FISH ASSEMBLAGE AND DIVERSITY IN ERINLE RESERVOIR, OSUN STATE, NIGERIA.

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ABSTRACT
The fish assemblage in Erinle reservoir was investigated to know the status and proffer necessary management procedures for sustainability. Three points (A, B, C) were randomly selected on the reservoir and measured for physical and chemical parameters and fish species from October 2019 to August 2020. Fish species from fishermen landings were identified using field guides and abundance recorded by family and species. Physical and chemical analysis were measured insitu and the mean values for temperature (17.07 ± 0.72^{o}C), dissolved oxygen (2.83 ± 0.31mg/L) and pH (5.55 ± 0.11) were below the recommended limits and significant (P<0.05) while ammonia was high (0.1 ± 0.03mg/L. A total of 213 individuals belonging to 15 species, with cichlids the most abundant family (58.2%) was identified. C. mariae was the most abundant species (18.8%) and May was the most abundant month (18.8%). Species richness (S) was 15, Shannon -Weiner diversity (H) was 3.56, and Evenness (E) was 5.74. It was observed that the fish abundance was low, diversity was high, and fairly evenly distributed despite the size of the reservoir, and wastes from human activities affected the physical and chemical parameters. It is therefore important to preserve biodiversity by ensuring and enforcing a clean environment.

Keywords: Erinle reservoir, Osun River, management, Water quality,

INTRODUCTION
The Nigerian aquatic system can undergo different seasonal hydrology which is associated with periods of low and high-water levels imposed by the changes in rainfall patterns within the wet and dry seasons. Environmental factors such as rainfall fluctuations, temperature fluctuations, humidity e.t.c can affect the abundance and sustenance of available fish species within tropical reservoirs vary with the water level. The freshwater fish species found in Nigeria are about 268 species that inhabit freshwater bodies such as streams, reservoirs, lakes, and rivers which constitute about 12% of Nigeria's total surface area (Taiwo, 2010). These fish species depend on water for support, food, dissolved oxygen, and shelter and the volume and quality of water determines the diversity and abundance of fishes within the water body. The increasing urbanization and industrialization have greatly affected the environmental system and altered the composition of aquatic resources, migration, and even death in extreme cases (IPCC, 2007). These activities have been more rampant over the last decade and have posed a direct effect on fish composition in the areas of recruitment, feeding habits, breeding seasons, and response to an environmental stimulus (FAO, 2020). Osun river system has numerous tributaries on which the Erinle reservoir is situated. It is one of the largest reservoirs in the state and serves as a cheap protein source for inhabitants within its environs. As the common practice in riverine areas, wastes and various materials from the community are emptied into the river which can pose a threat to fish composition. With limited documented studies on the reservoir, the reports by Badejo and Oriyomi (2015) on this reservoir were used as baseline information for this study to investigate the state of fish composition and physical and chemical parameters. This will provide clear information for appropriate agencies on the management of fish species in the reservoir.

MATERIALS AND METHODS
Study Area
The reservoir is located between Longitude 4° 47 E and Latitude 4° 46 N on Erinle river which is a tributary of Osun River. The river is encompassed with various human and commercial activities all of which empties into the river. The reservoir provides portable water and fish for the Ede community and its environs. Three points were purposively selected based on accessibility and tagged A, B, and C which was about 150m equidistant and sampled for a period of 12 months (October 2019 – August 2020).

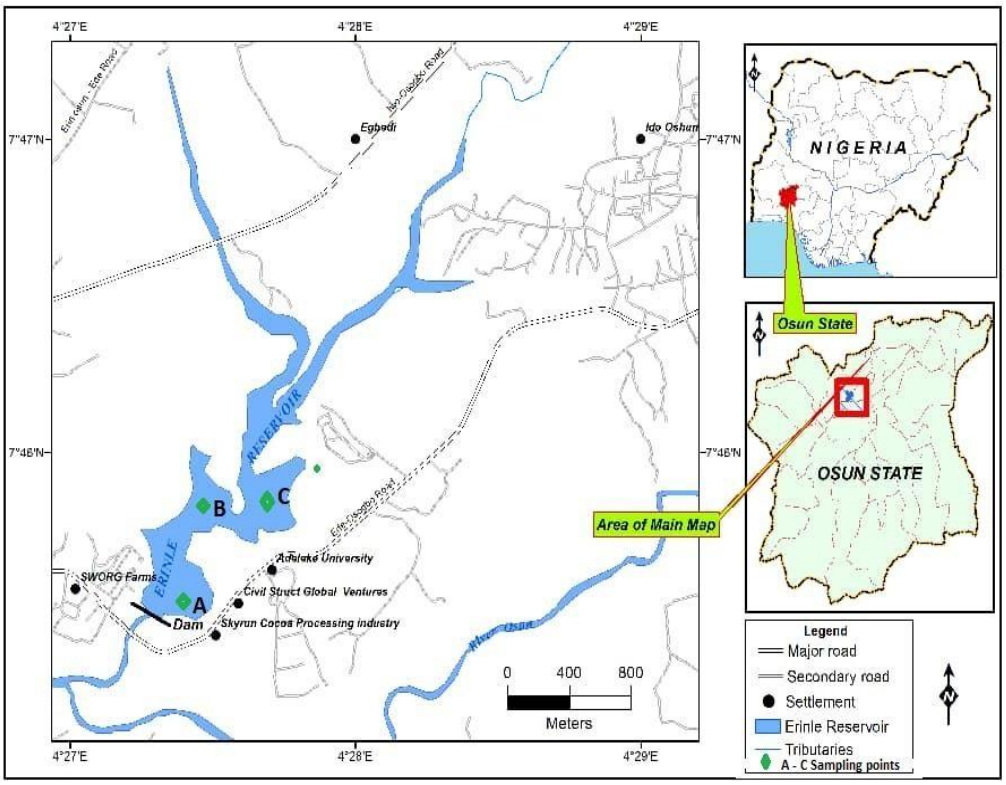

Fig. 1: Map of Erinle Reservoir

Physico-Chemical Parameters

Water samples were collected in 50ml sterilized sampling containers between the hours of 7 am and 9 am fortnightly for twelve months. Temperature, pH, Dissolved oxygen and, Ammonia was measured *insitu*. The temperature was measured using the mercury-in-glass thermometer and recorded in degrees Celcius, pH, Dissolved Oxygen (DO), and, Ammonia was measured using kits.

Fish Abundance

Fish species were sampled from landings by fishermen from points A, B, and, C. They were identified using guides by Holden and Reeds (1978) and Froese and Pauly (2019) and abundance recorded by individuals and family.

Biological Diversity

It was calculated using equations as stated by Shannon and Weiner (1948)

$$Shannon\,weiner\,(H) = \frac{NlogN - nlogn}{N}$$

$$Evenness\,(E) = \frac{H}{Hmax}$$

$$Simpsons\,Index\,(D) = \frac{\sum n(n-1)}{N(N-1)}$$

Where: N = Total number of individuals present in all the points

n = Total number of individuals present in each point

H = Diversity index

H_{max} = Natural log of richness

Statistical Analysis

Simple descriptive analyses such as means and percentages were used for data on fish abundance. The means of physical and chemical parameters were separated using Analysis of Variance ANOVA). Minitab 21.0 statistical package was used at $P<0.05$ significance level.

RESULTS

Physical and Chemical Parameters

The mean physical and chemical parameters measured during the study are presented in Table 4. The highest mean values of DO in May and August were significantly different ($P<0.05$) from the other months during the study period. For temperature, the overall mean temperature was 17.07 ± 0.72 ^{o}C and the mean monthly values in April and August were significantly different ($P<0.05$) from the other months during the study period. For pH concentration, the overall mean was 5.55 ± 0.11 and no significant differences ($P>0.05$) were observed among the months. For Ammonia concentration, the overall mean concentration was 0.1 ± 0.03mg/L and the mean monthly values in December, June and July were significantly different ($P<0.05$) from mean values in October, February, April, and May and significantly different ($P<0.05$) from mean values in November during the period of study.

Fish Abundance

A total of 213 individuals which belonged to 7 families and comprised of 15 species were observed (Tables 2 and 3). *Coptodon mariae* had the highest relative abundance (18.8%) and the least was *Synodontis sorex* (2.8%). The highest relative abundance was observed in May (18.8%) and the least relative abundance was in February (3.8%).

BIOLOGICAL DIVERSITY

The biological diversity indices of fish species calculated during the study are presented in Table 4. The highest monthly relative abundance was in August (13.6%) and the least was in February (3.8%) with a total of 213 individuals encountered in the reservoir during the study period. The reservoir had an overall richness of 15 with the highest richness encountered in December, January and, July with 7 species respectively and the least was in October and August with 4 species respectively. The overall Shannon Wiener (H) index was 3.53 with the highest index in February (3.63) and the least was in August (3.47). Simpson's index (D) was highest in May (0.03) and lowest in February (0) and October (0) with an overall value from the reservoir as 0. Evenness (E) was highest in February (6.96) and least in May (6.82) with the overall value of 5.84.

DISCUSSION

Physical and Chemical Parameters

The water quality parameters are required to be in the appropriate quantity and quality for optimal performance and sustenance of fish species. Therefore, any form of alterations in concentration can affect the body functions and survival of fish species (Kiran, 2010). Mean values measured was 2.83 ± 0.31mg/L which was lower than theminimum recommended levels for dissolved oxygen concentration of 3mg/L as stated by Viveen *et al.,* (1985). Although, it was observed that all the mean monthly values were above the recommended levels with similar reports by Badejo and Oriyomi (2015). The Analysis of variance presented a significant difference ($P<0.05$) in the mean monthly values of DO in May and August when compared with other months during the period of study. The mean temperature values (17.07 ± 0.72^{o}C) was observed to be below the recommended level of 20-30 ^{o}C by Viveen *et al.,*(1985). The mean values across the months were mostly observed to be within the recommended limits except for April and August. The Analysis of variance results showed that the mean monthly values in April and August were significantly different ($P<0.05$) from the other months during the study period. The recommended pH level by Viveen *et al.,* (1985) is between 6.5 – 8. It was observed from the reservoir that mean pH values was lower than recommended limits (5.55 ± 0.11), although mean values across the months were within the recommended limits and it implied the water was acidic in nature at the time of study. Santhosh and Singh (2007) reported the suitable pH range for fish culture is between 6.7 and 9.5 and values above or below this limit may stress the fish. Ammonia is mostly derived from excretion and decomposition of uneaten food (Badejo and Oriyomi, 2015). The mean value measured from the reservoir (0.14 ± 0.03mg/L) was observed to be higher than the recommended limits of < 0.05mg/L as stated by Viveen *et al.,* (1985). The mean concentration across the months were also observed to be relatively high and it is an indicator of increased organic pollution from wastes which empties into the river. Kolawole and Iyiola (2018) and Badejo and Oriyomi (2015) reported similar occurrence of increased ammonia concentration as a result of high influx of wastes in Aiba reservoir and Erinle reservoir respectively. Statistically, the mean monthly values in December, June and July were significantly different ($P<0.05$) from mean values in October, February, April and May and significantly different ($P<0.05$) from mean values in November during the study period.

FISH ABUNDANCE

The fish abundance encountered during the study (213 individuals belonging to 15 families) was low relative to the size of the reservoir. It was observed that the fish abundance in the wet season was more than the dry season which deviated from the reports by Negi and Mamgain (2013). Naturally, fish species are supposed to undergo breeding activities during the wet season because environmental conditions of rainfall and temperature are favorable. The peak abundance was also observed in May (18.8%) which deviated from a previous report by Badejo and Oriyomi (2015) who observed a peak abundance in March (17.47%). When compared with previous studies and other reservoirs in the Osun system, Ipinmoroti *et al.,* (2018) reported a total of 1780 individuals belonging to 19 species, Badejo and Oriyomi (2015) reported a total of 561 individuals belonging to 12 species in Erinle reservoir, Taiwo (2010) reported a total of 644 individuals belonging to 18 species in Eko-Ende reservoir; 645 individuals belonging to 15 species in Owalla reservoir. It was observed from these reports that the fish abundance was higher than the current study. This could be due to various factors which are majorly anthropogenic (Lawson and Olusanya, 2010). *C. mariae* was observed to be the most abundant during the study and it deviated from other reports such as Taiwo *et al.,* (2018) observing *C. zilli* (25.95%) in Opa reservoir, Badejo and Oriyomi, (2015) observing *S. galileaus* (55.08%) in Erinle reservoir; Taiwo (2010) observing *H. fasciatus* (27.44%) in Owalla reservoir while a report by Taiwo (2010) stated *C. marie* (17.02%) as the most abundant in Eko-Ende

reservoir and was slightly lower than the findings of this study (18.8%). Cichlids have been reported to be the most dominant family in Nigerian waters, this was the case of Erinle reservoir during the study with the relative abundance of 58.2% comprising of 7 species. This result was similar to findings by Badejo and Oriyomi (2015) reported 77.8% of Cichlids comprising of 5 individuals in Erinle reservoir, Komolafe *et al.,* (2014) reported 83.2% comprising of 5 individuals in Osinmo reservoir and Taiwo *et al.,* (2018) reported 72.63% of Cichlids comprising of 7 individuals in Opa reservoir.

BIOLOGICAL DIVERSITY

The H- value of the reservoir was 3.53 and values were observed to fluctuate across the months with the highest value was recorded in February (3.63). This indicated that the fish species in February despite low in abundance (3.8%) and richness (4) was highly diversified when compared to other months and the month with the least diversity was August (3.47). The H value recorded from the reservoir was higher than the values recorded in Eko-Ende and Owalla reservoirs with values of 2.369 and 2.099 respectively (Taiwo, 2010). It was also higher than the report of Ipinmoroti *et al.,* (2018) that Asejire Lake has an H-value of 1.926.

Simpson's index (D) and Evenness (E) provide information about the most occurring or dominant species in a place at a particular time. D values range between 0 – 1 (from no diversity to high diversity) (Lawson and Olusanya, 2010). The values recorded in terms of dominant species in the reservoir show that the fish species are not diversified in terms of their dominance. The value recorded was lower than the values observed by Taiwo (2010) in Eko-Ende and Owalla reservoirs with 0.88 and 0.84 respectively which indicated a high dominance in fish species and Asejire Lake by Ipinmoroti *et al.,* (2018) who recorded D values of 0.18. 1-D values also range between 0 – 1 with a value of 1 recorded from the reservoir during the study. It contradicts the reports of Ipinmoroti *et al.,* (2018) who reported a value of 0.812 which was lower than the value recorded during the study. The E value illustrates the highest value having an even distribution of fish species in the area at a particular time. An E value of 5.74 was observed during the study with the highest value in February (6.96).

CONCLUSION

It was observed that the fish abundance was low but the species present were fairly even and highly diversified. The low abundance could be attributed to the effects of human activities and wastes generated which were emptied into the reservoir and evident by increased ammonia levels as measured. The DO, pH, and temperature were within the recommended limits for the sustenance of aquatic life. It was worthy to note that the species richness was fairly high and the abundance in the wet season was more than the dry season rather than the usual increase in the dry season when compared with the wet season. Cichlids were the most occurring family and *C. mariae* was the most abundant. To this end, it is important to maintain a clean environment for the sustenance of aquatic resources.

REFERENCES

Badejo, O.A. & Oriyomi, O. (2015). Seasonal Variation, Abundance and Condition Factor of Fish Species in Erinle Reservoir. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, 12(1), 136-142.

FAO, (2020). The state of the World's Fisheries and Aquaculture. Sustainability in action; Food and Agricultural Organization, Rome. Available at https://doi.org/10.4060/ca9231en

Froese, R. & Pauly, D. (eds) (2019) World Wide Web electronic publication. www.fishbase.org, version (04/2019).

Holden M & Reeds W (1978). *West African Freshwater Fish*. Longman Group Ltd, London. ISBN 0 582 60426 5.

IPCC, (2007). Climate Change 2007: *The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, US, 996 pp.

Ipinmoroti M.O., Iyiola A.O., Akanmu O.A., Orisasona O. & Fawole N. (2018). *Diversity and Distribution of Fish Species in Lake Asejire, southwest Nigeria*. In: Kallel A., Ksibi M., Ben Dhia H., Khélifi N. (Eds) Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions. EMCEI 2017. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer, Cham. DOI https://doi.org/10.1007/978-3-319-70548-4_422. PP 1447-1448.

Kiran, B. R. (2010). Physico-chemical characteristics of fish ponds of Bhadra project at Karnataka, *RASĀYAN Journal of Chemistry*, 3(4), pp 671-676.

Kolawole, A.S. & Iyiola, A.O. (2018): Investigation of Human Activities on the Water and Bacteriological properties of a Tropical Reservoir in Osun, Nigeria. *Nigerian Journal of Fisheries*, 15(1):1308-1313.

Komolafe, O.O., Adedeji, A.A. and Fadairo, B. (2014). Assessment of the water quality with the fish community of Osinmo Reservoir, Ejigbo, Osun State, Nigeria. *Int. J. Biol. Chem. Sci*, 8(2):596-609.

Lawson O.E. & Olusanya, O.M. (2010). Fish Diversity in Three Tributaries of River Ore, South West, Nigeria. *World Journal of Fish and Marine Science*, 2(6), p524-531.

Negi, R.K. & Mamgain, S. (2013). Species diversity, abundance, and distribution of fish community and conservation status of Tons River of Uttarakhand State, India, *Journal of Fisheries and Aquatic Science*, 8: 617-626.

Santhosh, B. & Singh, N.P. (2007). *Guidelines for water quality management for fish culture in Tripura, ICAR* Research Complex for NEH Region, Tripura Center, Publication no.29

Taiwo, Y.F., Adedeji, A.A. & Adesakin, T.A. (2018). The Ecological Balance of the Fish Community in an Aging Reservoir. *Natural Resources*, 9, 327-335. https://doi.org/10.4236/nr.2018.99020.

Taiwo, Y.F. (2010). *Fish Diversity in two Reservoirs in South-Western Nigeria.* Proceedings of the Fisheries Society of Nigeria (FISON) ASCON, Badagry 25th – 29th October 2010. FNS-FB-0007; ISSN:1117-3149.

Viveen, W.J.A.R., Richter, J.J.C., Oordtrot, P.G.W.J., Janseen, J.A.L. & Huisman, E.A. (1985). *A practical manual for the culture of the African catfish Clarias gariepinus.* Directorate-General for International Cooperation. The Hague, The Netherlands.

Table 1: Mean monthly parameters measured

Months	DO (mg/L)	Temperature (°C)	pH	Ammonia (mg/L)
October	3.31 ± 0.11^{b}	21.3 ± 0.19^{b}	6.79 ± 0.03^{a}	0.17 ± 0.02^{b}
November	3.53 ± 0.25^{b}	21.0 ± 0.62^{b}	6.76 ± 0.11^{a}	0.25 ± 0.12^{c}
December	3.53 ± 0.91^{b}	20.0 ± 0.22^{b}	6.60 ± 0.21^{a}	0.08 ± 0.03^{a}
January	3.53 ± 0.22^{b}	21.4 ± 0.21^{b}	6.96 ± 0.18^{a}	0
February	3.53 ± 0.42^{b}	22.1 ± 0.12^{b}	6.56 ± 0.32^{a}	0.16 ± 0.01^{b}
April	3.53 ± 0.21^{b}	19.26 ± 0.71^{a}	6.60 ± 0.11^{a}	0.16 ± 0.03^{b}
May	2.86 ± 0.01^{a}	20.36 ± 0.22^{b}	6.63 ± 0.23^{a}	0.16 ± 0.01^{b}
June	3.53 ± 0.19^{b}	20.3 ± 0.29^{b}	6.60 ± 0.32^{a}	0.08 ± 0.01^{a}
July	3.53 ± 0.32^{b}	20.0 ± 0.43^{b}	6.56 ± 0.22^{a}	0.08 ± 0.01^{a}
August	3.08 ± 0.12^{a}	19.20 ± 0.11^{a}	6.53 ± 0.22^{a}	0
Mean	2.83 ± 0.31	17.07 ± 0.72	5.55 ± 0.11	0.1 ± 0.03

Values with different characters across each column are significantly different (P<0.05)

Table 2: Monthly abundance of fish species identified during the study

Fish species	Oct	Nov.	Dec.	Jan	Feb	Apr	May	Jun	Jul	Aug	total	Total (%)
Alestes nurse	1	0	0	3	0	0	11	0	2	2	19	8.9
Chrysichthys aluuensis	0	2	0	0	0	2	0	0	3	2	9	4.2
Coptpdon mariae	0	6	7	1	0	4	14	0	6	2	40	18.8
C. zilli	4	3	0	0	1	5	0	7	0	5	25	11.7
Hemichromis bimaculatus	0	2	0	0	0	0	0	0	5	5	12	5.6
Hemichromis elongatus	0	0	0	1	0	0	0	3	3	1	8	3.8
Mormyrus rume	4	3	1	0	3	0	3	0	0	2	16	7.5
Mormyrus tapirus	0	0	1	0	2	3	0	0	0	2	8	3.8
Oreochromis niloticus	0	2	0	0	0	0	0	2	2	3	9	4.2
Phago loricatus	0	0	0	6	2	0	0	0	0	0	8	3.8
Sarotherodon melanotheron	1	1	1	0	0	0	0	6	0	0	9	4.2
Schilbe isidori	1	0	0	2	0	0	3	2	3	0	11	5.2
Synodontis sorex	0	0	4	2	0	0	0	0	0	0	6	2.8
Synodontis violaceus	2	3	2	1	0	0	0	3	0	0	11	5.2
Tilapia guineensis	0	1	0	3	0	4	9	0	0	5	21	9.9
Total	13	23	16	19	8	18	40	23	24	29	213	100
Total (%)	6.1	10.8	7.5	8.9	3.8	8.5	18.8	10.8	11.3	13.6		

Table 3: Fish abundance by Family identified during the study

S/N	Family	Fish Species	Abundance	Relative abundance
1	Alestidae	*Alestes nurse*	19	8.9
2	Bagridae	*Chrysichthys aluuensis*	9	4.2
3	Cichlidae	*Coptodon mariae*	40	18.8
		C. zilli	25	11.7
		Hemichromis bimaculatus	12	5.6
		Hemichromis elongatus	8	3.8
		Oreochromis niloticus	9	4.2
		Sarotherodon melanotheron	9	4.2
		Tilapia guineensis	21	9.9
4	Distichodontidae	*Phago loricatus*	8	3.8
5	Mochokidae	*Synodontis sorex*	6	2.8
		Synodontis violaceus	11	5.2
6	Mormyridae	*Mormyrus tapirus*	8	3.8
		Mormyrus rume	16	7.5
7	Schilbeidae	*Schilbe isidori*	11	5.2
			213	8.9

Table 4: Biological diversity indices of fish species.

Diversity indices	Nov.	Dec.	Jan.	Feb.	April	May	June	July	Aug	Oct.	Total (N)
Abundance (n)	23	16	19	8	18	40	23	24	29	13	213
Relative abundance (n%)	10.8	7.5	8.9	3.8	8.5	18.8	10.8	11.3	13.6	6.1	100
Richness (S)	5	7	7	5	5	5	6	7	4	4	15
Shannon Wiener (H)	3.52	3.58	3.55	3.63	3.56	3.37	3.51	3.51	3.47	3.6	3.53
Simpson's index (D)	0.01	0.01	0.01	0.00	0.01	0.03	0.01	0.01	0.02	0.00	0.00
Evenness (E)	6.84	6.93	6.91	6.96	6.92	6.82	6.89	6.89	6.87	6.94	5.74