Diversity, distribution and abundance of fish species in Lake Asejire, Oyo State, Nigeria

Ipinmoroti, M. O.[1]* and Iyiola, A. O.[1]
[1]Department of Fisheries and Aquatic Resources Management, Faculty of Renewable Natural Resources Management, College of Agriculture and Renewable Natural Resources, Osun State University, P.M.B. 4494, Osogbo, Osun State, Nigeria
***Corresponding author:** mabel.ipinmoroti@uniosun.edu.ng; wumsco@yahoo.com

Abstract

Aquatic systems in Nigeria have suffered stress induced by human activities which alter the natural composition of the water resources. This study investigated the diversity, distribution and abundance of fish species in Lake Asejire. The lake was partitioned based on accessibility into upper, middle and lower sections for the study. Fish species were sampled using monofilament gill nets with stretched mesh sizes ranging from 44.45-169.33mm. Water and fish species were sampled fortnightly for a period of twelve months. Water quality parameters: temperature (28.96±0.28ºC), dissolved oxygen (5.6±0.13mg/l), pH (6.73±0.19) and conductivity (159.8±0.32µS/cm) measured were within suitable standard ranges for fish production in natural waters. A total of 16 species from 10 families were identified from the lake. Cichlids had the highest number of fish species (4) and relative abundance (66.82%) and *Coptodon zillii* was the most abundant fish species across the months and sampling stations (27.53%). The lower section of the lake had the highest relative abundance (52.90%) while the upper section of the lake had the least (16.14%) and the highest fish catch (13.35%) was in November. The species richness of the lake decreased from lower (S=16) to upper section (S=14), the middle section was highly diversified (H=0.73) with a combined value of H=0.67 for the lake. The fish species were evenly distributed across the lake with the highest evenness in the upper section (E=0.22). Simpson's index was highest in the lower region (D=0.30) and there was a high probability of picking different fish species at random. Trophic grouping showed forage to carnivore (F/C) ratio of 2.06 indicating an unbalanced fish population based on food habit, which should be addressed. There is need for proper regulation such as enforcement of fishing seasons and fishing across the trophic levels to ensure sustainability of the fish resources in the lake.

Keywords: Fish diversity and distribution, Forage-Carnivore ratio, Lake Asejire

Received: 28 April, 2022 **Revised:** 20 August, 2022 **Accepted:** 23 December, 2022

Introduction

Fish is an excellent source of protein in human diets; it is mostly exploited by man in the environment where they are commonly found (Craig *et al* 2002). They form the basic link in the aquatic food chain (Atobatele and Ugwumba 2008), a source of food; it improves food security and nutritional status of the populace (St. Laurent *et al* 2002) and represents about 55% protein intake in Nigeria (Zabbey 2013). Tropical inland freshwater and brackish ecosystems are endowed with abundant fish species, which constitute a rich source of animal protein to the populace, especially those who are trapped within the land lock environment with little access to alternative sources of protein, which when available are not affordable (FAO 2002).

The population of fishes in tropical water bodies experience fluctuations due to factors such as food composition and availability, spawning rate and changes in environmental factors (Ipinmoroti 2013; Rodrigues and Cunha 2017; Ipinmoroti *et al* 2018). Welcomme (2001) identified fishing, pollution and eutrophication among others as factors that could bring about series of changes in fish size, species composition and abundance in the aquatic environment. Bisht *et al* (2009) and Soyinka *et al* (2010) reported that changes in environmental factors such as water quality and depth, water current, availability of food and substratum have influence on the occurrence, abundance and distribution of fauna.

Aquatic ecosystems are mostly affected by stress imposed by human. Population growth, steep urbanization as well as industrial and agricultural land use have resulted in the discharge of diverse pollutants into water bodies causing a dwindling effect on the

http://dx.doi.org/10.4314/tzool.v21i1.8
© *The Zoologist*, *21*: 49-56 December 2022, ISSN 1596 972X.
Zoological Society of Nigeria (ZSN)

aquatic environment and the fisheries (Adeyemo 2003; Iyiola 2015). Lake Asejire was created by impoundment on Osun River at Asejire. The Lake is one of the prominent lakes that form the Ogun-Osun River Basin in South-western Nigeria. The lake serves as a major source of livelihood and plays significant role in the supply of fish to the people of South-western Nigeria living within a significant distance to it. As a result of its significance to the economy and food security of the people, the lake is exposed to various anthropogenic activities arising from its usage for agricultural, domestic and industrial purposes. The fisheries is affected by wastes and effluents discharged into the water, and increasing fishing intensity as human population increases. All these activities can have negative impact on the water quality and consequently the diversity and population of fish species within the lake (Akinyemi *et al* 1987; Yem *et al* 2011 and Ipinmoroti 2013). Periodic investigation of this water body is therefore essential to understand the dynamics between the water quality and fish diversity, distribution and abundance in the lake for enforcement of necessary sustainable measures; which this study was aimed at.

Materials and methods

Study area

Lake Asejire was constructed on River Osun in 1970. It is located in Egbeda Local Government Area of Oyo State, Southwestern Nigeria. It lies on 4.1333°E and 7.3669°N (Figure 1) at an altitude of 137m above sea level, covering a surface area of 525ha. Some of the regulations on the lake include prohibition of disposal of chemical or toxic wastes into the water and ban on the use of motorized boats.

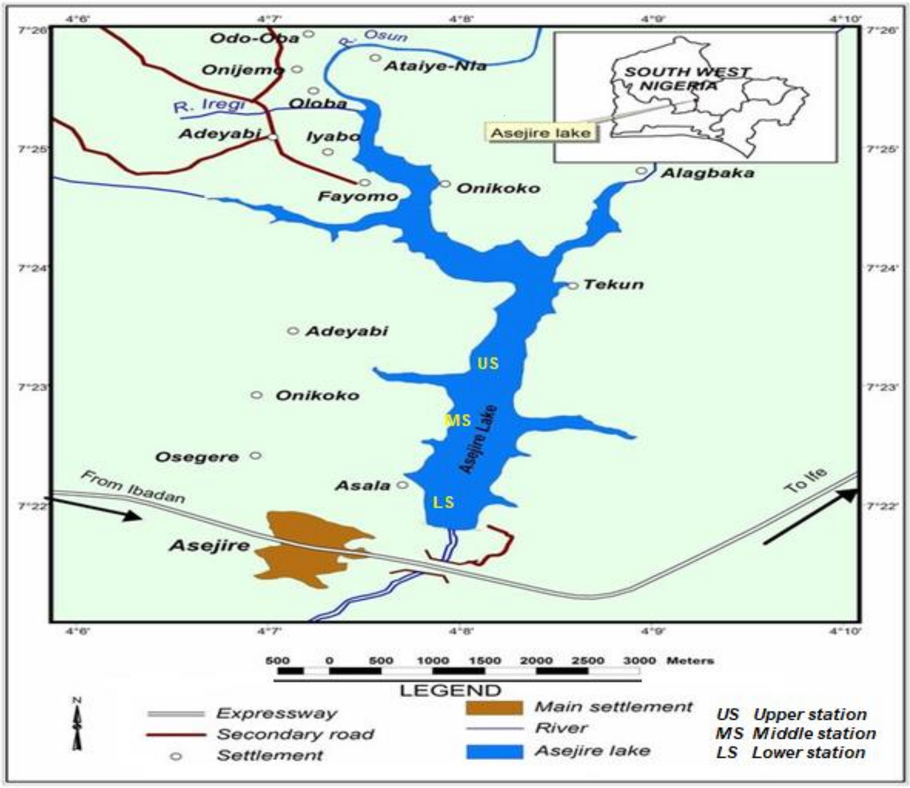

Figure 1. Map of Lake Asejire showing sampling sections

Sampling design

The lake was partitioned into three; the upper section (upstream), the middle section (midstream) and the lower section (dam wall area). Sampling was done fortnightly for a period of twelve months (November 2017-October 2018).

Assessment of water quality

Water samples were taken within 0.5-1m depth from each of the sampling stations and analysed for temperature, dissolved oxygen, pH and conductivity. Temperature was measured using a mercury-in-glass thermometer (calibrated in degree Celsius), which was dipped into the water sample in the sampling bottles for two minutes; readings were taken when the mercury level was steady. Dissolved oxygen was measured using DO meter (model-AD 630 DO meter manufactured by Adwa®). After calibration according to the manufacturer's directions, the probe was inserted into the water sample and reading was taken when the digital meter reading was steady. The pH was measured as described by APHA (2012) and conductivity was measured using a conductivity metre (CDH-222 manufactured by Omega, United Kingdom) as described by the manufacturer.

Sampling of fish
Sampling was done using gill nets of various mesh sizes ranging from 44.45mm to 169.33mm. The ranges of nets were set at various locations in each of the three sampling stations. The choice of gillnets was based on its efficiency in catching various sizes and species depending on the mesh sizes and also on its dominant use by fishers.

Identification of fish
Fish caught were identified, sorted into species using guides by Holden and Reeds (1982), Adesulu and Sydenham (2007) and Olaosebikan and Raji (2013), and counted.

Fish ecological diversity
The ecological diversity of fish species in the lake was determined as illustrated by Pielou (1966):

Simpson's Index of Diversity = $1/\sum pi^2$

Shannon-Weiner index (H) = $-\sum pi\mathit{ln}pi$

Where: pi=n/N = the number of individuals within a species (n) divided by the total number of individuals (N) present in the entire sample, *ln* = natural Log

Evenness (E) $= \frac{\mathrm{eH}}{\mathrm{S}}$

Where: H=Shannon-Weiner's index; S=Number of species in samples

Forage/carnivore (F/C) ratio
The sampled fish species were grouped based on their feeding habits into herbivores, carnivores and omnivores as described by Holden and Reeds (1982). The F/C ratio was determined by dividing the total number of herbivores by total number of carnivores (Ipinmoroti 2013).

$\frac{\mathrm{F}}{\mathrm{C}}\,\mathrm{ratio} = \mathrm{herbivores}\ \div \mathrm{carnivores}$

Statistical analysis
The data was summarized using simple descriptive statistics such as means and percentages. Analysis of Variance (ANOVA) was used to compare the means. Microsoft Excel 2010 and SPSS 23.0 were used for graphing and statistical analysis, respectively.

Results

Water quality parameters
The means of the water quality parameters of the lake are presented in Table 1. Mean dissolved oxygen (5.8±0.11mg/l), temperature (29.3±0.23ºC) and conductivity (160.1±0.23µS/cm), were highest in the lower section of the lake. Overall mean values of 5.6±0.13mg/l, 28.96±0.28ºC and 159.8±0.32µS/cm for these respective parameters were recorded for the lake. The highest pH (6.9±0.11) was recorded in the middle section of the lake.

Fish distribution by sampling stations
A total of 4344 individual fishes were identified from the study, comprising of 16 species namely *Coptodon mariae* (Gervais 1848), *C. zillii* (Gervais 1848), *Sarotherodon galileaus* (Linnaeus, 1758), *Oreochromis niloticus* (Linnaeus, 1758), *Chrysichthys nigrodigitatus* (Lacepede, 1803), *Lates niloticus* (Linnaeus 1758), *Schilbe mystus* (Linnaeus, 1758), *Alestes macrolepidotus* (Valenciennes, 1849), *Hydrocynus forskahlii* (Cuvier, 1819), *A. dentex* (Valenciennes, 1849), *Hepsetus akawo* (Bloch, 1794), *Hemisynodontis membranaceous* (Geoffroy Saint-Hilaire, 1809), *Synodontis budgetti* (Boulenger, 1911), *Labeo senegalensis* (Valenciennes, 1842), *Mormyrus rume* (Valenciennes, 1847), *and Parachanna obscura* (Gunther, 1861) from 10 families; Cichlidae, Claroteidae, Latidae, Schilbeidae, Alestidae, Hepsetidae, Mochokidae, Cyprinidae, Mormyridae, and Channidae. Cichlidae was the most abundant across the sections studied with 66.82% and four species with *C. zillii* as the most abundant (27.53%) species. *S. budgetti* and *Parachanna obscura* were not encountered in the upper section while *L. senegalensis* was not encountered in the middle section during the study. The upper section had the least abundance (16.14%) with 14 species identified, while the lower section had the highest abundance (52.90%) of catch with 16 species identified (Table 2).

Fish abundance by months
The monthly relative numerical abundance of the species is presented in Table 3. Generally, the fish abundance across the months were observed to fluctuate with highest monthly abundance in November (13.35%) and the least in July (5.29%). *C. zillii* recorded the most abundant fish species during the study (27.53%) and the least was *L. senegalensis* (0.16%).

Forage/Carnivore ratio of fish species
The trophic grouping of fish species identified in the lake is presented in Table 5. A total of five (5) species belong to the primary consumer (herbivores) group namely *C. zillii, S. galileaus, O. niloticus, C. mariae* and *L. senegalensis. C. zillii* was the most abundant in this group with 27.53% and the overall abundance of this group was 66.99%. The secondary consumer (carnivores) group had the highest fish species (8); namely; *L. niloticus, H. forskahlii, A. macrolepidotus, A. dentex, H. akawo, P. obscura, C. nigrodigitatus* and

Table 1: Mean water quality parameters recorded from Lake Asejire during the study period.

Parameters	Sections of the lake			Overall mean
	Upper section	Middle section	Lower section	
Temperature (°C)	28.4±0.31[a]	29.2±0.29[a]	29.3±0.23[a]	28.96±0.28
Dissolved oxygen (mg/l)	5.6±0.11[a]	5.4±0.16[a]	5.8±0.11[a]	5.6±0.13
pH	6.6±0.28[a]	6.9±0.11[a]	6.7±0.18[a]	6.73±0.19
Conductivity (µS/cm)	159.6±0.21[a]	159.7±0.52[a]	160.1±0.23[a]	159.8±0.32

superscripts with different alphabets are significantly different

Table 2: Fish distribution in Lake Asejire during the study period.

Family	Species	Lower Section	Middle section	Upper Section	Total Catch	Percentage Contribution
Cichlidae	*Coptodon marie*	78	51	32	161	3.71
	Coptodon zillii	631	422	143	1196	27.53
	Sarotherodon galilaeus	509	358	141	1008	23.20
	Oreochromis niloticus	298	148	92	538	12.38
Claroteidae	*Chrisichthys nigrodigitatus*	439	241	148	828	19.06
Latidae	*Lates niloticus*	21	9	11	41	0.94
Schilbeidae	*Schilbe mystus*	185	45	97	327	7.53
Alestidae	*Alestes macrolepidotus*	51	25	6	82	1.89
	Hydrocynus forskahlii	19	10	13	42	0.97
	Alestes dentex	33	21	4	58	1.34
Hepsetidae	*Hepsetus akawo*	9	5	4	18	0.41
Mochokidae	*Hemisynodontis membranaceous*	5	1	5	11	0.25
	Synodontis budgetti	3	1	NE	4	0.09
Cyprinidae	*Labeo senegalensis*	5	NE	2	7	0.16
Mormyridae	*Mormyrus rume*	4	3	3	10	0.23
Channidae	*Parachana obscura*	8	5	NE	13	0.30
Total		**2298**	**1345**	**701**	**4344**	**100**
Relative percentage		**52.90**	**30.96**	**16.14**	**100**	

*NE - not encountered during the study

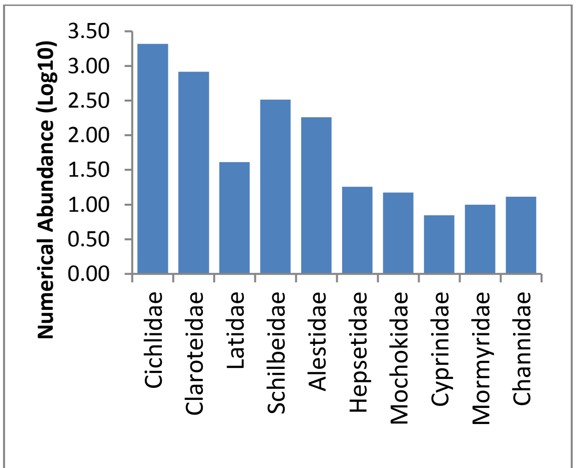

Figure 2. Taxonomic abundance of fish species in Lake Asejire during the period of study

S. mystus. *C. nigrodigitatus* was the most abundant in this group (19.06%) and the overall relative abundance of this group is 32.44%. Omnivores group was the least with three (3) fish species namely *S. budgetti*, *S. membraneceous*, and *M. rume*. *S. membraneceous* was the most abundant in this group (0.25%) and the overall relative abundance was the least with 0.57%.

Fish diversity indices

The diversity indices of fish species during the period of study is presented in Table 4. The highest richness was observed in the lower section (16) with a combined value of 16. H-values were highest in the middle section (0.73) and a combined value of 0.67. Evenness was highest in the upper section (0.24) and a combined value of 0.2208. Simpsons' index of diversity was highest in the middle section (0.90) and a combined value of 0.58.

Discussion

It was observed from the results that the various physical and chemical parameters measured were within the required ranges for fish survival, growth and reproduction in culture and natural environment. Mean monthly and overall dissolved oxygen concentration was above the recommended limit of 5mg/l (Boyd

Table 3: Monthly relative numerical abundance of species

Fish species/ Months	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Total	Total (%)
C. zillii	162	139	121	139	123	75	63	58	71	76	90	79	1196	27.53
S. galilaeus	112	148	91	98	66	71	56	77	74	98	75	42	1008	23.20
O. niloticus	78	102	71	68	71	55	21	11	12	15	13	21	538	12.38
C. marie	28	11	21	21	18	11	9	11	7	6	8	10	161	3.71
C. nigrodigitatus	121	91	88	102	80	75	81	39	28	52	28	41	826	19.01
L. niloticus	9	2	1	2	7	2	NE	NE	3	4	8	3	41	0.94
S. mystus	35	39	30	22	28	21	21	29	25	28	20	29	327	7.53
A. macrolepidotus	8	7	6	8	9	2	4	9	1	5	11	12	82	1.89
H. forskahlii	5	8	9	4	2	3	1	NE	1	4	2	3	42	0.97
A. dentex	11	8	9	11	5	NE	1	2	3	2	2	4	58	1.34
H. akawo	2	1	3	4	1	NE	1	NE	2	1	NE	3	18	0.41
H. membranaceous	2	3	1	NE	NE	2	NE	NE	NE	NE	1	2	11	0.25
S. budgetti	1	2	NE	NE	NE	NE	NE	NE	NE	1	NE	NE	4	0.09
L. senegalensis	2	1	2	NE	NE	NE	1	1	NE	NE	NE	NE	7	0.16
M. rume	3	2	1	NE	NE	NE	NE	NE	NE	2	NE	2	10	0.23
P. obscura	1	NE	2	2	1	1	NE	1	3	1	NE	1	13	0.30
Total fish/ month	580	564	456	481	411	318	259	238	230	295	258	252	4344	100
Total (%)	13.35	12.98	10.50	11.07	9.46	7.32	5.96	5.48	5.29	6.79	5.94	5.80	100	

NE – not encountered

Table 4: Diversity indices of fish species during the period of study

Diversity index	Lower section	Middle section	Upper section	Combined
Richness	16	15	14	16
Number of Individuals	2298	1345	701	4344
Shannon-Weiner index (H)	0.59	0.73	0.68	0.67
Evenness (E)	0.20	0.22	0.24	0.22
Simpson’s index of diversity (1-d)	0.70	0.90	0.97	0.58

Table 5: Trophic grouping of fish species Lake Asejire during the period of study

Trophic group	**Fish species**	**Abundance**	**Relative abundance (%)**
Primary Consumer (Herbivores)	*Coptodon zillii*	1196	27.53
	Sarotherodon galilaeus	1008	23.20
	Oreochromis niloticus	538	12.38
	Coptodon marie	161	0.36
	Labeo senegalensis	7	0.16
	Total	**2910**	**66.99**
Secondary consumers (Carnivores)	*Lates niloticus*	41	0.94
	Hydrocynus forskahlii	42	0.97
	Alestes macrolepidotus	82	1.89
	Alestes dentex	58	1.33
	Hepsetus akawo	18	0.41
	Parachanna obscura	13	0.29
	Chrisichthys nigrodigitatus	828	19.06
	Schilbe mystus	327	7.53
	Total	**1409**	**32.44**
Omnivores	*Mormyrus rume*	10	0.23
	Synodontis membraneceous	11	0.25
	Synodontis budgetti	4	0.09
	Total	**25**	**0.57**
	Total (%)	**4344**	**100%**
	Forage Carnivore Ratio (F/C)	2.06	

1979; Ayoade 2009 and Obot *et al* 2016). The result observed is similar to reports on tropical Niger Delta (Zabbey 2013) and Ogunpa River in Ibadan (Iyiola 2015). Slight variations were observed in the mean pH values but results were similar to results by Yem *et al* (2011) and Ipinmoroti (2013) that the pH of 6.5-9.0 is suitable for the growth of phytoplankton. The mean monthly and overall values measured were observed to be slightly higher than the recommended level. The mean monthly and overall conductivity values for Lake Asijiere were within the limits of unpolluted water. Chapman and Kimstach (1996) reported that conductivity of most freshwater systems ranges from 10 to1000µS/cm but if waters are polluted or receive intense run-offs, it may exceed 1000µS/cm. Conductivity can be used to determine the level of freshness or pollution in water (Ogbeibu and Egborge 1995). Based on this index and by this estimate and results from this study, Lake Asejire is not polluted. Though there were differences in the mean values from different sections they were not significant ($p>0.05$). The similarity in the values of physico-chemical parameters obtained in the different sections of the lake during the study could be as a result of the similarity in activities that took place in the various sections of the water body.

The study of abundance and diversity of fish species is essential for monitoring, conservation and management of stock (Guerriero 2017). All fish species were of freshwater origin and the family Cichlidae was the most diverse and abundant group although it was the most targeted in the lake (Ita 1998; Ogutu-Ohwayo, 2005); while the least diverse families was Cyprinidae (0.16%). The high catch in November could be attributed to fish susceptible to gear during the onset of the dry season in that region. Yem *et al* (2011) similarly observed higher abundance during the months of the dry season (November-March) than the rains (April-October).

The reduction in fish abundance and distribution may be attributed to various factors such as overfishing, migration of fish species and change in water conditions (Lawson and Olusanya 2010), which are all consequences of climate change. A similar case in disappearance of some species was reported in Lake Victoria and it was attributed to the open access nature of fishing and the use of unregulated fishing gear and efforts (Ogutu-Ohwayo 2005).

The low abundance recorded in the months of the wet season as compared with the dry season could be attributed to migration. The wet season which is characterized by increased rainfall (NiMET 2019) stimulates fish species to undergo breeding activities (Negi and Mangain 2013). They migrate from the open waters to shallow areas thereby reducing their abundance in the open waters. The highest abundance of fish species at the lower section was expected because the obstruction created by the dam wall resulted to the creation of a wide water surface area and depth for accumulation of fish species (Yem *et al* 2011).

The total number of species identified in this study was low compared with findings of Ipinmoroti (2013) who reported twenty seven (27) species. The total abundance (4344) from this study was similar to reports by Akinyemi *et al* (1987) and Ipinmoroti (2013) in Lake Asejire. The species composition in the sections and the lake generally was highly diversified and was close to 1, which indicates high diversity (Shannon and Weiner 1949). Diversity varied with the partitioned sections of the lake, the higher the Shannon-Weiner index (H) the more diversified the resources (Shannon and Weiner 1949). Generally, the lake can be said to have a good diversity of fish species using Simpson's diversity index. All the indices show that each of the sections was more diversify than the entire system put together. There was also a high probability of picking different fish species at random; these results are similar to reports of Ogutu-Ohwayo (2005) and Yem *et al* (2011) on the fisheries of Lake Tanganyika.

Herbivores dominated the catch and the Forage Carnivore Ratio (F/C) was 2.06. In a two-year study on the lake by Akinyemi *et al* (1987) and Ipinmoroti (2013), they recorded an F/C of 2.2 and 1.7, and 1.33 and 0.9 in the first year and second years, respectively. Swingle (1950) reported that a Forage Carnivore ratio of between 3-6 is ideal for best production. This study on the lake shows that the forage/carnivore ratio indicates an imbalanced fish population which could eventually lead to trophic cascade. This may occur from scenarios when the carnivores, which are the majority totally consume other fish species thereby leading to a trophic imbalance. The carnivores are mainly pelagic (Idodo-Umeh 2003) and their dominance in the lake implies they can feed across the water column as omnivores fed on the bottom and on herbivores (Ipinmoroti and Olasunkanmi 2004).

Conclusion

The water quality parameters measured were within the recommended limits for fish survival, which is probably responsible for the high fish abundance and diversity. Fish abundance was higher during the dry than the rainy season and Cichlidae was the most abundant and diverse family across the months and stations. However, the trophic imbalance in the lake system is of utmost concern because the number of herbivores, carnivores and omnivores in the lake is not balanced to promote ecologically sustainable coexistence.

Acknowledgement

The authors acknowledge the good will of the fishers on Lake Asejire for allowing us to check their catch and assisting during the sampling exercise.

References

Adesulu, E.A. and Syndenham, D.H.J. 2007. *The Freshwater Fish and Fisheries of Nigeria*. Macmillan Nigeria Publishers Ltd, Nigeria, 397pp.

Adeyemo, K. O. 2003. Consequences of pollution and degradation of Nigerian aquatic environment on fisheries resources. *Environmentalist 23(4*): 297-306.

Akinyemi, O., Ita, E.O. and Sado, E.K. 1987. A preliminary assessment of the post impoundment fisheries of Lake Eleiyele and Lake Asejire, Oyo State Nigeria. Kainji Lake Research Institute 1985 Annual Report, 24-31pp.

APHA, AWWA, WEF 2012. *Standard Methods for Examination of Water and* Wastewater (22nd ed.) American Public Health Association, Washington; 1360pp.

Atobatele, O.E. and Ugwumba, O.A. 2008. Seasonal Variation in the physicochemistry of a small tropical reservoir (Aiba Reservoir, Iwo, Osun, Nigeria). *Afr. J. Biotech. 7(12)*: 1962-1971.

Ayoade, A.A. 2009. Aspects of the Reproductive Biology of the African Butter Catfish *Schilbe mystus* (Teleostei: Schilbeidae) in an Artificial Lake in South Western Nigeria. *Zoologist 7*: 130-140.

Bisht, B., Badoni, A.K. and Bahuguna, S.N. 2009. Seasonality distribution and relative abundance of fish fauna of a Small Hill- Stream Dangchaura (Takoli) Gad along with River Alaknanda. *Our Nature 7*: 182-186.

Boyd, C.E. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University, Alabama, 482pp.

Chapman, D. and Kimstach, V. 1996. Selection of Water Quality Variables. In: D. Chapman (ed.), *Water Quality Assessments*. Chapman and Hall, London, 348pp.

Craig, A., Hancock, K., Tran, Y., Craig, M. and Peters, K. 2002. Epidemiology of stuttering in the community across the entire life span. *J. Speech, Lang. Hearing Res. 45*: 1097-1105.

Food and Agricultural Organization of the United Nations [FAO] 2002. *State of World Fisheries and Aquaculture.* FAO Rome, 202pp.

Guerriero, G., Rabbito, D. and Alwany, M.A 2017. Fisheries and biodiversity along Mediterranean Sea: Italian and Egyptian coast overview. *Euro-Mediterr J. Environ. Integr. 2*: 16. https://doi:/10.1007/s41207-017-0027-8.

Holden, M. and Reed, W. 1982. *West Africa Freshwater Fish*. Longman, London, 24pp.

Idodo-Umeh, G. 2003. *Freshwater Fishes of Nigeria (Taxonomy, Ecological Notes Diet and utilization*). Idodo-Umeh Publishers Ltd, Benin, 89pp.

Ipinmoroti, M.O. and Olasunkanmi, J.B. 2004. Food relationships among some fishes of Upper Ogun river. *Bull. Sci. Assoc. Nig*. 25: 29-33.

Ipinmoroti, M.O. 2013. Ichthyofauna diversity of Lake Asejire: Ecological implications. *Int. J. Fish. Aquac. 5*(*10*): 248-252.

Ipinmoroti, M.O., Iyiola, A.O., Akanmu, O.A., Orisasona, O. and Fawole, N. 2018. Diversity and Distribution of Fish Species in Lake Asejire, South West Nigeria. In: A. Kallel, M. Ksibi, H. Ben Dhia and N. Khélifi (eds.), *Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Sections.* EMCEI 2017. Advances in Science, Technology and Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer, Cham. https://doi:/10.1007/978-3-319-70548-4_422. PP 1447-1448. Accessed 24th April, 2022.

Ita, E.O. 1998. The current status of fish stocks and fisheries in Kainji Lake, 1996. Nigerian-German (GTZ) Kainji Lake Fisheries Promotion Project, 24pp.

Iyiola, A.O. 2015. Human impact on the water quality and benthic macro-Invertebrate compositions in Ogunpa River, Nigeria. *J. Agric. Ecol. Res. Int. 2*(*2*): 120-128.

Lawson, O.E. and Olusanya, O.M. 2010. Fish Diversity in Three Tributaries of River Ore, South west, Nigeria. *World J. Fish and Mar. Sci. 2*(*6*): 524-531.

Negi, R.K and Mamgain, S. 2013. Species diversity, abundance and distribution of fish community and conservation status of Tons River of Uttarakhand State, India. *J. Fish. Aquat. Sci. 8*: 617-626.

Nigerian Institute of Metrology (NIMET), 2019. *Food Security Cluster: Nigerian Metrological Agency (NIMET).* Seasonal Rainfall Prediction (SRP). Available at: https://fscluster.org/nigeria/document/nigerian-meteorological-agency-nimet. Accessed on 15 February, 2022.

Obot, O.I., Etim, L. and David, G.S. 2016. Review of physical and chemical properties of some Nigerian creeks. *Nig. J. Agric. Food Environ. 12*(*4*): 82-90.

Ogbeibu, A.E. and Egborge, A.B. 1995. Hydrobiological studies of water bodies in the Okomu Forest Reserve (Sanctuary) in southern Nigeria. Distribution and diversity of the invertebrate fauna. *Trop. Freshwat. Biol*. *4*: 1-27.

Ogutu-Ohwayo, R. 2005. The Fisheries of Lake Victoria: Harvesting Biomass at the Expense of Biodiversity:

http//www.cbd.int/doc/nbsap/fisheries/ogutu/summary/29pdf. Accessed 24th April 2022.

Olaosebikan, B.D. and Raji, A. 2013. *Field guide to Nigerian Freshwater Fishes* (Revised Edition), Remi Thomas Press, New Bussa, 241pp.

Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. *J. Theoret. Biol. 13*: 131-144.

Rodrigues, C. and Cunha, MÂ. 2017. Assessment of the microbiological quality of recreational waters: indicators and methods. *Euro-Mediterr. J. Environ. Integr. 2:* 25. https://doi:/10.1007/s41207-017-0035-8.

Shannon, C. E. and Weiner, W. 1949. *The Mathematical Theory of Communication*. The University of Illinois Press, Urbana, 117pp.

Soyinka, O.O., Kuton, M.P. and Ayo-Olalusi, C.I. 2010. Seasonal Distribution and Richness of Species in the Badagry Lagoon, South West, Nigeria. *Estonian J. Ecol. 59*: 57-147.

St. Laurent, L.C., Simmons, H.L. and Jayne, S.R. 2002. Estimating tidally driven mixing in the deep ocean. *Geophys. Res. Lett*. *29*(*23*). https://www.doi:/10.1029/2002GL015633.

Swingle, H.S. 1950. Relationships and Dynamics of balanced and imbalanced fish populations. Bulletin No. 274, Alabama Polytechnic Institute, Agricultural Experimental Station, Alabama.

Welcomme, R.L. 2001. *Inland Fisheries: Ecology and Management* FAO/Blackwell Science, 358pp.

Yem, I.Y., Bwala, R.L., Bankole, N.O., Olowosegun, M.O. and Yaji, A. 2011. Analysis of ichthyofaunal diversity and peculiarities of some lakes in Nigeria. *J. Fish. Int. 6*: 26-30.

Zabbey, N. and Malaquias, M.A.E. 2013. Epifauna diversity and ecology on intertidal flats in the tropical Niger Delta, with remarks on the gastropod species *Haminoea orbignyana. J. Mar. Biol. Assoc. UK. 93*(*1*)*:* 249-257.

Citation: Ipinmoroti, O. M. and Iyiola, O. A. 2022. Diversity, distribution and abundance of fish species in Lake Asejire, Oyo State, Nigeria. http://dx.doi.org/10.4314/tzool.v21i1.8.

The Zoologist, 21: 49-56 December, 2022, ISSN 1596 972X.
Zoological Society of Nigeria