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THE EXPLOITATION STATUS OF THE FISHERY RESOURCES OF RIVER OKURA, DEKINA LOCAL GOVERNMENT OF KOGI STATE CENTRAL NIGERIA

Meriyamoh Mero ONIMISI *
*Prince Abubakar Audu University Anyigba, Kogi State, Nigeria.
Corresponding Author: **onimisimeriyamohmero@yahoo.com**
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Abstract

The exploitation status of the fishery resources of River Okura was studied from November 2014 to October, 2016. The specific objectives were to survey the type of fishermen, species of fish exploited along the river and to estimate the exploitation rate. Parameters used to estimate exploitation rate include instantaneous mortality coefficient (Z), natural mortality (M) and fishing mortality (F). Z is the negative sign of the slope of the equation: $y = a + bx$ estimated from the age-structured catch curves of the species. M was estimated using the empirical formula: $Ln(M) = -0.0066 - 0.279\text{Log }(L\infty) + 0.6543Log\ (K) + 0.463Log\ (T^0C)$. F is obtained from the model: $F = Z - M$. Exploitation rate (E) of the fish was determined from mortality parameters. The occasional fishermen dominated the fishery of River Okura (72.2% by occurrence). The species exploited along the river include *Heterobranchus longifilis*, *Oreochromis niloticus*, *Brycinus longipinnis*, *Chromidotilapia guntheri*, *Ctenopoma petherici*, *Tilapia zilli*, and *Pellonula leonensis*. The mean exploitation rate (E) for the fishery stock is 0.3±0.2 with range value from 0.1 to 0.6. Natural mortality (range: 0.84/yr to 2.81/yr, mean: 1.39±1.48/yr) is observed to be higher than the fishing mortality (range: -2.18 to 0.14/yr, mean: -0.51±0.76/yr). The fish stock of River Okura is presently under-exploited (E > 0.5 and M< F). The value of M observed to be greater than F is an indication that most deaths of fish of River Okura resulted from natural causes and not fishing. The unemployed especially in communities along river Okura should be encouraged to go into fishing as a profession as this will generate employment and income for them, increase the protein quota and alleviate poverty in such communities.

Key words: Estimate, Fishing, Mean, Mortality, Natural.

Introduction

Fish is a primary source of protein. It accounted for 17 percent of the global population's intake of animal protein and 6.5 percent of all protein consumed in 2010 (FAO, 2014a). Dependence on fish protein by the populace is highest in developing countries (Béné *et al*., 2007). Fishery which is the occupation of harvesting or rearing of fish provides significant source of employment and livelihoods globally (Allison *et al*., 2013). It is estimated that more than 158 million people in the world depend directly on fish-related activities such as fishing, fish farming, processing and trading (HLPE, 2014). According to FAO (2014) the fisheries sector as a whole employs 12.3 million people as full-time fishers or full-time and part-time processors, representing 2.1 percent of Africa's population of between 15 and 64 years old. Fishers represent half of all people engaged in the sector, 42.4 percent are processors and 7.5 percent work in aquaculture. About 27.3 percent of the people engaged in fisheries and aquaculture are women, with marked differences in their share among fishers (3.6 percent), processors (58 percent), and aquaculture workers (4 percent). Capture fisheries and aquaculture provide 3.0 billion people with almost 20 percent of their average per capita intake of animal protein, and a further 1.3 billion people with about 15 percent of their per capita intake (FAO, 2012a).

The protein and nutrient content of fish as food; its role of fisheries and aquaculture activities as a source of income and livelihoods; and its relative efficiency to produce or transform proteins stand out to ground its importance for food security and nutrition (Tacon & Metian, 2013 and HLPE, 2014). The importance of fish to food security in developing countries cannot be overemphasized. Small and large scale fisheries are important for food security. In the poorest countries of Africa, more than half of the protein and minerals for over 400 million people were supplied by small scale fisheries (HLPE, 2014 and FAO, 2014).

Nigeria as a maritime nation with a vast population of over 160 million people and a coastline measuring approximately 853 kilometers, fish production as an enterprise possesses the capacity to contribute significantly to the agricultural sector (FDF, 2008). With an annual fish demand of about 2.66 million tons in Nigeria, domestic production of about 780,000 tons is supplied leaving a deficit of about 1.8 million tons for a population of steady increase rate of 2.2% per annum (UNDP, 2007; FDF, 2008 and Ahmed, 2015). The major sources of Nigeria's fish supply were imports (56%); coastal, brackish-water and inland fishery by artisanal fisher folks (37.6%); industrial trawl fishery (2.6%); and contribution of 3.8% from aquaculture (Anene *et al*., 2010). Nigeria spends N100 billion on fish importation annually while the present importation rate is over 750,000 metric tons. Domestic fish production is therefore far from meeting demand, and food imports will not provide a complete solution to fish food security problems arising from the population increase (Ahmed, 2015). Ensuring future food security demands therefore increase in productivity and careful management and governance that protects these resources from over-exploitation and other sectors' impacts (FAO, 2014a).

Fish mortality is a term widely used in Fisheries Science that denotes the loss of fish from a stock through any means. It can be divided into two types namely natural mortality and fishing mortality. Natural mortality is the removal of fish from the stock due to causes not associated with fishing. Such causes can include disease, competition, cannibalism, old age, predation, pollution or any other natural factor that causes the death of fish (MEA, 2005 and Biotoxins, 2006). In fisheries population dynamics natural mortality is denoted by M (Sparre *et al*., 1989). Fishing mortality is the removal of fish from the stock due to fishing activities using any fishing gear. It is denoted by F in fisheries models. The natural and fishing mortalities sum up to form instantaneous mortality (Gulland, 1969 and Buijse, 1992). These rates are usually calculated on an annual basis. Estimates of fish mortality rates are often included in mathematical yield models to predict yield levels obtained under various exploitation scenarios. These are used as resource management indices or in bioeconomic studies of fisheries.

Exploitation rate helps to determine whether or not a fish stock is over-exploited (that is overfished). This is based on the assumption that optimal exploitation (E_{opt}) value is 0.5. Optimum exploitation value of 0.5 is on the assumption that sustainable yield is optimized when fishing mortality equates natural mortality (Gulland, 1971; Pauly, 1983 and Francis, 2003). Tobor (1991) reported that the value of natural Mortality (M) for majority of the Gulf of Guinea fish stocks range from 0.5-1.0 and that a value of 0.7 was a good estimate for natural mortality. The exploitation ratio is defined as the fraction of fish present at the start of a year that is caught during the year (Ricker, 1975).

River Okura passes through many villages in Kogi state where it forms a large expanse at Ofejiji where it is dammed. Few fishermen which operate mostly occasionally are found along the river. In view of the massive unemployment situation in Nigeria and also to bridge the gap in production of fish protein for the growing populace, there is need to study the fishery and exploitation status of the river. This research seeks to study the exploitation status of River Okura at Ofejiji. The data generated will help in making policies that will guide the exploitation of the fishery resources if the stock is overexploited and if underexploited, an awareness scheme for the villagers along the river should be undertaken either by the government or non-governmental organization to encourage them into artisanal fishery. This will not only provide protein for the communities but will alleviate poverty by providing jobs for the fishermen and to people connected in the value chain.

Materials and Methods

Study area

The study area is River Okura at Ofejiji in Dekina local government area of Kogi State, north central Nigeria. The geographic coordinates of Ofejiji as determined by using Global Positioning System (G.P.S) was N:$07^{0}24.55'$ and E:$007^{0}19.39'$. It is currently dammed to form an expanse of water. The climate is characterized by that of Tropical Guinea Savannah. The hydrological regimes are two main seasons, the dry season (October/November to March) and the rainy season (April to September/October) approximately corresponding to the dry and flood phase respectively. Annual rainfall ranges from 1,100mm to 1,300mm. The average minimum and maximum temperatures are $22.8^{o}C$ and $33.2^{o}C$ respectively. The vegetation consists essentially of short to tall trees of different sizes, heights and species. Generally, there is a thick vegetation cover around the study area which is strongly supported by the flow of the river during the dry and wet seasons. There are economic trees such as cashew, mangoes and palm tree plantations along the water course. The river serves as a source of domestic water supply for the villagers around the settlement. It is being used for irrigation of crops during the dry season. The sampling points were accessed by a dug-out canoe. Figure 1 shows River Okura at Ofejiji in Kogi State of Nigeria.

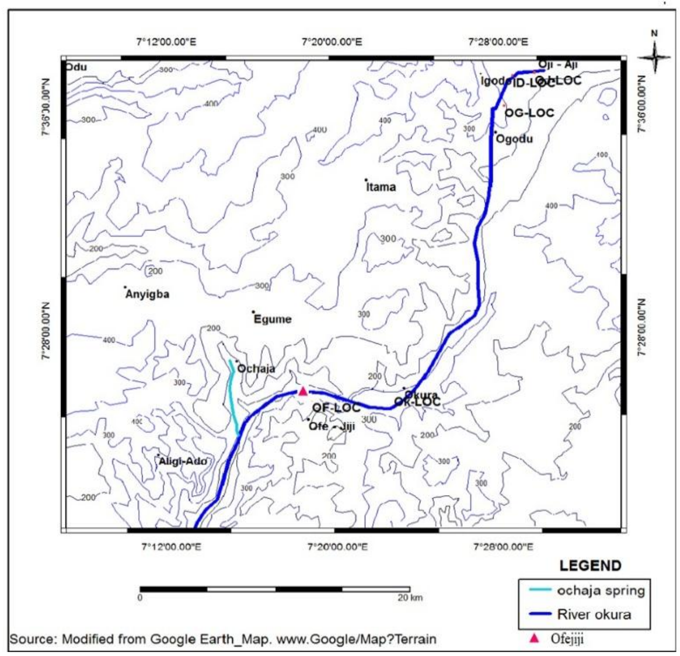

Fig. 1: Map of River Okura at Ofejiji in Kogi State of Nigeria

Fishery of the river

For fish species composition, fish samples were collected from November, 2014 to October 2016 both from experimental fishing and from the local fishermen. Fish samples were obtained from Okura-Olafia and Ofejiji. Fishermen used nets, traps, hook and lines. Intensive experimental fishing (conducted by two hired fishermen) was done using the following fishing gears such as gill net (4.5x4.5cm mesh size), setline with hooks of various sizes (12, 7, and 4), cast net (4x4 cm mesh size) and the gura traps. This was done forth- nightly for 24months. The fish samples were transported to Kogi State University Laboratory in a cooler of ice block to avoid postmortem. The fish species were identified to species level using keys and catalogue provided by Leveque *et al*. (2001) and Olaosebikan & Raji (2004).

Fishery data was collected from the fishermen along the River through the use of questionnaires. The questionnaires entailed the biological data of the fisherman, the type of fishing gear employed and the mesh size, the fishing craft used, the species of fish caught the time spent in one fleet, how many fishermen go per fleet, and the season of the year, the type of fishing they embark on whether part-time, occasional or professional. Also physical observations were made.

Mortality parameters

Mortality parameters used to determine exploitation rate include instantaneous mortality coefficient, fishing and natural mortalities

Instantaneous mortality coefficient (Z)

Instantaneous mortality coefficient was estimated from the age-structured catch curves of the species (Ricker, 1975). The age structure was obtained from the length frequency data. The age-structured catch curves method involved the linear regression of the natural logarithms of the number of species in various age groups i.e. Ln (N) against their corresponding relative age in years. Z is the negative sign of the slope (b). It will be obtained from the equation of the graph of $y = a + bx$, where y is In (N), 'a' is the intercept on y-axis,' b' is the slope and x-axis is the age of fish.

Natural mortality (M)

M was estimated using Pauly's empirical formula (Pauly 1980). It integrated mortality and size using the mean temperature of the water body in which the fish species are caught. River Okura for. The formula is

$$Ln(M) = -0.0066 - 0.279 \text{Log}\,(L\infty) + 0.6543 Log\,(K) + 0.463 Log\,(T^{0}C).$$

Where, M = Natural mortality coefficient, L∞ =Asymptotic length, K = Growth co-efficient or growth factor, T = Mean temperature of River Okura= 25.8^{o}C (Onimisi & Ogbe, 2018).

Fishing mortality (F)

Once instantaneous mortality rate (Z) and natural mortality (M) are obtained, fishing mortality (F) is derived after Ricker (Ricker, 1975) and Pauly (Pauly, 1980) from the relationship:

F = Z – M.

Where: Z is total mortality and M is natural mortality

Determination of the various parameters used in natural mortality

The von Bertalanffy growth parameters, asymptotic length (L_∞) and growth co-efficient (K) were both estimated directly from the length composition of the stock using Electronic Length Frequency Analysis 1(ELEFAN 1) after Pauly (Pauly, 1982). The age structure was estimated from the length frequency data after Bhattacharya (Bhattacharya, 1967).

Exploitation rates

Exploitation rate (E) of the fish were determined after Pauly (1983) and Beverton and Holt (1956). It is expressed as:

$$y = \frac{F}{(F+M)} \; or \; \frac{F}{Z}$$

Where M is the natural mortality rate, F is the fishing mortality rate and Z is instantaneous mortality.

Results and Discussion

Six thousand, seven hundred and ninety (6790) fish samples belonging to seven (7) species, seven (7) genera and five (5) families were recorded. The species recorded were *Heterobranchus longifilis, Ctenopoma petherici, Brycinus longipinnis, Pellonula leonensis, Oreochromis niloticus, Tilapia zilli and Chromidotilapia guntheri.* The presence of the above fish species have been recorded by Onimisi and Ogbe 2015. These species are also found in inland waters of Nigeria (Ita, 1993; Olaosebikan & Raji, 2004; Odoe *et al*., 2009; Offem *et al*., 2009; Ipinmoroti & Olasunkanmi, 2004 and Ipinmoroti, 2013).

There were eighteen (18) fishermen operating along the river from Okura-Olafia to Ofejiji categorized into occasional, professional and part-time fishermen (Table 1).

Table 1: Types of Fishermen operating along River Okura in Kogi

SN	Types of fishermen	Number	% Occurrence
1.	Occasional	13	72.2
2.	Professional	2	11.1
3.	Part - time	3	16.7
	Total	18	100

The occasional fishermen dominated the fishery of River Okura comprising 72.2% of the total fishermen. In an optimally exploited fishery stock, the professional fishermen should dominate the fishery of the river (Gulland, 1971) but on the contrary, they are the least abundant (9.5%) which is an indication of under exploitation. Fishing mortality ranged from -1.18/yr in *P. leonensis* to 0.14/yr in *H. longifilis.* The mean value is -0.51±0.76/yr. Natural mortality ranged from 0.84/yr *H. longifilis* to 2.16/yr in *P. leonensis* with mean value of 1.39±1.48/yr. Instantaneous mortality ranged from 0.62 /yr to 1.17/yr with mean value of 0.906±0.23. The mortality parameters are presented in Figure 2.

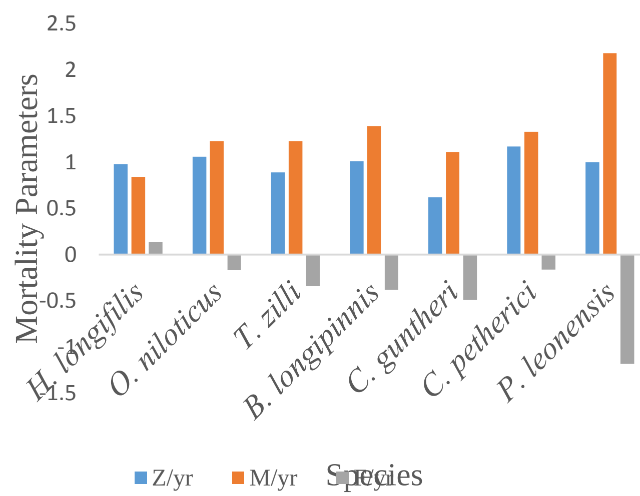

Figure 2: Mortality parameters of fish species of River Okura

In River Okura, fishing mortality (range is -1.18/yr to 0.14 /yr with mean value of -0.51±0.76/yr) is observed to be lower than natural mortality (range: 0.84/yr to 2.81/yr, mean: 1.39±1.48/yr). In an optimally exploited stock, fishing mortality must be about the same value with the natural mortality (Gulland, 1971; Pauly, 1983; Gulland, 1971 and Francis, 2003). Edmond *et al*., 2017 reported under exploitation of *Ilisha africana* as a result of higher value of total mortality rate (4.04/yr) than fishing mortality (1.77/yr). In this study, most deaths of fish of River Okura resulted from natural mortality and not fishing mortality. The lower fishing value shows that the fish is not maximally exploited and that death of fish is as a result of natural causes such as diseases, old age, predators, unfavorable weather etc.

The mean exploitation rate (E) for the fish species is 0.3 ± 0.2 with range value from 0.1 to 0.6. The exploitation parameters and exploitation status of the fish species of River Okura are presented in Table 2.

Table 2: Exploitation parameters and status of fish species of River Okura

SN	Species	L∞(cm)	K/yr	M/yr	F/yr	Z	ER	ES
1.	*H. longifilis*	68.6	0.51	0.84	0.14	0.98	0.15	E > 0.5 (UE)
2.	*O. niloticus*	21.8	0.53	1.23	-0.17	1.06	0.1	E > 0.5 (UE)
3.	*T. zilli*	14.7	0.51	1.23	-0.34	0.89	0.5	E = 0.5 (OPT)
4.	*B. longipinnis*	10.05	0.42	1.39	-0.38	0.62	0.35	E > 0.5 (UE)
5.	*C petherici*	13.1	0.49	1.11	-0.49	1.17	0.1	E > 0.5 (UE)
6.	*C. guntheri*	18.2	0.31	1.33	-0.16	0.62	0.2	E > 0.5 (UE)
7.	*P. leonensis*	4.05	0.9	2.18	-1.18	1.00	0.6	E < 0.5 (OE)
	Minimum	4.05	0.31	0.84	-1.18	0.62	0.1	
	Maximum	68.6	0.53	2.61	0.14	1.17	0.6	
	Mean			1.39	-0.51	0.91	0.3	
	SD			1.48	0.76	0.23	0.2	

M: Natural mortality, F: Fishing mortality, L∞: Asymptotic length, K: Growth co-efficient,
ER: Exploitation rate, ES Exploitation status, UE – under exploitation, OE – over exploitation and OPT – optimum

For a fishery stock to be optimally exploited, the E value must be equal to 0.5 (Gulland 1971). Abowei *et al* 2010 reported exploitation value of 0.7 for *Callinectes amnicola* from Okpoka Creek of Niger Delta, Nigeria. They pointed out that the species was overexploited and that the death of the species was due to excessive fishing pressure than natural death. The mean exploitation value of 0.3±0.2 for the fish species of River Okura observed in this study gives an indication that the fish stock of the River is presently under exploited.
According to FAO estimates, approximately 80% of the global fish stock are overexploited (FAO 2006). River Okura fish stock probably falls within the 20% that is not overexploited. The present study indicates under expolitation of the river.

Conclusions

The professional fishermen are the least abundant (9.5% abundance) in the fishery of River Okura. The mean exploitation rate (E) for the fish species is 0.3 ± 0.2 which is less than 0.5 in a maximally exploited fish stock. Fishing mortality (range is -1.18/yr to 0.14 /yr with mean value of -0.51±0.76/yr) is observed to be lower than the natural mortality (range is 0.84/yr to 2.81/yr with mean value of 1.39±1.48/yr). The few professional fishermen operating in River Okura with exploitation value of less than 0.5 and lower values of fishing mortality compared to natural mortally are all pointers to the fact that River Okura is underexploited. In view of the under-exploitation of the fishery resources of the river, commercial fishery should be encouraged. An awareness scheme for the villagers along the river should be undertaken either by the government or non-governmental organization to encourage them into artisanal fishery. This will not only provide protein for the communities but will alleviate poverty by providing jobs to the fisher folks,

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