KAINJI LAKE RESEARCH INSTITUTE
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A PRELIMINARY REPORT ON THE FISH STOCK ASSESSMENT AND MANAGEMENT PROPOSAL FOR THE I.I.T.A*. (IBADAN) IRRIGATION AND DOMESTIC WATER SUPPLY RESERVOIR

By

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*INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE.

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A PRELIMINARY REPORT ON THE FISH STOCK ASSESSMENT OF I.I.T.A. IRRIGATION RESERVOIR AND THE MANAGEMENT PROPOSAL

1. Summary

A fishery survey using diverse gears was carried out at IITA reservoir between 10th and 17th May, 1978 with the objective of estimating the species composition, production rate, yield and cropping rate for the 70 hectares irrigation reservoir. A total of 7 fish species were recovered and identified during the survey period.

The ratio of forage to carnivorous species (F/C) in the reservoir was estimated at 2.8. The low F/C ratio was attributed to the selective capture of Sarotherodon galileaus (Tilapia) to the exclusion of the carnivores all of which comprised approximately 26% by number of the total catch in gill-nets.

Comparative production and yield estimates using data for Kainji Lake and catch effort data for IITA reservoir revealed that IITA reservoir with a catch per unit effort of approximately 21 kg/1000 sq. meters of gill-nets is about four times more productive than Kainji Lake. The production rate for IITA was estimated at 960 Kg/h/year with a total production of about 67 metric tonnes for the 70 hectares reservoir. The reservoir could be described as eutrophic being supplied constantly with nutrients from fertilized farm lands and sewage effluent.

Previous catch records by the Ministry of Agriculture and Natural Resources (M.A.N.R.) Ibadan, revealed that the yield from the reservoir has been sustained at approximately 7.6 metric tonnes with little fluctuations within the past 4 years. About 98% by number of the yield within this period comprised mostly of Tilapia. It is estimated that a yield of approximately 22 metric tonnes could be sustained annually provided a multispecies cropping method is adopted.

The monthly catch records by the M.A.N.R. revealed a seasonal trend with a mean catch rate of 66.9 ± 7.5 kg per night between November and April and 85.9 ± 8.3 kg per night between May and October, an indication of approximately 22% reduction in the catch during the drier months of the year. Since over one third of the reservoir surface area remains unexploited on account of total vegetation cover (intended to prevent the spread of infective snails), it is recommended that a cropping rate

of about 18 metric tonnes per annum be maintained (i.e. 80% of the estimated sustainable yield).

The recommended mesh sizes of gill-nets for selective cropping are:

(a) 2.5 inch mesh for pikes
(b) 3.0 inch mesh for Chromidotilapia
(c) 4.0 and 4.5 inch meshes for Tilapia

It is estimated that if fishing is limited to two days in a week a daily landing rate of approximately 111 kg. of Tilapia, 38 kg of Pikes, 28 kg of Chromidotilapia and 13 kg. of other species could be anticipated using 2000 sq. meters of 2.5 and 4.0 inch nets, 1500 sq. m. of 3 inch net and 1000 sq. m. of 4.5 inch net. In addition a mean catch of approximately 5 carnivorous fish species weighing 6 kg. could be landed daily using a long line with 150 hooks of No. 10 specification. Also a mean daily catch of approximately 20 kg. of multispecies composition could be recovered from 50 bean-shaped wire traps set in shallow waters. If suitable beaches are made available a multispecies capture of over 20 kg per haul could be anticipated from beach seining with maximum mesh net of 3 inches.

The introduction of new species is recommended up to a maximum of 4 species taking into consideration the area-species relationship and the F/C ratio required to maintain a balanced population. The introduction of new species might necessitate the relaxation of capture by small mesh gill-net and intensification of other methods in order to give some measure of protection to the introduced species during their period of adjustment to the new habitat.

2. Introduction

The need for this investigation arose following a formal request by the Deputy Director General of I.I.T.A. Ibadan to the Director of Kainji Lake Research Institute for advice on a rational approach to the fishery management, effective methods of exploitation and stocking needs for the 70 hectares irrigation reservoir. Available information at the disposal of the Institute (Moriarty 1977) revealed that fishing has been taking place on a regular basis since 1970 but that supply to the IITA staff canteen started in 1975. Records of the early investigations revealed that fishing was conducted by fishermen from the Ministry of Agriculture and Natural Resources (M.A.N.R.) Ibadan using predominantly 89mm ($3\frac{1}{2}$") and 102mm (4") mesh nets which exploited mostly Sarotherodon galileaus (Tilapia). Other species identified by the above mentioned author during the period of his investigation (1976-1977) included:

Hepsetus odoe (3 specimens) Clarias lazera (13 specimens), Pelmatochromis (Chromidotilapia) guentheri (35 specimens) and Hemichromis fasciastus (13 specimens). During the same period about 3,978 specimens of Tilapia were recorded.

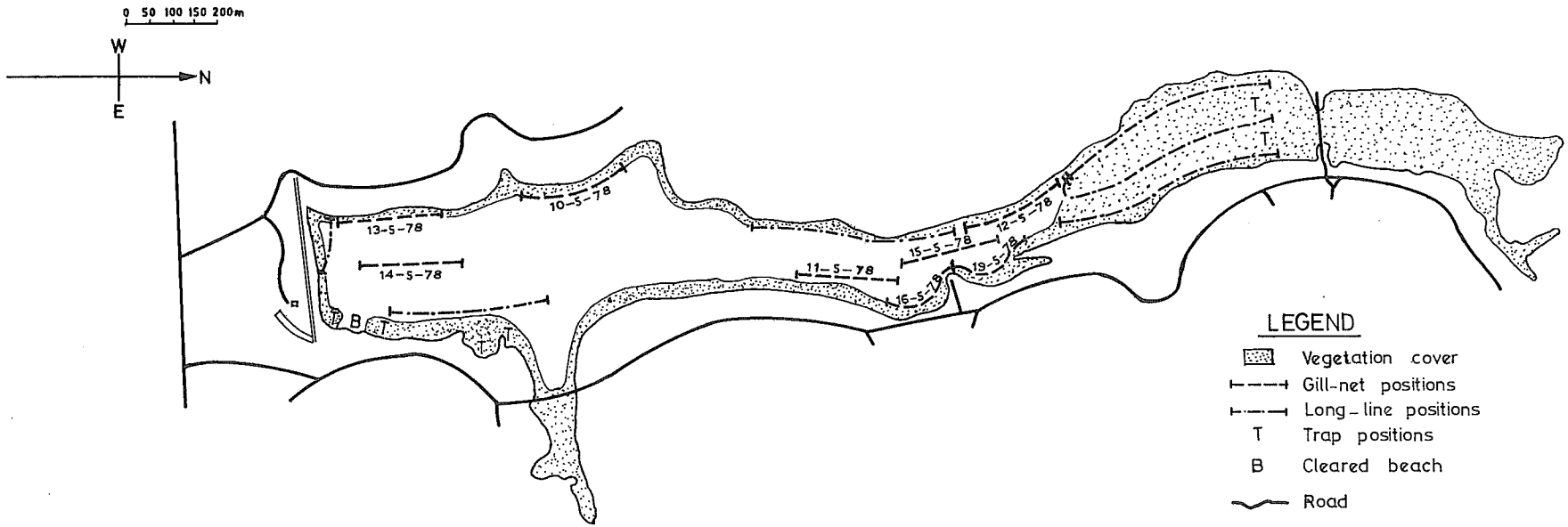
From the above record it was obvious that the mesh sizes of gill-nets used exploited mostly the Tilapias to the exclusion of other species. It was therefore necessary to carry out a survey of short duration with diverse gears and more mesh sizes of gill-net to supplement the available information. This survey was carried out therefore with the objective of elucidating the true relative abundance, production rate and yield of the fish species known to occur in the reservoir using a multi-mesh fleet of gill-nets. Other gears such as long-line, traps, and a beach seine net were also used in order to establish the relative effectiveness of the various gears for the different species and hence the effective methods of their exploitation.

3. Materials and Methods

For comparative reasons the gill-net fleet used in sampling at Kainji Lake was used for the survey. This consists of seven nets each measuring 30 meters long and 3 meters deep with meshes ranging from 5cm to 18cm (2", $2\frac{1}{2}$", 3", $3\frac{1}{2}$", 4", 5" and 7"). The fleet of nets was set for 24 hours at each of the stations shown on Fig. 1. It was checked in the mornings between 06.00 hours and 07.00 hours for night catches and between 17.30 hours and 18.30 hours for day catches. The nets were packed for resetting at other stations betweeen 18.30 hours and 19.30 hours.

Long-line consisting of 150 hooks at intervals of 1.5m and baited with assorted baits (e.g. live fish, pieces of dead fish, earthworms and soap) was used at positions shown on the map. Ten bean-shaped wire traps baited with palm nuts were set at shallow areas. Also two unsuccessful beach seine trials were carried out at a temporarily cleared beach close to the dam (Fig.1). Long-line was usually set last thing in the evening

FIG. 1. I.I.T.A. RESERVOIR SHOWING FISHERY SURVEY STATIONS SAMPLED BETWEEN 9th AND 17th MAY 1978.



and checked second thing in the morning after gill-nets. It was packed each morning for rebaiting and setting the following evening. The traps were checked twice daily, morning and evening. All catches were numbered and weighed by species and in most cases individual lengths, weights and gonad condition were recorded.

Water samples were also collected by the Institute limnologist for physical and chemical determinations. Details of this analysis and other biological information together with the interpretations of the echo traces of transects across the reservoir will be incorporated in a joint report later.

4. Results and Discussion

4.1 Gill-net Summary

The results of gill-net catches from a total of 8 nights and 7 days are shown in Table 1(a) and 1(b) respectively. Among the species recovered in gill-net were: Sarotherodon galilaeus (Tilapia), Chromidotilapia guentheri, Hepsetus odoe (African pike), Hemichromis fasciatus, Clarias lazera (mud fishes) and Channa obscurus (snake head). arranged in order of relative abundance (Table 1).

Tilapia made up approximately 52% by number and 59% by weight of the total night catches. Other major contributions came from Chromidotilapia 25% by number and 15% by weight and the pikes 19% and 20% by number and weight respectively. No pikes were caught during the day. Also open water surface set caught no fish during the day. All day catches came from the shore close to the marginal vegetation. Table 2 shows a comparison of the total catch by habitat (shore and open water surface). No Chromidotilapia and Hemichromis were caught in open water surface set.

Table 1 - Species composition in gill-net catches at IITA reservoir.

(a) Night Catch

Species	Total No.	Total Wt(gm)	%No.	%Wt
Sarotherodon galilaeus	151	61405	51.9	59.3
Chromidotilapia guentheri	74	15150	25.4	14.6
Hepsetus odoe	56	20770	19.2	20.0
Hemichromis fasciatus	4	900	1.4	0.9
Clarias anguillaris	3	1710	1.0	1.7
C. lazera	2	3200	0.7	3.1
Channa obscurus	1	500	0.3	0.5
Total	291	103635		
No. of Fleets sampled	8			
Mean catch/fleet	36.4	12954.4		
Standard deviation	±16.7	±5345.6		

Table 1 - Species composition in gill-net catches at IITA reservoir.

(b) Day Catch

Species	Total No.	Total Wt(gm)	%No.	%Wt.
Sarotherodon galilaeus	30	9615	35.7	48.7
Chromidotilapia guentheri	50	9380	59.5	47.5
Hemichromis fasciatus	4	750	4.8	3.8
Total	84	19745		
No. of Fleets sampled	7			
Mean catch/fleet	12	2820.7		
Standard deviation	±8.9	±2078.2		

Table 2 - Comparison of the shore and open water gill-net night catches

Habitat	Total Catch		Mean Catch/Fleet	
	No.	Wt.(gm)	No.	Wt.(gm)
Shore	242	82405	40.3	13,734.2
Standard deviation			±17.1	±5,517.6
No. of fleets	6			
Surface	49	21230	24.5	10,615.0
Standard deviation			±10.6	±5,762.9
No. of fleets	2			

Table 3 shows the numbers and weights of different species caught in the various mesh sizes of gill-nets used. Of a total of 151 tilapias caught only one was captured in 2 inch net by entanglement since it was much larger than the size most likely to be captured in a small mesh net. The weight reveals the size of Tilapia most likely to be gilled in either 4" or 5" mesh net.

All the pikes captured came from only two meshes (2" and 2½") in the ratio of approximately 1:2 for 2" and 2½" respectively. Although Chromidotilapia was recorded in four meshes (2", 2½", 3", and 3½") 80% of the catch was recorded in 3 inch mesh net.

Table 3. Mesh selection in gill-net catches at IITA reservoir

Species		MESH SIZES IN INCHES						
		2"	2½"	3"	3½"	4"	5"	7"
Tilapia	No.	1	11	18	64	54	3	0
	Wt.	550	2270	5550	23760	27605	1670	0
	Mean Wt. (gm)	550	206	308	371	511	557	0
Hepsetus (African pike)	No.	18	38	0	0	0	0	0
	Wt.	6320	14450	0	0	0	0	0
	Mean Wt. (gm).	351	380	0	0	0	0	0
Chromidotilapia	No.	2	10	59	3	0	0	0
	Wt.	250	1620	12620	660	0	0	0
	Mean Wt. (gm).	125	162	214	220	0	0	0
Clarias (Mud fish)	No.	0	0	2	1	2	0	0
	Wt.	0	0	1140	570	3200	0	0
	Mean Wt. (gm).	0	0	570	570	1600	0	0
Hemichromis	No.	0	2	1	1	0	0	0
	Wt.	0	400	250	250	0	0	0
	Mean Wt (gm).	0	200	250	250	0	0	0
Channa Obscurus (Snakehead)	No.	1	0	0	0	0	0	0
	Wt.	500	0	0	0	0	0	0
	Mean Wt. (gm).	500	0	0	0	0	0	0

4.2 Long-line Catch Summary

The summary of the results of baited long-line trials is shown in Table 4. Only No. 10 hooks were used. Pikes and snakeheads were caught during the first three trials using a combination of bait types. Because of the difficulty of catching live baits only soap bait was used for the last 4 trials. Only mudfishes were caught with soap bait. Altogether 37 fish weighing 40135 gm were caught during the seven days trial. It is possible that more pikes and snakeheads could have been captured with more trials using live and dead baits. The ratio of catch for the first 3 trials with combination of bait types was 9:6:2 for mudfish, pike and snakehead respectively.

Table 4 - Summary of the numbers and weights of fish species caught with long-line using different bait types.

Species	Worm	Live Bait	Dead Bait	Soap Bait	Total No.	Total Wt.(gm)	Mean Wt.(gm).
Mud fish	0	1	4	24	29	35650	1229
Pike	0	3	3	0	6	3585	598
Snake head	0	1	1	0	2	900	450
Total fish	0	5	8	24	37	40135	
No. of trials	1	2	4	7	-	-	
Mean/trial	-	-	-	-	5	5734	

4.3 Trap Catch Summary

The results of catches from wire traps baited with palm nuts are shown in Table 5. With the exception of the mudfish all other species were recorded in the traps. More Hemichromis were recovered in the traps than in the gill-net used.

Table 5 - Summary of the numbers and weights of fish species caught in $1\frac{1}{2}$ inch mesh wire traps.

Species	Total No.	Total Wt.(gm)	Mean Wt.(gm)
Tilapia	15	2250	150
Chromidotilapia	29	2530	87
Snakehead	7	4490	641
Hemichromis	7	520	74
African Pike	2	450	225
Total	60	10240	

The mean sizes of fish captured in the traps (with the exception of the snakeheads and the pikes) were small compared with the sizes captured in gill-nets. The capture of smaller fishes in the traps could be avoided by using larger mesh sizes of wire meshing.

4.4 Seine Net Catch Summary

The results of two trials with a beach seine net at an improvised beach near the dam on the eastern bank are shown in Table 6.

Table 6 - Summary of the numbers and weights of fish captured in seine net.

Species	Total No.	Total Wt.(gm)	Mean Wt.(gm)
Tilapia	7	2650	379
Chromidotilapia	15	2000	133
Snake-head	1	600	600
Hemichromis	1	150	150
Total	24	5400	
No. of Hauls	2		
Mean catch/haul	24	2700	

The low catches in seine net hauls could be attributed to (a) the rough nature of the beach (b) the mid-day operation of the seine and (c) the relatively large mesh size of the wings (5 inch). Even the 3 inch cod-end could not retain the pikes all of which escaped through the meshes during the operations. The effectiveness of this gear could be increased by reducing the mesh sizes of nets used and acquiring more suitable beaches for the operation. Because of the abundance of marginal vegetation, the majority of fish could avoid cleared beaches during the day. Experience from Kainji has shown that evening and early night catches are better than mid-day catches.

4.5 Comparison of Gears

The summary of the total numbers of fish species caught with the various gears used is shown in Table 7.

Table 7- Summary of species composition by numbers of fish and gear types.

Species	Gill-net	Long-line	Traps	Seine net
Tilapia	151	0	15	7
Chromidotilapia	74	0	29	15
African pike	56	6	2	0
Mud fish	5	29	0	0
Hemichromis	4	0	7	1
Snake head	1	2	7	1
Total	291	37	60	24
No. of nights fished	8	7	6	-
Mean catch/night	36	5	10	-
Gear dimension	1fleet	150hooks	5	

The multimesh fleet of gill-nets is by far the most effective for capturing all the representative species in the lake in relation to their relative abundance. It is possible that the mudfishes were not well represented in the gill-net since in most cases the net did not touch the bottom of the vegetation margins being only 3 metres deep. The maximum depth sampled along the vegetation was 6 metres hence a net suspended 5 meters deep with weighted bottom line should be able to exploit the mud-fishes effectively along the deeper southern part of the reservoir. Active long-line fishing is the only answer for harvesting this species along the shallower northern vegetated zone.

Recoveries from the traps were not encouraging initially but as the trap colour gradually changed larger fish were recovered. On 17th May, 1978 three tilapias weighing 1100 gm with a mean weight of 367 gm were recovered with one snake head weighing 750 gms and 2 Chromidotilapia weighing 230 gms. During the last couple of days (16th and 17th May, 1978) a total of 14 fish weighing 4010 gms were recovered from the 5 traps set giving a mean catch of 2005 gms per day per 5 traps set. With an increase in the number of traps, the quantity and variety of fish caught could be increased substantially. It might be possible to recover over 20 kg. of assorted fish species each day if about 50 traps are set at strategic positions.

The mean daily catch recorded for long-line (with 150 baited hooks) was 5 fish weighing 5.7kg. Although an increase in the number of hooks and hence the length of zone covered could lead to increased landing, the use of assorted baits may well be the controlling factor. More trials with assorted baits will be carried out during the second trial sampling.

Beach seine has a great potential if about 5 beaches of approximately 100 meters long by 70 meters wide are made available. In Kainji Lake a mean catch of between 10 kg and 40 kg per haul have been recorded. About double this quantity could be predicted for the IITA reservoir given suitable beaches. It may be possible to capture a combination of species if suitable mesh nets are used and seining carried out at the most suitable times of the day.

4.6 Comparative Production and Yield Estimates

Because of the utilization of the reservoir water for domestic purposes direct estimates of production using rotenone in blocked off areas was not practicable. However since the gill-net fleet used in IITA is the same one as is used in sampling Lake Kainji a comparative yield and hence production estimates will be attempted using the catch effort statistics. Also the catch statistics for the IITA reservoir for 1975 to 1978 will be summarized to support the estimates.

The current catch rate and production estimates for Kainji Lake can be summarized as follows:

Yield for inshore habitat = 5 kg/1000 sq.m. of gill-net
Open water habitat = 4 kg/1000 sq.m. of gill-net
Inshore production rate = 240 kg/h/year
Estimated yield at 1/3 the production rate = 80 kg/h/year
Estimated yield from IITA reservoir based on the 8 days catch data is: 20.6 kg/1000 sq. m. of gill-net.

Since there was no significant difference between the shore and open water surface catch, the mean for the two habitats was used in the computation of the above catch per unit effort figure.

If on the basis of the yield estimates it is assumed that IITA reservoir is four times more productive than Lake Kainji then the production rate of IITA reservoir could be estimated as 960 kg/h/year. The total production for the 70 hectares reservoir would therefore stand at 67,200 kg/year or 67.2 metric tonnes of fish annually. The estimated optimum yield per annum at one third the production figure stands at 22,400 kg/year or 22.4 metric tonnes of fish annually.

A summary of the four years catch record by the Ministry of Agriculture and Natural Resources (M.A.N.R.) Ibadan, based on the quantity of fish supplied to the staff canteen is shown on Table 8. The figures reveal that the cropping rate for the past four years has been sustained at an average total catch of 7,592.8 kg/year with a standard deviation of $\pm$ 1,428.7 kg.

Judging from this figure the estimated yield of 22,400 kg/year may at first appear to be an over estimate. However information available reveals that about 98% by number of the catch taken within the past four years comprised mostly of Tilapia. Table 1 however reveals that Tilapia made up only 52% by number and 59% by weight of all fish caught with the experimental multimesh gill-net fleet. This means that 41% of the estimated yield of 22.4 metric tonnes was not cropped by the commercial net of the M.A.N.R., Ibadan. This is evident from the fact that between 1975 and 1977 only 3 pikes (Hepsetus odoe) were captured whereas this fish comprised 19% by number and 20% by weight of all fish captured with our experimental nets. Similarly only 35 specimens of Chromidotilapia were captured within the same period whereas this fish made up about 25% by number and 15% by weight of all fish captured in the experimental nets. Within the same period only 13 specimens of mudfish (Clarias) were captured whereas our observation reveals that Clarias comprised about 2% by number and 5% by weight of fish caught in the gill-net and that a mean daily catch of four fish weighing about 5 kg. could be realised using baited long-line.

Table 8 - Summary of the quantity of fish in kg. supplied to IITA Staff Canteen monthly from the reservoir catches (The number of samples for each month is in brackets).

Month	1975	1976	1977	1978	Total	Mean Catch/ Set
January	-	691.8(8)	499.0(8)	627.5(9)	1818.3	72.7
February	-	467.1(8)	357.5(7)	579.5(9)	1404.1	58.5
March	-	718.6(10)	-	732.5(9)	1451.1	76.4
April	592.7(7)	478.4(7)	334.0(9)	380.5(8)	1785.6	57.6
May	1143.4(7)	286.4(6)	576.5(9)	-	2006.3	91.2
June	1098.9(8)	454.8(8)	825.5(8)	-	2379.2	99.1
July	854.8(9)	470.2(9)	824.0(9)	-	2149.0	79.6
August	899.6(9)	540.5(9)	691.0(9)	-	2131.1	78.9
September	677.7(9)	711.1(9)	661.0(8)	-	2049.8	78.8
October	600.9(7)	671.1(7)	657.5(8)	-	1929.5	87.7
November	591.8(8)	549.0(9)	563.0(8)	-	1703.8	68.2
December	832.3(9)	619.0(10)	455.5(9)	-	1906.9	68.1
Total (Kg)	7292.1	6658.0	6444.5	2320.0		
Mean/month	810.2	554.8	585.9	580.0		
Total No. of Sets	73	100	92	35		
Mean catch/ Set Kg.	99.9	66.6	70.1	66.3		
Total Catch/ 12 months	9722.4	6657.6	7030.8	6960.0		

From the above observation, it could be concluded that the mean annual cropping rate of 7.6 metric tonnes realised by the M.A.N.R. is much below the sustainable yield level. Similarly the estimated yield of 22.4 metric tonnes per annum could be an overestimate of the sustainable yield judging from the fact that it is not yet possible to exploit the teaming population inhabiting the northern vegetated zone which covers over one third of the reservoir surface area.

4.7 Estimates of Cropping Rate Using Gill-net

Table 9 shows the summary of the estimated catch in kg/1000 sq. m. of net for the three major species captured in gill-net.

Table 9 - Estimated total catch in kg/1000sq.m. of gill-net of different mesh sizes.

Unit Area	Species	2.5"	3.0"	3.5"	4.0"	Total (kg)
Catch/1000sq.m of net	Tilapia	3.2	7.7	33.0	38.3	82.2
	Pike	20.1	0	0	0	20.1
	Chromidotilapia	2.3	17.5	0	0	19.8
Total		25.6	25.2	33.0	38.3	122.1

From the above estimate it is evident that about 122 kg. of fish could be obtained from a fleet of nets consisting of 2.5,3.0 and 4.0 inch mesh sizes each measuring 1000 sq. meters in area. It could be argued that the inclusion of 2.5 and 3.0 inch mesh sizes would result in the capture of small sized Tilapia much below harvestable sizes. The two meshes combined catch approximately 11 kg. of Tilapia compared with about 40 kg. of pikes and Chromidotilapia. In terms of numbers of fish caught 3.2 kg. of Tilapia caught in 2.5 inch mesh with a mean weight of 206 gm. (Table 3) for each fish gives a total of 16 fish. Similarly 7.7 kg. of Tilapia from 3 inch mesh with a mean weight of 308 gm for each fish gives a total of 25 fish. Hence a total of about 41 undersized Tilapia could be expected from each night catch using the above fleet of nets.

The biological importance of cropping the pikes should be taken into consideration even though the pikes may not be highly cherished as food fish by the majority of workers at IITA because of their numerous bones. However 20.1 kg. of pikes from $2\frac{1}{2}$ inch mesh with a mean weight of 380 gm. for each fish would give a total catch of 53 pikes each night. This would mean eliminating 53 voracious predators on young fish including those of Tilapia.

Although 4.5 inch mesh was not included in the experimental fleet and the 5 inch mesh included only caught 3 tilapias, it is recommended that 3.5 inch mesh be eliminated to allow the tilapias grow into 4 and 4½ inch meshes.

Judging from the results of the 5 inch mesh it is anticipated that 4½ inch mesh will catch less than 4 inch mesh. However, the difference could be compensated for by doubling or tripling the surface area of 4½ inch mesh with the ultimate objective of eliminating 4 inch completely from the fleet.

Since these estimates of production, yield and catch rates are based exclusively on the results of a survey conducted only during the rainy season it is reasonable not to be very optimistic of a uniform level of production and yield all the year round. However Table 8 reveals that the minimum daily catch during the four years of sampling was 58. 5 kg. recorded for the month of February and the highest was 99 kg. recorded for June followed by 91 kg. for the month of May. It will be recalled that the current survey was carried out between 10th and 17th May. A closer look at Table 8 reveals that there is a definite seasonal trend with lower catches during the drier months of the year November to April with a mean catch of 66.9kg ± 7.5kg/set and higher catches between May and October with a mean catch of 85.9 ± 8.3 kg/set.

Based on the above monthly trend a decrease in yield of about 22% could be anticipated during the drier months of the year (November to April). To be on the safe side therefore, it is recommended that the cropping rate be maintained at 80% of the estimated yield of 22.4 metric tonnes which is approximately 18 metric tonnes per annum or a monthly cropping rate of 1.5 metric tonnes.

It is also recommended that the cropping rate be based on the pattern depicted in Table 1, with 59%, 20% and 15% of Tilapia, pike and Chromidotilapia respectively being cropped simultaneously. This would result in a monthly cropping rate of 885kg, 300kg and 225kg of Tilapia, pike and Chromidotilapia respectively. The remaining 6% or 90kg. would comprise of other species e.g. mudfishes, snakeheads and Hemichromis.

If sampling is carried out twice a week or 8 times a month a daily landing of approximately 111kg of Tilapia, 38kg of pikes and 28kg of Chromidotilapia could be anticipated plus approximately 12.9kg of other species.

If 3½ inch mesh is eliminated from the fleet, then the above catch rate for Tilapia could only be met by doubling the surface area of 4 inch net (Table 9). This will give a catch rate of approximately 77kg of Tilapia. If we assume that 1000 sq. meters of 4½ inch net will catch at least half as much as 4 inch net then we might anticipate approximately 96kg of Tilapia from 2000 sq. meters of 4 inch net and 1000 sq. meters of 4½ inch net. By doubling the surface area of 2.5 inch net about 40 kg of pikes, 6.2 kg of Tilapia and 4.6 kg of Chromidotilapia could be cropped.

Similarly by increasing the surface area of 3 inch net to 1500 sq. meters about 26 kg of Chromidotilapia and 11.6 kg of Tilapia could be croped. This gives a total of about 114 kg of Tilapia, 40 kg of pike and 31 kg of Chromidotilapia. Table 10 shows the summary of the predicted catch per unit area of net.

Table 10 - Predicted daily catch rate in kg. of fish in IITA reservoir per unit area of net set.

Mesh size in inches	2.5	3.0	4.0	4.5	Total
Surface area in sq.m.	2000	1500	2000	1000	6,500
Tilapia	6.2	11.6	76.6	19.1	113.5kg.
Pike	40.2	0	0	0	40.2kg.
Chromidotilapia	4.6	26.3	0	0	30.9kg.
Others	1.1	2.9	8.9	?	12.9kg.
Total (kg)	52.1	40.8	85.5	19.1	197.5kg.

Since the figure quoted for $4\frac{1}{2}$ inch net is not based on any experimental record it is recommended that another test fishing operation be conducted by the Institute's team in collaboration with the recruited and trained fishermen for IITA for a period of two weeks before the final handover. Subsequently accurate catch records would be kept by the Institute's Fishery Assistant (to be posted to IITA) for a period of six months covering both the wet and dry months of the year. The data so collected will help in determining whether there is need for a modification of the original recommendations since no recommendation involving a biological system, which is subject to both natural and artificial stressed conditions, could be regarded as final. The second trial operation requested will also provide the author the opportunity of more trials with long-line, traps and seine net in order to assess the impacts of these additional gears on the fish population.

5. Stocking

The introduction of new species into the reservoir is recommended provided the species are carefully chosen in order to maintain a balanced population. Swingle (1950) defines a balanced population as one in which the ratio of forage to carnivorous (F/C) species ranges from 1.4 to 10.0. Judging from the composition in gill-net sample the ratio of forage to carnivorous species stands at 2.8. According to Swingle (op.cit.) the F/C ratios from 3.0 to 6.0 appear to be the most desirable in the balanced range. His observation revealed that 77% of the best producing populations fell within that range. The low F/C ratio for the IITA reservoir could be explained from the fact that within the past 5 years cropping has been concentrated only on the forage species particularly Tilapia. This ratio could be increased by systematic cropping of the pikes and other carnivorous species in the reservoir. If this is done, then Lates niloticus (Niger perch) a carnivore could be introduced to promote sport fishing.

The introduction of Heterotis niloticus a plankton feeder and possibly a grass carp is recommended to maintain a favourable F/C ratio. Heterotis it is hoped will be able to reproduce in the reservoir since it is a swamp dwelling species. The occasional marginal grasses could provide suitable nesting grounds for this species.

If stocking is effected, records of the numbers, mean weight and possibly mean lengths of individuals introduced should be kept for the purpose of estimating the selectivity of the introduced species in gill-nets. This will help determine the need for adjusting the mesh sizes in order to limit the exploitation of the introduced species and allow them time to reproduce in the reservoir. If other gears prove effective for exploiting the pikes and Chromidotilapia then $2\frac{1}{2}$ and 3 inch mesh nets could be eliminated in order to give maximum protection to the new species.

Considering the surface area of the reservoir ($0.7km^2$) a maximum of 10 species would fit favourably into the observed range for area-species curve for African lakes (Barbour et al,MS). Indigenous species already number about six. It is believed that a maximum of four species belonging to different trophic levels (preferably those earlier recommended) could be added to the list without upsetting the balance in the system.

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