O R I G I N A L   R E S E A R C H

Catch per unit effort and some water quality parameters of Lake Kalgwai Jigawa state, Nigeria

Shola G. Solomon | Victoria O. Ayuba | Musa A. Tahir | Victor T. Okomoda

Abstract
This study investigated the catch per unit effort and water quality of Lake Kalgwai Jigawa state, Nigeria for the period of 10 month (July 2012-June 2013). The man hours, gears used, and fish catches of the Lake was determined by assessing the fisher-men operating on three major landing sites of the Lake, namely Marke (Site I), Dingare (Site II), and Kalgwai (Site III). Water samples from the landing sites were collected and analyzed. Concentration of fishers ranged from 41 (April) to 51 (September). The highest number of fishing hour was observed in August (64 hr), whereas the lowest was in March (49 hr). The average catch per fisher per day ranged from 107 kg/day (December) to 144 kg/day (August) during the study period. An average of 25 days was spent fishing in each month. The result also indicated similarities in the water qualities of all the three sampling sites per months. Based on the result gotten it was concluded that lake Kalgwa is not over fished and water quality are within recommended ranges for fish production.

K E Y W O R D S
catch, Effort, Fishers, Lake Kalgwai, Water quality

1 | INTRODUCTION

Fish supply in Africa is in crisis. Per capita consumption in sub-Saharan Africa is the lowest in all regions and it is the only part of the world where consumption is declining. The main reason for this decline is the leveling off in capture fish production and the ever-growing population. World Bank (2004) had estimated that fish production must be increase by 27.7% over if a per capita fish supply of 6.6 kg/year is to be maintained in sub-Saharan Africa by 2015. However, if capture fisheries is to continue to provide the bulk of fish food for Africans sustained efforts would have to be made to support, promote, and protect small-scale labor-intensive (both coastal and inland) fisheries. Investments in applied research and capacity building will be required to improve and strengthen the socio-institutional mechanisms underpinning the fisheries management process. But investments to improve environmental management are also required to sustain fisheries, especially in inland fisheries where increasing pressure on land and water is leading to high environmental degradation. These inland fisheries provide the basis of the livelihoods and therefore the indirect support to food security for millions of people, (World Fish Center, 2005).

The poor and uneconomic management of reservoir and lake fisheries is another major issue of concern. Therefore, creation of dams provides an ecosystem for the proliferation of wide range of aquatic organisms including fish thus promoting socio-economic activities of the surrounding communities (Fawole, 2002). However, closing fishing areas and regulating the use of fishing gear can result in more profitable catches and higher incomes. For instance, a 12-year study on fish caught in three locations off the coast of Kenya showed that fishing close to an area with restrictions led to larger catches of fish with higher market value (Spore, 2011). Alternatively, sustainable fishing regulations have been found to facilitate replenishment of stocks. Restricting catches, imposing a minimum size for fishing and halting fishing for a certain period each year are strategies that enable species to regenerates, whereas everyone benefits including fishermen and...
consumers. Fishermen at Lake Albert, Uganda, have witnessed a rapid change and firsthand benefits of a 20-month fishing ban imposed between March 2010 and January 2011 (Spore, 2012). Some species of fish that were seldom found overtime became dominate catches of the lake hence, market prices for this fish fell by 40%.

Fishes are generally poikilotherms (cold blooded) and therefore their metabolic rates are strongly influenced by the external environment conditions. The thermal tolerance of fish for instance could be lethal, controlling, and directly influencing the responses of fish (Fry, 1971). In many cases, changes in thermal conditions are also accompanied by changes in other water characteristics such as water levels, changes in composition and amount of food, changes in acidity and other chemical characteristics (Schindler, 2001). Therefore, seasonal influences and instances when such changes occur may be equally or even more severe than changes expressed on an annual basis (Pearson & Dawson, 2003). Fishes as been exploited as excellent bioindicators of water quality changes (Idodo-Umeh, 2002; Ogbuebi & Victor, 1989; Oguzie, 2003; Yamazaki, Tanizaki, & Shinikawa, 1996). The justification lies in the fact that fish communities respond to episodic events and therefore integrate environmental conditions over time. This study is therefore designed to evaluate the catch per unit effort of Lake Kalgwai for 10 months in relation to the water quality parameters.

2 | MATERIALS AND METHODS

Kalgwai Barrage Dam is situated in Auyo Local Government Area of Jigawa State, Nigeria (Figure 1). It was impounded on River Hadeja in 1984 by the Federal Government of Nigeria for the purpose of irrigation under the then Hadejia Valley Irrigation Project which was coordinated by Hadejia-Jama’are River Basin Development Authority (H.J.R.B.D.A). It covers an estimated area of 3,800 sqkm (Matthes, 1990). Its maximum surface area normally occurs at the end of the rain season in September. Thereafter, the water recedes so that minimum level is reached just before the start of rains in June. The extent of flooding varies from year to year and is mainly dependent on the amount of rainfall (Benthem, 1990). Hence fish production also varies depending on the extent of the volume of water during the season. This has brought an increased fishing activity especially in those villages surrounding the dam site.

The fish specimens used for the study were obtained through catch statistics at three major landing sites of the dam, namely Marke (Site I), Dingare (Site II), and Kalgwai (Site III), respectively. Fish species were randomly sampled and examined at each site fortnightly over a period of 10 months from July 2012 to June 2013 between 6:00 a.m. and 8:00 a.m. Fish identifications as well as measurement of weight and number of fishermen were taken directly from the landing sites according to identification keys provided by Thalwar and Jhingran (1991), FAO (1992), Olaosebikan and Raji (1998) and Bankole and Mbagwn (2000).

The body weight of each specimen was determined was measured in grams (g) using compact balance (Model MP-600A) sensitive electronic weighing scale. Catch per unit effort was determined using the formula:

\[
\text{CPUE} = \frac{\text{No. of fishing days} \times \text{Total Weight of Fish caught}}{\text{No. of boats or Fishermen}}
\]

![Figure 1](source: Hadejia - Jama'are River Basin Development Authority)
Water samples from the landing sites were collected using two liter capacity sampling bottle on monthly basis. The water samples were subjected to the following analysis as soon as possible after collection as described by APHA (1998). Analysis of variance (ANOVA) was used to test for significant difference at 95% confidence limit. Data were analyzed using Minitab 14® software for descriptive and summary statistics and Genstat Discovery Edition 4 for Analysis of Variance. Data were analyzed using one way analysis of variance for a completely randomized design. Some variants were analyzed using analysis of covariance where some dependent factors were found to be significantly different ($p < .05$). All significantly different means were separated using Fisher's least significant difference of means.

3 | RESULTS

The result of catch per unit effort is as presented in Tables 1–4. The number of fishers in any of the 10 months study period of the three landing sites ranged from 10 to 19, whereas the fishing hours ranged from 12 to 20. However, the average weight of fish caught per fisher per day ranged 60 kg in December to 30 kg in July, April September and October for site 1 at site 2, the average weight of fish caught per fishers per fisher is lower as it ranged from 32 to 44 kg in site 2 and 37 to 41 in site 3. (Tables 1, 2 and 3) catch per unit efforts CPUE in site 1 ranged from 18 to 70.83 kg/hr in site 3. Total weight of fish caught in all months across the three landing sites shows that in site 1 range from 18 to 70.83 kg/hr, 23.48 to 44 in site 2 and 27.79 to 42 kg/hr in site 3. Total weight of fish caught in all months across the landing sites shows that in site 1.

The summary of mean monthly catch per unit effort of the fishers on the dam is presented in Table 4. The number of fishers differed significantly ($p < .05$) between month, which ranged from 41 to 51 individuals. The highest number 51 fishers were recorded in the month of September, whereas the least value 41 fishers were in April. The highest number of fishing hours of 64 hr was observed in August, whereas the lowest was obtained in March with 49 hr. The average catch per fisher per day ranged from 107 kg/day to 144 kg/day; however, the highest value of 144 kg/day was recorded in December, whereas the least value of 107 kg/day was found in August. The number of fishing days showed no significant difference ($p > .05$) with similar number of 25 days for each month. The total catch per month differed significantly ($p < .05$). The highest catch per month was recorded for February with 158,750 kg/month and the lowest value of 111,725 kg/month for April. The total fishing hours varied between 1,225 hr in March to 1,600 hr in August. The mean catch per unit effort 114.11 kg/hr was recorded for September, whereas the least value of 75.23 kg/hr was obtained for August.

The mean monthly variation in water quality parameters at the three sites is presented in Tables 5, 6 and 7. The mean monthly temperature range from 24.60 ± 0.40°C in November to 28.90 ± 0.05°C in April, 24.90 ± 0.10°C in August and September to 28.60 ± 0.10°C in March, and 24.60 ± 0.60°C in November to 28.70 ± 0.10°C in March for site 1, 2, and 3, respectively. The transparency showed no significant difference ($p > .05$) among the months, the highest value 0.31 ± 0.02 was recorded in August, whereas the least value 0.25 ± 0.01 in April for site 1, the least value of 0.26 ± 0.01 was obtained for site 2 in March and December, whereas the highest record was 0.32 ± 0.02 in July and site 3 had the highest value of 0.32 ± 0.01 in the month of August, whereas the lowest record of 0.25 ± 0.01 was observed in April. The mean monthly PH of all the sites showed no significant difference ($p > .05$). The result indicated that the highest PH values of 6.60 ± 0.10 and .65.6 ± 0.15 for site 1 and 3 in March and site 2 exhibited in the month of July and December with the value of 6.65 ± 0.15, whereas the least PH values were recorded in October 5.80 ± 0.10 for site 1 and 6.00 ± 0.10 in September for both site 2 and 3. The monthly depth of all the three sites ranged between 4.10 ± 0.10 m and 5.40 ± 0.20 m, with highest depth (5.40 ± 0.20 m) experienced July, whereas least (4.10 ± 0.10 m) in September. The result revealed that on significant

### TABLE 1 | Catch and effort data for site 1 on Kalgwai Dam

| Months   | No. of Fishers | Hours Fishing | Average Wt Caught/Fisher/day (kg) | No of days Fishing | Total wt/ Month (kg) | Total Time (hrs) | CPUE (kg/hr) |
|----------|----------------|---------------|----------------------------------|--------------------|----------------------|-----------------|--------------|
| July     | 17             | 20            | 30                               | 25                 | 12,750               | 500             | 25.50        |
| August   | 15             | 25            | 30                               | 25                 | 11,250               | 625             | 18.00        |
| September| 18             | 15            | 30                               | 25                 | 13,500               | 375             | 36.00        |
| October  | 16             | 18            | 30                               | 25                 | 12,000               | 450             | 26.67        |
| November | 14             | 19            | 50                               | 25                 | 17,500               | 475             | 36.84        |
| December | 12             | 19            | 60                               | 25                 | 18000                | 475             | 37.89        |
| January  | 11             | 18            | 40                               | 25                 | 11,000               | 450             | 24.44        |
| February | 17             | 12            | 50                               | 25                 | 21,250               | 300             | 70.83        |
| March    | 16             | 17            | 50                               | 25                 | 20,000               | 425             | 47.06        |
| April    | 14             | 17            | 30                               | 25                 | 10,500               | 425             | 24.71        |
| Total    |                |               |                                  |                    | 147,750              |                 |              |
### TABLE 2  Catch and effort data for site 2 on Kalgwai Dam

| Months | No. of Fishers | Hours Fishing | Average Wt Caught/Fisher/day (kg) | No of days Fishing | Total wt/Month (kg) | Total Time (hrs) | CPUE (kg/hr) |
|--------|----------------|---------------|----------------------------------|--------------------|--------------------|-----------------|--------------|
| July   | 14             | 19            | 32                               | 25                 | 11,200             | 475             | 23.58        |
| August | 13             | 20            | 38                               | 25                 | 12,350             | 500             | 24.70        |
| September | 18         | 18            | 42                               | 25                 | 18,900             | 450             | 42.00        |
| October | 19            | 19            | 44                               | 25                 | 20,900             | 475             | 44.00        |
| November | 10           | 15            | 43                               | 25                 | 10,750             | 375             | 28.67        |
| December | 12           | 16            | 42                               | 25                 | 12,600             | 400             | 31.50        |
| January | 17            | 18            | 40                               | 25                 | 17,000             | 450             | 37.78        |
| February | 18           | 18            | 39                               | 25                 | 17,550             | 450             | 39.00        |
| March  | 15            | 18            | 41                               | 25                 | 15,375             | 450             | 34.17        |
| April  | 14            | 19            | 39                               | 25                 | 13,650             | 475             | 28.74        |
| Total  |                |               |                                  |                    | 150,275            |                 |              |

### TABLE 3  Catch and effort data for site 3 on Kalgwai Dam

| Months | No. of Fishers | Hours Fishing | Average Wt Caught/Fisher/day (kg) | No of days Fishing | Total wt/Month (kg) | Total Time (hrs) | CPUE (kg/hr) |
|--------|----------------|---------------|----------------------------------|--------------------|--------------------|-----------------|--------------|
| July   | 16             | 18            | 38                               | 25                 | 15,200             | 450             | 33.78        |
| August | 17             | 19            | 39                               | 25                 | 16,575             | 475             | 34.89        |
| September | 15         | 20            | 41                               | 25                 | 15,375             | 500             | 30.75        |
| October | 14            | 16            | 42                               | 25                 | 14,700             | 400             | 36.75        |
| November | 12           | 19            | 44                               | 25                 | 13,200             | 475             | 27.79        |
| December | 18           | 18            | 42                               | 25                 | 18,900             | 450             | 42.00        |
| January | 16            | 18            | 39                               | 25                 | 15,600             | 450             | 34.67        |
| February | 15            | 20            | 38                               | 25                 | 14,250             | 500             | 28.50        |
| March  | 14            | 14            | 41                               | 25                 | 12,950             | 350             | 37.00        |
| April  | 13            | 18            | 40                               | 25                 | 13,000             | 450             | 28.89        |

### TABLE 4  Mean monthly catch per unit effort of fishers on Kalgwai Dam

| Months | No. of fishers | Hours fishing | Average Wt Caught/Fisher/day (kg) | No of days fishing | Total Wt./Month (kg) | Total time (hrs) | CPUE (kg/hr) |
|--------|----------------|---------------|----------------------------------|--------------------|----------------------|-----------------|--------------|
| July   | 47             | 57            | 100                              | 25                 | 117,500              | 1,425           | 82.46        |
| August | 45             | 64            | 107                              | 25                 | 120,375              | 1,600           | 75.23        |
| September | 51          | 53            | 113                              | 25                 | 144,075              | 1,325           | 108.74       |
| October | 49            | 53            | 116                              | 25                 | 142,100              | 1,325           | 107.25       |
| November | 36           | 53            | 137                              | 25                 | 123,300              | 1,325           | 93.06        |
| December | 42           | 53            | 144                              | 25                 | 151,200              | 1,325           | 114.11       |
| January | 44            | 54            | 119                              | 25                 | 130,900              | 1,350           | 96.96        |
| February | 50            | 50            | 127                              | 25                 | 158,750              | 1,250           | 127.00       |
| March  | 45            | 49            | 128                              | 25                 | 144,000              | 1,225           | 117.55       |
| April  | 41            | 54            | 109                              | 25                 | 111,725              | 1,350           | 82.76        |
| Overall | 450           | 540           | 1,200                            | 25                 | 13,500,000           | 13,500          | 1000.00      |
difference (p > .05) for mean monthly dissolve oxygen at all the sites, the highest value of 6.35 ± 0.15 was recorded in November, whereas the least value of 5.55 ± 0.15.

Table 8 shows the summary of the mean water quality parameters in the three sites studied on Kalgwai dam. The result indicated that no significant difference (p > .05) in means values of the surface temperature, transparency, depth, and dissolve oxygen, however, the PH differed significantly (p < .05) across all the three sites. The parameters ranged from 26.70 ± 0.36 to 26.70 ± 0.36 for temperature, transparency 0.28 ± 0.01 to 0.29 ± 0.01, PH 6.17 ± 0.06 to 6.37 ± 0.06, depth 6.37 ± 0.06 to 6.44 ± 0.09, and dissolved oxygen 6.00 ± 0.17 to 6.18 ± 0.17 across the sites.
TABLE 8 Mean water quality parameters in the three sites studied on Kalgwai Dam

| Sites   | Temperature ± | Transparency ± | pH ± | Depth ± | DO ± |
|---------|---------------|----------------|------|---------|------|
| Site 1  | 26.70 ± 0.36  | 0.28 ± 0.01     | 6.17 ± 0.06b | 4.64 ± 0.09 | 6.18 ± 0.17 |
| Site 2  | 26.52 ± 0.37  | 0.29 ± 0.01     | 6.37 ± 0.06a | 4.43 ± 0.06 | 6.00 ± 0.17 |
| Site 3  | 26.15 ± 0.32  | 0.28 ± 0.01     | 6.32 ± 0.06ab | 4.52 ± 0.08 | 6.18 ± 0.16 |

Means in the same column with different superscripts differ significantly (p < .05).

4 | DISCUSSIONS

The catch per unit effort of this study revealed the highest fish catch in February and March which was during the dry months with low rains. Similar trend was observed for the monthly total weight of fish catches. This could be attributed to the high volume of water in the dam during the rainy season and most of the species are dispersed due to the increase in surface area. This agrees with results from Jebba Lake (Halstead, 1971), Kainji Lake (Imevbore, 1975), Asa Lake (Vander-Heide, 1982) Asejire Lake (Sendacz, Kubo, & Cestarolli, 1985), and Ikwori Lake (Offem, Ayotunde, Ikpi, Ochang, & Ada, 2011) where larger ichthyofaunal densities were observed in the dry season. Reasons for the variation were similar to those advanced in this study. However, during the wet season, it is assumed that the high level of water and subsequent flood favored reproductive activities, hence, fish species were less vulnerable to catch because of high water levels and restricted movement. This assumption agrees with the report of Willoughby and Tweddle (1978) who stated that early rainfall and subsequent rise in water level trigger spawning activities of most fish species in African water bodies.

Diversity of gear was observed used by fishermen in this study. The monthly CPUE variation might be linked to the difference in the number of fishers, man hours, and the category of fishing gears used. This is in line with the report of McClanahan, Kaunda-Arara, and Omukoto (2010), on CPUE of closed and open-access landing sites. The result of this study also revealed similarities in the physico-chemical water parameters of the three sites studied. The values recorded were within the recommended ranges suggested by Boyd (1979) for the survival and development of aquatic life. The variation in the water depth recorded in per month in this study is not unconnected with rainfall in the months studied. The highest depth of 5.4 m obtained during the peak of rain in August and September is suggestive that Kalgwai Lake is relatively shallow hence, may be connected to the high fish abundance noticed in the dam. Beyond this, Alabasster and Lyod (1980) had earlier opined that high depth might result in reduction in fish growth rate as a result of reduction in food availability in the ecosystem. Hence, the low depth of the lake in this study may be an advantage translated to higher food availability.

More so, the shallow depth of this study could also be linked to the uniformity of transparency, temperature and dissolve oxygen across the landing sites. The temperature does not seem to be stratified in the Lake, thus there is free mixing of the bottom and surface layers. This vertical mixing of the two layers brings nutrients from the bottom to the surface to enhance primary productivity which accounts for high fish species richness of the Lake. Similar to the findings of this study, Famara (2002) had reported that water temperature in the Gambia estuary was not stratified with a mean difference of only 0.68°C, between the upper and lower layer of the lake. Hence, this allows the water body free vertical mixing that brings nutrients to the surface to enhance primary productivity. In general, the water quality recorded in this study is similar to the studies by Boyd (1979), Elemi (1990), Atama (2003) and the recommendations of WHO (World Health Organization) (1984) and are suitable for fish survival and development. It was concluded that the lake is not over fished and the water quality parameters are within the right range to ensure growth and survival of the fishes.

ACKNOWLEDGMENTS

The authors are deeply thankful to fisher men who assisted in data collection during this study. We are also grateful to the administration of the University of Agriculture Makurdi for making available facilities for this research. This manuscript is published in loving memory of the second author Prof. V.O. Ayuba. May her gently soul rest in perfect peace.

CONFLICT OF INTEREST

None declared.

ORCID

Victor T. Okomoda http://orcid.org/0000-0002-6911-583X

REFERENCES

Alabasster, J. A., & Lyod, R. (1980). Water quality criteria for fresh water fisheries. 2nd edition. London: Butterworth-Heinemann. 361 pp.

APHA. (1998). AWW and NPCF Standard method for examination of water waste water 20th edition. Washington DC: American Public Health Association.

Atama, C. I. (2003). Studies of the physioco – chemical characteristics of effluent from RIMCO vegetable oil company, Nigerian Brewer Limited and their receiving fresh water ecosystem. Msc Thesis, University of Nigeria, Nsukka, 117p (Unpublished).

Bankole, N. O., & Mbagwn, I. G. (2000). Aspects of the fisheries of Lake Alau in North Eastern Nigeria. African Journal of Tropical Hydrobiology Fish, 9 (1 & 2), 49–61.

Benthem, W. (1990). Wetland Conservation. The world conservation union: A review of current issues and required action. IUCN publication.

Boyd, C. E. (1979). Water quality management in fish culture. Journal Aurb University Alabama. 30p.
Eleemi, B. E. (1990). A Limnological Assessment of Ona River, Ibadan Nigeria. 
MSc Thesis University of Ibadan, Nigeria (Unpublished).

Famara, S. D. (2002). Fish species abundance and distribution in the 
Gambia estuary. Hydrological Assessment of West African countries, 
country report: the Gambia.

FAO. (1992). Field guide to the freshwater fishes of Tanzania. Rome: Food 
and Agriculture Organization. pp: 145.

Fawole, O. O. (2002). Morphometry and diet of mormyrus rume in the 
FAO. (1992).

Famara, S. D. (2002). Fish species abundance and distribution in the 
Elemi, B. E. (1990). A Limnological Assessment of Ona River, Ibadan Nigeria.

McClanahan, T. R., Kaunda-Arara, B., & Omukoto, J. O. (2010). Composition 
Matthes, H. (1990).

Imevbore, A. M. A. (1975). The chemistry of lake Kainji waters. In A. M. A. 
Imevbore (Ed.), Adegoke SO; Ecology of Lake Kainji. Transition from River 
to Lake: University of Ife Press.

Matthes, H. (1990). Report on fisheries related aspects of the Hadejia – 
Nguru wetlands conservation project (p. 250). HNWLC, Nguru Nigeria: 
Unpublished internal report.

McClanahan, T. R., Kaunda-Arara, B., & Omukoto, J. O. (2010). Composition 
and diversity of fish and fish catches in closures and open-access fish-
eries of Kenya. Fisheries Management and Ecology, 17, 63–76. https:// 
doi.org/10.1111/j.1365-2400.2009.00717.x

Offen, B. O., Ayotunde, E. O., Ikpi, G. U., Ochang, S. N., & Ada, F. B. (2011). 
Influence of seasons on water quality, abundance of fish and plankton 
species of Ikwori lake, South Eastern Nigeria. Fisheries and Aquaculture 
Journal, 13, 1–18.

Ogbiebu, A. E., & Victor, R. (1989). The effects of road and bridge con-
struction on the bank-root macrobenthic invertebrates of a south-
ern Nigerian stream. Environmental Pollution, 56, 85–100. https://doi. 
org/10.1016/0269-7491(89)90168-1

Oguzie, F. A. (2003). Heavy metals in fish water and effluents of the lower 
Ikpoba river in Benin City, Nigeria. Pakistan Journal of Science and 
Industrial Research, 46(3), 156–160.

Olaosebikan, B. O., & Raji, A. (1998). Field guide to Nigeria Fresh water 
fishes. Federal College of Fresh Water Fisheries Technology New Bussa, 
Nigeria., 106, 88.

Pearson, R. G., & Dawson, T. P. (2003). Predicting the impacts of climate 
change on the distribution of species: Are bioclimate envelop mod-
els useful? Global Ecology Biogeography, 12, 361–37. https://doi. 
org/10.1046/j.1466-822X.2003.00042.x

Schindler, D. W. (2001). The cumulative effects of climate warming and 
human stresses on Canadian fresh waters in the new millennium. 
Canada Journal of Fisheries and Aquatic Science, 58, 18–29. https://doi. 
org/10.1139/f00-179

Sendacz, S., Kubo, E., & Cestarolli, M. A. (1985). Limnologia de reservatios 
do estado do Sao Paulo, Brasil. VIII Zooplankton, 12, 145–176.

Spore (2011). The magazine for Agricultural and Rural development in 
African, Caribbean and Pacific (ACP) Countries No. 150 Dec. 2010 – 
Jan 2011. http://spore.cta.int.

Spore (2012).The Magazine for Agricultural and Rural Development in 
African, Caribbean and Pacific (ACP) Countries. No. 157 Feb – March, 
2012. http://spore.cta.int.

Thalwar, I., & Jhingran, S. (1991). Inland Fisheries of India and adjacent coun-
tries, 1 and 2. Boca Raton, FL: CRC Press. 1–1158 pp

Vander-Heide, J. (1982). Lake Brokopondo: Filling phase limnology of a man-
made lake in the human tropics. Alblasserdam: Offsedrukkerij Kanters, B.V.

WHO (World Health Organization). (1984). Guidelines for drink water qual-
ity. Vol I Recommendations. Geneva: WHO, pp. 193-199.

Willoughby, N. G., & Tweddle, D. (1978). The Ecology of the catfish clarias 
gariepinus and clarias senegalensis in the shire valley. Malawi journal of 
zoolgy: London, 186, 507–534.

World Bank (2004). 2004 World Development Indicators. Washington, DC: 
The World Bank.

World Fish Center (2005). Fish and Food Security in Africa. Penang, 
Malaysia: WorldFish Center.

Yamazaki, M., Tanizaki, Y., & Shinikawa, T. (1996). Silver and other trace el-
lents in freshwater fish Conasus auratus langsendorfii, from Asakawa 
River in Tokyo, Japan. Environmental Pollution, 94(1), 83–90. https://doi. 
org/10.1016/S0269-7491(96)00053-X

How to cite this article: Solomon SG, Ayuba VO, Tahir MA, 
Okomoda VT. Catch per unit effort and some water quality 
parameters of Lake Kalgwa Jigawa state, Nigeria. Food Sci 
Nutr. 2018;6:450–456. https://doi.org/10.1002/fsn3.573