SOCIO-ECONOMIC APPRAISAL OF CAGE FISH CULTURE IN OGUTA LAKE, NIGERIA

BY PETER U. OKORIE
Department of Animal and Environmental Biology,
Imo State University, P.M.B. 2000, Owerri,
Nigeria.

ABSTRACT

Oguta lake is one of the largest natural lakes in south-eastern Nigeria. Traditionally, its fisheries support a large number of full-time and part-time fishermen with their families. However, in recent years, like most other capture fisheries in Nigeria, fish yields have either been declining or stagnating. Fish stocks in the lake have for long been subjected to over-fishing and use of wrong fishing methods. The paper proposes large-scale introduction of cage fish culture in the lake as a practical means of reducing fishing pressure on the lake as well as providing a sustainable means of livelihood for the local population around the lake. Limnological characteristics of lake are described to appraise the feasibility of cage culture in the lake. Recommendations are made on the design, choice of materials, construction and management of cages in the lake. Cost-benefit projections based on prevailing market prices are presented.

INTRODUCTION

With a surface area of over 300 ha (Ita and Balogun, 1983), Lake Oguta is the largest natural lentic system in the Imo river basin of southeastern Nigeria. The lake is of a rich ichthyofaunal taxonomic composition, represented by 28 fish families with over 91 species of teleosts. This large diversity of fish fauna has been attributed to the lake's close association with the major rivers in the area (Rivers Orashi, Njaba and Awbana) and the River Niger at its lower course (Nwadiaro, 1989).

Oguta lake fisheries is a substantial means of livelihood for hundreds of full-time and part-time fishermen and their families using a wide variety of fishing gear including gill nets, cast nets, hooks, traps, spears and sometimes explosives. It is a generally accepted view that yields from most capture fisheries in Nigeria are stagnating (Jamu and Ayinla, 2003). Oguta lake is not likely to be an exception to this general trend, considering the past (Ita and Balogun, 1983) and present (ISPEDC, 1999) records of high population densities of potential fishermen around the lake and the corresponding high fishing pressure on the lake. If this fishing pressure is allowed to continue, the fish yields from the lake will go into decline (if it has not already done so) with adverse short and long term ecological implications.

There is a need for shift of focus from wild fish capture to a more organized fish culture in the lake. When compared to similar lakes in the region, Oguta lake has received considerable research attention. Such studies include works on biology of fish species (Okorie, 1984; Nwadiaro and Okorie, 1987), morphometric, physical and chemical characteristics of lake (Nwadiaro and Umeham, 1985) and feasibility report on the fisheries development potential (Ita and Balogun, 1983). There is thus ample technical information to chart the future course of development of the lake.

Though the lake offers substantial opportunities for fish culture in cages and enclosures, this paper is restricted to cage culture. Cage culture is not

new in Nigeria. The problem is that the practice has remained at the experimental level for over two decades in Nigeria. There are encouraging studies (Otubusin, 1989; Otubusin and Olatunde, 1992) on the viability of cage culture in Nigeria, but these scientific contributions have not yet translated to large scale cage culture either at the subsistence or commercial levels. In other countries of similar socio-economic standards, cage culture has provided spectacular opportunities for creation of employment and large scale fish production. In Philippines, for instance, large scale tilapia/milk fish culture in cages is carried out in Lake Laguna (900 km2 surface area) based on industrial and domestic effluents of over 6 million inhabitants of Manila, the capital city. One of the likely reasons for the failure to popularize cage culture in Nigeria is that the idea has not been properly sold to potential farmers, especially in terms of economics of production. This paper appraises the feasibility and commercial viability of large scale introduction of cages in the lake both for subsistence and commercial fish production.

LIMNOLOGICAL CHARACTERISTICS OF OGUTA LAKE

Oguta Lake is located between longitude 5o42' and 5o44' east and latitude 6o45' and 6o50' north and is situated at about 50 km north of Owerri, capital of Imo State, Nigeria. Fig. 1 shows the map of the lake with the Njaba and Awbana rivers. The lake empties into River Urashi. During the colonial days the lake served as an inland port for the evacuation of palm produce to Port-Harcourt. Relics of landing jetties and produce wharehouses are still present around the lake.

Oguta lake covers a maximum surface area of about 1.80 km2 during the dry season and 2.48 km2 during flood season peak in October. The lake basin is very shallow (9.30 m at the peak of flood and 7.0m maximum in the dry season) with an average depth of 5.5m. Two flood regimes occur corresponding to the 'white' and 'black' floods in July and October respectively, and the annual drawdown is about 2.0m (Nwadiaro, 1989). As in most humic acid rich waters of the southern Niger delta, the conductivity is very low (8.6-16.5 us cm-1), lower than that of Lake Kainji in the north which has values in the range 45-50 □s cm-1. This low conductivity of Oguta lake is also reflected in the low cation concentration and alkalinity of the water. Apart from orthophosphates, the nutrient ions (nitrate and silica) are generally adequate Nwadiaro, 1989). Sodium and calcium, rather than calcium and magnesium as in Lake Kainji (Balogun, 1987), dominate the cations of Oguta lake. Details of morphemetric, physical and chemical characteristics of Oguta Lake are shown in Table 1.

Limnological features of Oguta Lake of special interest in cage culture include the relatively large surface area, the low depth, substantial length of shoreline and high dissolved oxygen content. The lake has a surface area of over 300 ha where, potentially, various forms of cage culture is possible. The lakes shallowness is also an advantage. Furthermore, the lake has a shoreline of 10.63 km length thus offering considerable opportunities for installation of cheaper standing cages. In view of the high stocking rates in cages, dissolved oxygen content is a critical consideration for cage culture. Oguta lake is, on the average, adequately oxygenated all year round (range in percentage saturation, 42-) 87%) and throughout the water column. During

most of the year water flow is noticeable on the surface and bottom, with current velocities of up to 144 cm 5-1 on the surface and 91 cm5-1 on the bottom (Nwadiaro, 1989). Thus there is constant mixing and oxygenation of lake water.

FISHING PRESSURE ON OGUTA LAKE

Based on an estimated (Ita and Balogun, 1983) mean standing crop of 41.5 kg/ha, the total standing crop for the 300 ha surface could be approximated at 12.5 metric tonnes of fish. Assuming yield to be one third of the standing crop, the expected yield is about 4.3 metric tonnes. Interestingly, a similar yield is obtained when the estimates are based on Ryder (1965) morpho-edaphic index (ME1) i.e. total dissolved solid (or conductivity) divided by mean depth. Estimates based on ME1 give a yield of 15 kg/ha and a total yield of 14.5 metric tonnes per annum.

Based on a standing crop of 12.5 metric tones in the lake, if the fisheries were to be exploited optimally, the lake should cater for only 6 full-time fishermen. But Ita and Balogun (1983) showed that a total of 2,657 people were engaged in fishing activities on the lake, of which 2,403 (90.4%) were full-time fishermen while the remaining 154 (9.6%) were either assistant fishermen or part-time fishermen (Table 2). Table 3 is a list of fishing gear used on the lake showing that the commonest fishing gear was the gill net. Use of explosives was only noted in one village.

Though this fishing survey was done long ago, it is unlikely that the fishing pressure has lessened now. ISPEDC (1999) report showed a population of over 106,000 people in Oguta L.G.A., the immediate environment of the lake. The main occupation of the rural community is farming and fishing while a small percentage is involved in petty trading and canoe transport on the lake. The growing human population will thus likely reflect on an increasing number of potential fishermen trying to make a livelihood out of the lake

ECONOMICS OF CAGE CULTURE IN OGUTA LAKE

Cages for fish culture can have a wide variety of designs, sizes and choice of materials. Cages may be designed to stand on the water bottom or float, with cage sizes ranging from 1-100 m3. Walls of cages may be made with bamboo, sieve cloth, nylon or metal nets. Flotation of cages may be achieved in the old fashioned way using empty old drums while modern installations are kept afloat using styrofoam floats.

The economic analysis in this study is based on use of simple 1 m3 standing cages of 1.0 m x 1.0m x 1.25m dimensions. The frames are made of wood while nylon nets were used for the walls. A complex of ten (10) of such cages was considered a minimum economic unit. The choice of standing cages in this study is largely influenced by the long shoreline of the lake with its relatively shallow bays. Potentially, the approximately 10.63km shoreline of the lake can accommodate thousands of standing cages along its shoreline. Ideally, large complexes of floating cages are preferred for easier management in large-scale commercial cage culture. The constraint of using such floating cages for subsistence farmers is the extra cost of installing the floats. Preliminary observations in this study showed that installation of floats and access wooden platforms can raise the cost of cage construction by 50-150%.

The fish species of choice in this study is the catfish, Clarias gariepinus, because of its hardiness, adaptability of feeding habits, good growth characteristics, high market value, and availability of its fingerlings within the project

area.

Two crops of 20-30 kg fish/m3 each are possible in cages using high quality artificial feeds. However, use of such feeds is highly capital intensive and could constitute up to 40-60% of the total operating cost in intensive aquaculture (Coche, 1979). This study assumes a production of one crop of 20 kg/m3/yr based on use of such locally available and cheap agricultural wastes as palm kernel cakes, groundnut cakes, brewery waste, rice bran, maize bran and blood meal to feed the fish. Another basic assumption in the study is the use of a 5 years life span for the cages. Generally, the life span of nylon cages is 3-5 years. The upper limit of 5 years life span can be ensured by cleaning the cages regularly and avoiding direct exposure to sunlight.

Table 4 shows the capital and operating costs for ten (10) units of 1m3 cages in year 1 while Table 5 presents the cash flow projections for five (5) years. Daily management procedure such as feeding fish and cleaning cages is not time consuming and can be accommodated within normal household activities on part-time basis. Thus, apart from labour costs of constructing cages, no other provisions have been made in this study for labour costs. Except for initial operating loss in year 1 as a result of high capital investment, other years (ii-v) show encouraging profit margins (Table 5). In year II, for instance, there is a net profit of N32,050.00 for the ten (10) cages. This translates to a net profit of N3,205.00 (USD 24.00) for 1m3 of cage culture in a year.

CONCLUSION

A yearly net profit of over N3,200.00 (USD 24.00) per cubic metre of cage culture is an attractive business enterprise, higher in economic returns than any other agricultural activity within the study area, and highly significant in a country where GNP per capita income is below USD 300.00. Cage culture in Oguta lake has the potential to contribute to rural incomes, generation of employment and fish production. The system is particularly suited to the rural poor who do not have access to land for any other form of agricultural production.

From the ecological perspective, it is obvious that cage culture will achieve a more efficient utilization of the lake than continued over-fishing of an already depleted fish stock in the lake. For instance, the estimated maximum sustainable yield (MSY) of 4.5 metric tonnes in the lake is equivalent to the fish output of just 225 m3 of intensive cage culture. Potentially, a total fish production of about 600 metric tonnes in the lake if as much as 1% (3 ha) of the lake is placed under intensive cage culture.

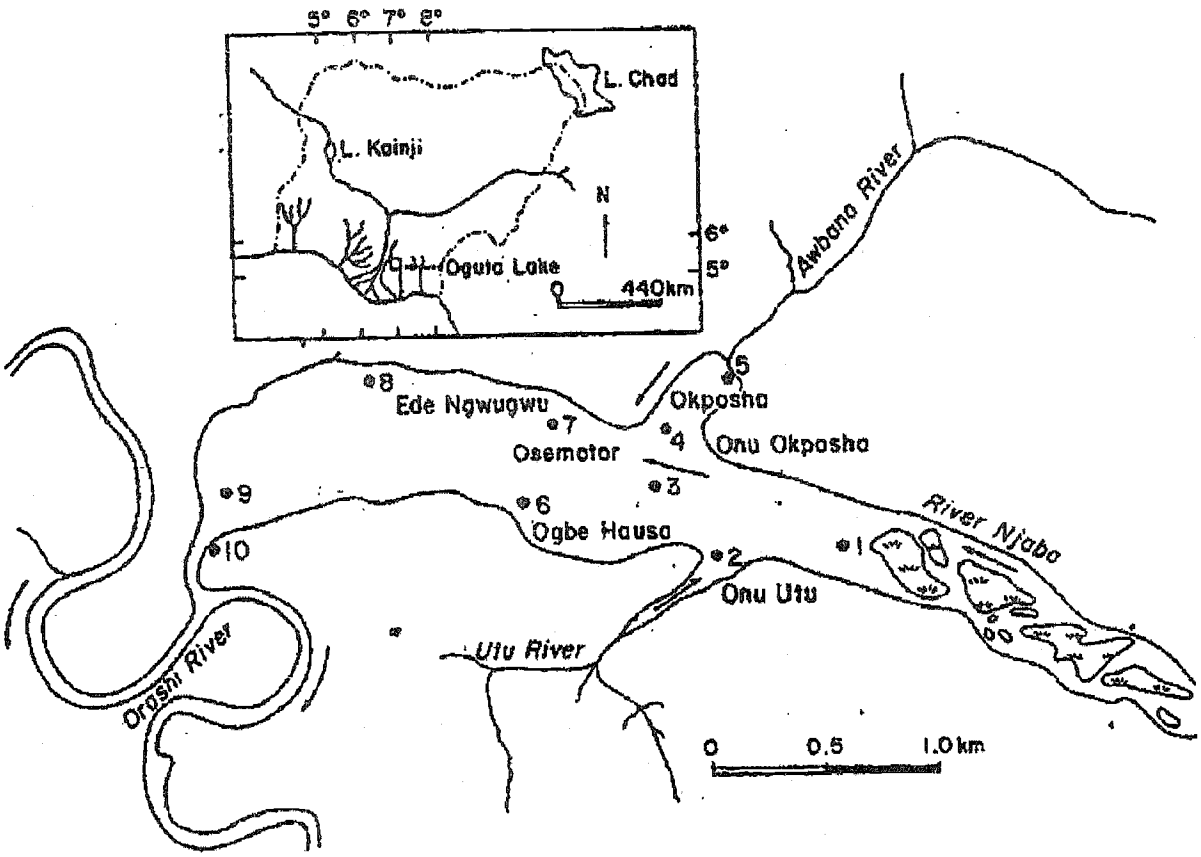
To ensure a large-scale adoption of cage culture and enhance its economic sustainability in the lake, government can play the following roles:

a) Re-invigoration of Oguta indoor hatchery: Cage culture requires high stocking rates of fingerlings. Stocking of cages in just 1% of the surface area of the lake will require a minimum of 1.5 million fingerlings yearly. The government-owned indoor hatchery in Oguta needs to be reinvigorated to meet the expected high demand for fish fingerlings. While interest has focused on production of Clarias and Heterobranchus fingerlins, there is need also to produce planktivorous species like Sarotherodon galilaeus which can give good yields in wastewater, with or without supplementary feeding.

b) Rehabilitation of Njaba river: The major inflowing river to Oguta Lake

is Njaba river. This river is now at an advanced stage of siltation which is having adverse hydrological influence on Oguta lake. With time, the lake will progressively get shallower and smaller. There is urgent need to disilt Njaba river and stop all forms of deforestation within at least 50 m of its banks.

c) Extension Services: There is need for an aggressive extension effort to disseminate information on establishment, management and profitability of cage culture.



approximate position of the lake

Table 1: Morphometric, physical and chemical characteristics of Oguta lake.

Characteristics	Values
Morphometric & Physical	
Total surface area	**1.796 km ^{2}**
Maximum length	**3.0 km**
Maximum breadth	**0.75 km**
Mean breadth	**0.60 km**
Maximum depth	**8.0 m**
Average depth	**5.5 m**
Relative depth	**0.27 m**
Length of shoreline	**10.63 km**
Shoreline development	**1.14**
Temperature	**26.0-31°C**
Secchi disc transparency	**0.61-4.50 m**
Chemical	
Phosphate – phosphorus (total)	**0.01-0.68 mg l^{-1}**
Nitrate-nitrogen	**0.17-2.24 mg l^{-1}**
Silica, SiO_2	**2.76-26.76 mg l^{-1}**
Conductivity	**8.6-16.5 is cm $^{-1}$**
Dissolved oxygen (surface)	**3.40-6.95 mg l^{-1}**
Biochemical oxygen demand	**0.11-2.60**
pH	**5.1-6.4**
Total alkalinity (ppm $CaCO_3$)	**7.5-25.0**

(Source: Nwadiaro and Umeham, 1985).

Table 2. Census of fishermen on Oguta lake

No of Villages	Owner fishermen	Assistant fishermen	Part-time fishermen	Total
52	2,403	167	87	2,657

(adapted from Ita and Balogun, 1983).

Table 3: Distribution of fishing gear in 52 villages on Oguta lake

Fishing gear	Distribution (%)
Gill net	96.2
Cast net	69.2
Hooks	84.6
Traps	65.4
Spear	9.6
Spear	9.6
Dynamite	1.9
Floating nets	7.7

(adapted from Ita and Balogun, 1983).

Table 4 Capital and operating costs for 10 x 1m3 cage culture for year 1.

Sub-head	Material	Cost (N)
Capital costs	Wood	11,160.00
	Nylon mesh (25.4 mm)	13,200.00
	Nails etc.	1,400.00
	Labour (80 man hrs @ N1500.00/man hr	15,000.00
Sub-total		40,760.00
Operating costs	Fingerlings (stocked at 50 fish/m^3 @ N12.00/fish).	6,000.00
	Feeding	22,500.00
	Repairs	1,000.00
Sub-total		29,500.00
Grand total		70,260.00

Table 5: Cash Flow Projections for 10 x 1m3 cage culture for five (5) years

	Years				
	1	2	3	4	5
	= N	= N	= N	= N	= N
Capital costs	40,760 -	-	-	-	
Operating costs					
a) Fingerlings	6,000	6,300	6,620	6,950	7,300
b) Feeding	22,500	23,600	24,800	26,050	27,350
c) Repairs	1,000	1,050	1,100	1,160	1,210
Sub-total	29,500	30,950	32,520	34,160	35,860
Grand total expenditure	70,260	30,950	32,520	34,160	35,860
Fish price index					
Clarias	300.00/kg	315.00	330.00	350.00	365.00
Gross income from sales	60,000.00	63,000	66,000	70,000	73,000
Profit/(loss).	(10,260)	32,050	33,480	35,840	37,140

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