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Status of *Oreochromis niloticus* (Linnaeus, 1758) fishery in liberty reservoir, Jos, Nigeria

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Abstract
Oreochromis niloticus samples (n = 203) were bought from one of the fishermen who fish in the reservoir on 31 October 2016. The fish were caught in fish traps. Length (mm) and weight (g) measurements of each fish were determined in the laboratory. The least-squares regression method (95% Confidence Level) was used to determine the length-weight relationship of the fish. The condition of the fish was also assessed by calculating the condition factor K. The size of the fish ranged from 62 to 292 mm total length and 50 to 244 mm standard length. The weight ranged from 4.2 to 324.2 g. Although there was a significant relationship between total length and weight (P<0.0001; r^2 = 0·945; slope = 2.855) the majority of the sampled fish were small. Approximately 64% of the fish were ≤ 125 mm total length, and about 90% of them weighed ≤ 90 g. The condition factor (K) of the fish ranged from 0.35 to 4.21, with majority (96%) of them having a K value of 2.01 to 4.21 and, hence, were in good condition. Fish that were judged to be in poor condition had a K value that ranged from 0.35 to 1.98. In view of the fact many small fish were retained by the fisherman, and, indeed, by the other fishermen, the fishing mortality was judged to be quite high. The Plateau State Government of Nigeria needs to acknowledge the current clandestine fishing and develop appropriate regulations. Monitoring and enforcement would help to ensure sustainability of the valuable *O. niloticus* fishery. Suggestions regarding appropriate and realistic fisheries management options are proffered.

Keywords: *Oreochromis niloticus*, fishery, fishing mortality, liberty reservoir, Jos, Nigeria

1. Introduction
Cichlids, in general, are important aquatic resources in African freshwater bodies [1]. In this regard, *Oreochromis niloticus* fishery plays an important role in the inland fisheries of many African nations. For example, it is a major component of the Lake Victoria fishing industry [2-4]. Similarly, in Liberty Reservoir, Jos, Nigeria, *O. niloticus* is a key natural resource, constituting a very important component of the daily clandestine landings by artisanal fishermen. A conservative estimate by Ajuzie C.C. (unpubl. data) puts the total fishery landings of this species at roughly 12 metric tons per annum. *O. niloticus* is not native to the Liberty Reservoir. A local fisherman (known simply as Joe) is thought to have introduced the species in the early 2000's and the favourable environment since has led to a significant fish population.

Frequently, inland fisheries assessment is based on the analysis of lengths and weights of captured fish [5]. This is because the length and weight data provide statistics that are cornerstones in the foundation of fishery research and management [6]. Generally, the weight of a fish can be related to its length, and a number of different ratios, which describe the fish well-being or condition, have been developed to define this relationship [5]. And as pointed out by Blackwell *et al*. [5], “Fish condition is very important to fisheries managers. Plump fish may be indicators of favourable environmental conditions (e.g., habitat conditions, ample prey availability), whereas thin fish may indicate less favourable environmental conditions. Thus, being able to monitor fish well-being can be extremely useful for fisheries biologists who must make management recommendations concerning fish populations”. Anderson and Neumann [6] suggested that condition could be eminently useful as an inexpensive, easily measured surrogate if it could be demonstrated that under given circumstances condition is a robust predictor of fecundity, reproduction, growth, or mortality rates.

Although there are a number of artisanal fishers operating in the reservoir, there is no published data on the *O. niloticus* fishery in this water body.

This work was undertaken in order to fill this gap. The main objective was to document for the first time the sizes of fish being taken away from the reservoir by the fishermen in their daily catch, as well as determine the condition of the fish. Such a study could act as a stepping-stone towards sustainable exploitation of the species in the reservoir. It could also prepare grounds for the proper management of the ecosystem.

2. Materials and Methods

2.1. Study site

The Liberty Dam, Jos, Nigeria was constructed in 1972 for the purpose of water storage for supply to water treatment plants in the city [7]. In recent years the immediate surroundings of the reservoir have been beleaguered by the activities of the ever increasing human population of Jos town. Herdsmen drive their cattle into the waterbody to drink. Drivers of heavy trucks have turned a section of the watershed into their parking lot. Subsistence farmers till within the floodplain of the reservoir and the resultant loose soil washes into the system. Water tankers are driven into the reservoir in order to extract water. Folks learning to drive automobiles have turned the reservoir's catchment into their practicing arena, and mechanic workshops have sprouted recently within the surroundings of the reservoir. These activities are seriously affecting the whole existence of the reservoir and surely will lead to a deterioration in the vital water quality. The surface area of 500 ha as reported by Ita *et al.* [8] is evidently reduced, partly, because of these human encroachments.

2.2. Fish samples

Oreochromis niloticus samples (n = 203) were bought on 31 October 2016 from one of the fishermen who fish clandestinely in the reservoir. The fish were caught in fish traps. Both total and standard lengths (mm), and the weight (g) of each fish were determined in the laboratory. The females appeared to be in the resting stage with red ovaries and no visible eggs. A regression analysis (at 95% Confidence Level) was performed in order to determine the weight-length (W-L) relationship of the fish samples, using least-squares regression method, after ln transformations of the data (i.e. ln W by ln L, where L is the total length). The condition factor of each fish sample was determined based on the equation: $K = 100 \times M/L^b$, where K = condition factor, M = weight (g), L = total length (mm), and b is a constant derived from regression of Ln M vs. Ln L [9].

3. Results

Morphometric data were obtained for 203 samples of *O. niloticus* from Liberty Reservoir, Jos, Nigeria (Table 1). The total and standard lengths of the biggest fish was 292 and 244 mm, respectively; and it weighed 324.2 g. The total and standard lengths of the smallest fish was 62 and 50 mm, respectively; and it weighed 4.2 g. The mean total length of the fish samples was 123.2 mm (sd = $\pm$ 42.8 mm), and that of the standard length was 99.59 mm (sd = $\pm$ 35.7 mm). The mean weight of the fish samples was 44.3 g (sd = $\pm$ 59.7 g). In all the measurements, the median values were less than the mean values. There was, however, a significant relationship between total length and weight (P<0.0001; r^2 = 0·945; slope = 2.855) of the fish (Fig. 1).

Results of length-frequency (of both total and standard lengths) and weight-frequency distributions are given in Figure 2. All of the charts skewed to the right. This positive skewness resulted because the means of the length and weight measurements were greater than their respective median values (see Table 1). The majority of the *O. niloticus* landed from the fish traps were small. Whereas 64% of the fish measured $\leq$ 125 mm in total length, 85% measured $\leq$ 125 mm in standard length. The maximum weight recorded for fish that measured up to 125 mm in total length was 34 g, and that recorded for fish which measured up to 125 mm in standard length was 64 g. Ninety percent (90%) of the fish weighed $\leq$ 90 g. The majority of these (66%) weighed $\leq$ 34 g and only 20% weighed between 34 and 64 g. The condition factor (K) of the fish ranged from 0.35 to 4.21, with median and mean (+ sd) values of 2.46 and 2.45 (+ 0.36), respectively. The K value of 94% of the fish ranged from 2.01 to 2.98. Four percent (4%) of the fish had a K value that ranged from 0.35 to 1.98. The remaining 2% had a K value that ranged from 3.07 to 4.21.

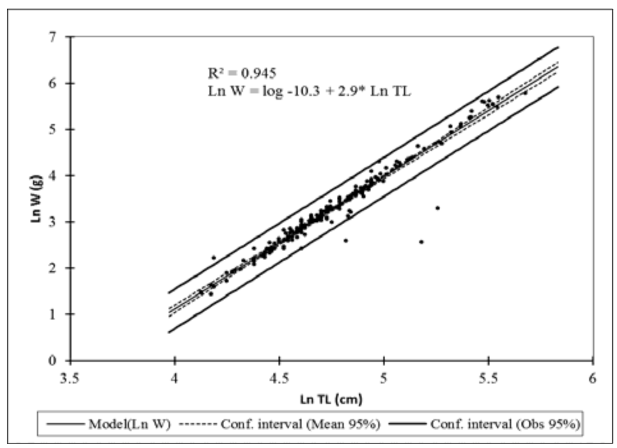

Fig 1: Regression analysis of weight (Ln W) by total length (Ln TL) of *O. niloticus* samples from Liberty Reservoir, Jos, Nigeria

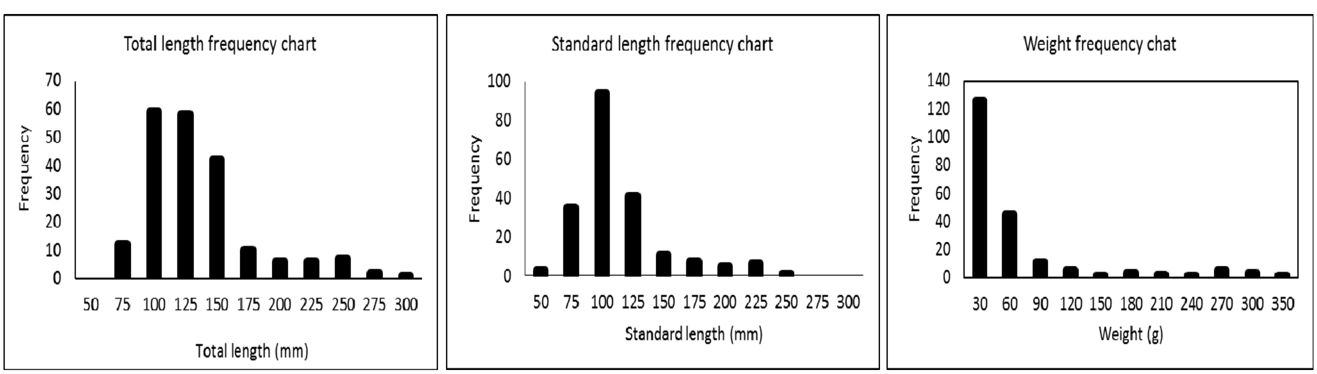

Fig 2: Length and weight frequency charts of O. niloticus from Liberty Reservoir, Jos, Nigeria

Table 1: Morphometric data of *O. niloticus* samples (n = 203) from Liberty Reservoir, Jos, Nigeria

Parameter	Score			
	Maximum	**Minimum**	**Median**	**Mean ± sd**
Total length (mm)	292	62	113	123.20 ± 42.80
Standard length (mm)	244	50	90	99.59 + 35.70
Weight (g)	324.20	4.2	24	44.30 ± 59.70
Condition factor (K)	4.21	0.35	2.46	2.45 ± 0.36

4. Discussion

When the maximum total length (TL_{max}) of *O. niloticus* caught in other freshwater bodies in Nigeria is compared with the TL_{max} of this species in the current study, it is readily seen that *O. niloticus* in Liberty Reservoir, Jos has the potential to grow very big. For example, Oso *et al*. [10] recorded a TL_{max} of 206 mm for *O. niloticus* sampled from Ero Reservoir in Ekiti State. Similarly, Imam *et al*. [11] recorded a TL_{max} of 205 mm for *O. niloticus* collected from Wasai Reservoir, Kano. And in Ona Lake in Delta State Omitoyin *et al*. [12] recorded a TL_{max} of 259 mm for this species. The different TL_{max} recorded by these workers are all smaller than the 292 mm recorded during the present study. However, as it stands now, *O. niloticus* in Liberty Reservoir, Jos has a very slim chance to survive and grow bigger. This is because the stock is currently being overfished. Many small fish ($TL_{max} \leq 125$ mm) are being retained by the fishermen. The sad thing is that these small fish are daily being landed from the reservoir. If this sort of fishing pressure is allowed to continue, *O. niloticus* longer than 100 mm soon could become a rarity. Jepsen *et al*. [13] observed that uncontrolled fishing pressure and the concomitant fishing mortality reduced greatly the abundance and average size of some peacock cichlids (*Cichla* spp.) in the Aguaro River in Venezuela within two decades. Apparently, overfishing is widespread in inland waters of developing nations, where, as a result of wide-spread poverty among the inhabitants, any fish that is landed, irrespective of its size has readily available buyers. No doubts, then, why Mulimbwa *et al*. [14] reported that immature fish comprised 95% of the catch of fishers operating in Nyangara wetland (the Laguna), in the fluvial plain of Rusizi River at the northern end of Lake Tanganyika. Excessive landing of small-sized fish has been reported to indicate high fishing mortality [see 14], which has a negative impact on stock recruitment.

Based on the resultant slope of length-weight relationship, growth of *O. niloticus* in Liberty Reservoir, Jos is allometric. The exponent *b* (i.e. a constant of the slope that results from a length-weight relationship) is close to 3.0 for most species. If a fish grows without changing its shape or its density then the fish is said to exhibit isometric growth. Isometric growth in fish (i.e. where *b* is 3) is, however, rare [15, 16]. If a fish changes shape or density as it grows, then *b* will not be equal to 3, and the fish is said to exhibit allometric growth. Where *b* is > 3 for a given species, it signals that the species tends to become relatively fatter or deep-bodied as it grows longer. And where *b* is < 3 it gives the signal that the species tends to be more streamlined [5, 6]. The slope of the present study indicates, on the average, that *O. niloticus* in this reservoir are more streamlined than deep-bodied.

Fish condition has been traditionally estimated by Fulton's condition factor [17, 18] as:

$K = 100 \times M/L^3$ (where K = condition factor, M = body mass, L = body length).

This equation assumes isometric growth, i.e. that the relative proportions of body length, height and thickness do not change in fish of similar condition as these increase in weight [9]. But we have seen from this study that fish can grow allometrically. In fish growing allometrically, body proportions are not constant, and the rate of allometry changes between different growth phases [9]. According to Nash *et al*. [18], to reduce or eliminate the effects of allometry from the estimation of fish condition, Bagenal and Tesch [9] proposed the following equation: $K = 100 \times M/L^b$ (where *b* is a constant determined from the length-weight relationship). Hence, this equation was employed to determine the condition of *O. niloticus* samples from Liberty Reservoir, Jos.

Fish condition is a very important parameter in fisheries science. It presupposes that fish in better condition are more full-bodied and, therefore, heavier at a given length [9]. Fish that are heavier than the average weight for their length are considered healthier, having more energy reserves for normal activities, growth and reproduction [19]. In the present study, fish with $K \geq 3$ were very robust and in excellent condition. On the other hand, fish with $K < 2$ were relatively thin and comparatively in poor condition. Fish with K values in between the fore-mentioned ($K < 3$ but ≥ 2) had a well-proportioned body and, hence, were in good condition. Fish may weigh less than expected for their length because of many reasons, including an empty stomach, sex and the state of sexual maturity [20]. In the present study, all the fish that were classed as relatively thin and in poor condition had an empty stomach. It should be noted that Bagenal and Tesch [9] reported that K values from 2.9 to 4.8 are an ideal range for normal growth and utilization of nutrients by freshwater fish.

5. Conclusion and Recommendation

Although Liberty Reservoir, Jos, Nigeria, may have a relatively low number of artisanal fishermen who fish in it, and although the population of *O. niloticus* in this reservoir has greatly increased since the species was introduced into the waterbody, uncontrolled fishing, which allows for the landing of very small fish, may soon impact the population negatively. The negative fishing activity of the artisanal fishermen, who fish clandestinely in the reservoir, if not properly managed, are likely to significantly reduce the abundance of average to bigger size *O. niloticus* in the waterbody, since small-sized *O. niloticus* that move in schools are readily caught in their fish-traps.

Therefore, government officials should formally recognize the artisanal fishermen fishing in the reservoir. By so-doing it will be possible to:

1. Keep a proper record of the total number of fishermen fishing in the water body.
2. Control the activities of the fishermen; for example government officials can:

i) Announce and enforce a closing period for any fishing activity in the reservoir for the improvement of stock numbers

ii) Can easily educate the fishermen on the best fishery practices that enhance fish population growth and sustainability of their chosen profession

As an emergency and in order to reduce fishing pressure in the reservoir:

a) The fishermen should be encouraged to set free any *O. niloticus* caught that is 100 mm or less in total length during a period of two years, after which the minimum landing size should be pegged at 120 mm total length for another two years. Fish released will certainly survive because it was observed that fish caught in the traps were still alive and active at landing
b) The local government should employ full-time fisheries biologists and aquatic ecologists to help with fisheries management in the waterbody, as well as the management of the reservoir itself.

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7. References

1. Fryer G, Iles ID. The cichlid fishes of the great lakes of Africa. Edinburgh: Oliver and Boyd, Edinburg, Scotland. 1974.
2. Acere TO. Recent trends in the fisheries of Lake Victoria (Uganda northern part). FAO Fish. Rep. 1988; 388:36-45.
3. Cowx IG, van Knaap M, van der Muhoozi L, Othina A. Improving fishery catch statistics for Lake Victoria. Aquat. Ecosyst. Health, 2003; 6:299-310.
4. Njiru M, Waithaka E, Muchiri M, van Knaap M, Cowx IG. Exotic introductions to the fishery of Lake Victoria: What are the management options? Lakes & Reservoirs: Res. Mangt. 2005; 10:147-155.
5. Blackwell BG, Brown ML, Willis, DW. Relative weight (Wr) status and current use in fisheries assessment and management. Rev. Fish. Sci. 2000; 8:1-44.
6. Anderson RO, Neumann RM. Length, weight, and associated structural indices, in fisheries techniques, second edition. Murphy, B.E and Willis, D.W. eds., American Fisheries Society. 1996.
7. NUWSRP. National urban water sector reform project: Dam safety measures report. E863 vol. 2. Federal Ministry of Water Resources. Federal Republic of Nigeria. 2004.
8. Ita EO, Sado EK, Balogun JK, Pandogari A, Ibitoye BA. preliminary checklist of inland water bodies in Nigeria with special reference to lakes and reservoirs. Kainji Lake Research Institute Technical Report Series No, 14, 1985.
9. Bagenal TB, Tesch FW. Methods of Assessment of Fish Production in Freshwaters. IBP Handbook No 3, 3rd ed. Oxford Blackwell Scientific Publication, London. 1978.
10. Oso JA, Ayodele IA, Fagbuaro O. Food and feeding habits of *Oreochromis niloticus* (L.) and *Sarotherodon galilaeus* (L.) in a Tropical Reservoir. World J. Zool. 2006; 1(2):118-121.
11. Imam TS, Bala U, Balarabe ML, Oyeyi TI. Length-weight relationship and condition factor of four fish species from Wasai Reservoir in Kano, Nigeria. Afr. J. Gen. Agric. 2010; 6:125-130.
12. Omitoyin BO, Salakoand AE, Eriegha OJ. Some Ecological Aspects of *Oreochromis niloticus* and *Heterotis niloticus* from Ona Lake, Asaba, Nigeria. World J. Fish Mar. Sci. 2013; 5:641-648.
13. Jepsen DB, Winemiller KO, Taphorn DC, Rodriguez Olarte D. Age structure and growth of peacock cichlids from rivers and reservoirs of Venezuela. J. Fish Biol. 1999; 55:433-450.
14. Mulimbwa N, Sarvala J, van der Knaap M. The effect of intensive fishing on two cichlids (*Oreochromis niloticus* and *Astatotilapia burtoni*) in Nyangara wetland at the north end of Lake Tanganyika (D. R. Congo) with fishery management implications. Aquat. Ecosyst. Health, 2010; 13:11-19.
15. McGurk MD. Effects of net capture on the postpreservation morphometry, dry weight, and condition factor of Pacific herring larvae. Trans. Am. Fish. Soc. 1985; 114:348-355.
16. Bolger T, Connolly PL. The selection of suitable indices for the measurement and analysis of fish condition. J. Fish Biol. 1989; 34:171-182.
17. Ricker WE. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 1975; 191:1-382.
18. Nash RDM, Valencia AH, Geffen AJ. The origin of Fulton's condition factor-setting the record straight. Fisheries, 2006; 31(5):236-238.
19. Ogle D. Fish R Vignette - Fish Condition and Relative Weights, June, 2013 https://sites.google.com/site/fishrfiles/gnrl/RelativeWeight.pdf?attredirects=0 26 January 2017
20. Williams JE. The Coefficient of Condition of Fish. Chapter 13. In Schneider, J.C. (ed.), Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources. Fisheries Special Report 25, Ann Arbor. 2000.