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(April 2020)

STATUS OF MAJOR FISHES OF THE KAFUE FLOODPLAIN, ZAMBIA FIVE YEARS AFTER COMPLETION OF THE KAFUE GORGE DAM

by

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Final Report Submitted to

the National Science Foundation

Scientists and Engineers in Economic Development Program

30 November 1976

Grant Number: OIP75-09239

Grant Period: 15 March 1975 to 30 April 1977

ABSTRACT

Sampling of fish populations in the mid Kafue floodplain revealed few changes since 1969 when similar data was collected. Gill net catches of major species in 1975-76 were similar to catches made in 1969-70 except the *Serranochromis angusticeps*, *Hepsetus odöe* and *Clarias gariapinus* were significantly less abundant and only *Labeo molybdlnus* was more abundant in the 1975 catches.

Slight differences in growth of *Sarotherodon andersoni* and *S. macrochir* between pre- and post-impoundment data were found. Spawning success of these two *Sarotherodon* species seems to have been depressed by higher dry season water levels.

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ACKNOWLEDGEMENTS

The Government of the Republic of Zambia was exceptionally kind in providing both equipment and manpower without which the project would have been impossible.

I am especially grateful to A. B. E. Mabaye, Director of the Zambian Fisheries Department and E. Muyanga, Chief Fisheries Research Officer, for their support and cooperation.

I thank J. Kaoma and D. Masuku for their assistance, comments and cooperation. M. Chimuka, B. Matengu, D. Nkausu, R. Sindandumuna, S. Mwenda, H. Liyowa, L. Kaluma, A. Mukupwa, A. Serna, P. Tembo, J. Similindi; assisted with field work. I also thank E. Machisa, S. Milambo, P. Chipungu, T. Osborne, J. Griffin and Drs. W. Handlos, and R. Schuster for their helpful comments during the project.

Food and Agriculture Organization personnel G. MacDonald, K. Hill, C. Grant and I. Clucas also provided helpful assistance.

The National Science Foundations Scientists and Engineers in Economic Development Program provided funds to support this research, under grant number OIP-09239.

The School of Forest Resources, University of Georgia kindly allowed me to take a leave of absence to carry out this project.

INTRODUCTION

The Kafue floodplain supports one of Zambia's major fisheries yielding about 5000 metric tons of fish per year. Although fish is one of its more important products, the floodplain is valuable for other, often conflicting, uses. Two small national parks have been established on the floodplain to protect the antelope Kobus leche Kafuensis (the Kafue lechwe) and numerous bird species. Grazing by large numbers of domestic cattle occurs during the period of receding water. More recently, use of floodplain waters for agriculture (e.g. Nakambala Sugar Estates) and industrial uses (at the town of Kafue) has become important. A part of the water supply for Lusaka, capital of Zambia, is also taken from the Kafue floodplain area. The most important recent modification of the floodplain, however, was the completion of the Kafue Gorge Hydroelectric Dam in 1971 which permanently flooded a portion of the floodplain and altered the flooding regime over an additional portion. This major disruption of the natural flooding pattern was expected to have a major impact on the commercial fishery of the Kafue floodplain. A new dam at Itezhitezhi just upstream of the floodplain will probably be completed in 1977. The dam will further disrupt the natural flooding pattern by lowering the maximum flood elevation and will allow a greater manipulation of the water regime.

Although fisheries research and surveys have been carried out on the Kafue floodplain since the late 1950fs a special effort was made in 1969 and 1970 to predict the possible effects of the Kafue Gorge Dam on commercial fisheries (Chapman et al. 1971; Lagler, Kapetsky and Stewart 1971; Dudley 1974, Scully 1972, Kapetsky 1974). Since completion of the dam the Zambian government has continued its research program on the floodplain and others have attempted to examine the effects of the dam and other factors on the commercial fishery (Muncy 1976).

In this report I have summarized my data and findings obtained during 10 months of research on the floodplain (August 1975 through May 1976). I have attempted to provide some insight into the factors affecting the commercial fishery by examining experimental gillnet catches, seine net catches and growth rates of some major species.

The Kafue Floodplain

*The Kafue River, a major tributary of the Zambezi River, arises near the Zaire - Zambia border. It flows southward about 400 km prior to flowing eastward onto the 6000 km^2 Kafue floodplain in South Central Zambia. After flowing the 250 km across the floodplain the river plunges 670 m as it flows through the 30 km Kafue Gorge to the Zambezi River. The grassy floodplain lies at an altitude of 900 m, 15°30' south of the equator.

The waters of the Kafue river typically start to rise in early December or late November shortly after the start of the rainy season. The highest water levels occur in April or May about one month after termination of local rainfall. The flood water then gradually recedes reaching a minimum in late November. The maximum flood height and duration of flooding varies considerably from year to year. Prior to construction of the dam the river was confined to a 50-75 m wide channels and lagoons at low water.

Since impoundment about 20 percent of the floodplain remains inundated when water is at spillway elevation. The flooding pattern has been altered over much of the floodplain where the minimum dry season water elevation has been raised. The mean maximum flood elevation has not changed. Since impoundment the amount of rise in water level during a flood cycle has decreased substantially (Table 1).

The shape of the typical post impoundment flood - time curve differs substantially from pre-impoundment curves. The difference is due primarily

Table 1. Means of three water level measurements in pre- and post-impoundment years on the Kafue floodplain. All calculations were based on data from the Nyimba gauging station. Data from which these figures were derived were obtained from the Zambian Water Affairs Department.

	Pre-Impoundment (1963 - 1971)	Post-Impoundment (1972 - 1975)
Mean Minimum Gauge Reading	1.6 meters (.9)[1]	2.8 meters (3.3)[2]
Mean Maximum Gauge Reading	6.9	6.5 (7.0)[2]
Mean Maximum Change within a Hydrological Year	5.1	3.3 (3.3)[3]

1/ Mean value calculated when omitting the exceptionally wet hydrological years of 1963 and 1969.

2/ Mean value calculated when omitting the record dry hydrologic year of 1973.

3/ Mean value calculated when omitting the two extremes resulting from the dry 1973 hydrological year.

to the deeper water during the dry season (Table 1). Another measure of the difference in flooding regime is the flood index. The index (measured in foot-months) used here is the area between the flood-time curve (derived from Nyimba gaugeboard data) and a depth of 6 feet. The mean flood index for typical post-impoundment years (1972 and 1975) is 134 (S.D. * 12.5) while that of typical pre-impoundment years (1964 through 1968) is only 85.6 (S.D. = 17.2). The mean index for pre-impoundment years 1963 through 1970 is 111 (S.D. * 42.5).

GILLNETTING AND LIMNOLOGY

Methods

Multimesh gillnets were set monthly at five locations in the central Kafue floodplain. The nets used, comparable to those used by Scully (1972) and Chapman et al. (1971), contained 10 panels of meshes ranging from 13 mm (1 1/2 inch) to 152 mm (6 inch) mesh by 7 mm (1/2 inch) increments.

Although nets used at the beginning of the University of Idaho study (Scully 1972, Chapman et al. 1971) had equal length panels of 9.14 m (30 feet), these were changed in December 1969 to a design in which panels were of different length but had an equal number of meshes. This was done because the 9.14 meter small mesh panels caught excessive numbers of small fish which hampered data collection. I followed the equal mesh size design in constructing nets for use in 1975-76 in order to have data comparable to that collected in 1969-70. The nets measured 91.4 meters by 2.13 meters in depth and were hung on a 50 percent basis. The length of each panel of a given mesh size appears in Table 2. In general the design of the net can be described as:

$$\sum_{i=1}^{n}\left(\frac{x}{d_i}\, h\, S_i\right) = L$$

where x is the number of meshes per panel (unknown)

d_i is the depth of each panel in meshes calculated from mesh size and hanging coefficient.

h is the hanging coefficient

S_i is mesh size i (stretch measure)

L is desired total length

At each of five locations two floating nets and two sinking nets were set for 24 hours. At the end of the 24 hour period all fish were removed,

Table 2. Multimesh nets used in 1975-76 consisted of 10 panels of mesh sizes from 1½ through 6 inches. The nets were designed so as to have an equal number of meshes per panel.

	Mesh Size (mm)									
	38	51	64	76	90	102	114	127	140	152
Length										
meshes	67	89	112	132	156	181.5	198	223	242	272
meters	1.28	2.26	3.56	4.80	6.93	9.22	11.32	14.16	16.90	20.73
Depth - all panels were 2.13 meters deep										
meshes	65	49	39	33	28	24	22	19.5	18	16
Number of meshes										
Theoretical					4357.6					
Actual	4355	4361	4368	4356	4368	4356	4356	4348.5	4356	4352

identified and counted and data tabulated for each mesh size of each net. Additionally all fish were measured (length to the median caudal ray - fork length) during September through December and March through May.

The original gillnet data collected by Scully (1972) was examined in Zambia and data from nets comparable to my own were recorded for comparison. Data of Scully's used herein differs from that used by Scully (1972) and by Chapman et al. (1971) because I have not used data from nets of Scully's which were set in densely vegetated areas with the exception of the Chunga station. Scully's interest was distribution of fishes while mine was the change in catch at comparable locations since 1969-70. When using data from the standard style (equal sized panel) nets I multiplied the number of fish caught in each panel by the length of the new style panel divided by the length of the old style panel. Since the two styles of nets were the same depth this is equivalent to using the number of meshes as a basis for conversion as was done by Scully (1972).

All gillnet data was recorded on computer cards and analyzed using various programs of the Statistical Analysis System (Barr and Goodnight 1972). Gillnet catches from 1975 were examined using a nested analysis of variance design (location within month for each species). A Duncan multiple range test was then employed for each species to find which catches differed significantly. Since Scully (1972) did not use paired samples I was forced to assume that the 1969-70 variances were the same as the calculated 1975-76 variances (as estimated from the error mean square of each ANOVA test). All analyses were performed on the log (X+l) where X is the number of fish in the catch. Analyses were performed for total catch of each species in top and bottom nets and for total catch of each species in small meshes (38, 51, 63.5 mm), medium meshes (76, 90, 101, 114 mm) and large meshes (127, 140, 152 ram).

During each gillnetting period basic limnological characteristics (temperature, oxygen concentration, conductivity, and secchi disc visibility) were determined at each gillnetting station. These were collected for comparison with similar data from 1969-70 (Chapman et al, 1971).

Sampling Stations: Limnological and other Characteristics

The five locations at which the nets were set were similar to those used during the 1969-70 studies.

Station 1 (Chunga, vegetation) is approximately 3 km north of Chunga in a narrow boat channel bordered on both sides by floating and submerged vegetation. Unlike a large part of the floodplain, vegetation in this area consists of *Nymphaea* sp. *Nymphoides* sp. and *Aschenemone fluitans* with submerged aquatic plants such as *Myriophyllum* becoming abundant in April through June or July. This station was not sampled when it was very shallow (November) or dry (December).

The general appearance of station 1 in 1975-76 was similar to its appearance in 1969-70 with the exception that the extent of this vegetation type was a bit less than in 1969-70. The limnological characteristics of the stations are similar to those found in 1969-70 (Table 3). The lower secchi disc readings in September, October and January in 1975-76 are due to wind caused turbidity from the surrounding open water area which was quite extensive in 1975-76.

Station 2 (Chunga - open water) is located about 5 km north of Chunga at least 2 km from the nearest vegetation. In 1969-70 a large open water area did not exist here and consequently this station was not sampled as a separate station during those years. This station was shallow or dry during November and December of 1975. It consisted of open water without vegetation 2 to 5 meters deep with considerable wave action at times.

Table 3. Limnological characteristics of the Chunga - vegetation sampling station (Station 1). The 1969 data is from Scully (1972) and Chapman *et al.* (1971).

Date		Temperature			Oxygen			Conductivity	Secchi Disc	Depth
		T	M	B	T	M	B			
Sept	1969	----	21	--		5.4		180	2.0	2
	1975	21.5	----	21	7.9	---	6.9	150	0.9	1.6
Oct	1969		23			5.1		185	2.0	1.5
	1975		26			6.3		157	0.5	1.2
Nov	1969		STATION DRY							
	1975									
Dec	1969		STATION DRY							
	1975									
Jan	1969		27.5			3.8		92	1.0	2.2
	1975	22	----	22	8.5	---	5.1	360	0.5	2
Mar	1969		28			5.0		117	1.6	2.9
	1975	27	----	26	6.9	---	5.5	280	1.8	2
Apr	1969		25.5			6.0		130	2.0	3.0
	1975		----			---		---	---	3.3
May	1969		22			6.2		150	1.6	2.6
	1975	24	22	22	6.4	4.0	3.6	101	1.3	3.5

The difference in extent of open water from year to year seems to be characteristic of the south central portion of the Kafue floodplain. In 1970, following the prolonged flood of 1969, areas which had formerly been covered with dense stands of aquatic grasses reverted to open water with floating islands of the previous years grasses (Scully 1972). In 1975 an even larger area lacked vegetation, presumably because of the high water in 1974. The extent of open water was increased even further in 1976 when (in April) one could see to the horizon over open water. Apparently water remaining on the floodplain through the end of the dry season discourages the growth of vegetation especially aquatic grasses the following year. This is probably due both to the standing water itself and to wave action which is considerable in the dry season.

With the exception of May the oxygen concentration at this station in 1975-76 were higher than those found in 1969-70. This is due primarily to the close proximity of the dense grass vegetation type in 1969 (Table 4).

Station 3 (Nampongwe) was not identical to the Nampongwe station of 1969-70 but is comparable. The 1969-70 station (Scully, 1972; Chapman et al. 1971) was near and in the Miande channel which was densely vegetated with aquatic grasses in 1969 and 70. That area was devoid of grass in 1975-76. A comparable station was established along the vegetation bordering the Nampongwe channel. Nets were set diagonally into the channel from shore during September through December but were set along the emergent aquatic grasses (Vossia cuspidata and Echinachloa sagnina) bordering the Nampongwe channel in January through May. Water depths in the channel at this station ranged from 2 meters (dry season) to 5 meters (peak flood).

Oxygen concentrations at Station 3 in 1975-76 consistently exceeded those found in 1969-70. The secchi disc readings of 1975-76 were

Table 4. Limnological characteristics of the Chunga - Open sampling station (Station 2). The 1969 data is from Scully (1972) and Chapman *et al.* (1971).

Date		Temperature T	Temperature M	Temperature B	Oxygen T	Oxygen M	Oxygen B	Conductivity	Secchi Disc	Depth
Sept	1969					5.0				3.1
	1975	21	20.5	20.5	8.1	7.3	7.7	160	1.0	2
Oct	1969					3.8				2.9
	1975		25.7			7.8		157	0.6	1.5
Nov	1969		STATION DRY							
	1975									
Dec	1969		STATION DRY							
	1975									
Jan	1969					0.5				3.4
	1975	25	23	23	7.7	7.3	6.6	360	---	2.5
Mar	1969					3.0				4.1
	1975	28	----	26.5	5.8	---	6.0	205	1.5	3.0
Apr	1969					5.0				4.0
	1975	--	24	----	---	6.0	---	127	2.2	5.0
May	1969					5.5				4.0
	1975	24	22.5	22.5	3.9	2.9	2.8	108	2.0	5.0

consistently below those found in 1969-70 (Table 5). Both these phenomena are a result of the increased amount of open water on the floodplain. The Nampongwe channel (Station 3) is a drainage channel for a large sector of the south central Kafue floodplain. When this area is densely vegetated with grasses (as in 1969-70) the resulting outflow to the Nampongwe Channel is very clear and low in oxygen. If open water predominates the resulting flow to the Nampongwe is somewhat turbid and has a moderate oxygen concentration. In addition, the water flowing down the Nampongwe channel in 1975 (October through December) contained numerous globular fragments of algae, which were not present in 1969-70.

Station 4 (Kafue River Channel) was located in the 30 to 50 meter wide main channel of the Kafue River about 4 km upstream from the Nampongwe - Kafue confluence. The banks of the Kafue River here are submerged during high water and support a lush growth of the grass Vossia cuspidata. The nets were set along the vegetation.

Oxygen concentrations found in the Kafue river proper are similar but slightly higher than those found in 1969-70. The oxygen concentration at this station in 1969-70 dropped to .1 ppm in January and March and .5 ppm in April. In 1975-76 the minimum oxygen concentration occurred in May (1.0 ppm) (Table 6).

Station 5 (Chulwe Lagoon) was located in the western portion of Chulwe Lagoon. Nets were set in a line from the north shore toward the middle of the lagoon. In 1969-70 this station had abundant submerged aquatic vegetation. In 1975-76 it was entirely devoid of submerged aquatics. The cause for the disappearance of submerged aquatics is unclear. Since Chulwe Lagoon was flooded throughout the dry season prior to the construction of the Kafue Gorge Dam it is unlikely that the prolonged

Table 5. Limnological characteristics of the Nampongwe sampling station (Station 3). The 1969 data is from Scully (1972) and Chapman *et al.* (1971).

Date		Temperature			Oxygen			Conductivity	Secchi Disc	Depth
		T	M	B	T	M	B			
Sept	1969		20			1.1		165	4.0	
	1975	21	21	21	6.0	5.7	5.1	160	1.5	5.3
Oct	1969		22			0.8		190	3.0	
	1975	24.5	----	24.5	6.7		6.5	156	1.0	4
Nov	1969		25.5			2.4		238	1.7	
	1975	25	25	24.5	7.2	7.1	6.0	230	0.5	4.5
Dec	1969		25			0.5		245	1.0	
	1975	27	27	27	6.9	6.7	6.2	364	0.3	4
Jan	1969		27.5			0.3		155	0.8	
	1975	24	23	23	6.0	5.6	5.1	---	0.8	3
Mar	1969		28			0.4		140	2.2	
	1975	27.5	----	26.5	5.5	---	4.8	165	1.8	5
Apr	1969		25.5			1.4		120	3.0	
	1975	24	----	24	5.5	---	5.1	116	2.2	4
May	1970		23.5			2.5		148	3.5	
	1975	23	22.5	22	3.8	2.5	3.1	110	2.5	4.5

Table 6. Limnological characteristics of the Kafue sampling station (Station 4). The 1969 data is from Scully (1972) and Chapman et al.

Date		Temperature			Oxygen			Conductivity	Secchi Disc	Depth
		T	M	B	T	M	B			
Sept	1969									
	1975	20.5	20.5	21.5	6.5	6.5	6.3	320	1.4	5.5
Oct	1969							295		
	1975	24.5	24.5	24.8	5.7	5.8	5.7			5
Nov	1969		26.5			4.4		310	0.8	
	1975	24.5	24.5	25	6.8	6.7	6.5	385	1.5	5
Dec	1969		26.5			5.0		325	0.6	
	1975	26.5	26.8	27.5	5.6	5.5	5.5	416	0.6	4.5
Jan	1969		28.5			0.1		135	1.0	
	1975	24	----	24	3.0	---	3.2	220	0.5	5
Mar	1969		28			0.1		130	1.8	
	1975	27	----	27	3.3	3.0	2.9	141	1.2	5.5
Apr	1969		26			0.5		155	2.1	
	1975	24	----	24	1.3	---	1.3	106	2.5	6
May	1969		24			1.1		185	1.9	
	1975	23	----	23	1.1	1.0	1.3	115	2.6	8

flooding caused by the dam has caused this change. A more likely explanation is that the extremely small flood of 1972-73 either allowed drying of most of the lagoon or that following the flood, large amounts of floating grass islands kept it shaded. In any case the 1975-76 vegetation was virtually nil compared to the dense beds of such vegetation found in 1969 and 70. By May of 1976 some of this vegetation type was reappearing.

Oxygen concentrations were similar in the two years at Station 5, but dropped more slowly in 1975-76 as the flood rose due to the less rapid rise in water level in 1976 compared to 1970. Secchi disc visiability increased more rapidly during the 1970 flood (Table 7).

Results of Gillnetting

Nineteen species of fish were caught in multimesh gillnets in large enough numbers to warrant comment (Table 8). Nine of these species were caught in large enough numbers to warrant analysis. These species were *Sarotherodon andersoni*, *Serranchromis angusticeps*, *Serranochromis macrocephala*, *Clarias gariapinus*, *Clarias ngamensis*, *Shilbe mystus*, *Hepsetus odoe*, *Labeo molybdinus* and *Marcusenius macrolepidotus*.

Members of the family Cichlidae comprise a large portion of the commercial fish catch of the Kafue floodplain. Of the Cichlids only *Sarotherodon andersoni*, *Serranochromis angusticeps*, and *Serranochromis macrocephala* occured in relatively large numbers in gillnets. *Sarotherodon macrochir* and *Tilapia rendalli* are numerous in seine net catches but do not comprise a large proportion of the gillnet catches.

For twenty-five comparable net sets made in both 1969-70 and 1975-76 the total catch of *S. andersoni* in all meshes was 455 in 1969-70 and 310 in 1975-76. (The 1975-76 catch is the total of the mean catch of paired sets. Catches reported for 1969-70 are derived from catches of single sets).

Table 7. Limnological characteristics of the Chulwe Lagoon sampling station (Station 5). The 1969 data is from Scully (1972) and Chapman et al. (1971)

Date		Temperature			Oxygen			Conductivity	Secchi Disc	Depth
		T	M	B	T	M	B			
Sept	1969		22			4.0		230	2.0	
	1975	21.5	21.0	21.5	7.3	7.0	6.8	240	1.8	3
Oct	1969		25			5.5		250	1.0	
	1975	25.5		24.5	4.9	---	3.6	270	1.3	2
Nov	1969		24			7.0		295	0.8	
	1975	26	--	26.5	5.5	---	5.4	300	0.7	2
Dec	1969		25			7.0		260	0.8	
	1975	27	--	27.5	6.0	---	4.9	365	0.7	1.6
Jan	1969		28			0.8		210	1.0	
	1975	25.5		24.5	4.3	---	4.0	380	1.1	2
Mar	1969		29			0.3		125	3.0	
	1975	28	--	27	.2	---	0.0	148	1.8	3.5
Apr	1969		25.5			1.8		155	3.2	
	1975	24	----	24	1.2	1.1	.7	100	2.8	4
May	1969		23			2.5		170	2.9	
	1975	24	23.5	23.0	1.5	.3	.3	118	4.0	5

Table 8. Fish species caught during gillnet sampling during August 1975 through May 1976.

Mormyridae

Mormyrus lacerda Castelnau
Marcusenius macrolepidotus (Peters)

Hepsetidae

Hepsetus odoe (Bloqh)

Characidae

Alestes lateralis Boulenger

Cyprinidae

Labeo molybdinus du Plessis

Schilbeidae

Schilbe mystus (Linnaeus)

Mochokidae

Synodontis kafuensis

Clariidae

Clarias gariapinus (Burchell)
Clarias ngamensis Castelnau

Cichlidae

Sarotherodon macrochir (Boulenger)
Sarotherodon andersoni (Castelnau)
Tilapia rendalli gefuensis Thys
Tilapia sparrmani A. Smith
Serranochromis angusticeps (Boulenger)
Serranochromis macrocephalus (Boulenger)
Serranochromis robustus jallae (Boulenger)
Serranochromis thumbergi (Castelnau)
Haplochromis codringtoni (Boulenger)
Haplochromis giardi (Pellegrin)

The proportion of S. andersoni caught in large, medium, and small meshes was significantly different between the two years ($X^2 = 39.12$). A significantly smaller proportion of fish were caught in small meshes in 1975 (Table A2).[1/]

In examining the overall total catches of S. andersoni (Table A1) the variation among stations within a month and among months within a station appears obvious. However, in only four cases were comparable 1969-70 and 1975-76 catches statistically different. This is due to the rather large variation in catch within the paired samples collected in 1975-76.

Fewer small S. andersoni appeared in the 1975-76 catches. In the three cases where the 1969-70 catch significantly exceeded that of 1975-76 a large portion of the 1969-70 catch came from the medium size meshes. In the one case where the 1975-76 catch was significantly larger, the bulk of the catch was from the large meshes. The mean length of S. andersoni caught in the small meshes was considerably smaller in 1969 than in 1970. The size of the fish caught in the three smallest mesh sizes corresponds to the expected length of one year-old-fish which were lacking in the 1975 catches (Table A3).

Although numbers of this species caught did not change drastically, there has been a change in the size composition which indicates that small size S. andersoni were not as numerous in 1975-76 as in 1969-70. This finding agrees with the apparent lack of strong yearclasses of this species in recent years with the exception of the 1974 (October - December 1973) yearclass. This yearclass was produced following a very dry hydrological year (1972-73).

[1/] Figures A1 through A26 appear at the conclusion of the text.

Additional information concerning the yearelass success of Sarotherodon andersoni is discussed in a later section.

Although much less abundant than Sarotherodon andersoni, Serranochromis angusticeps was the second most abundant Cichlid caught in gillnets. Of the twenty-five between year comparisons examined, seven indicated a higher total catch of S. angusticeps in 1969-70 while only one indicated a higher catch in 1975-76. Four of the seven significantly higher 1969-70 catches occurred in Chulwe Lagoon which in 1969 had an abundance of submerged vegetation (Table A4).

A significantly larger proportion of S. angusticeps were caught in large meshes in 1975-76 compared to 1969-70 (Table A5). The length of S. angusticeps caught in a given mesh size has not changed (Table A6). The greater abundance of S. angusticeps in 1969-70 was due primarily to larger numbers of this species in middle sized meshes in 1969-70. This may be an indication of poorer reproductive success in recent years. However, juvenile S. angusticeps appeared reasonably abundant in small mesh seine net hauls made along shore during rising water in 1976.

Serranochromis macrocephala was considerably more abundant in Chulwe Lagoon during September through December of 1969 compared to 1975 (Table A7). However, except for the Kafue Channel in May, no other significant difference between years was found. Thus the differences found for this species may be due only to the changed habitat at the Chulwe Lagoon sampling station. Omitting the catches of the Chulwe station numbers of fish caught in the two years are almost identical.

The three mesh size groupings caught S. macrocephala in equal proportions during the two years (Table A8). Mean size of S. macrocephala in each mesh size was similar during the two years (Table A9).

Two species of Clarias, Clarias gariapinus and C. ngamensis, were caught in gillnets. Of the two, C. gariapinus is more abundant.

Catches of C. gariapinus in 1975-76 were well below similar catches from similar gillnet sets in 1969-70 in nine of twenty-five comparisons (Table A10). Not only were the catches of the C. gariapinus different in the two sampling years, but the proportions of fish caught in the three mesh size groups changed as well. In 1969-70 a considerably larger proportion of C. gariapinus were caught in the larger meshes (Table All). The decreased numbers of this species caught in large meshes in 1975-76 represents a decrease in the numbers of larger individuals. The mean length caught in a particular mesh size did not differ between the two years (Table A12).

Clarias ngamensis, on the other hand, seemed to be as numerous in 1975-76 as it was in 1969-70 although slightly more fish of this species were caught during 1969-70 (Table A13). In addition the size composition of the catch of C. ngamensis, as indicated by a comparison of catches in the three mesh size groups, has not changed since 1969-70 (Table A14). The mean length of this species is quite variable within each mesh size and was similar for the two sampling periods (Table A15).

Abundance of Shilbe mvstus apparently did not differ between 1969-70 and 1975-76. However, differences in distribution of this species caused some significant differences in number caught at each station in the two years (Table A16). Gillnets caught more S. mvstus in Chulwe Lagoon in 1969-70 while more were caught in the Nampongwe Channel in 1975-76 during dropping water. S. mvstus seemed to favor the Chunga area during January of 1970 while remaining more uniformly distributed in January of 1976.

Interestingly, the sizes of S. mystus present during the two sampling periods differed considerably if one considers mesh size as a reasonable measure of fish size. A significantly larger proportion of the S. mystus catch was caught in small meshes in 1975-76 compared to 1969-70. A significantly larger proportion was caught in the medium meshes in 1969-70 (Table A17). A larger share of small fish was also caught in medium and large meshes in 1975 causing smaller mean length and larger standard deviations within each mesh size (Table A18).

Hepsetus odoe appeared in significantly larger numbers in 1969-70 catches in seven of the twenty-five comparisons. The major difference in catch of this species between the two sampling periods was in Chulwe Lagoon. However, 1970 catches of H. odoe were also significantly higher in the Kafue River Channel (April and May) and in the Nampongwe Channel (April) (Table A19). Gillnet selection data (Table A21) indicates that numbers caught in the middle and large mesh groups (76 mm and larger) would be a fair measure of catches of H. odoe over 30 cm length. The proportion of H. odoe over 30 cm did not differ between the two sampling periods (Table A20).

The cyprinid detritivore Labeo molybdinus was more abundant in gillnet catches made during 1975-76 (N = 341) than in 1969-70 (N = 171). Of twenty-five comparisons, six indicated significantly higher catches in 1975-76 while two indicated significantly higher catches in 1969-70 (Table A22). Since virtually all L. molybdinus were caught in the three smallest mesh sizes, changes in size distribution of this species are not readily apparent. However, data concerning the number and mean length of fish caught in each mesh size indicates that more larger fish were available in 1975-76 (Table A23).

The small tnormyrid Marcusenius macrolepidotus did not change drastically in overall abundance but differences in abundance at given stations was substantial. In 1969-70 (total catch of M. macrolepidotus = 273) significantly larger catches occurred in Chulwe Lagoon (September and October) in the Nampongwe Channel (November and April) and in the Kafue Channel (April). Significantly higher catches of M. macrolepidotus in 1975-76 (total catch = 269) occurred at all stations (except Chulwe) in January and in the Nampongwe in December (Table A24). The differences in catches between the two years may reflect differences in movements or migration of this species. Prior to construction of the Kafue Gorge Dam this species congregated in the upper Kafue Gorge area at the eastern extremity of the floodplain during the last few months of the dry season. Such movements may no longer take place now that the water level remains higher during that season.

Since M. macrolepidotus was caught primarily in the three smallest mesh sizes (Table A26), those caught in larger mesh sizes indicate the relative availability of larger individuals (say greater than 19 cm) of this species. A significantly larger proportion of large fish were caught in 1969-70 (Table A25).

Discussion of Gillnetting

Speculation concerning changes in gillnet catches since 1969 is made difficult by the lack of a clear trend affecting all species or a group of species. Although there has been no drastic change in abundance of any species, only numbers of L. molybdinus increased significantly. Three predaceous species, S. angusticeps, CL gariapinus and II. odoe, declined in abundance. Abundance of most of the remaining species declined slightly.

Size distribution of five species changed significantly. The proportion of small *S. angusticeps*, *S. andersoni*, and *L. molybdinus* was less in 1975 than in 1969. The proportion of small *C. gariapinus* and *S. mystus* was larger than in 1969 (Table 9).

The three species which showed a definite decline were predators. It is possible that several poor yearclasses of *Sarotherodon* (evidence for this is given elsewhere) may have contributed to this decline. The fact that large *C. gariapinus* made up a smaller part of the population in 1975 supports this theory since Chapman et al. (1971) found that *C. gariapinus* feeds on fish only after reaching 30 cm. The other predaceous species *S. angusticeps* and *H. odoe* feed on fish for virtually their entire lives.

Unfortunately the data collected during this project cannot reveal much detail concerning the population structure of each species. Information concerning the size distribution of each species and their reproductive success would be a great help in managing the fishery.

Table 9. Summary of significant differences encountered between 1969-70 and 1975-76 gillnet catches. Data based on Tables A1 through A26. Species falling in each of nine categories are shown.

	Proportion of Small Fish Caught in 1975		
Total Number Caught in 1975	Smaller than in 1969	Same as in 1969	Greater than in 1969
Less than in 1969	*S. angusticeps*	*H. odöe*	*C. gariapinus*
Same as in 1969	*S. andersoni*	*S. macrocephala* *C.* ~~*gariapinus*~~ *M. macrolepidotus*	*S. mystus*
Greater than in 1969	*L. molybdinus*	None	None

GROWTH OF *Sarotherodon andersoni* and *S. macrochir*

Methods

In order to examine differences in growth of two *Sarotherodon* species among several years scale samples were taken from individuals of each species during 1975-76. Scales were taken from the center of the left side of each specimen anterior to the second lateral line. The scales were examined on scale projector and the distance to each annulus and to the margin measured along the anterior radius. Methods followed those used during my 1969-70 study (Dudley 1974, Chapman et al. 1971). A geometric mean regression (Ricker 1973) was calculated from the pooled 1969 and 1975 scale data for each sex of each species. These regression equations (Table 10) were then used to calculate the growth increments made by each fish in each hydrological year (the hydrological years coincide with the growth years). The calculated growth increments derived from my 1969-70 data differs slightly from that previously published (Dudley 1974) due to the use of a different regression technique.

Results and Discussion of Growth Studies

Growth of the *Sarotherodon andersoni* and *S. macrochir* has not changed drastically since construction of the Kafue Gorge Dam. Growth increments calculated from 1975-76 data (Table 11 and 12) do not reveal any major differences when compared to the data collected in 1969-70 (Table 13 and 14).

A comparison of mean growth for typical pre- and post-impoundment years reveals only a few minor but statistically significant changes in growth (Table 15). In making this comparison, I assumed that 1964 through 1968 constituted typical pre-impoundment years consisting of a relatively narrow flood peak and a relatively dry season. Typical post-impoundment

Table 10. Geometric mean regressions used in calculating growth increments of two *Sarotherodon* species. (BL = body length to tip of median caudal ray, SL = anterior scale radius).

Species	Sex	Regression Equation
S. andersoni	male	BL * 2.7319 + 2.0351 SL
	female	BL * 3.4552 + 1.9079 SL
S. macrochir	male	BL = 2.2190 + 1.8099 SL
	female	BL « 2.5533 + 1.7506 SL

Table 11. Growth increments of *Sarotherodon andersoni* calculated from data collected during 1975 and 1976. Sample size is given in parentheses.

Year of Growth		Age							
		I	II	III	IV	V	VI	VII	VIII
1968	Male	14.54(5)							
	Female	13.66(4)							
1969	Male	15.25(6)	6.63(5)	5.04(4)					
	Female	13.65(18)	7.11(4)	----					
1970	Male	14.23(4)	4.51(6)	4.66(11)	3.76(4)				
	Female	13.61(14)	4.75(18)	2.53(4)	----				
1971	Male	-----	5.09(4)	3.61(14)	3.74(11)	2.95(4)			
	Female	13.72(5)	5.07(14)	2.72(29)	2.38(4)	----			
1972	Male	12.91(5)	----	3.41(8)	3.65(15)	3.03(11)			
	Female	-----	4.92(5)	2.70(17)	2.28(29)	3.05(4)	3.36(4)		
1973	Male	13.63(37)	4.80(5)	5.29(4)	3.64(8)	4.30(15)	3.92(11)	2.54(4)	
	Female	13.31(14)	----	3.21(6)	2.44(16)	2.37(29)	1.76(4)	----	
1974	Male	13.27(97)	6.90(37)	5.73(7)	5.90(4)	5.82(8)	4.18(15)	3.68(11)	2.75(4)
	Female	13.54(58)	4.61(14)	6.34(4)	5.95(6)	5.63(17)	3.21(29)	2.48(4)	----
1975	Male	13.35(6)	8.31(94)	5.06(32)	2.54(6)	4.32(4)	3.00(8)	2.96(15)	2.12(10)
	Female	12.56(11)	7.19(58)	5.43(17)	4.34(4)	2.67(6)	4.28(17)	2.57(28)	----
Mean Growth	Male	13.88	6.04	3.82	3.87	4.14	3.62	3.06	2.44
	Female	13.44	5.61	3.74	3.48	3.43	3.08	2.53	----

Table 12. Growth increments of Sarotherodon macrochir calculated from data collected during 1975 and 1976. Sample size is given in parentheses.

Year of Growth		Age I	II	III	IV	V	VI	VII	VIII
1968	Male								
	Female								
1969	Male	13.03(11)							
	Female	12.02(11)							
1970	Male	13.11(5)	4.36(11)						
	Female	11.92(10)	3.80(11)						
1971	Male	-----	4.20(5)	3.43(15)					
	Female	12.09(4)	4.90(10)	2.46(14)					
1972	Male	-----	----	3.12(11)	2.40(15)				
	Female	-----	3.59(4)	2.45(12)	2.14(14)				
1973	Male	11.66(6)	----	----	2.04(11)	2.06(15)			
	Female	-----	----	3.47(5)	2.01(12)	1.73(14)			
1974	Male	11.99(82)	4.04(6)	----	----	3.21(11)	2.14(15)		
	Female	11.57(67)	----	----	3.22(5)	2.87(12)	2.21(14)		
1975	Male	11.59(5)	6.90(78)	3.84(9)	----	----	2.07(11)		
	Female	11.74(6)	6.82(61)	----	----	2.63(5)	2.23(7)		
Mean Growth	Male	12.27	4.97	3.46	2.22	2.64	2.11		
	Female	11.87	4.78	2.79	2.46	2.41	2.22		

Table 13. Growth increments of <u>Sarotherodon andersoni</u> calculated from data collected during 1969 and 1970. Sample size is given in parentheses.

Year of Growth		Age I	II	III	IV	V	VI	VII	VIII
1961	Male	14.24(9)							
	Female	-----							
1962	Male	13.52(9)	6.96(9)						
	Female	13.41(15)	----						
1963	Male	14.49(5)	6.85(9)	4.88(14)					
	Female	13.81(15)	6.73(15)	3.53(6)					
1964	Male	13.52(11)	6.68(5)	4.90(22)	2.57(14)				
	Female	14.16(12)	6.58(15)	3.90(24)	2.28(6)				
1965	Male	13.67(12)	8.29(11)	4.80(10)	3.32(24)	2.54(14)			
	Female	-----	8.25(12)	3.43(28)	2.07(24)	1.34(6)			
1966	Male	13.11(19)	6.72(12)	5.53(17)	4.44(11)	3.07(24)	2.53(14)		
	Female	14.22(10)	----	3.63(15)	2.60(28)	1.88(24)	1.46(6)		
1967	Male	13.32(67)	8.18(19)	5.50(21)	4.74(17)	3.90(11)	3.42(24)	2.94(14)	
	Female	13.43(49)	8.62(10)	3.63(8)	2.43(15)	2.40(28)	2.12(24)	1.75(6)	
1968	Male	12.85(48)	6.42(67)	5.83(38)	4.53(22)	3.50(17)	3.57(11)	2.99(24)	2.62(14)
	Female	12.50(36)	5.72(49)	4.36(21)	2.93(10)	2.31(15)	2.47(28)	1.99(24)	1.81(6)
1969	Male	14.19(72)	8.49(47)	7.06(75)	4.57(32)	3.55(14)	2.44(12)	1.63(7)	1.92(9)
	Female	14.13(43)	7.78(34)	5.73(57)	2.83(19)	2.02(7)	1.47(10)	2.03(16)	1.51(14)
Mean Growth	Male	13.65	7.32	5.50	4.03	3.31	2.99	2.52	2.27
	Female	13.66	7.28	4.03	2.52	1.99	1.88	1.92	1.66

Table 14. Growth Increments of <u>Sarotherodon macrochlr</u> calculated from data collected during 1969 and 1970. Sample size is given in parentheses.

Year of Growth		Age I	II	III	IV	V	VI	VII	VIII
1962	Male	-----							
	Female	11.09(8)							
1963	Male	12.86(5)							
	Female	12.27(8)	6.65(8)						
1964	Male	-----	6.70(5)	3.21(7)					
	Female	11.87(5)	7.13(8)	2.76(12)					
1965	Male	11.49(5)	----	3.28(9)	2.28(7)				
	Female	-----	6.72(5)	3.02(13)	1.55(12)				
1966	Male	10.73(9)	8.43(5)	----	2.37(9)	1.65(7)			
	Female	10.89(5)	----	2.68(9)	1.70(13)	1.37(12)			
1967	Male	11.45(23)	9.03(9)	5.97(6)	----	1.71(9)	1.81(7)		
	Female	11.37(23)	8.30(5)	3.76(8)	2.16(9)	1.62(13)	1.42(12)		
1968	Male	10.63(29)	7.22(23)	4.32(26)	2.50(6)	----	1.63(9)	1.73(7)	
	Female	11.54(24)	6.04(23)	3.49(15)	2.69(8)	1.58(9)	1.28(13)	1.14(12)	
1969	Male	11.96(12)	7.90(27)	5.47(28)	3.04(17)	----	----	1.36(6)	
	Female	11.63(8)	7.23(23)	5.31(27)	2.01(8)	----	1.48(7)	1.37(5)	
Mean Growth	Male	11.52	7.85	4.45	2.54	1.68	1.72	1.54	
	Female	11.52	7.01	3.50	2.02	1.52	1.39	1.25	

Table 15. Mean growth increments of Sarotherodon andersoni and S. macrochir in typical pre- and post- impoundment hydrological years. The pre-impoundment years used in these calculations were 1964 through 1968. The post impoundment years used were 1972 through 1975 excluding the extremely dry year of 1973. Also shown are post impoundment calculations made excluding 1974 data since growth made during 1974 may have been influenced by the extremely dry season preceding it.

	Sarotherodon andersoni						Sarotherodon macrochir					
	male			female			male			female		
	$\bar{X}$	s^2	N	$\bar{X}$	s^2	N	$\bar{X}$	s^2	N	$\bar{X}$	s^2	N
AGE I												
Pre-impoundment	13.23	2.71	162	13.15	2.30	103	10.99	2.37	66	11.44	3.24	57
Post-impoundment including 74	13.25	2.58	108	13.38	1.82	69	11.97*	1.79	87	11.58	1.49	73
excluding 74	13.14	.76	11	12.56	2.24	11	11.57	2.15	5	11.74	.81	6
AGE II												
Pre-impoundment	6.93	4.87	114	6.68	5.02	75	7.69	2.85	42	6.61	1.70	41
Post-impoundment including 74	7.92*	4.71	131	6.57	3.89	77	6.69*	2.21	84	6.63	2.23	65
excluding 74	8.31*	2.91	94	7.01*	2.95	63	6.89*	1.39	78	6.82	1.32	61
AGE III												
Pre-impoundment	5.43	3.32	108	3.76	1.69	72	4.17	2.58	48	3.13	1.23	57
Post-impoundment including 74	4.88	4.49	47	4.31	4.35	38						
excluding 74	4.73*	4.55	40	4.07	3.59	34	3.44	1.63	20	2.45*	.71	12

*Statistically different from the pre-impoundment mean growth at the .05 level.

years included only 1972, 1974 and 1975 since the exceptionally light rains of 1973 produced a low flood followed by a dry season similar to that found in pre-impoundment years. The following year, 1974, may also have been atypical since it was similar to the pre-impoundment situation of a flood following a very dry period. Thus, calculations omitting 1974 are also shown (Table 15).

The only statistically significant differences apparent are a slight increase in growth of two- and three-year-old male and two-year-old female S. andersoni, a possible increase in growth of one-year-old male S. macrochir, and a decrease in growth of two-year-old male and three-year-old female S. macrochir. Overall little change in growth has occurred. There have been slight increases in growth of one species and slight decreases in growth of the other.

During my 1969-70 study and that of Kapetsky (1974) we found that growth of these Sarotherodon species was correlated with various flood indices. Higher floods seemed to produce better growth in a number of cases. This phenomenon is apparent in the combined pre- and post-impoundment data only for first year growth of S. macrochir (Table 16). Regressions utilizing the difference in flood index (between the growth year and the previous year) produced significant regressions in only 2 other cases (Table 16). Additionally a significant regression of growth on "year of growth" was found for age two female S. andersoni. Unfortunately temperature data was not available for several years since 1970 and temperature indices were not tested. The small number of typical post-impoundment years precluded attempts to correlate post-impoundment growth with possible independent variables.

Analysis of data collected in 1975 (which includes calculated growth of one-year-olds as far back as 1968) produced some results not predicted

Table 16. Age and sex of *Sarotherodon andersoni* and *macrochir* for which growth correlated significantly (a = .1) with a hydrological index. (K * Kapetsky 1974; D = Dudley 1974; D76 * Dudley 1974 plus data presented herein).

		S. andersoni K	*S. andersoni* D	*S. andersoni* D76	*S. macrochir* K	*S. macrochir* D	*S. macrochir* D76
Age I	Male	+	+	0	+	+	+
	Female	0	+	0	+	0	+
Age II	Male	0	0	0	+	0	0
	Female	+	0	0	+	0	0
Age III	Male	-	+ 1/	0	-	+ 1/	0
	Female	-	+ 1/	0 2/	-	+	0 2/

1/ Partial correlations were significant after another variable was entered in the regression equation.

2/ Although a significant regression on a flood index was not significant, the regression on the difference between the current and the preceeding flood index was significant.

by the 1969 data. Only the variable "year of growth" correlated significantly with first year growth of both sexes of both species in the 1975 data. Since this correlation was negative in all four cases it means that first year growth calculated from older fish is greater than first year growth calculated from younger fish. This is normally termed a negative Lee's phenomenon (Lee 1912, Ricker 1969). A comparison of calculated growth increments of the 1969 yearclass dervied from 1969 and 1975 data reveals the same phenomenon. The first year growth of the 1969 yearclass as derived from older fish (1975 data) is significantly ($a = .1$) greater than that derived from younger fish (1969 data) for males of both species. Analysis of 1969 data revealed a significant correlation with "year of growth" only for female three-year-olds of each species (Dudley 1974). At that time the correlation was positive rather than negative.

Apparently, in recent years, a selective mortality factor is operating on both Sarotherodon species which favors the survival of fast growing individuals. Ricker (1969) demonstrated that a negative Lee's phenomenon would not be caused by biased sampling and is unlikely to result from selective fishing mortality. It is possible that the correlations of growth with "year of growth" is not due to a selective mortality factor but is due to another factor which was not tested but which correlated with year.

SEINE NETTING AND SIZE DISTRIBUTION OF *Sarotherodon andersoni* and *S. macrochir*

Methods

During 1975-76 several type of seine nets were used to collect fishes at various water stages.

During September through early January two seine nets were used to sample populations of adult fish in the Nampongwe and adjacent channels. The net used most often was 100 meters in length when hung and had 89 mm mesh (all mesh sizes are stretch measure). Another net used during this period was a 100 meter bag seine with 25 mm mesh in the bag and 64 mm mesh in the wings. This seine was used to catch one-year-old *Sarotherodon*. Additionally two small mesh seines (6 mm mesh) 2 and 4 meters long were used from early November through January to sample young of the year *Sarotherodon*. Additionally a 75 meter bag seine with a 25 mm mesh bag graded to 51 mm mesh at the end of the wings was used along the flood margin in May to sample young of the year *Sarotherodon*.

The primary reason for seine netting was to collect information concerning size distribution to juvenile and adult *Sarotherodon* and to collect scale samples from *Sarotherodon*.

Other species were caught but are not recorded or discussed here.

Seine Netting Results

During September through December 1975 sufficient numbers of *Sarotherodon andersoni* and *S. macrochir* were collected and measured to construct length frequency distributions. The 1975 catches indicate a considerable lack of *Sarotherodon andersoni* in the 24 to 30 cm range (Figure 1) and a complete lack of *Sarotherodon macrochir* above 23 cm when compared to the 1969 data (Figure 2). This is a drastic change from the 1969 catches and is a

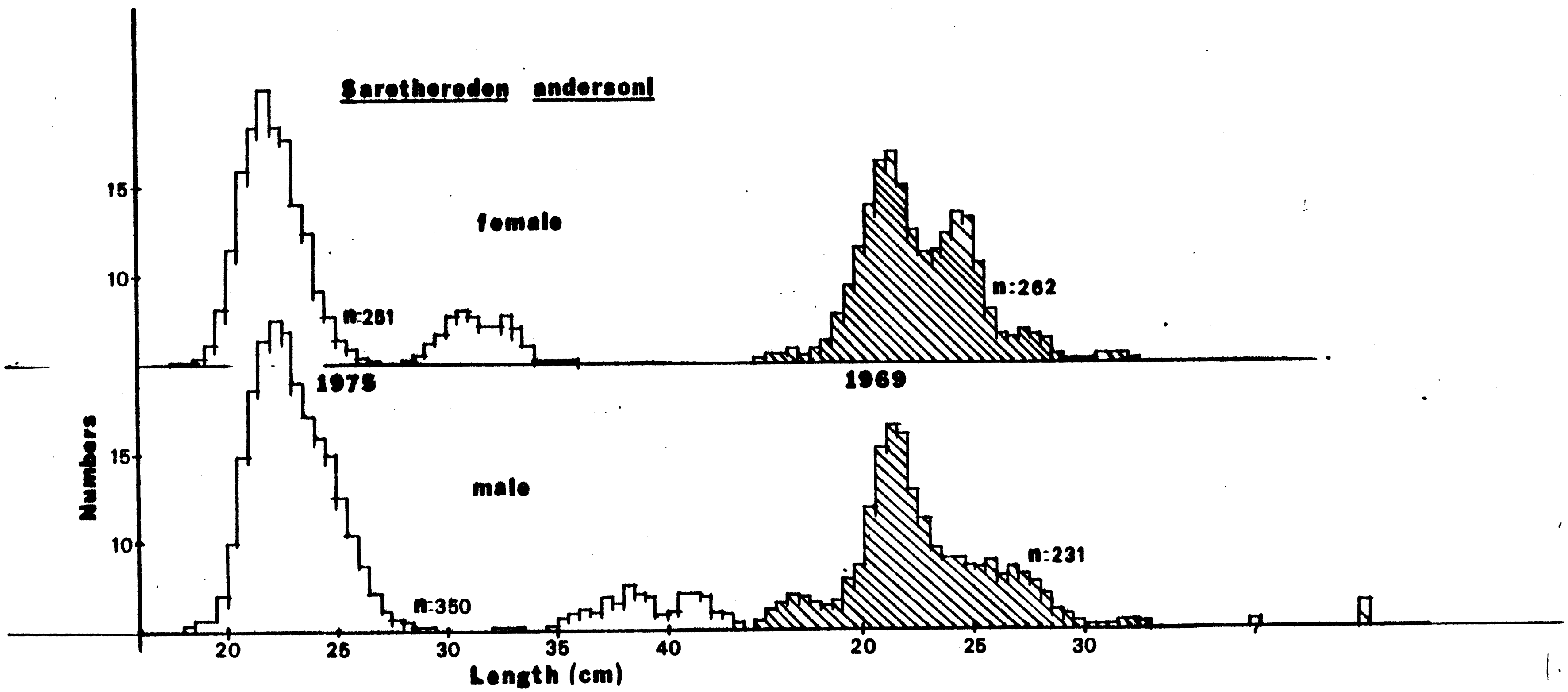

Figure 1. Length-frequency distributions of male and female *Sarotherodon andersoni* made during November of 1975 and 1969 (crosshatched). The 1969 data is taken from Dudley (1974).

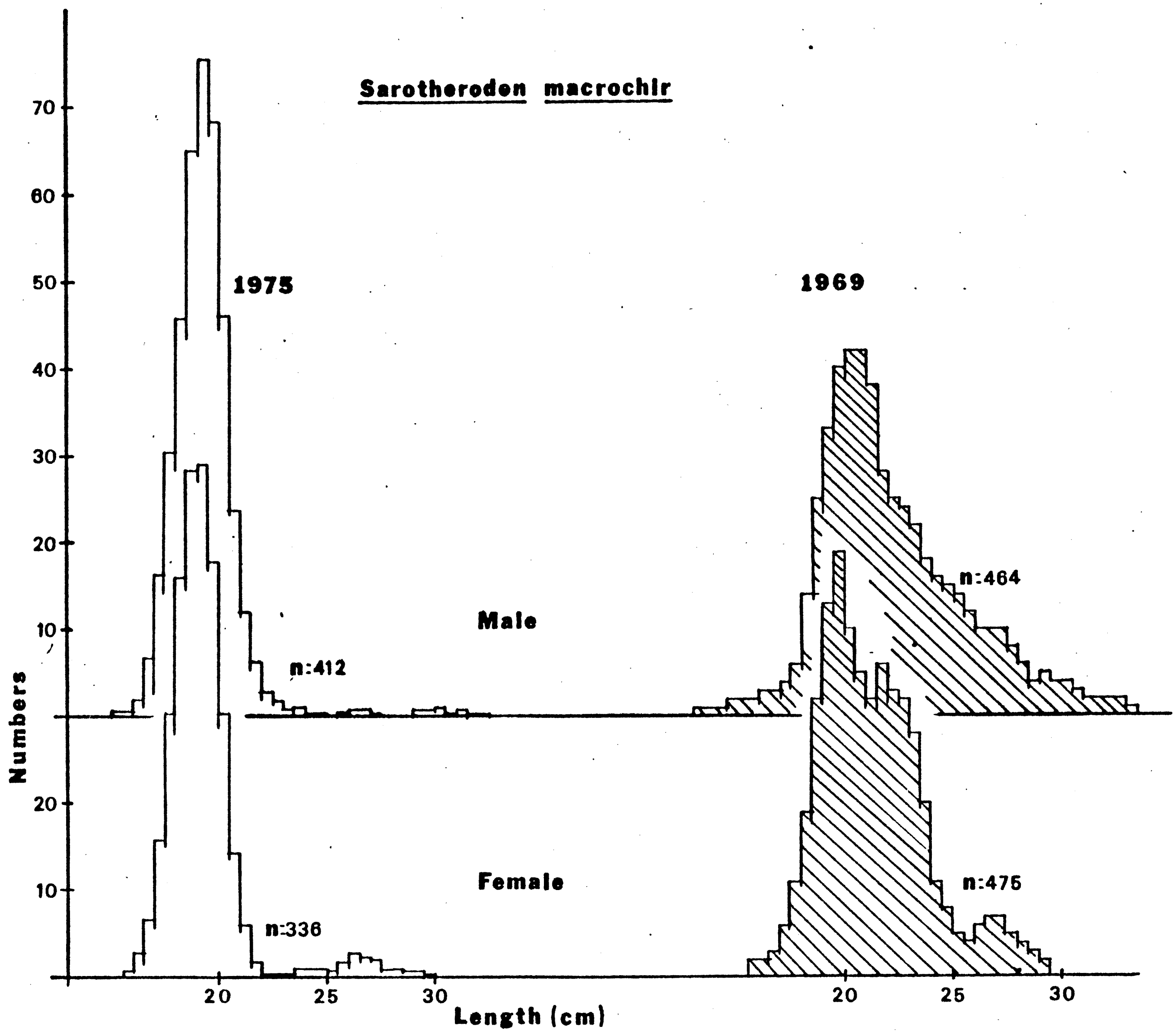

Figure 2. Length-frequency distributions of male and female Sarotherodon macrochir. Data is from seine net collections made during November of 1975 and 1969 (crosshatched). The 1969 data is taken from Dudley (1974).

change of major concern. Also important is the relatively large number of S. andersoni over 30 cm present in the 1975 catch. Although differences in abundance of large individuals could be due to differences in distribution, gillnet catches also indicated a large proportion of large S. andersoni in 1975-76. These large individuals are probably members of the 1969 yearclass. However, gillnet catches in 1969-70 also indicated a mode among large S. andersoni so this situation may have been present during sampling periods.

Catches made with small mesh seine nets help explain possible causes of changes in size distribution of Sarotherodon. During September through January 1975-76 an effort was made to collect one-year-old S. andersoni and S. macrochir with a 100 m bag seine (25 ram mesh bag). Twenty-five seine net hauls made with this net between 27 October 1975 and the 9th of January 1976 caught a total of only 36 one-year-old S. andersoni and one-year-old S. macrochir. In the same catches larger (age two) members of the same species were numerous.

Since a lack of one-year-old Sarotherodon indicated a possible failure in reproduction, a sampling program was established to search for young of the year. This sampling effort involved sampling 5 different locations with a 2 and a 4 m small mesh seine net at approximately weekly intervals from 13 November 1975 until 1 March 1976. With the exception of occasional catches of 100 or more very small Sarotherodon (about 10-15 mm) in mid-December catches were generally poor consisting of mixed species with few juvenile Sarotherodon. This is in extreme contrast with catches made on the rising 1970 flood when juvenile S. andersoni and S. macrochir were very abundant. Additionally the 50 meter small mesh bag seine was used at the flood margin on the 20th and 26th of May 1976 to sample for the 6-month-old juveniles. This sampling effort produced (in 9 hauls) a total of 134 (0 to 38) S. andersoni and 49 (0 to 13) S. macrochir, considerably less than were caught in 1969 but more than were caught in 1970 at the same location.

Discussion of Seine Netting and Size Distribution of Sarotherodon

Two major points emerged from this rather marginal seine netting data which provide an insight into factors affecting Sarotherodon populations.

Firstly two-year-old fish dominated seine and probably gillnet catches in 1975-76. Length frequencies of both species lack three- (and perhaps 4 and 5) year-olds. Mean weights calculated from data collected in previous years supports this contention. In 1969 when both age two and age three fish were present the mean weight of S. macrochir caught in 89 mm mesh seine nets was 231 g (as reconstructed from length frequency distributions and lenght-weight relationships). In 1975 when only age two fish appear to be present the mean weight was only 150 g. Interestingly, in 1974 for which no length frequency data is available, the mean weight of S. macrochir in similar seine nets was quite high (330 g) which indicates that two-year-olds (those spawned just prior to the 1973 flood) were probably lacking. Length frequency data of S. andersoni fit the same pattern but due to varying numbers of large individuals the same trend in mean weight data is masked. Thus in 1975-76 the 1972-73 yearclass dominates the Sarotherodon catches and there is a reasonable number of large Sarotherodon. In 1969 length frequencies indicated a variety of sizes present.

Secondly reproduction at the end of 1974 and the 1975 dry seasons produced few juveniles as indicated by catches made with small mesh seine nets. In 1970 the lack of juvenile Sarotherodon was not apparent until May or June since large numbers of juveniles were present on the rising flood. In 1975-76 the lack of successful reproduction was apparent in January.

Both the length frequency data and the lack of juveniles point to the strong possibility that high dry season water levels caused by the dam have decreased the reproductive success of Sarotherodon.

The lack of strong yearclasses of Sarotherodon andersoni and S. macrochir following the closure of the Kafue Gorge Dam is an item of great concern since these two species comprised the bulk of the commercial catch in pre-impoundment years. The hypothesis that the lack of strong yearclasses of these species is due to the increased dry season water levels is supported by the appearance of a strong yearclass following the dry year of 1973. This yearclass was spawned between September 1973 and January 1974 and grew well on the 1974 flood.

The question then becomes one of why should spawning be lessened on high floods. The answer to this question is, in all probability, tied in with the ability of "Tilapia" (including Sarotherodon) to stunt (i.e. to speed up their life processes so as to be able to spawn at a reduced age and size). Under this hypothesis I expect that during a dry year the fish start to enter their stressed phase and thus by the end of the dry season are able to spawn at reduced sizes (at least reduced compared to a wet year). A large number of spawners are thus triggered in low water years. Following the spawning period (probably September to January) the stressed fish are released from their stressed state by the suddenly rising waters and thus are able to grow well. In this manner many two-year-olds would be induced to spawn.

Conversely, during floods of long duration and with higher water levels fewer fish will be induced to spawn. Only the larger ones will and these perhaps would have been reduced in numbers by high mortality rates prevailing on the flood plain during low years and by fishing. The fact that Tilapia will stunt and breed at small size and age is discussed by Fryer and lies (1969, 1972).

Little data is available concerning the size of Sarotherodon at spawning in both dry and wet years. However, a comparison of available data supports the hypothesis. More small JS. andersoni developed to the spawning stage in dry years than in wet years (Table 17).

The role that fishing pressure might play here is also important. A fishery dominated by young fish (e.g. the 1975-76 Sarotherodon catch was dominated by two-year-olds the youngest size caught) can often be viewed as overfished. That is, as soon as the fish are large enough to be caught they are caught. Although this may appear to be the case in the Kafue Floodplain fishery other evidence indicates not. Reasonable numbers of 6 through 8 year-old Sarotherodon were present in draw net catches while younger fish (three- and four-year-olds) were absent. However, this does not mean high fishing pressure cannot harm the Sarotherodon stocks. If the above hypothesis is correct and the age at first reproduction is now older than it was prior to the closure of the dam, then more fish must survive to age four and five than did formerly in order to assure adequate reproduction.

Table 17. Percent of Sarotherodon andersonl of different lengths in spawning condition (ripe and running ripe), Data for dry years consists of data collected during October through January of 1964-5, 1965-6 and 1966-7 which was among records stored at Mansangu Fisheries Station. The wet year data was collected during 1969-70 and 1975-76.

Length Group (cm)	Dry Years %	Dry Years n	Wet Years %	Wet Years n
18 - 22.9	2	(44)	0	(77)
23 - 25.9	18	(16)	0	(57)
26 - 29.9	18	(11)	9	(31)
over 30	38	(16)	46	(136)

CONCLUSIONS

The limnological characteristics of the mid Kafue Floodplain have changed sightly as a result of the Kafue Gorge flam. Although the unusually dry 1973 hydrological year may have masked some effects, an overall effect as of 1975-76 has been to increase the amount of open unvegetated waters in the Chunga Lagoon area. This in turn has caused higher oxygen concentrations in the Nampongwe channel in 1975-76 compared to 1969-70 resulting in larger gillnet catches there in 1975-76. Otherwise the limnological characteristics were similar to those found in 1969-70.

Gillnet catches of the three predators Serranochromis angusticeps, Hepsetus odöe and Clarias gariapinus were significantly lower than in 1969-70. Of nine species examined only Labeo molybdinus was more abundant in 1975-76 gillnet catches. Distribution of other fishes among the five sampling stations differed between the two sampling periods but no overall changes in catches were apparent.

Growth of Sarotherodon andersoni and S. macrochir has changed only slightly since construction of the Kafue Gorge Dam. The previously discovered correlations with flood indices (Dudley 1974, Kapetsky 1974) are not apparent in the data collected in 1975. A negative Lee's phenomenon is apparent in the 1975 growth data indicating a factor favoring slightly the survival of faster growing fish. This at present is unexplained.

The size distribution of Sarotherodon andersoni and S. macrochir indicates a poor reproductive success in 1974 (1975 yearclass) and in 1975 (1976 yearclass) and perhaps in other post-impoundment years. The current (1975-76) population is dominated by the 1974 yearclass which was spawned in October through December of 1973 following a very dry hydrological year.

Apparently better spawning success is achieved following a severe dry season, although for optimum survival of the young so produced, a high flood should follow.

Without an accurate estimation of fishing mortality, the effect of the commercial fishery on Kafue floodplain fish populations is difficult to assess. Workers as far back as Williams (1960) and as recently as Muncy (1972) have presented evidence that the floodplain fishery has reached its maximum and may be overfished. Other workers (Lagler et al. 1971, and Chapman et al. 1971) felt that the floodplain fishery was underharvested and should be expanded. Data collected during this study cannot provide an answer to this question. The only new evidence for speculation is that reproduction of Sarotherodon seemed to be most successful during the dryest dry season (1973) of the last five years. Fishing during this year was probably more intense than in the high water years when spawning success was lower. The major factors affecting spawning success seemed to be physical factors rather than fishing. However, fishing could be sufficiently intense to be limiting overall catch.

Future research on the Kafue floodplain should have, if possible, as top priority a project to estimate mortality due to fishing. Information concerning the proportion fish caught (for the major species) is absolutely necessary to make a decision whether to expand the fishery or not. Additionally a continuing program to estimate the yearclass strength (spawning success) of Sarotherodon would be helpful in predicting the fishing success for these species and in finding what conditions are necessary for a high spawning success.

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Appendix: Tables A1 through A26 concerning experimental gillnet catches

Table A1. Total numbers of Sarotherodon andersoni caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

		Station				
Month	Year	1	2	3	4	5
Sept	1969		-	0	-	5
	1975	13	14	8	0	10
Oct	1969	6	-	6	-	7
	1975	20	23	27	23	28
Nov	1969	-	-	51	-	6
	1975	-	-	11	7	22
Dec	1969	-	-	14	-	6
	1975	-	-	70*	2	8
Jan	1970	54*	-	79*	1	11
	1976	7	5	13	10	25
Feb	1970	6	5	21	0	0
	1976	-	-	-	-	-
Mar	1970	20	-	46	3	0
	1976	13	10	13	4	1
Apr	1970	10	-	23	72*	0
	1976	3	7	3	1	1
May	1970	4	-	7	6	17
	1976	3	0	1	3	4
Jun	1970	11	-	30	0	12
	1976	-	-	-	-	-

Table A2 . Numbers of *Sarotherodon andersoni* caught in three mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

	Mesh Size Group			
Year	Small	Medium	Large	Total Caught
1969-70	57	287	110	454
	(37.8)	(275.7)	(140.4)	
1975-76	9	194	135	338
	(28.2)	(205.3)	(104.6)	
Total	66	481	245	792

$x^2 = 39.3$

Table A3. Mean lengths of _Sarotherodon andersoni_ caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

	1969			1975		
Mesh Size (mm)	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	13.2	.80	6	20.2	.71	3
51	14.8	1.05	19	19.6	----	1
64	14.9	1.08	70	19.9	1.35	7
76	16.7	2.82	11	20.2	1.53	101
90	23.3	3.38	4	20.7	2.09	101
102	26.3	.25	2	25.2	5.00	51
114	24.1	6.45	4	33.1	4.65	41
127	32.9	3.82	7	33.7	3.63	46
140	34.3	3.04	6	38.6	3.47	49
152	39.2	3.27	9	39.7	3.06	53

Table A4. Total numbers of *Serranochromis angusticeps* caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

Month	Year	Station 1	2	3	4	5
Sept	1969	–	–	3	–	59*
	1975	16	5	21*	3	1
Oct	1969	23	–	15	–	53*
	1975	27	11	18	9	0
Nov	1969	–	–	16	–	10
	1975	–	–	11	3	2
Dec	1969	–	–	6	–	29*
	1975	–	–	14	10	1
Jan	1970	15	–	0	1	0
	1976	8	7	2	3	0
Feb	1970	5	–	1	0	0
	1976	–	–	–	–	–
Mar	1970	11	–	1	0	0
	1976	6	0	0	1	0
Apr	1970	15	–	50*	6	0
	1976	3	0	1	0	0
May	1970	16	–	46*	39*	15*
	1976	5	0	3	1	0
Jun	1970	33	–	?	5	16
	1976	–	–	–	–	–

Table A5. Numbers of *Serranochromis angusticeps* caught in three mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

	Mesh Size Group			
Year	Small	Medium	Large	Total Caught
1969-70	24 (22.33)	336 (322.71)	69 (83.95)	429
1975-76	5 (6.66)	83 (96.28)	40 (25.05)	128
Total	29	419	109	557

$x^2 = 14.5$

Table A6. Mean lengths of Serranochromis angusticeps caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

	1969			1975		
Mesh Size (mm)	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	13.5	1.2	9	----	---	0
51	18.4	1.6	9	18.2	1.7	8
64	19.8	3.5	16	20.7	2.0	17
76	23.4	2.3	32	23.5	2.2	18
90	25.4	1.8	39	28.5	4.7	22
102	29.1	2.2	17	32.4	2.8	38
114	32.6	2.9	20	33.7	2.6	46
127	33.6	2.0	12	35.1	2.9	35
140	34.0	3.0	5	34.9	3.0	17
152	40	---	1	37.5	0.8	2

Table A7. Total numbers of Serranochromis macrocephala caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

		Station				
Month	Year	1	2	3	4	5
Sept	1969	-	-	4	-	67*
	1975	2	2	14	1	1
Oct	1969	5	-	14	-	47*
	1975	16	9	7	6	3
Nov	1969	-	-	9	-	15
	1975	-	-	4	4	7
Dec	1969	-	-	1	-	23*
	1975	-	-	7	3	3
Jan	1970	8	-	2	1	0
	1976	10	5	1	3	2
Feb	1970	2	1	0	0	0
	1976	-	-	-	-	-
Mar	1970	0	-	0	0	0
	1976	5	2	0	1	0
Apr	1970	1	-	10	0	0
	1976	1	3	1	1	0
May	1970	0	-	4	9*	11*
	1976	2	1	6	0	0
Jun	1970	0	-	6	0	0
	1976					

Table A8. Numbers of *Serranochromis macrocephala* caught in three mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

Year	Mesh Size Group: Small	Medium	Large	Total Caught
1969-70	20 (19.7)	190 (194.4)	21 (16.9)	231
1975-76	8 (8.3)	86 (81.6)	3 (7.1)	97
Total	28	276	24	328

$x^2 = 3.71$

Table A9. Mean lengths of *Serranochromis macrocephala* caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

	1969			1975		
Mesh Size (mm)	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	13.8	0.8	2	----	---	0
51	18.4	3.3	12	17.9	2.0	7
64	18.5	1.9	13	19.7	1.6	9
76	22.5	2.7	28	23.4	2.4	27
90	26.6	2.8	47	26.0	2.9	43
102	29.4	2.9	32	29.3	2.7	29
114	31.5	3.1	32	29.8	1.3	12
127	35.0	4.0	8	26.7	---	1
140	32.8	3.9	5	32.8	2.1	3
152	36.5	---	1	27.7	---	1

Table A10. Total numbers of *Clarias gariapinus* caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

Month	Year	Station 1	2	3	4	5
Sept	1969	-	-	9	-	18
	1975	5	3	10	7	5
Oct	1969	23	-	20	-	8
	1975	8	3	8	5	2
Nov	1969	+	+	48	-	8
	1975	+	+	14	13	3
Dec	1969	+	+	113*	-	5
	1975	+	+	17	0	2
Jan	1970	9	-	62*	15	84*
	1976	18	4	10	7	7
Feb	1970	15	14	9	7	3
	1976	-	-	-	-	-
Mar	1970	7	-	27*	7	0
	1976	3	1	3	2	6
Apr	1970	11	-	12*	26*	0
	1976	4	2	2	1	1
May	1970	8	-	29*	10*	28*
	1976	4	6	0	1	2
Jun	1970	12	-	14	2	32
	1976	-	-	-	-	-

Table A11. Numbers of *Clarias gariapinus* caught in three mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

Year	Mesh Size Group			Total Caught
	Small	Medium	Large	
1969-70	40 (34.7)	351 (377.1)	196 (175.2)	587
1975-76	3 (8.3)	116 (89.9)	21 (41.8)	140
Total	43	467	217	727

$x^2 = 26.4$

Table A12. Mean lengths of <u>Clarias gariapinus</u> caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

Mesh Size (mm)	1969			1975		
	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	----	----	--	----	----	---
51	30.5	1.8	3	37.5	----	1
64	32.7	7.4	3	37.0	3.9	5
76	37.6	4.7	19	39.1	5.1	33
90	41.2	5.6	31	44.8	6.7	36
102	52.4	10.9	17	50.2	7.4	28
114	51.7	7.8	21	55.3	6.2	16
127	57.6	6.0	23	59.9	5.4	12
140	62.5	8.2	12	53.6	13.8	3
152	64.6	6.9	16	66.3	2.4	10

Table A13. Total numbers of Clarlas ngamensis caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

Month	Year	Station 1	2	3	4	5
Sept	1969	-	-	5	-	1
	1975	6	1	1	0	3
Oct	1969	1	-	14	-	1
	1975	4	0	3	1	1
Nov	1969	-	-	12	-	0
	1975	-	-	4	1	2
Dec	1969	-	-	13	-	0
	1975	-	-	3	0	0
Jan	1970	2	-	12	10	19*
	1976	5	2	10	8	3
Feb	1970	1	1	4	3	1
	1976	-	-	-	-	-
Mar	1970	0	-	7	0	0
	1976	5	1	2	0	4
Apr	1970	1	-	3	1	0
	1976	3	0	0	2	9
May	1970	4	-	10*	5	6
	1976	2	2	0	1	6
Jun	1970	3	-	2	-	7
	1976	-	-	-	-	-

Table A14 . Numbers of Clarias ngamensis caught in three mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

Year	Mesh Size Group: Small	Mesh Size Group: Medium	Mesh Size Group: Large	Total Caught
1969-70	15	103	9	127
	(16.5)	(99.5)	(11.0)	
1975-76	12	60	9	81
	(10.5)	(63.5)	(7.0)	
Total	27	163	18	208

$x^2 = 1.6$

Table A15. Mean lengths of Clarias ngamensis caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

Mesh Size (mm)	1969			1975		
	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	----	----	--	----	----	---
51	31.0	1.0	2	34.5	----	1
64	32.7	5.7	5	33.4	3.1	7
76	38.5	4.4	12	41.5	13.4	6
90	43.6	4.0	7	39.1	3.9	8
102	47.7	8.2	16	49.5	5.8	5
114	49.6	2.0	10	57.8	5.6	2
127	49.7	1.6	3	----	----	---
140	55.5	----	1	45.6	----	1
152	71.0	----	1	53.8	1.4	2

Table A16. Total numbers of Shilbe mystus caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

		Station				
Month	Year	1	2	3	4	5
Sept	1969	-	-	12	-	23
	1975	33	13	18	13	16
Oct	1969	32	-	12	-	18
	1975	17	10	14	13	12
Nov	1969	-	-	25	-	30*
	1975	-	-	12	3	8
Dec	1969	-	-	0	-	33*
	1975	-	-	30*	9	6
Jan	1970	44*	-	1	0	8
	1976	11	6	9*	6*	15
Feb	1970	26	35	15	11	1
	1976	-	-	-	-	-
Mar	1970	17	-	5	1	0
	1976	25	10	13	13*	0
Apr	1970	35	-	25	20	0
	1976	11	13	17	11	2
May	1970	18	-	15	5	22*
	1976	36	18	16	8	1
Jun	1970	29	-	10	4	27
	1976	-	-	-	-	-

Table A17. Numbers of *Shilbe mystus* caught in three mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

Year	Mesh Size Group: Small	Medium	Large	Total Caught
1969-70	230 (268.8)	168 (123.4)	3 (8.3)	401
1975-76	258 (219.2)	56 (100.6)	13 (7.2)	327
Total	488	224	16	728

$\chi^2 = 56.8$

Table A18. Mean lengths of *Shilbe mystus* caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

	1969			1975		
Mesh Size (mm)	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	15.0	1.5	104	16.2	2.8	61
51	19.0	2.9	82	20.3	2.8	66
64	22.9	2.8	60	23.0	3.0	*8
76	27.1	2.1	37	25.0	3.3	32
90	27.1	2.0	30	25.2	4.8	25
102	29.1	1.3	9	24.1	5.4	10
114	30.7	1.8	2	25.0	7.9	4
127	----	----	---	20.4	2.4	5
140	14.5	----	1	20.2	1.9	2
152	15.5	----	1	21.7	5.0	7

Table A19. Total numbers of Hepsetus odoe caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

		Station				
Month	Year	1	2	3	4	5
Sept	1969	-	-	7	-	25*
	1975	10	5	9	5	1
Oct	1969	12	-	12	-	25*
	1975	15	8	6	7	4
Nov	1969	-	-	6	-	14
	1975	-	-	34	3	2
Dec	1969	-	-	1	-	16*
	1975	-	-	7	9	1
Jan	1970	16	-	1	2	1
	1976	8	4	7	16	2
Feb	1970	2	3	4	1	0
	1976	-	-	-	-	-
Mar	1970	9	-	3	0	0
	1976	3	3	3	2	0
Apr	1970	12	-	14*	10*	0
	1976	3	3	2	2	0
May	1970	10	-	18	33*	34*
	1976	3	1	4	1	2
Jun	1970	15	-	47	16	10
	1976	-	-	-	-	-

Table A20. Numbers of Hepsetus odbe caught in two mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

Year	Mesh Size Group: Small	Mesh Size Group: Medium and Large	Total Caught
1969-70	202 (203.7)	79 (77.3)	281
1975-76	101 (99.3)	36 (37.7)	137
Total	303	115	418

$x^2 = .16$

Table A21. Mean lengths of Hepsetus odoe caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

	1969			1975		
Mesh Size (mm)	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	23.9	2.3	29	23.0	3.0	14
51	25.4	2.6	113	26.2	3.2	74
64	28.0	2.7	72	30.1	2.5	51
76	30.0	3.1	33	32.1	3.0	27
90	32.8	1.3	2	35.2	2.5	9
102	----	----	---	37.2	----	1
114	----	----	---	----	----	---
127	----	----	---	----	----	---
140	----	----	---	33.7	4.3	2
152	----	----	---	----	----	---

Table A22. Total numbers of *Labeo molybdinus* caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

		Station				
Month	Year	1	2	3	4	5
Sept	1969	-	-	2	-	18*
	1975	15	18	14*	4	0
Oct	1969	13	-	1	-	6
	1975	4	2	15*	5	4
Nov	1969	-	-	7	-	7
	1975	-	-	3	2	6
Dec	1969	-	-	0	-	5
	1975	-	-	22*	2	1
Jan	1970	20	-	2	0	3
	1976	33	15	5	3	3
Feb	1970	14	24	0	0	0
	1976	-	-	-	-	-
Mar	1970	8	-	0	0	0
	1976	40	12	54*	5*	0
Apr	1970	13	-	5	0	0
	1976	26	9	13	4	0
May	1970	33	-	11	17*	0
	1976	8	3	77*	1	0
Jun	1970	37	-	8	51	0
	1976	-	-	-	-	-

Table A24. Total numbers of _Marcusenius macrolepidotus_ caught at each of five stations in 1969-70 and in 1975-76. Values for 1969-70 are total number of fish caught in one gill net set. Values for 1975-76 are mean total number for two sets. Each set consisted of one top and one bottom multimesh net. Asterisks indicate where the catch of one year was significantly higher the comparable catch for the other year.

Month	Year	Station 1	2	3	4	5
Sept	1969	-	-	4	-	15*
	1975	3	10	5	30	2
Oct	1969	43	-	28	-	26*
	1975	13	9	11	15	2
Nov	1969	-	-	22*	-	5
	1975	-	-	3	1	8
Dec	1969	-	-	0	-	7
	1975	-	-	62*	2	2
Jan	1970	7	-	0	0	0
	1976	27*	24	41*	57*	3
Feb	1970	3	1	1	25	0
	1976	-	-	-	-	-
Mar	1970	2	-	8	0	0
	1976	2	8	4	5	0
Apr	1970	7	-	57*	21*	0
	1976	5	4	0	3	0
May	1970	4	-	1	5	11
	1976	4	3	8	1	1
Jun	1970	9	-	1	0	2
	1976	-	-	-	-	-

Table A25. Numbers of *Marcusenius macrolepidotus* caught in two mesh size groups. Values shown for 1969-70 are the total number of this species caught in 25 net sets where each set consisted of one top and one bottom multimesh net. The 1975-76 values shown are the total of 25 means, each mean derived from two such sets at each of 25 locations. Values in parenthesis are the values expected under the hypothesis of no difference in proportion caught in each mesh size group between years.

	Mesh Size Group		
Year	Small	Medium and Large	Total Caught
1969-70	161 (200.5)	112 (72.5)	273
1975-76	237 (197.5)	32 (71.5)	269
Total	398	144	542

$x^2 = 59.0$

Table A26. Mean lengths of <u>Marcusenius macrolepidotus</u> caught in each of 10 gill net mesh sizes in September through December of 1969 and 1975. The 1969 data is from nets with panels 9.1 m long. The 1976 data is from nets described in methods.

	1969			1975		
Mesh Size (mm)	$\bar{x}$	S.D.	n	$\bar{x}$	S.D.	n
38	12.9	1.3	43	12.7	1.6	77
51	14.7	1.5	82	16.2	1.5	83
64	16.5	1.8	39	17.9	1.7	48
76	19.2	2.6	45	20.8	2.7	25
90	21.8	2.7	22	22.5	3.6	11
102	24.8	1.3	2	27.0	3.9	3
114	----	----	--	----	----	---
127	----	----	--	----	----	---
140	----	----	--	21.5	0	2
152	----	----	--	14.6	2.2	3