UMYU Scientifica, Vol. 1 NO. 1, September 2022, Pp 234 – 240
https://doi.org/10.56919/usci.1122.030
ISSN: 2955 – 1145 (print); 2955 – 1153 (online)
A periodical of the Faculty of Natural and Applied Sciences, UMYU, Katsina

ORIGINAL RESEARCH ARTICLE

Water Quality and Catch Per Unit Effort (CPUE) of Fish Species in Zobe Reservoir, Dutsin-Ma, Nigeria

*[1]Nababa, Abdulsalam Sani, Sadauki, Mustapha Amadu, Hadiza Yakubu Bako
[1]Department of Fisheries and Aquaculture, Federal University Dutsin-Ma, Katsina State Nigeria.

ABSTRACT
A twelve month study was carried out between March 2020 and February 2021, to assess water quality parameters and fishermen catch per unit effort of Zobe reservoir in Katsina State, Nigeria with the aim of understanding the contamination position of water body and fishing effort. Five chosen sampling stations are; Raddawa, Tabobi, Gada, Garhi, and Makera. Selected physicochemical parameters such as temperature, pH, NH_3, turbidity, alkalinity, BOD and alkalinity were assessed using standard methods. However, they were within all the recommended level for optimum performance of tropical fish species. Individual fishermen catch was used throughout the study period, where each of the five (5) Landing sites was visited twice monthly for catch assessment survey. Fish samples were randomly collected from 5 canoes/fishermen per sampling unit and catches were observed and recorded. There was high catch in the month of July and August (wet season) for all the species in Zobe reservoir. In contrary, there was strong negative correlation between temperature and DO; pH and DO; turbidity and DO; DO and BOD; DO and alkalinity. Makera had higher catches than any of the other stations with more than 700 bi-weekly catch representations between the months of July and August, 2020. Dry season CPUE was up to 22% for wet season and 9.80% for *Clarias gariepinus* in Garhi fishing station which recorded the highest, whilst for *Clarias anguilaris* CPUE recorded absolute zeros for all the stations and for both seasons except for Makera in wet season with 0.08% CPUE. Physicochemical parameters of Zobe reservoir showed that the water quality of Zobe reservoir changes with season, however, the parameters were within an acceptable range for fish growth and dependency of fish catch and water quality was observed.

ARTICLE HISTORY
Received September 2, 2022
Accepted September 27, 2022
Published on September 30, 2022

KEYWORDS
Catch per Unit Effort, Seasonal, Water quality, Zobe Reservoir

INTRODUCTION
Favorable water condition is among requirement for the continued existence and development of fish and other aquatic organism from the time the whole life cycle process of the fish is entirely reliant on the excellence of water and its surroundings. The physical, chemical and biological characteristics of water should be favorable for fish's health and survival (FAO, 2018). Physicochemical parameters/water quality is a chemical, physical and biotic characteristic of water features, habitually in respect to its fitness for a nominated usage (Roy, 2019). Water has been over the years used for sport, domestic water supply, fishing activities, irrigation/agriculture or trade. These nominated usages have different well-defined chemical, physical and biotic values needed for their maintenance. Consequently, Water quality is crucial to the health security of any ecosystem, which is a determination of the biochemical and physical features of the water (FAO, 2018). Surface water is a dynamic aquatic environment in which biotic and abiotic factors interact and influence the ecosystem. This implies that Biology of water is a product of its physical and chemical nature.

Photosynthetic activity of the algal population affects the seasonal variations of the physicochemical factors (such as alkalinity, pH, electric conductivity, turbidity, and dissolved oxygen content). Constant examining of physicochemical parameters of water is an important portion of some water excellence regulation/restraint (FAO, 2018). No research in Zobe reservoir on physicochemical parameters in relation to catch per unit effort of fishermen.

Catch per unit effort (CPUE) comprises of the quantity of fish trapped per day per craft which is expected to be directly associated to the quite amount fish trapped

Correspondence: Nababa A. S. Department of Fisheries and Aquaculture, Federal University Dutsin-Ma, Katsina State Nigeria. ✉ naababa77@gmail.com or asnababa@fudutsinma.edu.ng; Phone Number: (+234) 7066210660
How to cite: Nababa A. S., Sadauki M.A., Hadiza Y.B. (2022). Water Quality and Catch Per Unit Effort (CPUE) of Fish Species in Zobe Reservoir, Dutsin-Ma, Nigeria. UMYU Scientifica, 1(1), 234 – 240. https://doi.org/10.56919/usci.1122.030

(Yusuf and Abdulkarim, 2015). This provides a first estimate of the amount of the stock (fishes) for the entire part of the fishery. The limitation CPUE based data was fishermen's mark zones of great richness based on CPUE records may possibly miscalculate stock dimensions (Kevern and Serge, 2009). In addition, consistency of CPUE records in relations to honest recording is unknown pending the documents have remained authenticated (e.g. concluded eyewitnesses on boarding profit-making vessels, such as boats and trawlers).

MATERIALS AND METHODS

Study Area

The study was conducted in Zobe reservoir, an earth-filled structure completed in 1983 with a height of 19 m and a total length of 2,750 m. The reservoir coordinated between 12 ° 23 ' 18´´ N (latitude) and 7 ° 28 ' 29´´ E (longitude) in Katsina State of Nigeria. The southern part of the reservoir bounded with many villages that include; Marke, Makera, and Tsakko, by the south-east are Tuga, and Kuka-Damisa, whilst by the north was Garfi, Badole, Daguda, Katsalle and Tabobi remotes. The reservoir covers 4500 hectares of terrestrial land and for the duration of the raining period storing 177 million cubic meters of water which is released downstream for domestic usage, irrigation/agriculture and urban water supplies (SRBDA, 1981). The reservoir was made for local irrigation of 8,000 hectares, hydro-electric power supply and domestic water supply. Zobe reservoir has lone two streams/tributaries; which comprise of River Karaduwa and River Gada in which River Gada drains to River Karaduwa (Dan-kishiya *et al* 2018; Nababa *et al.*, 2019 and SRBDA, 1981). The Reservoir was built to Dam River Karaduwa and shelters about 2.7 kilometers long flowing North Westward to the Sokoto Basin.

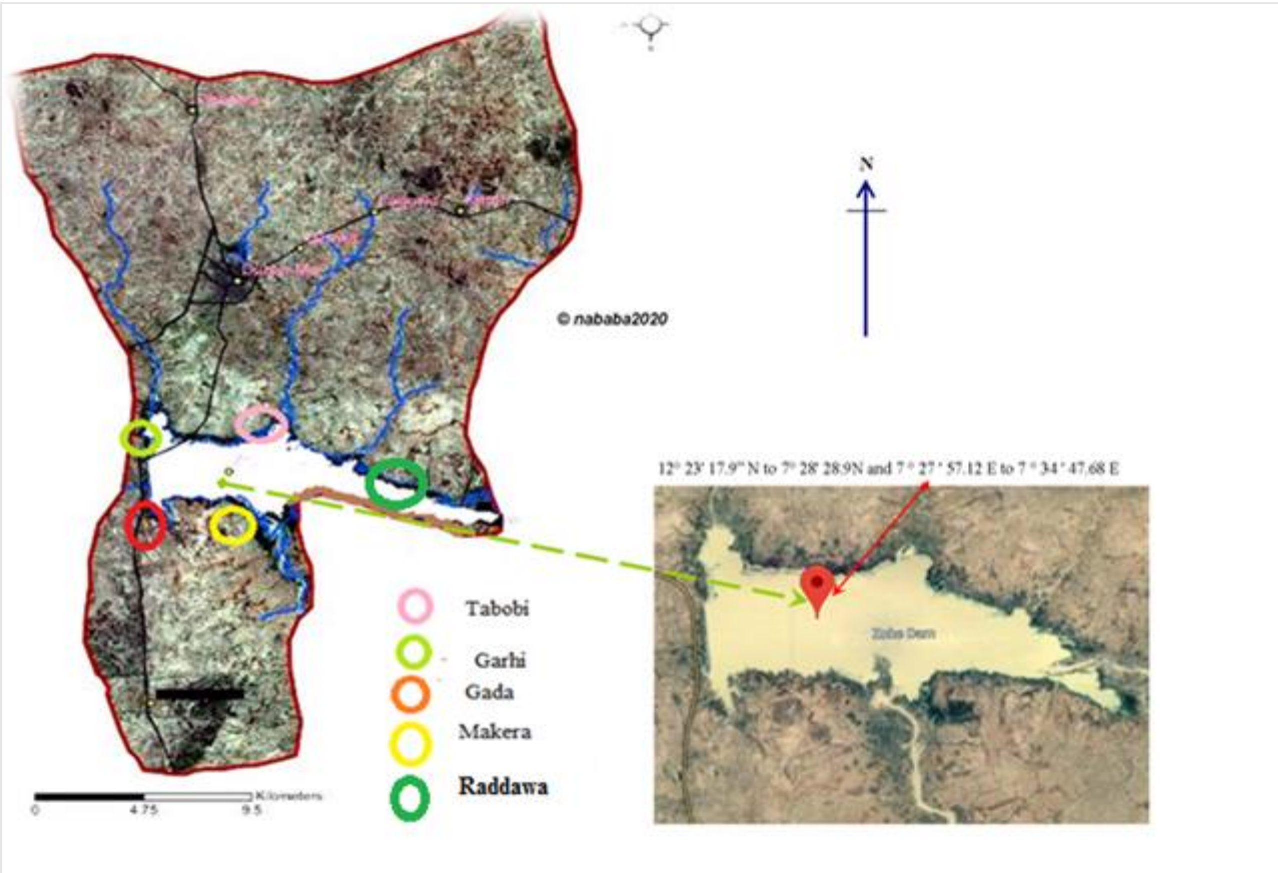

Figure 1: Map of the study area with sampling units marked (Nababa *et al.*, 2022)

Water Sampling and Analysis

Five sampling stations (Raddawa, Tabobi, Gada, Garhi, and Makera) were selected for this study. Water was collected concurrently with the fish catch assessment throughout the study period. All water samples were collected from each of the selected station to represents (upstream, middle and downstream) of the reservoir in the morning hours, between 7:00 am to 11:00 am by using sampling tools (glass jar, and yellow 2liters plastic containers) for physicochemical investigations (Apollos, *et al.*, 2016).

Physical Properties of Water

Physical characteristics of the water samples such as temperature, color, taste, Conductance, odor were examined as follows:

Temperature

Temperature reading was taken early in the morning of each sampling day by using Mercury in glass thermometer. The graduated thermometer was firstly exposed to the surface to allow it collide with an ambient surface temperature. The meter then was sunk into the water body and allow for about two (2) minutes and then lift up to record the reading. After which the water temperature will be recorded from the reading of the mercury in glass thermometer in Degree Celsius ^{O}C (Andem *et al.,* 2012).

Turbidity

Graduated Secchi disc was used in the determination of the water transparency for this study. It was held using long graduated rope of one meter long and inserted gently into the sampling point until the alternate colours on the plate start disappearing then the transparency reading was recorded as the immediate point of the color disappearance. It was recorded in centimeter (cm).

Electrical Conductivity

Electrical conductivity was measured using the Hanna measuring instrument (Combo meter, Model HI96301, with automatic temperature compensation). The measurement was also done at the same time as that of turbidity and recorded in μS/cm.

Chemical Properties of Water

Chemical properties of water such as Dissolve oxygen (DO), Biological Oxygen Demand (BOD), Ammonia (NH_3), and Alkalinity was determined using volumetric method, while pH was measured by mechanical method (using mobile Hanna combo meter, Model HI96301, with automatic temperature compensation (Yerima *et al.*, 2017 & Jouanneau *et al.*, 2014)

Dissolved Oxygen (DO)

The DO was determined using the modified Winkler Test. Water samples were collected in 0.5 liter glass bottle. The water sample was collected in a standard way by immersing the sample bottle in the water at certain depth while the bottle was still covered. It was then opened and allowed the air bubbles out of the container; the bottle was always covered while still under the water to avoid atmosphere air diffusion into the sample water. Eight drops of manganese sulphate was firstly added and precipitated was formed after a careful mixing without letting in surface air. Then eight drops of sulphuric acid was added to the sample and mixed and the sample was turned to light yellow-orange color which indicates the presence of high amount of dissolve oxygen in the samples. Few drops of starch indicator were added, when the sub-sample turned blue, and titrated with thiosulphate until it turned clear. The reading was then taken and recorded in Mg/L. The remaining water sample collected was reserved for other measurements including BOD (Yerima *et al.*, 2017 & Jouanneau *et al.*, 2014).

Biological Oxygen Demand (BOD)

BOD was determined according to a standardized technique, presently called the bolted/closed bottle test, described in the Worldwide Standards ISO 5815-1:2003 Physicochemical Determination of biological oxygen demand after n-days (BOD-n). The collected samples were kept for five days (Day 5 DO) and then determined and subtracted from (Day 1 DO), i.e DO_1 minus DO_5 (Jouanneau *et al.*, 2014).

Ammonia (NH_3)

Ammonia was determined using kit (Fresh Innovative Tech. NIFFR) for volumetric analysis, the water sample was filled in test tube and four drops of NH_3 reagents I was added, covered, and mixed. Secondly, 12 drops of NH_3 reagents II was added. Then the reactant color was observed, compared with the score card and the NH_3 value was recorded accordingly.

Alkalinity

100 ml of water was measured into the conical flask and phenolphthalein indicator was added. The colour remains unchanged. A methyl orange indicator was added which changed the colour to yellow. 0.1ml HCl was titrated against the mixture in the conical flask until the reddish color appeared, then the color was compared with the score card and the Alkalinity (ppm) value was recorded accordingly (Fresh Innovative Tech. NIFFR).

Hydrogen ion concentration (pH)

pH was measured early in the morning using Hanna measuring instrument (Combo meter, Model HI96301, with automatic temperature compensation). The meter was adjusted let down into the body of water for 2 to 3 minutes and reading was taken when the meter became stable.

Catch per unit effort (CPUE)

This is the entire quantity of fish trapped by experimented fishers each day after arrival/landing. CPUE was calculated using the formula below (Yusuf and Abdulkarim, 2015)

$$\textbf{CPUE} = \left[\frac{(C1)}{Fi} + \frac{C2}{F2} + \left(\frac{Cn}{Fn}\right)\right] \div \mathrm{N} \times T \ldots\ldots\ldots\ldots\ldots \text{eq.1}$$

Where; C1, C2,....Cn are the total catches per samples from selected landed fish species. F1, F2,....Fn are unit efforts per samples. N is total number of samples (counts in number) per catch obtained from fisherman or boat. Tis the number of days samples are taken within the study periods.

Statistical Analysis

With the aid of Microsoft excel package (2010 version), the raw data were subjected to Correlation and standard deviation, descriptive statistic (Mean, Least and Maximum) values, and calculating of CPUE using the mentioned formula above.

RESULTS

Annual water Quality of Zobe reservoir

The results of Physicochemical Parameters of Zobe reservoir (Table 1) showed the Standard deviation, with maxima, and minima values of all the parameters studied. The water temperature ranges between 22.00±2.2.54 and 32.00±.2.2.54°C. The pH values ranges between 5.90±0.497 and 9.00±0.497; Turbidity of the reservoir ranges from 4.5±0.844 and 8.00±0.844; The Dissolved Oxygen values in the reservoir ranged from 6.00mgL^{-1}±0.495 and 8.5 mgL^{-1}±0.495; The Biochemical oxygen demand of the reservoir ranged between 0.50 mgL^{-1}±0.538 and 3.80 mgL^{-1}± 0.07; The Electrical conductivity ranged from 65.00±13.227µS/cm to 199.00±13.227µS/cm; Total alkalinity of the reservoir ranges between 20.10 ±3.507 and 33.00 ±2.275ppm; Ammonia (NH_3) ranges between 0.10ppm ±0.1168 and 0.50ppm±0.078ppm.

Table 1: Annual water Quality of Zobe reservoir

	Garhi	Tabobi	Makera	Gada	Raddawa
Temperature ^{0}C	23.50-30.00 ± 1.82	23.00-31.00 ± 2.02	22.00-30.00 ± 2.12	22.00-30.50 ± 2.46	22.00-31.50 ± 2.26
pH	6.50-8.00 ± 0.33	6.50-8.00 ± 0.36	6.00-8.00 ± 0.54	6.00-7.50 ± 0.41	5.90-9.00 ± 0.50
Turbidity (cm)	4.00-8.20 ± 1.06	5.00-8.20 ± 1.33	4.00-8.00 ± 1.21	4.50-8.00 ± 0.91	4.00-8.50 ± 0.84
DO (mg/L)	6.00-8.00 ± 0.58	6.00-7.80 ± 0.40	6.00-8.00 ± 0.42	6.00-8.00 ± 0.38	6.50-8.50 ± 0.50
BOD (mg/L)	0.80 - 3.50 + 0.67	1.00 - 3.60 + 0.57	0.83 - 2.80 + 0.44	0.50 - 2.60 + 0.49	0.5 - 2.80 + 0.54
Alkalinity ppm	20.10-32.50 ± 3.51	23.00-33.00 ± 3.51	22.50-32.50 ± 2.30	22.50 -32.50 ± 2.11	21.50-32.00 ± 2.32
Conductivity (µS/cm)	65.00-120.00 ± 11.07	65.00- 199.0 ± 19	65.00-199.0 ± 19.83	65.00-120.00 ± 12.25	65.00-120.00 ± 13.23
NH3(ppm)	0.10-0.50 ± 0.12	0.20-0.50 ± 0.09	0.10-0.50 ± 0.08	0.15-0.40 ±0.08	0.10-0.40 ±0.08

Correlation analysis between Fish Catches and Physicochemical Parameters of Zobe Reservoir

Findings of this study indicated that, there was strong negative correlation between turbidity and catch and also, a strong positive correlation between conductivity and catch. While catch had weak negative correlations with other physicochemical parameters except for dissolved oxygen which was a positive weak correlation. There were also strong positive correlations between Temperature and pH; Temperature and NH_3; pH and turbidity; pH and Alkalinity; pH and NH_3; BOD and Alkalinity; BOD and Conductivity; Alkalinity and Conductivity as well as Alkalinity and NH_3. However, there were strong negative correlation between Temperature and DO; pH and DO; Turbidity and DO; DO and BOD; DO and Alkalinity

Table2: Correlation between Fish Catches and Physicochemical Parameters of Zobe Reservoir

	Catch	Temperature °C	pH	Turbidity (cm)	DO (mg/L)	BOD (mg/L)	Alkalinity (ppm)	Conductivity (µS/cm)	NH3 (ppm)
Catch									
Temperature °C	-0.004								
pH	-0.60	0.62							
Turbidity (cm)	-0.98	0.35	0.64						
DO (mg/L)	0.27	-0.81	-0.56	-0.86					
BOD (mg/L)	-0.33	0.31	0.48	0.43	-0.74				
Alkalinity ppm	-0.23	0.43	0.57	0.20	-0.75	0.97			
Conductivity(µS/cm)	0.60	0.18	-0.13	-0.13	-0.02	0.54	0.62		
NH3 (ppm)	-0.33	0.83	0.72	0.46	-0.69	0.44	0.61	0.09	

Key: DO: Dissolved Oxygen, BOD: Biological Oxygen Demand, NH_3: Ammonia.

Monthly Catch/yield

Relative fishermen yield or catches of fish species in Zobe reservoir was presented in figure 2 below. It showed that fishery yield in Zobe reservoir is not constant year-in-year-out. For all the sampling stations Makera signifies the higher yield followed by Garhi and the least was Tabobi. (Figure 2)

Catch per unit effort (CPUE):

CPUE was calculated based on behalf of every fish species and fishing stations designed for two seasons (dry and wet seasons) of 2020-2021 as shown in Table 3. Individual fishing stations was using mandays (daily fishermen effort and time spent) calculated for the two seasons.

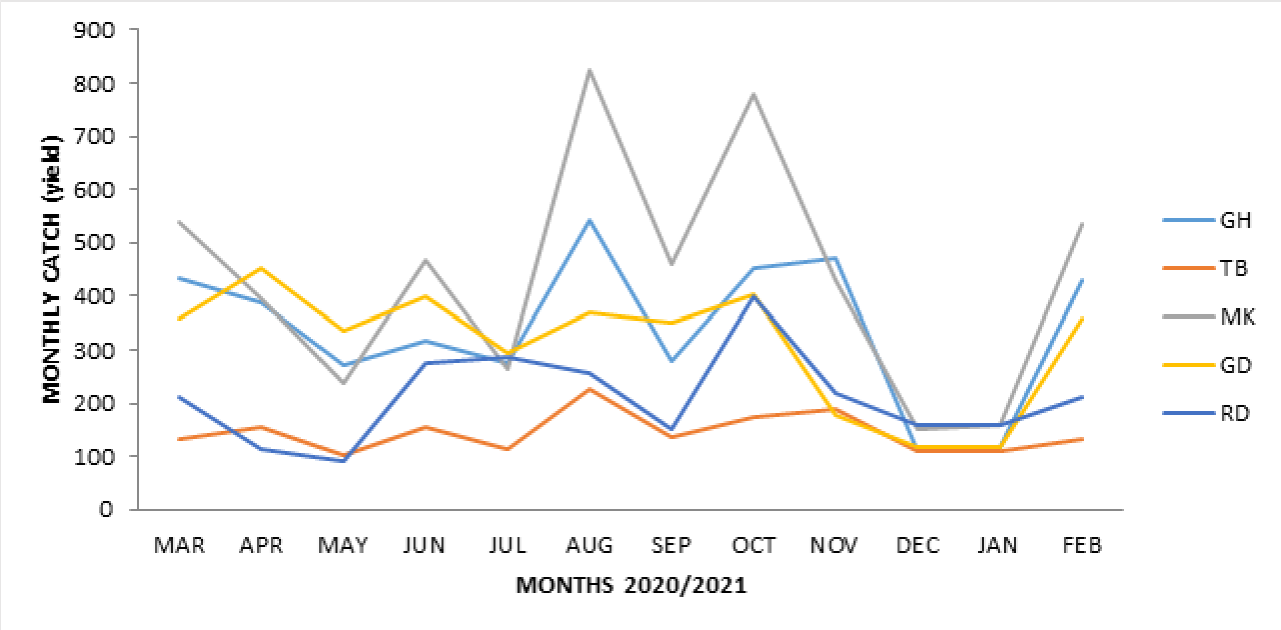

Figure 2: Monthly Catch/yeild of Zobe Reservoir

DISCUSSION

Water quality is crucial to the health security of any ecosystem, which is a determination of the biochemical and physical features of the water (Andem *et al*., 2012 & EAF-FAO, 2012). DO is as an important water quality indicator of seasonal variations. Although oxygen is needed by all kinds of life forms in water bodies (Yerima *et al.,* 2017).

The result of this research is in line with (Apollos *et al.,* 2016) an earlier study whereby the highest value of DO observed was 8mg and the lowest value was 6.10mg. The possible reason for the result obtained from our study can be attributed to the dilution effect of the physical characteristic of the study area which is related much more where greater photosynthetic events and the reduction in turbidity (Table 3) occurs and consequence the production of high oxygen amount in the reservoir. Nevertheless, the best pH range for sustainable aquatic life ranges from 6 and 9 (EAF-FAO, 2012). Deposits from agricultural farmlands around the water and flooded waters from neighbouring human habitants may changes the hydrogen ion concentration in water and becomes more acidic or more alkaline depending on the type of waste and chemical substances contained in it (EAF-FAO, 2012 & Abida and Harikrishna, 2008). Thus, the quality of the water changes in different sites based on the seasons as the changing concentration of pH is possibly due to the influence of lake water penetration, heavy metal pollution, and high biological activities (Apollos *et al.,* 2016), nevertheless, anthropogenic activities and the atmospheric thermal condition in the dry season might have influenced the pH concentration.

BOD is the quantity of DO essential to reduce organic materials present in a given sample of water at a certain temperature in a given time by aerobic bio-organisms in a water body (Yerima *et al.,* 2017). Decrease in BOD indicates a good water quality while its increase indicates polluted water bodies (EAF-FAO, 2012 & Abida and Harikrishna, 2008). Attributes of physicochemical water quality parameters such as (Temperature, Color, Taste, Conductance, Odor) can be detected by the sense of touch of touch, eyesight and scent. Water temperature is an important factor, which influences growth, reproduction and maturity of fish (Dadi-Mahmud *et al.,* 2014 & Apollos *et al.,* 2016). In addition, it affects the development of aquatic micro and macro-organisms, which are the principle components of the fish food chain (Yerima *et al*., 2017 and Anago *et al.,* 2013). For every fish species there is an optimum temperature at which the individual shows the best physiological performance. Furthermore, the temperature influences the amount of dissolved oxygen and consequently the rate of respiration of fish (Yerima *et al.,* 2017; Adakole and Annue, 2003). The reason was due the depletion of oxygen in the water during decomposition in dry season.

In line for high/great biological happenings, for instance decay of dead/lifeless and decomposing organic substance, photosynthesis, may perhaps be as an outcome of huge bacteriological inhabitants (Abida and Harikrishna, 2008).

According to (Yerima *et al*., 2017; Anago *et al.,* 2013 & Adakole and Annue, 2003) increase in biochemical oxygen demand may be due to biological as well as natural oxidation a process which increases in the rainy season. The negative correlation of BOD with catch of fish by fishermen, and DO indicates that there is lesser influence of this parameter on macro fauna (such as fish). However, there is positive correlation between the DO and the Catch. DO saturation is high in Raddawa and Gada fishing stations compared to other stations probably because of their shallow depth which might increase the dissolution of surface oxygen (O_2) into the water. This result supports the work of Kgibu and Muhammad (2014) who recorded BOD of 1.44 to 4.10 mg/L from river Amba, in Nasarawa State of Nigeria.

This research indicates that CPUE derived from the one year in relation to water quality can be used to measure relative abundance. While they cannot be easily translated into a fish density, they can be used to monitor, in a relative sense, if a fish population is increasing, decreasing or remaining constant. From this study CPUE derived in relation to water quality can be used to measure relative abundance, while they cannot be easily translated into a fish density, they can be used to monitor, in a relative sense, if a fish population is increasing, decreasing or remaining constant. In addition, it is important to note that a limitation such as susceptibility to gear affects CPUE or targeted habitat (Dana and Jacquelynne, 2006). Monthly catch for twelve months was estimated and presented in (Figure 2) which gave the vivid lead way for understanding the CPUE and also categorization wet and dry catches. With equal number of randomly sampled fishermen and their catches, Makera recorded higher catches than any of the other stations with more than 700 bi-weekly representations between the months of July and August, 2020, and this could be attributed to water depth, good environmental quality, and current stability as the site is deepest portion of the reservoir (Nababa *et al.,* 2022 and Nababa *et al.,* 2019). Catch per unit effort (daily fishing effort and time spent) was studied for the rainy and dry seasons for Zobe reservoir (Table 3) during the study period. During the same period of this study, effort is up to 22 for wet season and 9.80 in for dry season for *Clarias gariepinus* in Garhi fishing station which recorded the highest, whilst is as low as 0.08% for *Clarias anguilaris* for all the stations except for wet season in Makera (Table 3) this biological index that the *C. anguilaris* is not diverse in Zobe reservoir. The yield and CPUE have been varied with time and specie while the contribution of the African catfish *Clarias gariepinus* to the catches has been growing toward the flood with time, similarly, *Oreochromis niloticus* with the highest overall value in Garhi fishing station (22.30%) in wet season (Nababa *et al.,* 2022). The influence of time factor (two mighty season (Dry and Wet) was considered. However, other factors such as the decrease in lake volume associated with Irrigation usage, Domestic supply and climate variability and change was not adequately considered (Yusuf and Abdulkarim, 2015). This will provide a main estimate of the magnitude of the stock (fish) for the entire fishing activities in Zobe reservoir (Dan-kishiya *et al.,* 2012).

CONCLUSION

Physicochemical parameters of Zobe reservoir showed that the water quality of Zobe reservoir changes with season, however, the parameters were within an acceptable range for fish production. There is level of dependency of fish catch and water quality. The yield and CPUE varied with time and species while the contribution of the *Clarias gariepinus* African catfish to the catches grew in the direction of the flood with time. Similarly, *Oreochromis niloticus* had the highest overall catch value in Garhi fishing station in wet season which was as a result of stable good water quality in the area. It is also found that, there was high catch in the month of July and August (wet season) for all the species in Zobe reservoir, which implies that CPUE is not constant year-in-year-out.

ACKNOWLEDGEMENT

Scientific upbringing by Prof. Bichi H.A., Dr. Dan-kishiya Ahmad Salihu, Professor Sogbesan Olukayode Amos, Dr. Akeem Babatunde Dauda, and Dr. Joel Umaru was ever appreciated.

REFERENCES

Abida, B. and Harikrishna, G. (2008). Study on the quality of water in some streams of Cauvery River.E-Journal of Chemistry, 2: 377-384. **[Crossref]**

Adakole, J.A. and Annue, P.A. (2003). Benthic Macro-invertebrates as indicators of Environmental quality of an urban stream, Zaria, Northern Nigeria. Journal of Aquatic Science, 18 (2): 85-92. **[Crossref]**

Anago, I. J., I. K. Esenowo and A. A. A. Ugwumba (2013). The physico-chemistry and plankton diversity of Awba Reservoir, University of Ibadan, Ibadan, Nigeria. Research Journal of Environmental and Earth Sciences, 5(11): 638-644.**[Crossref]**

Andem, A. B., Udofia, U., Okorafor, K. A., Okete, J.A. and Ugwumba, A. A. A. (2012). A study on some physical and chemical characteristics of Ona River, Apata, Ibadan, South-West, Oyo State, Nigeria. European Journal of Zoological Research, 1(2): 37-46.

Apollos, T.G., Raji A., Modibbo U., (2016) Seasonal

Variation of Water Quality Parameters of Zobe Reservoir Dutsin-ma Katsina State, Nigeria. Hydrol Current Res 7: 261. [Crossref]

Dadi-Mahmud, N.J., Oniye, S.J., Auta, J., and Ajibola, V.O., (2014). Community pattern and Diversity index of macro-invertebrates in relation to surface water interference of river Ndakotsu, Lapai Nigeria. Asian Journal of Science and Technology. 5(9): 546-552.

Dan-kishiya, A. S., Bichi, A. H. and Nababa, A. S. (2018). Length-Weight Relationship and Condition Factor of Silver Catfish (Bagrus bayad -Forskali, 1775) in Zobe Reservoir, Dutsin-ma Local Government Area, Katsina State, Nigeria. FUDMA Journal of Sciences (FJS). 2(1): 178-182.

Dan-kishiya, A. S., Olatunde, A. A and Balogun, J. K. (2012). Fish Species Distribution in a Domestic Water Supply Reservoir: A Case Study of Lower Usuma Reservoir, Bwari, Nigeria. Researcher,4(2):56-60.

Dana R.H. Jacquelynne R.K., (2006) CPUE as an index of relative abundance for nearshore reef fishes. Pacific Biological Station, 3 190 Hammond Bay Road, Nanaimo, BC , C anada V9 T 6N 7 DOI:10.1016/j.fishres.2006.05.015.

EAF Toolbox: FAO (2012) EAF Toolbox: the ecosystem approach to fisheries. Rome. Interactive online version of EAF Tool box: FAO. 2011-2017. EAF-Net. EAF Toolbox. [online]. Rome. www.fao.org/fishery/eaf-net/toolbox

Jouanneau S., Recoules L., Durand M.J., Boukabache A., Picot V., Primault Y., Lakel A., Sengelin M., Barillon B., Thouand G., (2014) Methods for assessing biochemical oxygen demand (BOD): A review, Water Research, Vol. 49, P. 62-82, ISSN: 0043-1354. [Crossref]

Kevern L. C., Serge M. G., (2009) A Fishery Manager's Guidebook. The Food and Agriculture Organization of the United Nations and Wiley-Blackwell, Second Edition. ISBN 978-1-4051-

Kevern L. C., Serge M. G., (2009) A Fishery Manager's Guidebook. The Food and Agriculture Organization of the United Nations and Wiley-Blackwell, Second Edition. ISBN 978-1-4051-7085-7, FAO's ISBN: 978-92-5-105963-0. Pp 45-46

Kwaji B. P., and Sogbesan O. A., (2015) Catches Assessment and Biodiversity of Fish Fauna in Lake Ribadu, Adamawa State, Nigeria. International Journal of Scientific & Engineering Research, 6.11. ISSN 2229-5518

Nababa, A. S., Dan-Kishiya, A. S., and Umaru, J., (2019) Study on Food and Feeding Habits of Silver Catfish Bagrus bayad in Zobe Reservoir, Dutsinma Local Government Area, Katsina State, Nigeria. FUDMA journal of Science. 3 (1).pp 358 -361 ISSN online: 2616-1370

Sogbesan, O.A., and Barka L.G., (2017) Fish Biodiversity and Fishing Activities at Njoboliyo Lake, Adamawa State, Nigeria. Journal of Fisheries Livestocks Production 5: [Crossref]

SRRBDA-Sokoto Rima River Basin Development Authority (1981) A report submitted to Sokoto Rima Basin Authority, 1981, 86.

Yerima, R., Bolorundoro, P. I., Suleiman, B. and Usman, L. U. (2017). Temporal Variation of fish Species Composition, Abundance and Diversity in Relation to Physicochemical Characteristics of Dadin Kowa Reservoir Gombe State-Nigeria. *International Journal of Applied and Biological Research*, 8(2): 149-165.

Yusuf, Z. A., and Abdulkarim, M. (2015). Fundamentals of Tropical Fish Stock Assessment. Sagir Press, Bauchi. Pp 112

7085-7, FAO's ISBN: 978-92-5-105963-0. Pp 45