Preliminary Survey in to Biodiversity, Length – Weight Relationship and Condition Factor of some Fish Species in Waya Dam, Bauchi State

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Abstract - This study was carried out with the aim of generating the data on Biodiversity, Length – Weight Relationship (LWR) and condition factor (K) of fish species in Waya dam, Upper Benue River Basin Authority, Bauchi. Total catches (TC) were randomly sampled thrice a week from fishers fishing in Waya dam (from September 2014 to December 2015) covering a period of two months in the dry season and two months in the wet season. Lengths (L) and weights (W) of each fish species were measured from random samples of the catches once a month for the four months. TC data were analysed using percentages (%) for the composition of fish as a measure of their relative abundance; regression analysis was used for determining intercepts (a) and slope (b) of the LWR ($W = a*L^b$) while Shannon index of diversity was used for determining species diversity index (H') and species evenness (E). This research revealed that there are six species of fish belonging to four families: Cichlidae (*Oreochromis niloticus* and *Hemichromis fasciatus*); Cyprinidae (*Labeo senegalensis* and *Raiamas senegalensis*); Dischodontidae (*Distichodus engycephalus*) and Claridae (*Clarias gariepinus*). *O. niloticus* has the highest % composition of 53.38 and 52.05 in dry and wet seasons respectively with *R. Senegalensis* having lowest % composition of 1.92 in dry season and 1.90 in wet season. The biodiversity of fish species in dry season ($H'_D = 1.264$) is more diverse than the wet season ($H'_W = 1.251$) and the dry season's species evenness ($E_D = 0.7055$) is better than the wet season's species evenness ($E_D = 0.6982$) based on the diversity t – test ($P < 0.001$). All the b values of the fish species fall within the acceptable range of 2.5 to 3.5. Whereby *R. senegalensis* has the highest value (b = 3.2784) and *H. fasciatus* has the lowest value (b = 2.5785) with the mean value for the species being b = 2.9807. The fish with highest K value of 1.9199 is *H. fasciatus* while *C. gariepinus* has the lowest K value of 0.7267. From the results of this research it could be concluded that Waya dam has low biodiversity of six fish species with *O. niloticus* being most abundant in the dam and all the fish species are in good condition as 80% (4 species out of 6) of the fish species have their K- values above 1.0 and with almost isometric growth.

Index Terms – Biodiversity, Shannon index, Length-weight relationship, Condition factor, Waya dam

1. INTRODUCTION

Large proportion of Nigerian population live near water bodies such as lakes, reservoirs, swamp and coastal lagoons as they are invaluable ecological resources that serves many human needs by providing a lot of opportunities [1]. Many depend heavily on the resources of such water bodies for their main source of animal protein and family income [2]. Fisheries occupy a unique position in the agricultural sector of the Nigerian economy. In terms of gross domestic product (GDP), the fisheries sub-sector has recorded the fastest growth rate in agriculture to the GDP. The contribution of the fisheries sub-sector to agriculture GDP was estimated at 4.0% in the year 2007, out of the total estimate of 40% being contributed by agriculture to GDP [3]. Fish is an important source of protein to the large teeming population of Nigeria. Fish provides 40% of the dietary intake of animal protein to the average Nigerian. Fish, apart from its protein contents; it is also reach in vitamins and contains variable quantities of fat and minerals for human health [4]. The oil in the fish contains vitamins A, D, E and K which have been successfully used in controlling coronary heart diseases, arthritis, atherosclerosis, asthma, auto immune deficiency diseases and cancer [5]. Fish is often recommended for cardio-vascular disease patients because of its unique fat, which is composed mainly of Omega-3 polyunsaturated fatty acid.

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2. MATERIAL AND METHODS

2.1 Study Area

Waya Dam is a medium sized earth built on river Waya in Ganjuwa Local Government Area of Bauchi State, Nigeria. Its construction started through direct labour since 1994 by Upper Benue River Basin Development Authority (UBRBDA) for the purpose of small scale irrigation and supplementing water supply to Bauchi metropolis. The dam which is 25km away from Bauchi town is located between latitude 10.30982°N and longitude 9.845172°E. It has a reservoir storage capacity of 30million cubic meters ($30mm^3$). The maximum length of the dam is 26meters. The dam has an ogee over flow spill way type with a spillway discharge/second of $72m^3$.Its embankment has features which include base width: 96m, crest width: 6m, crest length: 370m and elevation: 505m [6].

2.2 Sample Collection

Fish samplings were conducted in the waya dam from September 2014 to December 2015 (covering both dry and wet seasons). Total catches were randomly collected thrice a week for each species of fish caught by artisanal fishermen at their two landing sites namely; Dabar 'yan burgi (station of those that mainly use cast nets) and dabar 'yan raga (station of those that use other fishing gears other than cast nets). Size frequency data were collected once a month, for the four months. Fishes were caught with a number of gears such as gillnets, hooks and line, long line, and cast nets. There are mainly four categories of fishers whom are differentiated by the kind of fishing gears they use. They are; 'Yan burgi (cast nets users), 'Yan raga (gill nets users), 'Yan mali (Malian trap users) and 'Yan kugiya (hooks and line users). Specimens were stored in coolers containing ice and transported to the laboratory where formaldehyde (20%) was used for sample preservation. The Total length (TL), Fork length (FL) and Standard length (SL) of sampled fish were measured to the nearest 0.1cm using 30cm ruler. Body weight of each species of fish was measured to the nearest 0.01g using electronic digital scale with Model No.: A – 110 C.

2.3 Fish Identification

The fish species were identified with the aid of a reference material by "Holden and Reed [7] and Fish base database [8].

2.4 Biodiversity

The pooled sample data of the total catches covering both wet and dry seasons was expressed in percentage composition of each fish species. The species richness was determined using Shannon diversity index (H'):

$$H' = - \Sigma (n_i/N) \text{ In } (n_i/N)$$

Where:

n_i = is abundance (Number) of each species in the sample

N = is the total number of all species in the sample

The species evenness was determined as follows:-

$$E = H'/ \text{In } S$$

Where S = is number of distinct species in all the samples

The t – test between the dry and wet seasons shall be determined using the formula:

t – test, $t = (H'_D - H'_W) / (\text{Var } H'_D + \text{Var } H'_W)^{½}$

2.5 Length – Weight Relationship (LWR)

The parameter of length – weight relationship of sampled fish species were evaluated using the equation:

$W = a L^b$ [9]

Where:

L = Length (cm)

a = Describe the rate of change of weight length (intercept)

b = length exponent (Slope)

The equation $W = a L^b$ is further transformed to linear equation using logarithm to give: Log W = log a + b log L, thus, the ''a'' and ''b'' values were estimated from the regression formula [10].

2.6 Condition Factor (K)

The condition factor was calculated using the formula:-

Condition factor (K) = $100W/L^3$ [11]

Where:

W = Weight of fish (g)

L = Total body length of fish (cm)

2.7 Statistical Analysis

Regression analysis was used at 99.999% ($P < 0.001$) Confidence Level.

3. RESULTS

The Study reveals that there are four families of fish, namely; Cichlidae, Cyprinidae, Claridae and Distichondontidae. The Cichlidae comprised of two species namely *Oreochromis niloticus* (Nile tilapia) and *Hemichromis fasciatus* (Banded jewel fish). Cyprinidae equally has two species which are *Labeo senegalensis* (African carp) and *Raiamas senegalensis* (silverfish). While Claridae and dischodontidae consist of one specie each which are *Clarias gariepinus* and *Distichodus ergycephalius* respectively. (Table 1). Table 2 shows Seasonal biodiversity of fish species of Waya dam using Shannon index of Diversity indicating significant differences in wet and dry seasons. Also Table 3 contains the seasonal percentage composition of species of fish from the commercial catches in Waya dam which showed disparity in the species' relative abundance for both seasons.

The length – weight relationships of fish species identified in Waya dam are presented in Table 4. Here, the Values of the exponent 'b' in the relationship varies. *Raiamas senegalensis* had the highest value of b (3.2784), while *Hemichromis fasciatus* had the lowest b value (2.5785). Others were *Oreochromis niloticus*, *Labeo senegalensis, Clarias gariepinus and Distichodus engycephalus* with b values of 2.8955, 3.2628, 3.0081 and 2.8607 respectively. Hence three species exhibited positive allometric growth pattern ($b > 3$) while the other three exhibited negative allometric growth pattern ($b < 3$). There was strong correlation between the length and weight of all the species. The mean condition factors (K) of all the species studied are shown in Table 5, while their percentage condition factor is presented in Table 6. There were differences in the condition factors of all the species. As shown in the table, the condition factors for the six species recorded ranged between 0.7267 and 1.9199. *Oreochromis niloticus* had a range of 0.2025 – 2.3841. While *Hemichromis fasciatus, Labeo senegalensis, Raiamas senegalensis, Clarias gariepinus*, and *Distichodus engycephalus* had their mean k-values of 1.9199, 1.1317, 0.7676, 0.7267 and 1.1693 respectively.

Table 1: Fish Species identified in Waya Dam

Family	Scientific name	English name	Hausa name
Cichlidae	*Hemichromis fasciatus*	Banded jewel fish	Harshen shanu
	Oreochromis niloticus	Nile tilapia	Karfasa
Cyprinidae	*Labeo senegalensis*	African carp	Akunu
	Raiamas senegalensis	Silver fish	Lakki
Claridae	*Clarias gariepinus*	North African catfish	Tarwada
Dischodontidae	*Distichodus engycephalus*	Grass eater	Kursa

Table 2: Seasonal Biodiversity of Fish Species of Waya Dam Using Shannon Index of Diversity

Parameters	Values
Dry Season Species Diversity Index (H'_D)	1.264
Wet Season Species Diversity Index (H'_W)	1.251
Dry Season Species Evenness (E_D)	0.7055
Wet Season Species Evenness (E_W)	0.6982
t – test calculated for both seasons	3.474
t – test tabulated @ degree of freedom 133,445 ($P < 0.001$)	3.291

Table 3: Seasonal Percentage Composition of Species of Fish from Commercial Catches in Waya Dam.

Species	Dry Season	Wet Season	Dry and Wet Season

	No. of Samples	Percentage Composition	No. of Samples	Percentage Composition	No. of Samples	Percentage Composition
Oreochromis niloticus	38,577	53.38	97,988	52.05	136,565	52.42
Clarias gariepinus	3,350	4.64	6,484	3.44	9,834	3.77
Labeo senegalensis	2,026	2.80	3,778	2.01	5,804	2.23
Hemichromis fasciatus	17,177	23.77	43,618	23.17	60,796	23.34
Distichodus engycephalus	9,746	13.49	32,810	17.43	42,556	16.34
Raiamas senegalensis	1,390	1.92	3,565	1.90	4,955	1.90
Total	72,266	100.00	188,243	100.00	260,509	100.00

Table 4: The length – weight relationship of fish species identified in Waya dam.

Fish species	**N**	Mean TL(cm)	Mean W(g)	a	b	S.E	r^2	Pattern
Oreochromis niloticus	300	10.9433	26.8235	0.0231	2.8955	±0.0706	0.9238	Negative Allometry
Hemichromis fasciatus	55	7.0527	6.8765	0.0434	2.5785	±0.0475	0.8409	Negative Allometry
Labeo senegalensis								
	51	14.7294	37.1682	0.0055	3.2628	±0.7838	0.7838	Positive Allometry
Raiamas senegalensis								
Clarias gariepinus	69	10.8768	13.0861	0.0039	3.2784	±0.0882	0.9464	Positive Allometry
Distichodus engycephalus	53	22.7585	144.4342	0.0070	3.0081	±0.0559	0.9847	Positive Allometry
	64	7.3313	4.8525	0.0152	2.8607	±0.0913	0.7799	Negative Allometry

N = Number of sample size; TL = Total length in gram; W = Weight in gram; a and b = regression coefficients; S.E = Standard error; r^2 = Correlation coefficient

Table 5: Condition Factors of Fish Species in Waya Dam.

Species	Total Length (cm)		Wet- Weight (g)		Number	Condition Factor (K)		
	Min.	Max.	Min.	Max.		Min.	Max.	Mean

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Oreochromis niloticus	6.7	20.3	5.26	150.52	300	0.2025	2.3841	1.8192
Hemichromis fasciatus	6.0	9.6	5.11	15.63	55	1.6065	2.6435	1.9199
Labeo Senegalensis	12.6	16.5	25.69	61.64	51	0.8982	1.3722	1.1317
Raiamas senegalensis	6.5	18.1	2.11	70.82	69	0.5045	1.1983	0.7676
Clarias gariepinus	14.0	57.6	21.34	1,600.00	53	0.5302	1.0943	0.7267
Distichodus engycephalus	4.5	10.0	1.38	12.72	64	0.2965	1.4094	1.1693

Table 6: Percentage Condition factor (K) of fish species in Waya dam

Species	**Condition factor(K)**	**Percentage Condition factor (%)**
Oreochromis niloticus	1.8192	24.1453
Hemichromis fasciatus	1.9199	25.4818
Labeo senegalensis	1.1317	15.0204
Raiamas senegalensis	0.7676	10.1879
Clarias gariepinus	*0.7267*	9.6451
Distichodus engycephalus	1.1693	15.5195
Total	**7.5344**	**100.0000**

4. DISCUSSION

Six (6) fish species belonging to four (4) families were identified from the commercial catches in the dam. They are; *Hemichromis fasciatus* and *Oreochromis niloticus* both belonging to the family Cichlidae. *Clarias gariepinus* belonging to the family Claridae. *Labeo senegalensis* and *Raiamas senegalensis* both belonging to the family Cyprinidae. And *Distichodus engycephalus* which belongs to the family Dischodontidae. The dam has a fewer fish species of six (6) compared to other bodies of water where similar studies had been carried out; For instance, in Gubi dam eight (8) species of fishes were identified [12]. Other water reservoirs where similar research has been carried out include Dadin-kowa dam Gombe, where fifteen (15) fish species were identified [13]. Twelve (12) species were also identified in Gbedikere Lake, Bassa in Kogi State [1].

From the Seasonal Biodiversity of the six (6) fish species examined, the result shows a significant difference between the wet and dry seasons; where by the dry season's is more diverse than in wet the season's (Table 1). This signifies that the number and equitability of population size of each specie are more pronounced in the dry season. The disparity in the Seasonal biodiversity is directly related to the wet season which is affected by certain ecological factors such as flooding, turbulence, temperature, food supply, spawning conditions, sex, age, fishing time and fishing gears (Kembenya *et al*., 2014). *Oreochromis niloticus* has the highest percentage composition of 53.38% and 52.05% in dry and wet seasons respectively. While *Raiamas senegalensis* has the lowest percentage composition of 1.92% and 1.90% in dry and wet seasons respectively. This is an indication that *O. niloticus* is doing well in both seasons.

The values obtained for length – weight relationships for all the six species showed that *Clarias gariepinus* has the highest maximum length and maximum weight of 57.6cm and 1,600g respectively and *Distichodus engycephalus* recorded the lowest values of minimum length (4.5cm) and minimum weight (1.38g). For `**b**` values, *Raiamas senegalensis* had the highest value of **b** (3.2784) while *Hemichromis fasciatus* had the lowest value of **b** (2.5785). The values of **b** significantly ($P<0.001$) rose from 2.5785 in *Hemichromis fasciatus* to 3.2784 in *Raiamas senegalensis*. The mean value of **b** for all species is 2.9807. According to "Pauly and Gayanilo [14], **b**-values may range from 2.5 to 3.5. Other literatures showed that in most fishes **b**-values ranged from 2.7 to 3.3 [15]. Hence, this suggests that the result of this is valid. This study corroborated with the study of LWRs reported by "Sarkar *et al.* [16] for different freshwater species from river Ganga, Gomti and Rapti, India. It also conforms to the study of LWRs of five fish species in Epe lagoon, reported by "Fafioye and Oluajo [17].

The regression co-efficient (**b)** for isometric growth is three (3). Values greater or less than "3" indicate positive allometric growth and negative allometric growth respectively [14]. It was observed from the '**b**'values obtained from the length-weight relationship of all the six species that, *Distichodus engycephalus* (b=2.8607), *Hemichromis fasciatus* (b=2.5785) and *Oreochromis niloticus* (b=2.8955) experienced a negative allometric growth pattern while *Clarias gariepinus* (b=3.0081), *Labeo senegalensis* (b=3.2628) and *Raiamas senegalensis* (b=3.2784) experienced a positive allometric growth pattern. Changes in the '**b**'value of the length-weight relationship experienced, is directly related to the weight influenced by factors such as; Change in temperature, overfishing, competition for food, sex, age and breeding periods [18].

The condition factor (K) gives information on the physiological condition of fish in relation to it welfare [19]. In fisheries science, the condition factor is used in order to compare the condition, fatness or wellbeing of fish [20]. Hence out of the six species examined, 80% (four species) of the fish species had their K-values greater than 1 while the remaining 20 %(two species) had their K-values slightly below 1.0 (Table 6). The condition factor (K) of the present study was similar to what was obtained in other tropical water bodies. For example in Nigeria, "Nazeef and Abubakar [13] reported 60% (9 species out of 15) fish species in Dadin-Kowa dam had their K-values within the range of 0.1 to 1.0 and 40% of the fish species had their condition factor greater than 1.0. A range of between 0.49-1.48 was recorded by "Nwadiaro and Okorie [21] in Ogunta Lake. "Adeyemi, [1] obtained K-values of between 0.39-0.08 from idah Area of River Niger. Other Authors who carried out similar studies include; "Nehemia *et al*., [22] whose records ranged from 0.53-0.74 from fresh water ponds in Tanzania. "Kembenya *et al*., [18] recorded K-values ranged from 0.3-3.7 from Lake Baringo in Kenya and "Abowei [23] obtained K-values ranged from 0.4-1.61 from Nkoro River Niger Delta, Nigeria. "Ahmed *et al*., [20] recorded a k-values ranged of 0.506 and 3.45. "Abdullahi *et al*., [19] recorded range of 0.516 to 1.809 from Wudil River in Kano. The mean K-value of the species sampled in the present study is greater than 1 which is an indication that the fish species were doing well in the dam [22]. The conditional Factor (K) greater than 1 is good and it is an indication of stable physiological condition [18].

5. CONCLUSION AND RECOMMENDATIONS

The result obtained in this study shows that Waya dam has a low diversity of six (6) fish species, which is more both in terms of number and equitability of population size of each specie in the dry season than in the wet season. It also showed that *C. gariepinus*, *L. senegalensis* and *R. senegalensis* exhibited a positive allometric pattern of growth while *D. engycephalus*, *H. fasciatus* and *O. niloticus* exhibited a negative allometric pattern of growth. The condition factor obtained (0.7267 to 1.9199) for all the fish species showed that the fish is faring well in the dam. It is therefore recommended that the government should impose adequate regulations for sustainable fishery management and conservation as the fishes are of commercial importance as well as beneficial for fishery biologists, ecologists and conservationists. Breeding programme through public – private partnership should be carried out in the dam so as to introduce more fish species in order to increase the dam's fish biodiversity.

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