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THE CAST NET FISHERY, KAINJI LAKE NIGERIA, 1970-1997

by M.D.B. Seisay

**Nigerian-German (GTZ)
Kainji Lake Fisheries
Promotion Project**

January, 1998

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EXECUTIVE SUMMARY

This study was carried out to establish trends in the cast net fishery of Kainji Lake.

The cast net fishery was second in importance to the gillnet fishery in the early years after impoundment of the lake and still continues to be an important component of the fishery.

Some of the economically important species such as *Citharinus spp*, Tilapia, *Labeo spp*, *Alestes spp* and *Synodontis spp* are exploited by cast nets.

The study has not revealed any drastic perturbation in the species diversity, catch composition, and any real ecosystem over-fishing. On the other hand, both the catfish, *Auchenoglanis spp* and the predator *Hydrocynus spp* appear to have increased in the catch in recent years.

Never-the-less there is a decline in the mean weight of the major exploited fish species due to the capture of under sized fishes without allowing them to grow to "legally" marketable sizes.

The use of small meshed cast net and also fishing in the shallow waters of the lake can give rise to this situation. Thus, there are signs of growth over-fishing in the fish stocks.

It must also be acknowledged that the situation is complicated by the fact that in a multi-gear fishery as on Kainji Lake, the cast net fishery could not be managed in isolation without due regard to the other competing gears.

The catch per unit of effort (Cpue) has declined in the cast net fishery possibly due to the increase in effort by the major fishing gears over the years. The ongoing extension campaigns by the KLFPP appears to be having the desired effect, as there was reduction in the number of the major fishing gears on the Lake in 1997. It can be anticipated that if this trend continues, the catch per unit effort will recover in the long run.

Yields observed from the mesh selectivity study revealed that for major species in the cast net fishery, both by number and weight, were maximal at 2.5" mesh, which contrasts with the fact that current minimum allowable mesh in the Fisheries Edict for the Lake is 2.0". The adoption of 2.5" as the minimum allowable mesh in the cast net fishery is recommended to be included in future revision of existing regulations. It is also recommended that for this control to have a desired effect, the casting of the net from the shore should be prohibited so as to reduce the incidence of juvenile mortality in the nursery areas.

List of Tables and Figures

1. Introduction

Kainji Lake, the first man-made lake in Nigeria, was built in 1968 to supply the country with hydro-electric power. At its highest level the lake can measure up to 136km in length and 24km in width, (Stride, 1975). The lake has a maximum total surface area of 1,270km^2. Over 100 species of fish have been identified in Kainji Lake.

The most important fishing gears used on the lake are gillnets, beach seines, cast nets, drift nets, longlines and fish traps. Gillnets were the most dominant fishing gear (35.3%) in the mid-1970' followed closely by the cast nets (33.5%).

In terms of fish yield, cast nets are the third most important fishing gear after gillnets and beach seines. The minimum allowable mesh size in the cast net is 2.0" but mesh sizes as low as 0.5" are recorded. This means that all fish caught between 0.5 - 1.5" are illegal since these are likely to be juvenile/immature stages of the major species caught.

Cast net is an active fishing gear. It can be operated in shallow water or on open water where the lake is free of bottom obstructions. Capture of fish largely depends on the efficiency of throw and degree of opening of the entire circumference of the net.

When targeting schooling fish populations in deep waters the net is quickly hauled prior to reaching the bottom. Fish caught in cast nets are retained in the band (bag) and are rapidly removed before they can escape through the meshes. Due to clogging effect (i.e. accumulation of fish and debris at the band), cast nets retain large number of under sized fish, especially when operated in shallow water. In this regard, they can be compared with the beach seine in terms of damage done to the fish stocks (du Feu, 1997).

The cast net has often been considered as an inefficient fishing gear because most fish tend to escape when the net is splashed against the surface of the water. The sound of the splash causes movement of the fish in all directions. It's effectiveness however depends upon the experience of the fisherman.

Turner (1996) argued in favour of the adoption of strict management measures for the cast net fishery since it is causing comparable damage to the stocks as the beach seines, which are now banned from the lake. This suggests that a thorough assessment of the cast net fishery to assess its present status and implications on the exploitation of the fish stocks.

2. Objectives of the Study

The Nigerian-German (GTZ) Kainji Lake Fisheries Promotion Project aims to implement a management plan for the sustainable exploitation of the fish stocks in Kainji Lake. As a step towards the realization of this objective, the project instituted a catch assessment survey on the lake which gives information on the size and distribution of the fishing units, the magnitude of the fish catch and the exerted effort by each fishing gear type.

Although studies and reports are available on several aspects of the fish stocks of the lake, (du Feu, 1997a and b; Ita, 1998; Seisay and du Feu, 1998; and Omorinkoba et el, 1998), no detailed, independent assessment of the cast net fishery has been undertaken despite its role and importance.

The objective of this report is therefore an assessment of trends in the changing fish populations in the cast net fishery and their likely effect upon the nature of the future lake fishery. Management recommendations of responsible fishing practice in the cast net fishery are part of the present study.

3. Methodology

The data for the present analysis were extracted from databases of the boat-based catch assessment survey carried out by the then Kainji Lake Fisheries Research Institute between 1970 and 1975 and the gear-based catch assessment survey undertaken by the Kainji Lake Fisheries Promotion Project since 1994 (du Feu, 1997).

Some of the data analyzed in this report were also retrieved from literature, for example Ekwemalor (1975). The analysis was carried out using Excel Spreadsheet.

The analysis concentrated specifically on the following aspects:

a) relative proportions of cast net count to the total gear composition data;
b) relative fish yield of cast net, by number and weight, compared to the total fish yield by all fishing gears;
c) variation in mean weight, catch per unit effort (Cpue), and species composition in the cast net fishery;
d) analysis of net characteristics and frequency distribution of mesh sizes in use in the cast net fishery; and
e) analysis of mesh sizes in relation to fish yield by number and weight.

With respect to the number and weight of fish in different mesh sizes, an approximation was made to obtain cast net selectivity for the major commercially exploited fish species in the fishery as follows: a cumulative frequency distribution was determined from the data to give the selectivity curves; a direct fit of yield data on mesh size distribution was graphed. This method could be considered as a direct way of identifying the appropriate mesh size for yield maximization.

It should be noted that there were severe instances of missing data for some species in the boat-based catch assessment data. This gave rise to lots of zeros in the mean weight, Cpues and species composition data. Notwithstanding this, the analysis proceeded fairly well and shed light on the state of the affairs in the cast net fishery in the early post impoundment years. The "old" data became particularly useful when comparisons were made with the recent data from the cast net fishery.

4. Results

4.1. The Fishery

The cast net fishery was and still is an important component of the fishing industry on the lake. About 33.5% of the total number of operating canoes on the Lake in 1975 were associated with the cast net alone. This was second only to gillnets with 35.3% (Table 1).

Cast nets now constitute about 7.3% of the total gear on the lake (Figure 1). In terms of yield, the cast net is the third most important fishing gear after beach seines and gillnets; accounting for about 13% of the total fish catch on the lake (Figure 2).

Table 1: Canoe count, as per gear type, during frame survey, 1975

Gear	No. of canoes	%
Gill net	3,444	35.3
Cast net	3,266	33.5
Long line	2,041	20.9
Trap	729	7.5
Beach seine	115	1.2
Attala net	150	1.5
TOTAL	9,745	100

Figure 1. Composition (%) of fishing gear types on Kainji Lake (from KLFPP Frame Surveys)

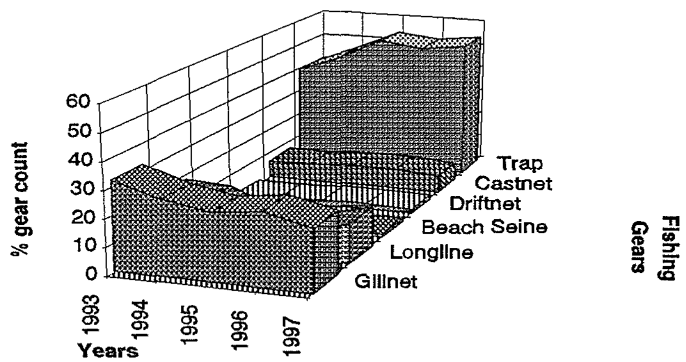
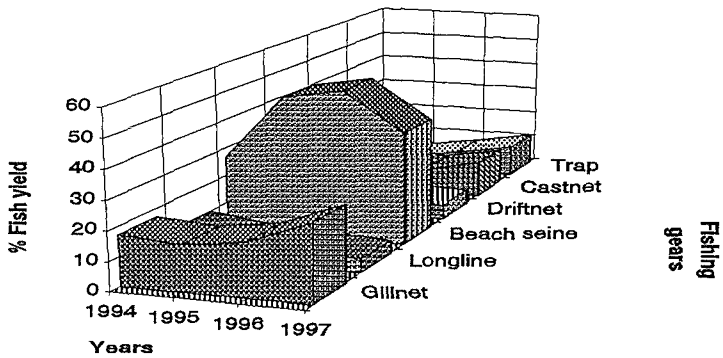


Figure 2. Percentage fish yield by gear type in Kainji Lake (from KLFPP CAS)



4.2. Mesh Size Distribution

The frequency distribution of the mesh sizes in use showed a mode at about 2.0", which is the minimum allowable mesh on the Lake (Table 2). The average mesh size between 1993 to 1997 was 2.23±0.97", implying a wide dispersal about the mean (Table 3). The distribution of the mesh size in reality ranges from 0.5 to 6.0" with a concentration between 1.5 and 3.0". According to the Fisheries Edict therefore, 18.76% of the cast nets in use on the lake between 1994 and 1997 were illegal .

Table 2: Frequency distribution of mesh size in use in the cast net fishery (from KLFPP CAS)

Mesh size (")	1994	1995	1996	1997	TOTAL
0.5	28	49	2	5	84
1.0	45	99	27	50	221
1.5	69	121	84	45	319
2.0*	215	538	222	135	1,110
2.5	114	449	184	68	815
3.0	74	181	169	73	49
3.5	43	53	18	0	114
4.0	11	21	25	33	90
4.5	21	0	2	0	23
5.0	1	1	38	8	48
5.5	0	0	0	1	1
6.0	0	0	4	0	4
TOTAL	621	1,512	775	418	3,326
illegal nets	142	269	113	100	624
% illegal nets	23	18	15	24	19

* allowable minimum mesh size

Table 3: Characteristics of cast nets used in the fishery (from KLFPP CAS)

Year	Avg.Mesh (")	Std.	Length (m)	Std.	Depth (m)	Std.	Sample Size
1993	2.02	0.94	7.97	2.52			114
1994	2.27	0.68	9.45	1.91			46
1995	2.70	1.33	7.77	2.58	5.42	2.75	46
1996	1.93	0.93	9.86	2.62	4.93	1.92	28
Average	2.23	0.97	8.76	2.41	5.18	2.34	

4.3. Species Composition of the Catch

The cast net fishery was dominated largely by five species taxonomic groups: *Citharinus spp*, Tilapia, *Alestes spp*, *Labeo spp* and *Synodontis spp* (Figure 3). The *Hydrocynus spp* also, to a lesser extent, contributed to the fishery.

The observed species composition from 1994/1997 catch assessment survey exhibited the same species profile as in the "old" catch assessment survey. The results indicate a decline in importance of *Citharinus spp, Labeo spp* and *Synodontis spp*. between 1973 to 1975. This could have been due to local depletion of these populations as a result of increased fishing intensity.

In any case, the species bio-diversity, as was also observed in the gillnet fishery (Seisay and du Feu, 1997), has not drastically changed. The stock composition in the lake has remained largely unperturbed. The fishery continues to be sustained by mainly five major species since lake impoundment.

There are however signs in recent years that two other species groups, *Auchenoglanis spp* and *Hydrocynus spp*, are gradually becoming prominent in the catch.

The catch composition by number shows that the population of *Citharinus spp* was severely depleted between 1973 -1975, the possible explanation is a reduction in population number due to increased fishing pressure resulting in growth over-fishing, and fluctuations in annual biomass (Table 4).

Figure 3: Catch composition by weight (%) in the cast net fishery (from KLFPP)

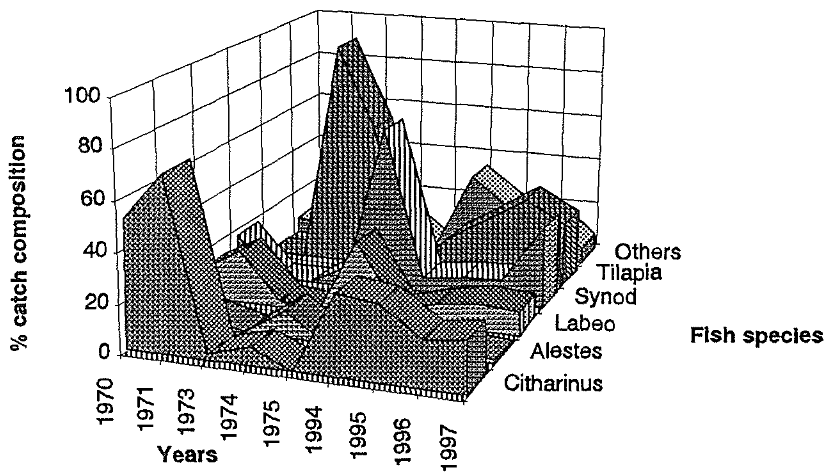


Table 4: Catch composition (%) by number of fish caught in the cast net fishery

Year	1970	1971	1973	1974	1975
Citharinus	55.95	69.23	6.45	4.34	0
Alestes	11.56	4.81	0	21.92	0
Labeo	9.95	20.19	6.45	0.20	20
Synod	16.59	0	0	5.05	80
Tilapia	0.23	0	87.10	65.35	0
Hydro	5.72	0.96	0	0	0
Gymn	0	4.81	0	0	0
Heterot	0	0	0	0.81	0
Polypt	0	0	0	0.71	0
Bagus	0	0	0	0.71	0
Clarias	0	0	0	0.40	0
Clarotes	0	0	0	0.51	0
others	0	0	0	0	0
TOTAL	100	100	100	100	100

4.4. Mean Weight and Catch per Unit Effort (Cpue)

There has been a decline in the mean weight of all the major species between 1970 and 1995 (Figures 4 and 5) but this stabilized and leveled off between 1994 and 1997.

At species level, the mean weight of *Citharinus spp* has declined from 1.52kg in 1970 to 0.13kg in 1997, representing a decline of 90.8 %. The Tilapia experienced a diminished mean size from 2.0kg to 0.19kg (about 90.5 % decline) during the period.

Figure 4: Annual variation in the total mean weight of all fish

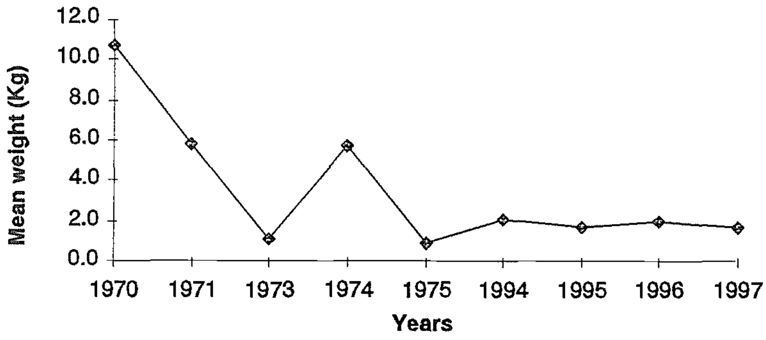
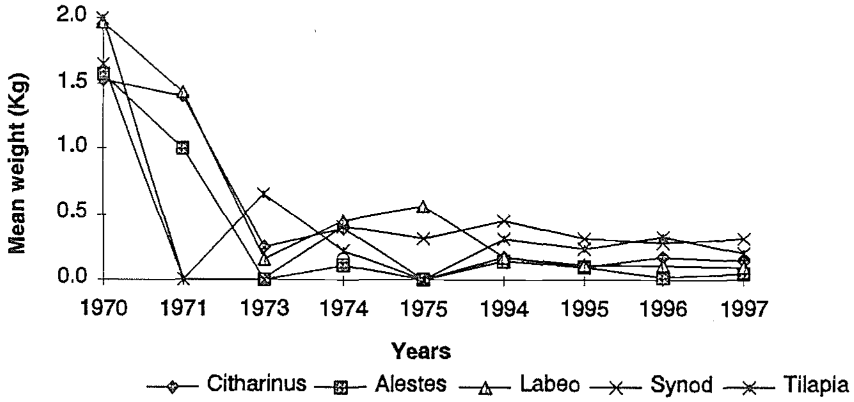


Figure 5: Variation in the mean weight of the major species

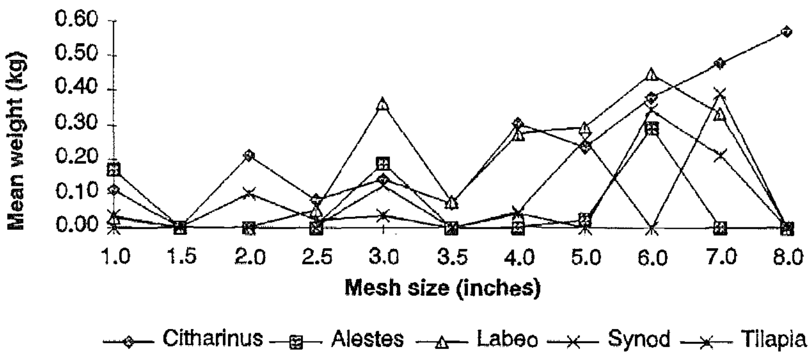


The average mean weight is generally found to increase with increasing mesh size (Figure 6). In the case of *Citharinus spp*, the mean weight increased from 0.11kg in the 1.0" mesh to 0.57kg in the 8.0" mesh whilst in the case of Tilapia spp, the mean weight increased from 0.03kg in the 1.0" mesh to 0.34kg in the 6.0" mesh.

This observed trend is positively correlated with the mesh size distribution in the fishery and this correlation is observed to be very significant, (r=0.9078, P=0.05, d.f=9), in the case of *Citharinus spp*. The correlation is positive in *Labeo spp*, *Synodontis spp* and Tilapia but not significant.

Large meshed nets are obviously not an advantage in the exploitation of *Alestes spp* as there is a negative relationship between its mean weight and mesh size (r= - 0.018), likely because the adult maximum size is lower than that of the other species.

Figure 6: Mean weight by mesh size for commercial species in the cast net fishery



The trend in Cpue between 1979 and 1997 exhibited similar pattern to that of the mean weight (Figure 7). The Cpue was at its peak in 1970, being 59.0kg/net/day in the years following impoundment, but drastically reduced to 3.61kg/net/day in 1975 representing a decline of about 94%. It rose slightly in 1994 but has been on a gradual decline since then, reaching to a minimum of 13.41kg/net/day in 1997.

The same pattern in Cpue fluctuation is also exhibited by *Citharinus spp* (Figure 8); the average daily catch rate dropped from 31.04kg/net in 1970 to 2.90kg/net in 1997. In the case of the Tilapia spp the catch rate has risen from 0.17kg/net to 3.57kg/net during the study period.

It is likely that fishing intensity (effort) increased on the lake at the beginning of 1971 and resulted in the reduction of Cpue and weight in all the major species, except Tilapia.

Figure 7: Annual variation of the over-all Cpue for the cast net fishery

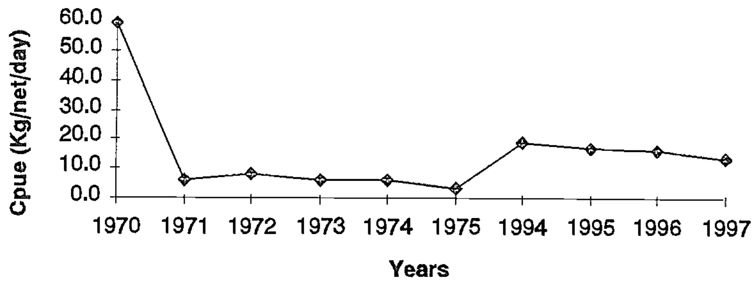
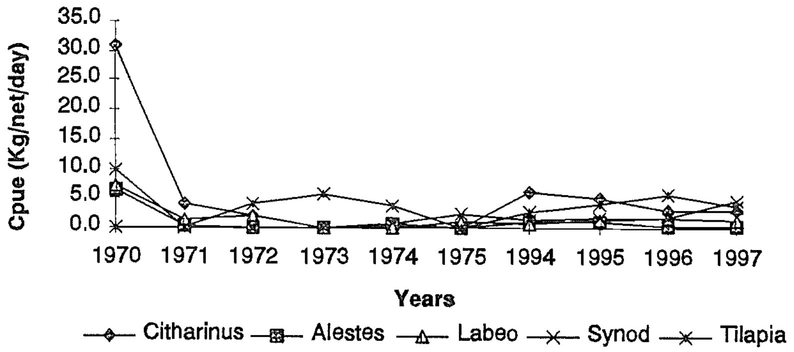


Figure 8: Annual variation of the Cpue of the major species



There is a significant positive relationship between mean weight and Cpue for most of the species (Table 5) suggesting that the decline in Cpue could have partly been due to the reduction in weight of the commercial species following a large increase in fishing intensity with under sized meshed nets in the later years.

Table 5: Correlation analysis between mean weight and Cpue of the major fish species

	1970	1971	1973	1974	1975	1994	1995	1996	1997
Citharinus									
Mean wt	1.52	1.40	0.25	0.38	0.00	0.17	0.10	0.17	0.13
Cpue	31.04	4.19	0.17	0.46	0.00	6.03	5.08	2.97	2.90
	r 0.7027								
Tilapia									
Mean wt	2.00	0.00	0.65	0.21	0.00	0.31	0.23	0.32	0.90
Cpue	0.17	0.00	5.87	3.83	0.00	2.87	4.13	5.71	3.57
	r -0.135								
Alestes									
Mean wt	1.57	1.00	0.00	0.11	0.00	0.14	0.09	0.01	0.05
Cpue	6.63	0.21	0.00	0.67	0.00	1.06	0.89	0.45	0.25
	r 0.8047								
Synodontis									
Mean wt	1.64	0.00	0.00	0.39	0.31	0.45	0.30	0.28	0.31
Cpue	9.92	0.00	0.00	0.55	2.50	1.49	1.54	1.62	4.61
	r 0.9156								
Labeo									
Mean wt	1.97	1.43	0.15	0.45	0.56	0.17	0.11	0.11	0.09
Cpue	7.13	1.25	0.10	0.03	1.11	0.84	1.44	1.74	1.36
	r 0.7503								
All species									
Mean wt	10.68	5.82	1.05	5.68	0.87	2.08	1.70	1.98	1.70
Cpue	59.00	5.90	6.13	6.14	3.61	18.84	17.03	15.92	13.41
	r 0.7185								

The cast net fishery showed a general increase in the overall Cpue with increasing mesh size (Table 6) reaching a maximum at 5.0 and 7.0" in 1970/75 and 1994/1997 respectively.
This trend is repeated by the *Citharinus spp.*, *Labeo spp* and *Synodontis spp* (Table 7).

There is a positive correlation in Cpue with mesh size in the "old" data set whilst the correlation was negative in the "new" catch assessment survey. This observation suggests that the large meshed nets were more productive in the early years of the fishery but these nets could no longer be sustained in the current cast net fishery. The analysis indicates that with large increase in mesh size more Tilapia and *Alestes spp* would disappear from the catches.

Table 6: Comparison of over all Cpue between 1977-75 and 1994-96

Mesh"	1970-75	1994-1996
1.0	10.00	12.74
2.0	8.40	13.22
2.5	8.90	17.46
3.0	20.86	13.22
4.0	43.25	16.52
5.0	51.05	19.82
6.0	136.00	6.14
7.0	144.50	
8.0	4.85	
r	0.55	-0.18

Table 7: Cpue by mesh size of the major species, 1970-1997

Mesh"	Citharinus	Tilapia	Labeo	Synod	Alestes	Total
1.0		2.00	1.00		2.00	5.00
2.0	2.50	2.90	0.65			6.05
2.5	2.10	6.60	0.30			9.00
3.0	1.69	3.49	1.51	2.10	0.86	9.65
4.0	5.75	3.50	9.25	3.50	2.70	24.70
5.0	27.76	0.24	4.00	11.24	4.53	47.77
6.0	32.75		13.50	17.37	36.00	99.62
7.0	43.50		34.00	23.50		101.00
8.0	2.43					2.43
r	0.55	-0.31	0.83	0.99	0.68	0.55

4.5. Mesh Selection by Number and Weight Caught

The minimum allowable "legal" mesh size in the cast net fishery is 2.0". Analysis of fish yield by mesh size between 1994 - 1997 (Table 8) shows that 19.9% by weight and 25.2% by number of all the major fish groups in the cast net fishery were from illegal mesh sizes consisting fish mainly of juveniles and/or immature stages. This is particularly true for *Citharinus spp* and Tilapia, for which 16.4% by number and 15.59% by weight were illegally caught in the fishery.

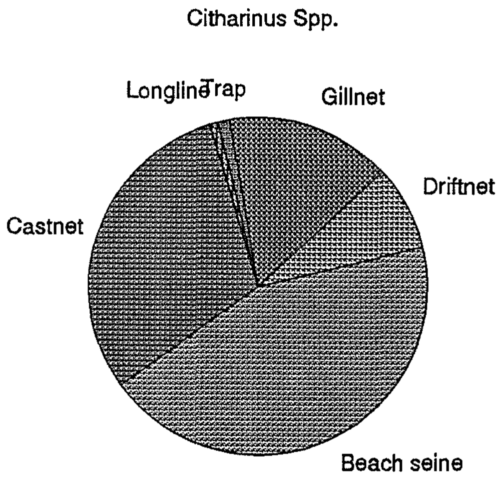
The situation is different for *Alestes spp* as its size at maturity is not more than 250mm in length. If by the Fisheries Edict, 56.2% of all *Alestes spp* in the fishery were illegal, though the majority of these species, for example *Alestes brevis* whose maximum observed length is 200 mm (Ita, 1984), may have attained maturity.

Table 8: Proportion of immature fish caught by illegal mesh nets (< 2.0") in the cast net fishery, 1994-1997

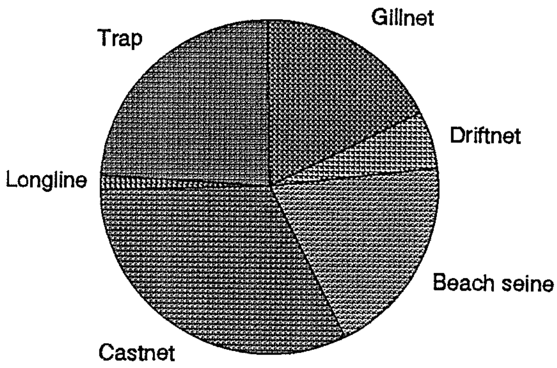
Species	% illegal by number	% illegal by weight	Total no. illegal	Total wt. illegal (t)
Citharinus spp	16.40	13.40	6,308,927	418.90
Tilapia	15.59	16.21	6,163,253	483.70
Labeo spp	23.69	24.38	2,189,321	241.90
Alestes spp	56.22	41.89	2,490,812	187.00
Synodontis spp	13.85	3.44	464,419	26.50

As mentioned earlier the present operation of the cast net fishery is having damaging effect on the *Citharinus spp* and Tilapia. It is demonstrated in Figure 9 that a large proportion of the total catch of these species (31.0% and 31.9%) are taken in the cast net fishery; in competition with the beach seine and small meshed gillnet fisheries.

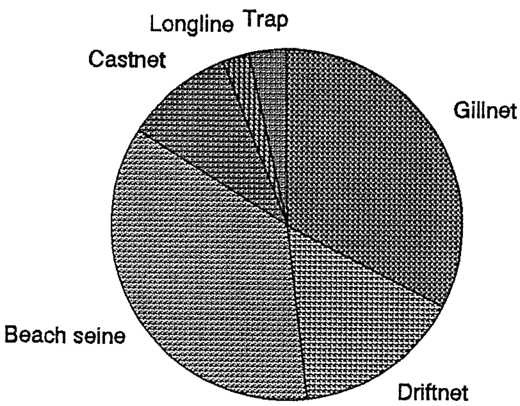
Figure 9: Distribution of the number of fish caught per fishing gear type for the commercial species of Kainji Lake, (1994-1997)



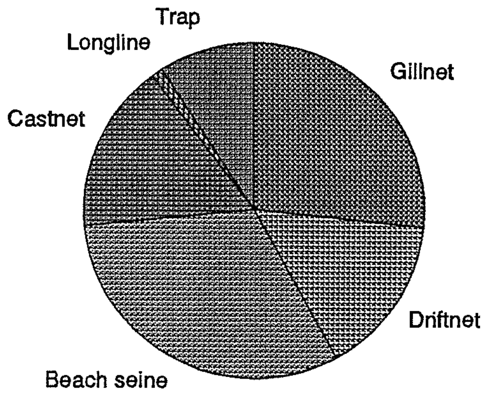
Tilapia



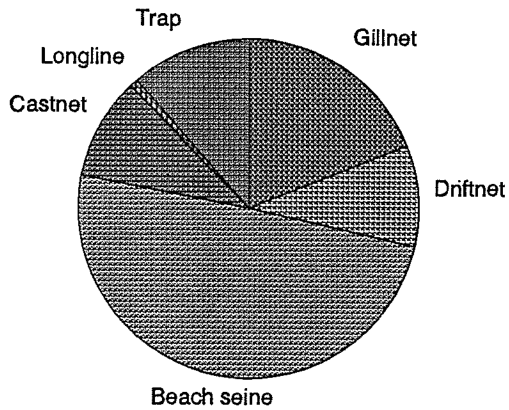
Synodontis spp.

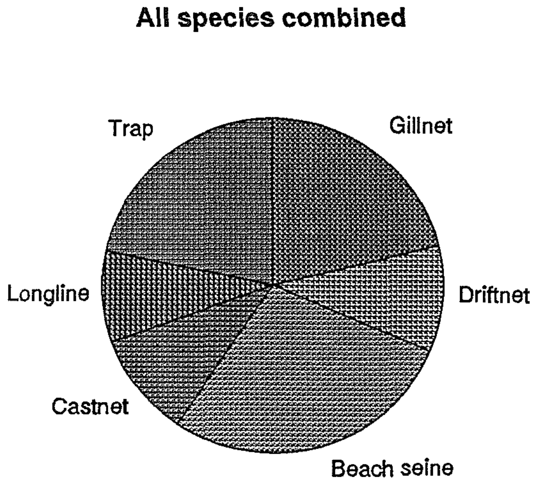


Labeo spp.



Alestes spp.

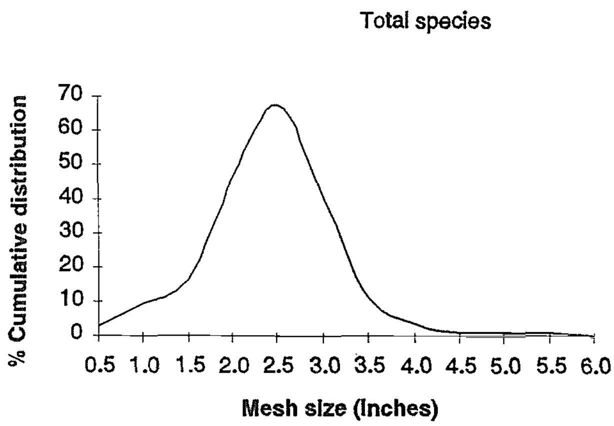




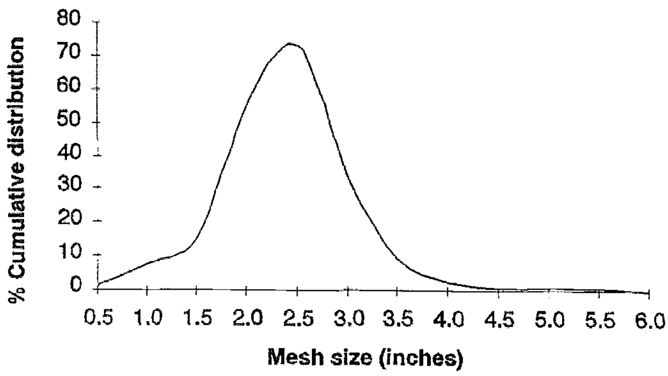
The analysis reveals that the yield is maximized at mesh size 2.5" for all species combined. The selection curves for *Citharinus spp*, *Labeo spp* and Tilapia (Figures 10) also demonstrates the same yield pattern as the mesh size, also maximizing at 2.5 inch mesh in each case.

There are fluctuations in the selectivity for *Alestes spp* and *Synodontis spp*. The *Alestes spp* are caught in large amounts in the small meshed nets. Due to the clogging effect at the band and their pelagic schooling behaviour, they can also be retained in the larger meshes. The dorsal spines of *Synodontis spp* render it vulnerable for retention in all meshes.

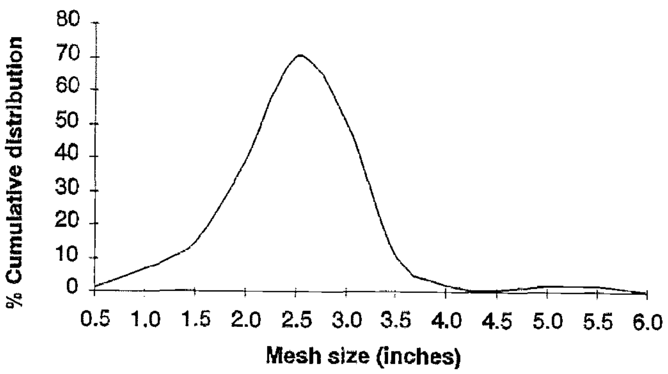
Figure 10: Mesh selection of fish species in the cast net fishery, 1994-1997



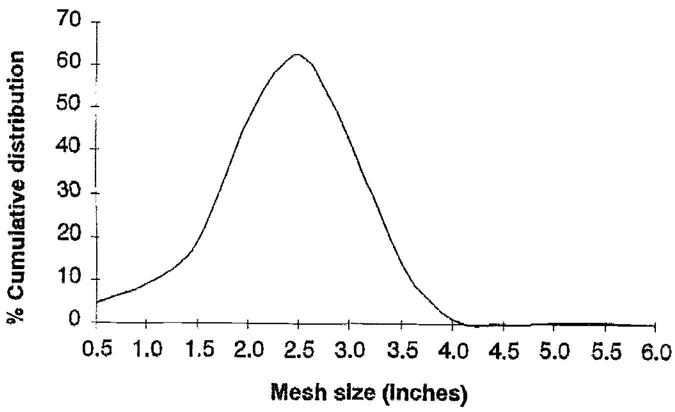
Citharinus spp.

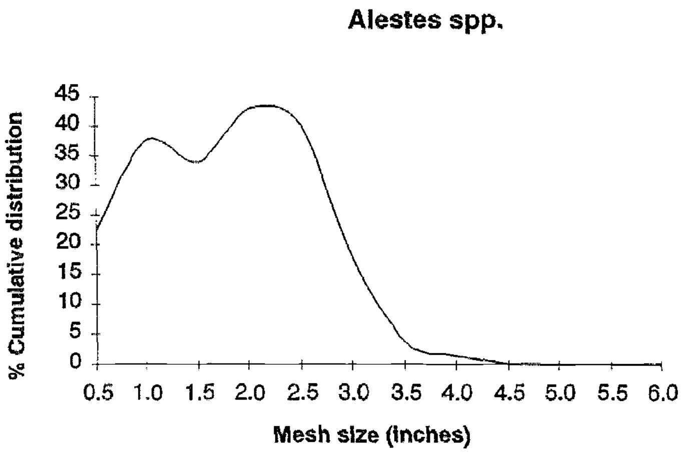


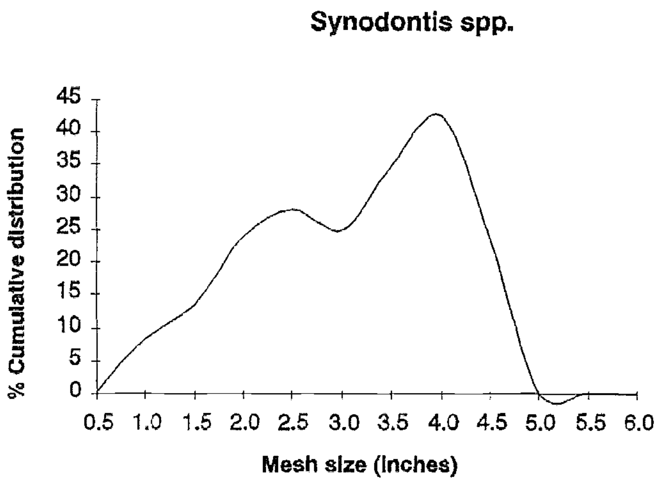
Tilapia



Labeo spp.

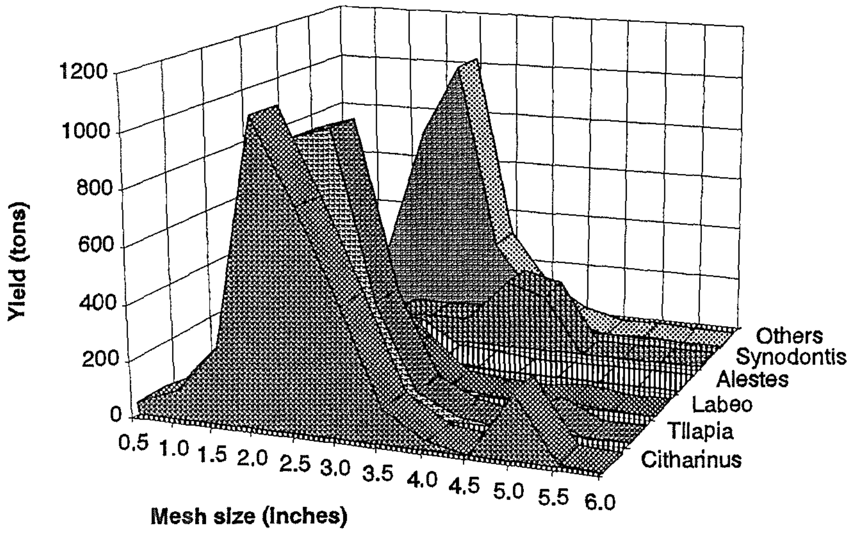






It is also shown that yield is at a maximum at 2.5" for almost all the species in Figure 11. It is evident that the choice of 2.5" as a minimum mesh size would be ideal for the fishery with little loss in yield in the short term. The initial loss in yield would be of very short duration for *Citharinus spp*, *Labeo spp* and Tilapia as these species would grow to sizes accessible to the fishery within a year or two.

Figure 11: Fish yield by mesh sizes in the cast net fishery, 1994-1997



5. Discussion and Recommendations

Variations in mean weight and Cpue are some of the factors that require regular monitoring for sustainable exploitation of fish stocks. They have proved to be reliable indicators of stock abundance and status of exploitation of any fishery. Declining mean size (weight or length) of commercially exploited fish species would normally suggest that the fish are cropped before reaching maximum size or the stocks have been overfished.

A fishing pattern of this nature would easily result in growth overfishing when the fish are harvested at immatured size. This again would collapse the fishery if there are no interventions on the part of the fisheries manager.

It is reasonable to suggest that the mean size of the five major species groups is determining the observed mesh size distribution. This trend would continue as long as the mean size of these species continues to reduce. The situation is complicated by the fact that the Kainji Lake fishery is multi-gear and the species above are also taken in other fishing gears such as gillnets, beach seines, drift nets and traps largely in undermeshed nets.

Therefore, management measures regarding mesh size regulation in the cast net fishery should not be taken in isolation without similar control measures on other gears.

As the Fisheries Edict stands now the current minimum mesh size gives the impression that there is minimum danger to the stocks by the cast net fishery.

If, however, the minimum cast net mesh size was assumed to be 2.5", the scenario would be different. With this mesh size, estimated 47% by weight and 56% by number of the major species caught in the this fishery between 1994 to 1997 would be illegal and 53% of the cast nets in use during this period would also be illegal.

The average mesh size in the cast net fishery is currently 2.2" which is within the legal limit in the Fisheries Edict. This is misleading and would tend to make the fisheries administrators complacent about the operations of the fishery. Adopting the 2.5" as the minimum legal mesh size would render the situation more realistic.

In the light of the above results and discussions, the following recommendations are made:

1. The existing legal mesh size in the cast net fishery should be increased to 2.5".
2. Prohibition of the cast net from operating in the shallow (inshore) areas of the lake (an arbitrary limit of 50m from the shoreline may be chosen).

6. Conclusions

As in the gill net fishery, there is no real evidence of ecosystem overfishing caused by the cast net fishery. The five major species *Citharinus spp, Tilapia, Labeo spp, Alestes spp* and *Synodontis spp* have been the major components in the catches and they still dominant.

However, the catfish *Auchenoglanis spp* and the carnivore *Hydrocynus spp* are increasingly becoming important in the fishery. It would therefore appear that there has not been major perturbations in the abundance of these species during the years under review.

It is also concluded that there has been signs of growth over-fishing in view of the declining mean weight and Cpue of the major species. These have been attributed to shrinking mesh sizes and increasing effort (number of cast nets) since 1994.

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Appendix 1. List of species and their identification codes

Code	Name
Alestes	Alestes spp
Bagrus	Bagrus spp
Citharinus	Citharinus citharus
Clarias	Clarias lazera
Clarotes	Clarotes laticeps
Gymn	Gymnarchus niloticus
Heterot	Heterotis niloticus
Hydro	Hydrocynus spp
Labeo	Labeo spp
Lates	Lates niloticus
Polypt	Polypterus spp
Synod	Synodontis spp
Tilapia	Tilapia spp
Others	All other species

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