



Comparative Study of Length-Weight-Relationship (LWR) of the Fishes and Fishing Gears Use in Goronyo Reservoir and River Rima in Sokoto State, Nigeria

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ABSTRACT

Length - weight relationship is an important fishery management tool in estimating the average weight at a given length group and in assessing the relative wellbeing of a fish population. This study was conducted for six months, from April to October 2018 in both Goronyo reservoir (GR) and downstream River Rima (RR) to compare and evaluate the Length-Weight-Relationship (LWR) of some important commercial fishes and fishing gears used in the two water bodies. Five (5) and three (3) fish landing sites were purposively selected from Goronyo reservoir and River Rima because of their high fish landings and 10 fishermen were randomly selected and their catches monitored. The length and weight values were transformed into natural logs through the regression equation $\text{Log } W = a + b \text{ Log } L$ using SPSS computer software version 22. A total of 66 fish species were identified from the two water bodies, Goronyo reservoir accounted for 28 while River Rima accounted for 38 and 22 species were common in both water bodies. The mean b values of the LWR indicated that *Lates niloticus*, *Bagrusbayad macropterus* and *Auchenoglanis occidentalis* exhibited positive allometric growth pattern in both water bodies, but slightly higher in Rima River ($b = 3.9, 3.51, 3.7$ in Rive Rima and $3.8, 3.04, 3.5$ in Goronyo Reservoir) respectively. The least mean b values ($b = 2.01$) of LWR was recorded in respect of *Synodon tiscobroni* in River Rima while *Labe ocoubie* exhibited the highest b value of 3.93 in River Rima with SE value of 0.392. Gill nets were the most frequent gear used in Goronyo reservoir, and the least (3.14%) was cast net while hook and lines were almost equally used in both water bodies. In conclusion, the positive allometric growth pattern exhibited by *Lates niloticus*, *Bagrusbayad* and *Auchenoglanis occidentalis* indicated favorable aquatic environments for the species to thrive well, therefore management practices should be centered on maintaining these aquatic environments. *Labe ocoubie* should be re-introduced in both water bodies because they exhibited positive allometric growth pattern despite expected predation from *Lates niloticus* and fishing mortality. More attention should be given to the types of gears used in the water bodies in order to avoid catching smaller fishes. Selective gears like gillnet must conform to the Sokoto State Fisheries Edict of 1988 in order to protect heavily fished species such as *Synodontis* species from being over exploited. Finally, more studies are recommended to determine the effect of sex on LWR of some fish species in the two waterbodies.

KEYWORDS: Trophy cascades, Fisheries Edict, Goronyo reservoir, River Rima, Fishing gears

Introduction

Stock assessment is a fundamental and important tool needed for generating inputs necessary in developing strategies for efficient and proper management, development and enhancement of the fish species in any water body (Gupta and Gupta, 2008; Nehemiah et al., 2012). The length-weight-relationship (LWR), length-length-relationship (LLR), weight-weight-relationship (WWR) and Fulton's condition factor (' k ') are some examples of stock assessment tools use in fisheries management. These tools can be used to predict the health status, standing crop or biomass, growth pattern and yield of fish stock. Length-weight data of population are basic parameters for any monitoring study of fishes since it provides important information concerning the structure and function of populations (Anderson and Neumann, 1996). In fish population studies, it is therefore imperative to study fish species diversity together with the fish stock assessments in order to have a clear understanding of the management strategies peculiar to the fish population in such a water body.

According to Ita (1993a), fishery management is water body specific. Fish growth is an addition in length and size as it ages with a growth pattern of either isometric or allometric (Pauly, 2002). The isometric growth pattern was when a fish shape did not change when growing up, while in an allometric pattern of growth, the fish either becomes slender as it grows or becomes deeper and bulkier.

Various scholarly works (Beni-ditto-cecillio, 1997; Barham and Baxter, 2003; Fafioye and Oluajo, 2005; Froese, 2006; Mansor et al., 2010; Nehemiah et al., 2012; Dan-kishiya et al., 2013 and Jin et al., 2015) were published which reported and described different means values for LWR, LLR, CF et cetera, for many important freshwater fish species. There was a paucity of information regarding fish LWR and fishing gears used in the Goronyo reservoir and downstream River Rima (Malami and Magawata, 2010). Thus, this study was aimed at bridging the gap and therefore provide information on LWR of some important fish species and the fishing gears used by the artisanal fishermen in the two water bodies.

Materials and Methods

Description of the Study Sites/ Locations

The study sites were downstream River Rima (RR) and Goronyo reservoir (GR) all in Sokoto State, Northwestern Nigeria (Fig. 1). The state lies between longitude 4^o 8' E and 6^o 5' E and Latitude 12^o N and 13^o 58' N (Mamman et al., 2000). The exact point on River Rima where this study was conducted was at latitude 13.0667^o and Longitude 5.1667^o E (Fig. 2). The upper Rima is seasonal before it was dammed at Goronyo village (Fig. 3) so it flows during the rainy season overflowing its banks in August and September (Ita et al. 1982). The reservoir (Fig. 3) formed after damming the Rima river is known as Goronyo reservoir, it lies on coordinates 13^o 31' 50" N 05^o 52' 56" E (Google Earth, 2016). The reservoir has a storage capacity of 976,000,000 cubic meters (Sembenelli Consulting, 2010). It has river Bunsuru, Maradi and Gangare as its main tributaries. Some of the fish landing sites selected were in Keita, Katsira, Killaro, Marima and Gidanyarfara fishing villages surrounding it.

Data Collection and Sample Size

A total of eight (8) landing sites were purposively selected because of their high fish landings from the study area. Three (3) landing sites selected from River Rima were Usmanu Danfodiyo University major bridge (Kwalkwalawa), Dundaye village and Sokoto State Water treatment Plant along Illela road and designated as stations A, B, and C. Five (5) fish landing sites, Keta, Rimawa, Killaro, Katsira and Gidanyarfara at Goronyo reservoir were selected. Ten (10) fishermen were randomly selected and their catches monitored. A total of about 1,535 (GR, 848 and RR, 687) fish specimen samples were collected for data collection. The specimen samples were collected monthly between April and October, 2018.

The Fish Length/ Size

The fishermen's fish catches were measured based on species. The length of the individual fish specimen was measured using a meter rule to the nearest mm expressed as total and standard lengths as described by Bagenal and Tesch (1978) and the same method carried out by Gray et al. (2005), Balogun (2005) and Shinkafi et al. (2013).



Figure 1: Map of Nigeria Showing Sokoto State

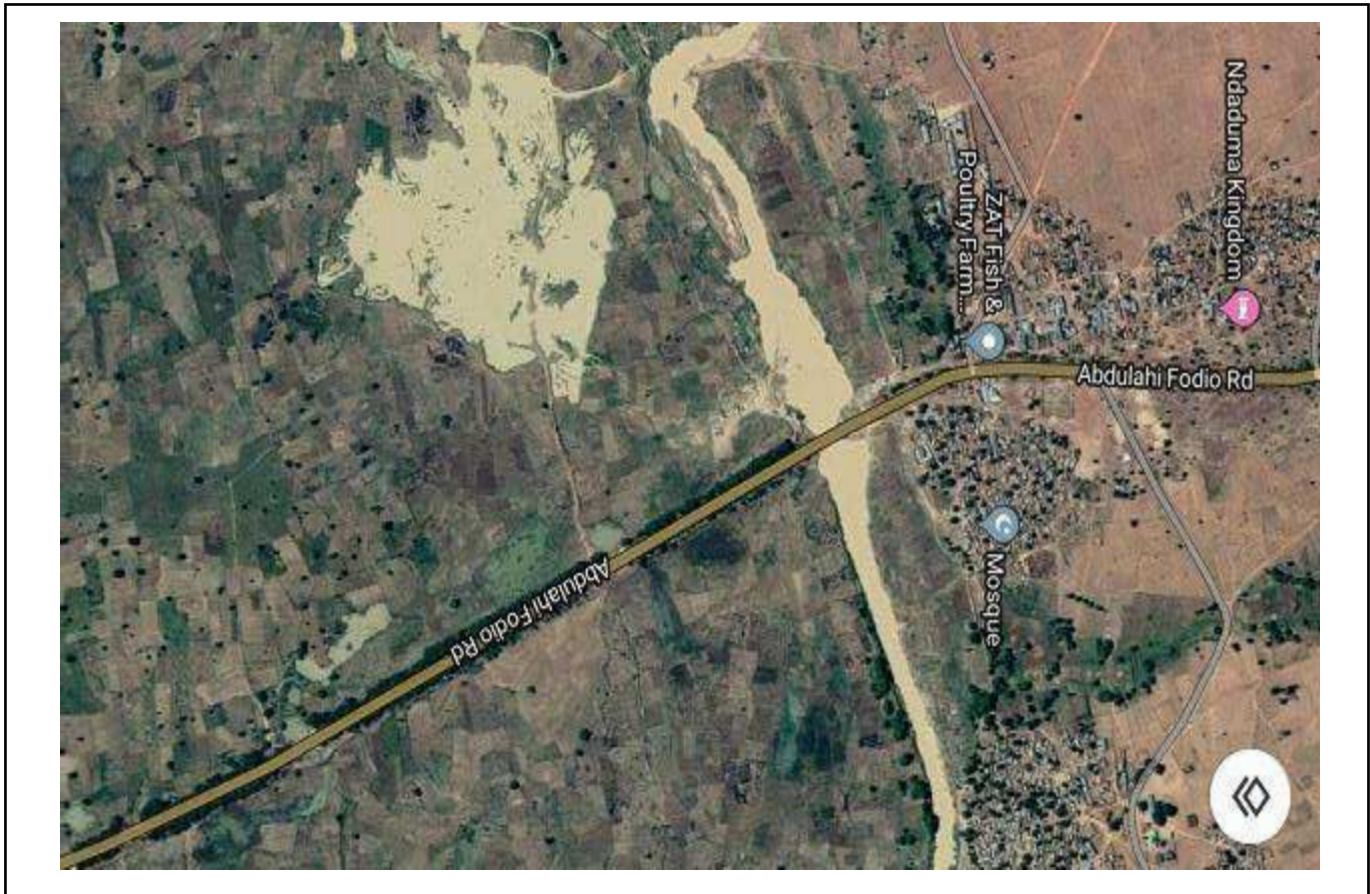


Figure 2: Sattelite Map of River Rima in Sokoto along University road



Figure 3: Goronyo Reservoir

The Fish Weight

The individual fish of each species was measured using a weighing balance to the nearest gram (g) as described by Bagenal and Tesch (1978) and the same method carried out by Gray et al. (2005).

Fishing Gears and equipment Survey

Information on types and kinds of fishing gears and equipment used by the fishermen from both water bodies was collected using a structured questionnaire. A total of 50 fishermen were selected randomly from both water bodies for an interview, using an open and closed structured questionnaire and display of their gears for inventory taking (Gusau et al. (2016).

Data Analysis

Length-Weight-Relationship (LWR)

The LWR parameter of the fish species from the two water bodies was fitted into the following regression equation using SPSS computer software:

$$W = a L^b$$

The regression equation was further transformed as follows:

$$\ln W = a + b \ln L, \text{ where}$$

W = weight of the fish specimen

L = length of the fish specimen

a = intercept of the slope

b = slope of the regression

ln = natural log

S/No.	Fish species	No. of individual		R		R ²		A		b		SEE	
		GR	RR	GR	RR	GR	RR	GR	RR	GR	RR	GR	RR
1	<i>Lates niloticus</i>	31	4	0.841	1	0.713	1	-12.02	-21	3.8	3.9	0.9	1.138
2	<i>Bagrus docmac</i>	47	16	0.810	0.707	0.66	0.499	-7	-3	3.04	3.51	0.7	0.65
3	<i>Bagrus bayad macropterus</i>	110	44	0.805	0.828	0.649	0.685	-53	-11	3.2	3.82	0.98	1.3
4	<i>Bagrus filamentous</i>	4	Nil	0.539	-----	0.288	-----	-14.6	-----	2.4	-----	1.5	-----
5	<i>Auchenoglanis occidentalis</i>	4	9	0.908	0.669	0.824	0.447	-28.5	-30	3.5	3.7	0.69	0.841
6	<i>Auchenoglanis biscutatus</i>	5	7	0.868	0.959	0.753	0.920	-23.1	-51	2.09	2.3	0.7	0.844
7	<i>Clarotes laticep</i>	5	21	0.006	0.542	0.000	0.295	-12.1	3.83	2.01	2.8	10.7	0.66
8	<i>Clarotes auratus</i>	Nil	7	-----	0.649	-----	0.418	-----	8	-----	2.3	-----	2.22
9	<i>Synodontis clarias</i>	66	58	0.827	0.645	0.693	0.416	-9.6	-1.5	3.77	3.8	1.8	1.318
10	<i>Synodontis sorex</i>	4	5	0.999	0.313	0.998	0.098	-7.1	-5.32	2.35	2.5	1.45	0.701
11	<i>Synodontis nigrata</i>	12	16	0.343	0.118	0.295	0.14	-2.3	-2.046	2.51	2.45	1.92	1.53
12	<i>Synodontis membranaceus</i>	5	Nil	0.992	-----	0.983	-----	-1.8	-----	2.75	-----	0.77	-----
13	<i>Synodontis gobroni</i>	5	Nil	0.000	-----	0.000	-----	10.5	-----	3.0	-----	1.1	-----
14	<i>Synodontis courteti</i>	9	4	0.115	1	0.013	1	-7	-6.47	2.35	3.09	0.9	1.091
15	<i>Synodontis vermiculatus</i>	Nil	6	-----	0.444	-----	0.19	-----	-6.56	-----	2.1	-----	0.219
16	<i>Synodontis budgetti</i>	Nil	5	-----	0.980	-----	0.980	-----	2.143	-----	3.8	-----	0.53
17	<i>Synodontis filamentous</i>	Nil	5	-----	0.992	-----	0.983	-----	-7.740	-----	3.2	-----	0.711
18	<i>Synodontis macropterus</i>	Nil	5	-----	0.969	-----	0.939	-----	-8.23	-----	3.6	-----	0.866
19	<i>Schilbemystus</i>	45	25	0.526	0.403	0.277	0.162	4.97	-1.66	3.65	3.1	0.74	0.870
20	<i>Schilbeinter medius</i>	Nil	24	-----	0.212	-----	0.045	-----	10.613	-----	2.4	-----	0.951
21	<i>Parailape lucida</i>	6	9	0.514	0.938	0.265	0.880	-3.67	6.55	2.53	2.09	0.886	1.078
22	<i>Clarias gariepinus</i>	41	25	0.960	0.868	0.921	0.740	-598	-3.13	3.24	3.4	0.66	0.414
23	<i>Clarias anguillaris</i>	22	11	0.862	0.792	0.743	0.627	-60.6	-20.4	2.15	2.6	1.74	1.9
24	<i>Malapterirus electricus</i>	31	21	0.710	0.170	0.504	0.029	-12	51.319	3-2.53	2.3	1.29	1.16
25	<i>Alestes nurse</i>	Nil	11	-----	0.793	-----	0.593	-----	-3.05	-----	3.4	-----	0.65
26	<i>Alestes baremose</i>	Nil	15	-----	0.616	-----	0.379	-----	-1.04	-----	3.5	-----	1.37
27	<i>Hydrocynus forskalii</i>	Nil	5	-----	0.983	-----	0.966	-----	-2.3	-----	3.3	-----	0.99
28	<i>Mormyrus rume</i>	134	102	0.735	0.833	0.540	0.695	-21	-8.6	3.48	3.7	2.31	0.99
29	<i>Hyperopsis bebe occidentalis</i>	52	39	0.901	0.854	0.812	0.730	8.1	-2.4	2.42	3.5	0.85	1.069
30	<i>Gnathomenus abadii</i>	27	15	0.939	0.772	0.882	0.596	-3	-10.5	2.49	2.8	0.49	0.9
31	<i>Marcusemus senegalensis</i>	4	27	0.999	0.998	-----	-----	-3	-----	2.1	-----	2.23	-----
32	<i>Petrocephalus bovie</i>	4	20	0.910	0.164	0.829	0.027	-12.9	14.56	2.9	3.1	3.995	1.38
33	<i>Mormyrops macrophthalmus</i>	7	-----	0.557	-----	0.311	-----	30.35	-----	2.61	-----	1.42	-----
34	<i>Mormyrops tapirus</i>	Nil	8	-----	0.982	-----	0.964	-----	-16.5	-----	2.3	-----	1.45
35	<i>Tilapia zillii</i>	5	-----	0.984	-----	0.968	-----	-6	-----	3.53	-----	1.29	-----
36	<i>Oreochromis niloticus</i>	65	33	0.757	0.609	0.573	0.371	-7.5	-5.70	3.8	3.01	1.30	0.73
37	<i>Hemichromis fasciatus</i>	Nil	5	-----	0.998	-----	0.997	-----	-12.1	-----	2.6	-----	1.462

37	<i>Hemichromis fasciatus</i>	Nil	5	-----	0.998	-----	0.997	-----	-12.1	-----	2.6	-----	1.462
38	<i>Labeo senegalensis</i>	Nil	8	-----	0.462	-----	0.214	-----	-34.84	-----	3.1	-----	1.121
39	<i>Labeo ooubie</i>	Nil	4	-----	0.999	-----	0.999	-----	-5.77	-----	3.93	-----	0.392
40	<i>Polypterus senegalensis</i>	21	Nil	-----	0.355	-----	0.128	-----	-12	-----	3.1	-----	0.23
41	<i>Polypterus ansorgie</i>	Nil	12	-----	0.504	-----	0.254	-----	33.5	-----	2.6	-----	0.84
42	<i>Protopterus annectens</i>	77	29	-----	0.932	-----	0.759	-----	0.868	-----	0.576	-----	22.24
				-----	27.87	-----	3.1	-----	2.9	-----	0.77	-----	0.82
43	<i>Distichodus rostratus</i>	Nil	13	-----	0.754	-----	0.568	-----	-4.5	-----	2.8	-----	1.1
44	<i>Distichodus engycephalus</i>	Nil	14	-----	0.376	-----	0.141	-----	-35.73	-----	2.7	-----	2.45

Table 1: The Mean b Values of the length-weight-relationships (LWRs) of some important fish species in Goronyo reservoir and downstream river Rima.

Source: The Study fieldwork, 2018

Key: R = R value, R² = R-square value, a = intercept, b = slope of the relation and SEE = standard error of estimate, RR= River Rima, GR = Goronyo Reservoir

S/No.	Gear Type	Goronyo Reservoir (%)	Rima River (%)
1	Malian trap	17.35	26.73
2	Gillnet	30.37	14.15
3	Clap net	10.85	23.58
4	Cast net	Nil	3.14
5	Ndrutu	10.85	Nil
6	Fish barrier/Screen	Nil	0.16
7	Seine net	0.43	0.31
8	Hook and line	29.28	29.87
9	Pole and line	0.87	1.89
10	Yawa (bottom gillnet)	Nil	0.16
Total		100	100
	Equipment		
1	Canoe/boat	1.72	0.45
2	Fishing gourd	98.28	99.55
Total		100	100

Table 2: Fishing gears and equipment Used by the Fishermen in both Goronyo and downstream River Rima

Source: The Study fieldwork, 2018

Results

Growth and Growth Pattern

Table 1 showed results for means b values of the LWRs which indicated that *Lates niloticus*, *Bagrus bayad macropterus* and *Auchenoglanis occidentalis* species from both water bodies had exhibited positive allometric ($b = 3.8, 3.04$ and 3.5) with those of downstream River Rima exhibiting slightly higher means values ($b = 3.9, 3.51$ and 3.7), respectively. The least mean b values of the LWRs were recorded in respect of specie *Synodon tiscobroni* from Goronyo reservoir. *Mormyrus rufus* and *Bagrus bayad macropterus* had the highest number of individuals accounting for 134 and 110 respectively while the least (4) individuals were recorded for *Labeo ooubie*.

Fishing Gears and equipment Survey

Results of the present study had indicated that gillnets and hook and line were the major gears used by the fishermen in the study area (Table 2). Gillnets account for 30.37% and 14.15% while hook and line recorded 29.28% and 29.87% in both Goronyo and river Rima respectively. The least gear (Yawa/bottom gillnet and screen fishing method) accounted for about 0.16 each in terms of usage and quantity in river Rima.

Discussion

The results showed most of the fish to be fairly exhibiting allometric growth patterns in both water bodies. For instance, the species *Lates niloticus* exhibited positive allometric growth pattern. This means as the fish were growing; they were adding weight and becoming bulkier and deeper. The same thing happened with other predators in both water bodies, such as *Bagrus docmac*, *Bagrus bayad macropterus*, *Auchenoglanis occidentalis* and *Hydrocinus forskalii*.

The results obtained were probably due to good/favourable aquatic environments, slightly better in river Rima as reported by Malami and Magawata (2010) and Abubakar et al. (2012). While some of our results are in agreement with other regional and international findings on biometrics of fish studied, others are contrary. Similar results were obtained in the studies conducted by Mansoret al. (2010) in Kerian river basin and Keru Lake all in Malaysia. Furthermore, the current study was in conformity with the positive allometric growth reported by Froese (2006) among 1773 specimens of fish.

Several studies corroborate the negative allometric growth reported in our study. According to Reed et al. (1967), *Bagrus filamentosus*, *Auchenoglanis biscutatus* and *Clarotes laticep* were relatively insectivorous or carnivores in feeding habits. These species exhibited negative allometric growth patterns from both water bodies. This could be due to steep competition from other species of the same families who are favorably disposed in the Rima and the reservoir. Imaobong et al. (2014) also reported steep competition for food among species of same families in Qua Iboe River estuary, Akwa Ibom State, southeastern Nigeria. This could probably be responsible for them exhibiting negative growth pattern in the two water bodies. Correspondingly, Waidi (2015) reported negative allometric growth patterns ($b = 2.114$) for an African silver fish, *Chrysichthys nigrodigitatus* in Ogun State coastal estuary.

Synodontis clarias and others from Mochokidae family exhibited positive allometric growth patterns more than the *Synodontis gobroni* in the Rima which exhibited negative growth patterns. This finding was also reported by Beneditto-cecillio et al. (1997) in Itaipu reservoir, Parana, Brazil where the authors observed mean b values ranged from 2.34 to 3.35 for about 72 fish species. *Clarias gariepinus* exhibited positive allometric growth pattern in both Goronyo and River Rima more than *Clarias anguillaris* which might be related to their feeding habits and reproductive strategy (Yusuf et al., 2013). *Mormy rusume* which accounted for the highest individuals caught exhibited positive allometric growth pattern for most of the 134 specimens examined. However, *Mormyrops tapirus* exhibited negative allometric growth pattern ($b = 2.3$) and was only found in Rima.

By adapting to bottom-feeding habit, this species successfully colonized the bottom strata as was reported by Reed et al. (1967) in the northern Nigerian water bodies. The fishermen successfully caught these species using Ndrutu and other traps and bottom gill nets in the two water bodies. Similar findings were reported by Reed et al. (1967) and Ita (1993) in northern Nigeria.

Oreochromis niloticus exhibited a positive allometric growth pattern in both Goronyo and the Rima, indicating the adaptability of the species in the reservoir. But *Hemichromis fasciatus* was not found in the reservoir and had exhibited a negative growth pattern in the Rima. According to Reed et al. (1967), *Hemichromis fasciatus* is a predatory Cichlid and probably could not survive the steep competition for food with the other predators in the reservoir. Nehemiah et al. (2012) reported both positive and negative allometric growth patterns in *Tilapia zilli* and some *Oreochromis niloticus* species cultured in freshwater and seawater ponds in Tanzania. But Dan-kishiya (2013) reported mean negative allometric growth patterns for 5 tropical fish species which included *Tilapia zilli*, *Tilapia mariae* and *Oreochromis niloticus* in a tropical reservoir in Abuja. *Labeo oocubie* and *Labeo senegalensis*, a very important fish species exhibited positive growth pattern in River Rima and were completely absent in the reservoir. This indicated the species to be suitable in lotic rather than lacustrine aquatic environment of the reservoir. Ita (1993a) also reported the high number of this species in river Niger prior to creating of Lake Kainji. *Distichodus rostratus* and *Distichodus biscutatus* all exhibited negative (2.8 and 2.7) allometric growth patterns in the reservoir. The reservoir had scanty macrophytes and other vegetation probably was responsible for the absence of these species. Reed et al. (1967) reported that this species lived on grasses and therefore could not thrive well in open water devoid of vegetation cover.

The agreements and disagreements with other works could be attributed to the condition of the species itself, its phenotype and its specific geographic location and hence its environment as several researchers have observed (Tsoumani et al., 2006). Phenotypic factors can play a role in affecting the allometric growth data. The bodyform and shape strongly affect the LWRs (Karachle & Stergiou, 2012). The variation in the obtained b values might be correlated with many factors such as food availability, season and sex (Yilmaz et al., 2012; Ali et al., 2016).

Survey on the fishing gears and equipment has shown that gillnets, hook and lines, and Malian traps are the most important fishing gears in both Goronyo and river Rima. Similar findings were reported by Reed et al. (1967) in Northern Nigeria and Gusau et al. (2016) in the Bakolori reservoir.

Most of the fishing gears are seasonal and selective and is based on the type of fish species to be catch. The types of fishing gears (gillnet, cast net, hook and line, and Malian trap) found in this area were also reported by Adeyemi et al. (2009) as the common fishing gears in fish gear survey of Gbedikere Lake, Bassa, Kogi State, Nigeria.

Conclusion

This study revealed that most of the predatory fish species in both river Rima and Goronyo reservoir exhibited positive growth patterns, indicating the ability to adapt and colonize the different ecological niche in the water bodies. But few species with low resilience and ability to compete for food and space became slender as they were aging. The study recommended paying attention to Labe ocoubie in the river Rima because of its ability to survive expected predation as they were growing. It's also very important for the gears to be regulated in order to protect the fishes in the two water bodies from been overfished.

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Hook and line no. 11



Clap net



Appendix 1: Some arrays of fishing gears and equipment used by Goronyo Fishermen

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