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The Ecological Balance of the Fish Community in an Aging Reservoir

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Abstract

Reservoir fishes contribute significantly to freshwater fish resources in Nigeria. The composition, size variation and relative abundance of fishes in Opa reservoir, Southwest Nigeria, were investigated to establish the ecological balance of the various trophic groups of fishes in the reservoir. The study was carried out in view of recent reports on the decline in the quality and quantity of water in the aging reservoir. Fishes were collected from the reservoir monthly for twelve months using monofilament gill nets and wire cages. The fishes were identified to species level and the ecological balance of the fish community was calculated as a ratio of the forage to the carnivore groups by number and by weight. Data were subjected to statistical analysis using the Stata 13 software. 1915 fishes belonging to 17 species and 10 families were collected from the reservoir. The fish composition was dominated by the family cichlidae, with its 7 species accounting for 89.8% of the total catch. There were 2 species of clariidae, which made 6.2% of the total catch. The ecological balance of the fish community was 3.4 (by number) and 6.2 (by weight). The result obtained revealed that the fish community in the reservoir is ecologically balanced. Comparative analysis of the fish composition of the Opa reservoir with reports from other reservoirs in Southwest Nigeria showed that the reservoir has more fish species than most of the other reservoirs around. The study concludes that the reservoir still supports a rich, diverse and ecologically balanced fish community. It is recommended that the management of these fish resources should be key in the holistic management of the aging Opa reservoir.

Keywords

Forage/Carnivore Ratio, Freshwater Fish Diversity, Size Composition

1. Introduction

Man-made reservoirs are important habitats of freshwater fishes in Nigeria, as such their stability has effects on the aquatic biodiversity of the nation. Many of these reservoirs were impounded primarily for purposes apart from fisheries. Such purposes include provision of portable water, irrigation and generating hydroelectricity. However, the reservoirs are naturally inhabited by riverine fishes which get adapted to lacustrine life. This secondary purpose is rarely considered in the management of these water bodies. However, the effect of these reservoirs on the overall picture of the nation's biodiversity records calls for closer attention to a more holistic approach to their management.

Opa reservoir, situated in the land-locked Osun State, Southwest Nigeria, was impounded by damming Opa and Esimirin rivers in 1978. The primary purpose for the impoundment was to supply portable water to members of the immediate and remote environments of the Obafemi Awolowo University, Ile-Ife. There is no information on reservoir's design life and pre-impoundment fish composition of the reservoir. The reservoir is a major fishing facility in Ile-Ife community, and a significant research facility in the University.

In recent times, human activities in the reservoir's catchment are accelerating its natural aging processes. Ogunkoya [1] brought to light significant evidences of aging in Opa reservoir. This included a sharp reduction in the volume of water enclosed between successive contours from 21,766 m^3 in 1978 to 65 m^3 in 2010 (**Figure 1**). The water quality of Opa reservoir has been reduced by the discharges from re-channelized rivers and municipal run off. Earlier work [2] reported that the water has low pH, low water transparency and high total dissolved solids. These aging processes affect the morphological features of the reservoir, which ultimately affects the life forms supported by the reservoir.

The fish composition of reservoirs changes with their age. Changes that occur in a reservoir during aging include changes in the growth of the fish population, size composition, species composition and the ratio of the predatory/non-predatory fishes [3]. The non-predatory fishes are made of herbivorous and omnivorous fishes. They are usually more in size and number than the predatory or carnivorous fishes, this ratio is used in calculating the ecological balance of a given fish community. Ecological balance is very important to the conservation of the fishes. It has been well documented that the higher the diversity of life in a given area, the better the life forms in the area are able to withstand adverse environmental conditions [4] [5] [6].

This study was carried out to ascertain the ecological balance of the fish community in Opa reservoir, to provide needful information for a holistic approach to its management. The result will be a useful contribution to the conservation management of freshwater fishes in Nigeria.

2. Materials and Methods

The Study Area: Opa reservoir is located within latitudes 007˚21'N - 007˚35'N

and longitudes 4˚E31' - 4˚39'E on the Obafemi Awolowo University, Ile-Ife, Nigeria. The reservoir is 2.5 km long and 0.8 km wide, it has a catchment area of 110 km^2 [1]. The reservoir's depth ranges from 1.01 m to 4.99 m. It has a shape that allows for a longitudinal zonation that is similar to the one described by Thornton *et al.* [7]. Fish samples were collected from three main zones on the reservoir. The lacustrine zone-A is close to the dam wall (Figure 2). This is followed by a transition zone-B—about 0.75km from A, the third zone-C—is riverine and it is about 1km from B.

Fish Sample Collection: Fish samples were collected on a monthly basis from the reservoir between November 2012 and October 2013. Two gill nets were set in each zone respectively. The nets were set around 1800 h on each sampling day

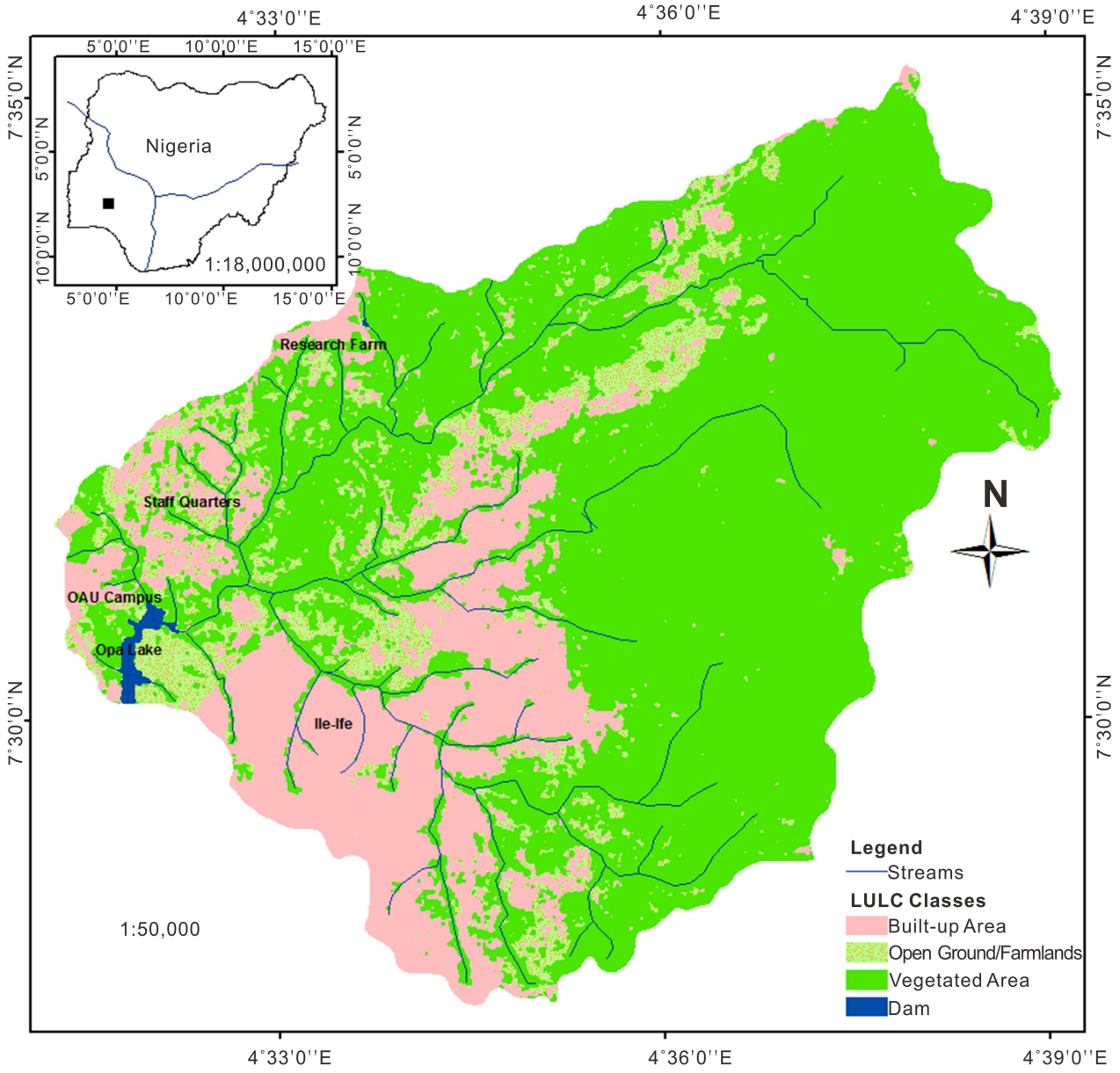

Figure 1. Opa reservoir and its catchment area [1].

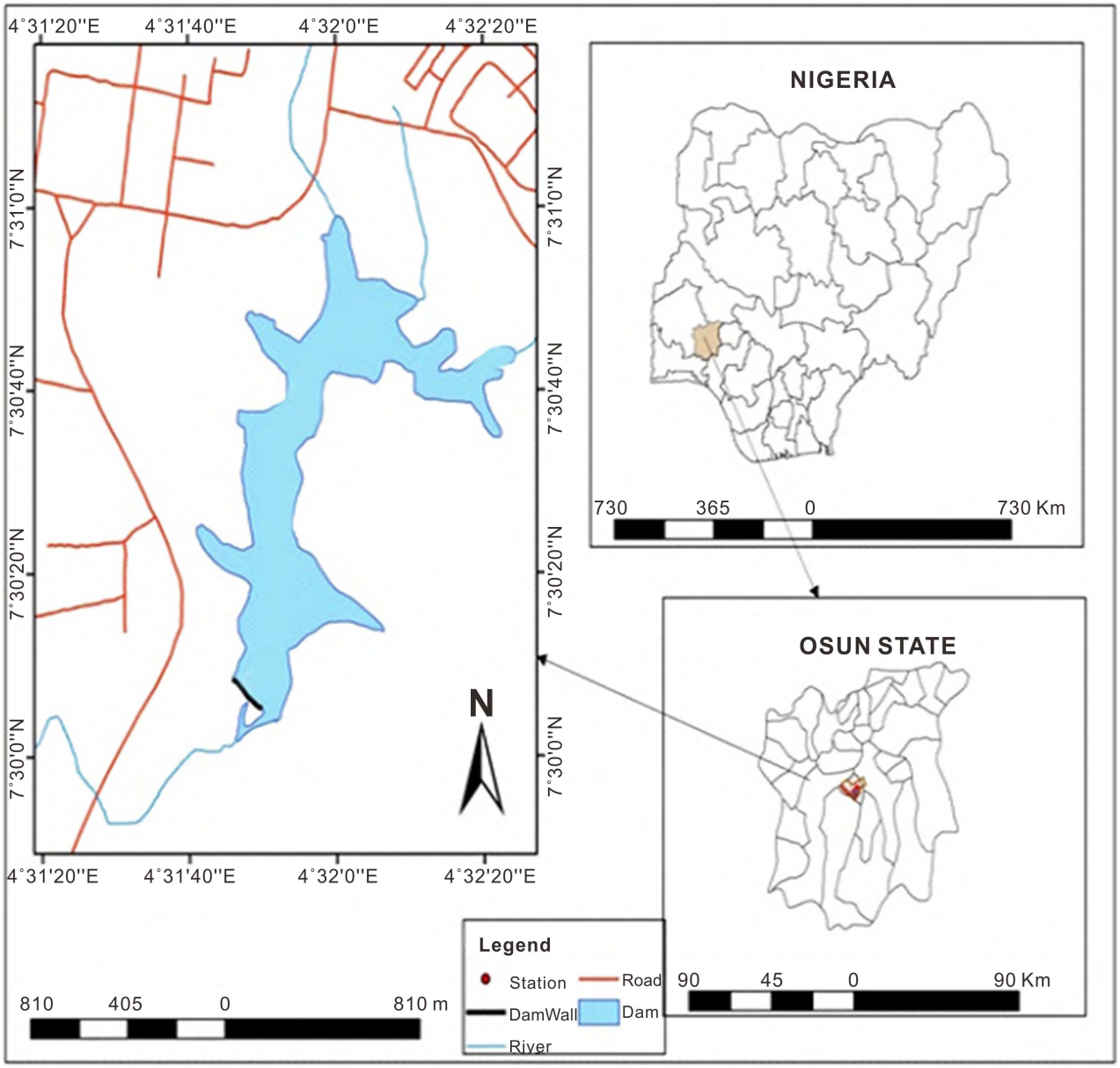

Figure 2. Opa reservoir showing the dam wall.

and were hauled the following morning between 0700 h and 0900 h. To ensure a complete inventory of the fish fauna of the reservoir, additional fish samples were collected with four wired cages from the lacustrine and riverine zones.

The fish samples were transported to the laboratory in ice boxes for identification, measurements and preservation. The fishes were identified to species level by a combination of identification keys [8] [9] [10] [11].

The standard length of each identified fish was measured in centimetres using fish measuring boards. Fish weight was taken in grams using a digital weighing scale. Fish samples were fixed in 100% ethanol and preserved in 70% ethanol. They were added to the fish collections in the Natural History Museum of the Obafemi Awolowo University.

3. Data Analysis

The length measurements were used in determining the size composition of the different fish species collected from the reservoir during this study. The relative abundance of fish species was computed as percentage of the pooled data by number. Statistical analyses were carried out using the Stata 13 software [12].

The information on the food of fishes species collected were obtained from literature [9] [13] [14] [15]. This information was used in grouping the fishes collected to two: forage and carnivorous fishes. The forage fishes were herbivores and omnivores. The ecological balance of the fishes in the reservoir was determined by the forage/carnivore (F:C) ratio. This is a summary description of the number of forage fishes (herbivores and omnivores) to carnivorous fishes. The F/C ratio by weight was also determined, using the weights of the fishes caught. Values between 1.4 and 10 indicate various levels of ecological balance between the two major trophic groups of fishes [16] [17].

4. Results and Discussion

A total of 1915 fishes from 17 species belonging to 10 families in 5 orders were collected from Opa reservoir during the study. Table 1 shows a checklist of fishes collected. 80% of the fish families had only one species. Clariidae had two species, while the Cichlidae had seven species. Four of the recorded species were

Table 1. A Checklist of fish species recorded from Opa reservoir during the study.

Order	Family	Species
Osteoglossiformes	Mormyridae	*Mormyrusrume* (Valenciennes, 1847)
Characiformes	Alestidae	*Brycinus longipinnis* (Günther, 1864)
	Hepsetidae	*Hepsetus odoe* (Bloch, 1794)
Cypriniformes	Cyprinidae	*Enteromius pobeguini* (Pellegrin, 1911)
Siluriformes	Clariidae	*Clarias anguillaris* (Linnaeus, 1758)
		C. gariepinus (Burchell, 1822)
	Claroteidae	*Auchenoglanis biscutatus* (G. St-Hilaire, 1809)
	Malapteruridae	*Malapterurus electricus* (Gmelin, 1789)
	Schilbeidae	*Schilbe intermedius* Rüppell, 1832
Perciformes	Channidae	*Parachanna obscura* (Günther, 1861)
	Cichlidae	*Sarotherodon galilaeus* (Linnaeus, 1758)
		Coptodonzillii (Gervais, 1848)
		C. rendalli (Boulenger, 1897)
		C. dageti (Thys van den Audenaerde, 1971)
		Hemichromis fasciatus Peters, 1852
		Oreochromisniloticus (Linnaeus, 1758)
		O. aureus (Steindachner, 1864)

very rare in the reservoir. Only one specimen each of *E. pobeguini*, *A. biscutatus*, and *P. obscura* were recorded throughout the period of study. Two specimens of *S. intermedius* were recorded. The number of specimens and the corresponding number of species recorded in each month is presented in Table 2.

The total number, size variations and relative abundance of each species collected are shown in Table 3. The fish composition of the reservoir is dominated

Table 2. Monthly variations in the number of fishes caught.

Month	Number of fish specimens	Number of Species
November	111	8
December	124	12
January	123	11
February	171	8
March	157	7
April	162	10
May	173	9
June	153	12
July	160	11
August	179	10
September	185	8
October	17	11
Total	1915	

Table 3. Size variations and relative abundance of fishes recorded.

Standard Length (cm)				
Species	Number	Range	Mean ± SD	R.A. (%)
Mormyrus rume	24	17.5 - 60.4	34.62 ± 9.82	1.25
Brycinus longipinnis	9	5.8 - 8.1	7.43 ± 0.71	0.47
Hepsetus odoe	29	7.6 - 32.4	21.04 ± 7.70	1.51
E. pobeguini	1	5.5		0.05
Clarias anguillaris	58	12.9 - 35.3	27.63 ± 4.42	3.03
C. gariepinus	61	20.9 - 34.4	28.33 ± 3.33	3.18
A. biscutatus	1	13.5		0.05
M. electricus	10	14.3 - 18.8	16.54 ± 1.43	0.52
S. intermedius	2	19.5 - 21.0	20.25	0.10
P. obscura	1	27.9		0.05
S. galilaeus	328	5.1 - 34.1	15.32 ± 5.05	17.13
Coptodonzillii	497	6.6 - 24.4	13.54 ± 2.00	25.95
C. rendali	45	12.6 - 15.9	14.50 ± 0.86	2.35
C. dageti	419	6.6 - 21.4	13.76 ± 2.28	21.88
H. fasciatus	367	5.8 - 19.0	9.94 ± 1.64	19.16
O. niloticus	18	8.2 - 25.8	14.75 ± 4.24	0.94
O. aureus	45	9.5 - 19.0	12.44 ± 2.27	2.35
		1,915,100		

R.A. = relative abundance.

by the family Cichlidae with seven species comprising 89.76% of the total number of fishes caught. The order of abundance of the cichlids is *C. zillii* > *C. dageti* > *H. fasciatus* > *S. galaelius* > *C. rendalli* > *O. aureus* > *O. niloticus*. The two species of Clariidae constituted 6.21% of the total number of fishes. *Clarias gariepinus* had more specimens than *C. anguillaris*, but the difference was not statistically significant ($p > 0.05$).

The mean length of the fishes showed that the water body favours their growth. The sizes of the fishes compares favourably with those of similar species from Osinmo, Owena and Egbe reservoirs in Southwest Nigeria.

Table 4 shows the trophic classification of the recorded fishes. The table shows the corresponding number and weight of each species. There were ten species in the forage category; six herbivorous fishes, and four omnivores. It is note-worthy that all the herbivores are cichlids. The carnivorous fishes were more diverse, the seven species in this category were from different fish families.

F:C ratio (by number) = Total number of forages (Herbivores + Omnivores) / Total number of Carnivores = 1481/434 = 3.41

F:C ratio (by weight) = Total Weight of forages (Herbivores + Omnivores) / Total Weight of Carnivores = 208,404/33,399 = 6.24

The F:C ratio by number and by weight fall within the expected range of 1.4 - 10. This shows that the fish community in the reservoir is ecologically balanced.

Table 4. Trophic categories of fishes caught.

Trophic Category	Fish Species	Number	Weight (g)
Herbivores	*Sarotherodon galilaeus*	328	68,716
	Oreochromis niloticus	18	2833
	O. aureus	45	3914
	Coptodonzillii	497	52,343
	C. rendalli	45	5517
	C. dageti	419	46,656
Omnivores	*Brycinus longipinnis*	9	106
	Clarias anguillaris	58	12,997
	C. gariepinus	61	15,265
	Auchenoglanis biscutatus	1	57
Carnivores	*Mormyrus rume*	24	11,762
	Hepsetus odoe	29	5579
	Enteromius pobeguini	1	5
	Malapterurus electricus	10	1308
	Schilbe intermedius	2	215
	Parachanna obscura	1	333
	Hemichromis fasciatus	367	14,197
		1915	241,803

Opa reservoir has more fish species than many other reservoirs reported in South west Nigeria. Earlier work [18] reported that the newly impounded Osimo reservoir (also located in Osun state) had seven species from four families; Egbe reservoir in Ekiti State had eight species from five families [19]; while Owena reservoir, in Ondo state had fourteen species in seven families [20]. This shows the importance of the Opa reservoir in fish diversity. All these reservoirs, with the exception of the Owena reservoir had a dominance of the cichlids. This is another confirmation of the significance of this fish family in the freshwater habitats of Nigeria.

The F:C ratio revealed that the fish community in Opa reservoir still maintains an ecological balance. This is mainly attributed to the high percentage of the cichlid fishes. The only carnivorous cichlid recorded during this study was *H. fasciatus*. Though this species is relatively high in abundance, it did not pose a danger in this reservoir as reported in Owalla reservoir [21], where its relative abundance was 27.4%.

5. Conclusion

The ecological balance in Opa reservoir should be harnessed for proper management, as it contributes significantly to Nigeria's aquatic biodiversity. As such, a holistic management should be established to ensure the sustainability of the fish resource of this reservoir.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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