International Journal of
Fisheries and Aquatic Studies

Akpa LE
Department of Zoology,
University of Jos, Nigeria

Ajima MNO
Department of Fisheries and
Aquaculture Technology,
Federal University of
Technology, Owerri, Nigeria

Oyedapo FA
Department of Zoology,
University of Jos, Nigeria

Evaluation of fisheries capacity, condition factor and physicochemical characteristics of different aquatic ecosystems in Jos, North Central, Nigeria

Akpa LE, Ajima MNO and Oyedapo FA

Abstract
Fishery potentials and physicochemical parameters of four selected reservoirs including Kogingirin, Liberty, Lamingo and Tolemache in Jos metropolis were investigated for an interval of three months from August 2015 to February 2016. A total of seven fish species namely *Oreochromis niloticus, Hemichromis bimaculatus, Tilapia zilli, Cyprinus carpio, Clarias gariepinus, Barbus occidentalis* and *Lates niloticus*, distributed into four families, were found cross the reservoirs. The highest numbers of six species were recorded in Liberty reservoir while only one species was found in Kogingirin reservoir. The condition factor of the fishes from Kogingirin and Liberty reservoirs was 1.50, while those in Lamingo and Tolemache were 2.30 and 2.00 respectively. The water quality parameters of the reservoirs showed that they were within the range for the survival of aquatic life. The findings are discussed with implications for sensitization of the relevant authority towards the fisheries potential of these water bodies which could improve the economic life of the communities around them by boosting adequate fishing activities for the purpose of best practices.

Keywords: Fishes, water quality, reservoirs, condition factor, ecosystem

1. Introduction
Fishes are animal protein as well as source of food for humans and other animals. They are rich in proteins and vitamins, especially, vitamin A (Retinol) [1]. Bankole et al. [2] reported on the diversity, abundance and distribution of fish species in Lake Alau, a small reservoir and the second largest in Borno state. They identified ten fish species belonging to eight families with annual fish catch from 471.1 metric tons at low water level to 584.9 metric tons at high water level. Among the commercially important species recorded were: *Oreochromis niloticus, Clarias gariepinus, Tilapia zilli, Schlibe intermedius, Mormyrus rume, Brycinius nurse, Heterotis niloticus, Hemichromis bimaculatus, Hemichromis fasviatus, Labeus sp, Protopterus annectus* and *Synodontis spp*. These species are economically exploited for food and ornamental purpose [3]. According to Yalcin et al. [4] cichlids are among the most commercially exploited fishes for human consumption especially in African lakes. In Lake Alau, *C. gariepinus* (Clariidae families) (Catfish), *O. niloticus* (Cichlidae families) and Tilapia fish are highly priced fishes of considerable economic importance, available throughout the year and widely distributed [5].

Information on condition factor can be vital to culture system management because they provide the producer with information of the specific conditions under which organisms are developing [6]. Condition factor, also known as the wellbeing of fish is an important tool for observing the feeding frequency, age, and growth rates in fish [7]. The condition factor of fish can be influenced by certain factor including stress, sex, season, state of maturity, illness, availability of feeds, sample size and water quality parameters [8, 9]. If condition factor index is high it indicates that the fish has an evidence of a better condition.

The functioning and the ability of an aquatic ecosystem to support life forms depend to a great extent, on the physicochemical characteristics of its water. Increasing anthropogenic activities and some natural processes may decrease the quality of water which may pose a great threat to all forms of life including humans [10]. Water quality deterioration may affect the growth, reproduction ability, feeding habit as well as the condition factor of fish species. Determination of physicochemical parameter of freshwater ecosystem is important to predict

Corresponding Author:
Ajima MNO
Department of Fisheries and
Aquaculture Technology,
Federal University of
Technology, Owerri, Nigeria

the productivity and the fishery potential of such habitat.

The reservoirs (Kogingirin, Lamingo, Liberty and Tolemache) serve as sources of water supply to residence within Jos metropolis through the management of state water board. The reservoirs may have very rich flora and fauna biodiversity and supports a diverse number of fish species which can contribute to the development of a comprehensive baseline data of freshwater fishes in the environment. To date, information regarding the fishery biodiversity as well as the physicochemical indices of the reservoirs is not available. The study was designed to investigate the fish fauna and physicochemical characteristics of the reservoirs in order to provide information for possible better management strategies as well as the conservation of the fisheries resources of the aquatic ecosystems.

2. Materials and methods
2.1 Study area
The study area is Jos, Plateau state, Nigeria with coordinates of 9º 55" N and 8º 57" E. The sampling areas covered four water supplying reservoirs managed by the State Water Board namely Kogingirin, Lamingo, Liberty and Tolemache. The distances from the various sampling areas are as follows: Liberty - Tolemache is 4290 m; Tolemache – Lamingo is 2852 m; Lamingo – Kogingirin is 2402 m; Kogingirin – Liberty is 4104 m and Liberty – Lamingo is 3381 m.

2.2 Collection of fish specimen
The fish samples (species) were obtained (captured) from the four different reservoirs at an internal of three months between August 2015 and February 2016 with the help of fishermen, who fish in these reservoirs with the aid of their nets (4.40cm) they set overnight. The water samples for physicochemical parameter tests from the reservoir were also collected. The captured fishes were kept in an ice-block and together with the water samples were transferred to Hydrobiology Laboratory unit, Department of Zoology University of Jos, Nigeria for identification, measurement and analysis of water.

2.3 Identification and measurement of the fish species
Identification of the fish species was carried out with the aid of relevant keys by Reed [11] and Raji et al. [12]. The total length (TL) of the fish (taken from the tip of the snout to the end of the caudal fin) was measured to the nearest 0.1 cm with a ruler, and total weight (TW) of each fish was measured to the nearest 1 g with a citizen electronic balance model MF 2000K [13]. The condition factor (CF) of the fishes in the reservoirs was calculated as follows:

$$CF = W.L^{-3}.100$$

Photographic documentation of the fish samples from the reservoirs was also carried out.

### 2.4 Analysis of water quality
The physicochemical characteristics of reservoirs were determined as follows: water temperature was determined *in situ* using a mercury-in glass thermometer. pH was determined using a pocket-sized pH meter model no H196107. Turbidity was measured using a Secchi disc. Dissolved oxygen, free carbon dioxide and total alkalinity were determined according to the methods of APHA [14].

2.5 Statistical analysis
Data were analyzed using the statistical package SPSS 20.0 computer program (SPSS Inc. Chicago, Illinois, USA). Differences in water quality were done using analysis of variance (ANOVA). Duncan multiple range tests was used to determine the level of significance at 5% probability level. Data are expressed as mean ± SE.

3. Results
Seven different fish species were found in the reservoirs in the course of the study period (Figure 1). They are mainly distributed among four families namely Cichlidae represented by *O. niloticus, H. bimaculatus, T. zilli,* and *Cyprinus carpio;* Claridae represented by *C. gariepinus;* Cyprinidae represented by *Barbus occidentalis*, and Centropmidae represented by *L. niloticus*. Six species of fish were recorded from Liberty reservoir, followed by Tolemache, Lamingo and Kogingirin reservoirs which had five, four and one species respectively (Table 1). The condition factor of the fishes in the reservoirs was 1.50 for Kogingirin and Liberty reservoirs while those in Lamingo and Tolemache were 2.30 and 2.00 respectively (Table 2).
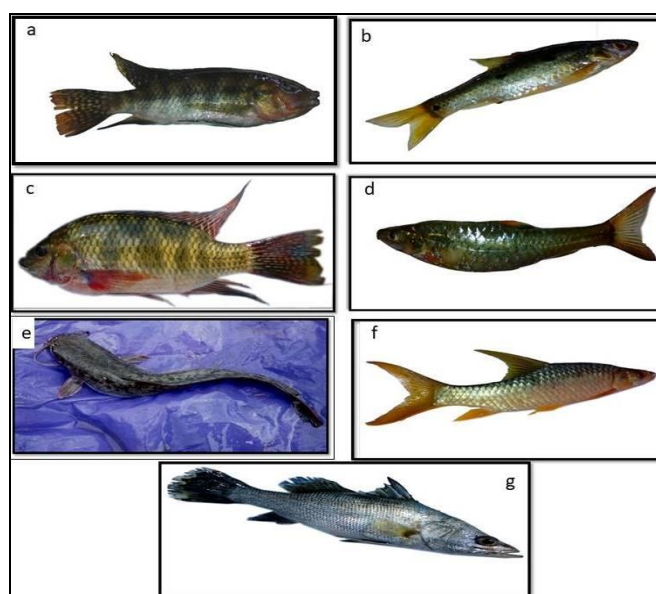
Fig 1: Fish Species (a) *Oreochromis niloticus* (b) *Hemichromis bimaculatus* (c) *Tilapia zilli* (d) *Cyprinus carpio* (e) *Clarias gariepinus* (f) *Barbus occidentalis* (g) *Lates niloticus* sampled from the Reservoirs

Table 1: Checklist and number of fish species sampled from the Reservoirs

		Reservoirs			
	Fish species	**Kogingirin**	**Lamingo**	**Liberty**	**Tolemache**
1	*Oreochromis niloticus*	+	+	+	+
2	*Hemichromis bimaculatus*	-	-	-	+
3	*Tilapia zilli*	-	+	+	+
4	*Cyprinus carpio*	-	-	+	-
5	*Clarias gariepinus*	-	-	+	+
6	*Barbus occidentalis*	-	+	+	+
7	*Lates niloticus*	-	+	+	-
	Total	1	4	6	5

Table 2: Mean values of condition factor of fishes sampled from the Reservoirs in Jos metropolis

	Reservoir			
Fish morphometrics	**Kogingirin**	**Lamingo**	**Liberty**	**Tolemache**
Number of Fish	60	30	30	19
Mean Weight (g)	17.70±1.03	51.20±0.09	101.20±1.06	33.70±0.08
Mean Length (cm)	10.50±2.04	13.10±0.17	18.90±1.18	11.90±1.12
Condition Factor (CF)	1.50±0.01	2.30±0.04	1.50±0.01	2.00±0.05

The results of physicochemical parameters as presented in Table 3 indicate variations in the parameters recorded in the reservoirs. There was no significant difference ($p>0.05$) in the values of water temperature, pH, free carbon dioxide (FCO_2) and alkalinity. The highest value of temperature was recorded in the month of February in the reservoirs when compared with that of August and November, but the increase was not significant ($P>0.05$). There was significant increase ($p<0.05$) in the level of dissolved oxygen across the reservoirs in November when compared with other months. The levels of dissolved oxygen recorded in all the reservoirs in February were low when compared with the values recorded in August and November. The value of turbidity found in the reservoirs showed significant difference ($p<0.05$) among the reservoirs. The highest value of the turbidity was found in Liberty reservoir throughout the study. In general the values of all the physicochemical parameters recorded across the reservoirs are within the range for the survival of the fish species.

Table 3: Mean values of physicochemical parameters of the Reservoirs for interval of three months between August 2015 and February 2016

		Parameter					
Month	**Reservoir**	**Water Temp. (°C)**	**pH**	**DO (mg/L)**	**FCO₂ (mg/L)**	**Alkalinity (mg/L)**	**Turbidity (cm)**
August 2015	Tolemache	22±0.01	7.41±0.11	7.69±0.05[a]	4.51±0.04	16.51±0.01	44.06±0.11[a]
	Lamingo	22±0.01	7.50±0.12	7.52±0.03[a]	4.42±0.05	16.50±0.06	65.69±0.02[b]
	Kogingirin	22±0.01	7.51±0.13	7.51±0.05[a]	4.82±0.02	15.81±0.11	79.54±0.03[c]
	Liberty	22±0.01	7.40±0.01	7.92±0.03[a]	4.70±0.05	16.52±0.12	90.36±0.08[d]
November 2015	Tolemache	21±0.02	7.40±0.01	8.50±0.05[b]	4.62±0.11	16.30±0.15	43.06±0.11[a]
	Lamingo	21±0.02	7.70±0.12	8.63±0.04[b]	4.31±0.12	17.41±0.13	64.76±0.04[b]
	Kogingirin	21±0.01	7.61±0.03	8.72±0.06[b]	4.32±0.11	17.42±0.16	80.54±0.04[c]
	Liberty	21.50.01	7.80±0.07	8.90±0.06[b]	3.98±0.03	16.30±0.06	85.89±0.12[d]
February 2016	Tolemache	23±0.02	7.20±0.01	6.71±0.07[a]	3.99±0.01	16.22±0.09	42.61±0.07[a]
	Lamingo	23±0.02	7.90±0.03	6.92±0.03[a]	4.10±0.02	17.20±0.11	62.71±0.07[b]
	Kogingirin	23±0.01	6.90±0.02	6.81±0.05[a]	4.20±0.02	17.51±0.11	70.44±0.09[c]
	Liberty	23±0.01	6.71±0.04	7.80±0.19[a]	3.89±0.01	18.52±0.09	80.33±0.11[d]

Values with different superscript letters along the column vary significantly ($p<0.05$) within and between the reservoirs

4. Discussion

The study has demonstrated that these reservoirs which supply water to the populace have the potential to supply also animal protein as source of food. The study also shows that the fish species of the reservoirs are of good health indicating the high productivity of the reservoirs.

Four out of the total fish species recorded in the reservoirs also have been reported by Mshelia et al. [16] in Alau reservoir in Borno state. These species namely *O. niloticus*, *C. gariepinus*, *T. zilli* and *H. bimaculatus* are economically exploited for food; with the first three species being highly priced fishes of considerable economic importance, available throughout the year and widely distributed [5]. *C. carpio* which was also sampled in the reservoirs is widely used in aquaculture practice. This agrees with Yalcin et al. [4] who stated that Cichlids are among the most commonly exploited fishes for human consumption especially in African lakes, and also with Abubakar [17] who reported that Cichlids dominated the fishes of Nguru Lake as high as 64% of the total population of fishes captured.

The highest numbers of fish species were caught from Liberty reservoir. This is expected because that reservoir is known to have the largest volume of water that harbored many different species of fishes, which were more likely to be encountered at random during fishing activities. Since these fishes were not subjected to any known intensive feeding practice, it could be stated that their growth and number were likely sustained by the different food resources therein which is in line with Pronob et al. [18] who reported that microalgae could enrich zooplankton for feeding fish and other larvae.

The condition factor of the fishes found in the reservoirs showed a suitable growth. Barnham and Baxter [19] noted that the condition factor of 1.00 indicates that the fish is in poor condition, a 1.20 value of condition factor indicates a

moderate condition of a fish while a value approximately 1.40 indicates that the fish is in good condition. Furthermore, Datta et al. [20] reported that a condition factor of greater than one showed the wellbeing of fishes fed with different experimental diets. The good condition factor obtained for the fishes could be a good reflection of the natural productivity of the water bodies because there was no supplementary feeding of any nature in the reservoirs. Similar good condition factor of fishes were recorded by Absalom & Ufodike [21] in a polyculture earthen pond.

The different condition factor found in the different reservoirs in the study (1.50-2.30) could be attributed to different feeding habit and well as different feeding regime. Nehemia et al. [22] noted that different ecological conditions can cause different condition factor. The values of condition factor could also differ significantly, depending on sex, gonad development, growth phase and availability of food [23, 24, 25].

The results of water temperature and dissolved oxygen in the study show inverse relationship. According to UNEP [26], a rising water temperature reduces dissolved oxygen level in a system and vice-versa. The increase of suspended solids loads from point and non-point sources especially in month of August could be attributed to different values reported for turbidity in the reservoirs. Similar to our report, Ikhuoriah & Oronsaye [10] recorded high turbidity values during the rainy season and low values during the dry season in Ossiomo River in Benin State, Nigeria. In general the values of physicochemical parameter recorded in this study are within the limit recommend by regulatory bodies for the survival and production of fish species USEPA [27].

5. Conclusion
The prospects of superimposing fisheries activities in these reservoirs with the primary purpose of water supply to the metropolis is very viable, even though most reservoirs are constructed to provide water for domestic use, irrigation and hydro- electric power generation. This will provide several fishing opportunities for the communities around these reservoirs. This will in turn improve their health status as a rich source of protein; a good source of income and for sport as a form of recreational activities. Therefore, these water supply reservoirs give a strong indication of healthy aquatic environments favourable for aquatic life. This study as it stands can provide management guide for the maintenance of reservoir water quality and stimulation of the reservoirs for higher productivity.

6. Acknowledgement

7. References
1. Royle W. Observation on feeding habits of Clarias barrage experimental pond found in food scheme. Technology. 2011; 5(2):76-79.
2. Bankole NO, Sule OD, Okwundu EC, Amadu M. Preliminary investigation into the fresh and catch assessment survey of Lake Alau. Annual Report to National Institute for Freshwater Fisheries, 1994; 22.
3. Njiru M, Okeyo-Owuor B, Muchiri M, Cowx IG. Shift in the food of Nile Tilapia, *Oreochromis niloticus* (L.) in Lake Victoria, Kenya. African Journal of Ecology. 2004; 42:163-170.
4. Yalcin S, Akyurt I, Solak K. Stomach Contents of the catfish (*Clarias gariepinus* Burchell, 1822) in the River Asi, Turkey. Turkish Journal of Zoology. 2001; 25:461-468.
5. Babatunde DO, Aminu R. Field guide to Nigeria freshwater Fisheries. Second edition, 2004, 47-49.
6. Araneda M, Perez EP, Gasca LE. White Shrimp *Penaeus vannamei* culture in freshwater at three densities; condition state based on length and weight. Aquaculture. 2008; 283:13-18.
7. Oni SK, Olayemi JY, Adegboye JD. Comparative physiology of three ecologically distinct fresh water fishes, *Alestes nurse* (Ruppell), *Synodontis schall* (Bloch), *S. schneider* and *Tilapia zilli* (Gervais). Journal of Fish Biology. 1983; 22:105-109.
8. Khallaf E, Galal M, Athuman M. The biology of *Oreochromis niloticus* in a polluted canal. Ecotoxicology. 2003; 12:405-416.
9. Adeyemi SO, Bankole NO, Adikwu IA, Akombo PM. Age, growth and mortality of some commercially important fish species in Gbadikere Lake, Kogi State, Nigeria. International Journal of Lakes and Rivers. 2009; 2(1):63-69.
10. Ikhuoriah SO, Oronsaye CG. Assessment of physicochemical characteristics and some heavy metals of Ossiomo River, Ologbo – A tributary of Benin River, Southern Nigeria. Journal of Applied Science and Environmental Management. 2016; 20(2):472-481.
11. Reed W, Burchad T, Hopson AJ, Jenness UJ, Yaro I. Fish and Fisheries of Northern Nigeria. Ministry of Agriculture, Northern Nigeria, 1967, 226.
12. Raji AO, Okaeme AN, Ibeun MO. Forty years of Lake Kainji fisheries research. National Institute for Freshwater Fisheries Research, New Bussa, 2011, 247pp.
13. Offem BO, Ayotunde EO, Ikpi GU, Ochang SN, Ada FB. Influence of Seasons on Water Quality, Abundance of Fish and Plankton Species of Ikwori Lake, South-Eastern Nigeria. Fisheries and Aquaculture Journal, 2011. FAJ-13
14. APHA (American Public Health Association, American Water works Association and Water Environmental Federation) (2005). Standard Methods of Examination of Water and Wastewater, 21st edition APHA, Washington, DC 20001-23710
15. Balarabe RS, Chavan SP, Kannewad PM. Gut contest analysis of *Wallago attu* and mystus (*Sperata seenghala*) the common catfishes from Godavari River system in Maharashtra State. Advances in Biological Research. 2013; 4(2):123-128.
16. Mshelia MB, Manneer MB, Garba U, Hassan MA. A frame and catch assessment of fishes of lake Alau, Borno State, Nigeria. International Journal of Fisheries and Aquatic Studies. 2015; 2(4S):35-40.
17. Abubakar MM. Biodiversity and Abundance of fish and plankton of Nguru Lake, North-Eastern Nigeria. Journal of Biology, Agriculture and Health Care. 2013; 3(5):18-23.
18. Pronob DS, Mandal SC, Bhagabati SK, Singh SK. Important live food organisms and their role in Aquacultures. Frontiers in Aquaculture 2012; 69-86.
19. Barnham C, Baxter A. Condition Factor, K, for Salmonid Fish. Fisheries Notes, 1998, 1-3.
20. Datta SN, Kaur VI, Dhawan A, Jassal G. Estimation of length- weight relationship and condition factor of

spotted snakehead, *Channa punctata* (Bloch) under different feeding regimes. Springer plus. 2013; 2:436-440.

21. Absalom KV, Ufodike EBC. Seasonal food selection by three-sized *Oreochromis niloticus niloticus* (Trewavas) in a polycultured earthen pond. Journal of Aquatic Sciences. 2005; 20(1):45-51.

22. Nehemia A, Maganira JD, Rumisha C. Length-Weight relationship and condition factor of tilapia species grown in marine and fresh water ponds. Agriculture and Biology Journal of North America. 2012; 3(3):117-124.

23. Pervin MR, Mortuza MG. Notes on length-weight relationship and condition factor of freshwater fish *Labeo boga* (Hamilton) (Cypriniformes: Cyprinidae). University of Zoology Rajshahi University. 2008; 27:97-98.

24. Gupta BK, Sarkar UK, Bhardwaj SK, Pal A. Condition factor, length-weight and length-weight relationships of an endangered fish Ompok pabda (Hamilton 1822) (Silurifomes: Siluridae) from the River Gomti, a tributary of the River Ganga, India. Journal of Applied Ichthyology. 2011; 27:962-964.

25. Hamid MA, Mansor M, Nor SAM. Length-weight Relationship and Condition Factor of Fish Populations in Temengor Reservoir: Indication of Environmental Health. Sains Malaysiana. 2005; 44(1):61-66.

26. UNEP (United Nations Environment Program). Water Quality for Ecosystem and Human Health. Prepared and published by the United Nations Environment Program. Global Environment Monitoring System (GEMS) Water Program. ISBN 92- 95039-10-6, 2006, 132pp.

27. United State Environmental Protection Agency (USEPA). The toxic substances control act, the reality and the reason, 1976, 1227pp.