Management Plan of Man-Made Lakes (Reservoirs) in EDO State Nigeria

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ABSTRACT

The deficiency of protein in Nigeria has necessitated looking inwards for increased fish production. Brackish water resources are declining and production from ponds is still insignificant to the level of protein needed by the populace. Lake Fishery has been found to provide the needed protein. Man-made lakes abound throughout the country but most of them are not regulated and there are no policies for the management of these lakes especially the man-made lakes in Edo State. To realize the benefits from reservoir fisheries we must learn how best to manage these reservoirs.

The objectives of reservoir fishery management are to increase fish yield and to maintain a steady state harvest of fish at a level near the optimum productivity of the reservoir. However, reservoirs are created primarily for hydro electric power, irrigation, flood control, water storage (supply of drinkable water) or navigation and rarely for fisheries, hence, little or no attention is given to the fisheries of reservoirs.

The potentials of man-made lakes in Edo State for fisheries was examined by studying the morphometric features of the lakes, activities around the lakes, the fisheries of the lakes (fishing intensity, types of fishes etc.) and the total annual catch and the climatic conditions of the study area. Based on these, management practices to follow in other to realize the fisheries benefits of these lakes were fully discussed especially the involvement of fishery expert in the daily running of the reservoir and changes in the reservoirs operations.

If these management practices (policies) are strongly pursued, the gap between the present level of domestic fish production and consumption in Nigeria and Edo state in particular will be bridged, thereby raising the nutritional and socio-economic status of the populace.

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Key words: Morphometric Features, Potential Fish Yield, management, policies, fishery expert

INTRODUCTION

Lakes and reservoirs constitute a very important part of our heritage and have been widely utilized by mankind over the centuries. A dam is a barrier that blocks the flow of water and produces a reservoir. Natural dams can include beaver dams, lava flows or landslides. Artificial dams are built for water storage or flood control or to generate electricity (Jackson, 2009). Reservoirs created by dams are major sources of agricultural irrigation water, and irrigation water contains significant amount of silicon, calcium, sulphur, potassium and magnesium, which are taken up by rice plant (Husnain and Tsugiyuki, 2009).

Reservoir Fisheries in Africa are important by virtue of the areas they occupy, some 40, 000km^2 for reservoirs exceeding 10km^2 and for their contribution to overall inland fishery yield in Africa, which amounts 10 percent or 150, 000t. (Kapetsky and Petr., 1984). Despite this, the full biological and economic potentials of reservoir fisheries have rarely been established for purpose other than for fisheries and even when substantial fishery benefits are expected from reservoir projects fishery experts are not involved early enough during the planning process. Hence, the problem of impact of such measures as bush and tree clearing, weed control, the construction of all-level landing stages etc. on the development of fishery are not considered during the engineering design and basis development plan.

Planning at the early pre-impoundment stages of reservoir development is a means of increasing benefits from reservoir fisheries. Fishery yield prediction in reservoirs is a planning tool fundamental to estimating the kinds and magnitudes of fishery management and development inputs which would be required in future especially in small reservoirs like Ikpoba dam and Onyami dam. This was also confirmed by Ita, (1981) when he said that the large, older African reservoirs are now nearing their maximum capacity for exploitation while others (smaller) are underexploited despite their potential for expansion of fisheries.

Reservoirs support fish populations and fisheries where yields are comparable to or higher than the rivers they submerged (Welcomme, 1985). He also stressed further that the net gain is usually far higher in rapids reaches where the relative low productivity of the main channel is easily exceeded by the lake.

In Nigeria, there has been no systematic approach towards the management and development of the lake (reservoir) fisheries, hence any observed trend in production is purely a natural control.

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However, proposals have been made (Ita, 1981a) towards a systematic management approach aimed at increasing the current yield of reservoir fisheries

Currently there is no fishing activities in the two man made lakes in Edo state.

From the foregoing, the state of reservoir fisheries in Nigeria and Edo state in particular calls for an urgent need for management plan to be able to realize the benefits thereof.

JUSTIFICATION OF STUDY

Nigerian populace, which was estimated at about 162.5million in 2011 with an annual population growth rate of 2.1% is expected to be 258 million by 2030 (UNDP 2010), food supply is expected to triple to cater for this increase. The current demand for fish in Nigeria is 3.21 million tonnes (FDF 2007). The present situation calls for serious and urgent action on how to ensure sustainable and sufficient production of fish. The transition to scarcity of fish cannot be prevented by only intensive fishing and aquacultural practices, but rather by better management of fisheries resources. Reservoir fisheries is still very low in Nigeria (Table 1)

TABLE 1: ESTIMATE OF FISH YIELD POTENTIALS IN INLAND & MARINE WATERS OF NIGERIA

SOURCE	ANNUAL YIELD POTENTIALS (TONNES)
Rivers and Flood plains	226, 550
Lake Chad	24, 500
Kainji Lake	8, 500
Other Natural Lakes & Reservoirs	35, 000
Coastal and Brackish waters	190, 000
Inshore Water (5.50m)	16, 620
Offshore Waters (demersal resources)	6, 730
Offshore Waters (Pelagic resources)	9, 460
Aquaculture	1, 313, 634
TOTAL	**1, 830, 994**

Source: Olaifa (2015)

This therefore calls for the expansion and development of the fishery sector of the economy. Especially, freshwater fish as a renewable natural resource, if carefully managed can be exploited to supply part of the nation's protein requirements.

Nigeria, with a coastline of 853 km, 200 nautical miles Exclusive Economic Zone (EEZ), over 2,658 fish farms as well as 937 dams and reservoirs, 365 lakes and reservoirs and 687 ponds and floodplains covering over 13 million ha of water bodies has an enviable potential for fish production (WRI., 2003). These resources have immensely contributed economically, socially and culturally to the development of the country through hydroelectric power generation, irrigation, recreation, research, fishing and aquaculture. Exploitation of fish resources from inland waters, mostly from rivers has been a very common practice amongst the riparian communities for many years.

The artisanal fishery sector constitutes the most important sector of fisheries as it accounts for the major fish supply in the developing world. Over 90% of domestic fish production in Nigeria comes from this sector (Ogunbadejo *et al*., 2007). Faturoti (2010) also reported that artisanal fisheries in Nigeria provided more than 82% of the domestic fish supply, giving livelihoods to 1 million fishermen and up to 5.8 million fisher folks in the secondary sector. Within the sector, overfishing and destructive fishing practices are reported to have contributed to reduction in stocks. The sustainability of productions from this important arm of capture fisheries however, is dependent on availability of correct data on the status of the resources being exploited as well as the effect of fishing methods on the stock (Shrestha, 1990). The development of appropriate strategies and policies for sustainable economic and biological exploitation of inland fisheries resources such as Ikpoba and Ojirami reservoirs being studied require adequate information on the lake environment and the targeted resources.

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OBJECTIVE OF STUDY

Proper management of water bodies, especially, small water bodies like lakes, reservoirs and ponds, enhances fish production, it is therefore important to learn how to manage lake fisheries to give maximum sustainable yields of desired species (Welcome, 1985). Most lakes in Nigeria are not regulated and there are no policies for the management of these lakes especially the lakes in Edo-State where there is no single policy of how the lakes should be managed or regulated for fishery development. Hence this study tries to find out how best to manage each of the man-made lakes (Reservoir) in Edo-State by:

1. Examining the morphometric features such as:
   i. Source of water
   ii. Area
2. Surveying the activities around the lakes
3. Study the fisheries of the man-made lakes such as:
   i. Fishing intensity ii. Types of Fishes etc.

And to achieve this aim the state of the lake is determined and management policies are formulated for the man-made lakes in Edo State.

MATERIALS AND METHODS

Study Area

There are two man-made lakes in Edo-State; the Ikpoba dam (at Okhoro) created out of the Ikpoba river located in Benin city of Oredo local government area, the geographical location in $5^0$32'N and $6^0$15'E (Fig. 1). The Onyami dam, commonly called Ojirami dam by the people of the community, created out of the Onyami river located in Ojirami of Akoko Edo local government area, the geographical location is $6^0$15'N and $6^0$45'E (Fig. 1)

Akoko Edo is a Local Government Area in Edo State, Nigeria. Its headquarters is in the town of Igarra. It has an area of 1,371 km² and a population of 262,110 at the 2006 census. The postal code of the area is 312. The towns include Atte, Igarra, Enwan, Aiyegunle, Ugboshi-Afe, Ugboshi-Ele, Ekpesa, Ibillo, Ikiran-Ile, Ikiran oke, Ekor, Somorika, Lampese, Imoga, Ojah, Uneme-Akiosu, Ososo, Akuku, Ojirami-Dam, Imoga, Eshewa, Ojirami-Peteshi, Ojirami-Afekunu, Dagbala, Makeke, Ekpe, Ekpedo, Bekuma, Okpe, Ijaja, Oloma, Uneme-nekwa, Ikpeshi

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The Ikpoba dam is located, spanning from Okhoro to Teboga, along the Ikpoba river running through Egor and Ikpoba – Okha local government areas in Benin City, Edo State. It is situated on the sandy coastal plain, which covers the central part of Edo State and some 360km due east of the popular Lagos State of Nigeria. Elevation within the centre of the town; as well as along the periphery of the city; range from about 75m in the southeast to about 90m in the northeast.

It is earth dam, supported at the sides with rip – rap, with a river flow all year round. Its level of water is the same at all time during the year with just minor variation. The geological terrain is tertiary while the foundation is pile. It covers a catchment area of 1.07 x 10^6 m^2. The dams is 610m long with a height, at crest level, of 35m above mean sea level. It has a spillway length (weir) of 60m and an emergency spillway length of 4m. The dam has a reservoir capacity of 1.5 x 10^6 m^3, Backwash reservoir capacity 1368 m^3. It is the main source of water supply for the city with water production per pump day of 34080m^3. The water supply design capacity is 90000m^3 / day serving an estimated population of 1.0 million people at design. The dam was impounded first in 1975 and commissioned October, 1987. At present, problems associated with the reservoir are over silting and growth of weeds over the years. (Edo State Water Board, 2015). Ojirami

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dam has the same size and specification as the Ikpoba dam and is controlled by the same Edo state water resources (ESWB).

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Figure 1: Maps showing: i. Location of Edo State in Nigeria

ii. Location of study areas in Edo State

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TOPOGRAPHY

Edo State can be divided into zones based on topography. The terrain in the study areas are in the broad zone (project site A (Ikpoba Dam)) and Narrow zone (project site B (Ojirami Dam)) of the state which may be geographically describes as the Benin lowlands and Benin highlands .

METHODOLOGY

A survey was carried out by map reading to locate the man-made lakes in Edo State. A comprehensive survey of the lakes were carried out to examine the morphometric features of the lakes like the source of water by paying a visit to the sites. And the activities around the lakes were also examined, the type of vegetation within 2km radius, the effluent discharge type into the lakes like industrial waste, and the watershed type whether it was still preserved, destroyed, or partly damaged. And also the access to the lakes whether motorable or not and if the roads are tarred or laterite.

A survey was carried out to study or examine the fisheries of the man-made lakes – the fishing intensity; the number of fishermen, the number of canoes, the types and sizes of the canoes, the average catch per day in kilograms. The fishing method and the gear types and their mesh sizes. The types of fishes found in the lakes were also examined and their diversity in order of abundance. A survey was also carried out on the disposition of catch and the nearest markets to the lakes and their percentage post-harvest losses.

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Collection of Data

Information was collected from the Edo State Water Corporation on the area of the lakes, the water surface area (hectares), catchment area (km^2), maximum length (metres), maximum width (metres) and mean depth of the lakes.

Information was also collected from the Department of meteorological services (NIMET), Benin city, Edo State on mean piche evaporations, maximum and minimum temperatures, highest and lowest relative humility, sunshine and rainfall in the past six years so as to determine the climatic conditions of the place of study and how it affects fish production.

Information was also collected from the fishery heads of the state's Ministry of Agriculture and Natural Resources and Agricultural Development Programme.

RESULTS AND DISCUSSION

TABLE 2: 2010 METEOROLOGICAL DATA

MONTH		TEMPERATURE		RAINFALL			WIND	MEAN COLD	EVAPORATION	SUNSHINE
		Max.	Min.	Optim.	Min.	Max.	Km			
Jan.	total	1057	152	7.9	7.6	15.5	2757.16	21.70	131.87	199.5
	mean	34.1	24.3				88.91	7.0	4.3	6.5
Feb.	total	981	710	78.0	21.8	99.8	320328	1954	1212	176.7
	mean	35.0	25.4				114.40	7.0	4.3	6.3
Mar.	total	1077	792	55.1	0.2	55.3	2951.66	216.7	131.1	120.9
	mean	34.7	25.5				95.21	7.0	4.2	3.9
April	total	1018	731	2183	103.2	321.5	3423.35	209.7	102.2	202.2
	mean	33.8	24.4				114.11	7.0	3.4	6.7
May	total	1070	772	67.1	91.3	158.4	3055.55	216.1	91.5	166.7
	mean	32.6	24.9				98.57	7.0	3.0	5.4
June	total	949	719	170.4	42.2	212.6	2853.83	209.4	67.1	144.0
	mean	31.8	24.0				95.13	7.0	2.2	4.8
July	total	921	714	148.9	50.7	199.6	3055.68	218.3	60.0	115.8
	mean	29.7	23.0				98.57	7.0	1.9	3.74
Aug.	total	902	711	392.9	140.0	532.9	3271.26	220.1	46.6	76.4
	mean	29.1	22.9				105.52	7.1	1.5	2.5
Sep.	total	908	686	352.3	256.4	608.7	2966.85	210.3	54.0	107.9
	mean	30.3	22.9				98.89	7.0	1.8	3.6
Oct.	total	989	713	254.7	12.7	267.4	1900.81	213.4	57.8	142.0
	mean	31.9	23.0				61.32	7.0	1.9	4.6
Nov.	total	989	858.0	298.9	7.6	306.5	1408.35	208.0	58.1	147.7
	mean	33.0	28.4				46.95	6.9	1.9	4.9
Dec.	total	1040	711	35.8	13.4	49.2	1970.76	215.5	118.4	1924
	mean	33.5	22.9					7.0	3.8	6.21

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TABLE 3: 2011 METEOROLOGICAL DATA

MONTH		TEMPERATURE		RAINFALL			WIND Km	MEAN COLD	EVAPORATION	SUNSHINE
		Max.	Min.	Optim.	Min.	Max.				
Jan.	total	1042	680	00	00	00	289486	216.7	1991.1	159.9
	mean	33.6	21.9				93.38	70	6.4	5.2
Feb.	total	951	669	53.6	24.6	78.2	3474.20	195.7	126.02	136.0
	mean	34.0	23.9				124.18	7.0	4.5	4.9
Mar.	total	1056	757	71.6	12.7	84.3	3755.77	217.6	118.1	171.8
	mean	34.1	24.4				121.15	7.0	3.8	5.57
April	total	1013	739	181.0	172.5	353.5	3115.75	213.3	86.8	155.6
	mean	32.7	23.8				100.57	6.9	2.8	5.01
May	total	983	718	290.3	32.1	322.4	2902.41	209.6	89.4	107.5
	mean	32.8	23.9				96.75	7.0	3.0	3.6
June	total	892	706	360.9	190.7	551.6	317154	2193	43.0	78.0
	mean	2.88	22.8				102.31	7.1	1.4	2.52
July	total									
	mean									
Aug.	total	882.8	699.0	366.6	133.9	502.5	3665.53	221.3	46.5	66.0
	mean	28.3	22.5				118.24	7.1	1.5	2.1
Sep.	total	89.43	690.5	306.6	103.5	4101.1	319505	209.7	47.7	85.1
	mean	29.8	23.0				106.50	7.0	1.6	2.84
Oct.	total	970.1	712.1	232.8	44.8	277.6	240313	216.7	63.8	957
	mean	31.3	23.0				77.52	7.0	2.1	3.1
Nov.	total	1006	717.4	47.8	2.4	50.2	209887	209.7	95.9	210.7
	mean	33.5	23.9				6996	7.0	3.2	7.01
Dec.	total	1075.1	7057	00	00	00	286601	2170	1956	224.9
	mean	34.7	22.5				92.53	7.0	6.3	7.25

TABLE 4: 2012 METEOROLOGICAL DATA

MONTH		TEMPERATURE		RAINFALL			WIND	MEAN COLD	EVAPORATION	SUNSHINE
		Max.	Min.	Optim.	Min.	Max.	Km			
Jan.	total	1038.9	690.6	14.5	33.2	47.7	291943	277	185.9	93.9
	mean	33.5	22.3				9418	7.0	6.0	3.0
Feb.	total	940	698.9	43.1	11.0	54.1	2995.31	203.3	90.6	115.1
	mean	32.4	24.1				103.29	7.0	3.1	4.0
Mar.	total	656.4	771.8	61.1	13.7	74.8	377258	217.	1219	121.6
	mean	34.1	24.9				121.70	7.0	4.3	3.9
April	total	977	726.8	47.0	121.3	168.3	341219	208.1	106.6	171.0
	mean	32.6	24.2				11.3674	6.9	3.6	5.7
May	total	982.1	732.0	234.0	149.6	383.6	3021.41	213.6	86.2	149.7
	mean	31.7	23.6				97.46	7.0	2.8	4.8
June	total	900	8301	3020	245.4	547.4	290457	2127	549	115.2
	mean	30.6	27.7				96.83	7.1	1.8	3.84
July	total	884.4	710.3	24.2	147.3	394.3	321095	222.6	46.0	71.7
	mean	28.5	22.9				103.58	7.2	1.5	2.3
Aug.	total	867.9	692.7	87.5	83.8	171.3	4228.33	218.4	60.5	103.0
	mean	28.0	22.3				136.40	7.0	1.8	3.32
Sep.	total	878.3	693.1	212.6	42.9	255.5	283899	112.8	45.4	69.4
	mean	29.3	23.1				9463	1.5	1.5	2.3
Oct.	total	946.7	710.3	210.7	74.5	285.2	2129.98	217.0	66.6	129.4
	mean	30.3	22.9				68.71	7.0	2.0	4.2
Nov.	total	963.5	718.0	163.1	24.8	187.9	215893	209.3	74.5	167.3
	mean	32.1	23.9				7196	7.0	2.5	5.6
Dec.	total	1032.4	716.3	189	00	18.9	2007.62	207.7	122.8	209.4
	mean	33.3	23.1				64.76	6.7	7.7	6.7

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TABLE 5: 2013 METEOROLOGICAL DATA

MONTH		TEMPERATURE		RAINFALL			WIND Km	MEAN COLD	EVAPORATION	SUNSHINE
		Max.	Min.	Optim.	Min.	Max.				
Jan.	total	1048.4	726.1	14.0	1.4	15.4	306440	201.1	169.9	179.4
	mean	33.8	23.4				9883	6.5	5.5	5.8
Feb.	total	945.8	690.0	57.7	4.4	61.8	3206.83	190.3	133.0	105.9
	mean	33.8	24.6				114.53	6.8	4.8	3.8
Mar.	total	1047.6	772.4	121.2	5.0	126.2	377112	216.3	133.1	193.3
	mean	33.8	24.9				12165	7.0	4.3	6.2
April	total	979.6	737.5	125.6	76.4	202.0	305707	209.4	105.6	190.3
	mean	32.7	24.6				10170	7.0	3.5	6.2
May	total	980.3	744.6	172.1	130.1	322.2	3092.90	217.2	90.5	1694
	mean	31.6	24.0				99.77	7.0	2.9	5.47
June	total	894.9	707.6	158.9	96.7	255.6	700000	208.8	65.3	1202
	mean	29.8	23.6				100.00	7.0	2.2	4.0
July	total	876.1	710.8	250.0	140.0	390.0	3205.39	219.4	50.3	92.6
	mean	28.3	22.9				103.40	7.1	1.6	3.0
Aug.	total	872.3	701.4	718	74.5	106.3	386977	216.9	64.6	89.7
	mean	28.1	22.6				124.83	7.0	2.1	2.9
Sep.	total	867.9	686.4	47.2	116.8	564.0	15076.3	213.2	54.2	64.7
	mean	28.9	22.9				502.5	7.1	1.8	2.2
Oct.	total	952.6	727.5	219	89.8	338.8	2870.1	216.6	72.5	145.8
	mean	30.7	23.5				92.58	7.0	2.3	4.70
Nov.	total	950.3	727.6	96.0	9.8	105.8	244039	209.6	78.5	502.6
	mean	31.7	24.3				81.35	7.0	2.6	16.8
Dec.	total	986.0	722.0	40.2	19.9	66.1	7725.78	217.3	123.3	162.5
	mean	31.8	23.3				87.93	7.0	4.0	5.2

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TABLE 6: 2014 METEOROLOGICAL DATA

MONTH		**TEMPERATURE**		**RAINFALL**			**WIND**	**MEAN COLD**	**EVAPORATION**	**SUNSHINE**
		Max.	**Min.**	**Optim.**	**Min.**	**Max.**	**Km**			
Jan.	total	1015.9	755.7	75.5	7.3	82.8	3158.84	217.3	120.5	151.4
	mean	32.8	24.4				101.90	7.0	3.9	4.9
Feb.	total	929.2	690.8	49.6	3.7	53.3	2658.79	196.0	118.6	68.0
	mean	33.2	24.7				94.96	7.0	4.2	2.4
Mar.	total	1030.6	758.6	87.1	43.3	130.4	3244.97	215.6	124.5	112.1
	mean	33.2	24.5				104.68	7.0	4.0	3.62
April	total	973.4	735.9	92.2	11.98	2120	3068.05	208.2	107.5	131.3
	mean	32.4	24.5				102.27	6.9	3.6	4.4
May	total	994.5	755.6	144.8	107.2	252.0	2786.89	216.6	98.6	156.4
	mean	32.1	24.4				89.90	7.0	3.2	5.1
June	total	919.5	715.8	153.4	66.9	213.1	2715.73	208.6	75.6	147.8
	mean	30.7	23.9				90.52	7.0	2.5	4.9
July	total	8916	730.9	153.6	120.4	274.0	2908.21	218.6	580	74.3
	mean	28.8	23.6				93.81	7.1	1.9	2.4
Aug.	total	865.6	709.3	18.7	220.5	407.5	3550.51	217.6	59.6	79.6
	mean	27.9	22.9				114.5	7.0	1.9	2.6
Sep.	total	870.5	690.9	239.3	128.8	368.1	2864.84	210.7	56.3	89.5
	mean	29.0	23.0				95.49	7.0	1.9	3.0
Oct.	total	939.6	730.7	269.3	95.7	365.0	2396.79	217	68.9	134.1
	mean	30.3	23.6				77.32	7.0	2.2	4.3
Nov.	total	966.0	711.9	111.0	49.6	160.0	2035.61	207.6	75.8	175.9
	mean	32.2	23.7				67.85	6.9	2.5	5.9
Dec.	total	1040.7	714.6	28.1	5.6	33.7		215.7	135.9	192.3
	mean	33.6	23.0					6.9	4.4	6.2

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TABLE 7: 2015 METEOROLOGICAL DATA

MONTH		TEMPERATURE		RAINFALL			WIND	MEAN COLD	EVAPORATION	SUNSHINE
		Max.	**Min.**	**Optim.**	**Min.**	**Max.**	**Km**			
Jan.	total	1061.8	688.7	26.5	00	26.5	3780.55	217	263.3	152.2
	mean	34.3	22.2				121.95	7.0	8.5	4.9
Feb.	total	1049.4	750.9							
	mean	33.9	75.0							
Mar.	total	1033.1	777.2	116.6	65.4	182.0	2799.80	215.6	107.8	127.6
	mean	33.3	25.1					7.0	3.5	4.1
April	total	1004.2	750.9	91.3	17.2	108.5	2030.07	210	108.8	128.0
	mean	33.5	25.0				67.7	7.0	3.6	4.3
May	total	991.6								
	mean	32.2								
June	total	911.6	723.4	142.2	158.0	300.2	2619.20	208.9	55.0	97.6
	mean	30.4	24.1				87.31	7.0	1.8	3.3
July	total	899.3								
	mean	29.3								
Aug.	total	875.3	720.5	166.9	49.6	210.5	3461.31	42.1	465	34.5
	mean	28.2	23.2				11.66	1.4	8.5	1.1
Sep.	total									
	mean									
Oct.	total	979.5	726.4	182.0	89.7	271.7	22.57.4	70	10595	130.7
	mean	31.6	23.4				72.82	2.3	342	4.22
Nov.	total	1004.1	735.1	30.6	22.6	52.6	199405	112.4	182	153.7
	mean	33.5	24.5				66.47	3.7	6.1	5.1
Dec.	total	1051.6	643.4	12.1	00	12.1	2842.18	217	340.6	179.8
	mean	33.9	20.8				91.68	7.0	11.0	5.8

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MORPHEMETRIC FEATURES OF IKPOBA DAM AND ONYAMI DAM

The morphometric features of Ikpoba and Onyami dams collected from Edo State Water Corporation in Benin City is presented in Table 8 and figure 1 shows their different locations in the state.

From the data collected, it was observed that the mean depth of the two lakes were 2.25m for Ikpoba dam and 9.5m for Onyami dam which shows that the dams are shallow. According to Kapetsky et al., (1984) small or shallow lakes are lakes with mean depth between 3m and 10m. And this shallowness can lead to high productivity if the dams are used for fish production. Mean depth is also attributed to the shallowness of water body and this contributes to relatively high productivity (Henderson et al., 1973). A reservoir with low mean depth will be more productive than a deep lake with high mean depth and the shallower the lake, the more the productivity hence, Ikpoba lake will be more productive than Onyami dam. Rawson (1955) also stressed that mean depth is the most important morphometric features of lakes and on its inspection shows that it depicits the extent of euphotic littoral zone. In addition, depth stratum of a lake allow adequate light penetration for the growth of planktonic algal which is fish food (Boyd, 1979). It is also a common knowledge that a lake with low mean depth does not serve as a “nutrient sink” in which seston settles temporarily or permanently as in Lake Tanganyika (Tanzania) on African lake with meromictic characteristics. Comparing the two lakes, fishing will be easier in Ikpoba dam and productivity will be higher because it is more shallow than Onyami dam.

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TABLE 8: MORPHO-METRIC FEATURE OF THE RESERVOIRS

ITEM	PROJECT SITE A IKPOBA DAM	PROJECT SITE A ONYAMI DAM
Year of Impoundment	1985/86; commissioned 1987	1971
Water Surface Area (Ha)	106.30Ha	93Ha
Location	5[32’N 6[15’E	6[15’N 6[45’E
Local Government Area	Oredo	Akoko-Edo
Ownership	Edo State Government	Edo State Government
Primary use of water	Supply of Drinkable water	Supply of Drinkable water
Catchment Area	1, 070, 000^2 (1, 070, km^2)	$6km^2$
Major Inflowing River	Ikpoba River	Onyami River
Major Out flowing River	Ikpoba River	Onyami River
Maximum Depth	3m	14.7m
Minimum Depth	1.5m	10.0m
Maximum Depth of Lake	2.25m	9.5km
Maximum Length of Lake	1.5km	1.5km
Maximum Width of Lake	700m	268m
Watershed type	Destroyed	Preserved
Vegetation type	Shrubs	No vegetation (Rocky)
Land use Around lake	Farming and excavation of soil	Farming

Effluent Discharge	None	None
Access to lake	Motorable/tarred	Motorable/laterite road

Source: Edo State Water Corporation

It was also inferred from the amount of rainfall that there will be high total dissolved solids due to run-off. According to Akinyemi (1987), the higher the total dissolved solids (TDS) the more fertile the bedrock which also infer the fertility of the lakes being considered. And the relationship between TDS and mean depth can be used to determine the potential yield of the lakes as follows:

Morpho-Edaphic Index (MEI) which according to Akinyemi (1987) provides the simplest and general estimates of potential yield in reservoir and lakes

$$MEI = \frac{\text{Total Dissolved Solids}}{\text{Mean Depth}}$$

Take water samples periodically and determine the TDS by evaporation and determine the mean depth by arranging equidistant depth readings for minimum number of lake sounding transects.

After doing this you obtain a value and this value is used to predict the yield by using the following equation. (Appendix 1)

Y = $23.281MEI^{0.447}$ (After Henderson and Welcomme, 1974)

Y = Prediction value for estimating fish yield

This gives you the yield/ha of the lake per annum,

From the TDS and mean depth relationship of the two lakes being considered, it can be seen that the potential yield will be high. Hence the need to carry out an estimation of the potential yield of the two lakes using Morpho-Edaphic Index. Furthermore, the ability to estimate fish production is very important in permitting management personnel to make a more accurate appraisal of the expected harvest from reservoirs.

TDS can also be attributed to the surface area of the water body, the smaller the surface area the higher the TDS (Boyd, 1979). Ikpoba dam has 106.30ha surface area and Onyami dams has 93ha surface are. When compared, it can be seen that Onyami dam will be able to retain more nutrients, leaching will be higher in Ikpoba reservoir due to the larger surface area. According to Boyd (1979), the smaller the surface area the lower the leaching.

These two lakes compare with Oyan reservoir in Ogun state which has a surface area of 4000ha, they have small surface areas but compare with reservoirs like Esa-Odo (Oyo state) with surface area 50ha and Oyun (Kwara state) with relatively small surface areas among other factors will be more

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productive than deep lakes with large surface areas (Jenkins, 1967; Rawson, 1955). Hence the shallowness and relatively small surface areas of these two lakes will make them productive.

The watershed of Ikpoba-dam is destroyed due to erosion pushing from both sides and soil excavation for building purposes while the watershed of Onyami dam is still preserved. The destruction of the water shed reduces the amount of water entering the lake due to high evaporation. It has been proved that the fluctuations of water level in reservoirs are not always injurious (Hulsey, 1957).

There is no effluent discharge into both lakes hence there is no pollution of which ever form. The land use around the lakes within $2km^2$ radius is farming for Onyami dam and farming and soil excavation for Ikpoba dam. It was discovered that the farmers do not use any fertilizer or insecticide spray on their farms. It was discovered by Boyd (1979) that ponds on row-cropped watersheds are often turbid with colloidal soil particles. The turbidity of these two lakes are not very high since the water bodies were still clear as at the time of this survey. The more the transparency of a water body the higher the penetration of light the higher the growth of phytoplankton which leads to an increase in fish production (Boyd, 1979).

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MANAGEMENT POLICIES FOR THE MAN-MADE LAKES FISHERY IN EDO STATE

The production of fish in reservoir usually increases over the pre-impoundment conditions. It is believed that fish production reflect the general fertility of reservoirs. This includes a number of processes, the leaching of nutrients and other elements from the soil; the decomposition of organic matter predominantly of plant origin flooded by rising water, the loss of nutrients locked up in the bottom sediments and reduction in the bottom fauna due to rapid sedimentation.

A decline of fish field in a reservoir is often followed by a recovery and stabilization at a new and lower level. The fish population and their food organism become naturally adjusted to the permanent basic fertility of the basin additional nutrients from the inflows and water shed run off. However, the productivity capacity may be different for each reservoir and will fluctuate from year to year in the same reservoir depending upon its water supply and the operation by other users.

In the man-made lakes in Edo state it was discovered that there were low landings which means that there is overfishing in the lakes and this is partly due to the flushing of the water occasionally. Overfishing has been characterized as the worst thing that can happen to a fishing community and it is also the heart of the problem of fisheries management in many fishing communities (Beddington and retting, 1984) low landings indicate either low fishing effort or overfishing (Gulland, 1970) and this could be due to intrinsic factors like persistent " wrangling" within the rank and file of fishermen and danger posed by other dangerous aquatic inhabitants (Bardach, 1978), overfishing in the man-made lakes in Edo-state is due to low productivity because of the occasionally flushing of water which of course carries along with it fish and fingering into river, hence the need for the formulation of management policies for the lakes.

Since the objectives of reservoir fishery management are to increase the yield and to maintain a steady harvest of fish at a level near the optimum productivity of the reservoir. These objectives can be realized through certain management practices. These practices fall into the following categories:

1. Involvement of fisheries scientist
2. Change in the reservoir operation
3. Assessment of stock
4. Regulation and control of fisheries

INVOLVEMENT OF FISHRIES SCIENTIST

Fish production in reservoirs is usually considered secondary to other uses of the reservoir hence fisheries biologists are not involved in the planning team with engineers before the impoundment of the lakes hence there are no pre-impoundment data and no knowledge of the biology of the fisheries. In the man-made lakes in Edo state it was discovered that the state water board was fully in charge of the reservoir hence is there is no regulation and control over the fisheries of the reservoirs. Information was also gotten from a staff of the department of fisheries of the Edo state ADP that they have not been welcomed into the place especially the Ikpoba dam and that attempts to go into it have always proved futile.

The government of the state should involve fisheries scientist in the running of the reservoir so as regulate and control the fisheries thereby increasing fish production and raising the protein level of the populace. The fishery scientist will be able to predict the potential fish yield of the reservoir and river basin. However, Kapetsky and petr. (1984) have suggested that the ability of fishery scientist to reliable predict the potential fish yield of the reservoir and river basin both above and below each of any alternative reservoir sites must be improved. The fisheries scientist will give information on the status of fisheries resources which Is required for planning for rational fishery management and for further fishery development. The fishery scientist should be involved in the daily running of the reservoir. Ita et al, (1982) supported this fact that fishery experts are not always consulted in the planning stage (since fishery is not the main objectives) so as to pave way for fishery interests. Hence, fishery problems are not usually considered in the engineering design or provided for in the basin development plans even when substantial fishery are economically visible, viable and accruable. Thus a great deal has to be done in the operation of the reservoir.

CHANGES IN THE RESERVOIR OPERATIONS

It was discovered that the primary purpose of the man-made lakes in Edo state is the supply of drinkable water. There should be a change in the reservoir operation so as to include fishery as one of the main objectives from the results of the survey it was discovered that the two man-made lakes have the potential for substantial fisheries which can be economically visible, viable and accruable.

Reservoir fishery yield potential is affected by dam design and by reservoir operation, for example, the amount of drawdown can affect littoral biological production as well as the efficiency of fishing. This was supported by Kapetsky and Petr (1984), evidence was presented which suggests that there is a leeway in reservoir operation for optimizing fisheries without jeopardizing the reservoir ability to produce electrical power or water supply. They further stressed that this kind of manipulation should therefore be applicable to existing reservoir fisheries.

More should be known about the effects of drawdown (timing, rate, magnitude) on types of species which will successfully inhabit the reservoir, and on the relationship of the timing and size of "stimulated" floods downstream to the potential of fisheries in the river and on floodplains below the dam, this could be the work of a fishery expert.

Lagler, (1969) has observed that major interdisciplinary investigations in co-operations with the United Nations Development Program (UNDP) on major lakes in Africa began essentially, as salvage operations by the countries involved. These operations were post-impoundment ones. Sagua, (1983) declared that because of its wide disciplinary mandate and restricted ecologically defined coverage , Lake Chad Research Institute (LCRI) and Kainji Lake Research Institute (KLRI) are not able to cover the inland fisheries (especially man-made lakes and major rivers) of 12.05 million hectares of water mass. He stressed further that KLRI has mandate for man-made lakes and major rivers. He then questioned, 'what of other smaller lakes like Ikpoba dam and Onyami dam, and Mirror Rivers of the country; who does the fishery research on them'. He asked further 'No one has special responsibility' he lamented'.

Thus in smaller man-made lakes like the man-made lakes in Edo state, a great deal has to be done in resource inventory survey that is estimating the existing stock and the potential stock.

ASSESSMENT OF STOCK

There is need for a periodic or continual post-impoundment fishery resource evaluation so as to know the actual and potential yields of the fishery in order to be able to apply the appropriate management

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tool at the right time. According to Kapetsky and Petr, 1984 stock assessment carried out by sampling techniques, explosive grids, applied in littoral areas have proved efficient.

Potential yield is regarded as a prediction of the probable maximal level of yield that will be attained in a specific self-renewing resources, given a rate of development intended to reach this maximum in a relatively short period of time (Henderson et al., 1973) Thus assessment of fishery resource has two main phases:

i. The initial evaluation of a stock on fishery aimed at determining it approximate potential
ii. The monitoring of the resources to gauge the effect off fishing practices and management policies.

METHOD FOR ESTIMATING POTENTIAL FISH YIELD

There are various methods available for estimating potential fish yield some of which are highlighted below:

1. **Exploratory Survey**= **The Gulland Model.**

From exploratory surveys, Gulland (1970a) estimated potential yield from:

Ye = X.M. Bo

Ye = Potential Yield

X = a factor which probably lies between 0.3 and 0.5

M = Estimate of natural mortality

Bo = Ichthyomass of stock.

This equation is particularly appropriate at the first stage of a developing fishery. This approach was used in Lake Victoria in East-Africa. It was known that inshore stock were being heavily exploited, but suspected that large mixed stock of Haplochromis existed off shore which might be exploited by trawling. A program of exploratory trawling was carried out based on over 1200 hauls distributed over the showed a distinct distribution pattern by depth of the major species in the lake. The Haplochromis species complex was found to be eurybathic and constituted most of the total biomass or demesal species which was 100kg/ha.

Assuming X=0.4 and M=0.8, the potential yield of Haplochromis was estimated at 30kg/ha or 200,000 metric tons/year as compared with the inshore harvest of about 100,000 tons/years (welcome, 1972).

Gulland (1971) also derived an approximate formula from models propounded by Berverton and Holt (1956), Schaefer (1954) for more or less a virgin stock which can be used when available data on the stock of certain area are insufficient for detail assessment.

Gulland showed that potential yield can be estimated from: Py = Mo.5Bv

Where: B = the virgin standing stock (biomass)

M = estimate of natural mortality.

This formula is based on the following assumptions;

i. Recruitment remains more or less constant even under high levels of fishing mortality.

ii. That no growth overfishing occurs even at high models levels of fishing mortality from the simple Schaefer models (1954).

iii. Virgin biomass Bv is equal to the carrying capacity for the stock in question.

iv. MSY is when harvesting at the MSY fish mortality (f) is roughly equal to the natural mortality (m).

2. Spot Poisoning

Estimates of fish production have been made by many workers using fish poison like Rotenone, to sample blocked coves or enclosed sample areas. This method is attractive for obtaining direct estimates of standing stock and simultaneously estimated mortality and product in many assumed and this latter provides a seemingly direct approach to estimate potential yield. This method was used by Ita et al (1982) for estimating potential fish yield of Gorronyo reservoir.

3. Morph-edaphic Index

It has been established that the mineral contents of the water expressed as total dissolved solid (TDS) (Alkalinity or conductivity) can be used as a rough indicator of the edaphic conditions which play a fundamental role in determining the biological productivity of reservoirs or lakes. Ryder (1965) developed an index called Morph-edaphic index (MEI) which has been found every useful in predicting fish yield in both temperate and tropical lakes. The morph-edaphic index is expressed as follow:

$$MEI = \frac{\text{Total dissolved solids} \quad (Mgl^{-1})}{\text{Mean depth (m)}}$$

The MEI is an empirical formula that was first describe as a convenient method for rapidly calculating potential fish yield. It has been applied successfully to sets of lakes (Akinyemi, 1987).

The mean depth is obtained by obtaining by dividing the volume of the lake by its area when such data are available but when lacking, a reasonable approximation of mean depth can be obtained by averaging equidistant depth reading for a minimum number of lakes surrounding transects.

TDS is a correlate of nutrient levels (Edaphic factor) and this is gotten by evaporating a known of water and weighing the substrate. The significance of MEI is that it is usually applied when a first approximation of fish yield is being made where specific data on historical catch and effort are lacking for precise estimate.

MEI has been used since after Ryder's work in (1965) as a management tool in Canada and United states, and has been of wide application for fish yield in Africa and south America (Jenkins, 1970). Henderson and welcome (1974) predicted the following yield function for African lakes.

$$Y = 23{,}281\ MEI^{0.447}$$

After Ryder's formula (1965), Schlesinger and Regier (1982) gave 3 useful relationship based on tropical and temperate lakes, with the mean temperature included as a parameter (+)

i. Logy = 0.61 Tm.0.43
ii. Logy = 0.050 Tm + 0.280log MEI + 0.230 ……………
iii. Logy = 0.044Tm + 0.482log MEI_{25} + 0.021 …………….

In (iii) the MEI was calculated with 25m as the maximum for mean depth because mean depth greater than 25m have a limited effect on fish production (Rawson, 1952 and Oglesby, 1977).

There should be an assessment of the stock of the man-made lakes in Edo state using any of the above methods. Having carried out stock assessment and there is high potential for fish yields compared to the actual catch in the man-made lakes in the state, then something should be done about the stock and this can be carried out by stocking the lakes.

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STOCKING

Tropical forest reservoirs are relatively unproductive and are depauperate in fish fauna, hence, the introductions of fishes and in some cases continual stocking, may be the most appropriate method (Kapetsky and Petr, 1984).

Fish stocking has proven to be one of the most successful tangible tools in reservoir fishery management (Jenkins, 1961). Indigenous species or exotic species could be stocked in a reservoir depending on certain circumstances and purposes. The introduced fish should be fast growing, be able to breed in confinement, have its feeding habit related closely to the base of the food chain or food available in reservoirs, and be finally accepted by the people (Adesanya, 1969).

The purposes of stocking or introducing fish to reservoirs according to (Bhukaswan, 1980) include the following:

a. To utilize ecological niches to which none of the existing species are adapted.
b. To increase fishing success to be more desirable in the fisheries.
c. To provide a source of food for sport and commercial species.
d. To control aquatic weeds.
e. To provide more food fish.
f. To curb unemployment through fishery development.

In order to maintain and improve this stock, the fisheries must be regulated and controlled.

REGULATION AND CONTROL OF FISHERIES

The essence of fishing regulations and controls is to ensure the management of reservoir fisheries to give maximum sustainable yields of desired species and to prevent overfishing that could result in the extinction of desired species. To achieve this aim the following measures are taken:

1. Closed Areas and Seasons

The aim of this measure is to increase fish yields by increasing recruitment and reducing fishing mortality. This is achieved by declaring certain areas closed to fishing especially grounds of valuable fishes during the spawning season and the feeding sites of fingerlings resulting from spawning, The prevention of fishing in these areas and season disallows growth and recruitment overfishing. Several factors must be considered before this measure is applied and these factors include species composition of fishes, their life history, fishery activities and types of fishing gear used, climate fertility of impounded water and so on.

2. Size Limitation

The establishment of minimum size is considered an important control measure, particularly for fishes whose reproductive capacity is low. Thus a limiting minimum size will not only protect immature fish, but should be large enough to protect first spawning fish (Bhukaswan, 1980). The application of this measure must be considered carefully in reservoirs where the fisheries depend on multi-species of fishes because it is impossible to set a proper size limit suited for all species.

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3. Limitation of Entry

This includes restriction on the number of the fisherman and fishing and fishing gears, imposition of quotas, taxation, and licensing. These measures aim at promoting the conservation and the sustained yield management of fishery resources since it not only allocates the resource but also affects the size of the harvest. The restrictions on the number of fisherman and gears will directly reduce the total fishing effort. Quotas will shorten the fishing season by establishing a total allowable catch for a given period. This practice will arrest overfishing and lead to the recovery of only depressed stocks. Taxes and license will result in a reduction of fishing pressure and help protect the fish stocks from overfishing and depletion (Bhukawasan, 1980).

4. Prohibition of Destructive Fishing Methods

This involves the prohibition of or limits on the use of damaging methods and gears and implements, or mesh size limits (Dill and Pillay, 1968). Such restrictions are necessary when increased fishing effort will affect recruitment. Use of poisons and explosives must be prohibited. Since they are likely to indiscriminately kill fish without regard to species and sizes, endangering the existence of the fish stock, and providing at one time more fish than can be consumed. They are also likely to cause other and often long-lasting damage to the local ecosystem (Gulland, 1979).

5. Information Link

The resources information should be made available in a usable form for the various use groups. Where commercial fisheries are to be developed direct liaison of the commercial entities with the resource people can be useful for fishery planning e.g. the passing on the commercial fishermen of information on fish distribution and forecasts of future fish abundance can increase the efficiency of fishing and allow for expansion and contraction of fishing effort as required. In the case of reservoir littoral (artisanal) fisheries two ingredients for successful management are good public relations and political back up which can be transformed into legal power. Both of these depend on frequent contact either with fishermen or with government authorities.

CONCLUSION

The objectives of reservoir fisheries management are to increase fish yield and to maintain a steady state harvest of fish at a level near the optimum productivity of the reservoir.

The man-made lakes Edo state though at the level of overfishing due to the occasional flushing of the water leading to the loss of fish and fingerlings, the rivers have potentials for substantial fish production if properly managed.

RECOMMENDATIONS

For effective usage of the man-made lakes in Edo state for fishery, the following should be embarked upon:

1. There should be an assessment of the stock using spot poisoning and morph-edaphic index methods of estimation of potential yield.
2. More input is necessary into the evaluation of both the biology of species and fishing technologies for the optimal use of the stock.
3. The lake should be stocked with domesticated ad semi domesticated fish like Tilapia spp., and Clarias gariepinus (common to both lakes) in the ratio of 1:3 annually or seasonally. The purpose of this is to harvest the fast growing introduced species together with resident fishes. Bigger fingerlings coupled with selective restocking finishing would give a high fish yield.
4. Reservoir fishery regulations should be embedded in the Edo state's fisheries edicts and regulations.

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5. Fishery staff recruitment from the Ministry of Agriculture and Agricultural development Program of Edo state to enforce and implement these regulations for proper management of the stock.
6. After stocking the reservoir should be close to fishermen so as to prevent them from exploiting the introduced fishes. The aim is that within a few years after dam closure reservoir productivity will peak.
7. Continuous monitoring of fish population is essential for sound management and fisheries scientists must continue to work in close co-operation with those responsible for water levels because water level adjustment could be a powerful management tool.

For reservoir fishery benefits in Edo state to be realized, lines of communication and implementation of policy has to be effected.

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