LENGTH-WEIGHT RELATIONSHIPS AND CONDITION FACTORS OF FIVE FRESHWATER FISH SPECIES IN ROSEIRES RESERVOIR, SUDAN

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ABSTRACT

This study describes the length-weight relationships (LWR) and condition factors of five fish species from 4 families of ecological and economic importance, found in Roseires reservoir, Sudan. A total of 2820 specimens were caught by using various mesh size of gill nets from May, 2010 to March, 2011. The slope (b) values obtained for the five fish species ranged between 2.029 for *Alestes baremose* and 2.973 for *Eutropius niloticus* and differed significantly ($p<0.005$) from 3, which indicates that all of the fish species have negative allometric growth. The condition factors (K) of the fish species ranged from (0.7018±0.1912) in *Hydrocynus froskalii* to (1.9505±0.2293) in *Eutropius niloticus* and about 80% of these condition factors fall outside the range recommended as suitable for matured fresh water fish species in the tropics. This indicates that Roseires reservoir may be unfavorable to fishes due to sedimentation.

Keywords: Freshwater fish species, Roseires reservoir, length-weight relationship, Condition factor and allometric growth.

INTRODUCTION

Fisheries management and research often require the use of biometric relationships in order to transform data collected in the field into appropriate indices (Ecoutin and Albaret, 2005). Length-weight relationship (LWR) of fishes are important in fisheries and fish biology because they allow estimation of the average weight of the fish of a given length group by establishing a mathematical relation between them (Sarkar *et al.*, 2008 and Mir *et al.*, 2012). The length-weight relationship is an effective technique that affords evidence on the reproductive history, health condition, spatial distribution of different ecologically different species and their historical comparisons among different populations (Kara and Bayhan, 2008). The length and length-weight relation is a fundamental data for fishery biologists to enforce regulations for a sustainable management of fishery (Chaki *et al.*, 2013). However, the length-weight parameters of the same species may be different in the population because of feeding, reproduction activities and fishing etc. Therefore, data on functional LWR of fish species is important for fish stock assessment and parameters *a* and *b* can be used for length-weight conversion (Hajjej *et al.*, 2010). At the same time, the relationship of length-weight estimates condition factor (c.f.) of the fish species and fish biomass through the length frequency (Wallace et al., 1994; Blackhart et al., 2006). The condition factor which show the degree of well-being of the fish in their habitat is expressed by 'coefficient of condition' also known as length – weight factor. This factor is a measure of various ecological and biological factors such as degree of fitness, gonad development and the suitability of the environment with regard to the feeding condition (Mac Gregoer, 1959). When condition factor value is higher it means that the fish has attained a better condition. The condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds and other water quality parameters (Khallaf *et al*., 2003). In length weight relationship weight can be casted by length which can be used for assessment of biomass offering as a beneficial technique in the fishery biological studies (Moreyet *el al*., 2003). Despite the usefulness of length-weight relationship and condition factor in fisheries science and the importance of the Roseires reservoir to the fisheries of the southeast of Sudan, information about the length-weight relationships and condition factors of fish species in Roseires reservoir are very rare. The paucity of this information propelled this study, which is aimed at bridging this gap and also provide useful information for the management of Roseires reservoir fisheries.

MATERIALS AND METHODS

Sampling area

The Roseires reservoir is located in the Blue Nile state and lies between latitudes 11° 47' 54.7" N and 34° 23' 36.6" E. The impoundment extends to some 80 km upstream of the dam and has a surface area of about 290 km^2, mean depth is 10m, maximum depth is 50 m and maximum drawdown is 13m. Based on the proposed survey and preparations, six sampling stations were selected as representative of the study area based to covered baseline information on fisheries within the up and downstream of the dam location (Fig 1).

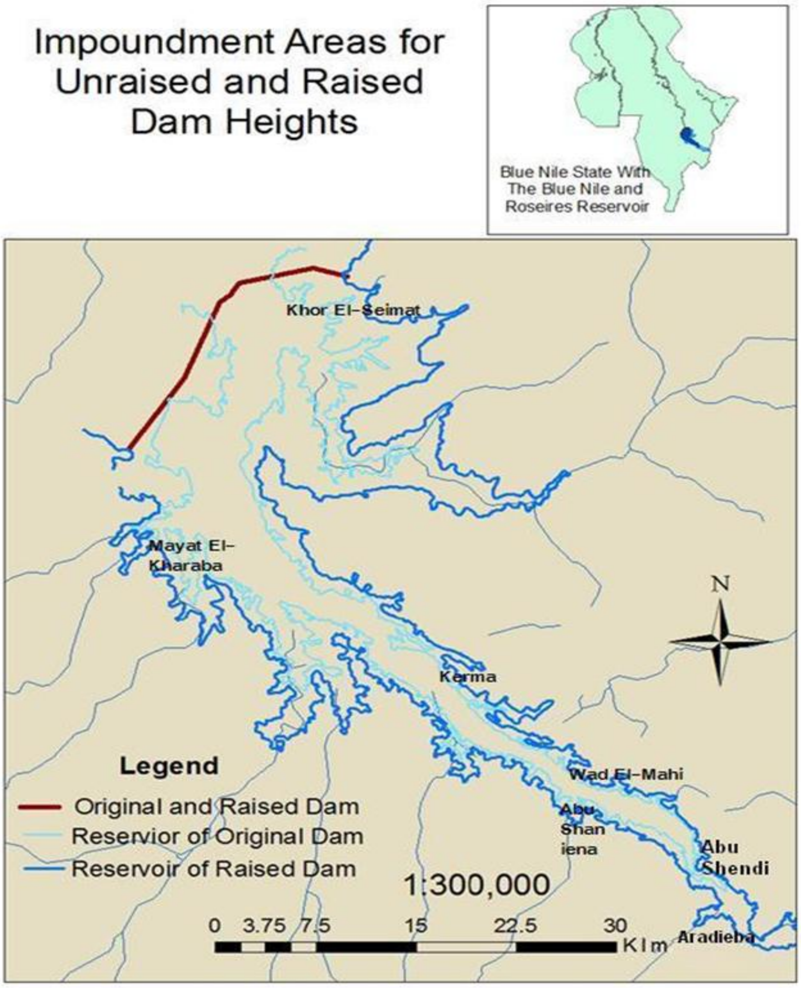

Fig 1: Locations of study sites

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Sampling of Fish

A total of 1,270 fish samples belonging to families (Characidae, , Schilbeidae, Mochokidae, and Centropomidae) were collected randomly from the sampling stations, as shown in (Fig. 1) between May, 2010 and March, 2011. The fisher folks operating in this reservoir deploy surface and bottom set gillnets using various mesh sizes including 2,3, 4.& 5 cm. The Fish individuals that were obtained from six sampling locations were identified using keys provided by Boulenger, (1907), Abu Giederi (1984), Bailey (1994) and Bishai & Khalil, (1997).

Total length (cm) of each fish was taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a measuring board. Body weight was measured to the nearest gram using an Electronic Digital Balance (KRUTPS TYPE 875). Parameters of the length-weight relationship of identified fish species were estimated using the equation of (Rickter, 1973).

$$W = aL^b \qquad (1)$$

where,
W = Weight of fish (g)
L = Length of fish (cm)
a = y-intercept or the initial growth coefficient
b = Slope or the growth coefficient.

The values of the constants a and b were estimated after logarithmic transformation of Eq. (1) using least square linear regression (Zar, 1984).

$$\log W = \log_{10} a + b \log_{10} L \qquad (2)$$

Prior to regression analysis of logW on logL, log-log plots of length and weight values were performed for visual inspection of outliers (Froese, 2006). Only extreme outliers attributed to data error were omitted from analyses. The 95% confidence interval, CI of b was computed using the equation:

$$CI = b \pm (1.96 \times SE)$$

Where, SE is the standard error of b.

The condition factor was calculated by the formula:

Condition Factor (K) = $100W/L^3$ (Pauly, 1983)

Where, W= weight in grams;
L= total length (cm).

Fish Grouping

The body shape/weight of fish species was determined using Smith (1996), grouping scheme where the analysed samples were classified into three groups *i.e.* light, isometric and heavy. The light group was determined when the value of b was<3.0. In this group, the length growth is not proportionate to the increase in weight.

Data Analysis

Variations in the length-weight relationship (represented by 'b') and condition factor (represented by K) of the individual fish living in the two locations were described throughout the year. Relationship between length and weight of the fish was examined by simple linear regression analysis. The nonparametric Kruskal-Wallis test (One-way Analysis of Variance) was conducted to perform comparisons the condition of fish between the different sampling sites. The minimum significant level for the relevant test was set at $p < 0.05$.

RESULTS

The length-weight distribution of the five major fish species collected from the Roseires reservoir were analysed in this study. The species, length-weight relationship parameters a and b, 95% confidence interval for b and correlation coefficient (r) are presented in table 1,while number of specimens, min-max length, min- max weight and condition factor of fish species are presented in Table 2. The estimated value of allometry coefficient (b) ranged between 2.029 for *Alestes baremose* and 2.973 for *Eutropius niloticus* . The values of correlation coefficient (r) varied from 0.824 in *Hydrocynus froskalii* to 0.960 in *Eutropius niloticus*. The lengths ranged from 5.70- 605.0 cm while the weights were between 4.00 and 1954g. The lowest condition factor (K) (0.7018±) was recorded in *Hydrocynus froskalii* while the highest value (1.9505±0.2293) was observed in *Lates niloticus*.

DISCUSSION

The length-weight distributions of fishes from Roseires reservoir showed considerably large variations in fish sizes indicating that the samplings with gill nets were carried out efficiently. Selection of mesh size of nets also contributed to the minimum-maximum length of fish caught (5.70- 605.0cm), hence the weight which ranged from 4.00 to 1954g. The size of the fish captured ranged from the smallest to the biggest and from young to adult stages with differences in their growth rates (Fafioye et al., 2005). The slopes (*b*) of the fish L-W regression lines from the reservoir fell within 2.027 and 2.973. Differences in b value can be attributed to the combination of one or more factors such as: number of specimens, gonad maturity, sex, health, habitat, seasonal effect etc. (Wootton 1991). Values of the exponent 'b' provide information on fish growth. When $b = 3$, the fish grows isometrically resulting in ideal shape of fish such was not observed for all fish sampling in this study. When the value of *b* is less than 3.0, the fish experiences a negative allometric growth and positive allometric growth when the value of *b* is greater than 3.0 (Froese 2006). In this study, the regression trend indicate that, all fish species exhibited negative allometric growth pattern(b<3), with length of exponent "b" value range from 2.027 (*Alestes baremose*) to 2.973 (*Eutropius niloticus*). Many factors could contribute to the differences of growth of fish such as differences of habitat, fish activities, food habits and seasonal growth rates (Lowe, 1987 & Mizuno, 1982.). Other factors such as temperature, trophic level and food availability in the community were also important. The 95% confidence interval of b for all the fish species ranged from 2.368 to 3.765. This is similar to the observations of previous studies of Tiago *et al*., (2017) who studied the length weight relationships of the ten most common fish in the Lower Nhamundá river, left tributary of the Amazon River and reported 95% CI of b values that ranged from 2.680 to 3.698. The correlation coefficient (r) for length-weight relationships is high for all fish species which indicates that the length increases with increase in weight of the fish. This is in agreement with previous studies on different fish species from various water bodies, (Fagade, 1983; Layèyè, 2006; Ayoade and Ikulala, 2007 & Egbal *et al*., 2011). The condition factor (K) reflects, through its variations, information on the physiological state of the fish in relation to its welfare. From a nutritional point of view, there is the accumulation of fat and gonad development (Le Cren, 1951). From a reproductive point of view, the highest K values are reached in some species (Angelescu *et al.*, 1958). The condition factors (K) of the 5 fish species ranged between 0.7018±0.1912 and 1.959±0.2293. The condition factor value estimated in this study compared to previous work showed that it's close to the values reported by Abowei, 2010, Mousavi-Sabet et al., 2013 and Seiyaboh et al.,2016, these results were almost same as our study. K value of the rest of species were >1 showing their perfect condition whereas, its value <1 reflects that the well being of the fish is not in a good condition (Manorama & Ramanujam 2014). In the present study, the condition factors revealed that 80% (4 out of 5 fish species) of the fish species had their K values less than one, indicating that the well being of fishes are not good in the Roseires reservoir. This could have been caused by adverse environmental factors (Anene, 2005). Roseires reservoir has a special problem, because each year it is affected by sedimentation, according to SMEC Report, (2011), the capacity was loss 34%. Also silt and debris, largely reduced transparency and then stimulated phytoplankton growth. Therefore, sediment may be one of the most important factors delaying the recovery of eutrophic conditions. For this reason it is suggested that the conditions of Roseires reservoir in comparison to fresh water bodies may be unfavorable to fishes in the reservoir. Therefore, there would be need for more studies on the relationships and condition factors of some fish species in the reservoir.

CONCLUSION

The study assessed the condition factor and length-weight relationship of five species of fish from Roseires reservoir. The result of the length-weight relationship of the fish species exhibited negative allometric growth pattern. The condition factor for the five fish species across both season ranged from 0.7018±0.1912 to1.950±02293. The low condition factor recorded in this study could be due to impacts of sedimentation.

Table 1: Estimated parameters of the length-weight relationships for five fish species in Roseires reservoir

Family	Species	N	ln a	b	95%of C.I	R^2	G.P
Characidae	*Alestes baremose*	853	-1.813	2.029	2.368	0. 929	NA
	Hydrocynus Forskalii	345	-5.933	2.796	3.231	0.824	NA
Centropomidae	*Lates niloticus*	207	-3.676	2.259	2.853	0.848	NA
Schilbiedae	*Eutropius niloticus*	674	-4.401	2.973	3.765	0.960	NA
Synodontidae	***Synodotis schall***	741	-3.661	2.569	2.699	0.913	NA

N= number of samples, a= intercept of regression line, b= slope of regression line, Cl= confidence level, R^2 = regression coefficient, GP=Growth pattern, NA= negative allometric.

Table 2: Growth performance of five fish species (TL& W) and their values of mean relative factor with standard deviation (K ± Sd) collected from sampling sites in Roseires reservoir

Family	**Species**	Total length (cm)			Weight (g)			K ±SD
		Min	Max	Mean ±SD	Min	Max	Mean ±SD	
Characidae	*Alestes baremose*	11.7	34.5	23.1±0.727	40	785	412.5±0.7270	0.7251± 0.1828
	Hydrocynus Forskalii	19.50	37.50	38.25±0,445	28.60	646.00	351.6±0.4448	1.9505± 0.2293
Centropomidae	*Lates niloticus*	13	46	29.5±0.812	230	1954	1092±0.8120	0.8865± 0.1617
Schilbiedae	*Eutropius niloticus*	11.50	27.50	25.25±0.662	17.00	272.00	153±0.6623	0.9027± 0.1986
Synodontidae	***Synodotis schall***	5.70	34.22	22.81±0,067	40.00	175.00	127±0.0671	0.7018± 0.1912

Min= minmum, max= maximum, k= condition factor, SD= standard deviation

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