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Mortality and Exploitation Rates of Challawa Gorge Dam Fishes, Kano State, Nigeria

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Abstract

Analyses were done on length-frequency data to study the mortality and exploitation rates of fish species of Challawa gorge dam. The species were: *Bagrus bayad macropterus, Synodontis schall, Oreochromis niloticus, Pollimyrus isidori, Marcusenius senegalensis, Schilbe uranoscopus, Clarias lazera, Lates niloticus, Brycinus nurse and Auchenoglanis occidentalis*. The total mortality (Z), the fishing mortality (F), the natural mortality (M), the current exploitation rate (E), Probabilities of Capture and their Biological Reference Points were all assessed. *Bagrus b. macropterus, Synodontis schall, Clarias lazera, Lates niloticus, Schilbe uranoscopus and Auchenoglanis occidentalis* were over-exploited. *Oreochromis niloticus* was optimally harvested. While *Pollimyrus isidori, Brycinus nurse* and *Marcusenius senegalensis* were underexploited.

Keywords: Mortality; Exploitation; Fish; Challawa; Dam

Introduction

Livelihoods and food security of millions of people across the world are supported by small-scale fisheries that if it is managed appropriately, it can make tremendous contributions to socio-economic development of fishing communities. In Nigeria, fish forms an important part of the diet of many households, especially in rural areas [1,2]. It makes up around 40% of Nigeria's protein intake, with fish consumption at 13.3 kg/person/per year [3]. Total fish production per year is close to 1 million metric tons (313,231 metric tons from aquaculture and 759,828 metric tons from fisheries). The majority of this fish is consumed domestically, while around 10% is exported [4].

But inland fish resources, most of the time, seems to be on a steady decrease [5,6]. This can be attributed to overexploitation of the resources, illegal fishing methods [7], minimal conservation commitments and majorly lack of review, compliance or enforcement of fishery management policies and laws [8]. It has been noticed that inland fishery resources are often over-exploited because of the fishing pressure and the fact that bigger aquatic resources – Seas, Oceans, Estuaries, Lagoons etc. – which produce the bulk of fish resources are far from the inland areas, therefore the pressure on the inland freshwaters [9,10].

Fish mortality is a parameter used to infer the loss of fishes through death. Mortality in exploited fisheries is either natural or fishing mortality. Natural mortality is all causes of death that are not as a result of anthropogenic harvest. These include; Diseases, predation, unfavourable environmental conditions (such as pollution), senescence, competition, cannibalism or any other factor(s) that might cause death in fisheries.

On the other hand, fishing (harvest) mortality is the removal, from fish stock, of fishes using any fishing methods [11]. Fish mortality may account for the shrinkage of fish population overtime. Mortality in fishes is highest at the egg/larval stages due to vulnerability to predation, starvation and unfavourable conditions [12] and decreases as the fish progresses in their life history [13].

Many fisheries are being direly over-exploited, including those in countries with well-developed fishery management institutions. Example the Canadian cod fisheries have not recovered from a collapse and closure of the fishery in 1992 [14,15]. Top predator species are continually being over-harvested leading to their noticeable decline in stock [16,17].

According to Chukwu [18] small-scale fisheries in Nigeria are continually negatively affected by pollution and obnoxious fishing practices. But as reported by Bergkamp et al. [19] in a review for the World Commission on Dams (WCD) one pertinent issue that escapes our notice is the fact that pre-impoundment population tend to reduce in biodiversity post-impoundment, and this definitely affects the fisheries yield, while Jackson et al. [20] added that after impoundment, the fish communities become distinct depending on the geography and climate of the basin.

But illegal fishing methods, especially in third world countries, are a major concern to the conservation and yield of the fisheries [7]. In a survey by Ogundiwin [21] on the fishing gears and crafts of Kainji lake, Nigeria she discovered that there is a strong relation between part-time fishing and reduced stock. The reduction in catches is supplemented by; largely farming and other vocational activities.

As revealed by Brodziak et al. [22] majority of fishermen target the adults and the juvenile in the population. But population are largely replenished through recruitment [23]. However, when the adult and juvenile stock are depleted, focus tend to shift to fingerlings [11,23].

This research aims to estimate the mortality and exploitation rates of the fish species of this dam that are fast declining according to verbal communication from the veteran fishermen.

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Materials and Methods

The study was carried out in Challawa gorge dam, Kano state, Nigeria with coordinates 8⁰06'58.04"E 11⁰41'21.95"N. The dam was completed in 1993 on the Challawa River. It is the 2nd largest of the 23 dams along Hadejia-Jama' are River Basin [24]. It is 42 m high and 7.8 km in length. The dam has a full storage capacity of 904,000,000 m^3. The direct catchment area is 3857 km^2. Apart from irrigation and township water supply, the dam was constructed with hydropower potential of around 3 MW.

Data collection

Fish samples were collected from three of the seven landing sites of the dam from artisanal fishermen, on a monthly basis. The 3 landing sites were - ***TURAWA***: 11⁰ 40I 52.4IIN 008⁰ 02I 31.9IIE, ***SAKARMA***: 11⁰ 39I 543IIN 8⁰ 00I 611IIE and ***PEGIN MA***: 11⁰ 39I 28.1IIN 007⁰ 581I 18.9IIE. The Total lengths and Weights of the fish samples were measured using a measuring tape and a digital weighing balance (Sarturius T630) to the nearest 0.1 cm and 0.1 g respectively. The study was conducted from March – August, 2017.

The fish were identified to species level and Olaosebikan and Bankole [3]. The sampling sites were chosen based on a reconnaissance survey and responses of the fishermen that the 3 sites have the largest landings by volume. The fishermen use non-motorized canoes and the predominant fishing gears were gill net and hook and line. The data were analysed using the FAO-ICLARM fish stock assessment software, *FiSAT_II*.

Mortality parameter

Total mortality rates (Z) of each of the species were estimated using Length-converted catch analysis taking 26.1°C as the mean annual surface temperature of the dam. The Natural mortality rates (M) were estimated using Pauly M's equation (Pauly and Morgan, 1987):

$$\ln(M)= -0.0152-0.279 \ln(L_\infty)+0.6543\ln(K)+0.463 \ln(T)$$

Where;

L_∞=Asymptotic length

K= VBGF growth constant

T= Mean annual surface temperature

The Fishing mortality rates were derived from the difference between the Total and Natural mortality rates

$$F=Z-M$$

The exploitation ratio (E) were arrived at using the function,

$$F/Z$$

Growth Performance indices were calculated as explained by Gayanilo et al. (2005) using:

$$Ó=\log_{10}(K)+2.\log_{10}(L_\infty).$$

Where *K* is the VBGF growth constant and L_∞ is the asymptotic length. From the length-converted catch curve, Probabilities of Capture (L_{25}, L_{50} and L_{75}) were estimated using running average. These parameters indicate the length at which 25%, 50% and 75% of the fish population will be vulnerable to a fishing gear.

Exploitation parameters

Employing Beverton and Holt Y/R analysis [25,26], the relative biomass per recruit (B'/R) was estimated as B'/R =(Y'/R)/F [27]. The parameters needed for this routine are: Length-frequency data with constant class sizes, M/K, L_C/L_∞, *a* and *b* values. The output gives the values of the following parameters:

E_{max} which shows exploitation rate that produces maximum yield [28],

E_{10} highlights exploitation rate at which the marginal increase of Y'/R is 10% of its virgin population;

While E_{50} implies exploitation rate under which the population is reduced to half its virgin biomass, were all computed using the procedure incorporated in the FiSAT program.

The "*selection ogive*" option was employed instead of "*Knife - edge*" because according to [26,29,30] while *Knife-edge* assumes that species that are $<L_{50}$ are not caught by fishing gears, the "*selection ogive*" procedure assumes that the probability of capturing any species is the function of their length, therefore it was more realistic for this study (Figure 1).

Results

A total of 10 species of fishes, belonging to 9 families were identified during the period under study and they are presented below in Table 1, including their English names and the local names (in Hausa language).

As reported from the fishermen, about 13 fish species belonging to 9 different families were available before in Challawa gorge dam. Table 2 below presents some with their English and Local names.

Mortality rates

Below in Figures 2a–2j, are the length-converted catch curves of the species. The mortality parameters: Total mortality (Z), Natural mortality (M), Fishing mortality (F) and Exploitation rate (E) were estimated from length-converted catch curves by inputting the corresponding L_∞ and K values.

Probabilities of capture

The probabilities of capture of the species were determined from the length-converted catch curves. Length-frequencies of the species were used to extrapolate the length at which they might be vulnerable to fishing gears. It is given in percentages of 25, 50 and 75. They are presented below in Figures 3a–3j.

In Table 3 below, the values of Z, Z/K, M, F, E and Probabilities of capture are presented. *Clarias lazera* had the highest total mortality followed by *Late niloticus*. From the Z/K values [31] The Population of *B. nurse* and *P. sidori* had growths that dominated their mortality. *S. schall* and *M. senegalensis* mortality lightly dominated growth. While the population of *Bagrus b. macropterus, Oreochromis niloticus, Clarias lazera, Lates niloticus, Schilbe uranoscopus* and *Auchenoglanis occidentalis* all had mortality that dominated growth greatly (Over-exploitation). *M. senegalensis* had the highest natural mortality while *S. uranoscopus* had the lowest natural mortality. *Lates niloticus* was the most fished species in Challawa dam, whereas *B. nurse* was the least fished species. *Lates niloticus* was the most exploited fish species followed by *C. lazera*. *B. nurse* was the least exploited species followed by *P. isidori*. The probabilities of capture of the species show that fingerlings of all the species with the exception of *M. Senegalensis* were caught and retained.

The *Z/K* values for the species indicate the extent of mortality in relation to growth, for the given species in a year:

- *Z/K* values of <1 indicates Growth dominates Mortality;

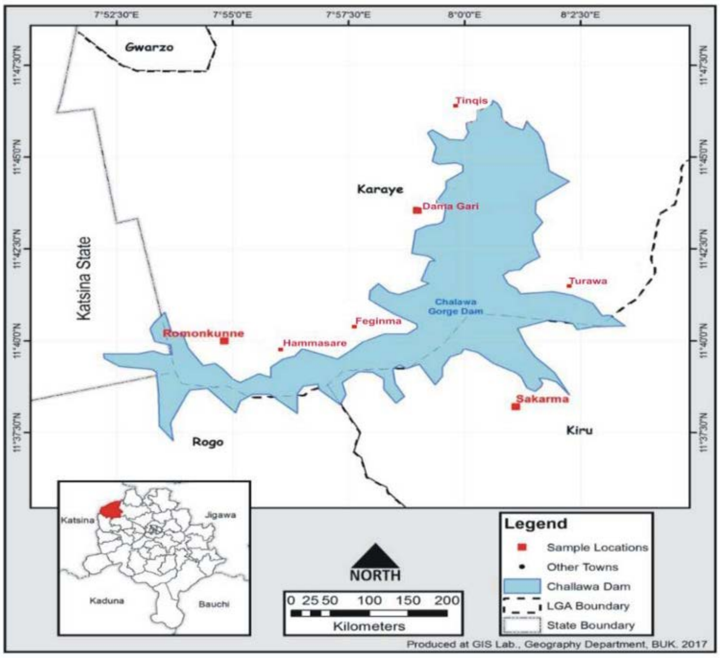

Figure 1: Map of the study area.

Family	Species	English name	Local name
Bagridae	*Bagrus b. macropterus*	Bayad, Silver catfish	Ragon ruwa, Doza, Misko
Mochokidae	*Synodontis gambiensis*	Wahrindi	'Karaya
	**Synodontis schall*		
Cichlidae	*Oreochromis niloticus*	Nile Tilapia	Karfasa
Mormyridae	*1. Marcusenius isidori*	Baby whale,	Lausa
	**Pollimyrus isidori*	Stonebasher	
	2.Gnathonemus senegalensis		
	**Marcusenius senegalensis*	-	Farin wata, Kuma, Lali
Clariidae	*Clarias lazera*	African catfish	Tarwad'a
Cetropomidae	*Lates niloticus*	Niger/Nile Perch	Giwan ruwa, 'Barya
*Latidae			
Characidae	*Alestes nurse*	Silversides	'Kawara, Jan wutsiya
*Alestidae	**Brycinus nurse*		
Schilbeidae	*Schilbe mystus*	Butterfish	Balo, Rampai
	**Schibe uranoscopus*		
Bagridae	*Auchenoglanis occidentalis*	Bubu, Armored catfish	Buro
*Claroteidae			

*****Illustrates latest names.

Table 1: Fish species identified at Challawa gorge dam during the study.

Family	Species	English name	Local name
Malapteruridae	*Malapterus electricus*	Electric catfish	Minjirya
Cichlidae	*1. Sarotherodon galiliaeus*	Mango tilapia	Gargaza
	2. Other tilapia spp.	Tilapia	Karfasa
Osteoglossidae	*Heterotis niloticus*	Heterotis	Bargi
Clariidae	*Heterobranchus* spp.	Catfish	Mari
Mormyridae	*1.Mormyrus hasselquisti*	-	Taku, Fura
	2.Mormyrus rume	Bottlenose	Milligi
	3. Mormyrus deliciosus	Trunkfish	Sangwami
Cyprinidae	*1.Labeo senegalensis*	African carps	'Data
	2. Other labeo spp.		
Characidae	*Hydrocynus* spp.	Tiger fish	Tsege, Zawai
Mochokidae	*Synodontis* spp.	Squeker	'Kurungu
Gymnarchidae	*Gymnarchus niloticus*	-	'Dan-sarki

Table 2: Fish species that were available before.

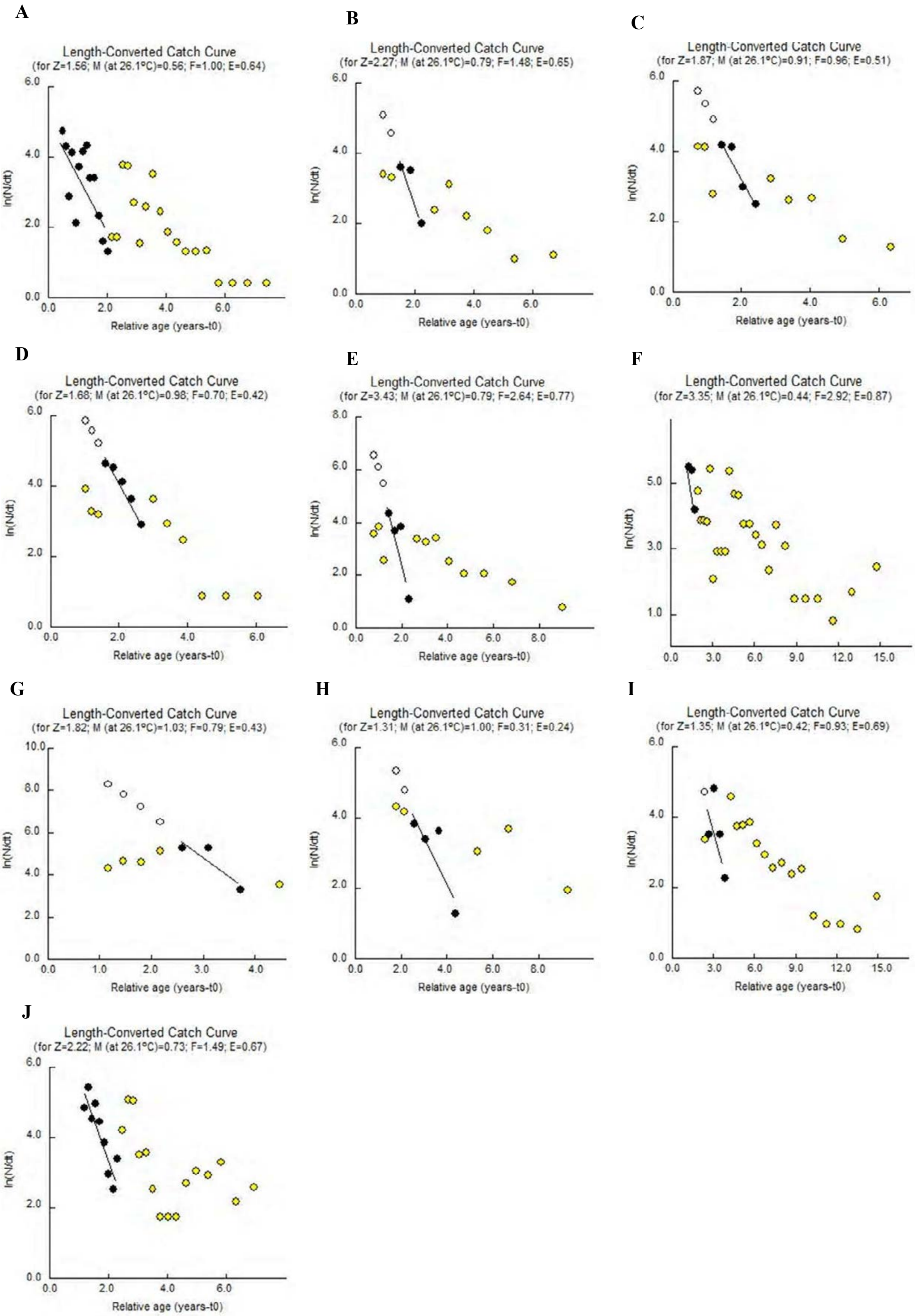

Figure 2: Length-converted catch curves used to estimate Total mortality, Natural mortality, Fishing mortality and Exploitation rate. A (*Bagrus b. macropterus*), B (*S. schall*), C (*O. niloticus*), D (*P. isidori*), E (*C. lazera*), F (*L. niloticus*), G (*M. senegalensis*), H (*B. nurse*), I (*S. uranoscopus*) and J (*A. occidentalis*).

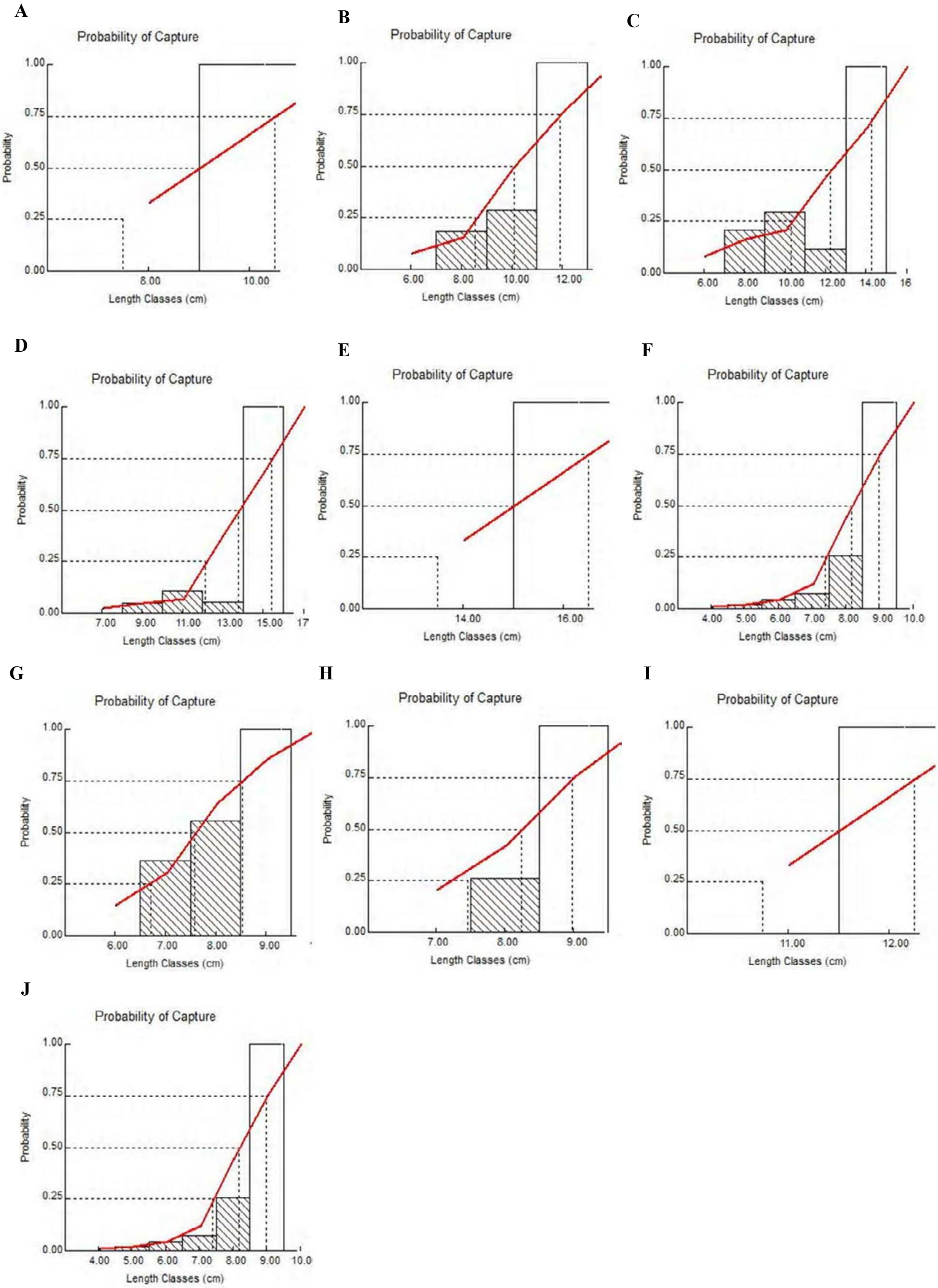

Figure 3: Probabilities of capture. A (*Bagrus b. macropterus*), B (*S. schall*), C (*O. niloticus*), D (*C. lazera*), E (*L. niloticus*), F (*M. senegalensis*), G (*B. nurse*), H (*S. uranoscopus*), I (*A. occidentalis*) and J (*P. isidori*).

- *Z/K* value of 1 indicates population is in equilibrium (Where mortality balances growth),
- *Z/K* values of >1 indicate mortality domination; and
- *Z/K* value of ≥2 indicates the fish population is highly exploited [31]. These values are relative to the population size, fecundity and the exploitation rate for a given species.

The growths of *B. nurse* and *P. isidori* dominated their mortalities. The mortalities of *S. schall* and *M. senegalensis* dominated their growths. While, *Bagrus b. macropterus, O. niloticus, C. lazera, L. niloticus, S. uranoscopus* and *A. occidentalis* were highly exploited more than their growth could replace their biomass.

Exploitation status of Challawa fishery

Using the *FiSAT_II* software, the exploitation status of the individual species studied from Challawa dam were estimated. The required inputs for this function are: M/K, L_c/L_∞, "*a*" and "*b*" values (from length-weight relationships). Below are the outputs (graphs) generated for each of the species in Figures 4a–4j.

L_c/L_∞ of less than 0.5 indicates that small-sized fishes are exploited. M/K and L_c/L_∞ were used as inputs for the Beverton and Holt exploitation analysis. The *Selection ogive* was preferred because it was more practical to the fishery of the area under study. Because fishes caught below the $L_{c(50)}$ are retained and never returned to the water. When $E_{current}$=0.5, that is the optimum level of exploitation. Therefore when F=M, then E=0.5.

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Bagrus b. macropterus: *Bagrus b. macropterus* population in Challawa dam are overly exploited. The Maximum Sustainable Yield (MSY) was 0.398, but the current exploitation rate was 0.64. The Maximum Economic Yield (MEY) which is the value that will ensure maximum economic return to the fishermen was (E_{10}) 0.320. It was slightly below the *MSY* which shows that the *Bagrus* population is highly sought after by the fishermen, but its exploitation is highly unsustainable. Hence the probable reason for its rapid decline. At current exploitation rate the Y/R and B/R stand at 0.011 and 0.049, respectively, which is far lower for replenishing depleting stocks, considering the exploitation rate (Figure 4a).

Species	Z^{-yr}	Z/K	M^{-yr}	F^{-yr}	E	Probability of capture(cm)		
						L_{25}	L_{50}	L_{75}
Bagrus b. macropterus	1.56	2.19	0.56	1	0.64	7.76	9.3	16.18
Synodontis schall	2.27	1.92	0.79	1.48	0.65	8.56	10.08	11.92
Oreochromis niloticus	1.87	2.36	0.91	0.96	0.51	10.32	12.24	14.3
Pollimyrus isidori	1.68	0.1	0.98	0.7	0.42	8.43	9.29	10.13
Clarias lazera	3.43	2.67	0.79	2.64	0.77	12.13	13.76	15.41
Lates niloticus	3.35	4.66	0.44	2.92	0.87	13.5	15	16.5
M senegalensis	1.82	1.4	1.03	0.79	0.42	7.39	8.18	8.99
Brycinus nurse	1.31	0.66	1	0.31	0.24	6.7	7.58	8.52
Schilbe uranoscopus	1.35	2.71	0.42	0.93	0.69	7.45	8.24	8.99
A occidentalis	2.22	2.03	0.73	1.49	0.67	10.75	11.5	12.25

Where; Z=Total instantaneous mortality, M=Natural mortality, F=Fishing mortality, E=Exploitation rate

L_{25}=Length at which 25% of the population will be vulnerable to fishing gear.

L_{50} (Length at first capture)=Length at which 50% of the population will be vulnerable to fishing gear.

L_{75}=Length at which 75% of the population will be vulnerable to fishing gear.

Table 3: Mortality Rates Parameters.

	Biological Reference Points					
Species	E_{max}	E_{10}	E_{50}	$E_{current}$	M/K	L_c/L_∞
Bagrus b. macropterus	0.4	0.32	0.25	0.64	2.08	0.12
Synodontis schall	0.56	0.47	0.28	0.6	2.14	0.32
Oreochromis niloticus	0.64	0.51	0.33	0.51	2.33	0.37
Pollimyrus isidori	0.7	0.56	0.34	0.42	2.65	0.42
Clarias lazera	0.62	0.52	0.32	0.77	2.33	0.36
Lates niloticus	0.45	0.37	0.27	0.87	2.45	0.2
M. senegalensis	0.75	0.61	0.37	0.42	3.01	0.53
Brycinus nurse	0.65	0.52	0.2	0.24	3.03	0.48
Schilbe uranoscopus	0.56	0.46	0.22	0.69	3.5	0.26
A. occidentalis	0.54	0.45	0.3	0.67	2.43	0.29

Where; E_c=Current Exploitation rate;

E_{max}=Exploitation rate that will produce maximum sustainable yield;

E_{10}=Exploitation rate at which the marginal increase in Y/R is 10% of its virgin population.

E_{50}=Exploitation rate under which the population is reduced to half of its virgin population.

M/K=Indicates the health of the habitat of the fish

L_c/L_∞=The growth rate of fish at L_c relative to the L_∞.

Table 4: Exploitation Parameters.

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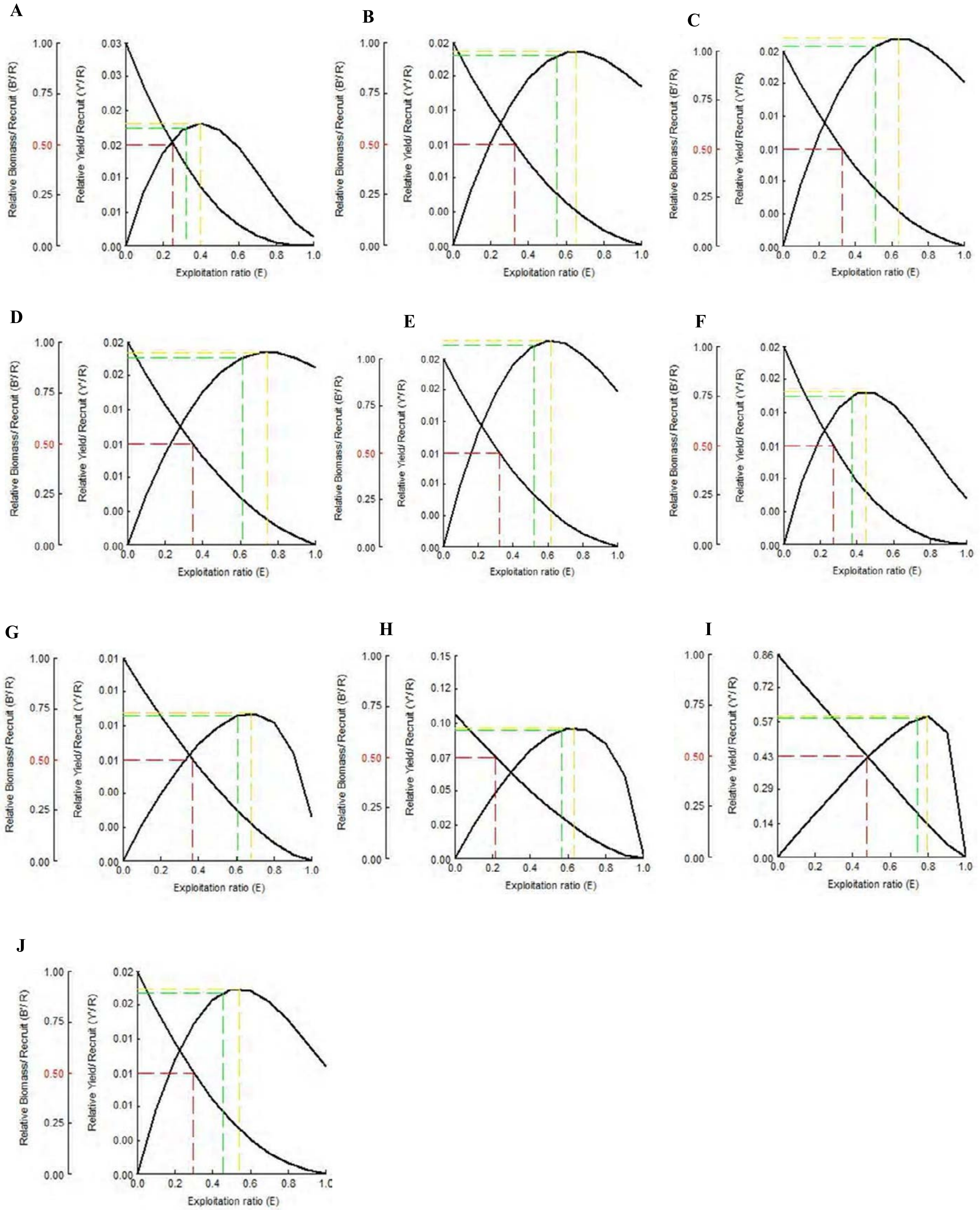

Figure 4: Relative Y/R and B/R using selection Ogive. A (*Bagrus b. macropterus*), B (*S. schall*), C (*O. niloticus*), D (*P. isidori*), E (*C. lazera*), F (*L. niloticus*), G (*M. senegalensis*), H (*B. nurse*), I (*S. uranoscopus*) and J (*A. occidentalis*).

Synodontis schall: *Synodontis schall* exploitation in Challawa dam can be said to be within safe limits because the difference between the current exploitation rate and the (E_{max}) is slim. It's *MEY* (E_{10}) indicates catches should be reduced by 10%. But according to the Virtual Population Analysis (VPA) fishing pressure to the juvenile stock might cause decline of the population. The Y/R & B/R was 0.019 and 0.211 (Figure 4b).

Oreochromis niloticus: *Oreochromis niloticus* population are exploited at par with the Maximum Economic Yield 0.51 (Table 4). Their exploitation even if upped by 13% might not affect the Tilapia population. It might be as a result of the fact that they are prolific breeders and they are lower on the food chain. Though the juvenile of the Tilapia are exploited there was no reason for concern. The Y/R and B/R were estimated at 0.020 and 0.30, respectively (Figure 4c).

Pollimyrus isidori: *Pollimyrus isidori* population are very abundant in the Challawa dam considering its high E_{max} 0.70 compared to current exploitation rate of 0.42 (Table 4). Therefore they under-exploited probably because of their low market demand. *Pollimyrus isidori* exploitation might be increased by about 28%. The Y/R & B/R were about 0.017 and 0.33 respectively (Figure 4d).

Clarias lazera: *Clarias lazera* are highly exploited in Challawa fishery. If the fishing pressure on *Clarias* population might be reduced by 15%, the Maximum Economic Yield (MEY) might be increased by about 10%. The Optimum exploitation rates (E_{50}) – 0.32 (Table 4) was doubled by (E_{curr}) – 0.77 indicating that it is one of the highly sought after species. The Y/R & B/R were found to be close to 0.02 and 0.07, respectively(Figure 4e).

Lates niloticus: *Lates niloticus* was the most exploited species in Challawa dam with an exploitation rate of 0.87 (on a scale of 0-1) (Table 4). It has the highest fishing mortality of 2.92 (Table 4) with a length at first capture as small as 15.00 cm (Table 3). Whereas the *MSY* was 0.45 the Optimum Exploitation rate was as low as 0.27. This indicates that *Lates* are exploited well beyond their replenishing capacity. It was not surprising bearing in mind that the predominant fishing methods were Gill nets & Baited long lines. And almost all the fishermen target this species. The Y/R and B/R was 0.001 and 0.01 indicating low recruitment yield and biomass return for this species in Challawa dam (Figure 4f).

Marcusenius senegalensis: *Marcusenius senegalensis* population is under-exploited probably because of low market return. Their exploitation rates can be raised by about 30% for all the length classes without concern, in fact they had the highest Y'/R of 0.464 (Figure 4g).

Brycinus nurse: *Brycinus nurse* population is under-exploited by the fishermen. The low $E_{current}$ value of 0.24 suggests that little interest is accorded this specie by the resource users. From the values generated by the FiSAT_II software it was apparent that increasing the catches of *Brycinus nurse* won't negatively affect the population. The Y/R and B/R values were 0.064 and 0.34, respectively (Figure 4h).

Schilbe uranoscopus: *Schilbe uranoscopus* population is over-exploited. Its exploitation rate should be decreased by about 19% because further fishing pressure to the juvenile stock will decrease the E_{10} (Maximum Economic Yield) by about 10%. The Y/R and B/R were found to be about 0.57 and 0.26. These indicate that recruitment into the fishery per outweighed fishing mortality (Figure 4i).

Auchenoglanis occidentalis: *Auchenoglanis occidentalis* population is overexploited by about 17%. The exploitation rate of 0.67 shows that it was beyond the *MSY*=0.54 and the E_{opt}=0.5. As with other species, fingerlings and juvenile overfishing was very high considering the length at first catch and length at first recruitment (L_{50})=11.50 cm (Table 4). The Optimum exploitation level, E_{50}=0.30 for this specie indicated high fishing pressure. The high instantaneous fishing mortality rate of 1.49 out of 2.22 suggests that it is one of the species that command considerable market value (Figure 4j).

Discussion

Bagrus b. macropterus

The ideal length at first maturity for *Bagrus* is 17.1 cm (Fishbase.org). The Challawa species' L_c=9.30 cm. This showed that there is growth and recruitment overfishing, characterised by small-sized fishes in the landings. From the study (Table 4) the value of L_c/L_∞ was 0.12, which was lower than 0.5 [31]. This affirms the presence of many small-sized *Bagrus* spp. in the landing, indicating that small mesh sizes were employed.

The estimated Z/K ratio (Table 3) for *Bagrus* this study was greater than 1, which depicts mortality domination for the targeted species. A Z/K value of ≤ 2 shows that the species are lightly exploited. From Table 4, the $E_{current}$ for this species was estimated at 0.64, which was above the E_{opt}=0.5. Also, the E_{max} (Exploitation level that maximises Y/R or B/R) was relatively lower at 0.40 (Table 4). In comparison to a similar study conducted in Lake Akata, Benue state, Ikongbeh et al. [32] reported lower total mortality of 1.43 compared to 1.56, lower fishing mortality of 0.381 compared to 1.00, lower exploitation level of 0.266 compared to 0.64. Also, Akombo et al. [33] found out that the population parameters *C. auratus* (Bagridae) of River Nile, Egypt were Z=1.44, M=0.60, F=0.84, E=0.58, Y/R=0.0158.

Synodontis schall

The length at first capture 10.08 cm (Table 3) was far below the length at first maturity - 21.00 cm (fishbase.org). This indicates serious growth overfishing that does not spare fingerlings. The L_c/L_∞ of 0.32 < 0.5, confirms the fact that smaller sized fishes dominated the catches.

Mospela and Nongu reported L_∞=30.9 cm, L_{50}=14.28 cm, M=1.40, Z=3.57, F=2.17 and E=0.61 for Okavango Basin, Botswana. Ragheb [34] in another study on *S. schall* in the lower Benue river, got the following values: M=1.045, F=2.360, Z=3.405 and E=0.69.

Oreochromis niloticus

The estimated length at first capture (12.24 cm). The Z/K ratio (2.36) indicates that Tilapia are mortality dominated, but the E value (0.51) in Table 4, shows that the fish stock are replenished enough to counter the exploitation, and adjusted to optimal level. Abdul et al. [35] studied the Tilapia of Ogun estuary and they got; Z=3.93, M=1.46, F=2.47, E=0.63 and $L_{r(50)}$=10.23 cm. The asymptotic length and growth rates were higher than this study, but the length at first maturity in this study (12.24 cm) was higher than the Ogun estuary which means Tilapia in the Estuary are recruited earlier than in Challawa dam. The L_r for Lake Timsah, Egypt [36] was even lower at 8.4 cm. But these lower values might be due to differences in fishing gears and mesh sizes employed in the localities [7,26,37]. In a WorldFish Center report [38], on lake Nasser Egypt in 1972 and 1992 showed; L_∞=50.39, 54.73; K=0.16,0.27; Z=1.21,0.83; M=0.42, 0.24; F=0.31,0.97; and E=0.4,0.8, respectively.

Pollimyrus isidori

The cut-off length (3.15 cm) being lower than the L_{50}=9.29 cm proves that all landings catches are retained no matter the size. The *E* value of 0.42 (Table 4), shows that it is a less sought-after species. A

Z/K value of 0.10 further illustrates the fact that the species' growth outweighed mortality.

Clarias lazera

The estimated L_c (13.76 cm) was found to be lower than the L_r which was 30.86 cm. This indicates recruitment overfishing. The Z/K and E values of 2.67 and 0.77, respectively show that *Clarias* are highly exploited in this fishery. In a report on Lake Kainji [39] found M=0.90, F=1.17, Z=2.07, L_∞=56.6 cm, K=0.47.

In Cross-River floodplain, Mustapha [40] found L_∞=80.24 cm, K=0.49, Z=2.54, M=0.88, E=0.66. In another research [40] found L_{50}=45.7 cm, K=1.67, F=2.37, M=1.18, Z=3.55, E=0.67. And in Gubi dam, Bauchi state [41] L_∞=43 cm, K=0.65, F=1.20, M=0.22, Z=1.44, E=0.833. This shows that *Clarias* in Gubi dam grow faster than the Challawa species and are exploited much more than Challawa dam.

Marcusenius senegalensis

The L_{50}=8.18 cm. In Bontanga Reservoir, Ghana. Kwarfo-Apegyah et al. [42] found L_∞=24.68 cm, K=0.69, Z=2.4, M=1.49, E=0.38, F=0.91. This shows that the species in Bontanga grow bigger and faster than the Challawa species. But they are all within safe limits of exploitation.

Brycinus nurse

The estimated length at fist capture (L_{50})=7.58 cm. In lake Nasser, L_∞=20.3 cm, Z=0.8, M=0.7, F=0.1, E=0.1. In Bontanga Reservoir, Ghana. Kwarfo-Apegyah et al. [42] the values obtained were; L_∞=20.48 cm, K=0.52, Z=2.54, M=1.3, E=0.49, F=1.24. *B. nurse* grow faster and attain bigger sizes than Challawa, but are exploited more in Bontanga Reservoir but less in Lake Nasser. However, they are all sustainably harvested.

Schilbe uranoscopus

The estimated length when first captured was L_{50}=8.24 cm. Olaosebikan et al. [43] in southeast Nigeria got L_∞=11.03 cm, K=0.63, Z=2.42, M=1.68, F=0.74, E=0.31. In Jebba reservoir, Etim et al. [44] got L_∞=12.92 cm, K=1.81, Z=6.54, M=1.71, F=4.82, E=0.73. These show that this species attain bigger sizes in Challawa than both the localities, probably because they are exploited more in those localities than in this dam.

And from Cross River, Chukwu and Deekae [45] reported L_∞=27.5 cm, K=0.29, Z=1.85, M=0.81, F=1.04, E=0.56. Bawole et al. [46] in New Calabar River got L_∞=15.28 cm, K=0.65, Q'=2.181, Z=2.03, M=1.68, F=0.35, E=0.17.

Lates niloticus

The estimated length at first capture was 15.0 cm. These point-out growth overfishing. In lake Nasser [38] got L_∞=180 cm, K=0.069, Z=0.35, M=0.17, F=0.18, E=0.5. This indicates that Nile perch in this lake attain bigger sizes and are exploited within safe limits. While at Kainji lake [39] got L_∞=158.7 cm, K=0.25, Z=3.61,M=0.49, M/K=1.96, F=3.12, E=0.86. Kainji lake species attain bigger sizes but are over-exploited despite good yearly growth rate [47].

In lake Victoria, Udoh and Ukpatu [47] reported L_∞=169 cm, K=0.0195, Z=0.724, M=0.372. F=0.352, E=0.49. This means Lake Victoria Nile perches are exploited optimally.

Auchenoglanis occidentalis

The estimated length at first capture was 11.50 cm. In Cross River [33] the results obtained were; K=1.5, L_∞=120.23 cm, Θ'=4.045. This indicates better growth performance than Challawa species. In Bontanga Reservoir, Ghana [42] L_∞=54.08 cm, K=0.1, Z=1.04, M=0.34, E=0.68, F=0.71. The Asymptotic length was higher than this study (Table 4). The growth rate was lower, but that is understandable considering the fact that as fish grow older, the annual growth rate slows down [13,48-55]. The exploitation level was higher compared to Challawa dam fishery [56-59].

Conclusion

Small-sized fishes are highly exploited in the dam for all the species with the exception of *Marcusenius senegalensis* probably because their adults are 12-15 cm. As with similar findings, species deemed to be of commercial value were over-exploited and species of lower demand were mostly under-exploited.

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Conflicts of Interest

The authors declare no conflict of interest.

References

1. Affognon H, Christopher M, Pascal S, Christian B (2015) Unpacking Postharvest Losses in Sub-Saharan Africa : A Meta-Analysis. WORLD Dev 66: 49-68.
2. Williams SK, Adesogan AT, Dahl GE (2016) Survey to determine current methods for handling and preservation of fresh fish in three Malawi cities.
3. Olaosebikan BD, Bankole NO (2005) An analysis of Nigerian freshwater fishes: those under threat and conservation options.
4. Pauly D, Morgan GR (1987) Length-based methods in fisheries research. World Fish 13.
5. Cohen PJ, Cinner JE, Foale S (2013) Fishing dynamics associated with periodically harvested marine closures. Glob Environ Chang 23: 1702-1713.
6. Grema HA, Geidam YA, Egwu GO (2011) Fish Production In Nigeria: An Update. Niger Vet J 32: 226-229.
7. Raji A, Okaeme AN, Omorinkoba W, Bwala RL (2012) Illegal fishing of inland water bodies of Nigeria: Kainji experience. Continental Journal of Fisheries and Aquatic Science 6: 47-58.
8. Linus BG, Amos SO, Michael ET, Michael KG (2014) Fishing communities and fishing as livelihoods in Adamawa state. Direct Res J Agric Food Sci 2: 195-204.
9. Ali J, Abubakar UM (2015) Fish Species Diversity and Abundance of Dadin Kowa Dam, Gombe State Nigeria. Int J Innov Res Dev 4: 374-378.
10. Arome G, Ugondo M (2014) Fish Species Diversity and Abundance of Gubi Dam, Bauchi State of Nigeria 3: 60-67.
11. Enin UI (1995) First estimates of growth, mortality and recruitment parameters of Macrobrachium macrobrachion Herklots, 1851 in the Cross River estuary, Nigeria. Dana 11: 29-38.
12. Auburn University, USDA/Natural Resources Conservation Service (2004) Fish Mortality Management. Best Manag. Pract.
13. Meekan MG, Vigliola L, Hansen A, Doherty PJ, Halford A, et al. (2006) Bigger is better: size-selective mortality throughout the life history of a fast-growing clupeid, Spratelloides gracilis. Marine Ecology Progress Series 317: 237-244.
14. Kitinoja L, Saran S, Roy SK, Kader AA (2011) Postharvest technology for developing countries: Challenges and opportunities in research, outreach and advocacy. J Sci Food Agric 91: 597-603.
15. Mason S (1997) Length-based fish stock assessment in Senegal.
16. Amarasinghe US, Kumara R (2008) Population dynamics of Hyporhamphus (Beloniformes, Hemiramphidae) in two reservoirs of Sri Lanka lowland 13: 23-38.
17. Pope KL, Lochmann SE, Young MK (2010) Methods for assessing fish populations.

18. Chukwu LO (1997) Environmental Hazards to Small-Scale Fisheries in Nigeria, In: 13th Annual Conference of the Fisheries Society of Nigeria (FISON): 252-259.
19. Bergkamp G, Mccartney M, Dugan P, Mcneely J (2000) Dams, Ecosystem Functions and Environmental Restoration (No. II), Thematic Review. Cape Town.
20. Jackson PBN, Marshall BE, Paugy D (1983) Fish Communities in Man-Made Lakes In: Peuplements Ichtyologiques Des Lacs De Barrage.
21. Ogundiwin DI (2014) Survey of artisanal fishing gear and craft. A case study of Kainji Lake lower basin, Nigeria. Master's thesis, UiT the Arctic University of Norway.
22. Brodziak J, Ianelli J, Lorenzen K, Methot RD (2011) Estimating Natural Mortality in Stock Assessment Applications, NOAA Tech. Memo. NMFS-F/SPO, 119.
23. Caley MJ, Carr M, Hixon MA, Hughes TP, Menge BA (1996) Recruitment and the Local Dynamics of Open Marine Populations Population Dynamics in Open Systems. Annu Rev Ecol Syst 27: 477-500.
24. Acharya G (1998) Hydrological-Economic Linkages in Water Resource Management. University of York.
25. Amponsah SKK, Ofori-danson PK, Nunoo FKE, Ameyaw G (2017) Virtual population analysis and estimates of maximum sustainable yield of some commercially important fish species in the coastal waters of Ghana and management implications. Int J Fish Aquat Res 2: 1-7.
26. Pauly D, Soriano ML (1986) Some practical extensions to Beverton and Holt's relative yield-per-recruit model. In: Asian Fisheries Forum, Manila (Philippines), pp: 26-31.
27. Mirza ZS, Nadeem MS, Beg MA, Qayyum M (2012) Population Status and Biological Characteristics of Common Carp, Cyprinus carpio, in Mangla Reservoir (Pakistan). Journal of Animal and Plant Sciences 22: 933-938.
28. Yohannes F (2003) Management of Lake Ziway Fisheries in Ethiopia. Master's thesis, Universitetet i Tromso.
29. Dadzie S, Manyala JO, Abou-seedo F (2005) Aspects of the population dynamics of Liza klunzingeri in the Kuwait Bay. Cybium: International Journal of Ichthyology 29: 13-20.
30. Kalhoro MA, Liu Q, Valinassab T, Waryani B, Abbasi AR, et al.(2015) Population Dynamics of Greater Lizardfish, Saurida tumbil From Pakistani Waters. Pak J Zool 47: 921-931.
31. Wehye AS, Amponsah SK (2017) Growth, Mortality and Exploitation rates of Lesser African threadfin, Galeoides decadactylus (Bloch, 1795) within the coastal waters of Liberia. Growth 2.
32. Ikongbeh OA, Ogbeh FG, Solomon SG, Ataguba GA (2015) Age, growth and mortality of Chrysichthyes nigrodigitatus (Lacépède, 1803) from Lake Akata, Benue State, Nigeria. Asian J Conserv Biol 4: 81-88.
33. Akombo PM, Cheikyula JO, Kwaghvihi OB (2017) Recruitment, Exploitation, Relative Yield Per Recruit and Mortality of Synodontis Schall (Bloch and Schneider, 1801). In Lower River Benue at Makurdi. Octa J Environ Res 5: 156-161.
34. Ragheb E (2014) Fishery biology of catfish (Chrysichthys auratus, Family: Bagridae) from Damietta branch of the river Nile, Egypt. The Egyptian Journal of Aquatic Research 40: 171-180.
35. Abdul WO, Omoniyi IT, Akegbejo-samsons Y, Akinyemi AA, Agbon AO, et al. (2012) Management Indicators and Growth Performance Index of Tilapia zilli in a Tropical Coastal Estuary. Journal of Agricultural Science 4: 66-71.
36. Mahomoud WFA, Amin AMM, Ramadan KFEAM, EL-Halfawy MMKO (2011) Reproductive biology and some observation on the age, growth, and management of Tilapia zilli (Gerv, 1848) from Lake Timsah, Egypt. International Journal of Fisheries and Aquaculture 3: 16-26.
37. Idowu RT, Eyo JE (2005) Fisheries Status and Fishing Gears of a West African Arid Zone Lake. Anim Res Int 2: 353-357.
38. Halls AS, Habib OA, Nasr-Allah A, Dickson M (2015) Lake Nasser Fisheries: Literature Review and Situation Analysis. Penang, Malaysia.
39. Feu T (2014) Population Parameters for the six commercial species in Lake Kainji, Nigeria Using Length Frequency data sampled from Artisanal Fish Catches. Kainji, Nigeria.
40. Mustapha MK (2016) Estimation of Some Life-History Parameters from Length at First Maturity of African Catfish Clarias Gariepinus (Burchell, 1822) Cultured Under 0l: 24d Photoperiod Using Empirical Equations. Malaysian Journal of Science 35: 1-7.40
41. Abdulkarim M, Yusuf ZA, Musa BL, Ezra AG (2009) Population Parameters of Clarias gariepinus (catfish) in Gubi dam, Bauchi state, Nigeria. Journal Animal Plant Science 5: 531-538.
42. Kwarfo-Apegyah K, Ofori-Danson PK, Nunoo FKE (2009) Exploitation rates and management implications for the fisheries of Bontanga Reservoir in the Northern region of Ghana. West African Journal of Applied Ecology 14.
43. Olaosebikan BD, Muschoot T, Umar Y (2006) Growth, Mortality and Yield OF Paraila pellucida. Niger J Fish 23: 343-357.
44. Etim L, Lebo PE, King RP (1999) The dynamics of an exploited population of a siluroid catfish (Schilbe intermidius Reupell 1832) in the Cross River, Nigeria. Fish Res 40: 295-307.
45. Chukwu KO, Deekae SN (2011) Growth, mortality and recruitment of Periopthalmus barbarus (Linneaus 1766) in New Calabar River, Nigeria. Agric Biol J North Am: 1066-1068.
46. Bawole R, Rembet UN, Ananta AS, Runtuboi F, Sala R (2017) Growth, mortality and exploitation rate of Plectropomus maculatus and P. oligocanthus (Groupers, Serranidae) on Cenderawasih Bay National Park, Indonesia. The Egyptian Journal of Aquatic Research 43: 213-218.
47. Udoh JP, Ukpatu JE (2017) First estimates of growth, recruitment pattern and length-at-first-capture of Nematopalaemon hastatus (Aurivillius, 1898) in Okoro River estuary, southeast Nigeria. AACL Bioflux 10.
48. Waters P (2014) Growth and Population dynamics of flathead grey mullet, Mugil cephalus (Linnaeus, 1758) from Parangipettai waters (Southeast coast of India). Thalassas 30: 47-56.
49. Idumah Okogwu O (2011) Age, growth and mortality of Clarias gariepinus (Siluriformes: Clariidae) in the Mid-Cross River-Floodplain ecosystem, Nigeria. Revista de Biologia Tropical 59: 1707-1716.40
50. Oladejo DA, Adebayo-Tayo BC (2011) Moulds, Proximate Mineral Composition and Mycotoxin Contamination of Banda (“kundi”/“tinko”) Sold in Ibadan, Oyo State, Nigeria. AU Journal of Technology 15.
51. Orire AM, Sadiku SOE, Emmanuel AJ (2013) Fish Species Diversity and Abundance of Tagwal Dam Minna, Niger State.
52. Rabour CO, Gichuki J, Moreau J (2003) Growth, mortality and recruitment of Nile perch Lates niloticus (L. Centropomidae) in the Nyanza Gulf of Lake Victoria: an evaluation update. NAGA World Fish Center Quarterly 26: 8-12.47
53. Sarr SM, Kabre TJA, Cecchi P (2013) Recruitment, mortality and exploitation rates estimate and stock assessment of Mugil cephalus (Linnaeus, 1758 Mugilidea) in the estuary of the Senegal River. International Journal of Agricultural Policy and Research 1: 1-10.
54. Tonye IA, Francis A. Women and Post-Harvest Fish Production in the Niger Delta Area.
55. Victor BC (1983) Recruitment and population dynamics of a coral reef fish. Science 219: 419-420.
56. Team ASPE, Lake Chad Basin Commission. Appraisal of the safety of the Tiga and Challawa Gorge Dams, Nigeria.
57. Mshelia MB, Manneer MB, Garba U, Hassan M (2015). A frame and catch assessment of fishes of lake Alau, Borno State, Nigeria. Int J Fish Aquat Stud 2: 35-40.
58. Akinpelu OM, Ayeloja AA, George FOA, Adebisi GL, Jimoh WA, et al. (2013) Gender Analysis of Processing Activities among Commercial Catfish. J Aqu Res Dev 4: 3-7.
59. Edun OM, Uka A (2011) Biotechnology in Aquaculture: Prospects and Challenges. Niger J Biotechnol 22: 8-12.