STATUS AND ECONOMIC IMPACT OF THE FISHERIES OF OSINMO RESERVOIR, EJIGBO, NIGERIA.

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ABSTRACT

The present study examined the status and management of the fisheries in Osinmo reservoir created in 2005. A total of 3996 fishes were caught by gill-net and trap fishing gears between December 2010 and November 2012. Eight fish families comprising fourteen species of fish were identified. The Cichlidae constituted 62.5% of the population. The dominant species were *Tilapia zillii*, *Sarotherodon galilaeus*, *Clarias gariepinus* and *Parachana obscura*. All the fish species thrived well in the habitat with a mean condition factor between 0.612±0.047 (*Barbus callipterus*) and 1.849 ± 0.129 (*Sarotherodon galilaeus*). The levels of water quality parameters showed a slight variation between the rainy and dry seasons and were within the values recorded for most lakes and streams of the world. A gradual increase in mean length and mean weight of seven fish species was observed as the reservoir matured. Fishermen in the reservoir earned relatively higher income than the middle-income wage earners in public services. However, the use of 2.5 cm mesh size net contrary to 7.62cm mesh size recommended, and unlimited fishing gears of various dimensions and fishing methods by fishermen were detrimental to the development and conservation of the reservoir fisheries.

Keywords: Water Quality, Fishing Activity, Length-Weight Variation, Management, Economic Impact.

INTRODUCTION

Natural and man-made lakes have contributed immensely to the fresh finfish resources of Nigeria. However many of the man-made lakes in the country had virtually little or no consideration for fisheries development and conservation (Arawomo, 1993). Osinmo reservoir was built primarily to supply portable water to the inhabitants of Ejigbo and Ara in Osun State. The reservoir is also providing a number of ancillary benefits among which is the production of fish to these communities. Inland fisheries play important role in the provision of protein to Nigerians, most especially when imported fishes are becoming very expensive (Komolafe and Arawomo, 2008). The rivers, reservoirs and lakes fish fauna are quite vulnerable to exploitation and deserve active management. Low level management practices and over-exploitation of inland waters however could be responsible for down-ward trend of fish production in Nigeria (Komolafe and Arawomo, 2011). The target to achieve self sufficiency in fish production in Nigeria is being done through the exploitation of fishes in streams, rivers, ponds as well as natural and man-made lakes (Arawomo, 2004). Management of freshwater fish fauna therefore is a wise use of the renewable natural fish resources of water-bodies essential to man's survival and to safeguard future fish potentialities. Apart from understanding the factors governing fish production, early application of fish management techniques will sustain the existing fish stocks in inland water bodies. The present study therefore aims at providing information on fish abundance and diversity, types of fishing gears, fishing activities, fish species status, benefits to fishermen and the water quality assessment of a newly impounded reservoir.

AREA OF STUDY

Osinmo reservoir was created in 2005 by the impoundment of Ataro River which took its source from Iware in Oyo State. It has a catchment area of about 102 km^2. The reservoir basin extends from Longitude 04°21.2' E to 04°21.7' E and from Latitude 07° 52.8' N to 07° 53.2' N. (Fig. 1). It occupies an undulating terrain with highest altitude of 365.76 m above the sea level. The vegetation of the area is a lowland rain forest with some area of derived grassland (Keay, 1959). There is heavy rainfall between July and September of each year and an annual rainfall of 130.88 mm has been recorded (Komolafe and Arawomo, 2008). The reservoir has a surface area of about 0.114 sq km with a mean depth of 3.2

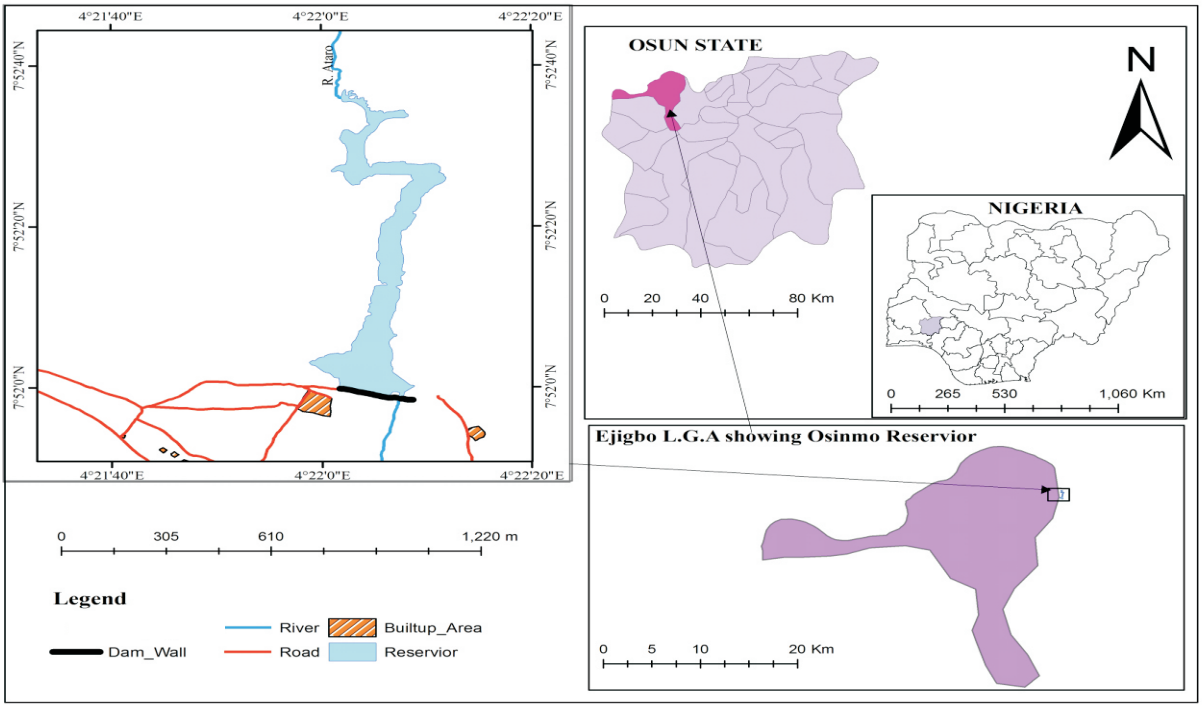

Figure 1: Map Showing Osinmo Reservoir

meters. The substratum is mainly mud and sand with a lot of scattered submerged logs of wood.

MATERIALS AND METHODS

Fish Collection

Samples of fish for this study were collected on monthly basis between January 2010 and December 2012 using trap and gill-net fishing gears. The gill net measuring 100 m long and 3 m deep with a 2.54 cm mesh size was set overnight and hauled the following morning. The fish traps used were made from the bark of *Eremozpatha sp* with entrance designed inform of funnel leading to two non-return valves. The traps were baited with ripe palm fruits and set under submerged vegetation cover along the shoreline. Fish samples caught were put in an ice-chest covered with ice and brought to the laboratory where the standard length (cm) and weight (g) of each fish specimen were measured and recorded. Fish samples were identified using the key prepared by Reed *et al.* (1967), Paugy *et al.* (2003) and Adesulu and Sydenham (2007). The Ponderal Index (Weatherly, 1972) or the Condition Factor (K) which primarily expresses the condition of a fish such as the degree of well-being and relative robustness or fatness in numerical terms was calculated using the formula:

$$K = \frac{100{,}000W}{L^3} \text{ (William, 2000)}$$

Where

W = the weight of fish (g) and
L = the standard length of fish (mm).

Analysis of Variance (ANOVA) and the Duncan's Multiple Range Tests were used for the fish mean length/weight variations.

Economics of the Fisheries

Fishermen were orally interviewed and their fishing gears visually inspected at various sites within the reservoir. Economic issues related to the use of the reservoir for fishing was based on assumptions that:

a. There were five fishing days per week and 52 weeks per year.
b. No close season for fishing was observed on the reservoir
c. The fisherman operated on full-time basis.
d. Fish caught were sold fresh with no spoilage realized.
e. Exchange rate was N150.00 (Nigerian Naira) = US $1.00 in 2012

Water Quality Determination

The reservoir water transparency was determined with a Sechi-disc measuring 15 cm in diameter

(Quayle, 1988). Water samples for chemical determination were collected between 8.30 am and 9.30 am using water bottles rinsed with distilled water. The bottles were immersed inside the reservoir water to allow air out of the bottle and corked inside the water when filled up. Total alkalinity of the water was determined by titrimetric method (APHA, 1995). Dissolved oxygen (DO) samples were fixed on the field between 8.00 am and 9.00 am and were determined by a modified Winkler's titrimetric method (APHA, 1995). The pH of water was measured *in situ* using the pH meter (Meter MP200) while mercury-in-glass thermometer was used to take the water temperature.

RESULTS

Relative Abundance and Diversity of Fish Species.

Fourteen species of fish belonging to eight families were caught during the period of study. Members of the Cichlidae and Mormyridae constituted the largest families with five and three species each. This was followed by other fish families with one species each. The cichlid family constituted 62.5% of the catch. The order of relative abundance of the species was *Tilapia zillii* (36.3%), *Sarotherodon galilaeus* (17.58%), *Clarias gariepinus* (15.47%), *Parachanna obscura* (12.29%), *Hepsetus odoe* (7.99%) and *Hemichromis fasciatus* (7.69%). The remaining species made- up 2.7% of the total fish catch (Table 2). *Mormyrus rume*, *Barbus callipterus* and *Malapterurus electricus* were caught only in the second year of study while *Heterotis niloticus* and *Marcusenius senegalensis* were caught only in the third year of sampling.. All other fish species were available throughout the sampling period except *Marcusenius cyprinoides* and *P. obscura* as shown in (Table 3).

Water Quality of Osinmo Reservoir

The water quality parameters of the reservoir showed very slight variations in rainy and dry seasons (Table 1). Highest reading of mean transparency was 99 ±0.77cm in dry season of 2010 and the least mean transparency of 8.2 ± 0.62 cm in the rainy season of July 2011.The least mean pH value in the rainy season was 7.1 ± 0.72 (2010). During the dry season, the least pH value recorded was 7.4 ± 0.05 (2011) while the highest value of 7.6 ± 0.31 was recorded during the dry season of 2012. The water temperature during the period of study varied within a narrow amplitude varying between 26.5 ± 0.25°C and 29.2 ± 0.19°C in the rainy and dry seasons of 2010 and 2012 respectively.

Table 1: Summary of Water Quality Parameters

Water Parameters	2010		2011		2012	
	Rain	Dry	Rain	Dry	Rain	Dry
Transparency (cm)	97±0.90	99±.077	82±0.62	90±0.81	88±1.05	92±0.88
pH	7.5±0.72	7.6±0.05	7.2±0.09	7.4±0.05	7.1±0.72	7.6±0.031
Water Temperature (°C)	26.5±0.25	28.8±0.31	27.8±0.10	28.1±0.24	27.4±0.28	29.2±0.19
Dissolved Oxygen (mg/l)	3.7±0.06	3.6±0.04	2.9±0.06	3.0±0.06	3.1±0.91	2.8±0.92
Total Alkalinity (mg/l)	84.7±0.81	68.3±1.02	95.4±0.60	76.3±0.72	85.9±1.21	87.6±0.99

Table 2: Abundance, Diversity and Condition Factor of the Fish Species

Fish Species	Number caught	% of Total catch	Condition factor	
			Range	$\bar{X}$±S.D
Heterotis niloticus	6	0.10	0.855-1.137	0.963±0.075
Marcusenius cyprinoides	16	0.40	0.561-1.079	1.115±0.101
Marcusenius senegalensis	14	0.35	0.828-0.956	0.789±0.208
Mormyrus rume	19	0.48	0.571-0.881	0.631±0.054
Babus callipterus	5	0.12	0.513-0.721	0.610±0.047
Hepsetus odoe	319	7.99	0.587-0.842	0.718±0.038
Malapterurus electricus	11	0.28	1.237-1.288	1.196±0.831
Clarias gariepinus	618	15.47	0.750-0.913	0.692±0.081
Parachanna obscura	491	12.29	0.881-0.978	0.792±0.068
Hemichromis fasciatus	307	7.69	1.128-2.211	1.582±0.266
Oreochromis niloticus	20	0.50	1.812-2.109	1.792±0.138
Chromidotilapia guntheri	19	0.47	1.480-1.581	1.478±0.058
Sarotherodon galilaeus	702	17.58	1.511-2.371	1.849±0.129
Tilapia zillii	1449	36.28	1.612-2.417	1.685±0.217

Table 3: Yearly Range and Mean Length/Mean Weight Variations in the Fish Species

	2010				2011				2012			
	Std. Length (cm)		Weight (g)		Std. Length (cm)		Weight (g)		Std. Length (cm)		Weight (g)	
	Range	$\bar{X}$±S.D	Range	$\bar{X}$±S.D	Range	$\bar{X}$±S.D	Range	$\bar{X}$±S.D	Range	$\bar{X}$±S.D	Range	$\bar{X}$±S.D
H. niloticus	-	-	-	-	-	-	-	-	28.0-38.5	33.0±8.43	268-754	510.5±48.21
M. cyprinoides	7.4-11.5	9.1±1.21	6.0-22	11.7±5.17	-	-	-	-	17.5-23.2	20.4±2.4	112-176	144±32
M. senegalensis	-	-	-	-	-	-	-	-	14.1-20.5	16.6±1.99	48-150	86.7±31.92
M. rume	-	-	-	-	12.4-35	26.1±6.96	17-44.5	244.3±124.3	-	-	-	-
B. callipterus	-	-	-	-	6.0-6.5	6.25±0.58	2.0-2.7	2.4±0.36	-	-	-	-
H. odoe	10.2-32.1	23.7±1.78	12-432	233.9±41.29	18.2-35.0	24.5±3.04	86-647	283.5±114.3	17.6-36.0	29.1±0.16	74-690	421.9±48.78
M. electricus	-	-	-	-	16.7-18.2	17.5±1.84	106-136	12.1±6.32	-	-	-	-
C. gariepinus	18.2-32.6	21.7±2.24	54-304	110.2±39.47	22.1-33.2	30.7±2.6	102-567	348.3±90.7	33.0-40.5	35.6±8.9	344-732	555±57.0
P. obscura	-	-	-	-	9.9-35.4	27.5±1.46	12-640	323.1±53.55	22.5-34.5	25.8±1.56	143-588	342.2±42.42
C. guntheri	7.5-8.5	8.1±0.30	11-22.4	15.1±3.64	8.4-12.8	9.9±0.37	18-80	35.1±4.90	10.1-11.0	10.5±0.16	40-50	42.6±2.04
H. fasciatus	7.9-9.3	9.3±0.52	21.7-30.2	31.2±3.83	8.9-11.5	10.0±0.36	22-64	39.9±0.35	12.0-13.1	12.6±0.55	66-68	67±1.0
O. niloticus	10.2-30.0	17.3±2.30	38-984	269.1±103.00	14.0-36	24.9±2.52	125-1720	715.8±53.47	15.4-36.0	24.2±7.23	166-1740	730.3±23.69
S. galilaeus	7.4-23.9	18.5± 0.677	16.9-532	260.5± 24.72	7.1-23.9	14.4± 1.72	16.9-514	164.4± 60.19	13.8-26.1	18.5 0±.90	115-634	295.1± 36.58
T. zillii	6.3-21.3	12.1±0.51	10-432	108.5±12.75	6.7-22.7	14.2±0.72	12-508	156.7±22.66	10.0-22.5	17.4±0.48	43-488	266±18.78

Table 4: Mean Yearly Variation in the Standard Length of Fish Species

Fish species	Mean Std. length (cm)			F-value	P-value
	2010	2011	2012		
	± SD	± SD	± SD		
H. Odoe	23.69±1.20a	24.48±1.34a	29.13±2.58a	2.087	0.144
C. gariepinus	21.67±2.80a	30.70±2.91b	36.50±3.75b	8.583	0.007
C. guntheri	8.07±0.27a	9.87±0.81b	10.46±0.75b	4.608	0.024
H. fasciatus	9.28±0.32a	10.04±0.97a	12.55±1.26b	7.022	0.01
O. niloticus	17.34±1.33a	24.92±3.15a	24.17±2.18a	2.239	0.137
S. galilaeus	16.86±a0.72	14.43±1.27a	18.51±2.21a	1.541	0.223
T. zillii	12.14±0.38a	14.23±1.81b	17.44±1.92c	21.814	0.000

*Row means with the same alphabet are not significantly different (P>0.05)

The mean Dissolved Oxygen varied between 2.8 ± 0.92 mg/L (2012) and 3.6 ± 0.04 mg/L (2010) in the dry seasons while it varied between 2.9 ± 0.06 mg/L (2011) and 3.7 ± 0.06 mg/L (2012) rainy season. The mean total alkalinity of the reservoir water varied between 68.3 ± 1.02 mg/L and 87.6 ± 0.99 mg/L (2012) during dry seasons while it varied between 84.7± 0.81mg/L (2010) and 95.4± 0.60 mg/L during the rainy season.

Fish Condition Factor

The range of Condition Factor (CF) for the fish specimens is shown in Table 2. The mean Condition Factor of fish species varied. The least mean CF was observed in *Barbus callipterus* (0.610 ± 0.047) and the highest was (1.849 ± 0.129) in *S. galilaeus*. The highest condition factor in the family Cichlidae was recorded in May 2012 while the least was recorded in November 2010. In the family Mormyridae, the highest condition factor was recorded in September 2011 while the least condition factor was recorded in December of the same year.

Comparison of the Mean Standard Length/weight Variations

Comparison of the mean standard length/weight variations were based on seven abundant species out of fourteen fish species caught during the study period. Four fish species which showed significant variations (P<0.05) in the mean lengths between year 2010 and 2012 were *C. gariepinus, H. fasciatus, C. guntheri* and *T. zillii* (Table 4). There was no significant difference (P<0.05) in the mean lengths of *C. gariepinus* and *C. guntheri* caught in 2011 and 2012, however the standard length of fish caught in the two years was significantly different (P<0.05) from those caught in 2010. Also, the standard of *H. fasciatus* caught in the year 2010 and 2011 were not significantly different (P>0.05) from each other but were significantly different (P<0.05) from the fish caught in the year 2012. The result also showed that the standard length of *T. zillii* specimens were significantly different (P<0.05) between the three years. The mean lengths of *H. odoe, O. niloticus* and *S. galilaeus* were not significant different (P>0.05) between the three years in which the collections were made. The mean weight variations (Table5) In *C. gariepinus, H. fasciatus* and *T. zillii* were significantly different (P<0.05) in the collections made in year 2010 and 2012. The mean weights of *H. odoe, O. niloticus* and *S. galilaeus* caught were not significantly different (P>0.05) for each of the year of sample collection. In *C. guntheri* the mean weight in the year 2011 and 2012 which were not significantly different (P>0.05) from each other were significantly higher than for the year 2010 (Table 5) The present results however showed that the mean length and mean weight of these fish species caught showed a noticeable gradual increment annually as the reservoir matured.

Table 5: Mean Yearly Variation in the Weight of The Fish Species

Fish species	Mean weight (g)			F-value	P-value
	2010 ± SD	2011 ± SD	2012 ± SD		
H. Odoe	233.85± 35.12a	283.50± 37.34a	421.90±48.29a	2.558	0.097
C. gariepinus	110.17± 14.28a	348.25±45.91b	555.00±65.4c	8.195	0.008
C. guntheri	15.13± 1.24a	35.08±3.59b	42.60±3.67b	3.339	0.058
H. fasciatus	31.16± 3.69a	39.88±3.96a	67.00±4.01b	6.051	0.015
O. niloticus	269.11± 30.42a	715.80±43.51a	730.33±57.73a	2.073	0.156
S. galilaeus	260.45± 22.41a	164.43±15.08a	295.11±27.48a	1.491	0.234
T. zillii	108.14± 8.75a	157.61±11.31b	288.27±30.42c	22.997	0.000

*Row means with the same alphabet are not significantly different (P>0.05)

Table 6: Costs and Return Analysis

a.	**Fixed costs**	**Purchase cost (₦)**	**Life span**	**Depreciated cost per trip (₦)**
1.	Canoe	25,000.00	3 years	32.05
2.	Net	5,000.00	6 months	38.46
3.	Traps	600.00	6 months	4.62
4.	License fees/Annual permit	1,500.00	1 year	5.77
			Total	**80.90**
b.	**Variable costs**			
1.	Additional labour for net setting (optional)		-	
2.	Transportation (to and from reservoir)		₦350.00	
		Total	**₦350.00**	
c.	**Total cost per trip** =	₦80.90+₦350.00 =	₦ 430.90 (US $ 2.87)	
	Total revenue per trip =	₦3,000 (US $ 20.00)		
d.	Net revenue realized per trip	= ₦(3,000.00 - 430.90) =	₦ 2,569.10 (US$17.13)	
	Net revenue realized per week	= ₦12,845.50 (US $ 85.65)		
	Net revenue realized per month	= ₦51.382.00 (US $ 342.55)		
	Net revenue realized per annum	= ₦616,584.00 (US $ 4,110.56)		

Fishery Activities in Osinmo Reservoir

The results showed there were six regular fishermen operating in the reservoir with additional two men in the raining seasons. All the fishermen were not resident, because they were operating on other water bodies. All the fishermen were found to use unapproved fishing gears made up of 2.54 cm mesh size for gill-net and cast-net, bamboo traps, raffia traps, cages, hooks and lines. The gill-nets used varied in length between 150 m to 200 m and each of the fishermen had a minimum of two gill-nets. Many of the farmers in the area were found to use herbicides and pesticides on their farms and the remains were washed into the reservoir annually. The costs and returns for a representative fisherman operating on the reservoir were as shown in (Table 6). The fisherman made the average net revenue of N2, 569.10 (US $17.13) per fishing trip or N 616,584.00 (US $4,110.56) per annum. All the fishes caught were reported sold fresh and no spoilage was recorded due to high demand for fresh fish in the locality.

DISCUSSION

Studies of the changes in fish length, weight and distribution in fresh water bodies had been described by many authors (Turner, 1970; Lelek, 1972, and Ita, 1980) to assess the status of the fishery at various periods after formation of lakes and reservoirs. Many natural and man-made lakes had contributed immensely to the fresh water fish resources of Nigeria but many of the man-made lakes had little or no consideration for fisheries development (Arawomo, 1993). The diversity of fish in Osinmo reservoir had changed with time. Presently there were eight families comprising fourteen species of fish when compared to four families and seven species earlier recorded Komolafe and Arawomo (2008). The percentage of the cichlids in Osinmo reservoir recorded in earlier study was 59.7% while the present study was 62.6%. The population of *H. odoe* also increased from 6.3% to 7.99% during the present study while other fish species also showed appreciable increase in the population. The gradual cichlids population build-up in Osinmo reservoir however, probably was not yet at optimum when compared to Opa reservoir 98% and Erinle Lake 71% (Komolafe and Arawomo, 2003, 2011).

High condition factors between 0.610 ± 0.047 and 1.349 ± 0.129 observed in the fish species caught were a reflection of the presence of adequate food and other essential materials for the fishes. It was also an indication that the fishes thrived well in the habitat (Komolafe and Arawomo, 2008).

The reservoir had a limited wind fetch as a result of forest trees and shrubs surrounding the reservoir. Water temperature and transparency which showed little variation had been observed by Komolafe and Arawomo (2011) earlier in Erinle reservoir. The little variation recorded in the dissolved oxygen content of the reservoir was similar to the observation of Akinbuwa (1988) and Komolafe and Arawomo, (2011) in Opa reservoir and Erinle Lake. The low level of DO might probably be due to low level of oxygen production as a result of activities of benthos organisms in the decomposition of allochothonous organic matters and phytoplankton blooms, as reported by Atobatele and Ugwumba (2008) in Aiba reservoir. Hydrogen ion concentrations (pH) of the reservoir during the seasons were moderately alkaline with mean values between 7.1 ± 0.72 and 7.6 ± 0.03. A similar pH was recorded by Okayi (2003) in river Benue. These values were within the pH values known for most lakes and streams of the world with a range of 6.5 and 8.5 (Welch, 1952). The mean total alkalinity values recorded in the reservoir were within the optimum tolerable alkalinity value for freshwater fish which was between 50 mg/l and 700 mg/l (Chapman and Kimstach, 1992). The reservoirs mean total alkalinity along with other parameters indicated that the reservoir habitat was stable and support population of different species of fish. Similar situations were also observed by Akinbuwa (1999) in Erinle Lake and Obodai and Waltia (2003) in Tono reservoir where high water parameters were reported to support fish reproductive activities and subsequent development of the fishery resources.

The observed increase in mean length and mean weight of fish in the third year of sampling was comparable to the sizes of fish reported by Abayomi (1995) and Fawole (1995) in Opa reservoir which was created in 1972. The fish mean length and mean weight increments in the seven fish species caught indicated good developmental stages as the reservoir matured. As observed by Ita (1980) for the family Citharinidae in Lake Kainji, the mean-size statistics was not only useful in assessing the status of the changing fisheries but also a developmental guide for requisite management.

In Osinmo reservoir fishermen mostly used Bamboo traps, Raffia traps, Cages and Hooks and Lines. The 2.5cm mesh size gill net used was short of the 7.62cm mesh size approved by the Federal Fisheries Department (Komolafe and Arawomo, 2008). Numerous under water logs of wood did not encourage the use of cast-net which were quickly torn to shreds. The use of various traps under sedges resulted to big catches, most especially *H. niloticus, C. gariepinus, P. obscura and O. niloticus*. When compared with the national wage level in Nigeria, the average amount of N 616,584.00 (US $4,110.56) earned by a fisherman per annum compared favourably with the amount earned by a middle income wage earner in the Government service (Idowu *et al.,* 1999). The amount was also much higher than the net income of most small and medium scale crop farmers in the country (Idowu and Adesiyan, 2007). This relatively high income realized by the fisherman operating on the pond was as a result of the high prices of fresh fish in the State where it was regarded as a delicacy by the high net-worth individuals.

The gradual build-up of the fisheries of Osinmo reservoir had been observed and the need for management techniques to conserve and sustain the stock of fish was highly recommended. There was need for enforcement measures in the reservoir with respect to types of fishing methods that could be used by the fishermen. Gear regulation through the control of mesh size would help to prevent over-fishing so as to build up the fish stocks. Monitoring of the fishermen activities were necessary to forestall wasteful fisheries practices observed in Erinle Lake (Komolafe and Arawomo, 2011). Even though the reservoir was in its early stage of development, there was need to protect the fish habitats to encourage population increase of major fish species. The use of traps and cages under sedges should be discouraged. As reported by Arawomo (2004), there was need to regulate periods of fishing in order to preserve fish species during spawning seasons.

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