-	1,2
L. lunatus	0,9	-
A. ngamensis	1,0	-
B. poechii	-	0,5
C. gariepinus	0,6	0,4
C. ngamensis	0,5	0,5
C. stappersi	0,2	-
S. mystus	7,9	18,8
S. woosnami + *S. leopardinus*	6,1	8,2
S. macrostigma	-	1,5
S. nigromaculatus	5,6	0,6
S. macrochir	0,9	0,6
S. andersoni	0,7	0,7
T. sparrmanii	1,8	0,5
T. r. rendalli	0,7	0,5
H. giardi	0,4	0,2
H. codringtoni	0,4	0,5
H. carlottae	0,3	0,1
H. darlingi	0,6	1,3
S. robustus jallae	0,3	0,03
S. macrocephalus	0,8	1,6
S. longimanus	-	0,3
S. angusticeps	0,5	0,6
S. thumbergi	-	0,2

*data computed from FAO (1969)

TABLE 13. Gill net catch composition on the Barotse Flood Plain (1967) and Lake Liambezi (1973 - 1975) in number per 50 mm net caught per night.

a fast decrease in weight of fish caught to 100 mm mesh and a steady further decrease to only 0,9 kg per 50 m per night in the 190 mm mesh gill net.

Seasonal changes in efficiency or composition were not clear as conditions in the lake changed during the 18 month survey period, mainly caused by a rise in lake level. Other factors such as weather and moon phase also play a role and no analyses of gill net composition of efficiency over this short study period was therefore attempted. No great difference

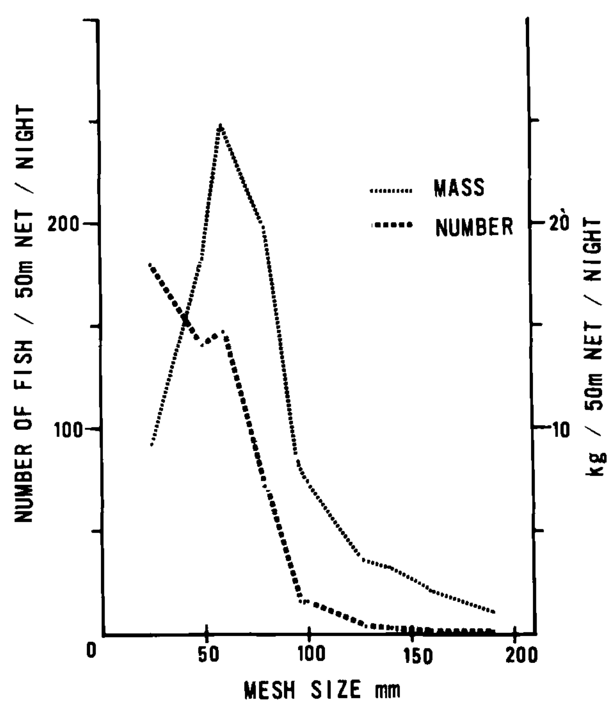

FIGURE 6. Efficiency of various mesh size gill nets expressed as numbers and mass of fish collected.

Fish species	Mesh size (Stretched) (mm)										
	25	50	60	80	96	100	127	140	160	190	Average
P. catostoma	648,0	-	-	-	-	-	-	-	-	-	64,8
	(67,5)	-	-	-	-	-	-	-	-	-	(6,8)
M. macrolepidotus	70,7	4949,9	8316,3	2805,8	21,5	26,9	-	-	-	-	1691,1
	(3,6)	(37,4)	(57,0)	(14,5)	(0,06)	(0,1)	-	-	-	-	(11,3)
M. lacerda	-	-	-	29,0	26,8	76,0	-	-	-	-	13,2
	-	-	-	-	(0,03)	(0,1)	-	-	-	-	(0,01)
H. vittatus	-	-	-	192,0	36,2	-	-	-	-	-	22,8
	-	-	-	(0,04)	(0,03)	-	-	-	-	-	(0,01)
H. odoë	903,4	109,1	222,0	2002,0	165,3	261,3	5,0	-	-	-	566,7
	(2,9)	(3,8)	(5,9)	(3,6)	(0,2)	(0,3)	(0,01)	-	-	-	(1,7)
A. lateralis	212,9	-	-	-	-	-	-	-	-	-	21,3
	(12,1)	-	-	-	-	-	-	-	-	-	(1,2)
B. poechii	52,0	-	-	-	-	-	-	-	-	-	5,2
	(5,2)	-	-	-	-	-	-	-	-	-	(0,5)
C. gariepinus	212,8	108,8	173,0	67,1	983,6	1316,8	1054,2	1221,0	488,0	88,0	571,5
	(0,2)	(0,1)	(0,3)	(0,1)	(1,0)	(1,2)	(0,5)	(0,3)	(0,1)	(0,02)	(0,4)
C.ngamensis	33,0	79,0	64,1	1136,2	1635,1	648,3	12,3	39,2	8,4	-	365,6
	(0,1)	(0,1)	(0,1)	(1,9)	(1,9)	(0,8)	(0,01)	(0,04)	(0,02)	-	(0,5)
S, mystus	5856,7	7684,7	7085,9	4607,6	195,5	197,4	-	-	-	3,2	2563,1
	(66,5)	(68,0)	(38,3)	(14,1)	(0,6)	(0,6)	-	-	-	(0,02)	(18,8)
S. leopardinus } *S. woosnami*	1014,3	3568,1	4350,3	4956,2	465,0	348,1	33,0	-	-	3,0	1473,9
	(7,4)	(17,5)	(29,4)	(23,5)	(2,2)	(1,5)	(0,2)	-	-	(0,02)	(8,2)
S, macrostigma	80,3	1012,9	1239,4	23,0	7,1	10,1	1,1	-	-	-	237,4
	(0,9)	(7,3)	(6,8)	(0,2)	(0,1)	(0,07)	(0,01)	-	-	-	(1,5)
S. nigromaculatus	24,6	496,5	476,0	314,5	80,7	273,6	-	-	-	-	166,6
	(0,1)	(1,6)	(1,9)	(1,3)	(0,3)	(0,9)	(0,2)	-	-	-	(0,6)
S. macrochir	-	32,9	7,1	57,2	655,2	677,3	1172,7	150,6	10,8	57,1	262,1
	(0,7)	(0,3)	(0,1)	(0,1)	(1,5)	(1,6)	(1,8)	(0,2)	(0,02)	(0,05)	(0,6)
S. andersoni	1,4	13,0	21,8	20,1	405,7	528.9	1082,8	1977,7	1601,6	794,2	644,7
	(0,08)	(0,3)	(0,3)	(0,04)	(0,6)	(0,8)	(1,4)	(1,9)	(1,3)	(0,6)	(0,7)
T. sparrmanii	0,7	67,5	291,7	51,4	-	-	-	-	-	-	41,1
	-	(1,3)	(3,4)	(0,4)	-	-	-	-	-	-	(0,5)
T. r. rendalli	-	4,3	12,4	72,1	815,4	763,7	29,9	-	-	-	169,8
	-	(0,1)	(0,1)	(0,4)	(2,1)	(1,8)	(0,05)	-	-	-	(0,5)
H. giardi	-	-	4,1	75,2	152,5	25,4	48,7	-	-	-	30,6
	-	-	(0,03)	(0,3)	(0,4)	(0,8)	(0,08)	-	-	-	(0,2)
H. codringtoni	-	26,9	74,2	508,7	291,3	348,1	-	-	-	-	124,9
		(0,3)	(0,6)	(2,2)	(0,9)	(1,1)	-	-	-	-	(0,5)
H. carlottae	-	15,5	20,4	17,5	-	14,1	-	-	-	-	6,8
		(0,3)	(0,3)	(0,1)	-	(0,03)	-	-	-	-	(0,07)
H. darlingi	222,3	3,3	-	-	-	-	-	-	-	-	22,6
	(12,6)	-	-	-	-	-	-	-	-	-	(1.3)
S. robustus jallae	-	-	20,5	-	16,4	97,3	-	-	-	-	73,4
	-	-	(0,1)	-	(0,03)	(0,2)	-	-	-	-	(0,03)
S. macrocephalus	11,7	78,7	157,6	1662,5	1837,7	959,7	5,1	-	-	-	471,3
	(0,2)	(1,0)	(1,2)	(6,5)	(3,8)	(2,8)	(0,01)	-	-	-	(1,6)
S. longimanus	-	67,5	94,7	304,9	71,1	101,1	-	-	-	-	63,9
	-	(0,8)	(0,7)	(1,3)	(0,2)	(0,3)	-	-	-	-	(0,3)
S. angusticeps	-	9,7	81,3	683,5	424,0	720,9	59,8	-	-	-	197,9
	-	(0,1)	(0,3)	(2,4)	(0,9)	(1,7)	(0,08)	-	-	-	(0,6)
S. thumbergi	2,0	34,4	128,6	243,7	42,2	20,5	-	10,4	-	-	48,1
	(0,1)	(0,3)	(0,6)	(0,8)	(0,1)	(0,1)	-	(0,04)	-	-	(0,2)
Total mass (average number) per 50 m net per night	9346,6	18362,7	24839,8	19832,1	8329,3	7414,7	3504,5	3398,9	2108,7	945,1	9808,3
	(180,2)	(140,6)	(147,4)	(73,8)	(16,9)	(16,8)	(4,4)	(2,5)	(1,4)	(0,7)	(58,4)

TABLE 14. Composition of gill net catches by mass and number (in brackets) in Lake Liambezi expressed in kg per 50 m net per night (number of fish per 50 m net per night).

between catches at the four stations selected could be deducted and they were therefore treated as one. Limnological observations on Lake Liambezi affirm these findings of a homogeneous environment in spite of some local differences (Seaman, Scott, Walmsley, van der Waal and Toerien, 1978).

Comparison between commercial and experimental gill net catches

It has been shown that non-Cichlids form the major part of experimental gill net catches, whereas the larger mesh commercial gill nets çatch predominantly Cichlids.

An inspection of Table 16 and Figure 7 clearly shows that the commercial fishery is very selective towards especially *S. andersoni*, *S. macrochir* and also to *C. gariepinus*. The experimental gill net series which was effective for catching fish of all sizes, caught the greatest numbers and weight of non-Cichlid fishes like *S. mystus*, *Synodontis* spp. and *M. macrolepidotus*. These results may be indicative of a large population of non-Cichlids in the lake that are not being cropped by the present commercial fishery at all. The average catch of commercial nets of 1,8 kg per 50 m per night is also even lower than the catch of corresponding mesh sizes of experimental gill nets (100 mm : 7,4 kg; 127 mm : 3,5 kg; 140 mm : 3,4 kg). Two reasons can be given for the low catch of commercial nets:

1 Nets do not reach up to the surface as result of waterlogged floats. Most fish are caught at or near the surface in Lake Liambezi.

2 Commercial nets are left for a number of days at the same place, with usually a drop in the efficiency of the nets after a few days.

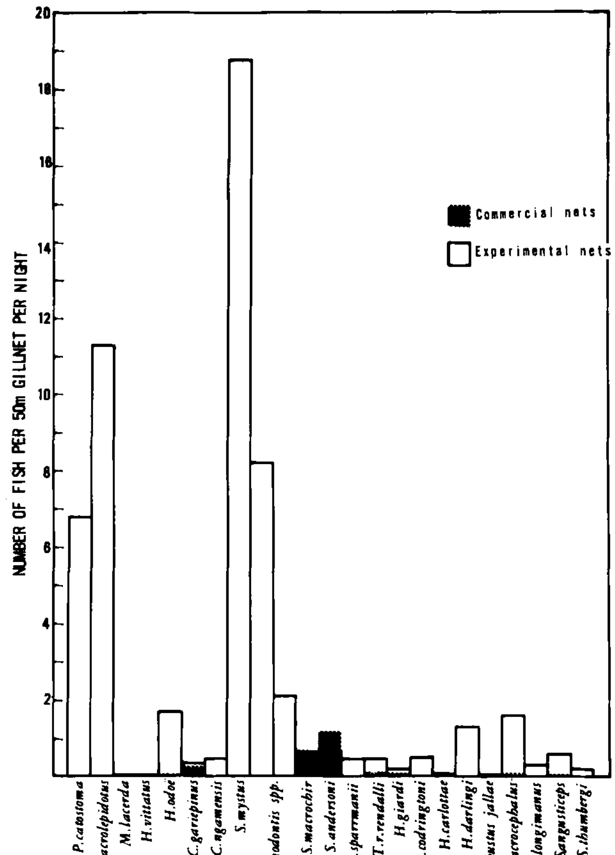

FIGURE 7. Species composition of commercial and experimental gill net catches in Lake Liambezi.

Marketing of fish

In 1973 when the project was started, a marketing problem existed. The main market at Katima Mulilo was connected to the lake only by a bush road that could be used in the dry season from May to December. Fish buyers were unorganized and could only carry up to 80 kg of fresh fish at a time which then had to be carted to Katima Mulilo on a bicycle. As an alternative there was a more dependable fish market in Satau, Botswana near Lake Liambezi where fish was sold by a Botswana fish co-operative to Zambian and Rhodesian fish traders. These traders packed fish on ice in large home-made cool boxes on small lorries and sold their fish in Livingstone and even in Bulawayo. By waiting until their boxes were filled, uneconomic trips were avoided. The deteriorating political situation eventually caused a collapse of this fish co-operative around 1976.

Great improvement was achieved in 1975 when the entire road from Muyako to Bukalo was gravelled and lifted so that it could be used by motor vehicles throughout the year.

A freezing room was also built by the Works Department of the Caprivi Government in 1975 which did not come into operation until 1976. An agreement was reached with the local fishermen on a fixed fish price and it was then sold mainly at the large Black township of Ngwezi near Katima Mulilo and at Bukalo by the Agriculture and Forestry Department. Technical problems and breakdown of the cooling equipment in 1977 caused a temporary interruption in marketing facilities after which it was decided to lease it to a private entrepreneur. Modifications were made to the equipment and since the beginning of 1978 the freezing room has been running satisfactorily. The constant supply of fresh fish made it possible to open a small fish shop at Katima Mulilo.

Table 17 summarizes fish prices recorded during the study period. Over a period of about two and a half

Fish species	Mesh size (Stretched) (mm)									
	25	50	60	80	96	100	127	140	160	190
P. catostoma	9,6	-	-	-	-	-	-	-	-	-
M. macrolepidotus	19,6	132,4	145,9	193,5	357,5	268,5	-	-	-	-
M. lacerda	-	-	-	580,0	894,0	760,0	-	-	-	-
H. vittatus	-	-	-	4499,0	1207,0	-	-	-	-	-
H. odoë	311,5	28,7	376,4	556,1	826,5	871,0	497,0	-	-	-
A. lateralis	17,6	-	-	-	-	-	-	-	-	-
B. poechii	10,0	-	-	-	-	-	-	-	-	-
C. gariepinus	1064,0	1088,5	576,5	690,6	983,6	1097,4	2108,4	4070,0	4879,5	4400,0
C. ngamensis	330,0	790,0	640,6	598,0	860,6	810,4	1229,0	980,0	420,0	-
S. mystus	88,1	113,0	185,0	326,8	325,9	329,0	-	-	-	161,0
S. leopardinus *S. woosnami*	137,1	203,9	148,0	210,9	211,8	232,1	165,0	-	-	152,0
S. macrostigma	89,2	138,8	182,3	115,2	71,0	144,3	109,0	-	-	-
S. nigromaculatus	246,0	310,3	250,5	242,7	269,0	304,0	-	-	-	-
S. macrochir	-	109,6	70,5	572,0	436,8	423,3	651,5	753,3	540,0	1142,5
S. andersoni	18,0	43,4	72,7	503,0	676,1	661,1	773,4	1040,9	1232,0	1323,7
T. sparrmanii	15,0	51,9	85,8	128,5	-	-	-	-	-	-
T. r. rendalli	-	43,0	124,0	180,3	388,3	424,3	597,0	-	-	-
H. giardi	-	-	135,0	250,6	381,3	31,7	609,2	-	-	-
H. codringtoni	-	89,5	123,6	231,2	323,7	316,4	-	-	-	-
H. carlottae	-	51,5	68,0	174,5	-	470,0	-	-	-	-
H. darlingi	17,6	65,0	-	-	-	-	-	-	-	-
S. robustus jallae	-	-	205,0	-	546,0	486,5	-	-	-	-
S. macrocephalus	51,6	78,7	131,3	255,8	483,6	342,8	506,0	-	-	-
S. longimanus	-	84,3	135,3	234,6	355,3	337,0	-	-	-	-
S. angusticeps	-	96,8	271,0	284,8	471,1	424,0	747,4	-	-	-
S. thumbergi	20,0	114,5	214,4	304,6	422,0	200,0	-	260,0	-	-

TABLE 15. Average mass of fish species collected with experimental gill nets in Lake Liambezi. Mass in g.

Fish species	Catches as number of fish per 50 m net per night		Catches as mass (g) of fish per 50 m net per night	
	Experimental	Commercial	Experimental	Commercial
P. catostoma	6,8	-	64,8	-
M. macrolepidotus	11,3	0,018	1619,1	5,2
M. lacerda	0,01	0,023	13,2	16,4
H. vittatus	0,01	0,010	22,8	51,2
H. odoë	1,7	0,044	566,7	38,1
A. lateralis	1,2	-	21,3	-
B. poechii	0,5	-	5,2	-
C. gariepinus	0,4	0,142	571,5	203,8
C. ngamensis	0,5	0,031	365,6	29,3
S. mystus	18,8	0,018	2563,1	5,7
S. woosnami }				
S. leopardinus }	8,2		1473,9	
S. macrostigma	1,5	} 0,020	273,4	} 5,9
S. nigromaculatus	0,6		166,6	
S. macrochir	0,6	0,666	282,1	408,3
S. andersoni	0,7	1,112	644,7	838,4
T. sparrmanii	0,5	-	41,1	-
T. r. rendalli	0,5	0,134	169,8	67,9
H. giardi	0,2		30,6	
H. codringtoni	0,5	} 0,121	124,9	} 59,2
H. carlottae	0,07	-	6,8	-
H. darlingi	1,3	-	22,6	-
S. robustus jallae	0,05	0,039	13,4	20,8
S. macrocephalus	1,6	0,075	471,3	32,5
S. longimanus	0,3	-	63,9	-
S. angusticeps	0,6	0,129	197,9	74,1
S. thumbergi	0,2	-	48,1	-

TABLE 16. Composition of experimental and commercial gill net catches in Lake Liambezi.

years, the price rose from 9,1 cents per kg live weight to more than 21 cents per kg, representing a yearly inflation in price of between 14 and 68 percent. Compared with prices paid for Cichlids at Kariba during the same years (17,6 c/kg, Junor, pers. comm.) the fish prices in Caprivi are realistic but a much higher inflation rate existed in Caprivi.

Month	Fish price (SA Rand)		Daily gross income per fisherman
	Per fish	Per kg	
1973			
August	0,056	0,091	1,54
October - November	0,060	0,100	1,50
November - December	0,063	0,107	1,64
1974			
January	0,054	0,081	2,51
March	0,071	0,104	1,67
April - May	0,069	0,099	1,57
June	0,065	0,100	1,86
July - August	0,067	0,112	±0,81
September	0,088	0,120	1,75
November	0,084	0,097	1,68
1975			
January	0,080	0,102	1,18
February	0,093	0,131	1,26
April	0,093	0,108	1,31
May	0,097	0,120	±0,92
June	0,096	0,125	1,47
August	0,136	0,188	2,11
September	0,138	0,173	1,58
October	0,130	0,174	0,72
December	0,132	0,169	1,53
1976			
January	0,121	0,169	1,35
February - March	0,173	0,231	2,01
March - April	0,180	0,214	4,72
August 73 - March 74	0,061	0,097	1,77
May 74 - April 75	0,080	0,109	1,43
May 75 - April 76	0,134	0,174	1,82

TABLE 17. Fish prices (in SA Rand) and income of fishermen at Lake Liambezi.

Table 17 shows, however, that the average income per working day for the fishermen stayed more or less constant from August 1973 to April 1976.

DISCUSSION AND RECOMMENDATIONS

Results of experimental area collections show that Lake Liambezi has a standing crop in the order of 100 kg ha^{-1}, which is comparable to that of similar waterbodies. The actual yearly crop varied during the study period between 4 and 21 kg ha^{-1} for the entire lake, including the vast circumfering reed beds. It appears that the fish population as a whole might be under-utilized, but on the other hand there is a possibility of selective over-exploitation of the larger Cichlids and Clariids. This tendency is borne out by the fact that there was not only a decline in total crop, but also in the catch per unit effort (c.p.u.e.) in the commercial fishery which dropped from 4.0 fish per 50 m net per night in 1973-74 to 2,2 in the period 1975-76. The lowering of c.p.u.e. may also partly be attributed to:

1 Increase in water level of the lake and accompanying decrease in efficiency of gear as nets do not reach from the bottom to the surface anymore.
2 Doubling of lake surface resulting in a despersion of fish and temporary lower standing crop.
3 Decrease in turbidity with higher water levels again negatively influencing net efficiency. (See Seaman *et al.*, 1978).

In spite of the persistent drop in c.p.u.e. in commercial catches, no concurrent decrease in average size of fish caught was observed, in fact the average size of especially Cichlids increased over the three year period, possibly indicating that over-exploitation and decrease of average size of fish caught in gill nets did not take place.

Results of a fleet of experimental gill nets show that the fish population of Lake Liambezi is comparable to that of the Barotse Flood Plain (Bell-

Cross, 1974). On basis of the experimental gill net catches it is strongly recommended that small mesh gill nets (50-70 mm mesh) are introduced on Lake Liambezi, so that non-Cichlid fish species which form a high percentage of the fish population are cropped besides the Cichlids and Clariids. A more balanced harvest pressure will be achieved if half of the nets used on the lake consist of 50 to 70 mm and the rest of 100 to 150 mm meshes. Higher catches in terms of c.p.u.e. were consistently obtained using small mesh experimental gill nets, up to more than tenfold that of the present commercial c.p.u.e. This higher catch will easily compensate for the extra labour needed to collect smaller fish from the nets and the lower economic value of some of the smaller fish species.

One objection that might be raised against the introduction of small mesh gill nets is that it might catch juvenile fish of large fish species before reaching maturity. This is fortunately not the case in Lake Liambezi where very few juveniles of *S. andersoni* and *S. macrochir*, *Clarias* species or any other large fish species were collected with the small mesh gill nets. Similar observations have also been made by the author on gill net catch composition of nets placed in a number of dams in the Transvaal.

On the basis of limnological observations (Seaman *et al.*, 1978), the morpho-edaphic index and relative cropping level, as well as on results of experimental gill net catches, a cropping rate of 25 kg ha^{-1} a^{-1} is proposed as management aim for Lake Liambezi, provided that exploitation is continuous and balanced. With a calculated lake surface of 30 000 ha, this represents 750 tons of fish per year.

If the general present income of fishermen in Caprivi is taken as a basis, the full exploitation of Lake Liambezi will afford a permanent living for more than a hundred people.

To promote and develop the fisheries potential of Lake Liambezi as well as the many permanent lakes and channels on the Eastern Flood Plain of Caprivi it is suggested that:

1 A fisherman's shop is opened at Bukalo by the local Development Corporation where nets, twine, floats, salt, mosquito repellents, braiding needles etc., are kept in stock.
2 The cold storage facilities at Lake Liambezi are maintained and a reasonable price paid for fish landed at the market.
3 Marketing is organized by the Department of Agriculture and Forestry and the Development Corporation and that an export market for any surplus fish is found.
4 A Fishery Section is added to the Department of Agriculture and Forestry and that all fishing activities in Caprivi are monitored. Registration of gill nets by a licence system should also be contemplated. It is important that fishery statistics are computed and any changes interpreted and the correct management steps taken to ensure that the valuable fish stocks are not overutilized. An extension service should be established to teach better fish processing techniques such as brining and smoking fish.
5 Regular aerial surveys are made of the extent of *Salvinia* mats on Lake Liambezi. Suitable biological control agents should also be bred and released on all *Salvinia* mats. The mats preventing access to the western half of Lake Liambezi will additionally have to be controlled with a suitable herbicide so that the whole lake can be fished.
6 With the development of a saw mill and availability of planking the building of plank boats should be promoted by the Department of Agriculture and Forestry and the wasteful traditional mukolo building activities be discouraged.
7 Research into the hydrology of the Kwando - Linyanti - Liambezi - Chobe system should be initiated as it is well known that great changes have taken place in this system over the last fifty years. Further research on the fish life of Lake Liambezi and other waters of Caprivi and especially on the influence of exploitation on fish populations is also required for proper management of this valuable natural asset.

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