SHORT COMMUNICATION

FISH PRODUCTION ESTIMATES FOR GBEDIKERE LAKE, BASSA, KOGI STATE, NIGERIA

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ABSTRACT

Annual estimates of the fish caught by local fishermen in randomly selected fishing villages adjacent to Gbedikere Lake were determined using Catch Assessment (CAS). The studies were carried out within two seasons of low water (February) and high water (September) periods between 2006 and 2008. Annual fish catch varied from 537.4 mts to 576.9 mts at high water. Mean catch per boat ranged from 7.40 kg to 10.60 kg among the landing sites. A total of 12 fish species were identified belonging to ten families. The catches were dominated by cichlids with *Orechromis niloticus* dominating the overall catch compositions. Production estimate was compared with the catches obtained through experimental gill-net sampling and potential fish yield estimates using Ryder's Morpho - Edaphic Index (MEI) as modified by Henderson and Welcomme (1974). Contributions of the gears in use were also done with cast nets ranking above others (29%), followed by the set net (25%), hook and lines (16.6%), traps (16.6%), clap net (8.3%). Management measures were suggested.

INTRODUCTION

Lakes are invaluable ecological resources that serve many human needs and, therefore, enhance our lives by providing a lot of opportunities. This explains why a large proportion of Nigeria population lives near water bodies such as lakes, reservoirs, rivers, swamps and coastal lagoons. Many depend heavily on the resources of such water bodies as their main source of animal protein and family income (Haruna et al., 2006).

Catch Assessment Surveys (CAS) are conducted to obtain reliable current estimates of the total quantity of the fish harvested by fishers. Species composition and fishing effort involved in the catch are considered as secondary objectives while frame surveys among other things provide reliable estimates of changes in the size and structure in the fishing industry over time. Bazigos (1972) studied the yield pattern at Kainji Lake using CAS just as Moses et al. (2002) also used catch assessment method to estimate catches for the artisanal fisheries of south-eastern Nigeria.

CAS could also reveal whether a lake has been overfished or is being underfished. Coulter (1988) found that Lake Tanganyika was underfished in his assessment of the pelagic fish biomass of the lake. Ryder and Henderson (1975) also estimated the potential fish yield for Nasser Reservoir in Egypt using catch assessment and found little evidence to support overexploitation of the stock.

This study describes the fish production in five communities located along the shores of Gbedikere Lake, as well as the contribution of various gears employed for fishing.

MATERIALS AND METHODS

Frame surveys were carried out involving the count of all the fishing villages, number of fishermen, boats and fishing gears after the methods described in Apeloko and du Feu (1995) and Bankole and

Mbagwu (2000). Physico-chemical parameters for the lake were obtained using standardized methods as given in APHA (1980). Fish production was estimated using CAS (Bankole and Mbagwu, 2000).

The catch assessment surveys were carried out six times. These were conducted in 3 randomly selected villages among the ones identified from the frame survey. Daily records of catches for six fishermen for 3 days each were obtained once for a low water period and a high water period of 1998, 1999 and 2000. This was done to determine fish abundance by species, weight, catch per boat and overall fish production for the entire lake as stated earlier.

Production estimate was compared with catches obtained through experimental gill-net sampling, as well as potential fish yield estimates using Ryder's Morpho-Edaphic Index (MEI) as modified by Henderson and Welcomme (1974) using conductivity, Toews and Griffith (1979) using conductivity and Schlesinger and Regier (1982) using Total Dissolved Solids (TDS) in the MEI models. These are given by:

(1) Henderson and Welcomme (1974)

$Y = 14.3136 \, MEI^{0.4681}$

Where MEI is $\dfrac{Conductivity}{Mean \, Depth} \, or \, \dfrac{Total \, Dissolved \, Solids}{Mean \, Depth}$

(2) Toews and Griffith (1979)

$\text{Log } Y = 1.4071 + 0.3697 \text{ Log } MEI - 0.00004565 \, A_0$

Where A_0 = Lake area in km^2

(3) Schlesinger and Regier (1982)

$\text{Log } Y = 0.050 \, T_m + 0.280 \text{ Log } MEI + 0.236$

Where T_m = Mean Temperature.

RESULTS

Physical and chemical parameters of Gbedikere Lake are provided in Table 1 and 2. Water quality parameters of temperature, pH, oxygen, conductivity, total dissolve solids and transparency showed that the lake exhibits a nutrient fair system.

The fish landing identified around Gbedikere Lake was Biroko, being the only location where all the fishermen landed their respective catches. Generally, fewer numbers of fishers and boats were recorded between 2006 and 2008.

Fishers' population was 55, 50 and 48 in 2006, 2007 and 2008, respectively (Table 3). This shows a declining trend. The general decline could be attributed to the tenancy nature of the lake coupled with the migratory nature of the fishers. The fishers are constantly on fishing migration when informed of an improved fishing ground. The lake (6.75 ha)

is grossly underexploited with only one fisherman given the $1^{1/2}$ or 2 fishermen per km^2 recommendation by Henderson and Welcomme (1974).

Table 1. Physical characteristic of Gbedikere lake (ADP, 1995)

PARAMETER	VALUE
Average annual run – off (m^3)	1.50×1.0^8
Type of lake	Natural lake
Crest elevation(m)	31.50
Crest length (m)	1.0
Dead storage level (mAMSL)	50
Top width (m)	4.50
Maximum base width (m)	15.0
Maximum height (m)	1.50
Total storage capacity (m^3)	0.50×1.0^8
Dead storage capacity (m^3)	1.50×1.0^6
Active storage capacity (m^3)	0.70×1.0^8 @50m AMS
Surface Area (ha)	6.75
Spillway width (m)	0.70×2
Spillway level (m)	50.10
Spillway type	Free flow
Mean depth (m)	12.00-15.00

Table 2. Monthly water quality parameters for Gbedikere Lake from 2006 to 2008

Parameter	Mean±sd	Range
Surface Water Temperature °C	27.50 ± 0.05	26.00 -29.00
pH	6.55 ± 0.12	5.08 - 8.02
Conductivity (μmhos/cm)	14.07 ± 11.08	0.04 - 49.19
Dissolved Oxygen (DO_2) mgL^{-1}	8.65 ± 1.08	6.10 - 19.85
Total Dissolved Solid (TDS) mgL^{-1}	19.33 ± 10.09	13.00 - 45.00
Water Transparency(cm)	26.60 ± 8.17	8.00 -68.7

In the fishermen's landings fish from 10 families were recorded. These include Osteoglossidae, *Heterotis niloticus* (Linnaeus, 1762); Cichlidae, *Oreochromis niloticus* (Linnaeus, 1758) and *Tilapia zilli* (Gervais, 1848); Clariidae, *Heterobranchus bidorsalis* (Geoffrey Saint – Hilaire, 1809; Citharnidae, *Citharinus citharus* (Geoffrey Saint – Hilaire, 1809); Gymnarchidae, *Gymnarchus niloticus* (Linnaeus, 1758); Protopteridae, *Protopterus annectens* (Owen, 1883); Mochokidae, *Synodontis nigrita* (Valenciennes, 1840); Clariidae, *Clarias gariepinus* (Burchell, 1822); Cyprinidae, *Labeo senegalensis*; Mormyridae, *Mormyrus rume* (Valenciennes, 1846); and Malapteruridae *Malapterurus electricus* (Gmeiin, 1789).

The highest fish landing was 21,721.5 kg recorded in January 2007, 21,655.4 kg in February 2007 and 20,216.3 kg in December 2006. These form 38.6%, 38.5% and 35.9%, respectively. Cichlidae dominated the catches constituting 30.91%, followed by *H. niloticus* (15.56%) and *C. gariepinus* (13.16%), while

Table 3. Frame assessment result showing the distribution of fishermen's boats and gears along the shores of Gbedikere Lake in September 2006, 2007 and 2008

Landing site	Type of fishing village	No. of fishermen						Types of gears				
		Boat owners			Assistants			Cast net	Set net	Hook and line	Traps	Clap nets
		2006	2007	2008	2006	2007	2008					
Biroko	Village	5	3	3	10	7	7	x	-	x	-	-
	Fishing camp	5	3	2	11	9	10	x	x	x	x	-
	Fishing camp	5	2	3	12	10	9	x	x	-	-	-
	Village	4	3	3	12	12	11	x	-	x	x	-
	Village	4	3	2	10	12	11	x	x	-	x	x
Total					55	50	48					

Table 4. Estimated landings (kg) from fishermen's catches for Gbedikere Lake for the low water period of 2006 –2007, February 2008

Species	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Total
Heterotis niloticus	27.6	22.6	30.3	24.5	24.4	28.4	20.5	31.3	30.0	54.4	46.7	50.3	391.0
Oreochromis niloticus	38.5	38.3	44.4	36.4	28.6	29.2	24.6	20.2	18.2	29.9	22.6	26.6	357.5
Tilapia zilli	10.2	10.7	13.4	11.3	13.6	15.7	17.3	16.5	14.4	13.2	14.6	11.3	162.2
Heterobranchus bidosarlis	7.3	15.4	23.2	19.5	15.4	12.8	22	19.6	17.9	20.8	23.6	18.6	216.1
Citharinus citharus	5.7	4.6	3.9	5.4	4.3	7.5	8.3	7.7	10.3	14.4	12.5	11.1	95.7
Gymnarchus niloticus	13.2	15.3	14.7	15.9	15.3	8.3	6.2	6.0	5.2	4.5	3.3	2.1	110.0
Protopterus annectens	6.3	4.7	5.1	5.0	4.8	2.5	2.2	1.7	2.3	2.7	1.8	2.1	41.2
Synodontis nigrita	7.9	5.7	6.9	7.4	9.6	7.8	9.3	7.8	8.7	9.2	5.8	6.3	92.4
Clarias gariepinus	19.8	14.2	29.8	22.6	18.7	16.7	25.8	23.7	18.6	20.3	17.3	17	244.5
Labeo senegalensis	2.3	3.9	2.0	3.5	4.1	3.2	4.5	5.7	5.9	7.8	6.3	5.8	55.0
Mormyrus rume	2.9	3.9	1.2	3.1	1.1	1.0	2.0	2.6	5.1	4.3	3.4	4.2	34.8
Malapterurus electricus	0.0	0.0	1.6	2.2	1.1	1.0	1.5	2.6	2.8	3.0	1.1	2.1	19.0
Total	141.7	139.3	176.4	156.8	140.9	134	144.2	145.4	139.4	184.5	159	157.5	1819.1
No. of boats sampled/day	6	6	6	6	6	6	6	6	6	6	6	6	72
No of boats sampled for 3days	18	18	18	18	18	18	18	18	18	18	18	18	216
Catch per boat (kg)	7.9	7.7	9.8	8.7	7.8	7.4	8	8.1	7.7	10.3	8.8	8.8	101

Table 5. Estimated Landings (kg) from fishermen's catches for Gbedikere Lake for the high water period of 2006-2008

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total
Heterotis niloticus	53.2	51.4	27.8	23.7	21.7	30.2	28.7	26.4	18.9	282.0
Oreochromis niloticus	34.7	45.3	40.4	42.1	41.9	34.8	40.9	42.3	38.2	360.6
Tilapia zilli	10.2	9.6	13.6	9.8	12.8	14.6	12.9	18.4	17.9	119.8
Heterobranchus bidosarlis	15.9	12.6	11.8	19.8	18.0	20.9	25.7	23.0	21.6	169.3
Citharinus citharus	9.4	14.9	8.9	8.2	7.3	11.7	13.3	12.6	16.3	102.6
Gymnarchus niloticus	6.6	8.9	14.8	18.6	20.4	20.9	14.5	12.5	10.4	127.6
Protopterus annectens	2.1	3.2	2.6	2.9	3.7	3.9	4.1	4.0	3.7	30.2
Synodontis nigrita	6.0	8.9	5.8	6.2	6.4	8.7	9.3	8.6	8.8	68.7
Clarias gariepinus	18.9	13.3	20.6	23.2	20.3	20.0	23.6	28.1	22.4	190.4
Labeo senegalensis	4.5	3.5	3.3	2.6	2.1	4.5	3.8	4.9	6.9	36.1
Mormyrus rume	4.0	2.7	2.3	3.1	4.4	3.5	6.4	7.7	6.9	41.0
Malapterurus electricus	1.0	1.0	0.0	0.9	1.1	1.0	2.0	2.6	2.0	11.6
Total	166.5	175.3	151.9	161.1	160.1	174.7	185.2	191.1	174.0	1539.9
No. of boats sampled/day	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	54.0
Total No of boats sampled for 3 days	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	162.0
Catch per boat (kg)	9.3	9.7	8.4	9.0	8.9	9.7	10.3	10.6	9.7	85.5

the rest altogether form 40.37%. The mean catch per month was 24.4% for Gbedikere Lake (Table 4 and 5).

Estimated landings for the whole lake during the low water period were 11.913.3 mts of fish, recorded in 2006. This declined to 6.449.2 mts in 2007 and 2008. For the high water periods the estimated landings were 7.580.3 mts in 2007, followed by 6.923.2 mts in 2008. In general, about the same amount of fish seemed to have been landed for both periods. These are evident in the mean catches for both 537.4 mts for low water and 576.9 mts for high water. A closer observation reveals that the trend for low water (February) showed a steady decline. The landing for low water of 2007 was 2165.5 mts, while in 2008 it was 1000.1 mts. These show a decline from 27.3% to 14.8%, respectively. The trend for high water (September) showed a sharp decline between 2006 and 2008. The trend is 16.6% in 2006 to 15.8% decline in 2008 due to poor catches within this period. Generally, small sized fish were caught at this time which could be attributed to growth overfishing. Growth overfishing occurs when the effort is so high that the total yield decreases with increasing effort. Thus the fish are caught before they can grow to a sufficiently large size that can substantially contribute to the fishery. Thus the mean annual yield obtained through Catch Assessment Surveys during the study was 240.2 mts. Catch per unit of effort was 24.4 kg ha^{-1} for the experimental gillnets. Estimated total catch from the experimental gillnets was 326.6 metric tons.

DISCUSSION

The result shows that the lake is overfished based on the statistics recorded for the year 2006, 2007 and 2008, as well as low fish catch. Catches are lower both quantitatively and qualitatively. This general decline observed in fish abundance on the lake could thus be attributed to the declining fish catch coupled with the declining number of fishermen. The fishermen are constantly on the move once they receive information about improved catches anywhere; they migrate to such a new 'greener pasture'. Reproduction is very vital to the sustenance, replenishment and progeny maintenance of every living organism. Fish stock is a renewable natural resource which gets replenished from incessant cropping by fishermen through reproduction. The conversation and survivability of any fish species depend more importantly on its reproductive potential. The Gbedikere Lake species are exposed to a daily vigorous harvesting regime by the fishermen. Yet the fish stock had been able to sustain itself even in the face of such onslaught through its resilience. This resilience is made possible through its reproduction potentials.

The number of fishermen recorded for the lake varied from 48-50. This is more than expected; the reservoir with a surface area of 9.6 km^2 ought not to have more than 1 fisherman at the recommended rate of 2 fishermen per square kilometer (Henderson and Welcomme, 1974).

The yield result obtained from experimental gill net catches was observed to constitute above 60% of the landings by all gears on the lake pooled together.

Thus the landings on the lake could be in the range of 326.6 metric tons of fish. This is not far from the overall mean landing of 240.2 metric tons obtained from CAS. It could therefore be said that the fish landing on the lake could be between 300 and 400 metric tons. This would fetch the lake a modest estimate of N24, 000,000.00 yr^{-1} at the rate of N80.00 per kg of fish. This is much lower than the earlier estimates of 870 mt yr^{-1} obtained in Bankole and Mbagwu (2000). However, this production is more than the predicted potentials obtained using the various predictive models above. In a similar study around the southeastern area of Nigeria, Moses et al. (2002) obtained a mean catch per boat of over 6000 kg from the artisanal fisheries. However, the study by Moses et al (2002) covered a much wider area and included tributaries of major rivers.

The catches on Gbedikere Lake showed a dominance of cichlids, particularly *T. zillii* and *O. niloticus*. These were followed by *H. niloticus* and *C. gariepinus* in abundance. Apart from the *C. gariepinus* that reflected promising sizes, the catches generally showed small sized fish, even though most of the species could attain bigger sizes.

To conserve the fish resources, there is the need for intervention through enforcement of the state fishery edict, especially in the area of harvesting small sized (juvenile) fish. This could be done through a community based management approach. This approach will engender/involve a close cooperation among the stakeholders, i.e. the government of the state, the fisher folks and the local community. Once this cooperation is achieved it would be easier to manage the fishery at a sustainable level and the anticipated contribution of the lake to the fish production of the North Centre zone of Nigeria would be achieved.

Sažetak

PROCJENA PRODUKCIJE RIBA U JEZERU GBEDIKERE (BASSA, DRŽAVA KOGI, NIGERIJA)

Godišnja procjena ulova lokalnih ribara za slučajno odabrana ribarska sela iz obližnjeg jezera Gbedikere izvršena je CAS metodom. Istraživanja su provedena u dvama razdobljima tijekom niskog vodostaja (u veljači) i visokog vodostaja (u rujnu) u periodu od 2006. do 2008. godine.

Godišnji ulov kretao se između 537,5 t i 576,9 t pri visokom vodostaju. Prosječan ulov po ribarskom brodu kretao se od 7,4 kg do 10,6 kg između mjesta iskrcaja. Ukupno je identificirano 12 vrsta koje pripadaju u 10 porodica. U ulovu su dominirale vrste iz skupine Ciclidae, od kojih je *Orechromis niloticus* bila najzastupljenija u ukupnom ulovu. Procjena produkcije je uspoređena s eksperimentalnim ulovom mrežama i potencijalnom procjenom prirasta upotrebom Morpho-Edaphic indeksa (MEI), kako su odredili Henderson i Welcomme.

Doprinos je napravljen i međusobnom usporedbom ribolovnih alata, a najčešće su korištene mreže sačmarice (29%), zatim stajačice (25%), udice i parangali (16,6%), vrše (16,6%) te povlačne mreže (8,3%). Predložene su daljnje mjere gospodarenja.

Ključne riječi: jezero Gbedikere, produkcija, procjena ulova, ribari, ulov, prirast

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