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CATCH COMPOSITION AND EFFICIENCY OF MAJOR FISHING GEARS USED IN STRATUM II OF THE VOLTA LAKE - IMPLICATIONS FOR MANAGING THE FISHERIES

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Abstract

Catch composition and efficiency of major fishing gears *viz*; gillnets, basket traps, net traps and 'atidza' (brush park), deployed by fishers on the Volta lake at Dzemeni (Stratum II), was assessed over a 16-month period to determine how their deployment can impact on the fish stocks. Fifty thousand seven hundred and ninety four individual specimens were recorded during the study period. This represented 13 taxonomic families, 21 genera and 32 fish species. Only five genera constituted 95 per cent and 84 per cent by number and weight, respectively, of the total catch. *Chrysichthys* spp. was the most abundant genus (59.1%) followed by the tilapias (15.7%), *Hydrocynus* spp. (9.7%), *Synodontis* spp. (8.8%) and *Bagrus* spp. (2.6%). Catches by 'atidza' and basket traps were predominantly Tilapias and *Chrysichthys* spp., respectively, while that by gillnets and net traps were more heterogeneous. The highest catch of 20 t during the period was made by basket traps, while that from the other gears ranged from 0.33 to 6 t indicating that basket traps were very efficient. Knowledge about the catch composition by the various gears and their efficiency will help to regulate their use when it comes to formulating measures to manage the fisheries of the lake.

Introduction

The Volta lake offers great livelihood opportunities for riparian communities. One of such livelihood opportunities is fishing and its related activities. The lake, according to the last Frame survey conducted over 10 years ago, offers direct livelihoods for about 71,000 fishers, operating about 24,035 fishing boats from 1,232 fishing villages along the lake (DoF, 2003). Indirectly, about 20, 000 people are engaged in fishing related activities e.g., fish processing, boat building, marketing, trap weaving and servicing of outboard motors. It is estimated that about 150,000 t of fish are landed annually from inland capture fisheries, out of which 82, 000 t is from the Volta lake (DoF, 2007), thus, making the lake the mainstay of inland fisheries in Ghana. Fish is the main source of animal protein for most Ghanaians, and has a special cultural significance throughout the country. The national per capita fish consumption is estimated at 23 kg (DoF, 2007), much higher than the global average of 13 kg per capita.

The fisheries potential of the Volta lake, however, keeps decreasing with time due to various factors either natural or man-made. This is reflected in the lesser number of species, and the predominance of relatively small sizes in catches (IDAF, 1993; Braimah, 1995; Abban, 1999; DoF, 2003). There

is, however, a generally accepted underlying assumption that there are substantial opportunities for increasing the productivity of reservoirs from a combination of better harvesting strategies, carefully adapted stock enhancements and aquaculture. Harvesting strategies (i.e., the choice of fishing gears, when and how they are deployed) are very important so far as fisheries management is concerned since the types, sizes of fishes and quantities caught depend, to a large extent, on the fishing gears or methods used. The fact that the prospects for meeting the country's fish demands keeps worsening due to decreasing landings from capture fisheries calls for prudent management of its fisheries, among other measures, to offset the annual deficit of 502, 000 t (MOFAD, 2013).

The study sought to assess catch composition and efficiency of the major fishing gears used on the Volta lake, and how the findings could be used as a management tool for the lake fisheries.

Experimental

Study area

The Volta lake is a man-made tropical lake which started forming in 1964 when a dam built across the Volta river at Akosombo was closed. It lies between longitudes 5° 30` W and 2° 30` E and latitudes 5° 45` N and 14° 30` N (Fig. 1). At the maximum operating level of 84 m, the lake has a volume of 165 km^3, a surface area of about 8,480 km^2 (constituting 3.6% of the surface area of Ghana) and a shore line of 4,800 km^2. Mean depth of the lake is 19 m. The annual drawdown caused by the dam operation is between three and four metres which in turn creates a drawdown area of approximately 85,000 ha (Kalitsi, 1999; Braimah, 1999). The mean annual discharge from the lake is 1,150 $m^3 s^{-1}$ (Gordon, 1999), and an estimated mean annual suspended sediment input of 17 × 106 t yr^{-1}, an equivalent of a mean annual specific suspended sediment yield of 52 t $km^{-2} yr^{-1}$ from the catchment (Akrasi, 2005). For management purposes the lake has been divided into eight strata based on ecology (Fig. 1). The study was carried out at Dzemeni in Stratum II of the Volta Lake.

Data collection

Fifteen fishers were selected and trained by a team of researchers from CSIR-Water Research Institute during a 3-day workshop. They were trained on how to sort out their catch according to species and mesh size, measure the total length (to the nearest 1.0 mm), and weight of fish (to the nearest 1.0 g) with a specially designed measuring board and top pan scale, respectively. The fishers collected these data on their own catch from March 2007 to June 2008 using their own fishing gears. The selected fishers were grouped into five with two fishers and one recorder in each group. The recorder in each group was also the leader of the group, and was solely responsible for recording the data twice a week on days convenient to them. In addition to recording data, the leader in Group 1 was given a set of experimental multifilament nets of various mesh sizes to fish with. The gears and methods employed varied within the groups and ranged from 'atidza' (brush park), monofilament gill nets comprising various mesh sizes, basket and net traps. Table 1 shows the five groups, the types of gears and mesh sizes used by each fisher in the group.

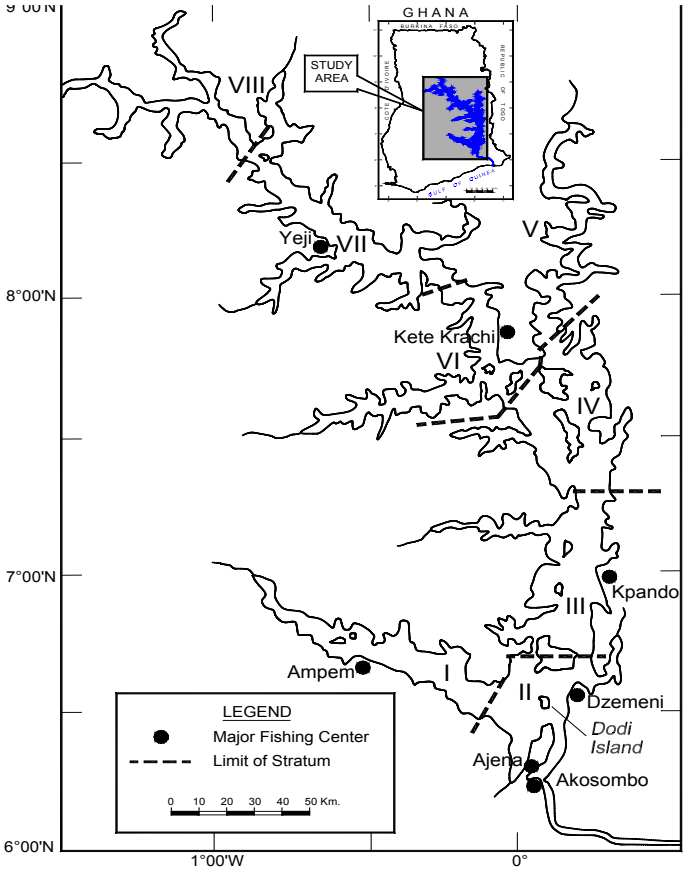

Fig. 1. Map of the Volta lake showing the various strata and the study

In order not to waste the fishers' time and prevent their catch from deteriorating before sales were made, they were asked to record 50 individuals of each species from each mesh size. Likewise, those using traps and 'atidza' recorded 50 individuals of each species in the catch. The bulk weight of the rest of each species was recorded according to the species and mesh size. The names of the species were recorded in their local dialect to avoid mis-identification. Most of the fishes were identified to the species level while others were identified to the genus level. For those that were identified to the genus level, verification (based on identification of Dankwa *et al*., 1999; Paugy *et al*., 2003) was made from fish landings to find out what species was caught for the genus concerned.

The data were collected from the recorders and compiled on monthly basis in excel, and then exported into PasGear 2 Version 2.3 (Kolding & Skålevik, 2009) for analyses with respect to catch composition, length frequency distribution of fish caught in each gear and mesh size of gill nets. The catch per unit of effort (CPUE) was calculated as catch in kg/boat/day.

Results

Fish species caught

Records of fishes caught belonged to 13 taxonomic families representing 21 genera and 32 species (Table 2).

Length-frequency data

Total length measurements of 50,794 individual fishes were recorded from the various gears deployed during the study period. These were computerised in excel and exported into PasGear. The length distribution of all species caught in each of the gears is shown Fig. 2. The mean total length of fishes caught in 'atidza' was 29 ± 11 cm compared to that from traps which was 20 ± 10 cm. Mean total length of fish caught in gillnets

TABLE 1

Fisher groups and fishing gears used

Group	*Gears/method used*	*Mesh size*
Group 1		
Recorder/Fisher # 1 Golo Atsu	Big net traps (BNT)	Diameter of base 55 cm
Fisher # 2 Golo Robert	Small net traps (SNT)	Diameter of base 50 cm
Fisher # 3 Golo Godstime (Recorder)	WRI experimental gillnets	15, 20, 25, 30 and 40 mm
Group 2		
Recorder	-	
Fisher # 4 Daniel Fede	Monofilament gillnets (GN)	2 ½, 3 in.
Fisher # 5 Wisdom Adanya	Medium basket traps (MBT)	Diameter of base 65 mm
Group 3		
Recorder	-	
Fisher # 6 Stephen Kweku	Monofilament gillnets (GN)	2 ½ , 3, 3 ½ , 4 in.
Fisher # 7 Patience Akoi	'Atidza' (Brush park) (ATZ)	N/A
Group 4		
Recorder	-	
Fisher # 8 Xevizi Edoh	Monofilament gillnets (GN)	17/8, 1 5/8, 2 ¼, 2 ½ in.
Fisher # 9 Lydia Tsidi	Monofilament gillnets (GN)	17/8, 2 ¼ , 2 ½ , 3 in.
Group 5		
Recorder	-	
Fisher # 10 Prince Agbeko	Monofilament gillnets (GN)	4, 4 ½ , 5, 5 ½ , 6, 6 ½ , 7, 7 ½
Fisher # 11 Agbofa Paulina	'Atidza' (Brush park) (ATZ)	N/A

ranged from 18 ± 8 cm (in mesh 15 mm or 0.6 inch) to 80 ± 20 cm (in mesh 191 mm), confirming bigger fish being caught in bigger mesh nets.

Catch composition of fishers (fishing gears)

Chrysichthys were the most abundant species in the catches of traps forming between 80 per cent to 100 per cent of the catch. This is shown by the catches of Golo Atsu and Golo Robert who used net traps, with *Chrysichthys* constituting 96 per cent and 88 per cent, respectively, of their catch whilst it constituted 100 per cent of the catch from basket trap used by Wisdom Adanya (Fig. 3). In contrast to the basket trap, catches from the net trap, gillnet and 'atidza' were more diverse. Catches of Daniel Fede, who deployed gillnets with only net meshes two and half and three inches consisted predominantly (98 %) of *Hydrocynus* spp. Fede is known to specialise in catching *Hydrocynus* spp. and sets his nets at the surface in open windy areas. The tilapias, especially *Sarotherodon galilaeus* and *Oreochromis niloticus* dominated catches from 'atidza' operated by Patience Akoi (94 %) and Paulina Agbofa (98 %). The Nile perch (*Lates niloticus*), the largest predatory fish in the lake, was found only in the catches of Prince Agbeko, who used bigger mesh sizes ranging from four to seven and half inches. *Synodontis* spp. was also important in gillnet catches constituting 46 per cent, 20 per cent and 16 per cent of the catch in some cases.

Average daily catch by fisher

The total number of days fished over a period of 16 months, and the average catch per fishing day (kg/day) for the fishers is pre-

TABLE 2

List of fish species caught by fishers in Stratum II of the Volta lake at Dzemeni from March 2007 to June 2008

Family	*Genus*	*Species*
Claroteidae	*Chrysichthys*	*auratus*
	Chrysichthys	*nigrodigitatus*
	Auchenoglanis	*occidentalis*
Arapaimidae	*Heterotis*	*niloticus*
Characidae	*Hydrocynus*	*forskalii*
Alestidae	*Alestes*	*baremoze*
	Brycinus	*macrolepidotus*
	Brycinus	*nurse*
Cyprinidae	*Labeo*	*senegalensis*
	Labeo	*coubie*
	Labeo	*parvus*
Bagridae	*Bagrus*	*docmac*
	Bagrus	*bayad*
Mochokidae	*Synodontis*	*schall*
	Synodontis	*velifer*
	Synodontis	*ocellifer*
	Synodontis	*nigrita*
Latidae	*Lates*	*niloticus*
Cichlidae	*Oreochromis*	*niloticus*
	Tilapia	*zillii*
	Sarotherodon	*galilaeus*
	Hemichromis	*fasciatus*
	Astatotilapia	*guntheri*
	Steatochranus	*irvinei*
Schilbeidae	*Schilbe*	*intermedius*
	Schilbe	*mystus*
Mormyridae	*Mormyrus*	*macrophthalmus*
	Mormyrus	*hasselquistii*
	Mormyrus	*rume*
Clariidae	*Clarias*	*gariepinus*
	Heterobranchus	*isopterus*
Tetraodontidae	*Tetraodon*	*lineatus*

sented in Fig. 4. The daily catches by fishers who used traps (Wisdom Adanya, Golo Robert and Golo Atsu) were the highest (160 kg) with Godstime, who used WRI experimental nets recording the lowest (8 kg). This is reflected in the total catch by each fisher during the period as shown in Table 3.

Catch per unit of effort (CPUE) by gear

CPUE by gear and estimates of annual fish catch at Dzemeni are presented in Table 4. Generally, CPUEs of traps (basket and net) were higher than that of gillnets and 'atidza', implying that they were more efficient compared to the other gears.

Discussion

Within a period of 16 months 50,794 specimens of fish were recorded, which would not have been possible if experimental fishing alone had been used. The data set comprised 13 families representing 21 genera and 32 species.

The Volta lake fishery is a multi-species and multi-gear which is highly specialised. Fishers exploit the different levels of the fish community structure, with an array of fishing gears to ensure that their livelihood is always assured. Gillnets were deployed not only to capture a wide range of species, but also a wide range of sizes depending on the mesh size. Most of the large-sized fishes (*L. niloticus* and *Bagrus* spp.) were caught in big net mesh sizes as expected. Gillnets were also specially constructed and set in a particular way to target mostly *Hydrocynus* spp. by one of the gillnet operators. This was considered an innovation by local fishers, which would be evaluated for a species-specific fishing and fisheries management approach.

There were differences between the catches from the various gears deployed, the most remarkable being that between the two types of traps and that of 'atidza'. Predominance of *Chrysichthys* spp. in basket traps compared to heterogeneous catch in net traps was attributable to *Chrysichthys*

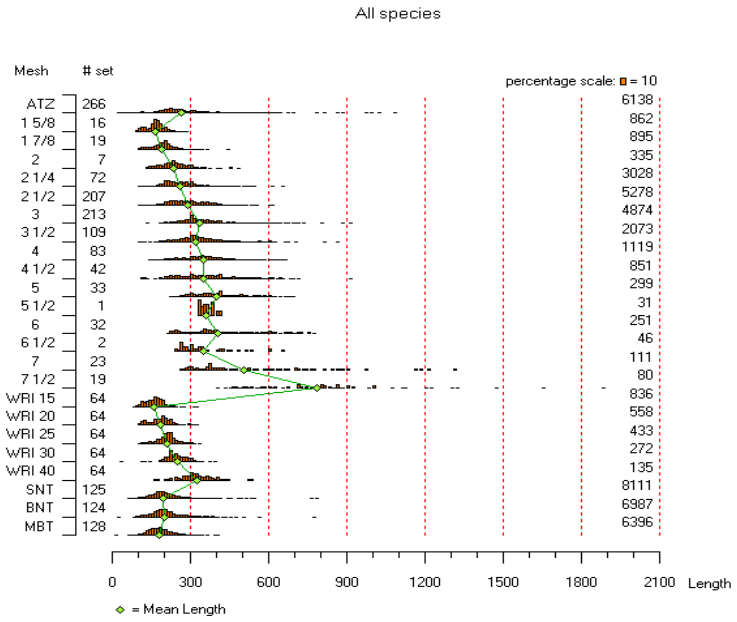

Fig. 2. Length (TL mm) distribution of all species in fishing gears used in Stratum II of the Volta lake at Dzemeni from March 2007 to June 2008. (ATZ = 'Atidza'; 1 5/8 to 7 ½ are mesh sizes (inches) of stationary gillnets from commercial fisheries; WRI = experimental gill nets 15 – 40 mm mesh; SNT = small net trap; BNT = big net trap; MBT = medium basket trap).

spp. preferring 'darker' areas which provide ideal places for hiding, whilst the preference of tilapias for 'atidza' could be attributed to brush parks that attracted fishes with affinity for woody and vegetated areas in waters (Hem *et al.*,1994; Welcomme, 2000). It is worth noting that, the type of tilapia targeted depended on where 'atidzas' were sited. When *O. niloticus* was the target, it was sited near the shore at areas with muddy bottom whilst it was sited in offshore areas with hard bottom, if the target was

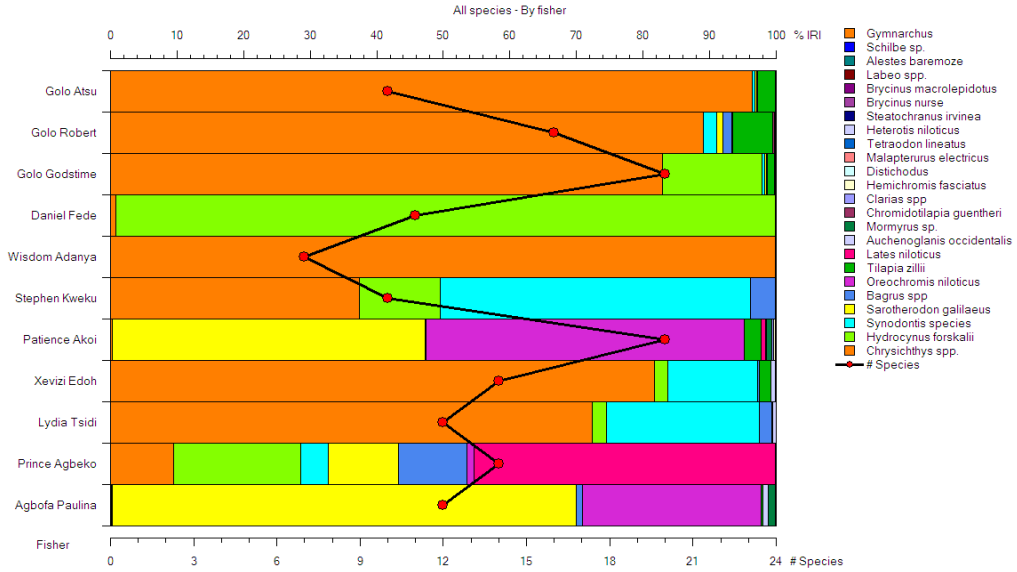

Fig. 3. Catch composition of each fisher during the period March 2007 to June 2008 from the Volta lake at Dzemeni

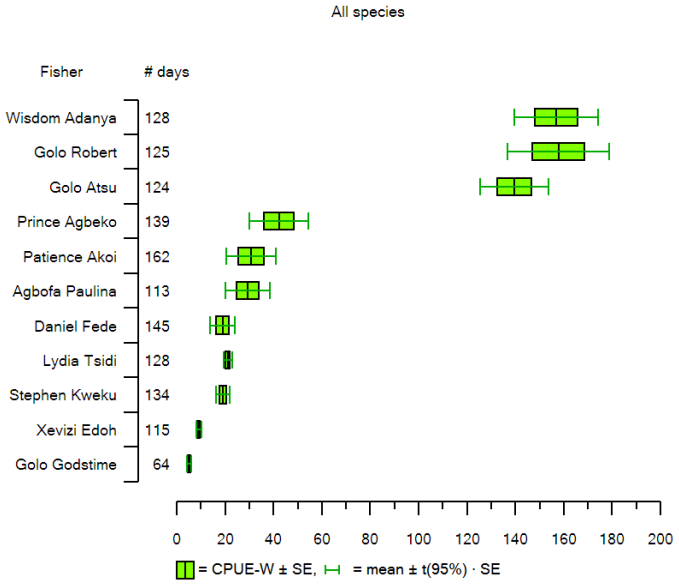

Fig. 4. Total number of days fished over 16 months and average catch per fishing day (kg/day) for the 11 fishers engaged in the sampling scheme at Dzemeni on the Volta lake from March 2007 to June 2008

S. galilaeus.

Interviews conducted on fishers indicated that there was seasonality in the usage of gears. Basket traps and net mesh traps were used on the lake at different times of the year in response to changes in season. Basket traps were predominantly used during rising or high water periods, between June and December, but occasionally extending to March. Net traps were normally set during receding or low water periods, from December through to June of the following year whilst gillnets were used throughout the year. Harvesting of 'atidza' is minimised during the rising water period

TABLE 3

Total effort (number of gear set) and total catches (16 months) by each fisher in the sampling scheme.

Fisher	*Atidza*	*Com gillnet*	*WRI gillnett*	*Net trap*	*Basket trap*	*Total*	*Wt (Tons)*
Wisdom Adanya	-	-	-	-	18000	18000	20.08
Golo Robert	-	-	-	20400	-	20400	19.73
Golo Atsu	-	-	-	12410	-	12410	17.30
Prince Agbeko	-	892	-	-	-	892	5.88
Patience Akoi	310	-	-	-	-	310	4.99
Agbofa Paulina	210	-	-	-	-	210	3.32
Daniel Fede	-	1592	-	-	-	1592	2.75
Lydia Tsidi	-	284	-	-	-	284	2.70
Stephen Kweku	-	934	-	-	-	934	2.54
Xevizi Edoh	-	250	-	-	-	250	1.05
Golo Godstime	-	-	320	-	-	320	0.33
Total	520	3952	320	32810	18000	55602	80.67

– That particular gear was not used by the fisher concerned

TABLE 4

Catch per unit of effort (CPUE) by fishing gear and estimated annual fish catch from Stratum II of the Volta lake at Dzemeni from March 2007 to June 2008 (GN- gillnets, NT- net traps, BT- basket traps, ATZ- 'atidza')

Gear	*Mean no. of boats /day (±se)*	*No. of fishing days*	*CPUE daily (kg/boat/day)*	*No. of fishing weeks*	*Catch/week (tons)*	*Catch/year (tons)*
GN	55 ± 15	5	24.9	52	6.85	356.07
NT	45 ± 13	3	148.7	39	20.07	782.91
BT	50 ± 13	3	156.9	35	23.54	823.73
ATZ	24 ± 6	3	16.0	36	1.15	41.47
TOTAL						2004.18

from September to early December because harvesting becomes difficult. Application of different fishing gears, where and how to deploy them to target specific species, and when to intensify the use of particular fishing gears, is a clear indication of how fishers understood the dynamics of the fisheries and, therefore, directed their efforts to maximise their catch.

Essentially, data obtained suggested that locally evolved traps (basket and net traps) were most efficient in catch compared to gillnet. Even more important for fisheries management, was the indication that bigger mesh sized gillnets were more effective in fishing (Fig. 4, catches of Prince Agbeko) compared to smaller-meshed gillnets as fishers usually think, a situation which normally brings them into conflict with fisheries managers. It is also worth noting that the mean length of fish caught in 'atidza' was 29 ± 11 cm, which clearly showed that fishers operating 'atidza' were not interested in harvesting small-sized and juvenile fishes. This should dispel the erroneous view that because 'atidza' serve as refugia and nursery areas, juvenile fishes constitute the bulk of fish harvested from them. This was one of the reasons, apart from deforestation and conflicts with other users of the lake, which have been advanced for abolishing the use of 'atidza' on the lake.

Knowledge of the catch composition by the various gears and their efficiency will help to regulate their use, when it comes to formulating measures to manage the fisheries of the lake. For example, the use of 'atidza' could be regulated if it is found that tilapia stocks are dwindling, since it has been established from the study that 'atidza' is the most efficient gear for harvesting tilapias. Similarly, the use of basket traps can be regulated if *Chrysichthys* stocks are being over exploited. The use of fishing gears (gill nets and net traps) that targets wide range of species should be encouraged since it would not put undue pressure on any particular species.

Conclusion

Catches of basket traps was dominated by *Chrysichthys* spp. unlike that of net traps which were more heterogeneous, whilst tilapias were the dominant species caught in 'atidza'. The data also suggested that locally

evolved traps (basket and net traps) were most efficient compared to gillnet. Knowledge of the catch composition by the various gears, and their efficiency will help to regulate their use when it comes to formulating measures to manage the fisheries of the lake. Even more important for fisheries management, was the indication that bigger mesh-sized gillnets were more effective in fishing than smaller mesh-sized gillnets.

The lake fishery is a multi-species and multi-gear, the dynamics of which was well understood by the local fishers who, therefore, directed their efforts in such a way as to maximise their catch.

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References

Abban, E. K. (1999) *Integrated development of artisinal fisheries*. IDAF Project GHA/93/008.

Akrasi, S. A. (2005) The assessment of suspended sediment inputs to Volta lake: Lakes and resevoirs. *Research and Management* **10**, 179-186.

Braimah, L. I. (1999) The role of Volta River Authority in the development of the Volta basin. In *Sustainable integrated development of the Volta basin in Ghana*. (C. Gordon and J.K. Ametekpor, eds) Gold Type Press, Accra. 159 pp.

Braimah, L. I. (1995) Recent developments in the fisheries of Volta lake (Ghana). In *Current status of fisheries and fish stocks of the four largest African resources; Kainji, Kariba, Nasser/Nubia and Volta. Current status of fisheries and fish stocks of the four largest African resources; Kainji, Kariba, Nasser/ Nubia and Volta.* (R.C.M Crul and F.C Roest eds), pp. 111 – 134. CIFA Technical Paper 30, Food and Agriculture Organisation of the United Nations, Rome, 142 pp.

Dankwa, H. R., Abban, E. K. & Teugels, G. G. (1999) Freshwater fishes of Ghana: Identification, distribution, ecological and economic importance. *Annals Sciences Zoologiques* Vol. 238 53pp.

DoF (2007) *A summary of fisheries statistics in Ghana (Mimeo*). Directorate of Fisheries, Ministry of Fisheries, Accra. 75 pp.

DoF (2003) *Fisheries management plan for the lake Volta, Ghana*. Directorate of Fisheries, Ministry of Fisheries, Accra. 75 pp.

Gordon, C. (1999) An overview of the fish and fisheries of the Volta basin. In *The sustainable integrated development of the Volta basin in Ghana.* (C. Gordon and J. K. Ametekpor, eds) Gold Type Press, Accra.159 pp.

Hem, S. & Avit, J. L. B. (1994) First results on acadja-enclosure as an extensive aquaculture system (West Africa). *Bulletin of Marine Sciences* **55**, 1040 – 1051.

Kalitsi, E. A. K. (1999) The role of Volta River Authority in the development of the Volta basin. In *Sustainable integrated development of the Volta basin in Ghana*. (C. Gordon and J.K. Ametekpor, eds) GoldType Press, Accra. 159 pp.

Kolding, J. & Skålevik, Å. (2009) PasGear 2 Version 2.3. *www.cdcf.no/data/pasgear.*

MOFAD. (2013) Meet the press by Minister, MOFAD. Wednesday 11th December edn of

Ghanaian Times.

Paugy, D., Lévêque, C. & Teugels, G. G. (2003) The fresh and brackish water fishes of West Africa. *Collection Faune et Flore Tropicales 40, Vol. I* Paris. 457 pp.

Paugy, D., Lévêque, C. & Teugels, G. G. (2003) The fresh and brackish water fishes of West Africa. *Collection Faune et Flore Tropicales 40, Vol. II.* Paris. 815 pp.

Ticheler, H., Kolding, J, & Chanda, B. (1998) Participation of local fishermen in scientific fisheries data collection, a case study from the Bangweulu swamps, Zambia. *Fisheries Managementand Ecology* **5**, 81 – 92.

Welcomme, R. L. (2000) An evaluation of brush and vegetation park fisheries. *Fisheries Management and Ecology* **9**, 175 – 188.

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