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An Investigation of Fish Catch Data and Its Implications for Management of Small-scale Fisheries of Ghana

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Abstract: Most statistical information on fish catch in Ghana and that of many other African countries are deficient in supporting effective fisheries management. Fish catches were examined between January 2009 and December 2010, to enhance the management of small-scale fisheries of Ghana. The methods employed were: Fish Catch Assessment (FCA) and documents analyses. The case study focused on four important fishing communities, namely: Elmina and Ahwiam (coastal communities); and Kpong and Small London (inland communities). The results provide evidence from empirical data to confirm observed declining Catch Per Unit Effort (CPUE) and therefore declining fish abundance in Ghanaian water, both freshwater and marine. The average CPUE (kg/canoe/day) for 2009/2010 were: 22.72, 10.57, 44.28 and 133.81 for Small London, Kpong, Ahwiam and Elmina, respectively. There were significant differences in CPUE among habitats and sites ($p<0.05$). Annual fish catch estimated from CPUE data were as follows: freshwater habitats Small London (716.04 tons) and Kpong (186.68 tons); marine habitats Elmina (4716.80 tons) and Ahwiam (630.99 tons). A total of 21 and 18 fish species were identified at Kpong and Small London, respectively. Furthermore, a total of 71 and 79 fish species were identified at Ahwiam and Elmina, respectively. For management and sustainability of fishery resources in relation to the small-scale fisheries of Ghana and the sub-region as a whole, it is recommended that fishery managers, policy makers and all relevant stakeholders assiduously work together to reverse declining CPUE by reducing fishing effort and encourage income diversification and wealth creation.

Keywords: Catch per unit effort, fish catch, freshwater, Ghana, marine, poverty

INTRODUCTION

Ghana borders on the Gulf of Guinea with one of the highest fish production in Africa (305,000 tonnes in 2010, FAO (2011)). It is an important and a powerful fishing nation (Atta-Mills *et al*., 2004) and Ghanaian fishers can be found all over the continent of Africa (e.g., Namibia, Angola, Liberia, Mauritania, etc.). The fishery industry of Ghana comprises mainly the marine sector and the inland sector. The marine fisheries sector is the main source of fish producing 85% of the total catch. The inland sector accounts for the remaining 15% of Ghana's fisheries. The marine sector can be categorized into four according to fishing unit, namely, small-scale (or artisanal), semi-industrial (or inshore), industrial (or deep sea) and tuna sectors. The inland fishing industry is mainly artisanal.

Fisheries in Ghana constitute an important sector in national economic development. Fishing activity accounts for an estimated 4.2% of Ghana's GDP, of which the small-scale sector alone contributes 3.5% (GSS, 2011; FAO, 2006). The sector also plays a major role in sustainable livelihoods and poverty reduction in several households and communities.

Fish is the preferred and cheapest source of animal protein in Ghana; about 75% of total annual catch of fish in the country is consumed locally (a reliable source of food security). The per capita consumption of fish is estimated at about 25 kg/annum, representing 60% of animal protein intake by Ghanaians (Sarpong *et al*., 2005).

The fishing industry provides employment to many rural people and urban dwellers, with one (1) in ten (10) Ghanaians depending on fisheries (FAO, 2006). It is estimated that a total of 372,049 fishermen, fish processors, traders and boat builders are employed in the fisheries sector and a source of livelihood for about 2.2 million people (World Bank, 2011; BNP, 2009). Moreover, the sector is significant for its gender distribution. Men are involved in fish harvesting, undertaking the main fishing activities in the artisanal, semi-industrial and the industrial sectors while women are the key players in on-shore post-harvest activities, undertaking fish processing and storage and trade activities. Many are also engaged in the growing frozen fish distribution trade as well as marketing fish within and outside the country. Major players in the post-harvest fishery sector are the 'fish mummies' who

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informally fund the artisanal fishery and provide financial support in processing and trade (Bank of Ghana, 2008).

Despite its importance, the small-scale fisheries sector in Ghana, like in other African countries, is often excluded or under-represented in most national and local policies. This is due probably to widely held perception that small-scale fisheries have low potential in terms of economic contributions, in spite of its huge social contributions (e.g., employment, safety livelihood, cultural, rural development). The fundamental reason behind this perception is insufficient fish catch data to give accurate picture of the small-scale fisheries. In fact, the marginalization of the small-scale fisheries sector has greatly influence how fish catch data are collected, reported and interpreted.

The present study, using case studies from four fishing communities, examines catches made by the small-scale fisheries sub-sector in order to contribute to sustainable management of fishery resources in Ghana and Africa. Since Ghanaian fishers are found in many nations in Africa, fish catch, fishing operations and livelihoods are generally similar to that of other sister African countries.

MATERIALS AND METHODS

Area of study: Area of study was Small London (rural inland fishing community, Latitude; 6° 13′ 51″ N, Longitude: 0° 5′ 29″ W), Kpong (urban inland fishing community, Latitude; 6° 9' 0 N, Longitude; 0° 4' 0 E), Ahwiam (rural coastal fishing community Latitude; 5° 45' 0 N, Longitude; 0° 13' 60 E) and Elmina (urban coastal fishing community, Latitude 5° 5′ 0″ N, Longitude: 1° 21′ 0″ W) (Fig. 1). These communities are involved in varieties of important fishing activities and are destinations for a significant number of migrant fishers. In summary, the reasons for selecting these 4 locations are as follows:

- **Previous regional fisheries research programmes:** Sustainable Fisheries Livelihood Programme (SFLP) (in Small London) vs. Non-Sustainable Fisheries Livelihood Programme (in Kpong). SFLP was a regional poverty alleviation programme for small-scale fisheries in West Africa by DFID and FAO (1999-2006)
- **Results of Ghana canoe frame survey 2004:** Elmina-2nd most important fisheries landing site after Tema, Ghana; Ahwiam-2nd most important fisheries landing site in Greater Accra after Tema, Ghana
- **Reservoir relative importance and fishery potential:** Kpong reservoir-2nd most important reservoir on the Volta basin next to the Volta Lake. Kpong and Small London are located in the south and north sections of Kpong reservoir, respectively
- **Migration status:** Settler community (Small London) vs. non-settler community (Kpong)
- **Political zoning:** Ahwiam (Eastern coast of Ghana), Elmina (Central coast of Ghana)
- **Artisanal fisheries sampling sites:** Elmina and Ahwiam

Data collection:

Sampling design: In this study, stratified random sampling was adopted. The major stratum was defined as habitat of fishery resources, referred as follows:

- Marine (or coastal)
- Freshwater (or inland)

The minor stratum was defined based on community size, referred as follows:

- Rural
- Urban

The overall aim of this approach was to improve sampling for accuracy.

Data collection-fish catch assessment: Fish Catch Assessment (FCA) was employed as a means of data collection which is detailed below:

- **Fish sample collection:** The catches made by local canoe fishers utilizing all major gears (Table 1) were randomly sampled for 22 months between January 2009 and December 2010. Randomization was done by randomly selecting every third canoe until sample size was reached on each sampling occasion. Catches of up to 20 canoes (representing between 90-95% of sampling accuracy in small population, Stamatopoulos (2004) were sampled at monthly intervals. On each sampling occasion, catches of individual fishers were sorted by species and gear. Fish weights were taken using a 20 kg capacity top pan scale.

Table 1: Types of fishing gears at sampling stations

Sampling station	Habitat	Gear
Small London	Freshwater	Seine net, drift gill net, cast net, hook and line, traps (basket, wire mesh), spear
Kpong	Freshwater	Drift gill net, cast net, hook and line, traps (basket, wire mesh), seine net, spear, combined gill nets and traps
Ahwiam	Marine	Purse seine nets (APW), hook and line, lobster nets, set net, drift gill net
Elmina (main)	Marine	Purse seine nets (APW), drift gill net, hook and line, lobster nets, set net, cast net (benya lagoon)

APW: “Ali Poli Wasta”

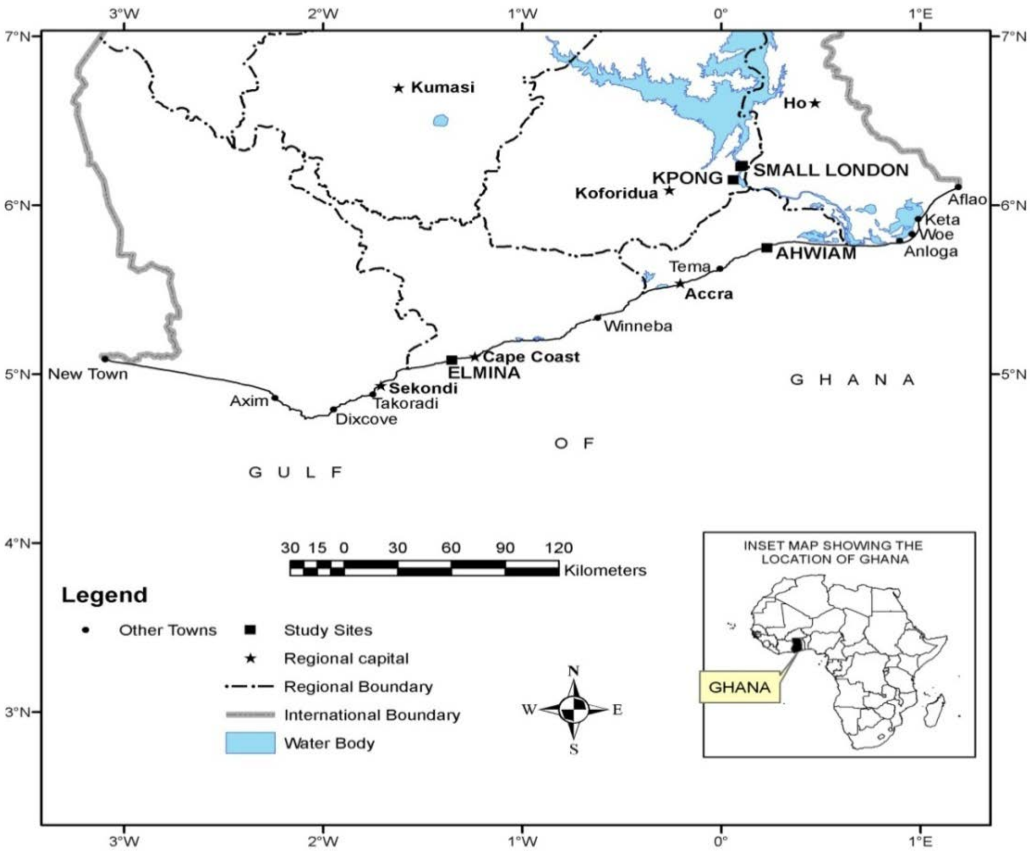

Fig. 1: A map of southern Ghana showing study sites

- **Fish identification:** Fishes were identified individually using taxonomic keys and guides as follows:
  Freshwater: Dankwa *et al*. (1999)
  Marine: Schneider (1990), Edwards *et al*. (2001) and Kwei and Ofori-Adu (2005)
- **Fish catch composition and diversity:** To determine the relative importance of individual species caught, percentage of relative abundance of species was estimated from catches of fishers by dividing the weight of particular fish species per catch by the total species weight and multiplying the result by 100% (weight of individual species/ total species weight*100). Estimation of Similarity Index (SIM) for species encountered was made as follows:

$$SIM = 2\sum nc/\sum nc_1 + \sum nc_2$$

where,
nc = The common species between two sites
nc_1 = The species of site 1
nc_2 = The species of site 2

Values range from 0 to 1 with the higher value suggesting greater similarity.

Catch per unit effort and annual catch: Catch rate in terms of Catch per Unit Effort (CPUE) was estimated as follows: catch per canoe per day (kg/canoe/day). All important gears were summed-up in estimating CPUE.

Total catch (kg) per day was estimated as follows: mean CPUE multiply by number of active canoes [mean CPUE*No. of active canoes/day].

Total monthly fishing days (Ahwiam, Elmina and Kpong) = Number of days in a given month minus eight days, giving 23 or 22 days for 31 or 30 day month, respectively. Fishers normally take two days off within the week (usually, Sundays and Tuesdays).

Total monthly fishing days (Small London) = Number of days in a given month minus four days, giving 27 or 26 days for 31 or 30 day month, respectively. Fishers normally take one day off within the week (usually Sundays).

CPUE data was used to estimate annual catch as follows: mean CPUE * average number of canoes per day* average number of fishing days per week* number of fishing weeks per year.

RESULTS

Fish catch composition: Fish species encountered during the study is presented in Table 2 (freshwater) and 2 (marine). Multiple species were encountered at

Table 2: List of freshwater fish species encountered at Kpong and small London (January 2009 to December 2010)

Family	Fish species	Common name*	Kpong	Small London
Alestidae	*Brycinus brevis*	Silversides	√	√
	Hydrocynus forskalii	Elongate tiger fish	√	√
Bagridae	*Bagrus bayad*	Bayad	√	√
	Bagrus docmak	Silver catfish	√	√
Centropomidae	*Lates niloticus*	Nile perch	√	
Cichlidae **	*Hemichromis fasciatus*	Banded jewelfish	√	
	Hemichromis bimaculatus	Jewelfish	√	
	Tilapia guineensis	Guinean tilapia	√	√
	Tilapia zilli	Redbelly tilapia	√	√
	Oreochromis niloticus	Nile tilapia	√	√
	Sarotherodon galilaeus	Mango tilapia	√	√
Clariidae	*Clarias gariepinus*	North African catfish	√	√
Claroteidae	*Chrysichthys auratus*	Golden Nile catfish	√	√
	Chrysichthys nigrodigitatus	Bagrid catfish	√	√
	Auchenoglanis occidentalis	Bubu	√	√
Clupeidae	*Sierrathrissa leonensis*	West African pygmy herring	√	√
Malapteruridae	*Malapterurus electricus*	Electric catfish	√	√
Mochokidae	*Synodontis nigrita*	Catfish	√	√
	Synodontis schall	Wahrindi	√	√
Mormyridae	*Mormyrus rume*	Mormyrids	√	√
Osteoglossidae	*Heterotis niloticus*	African bonytongue	√	√
Total 11			21	18

*: FAO common name (http://www.fishbase.org, July, 2011); For major key gears including; drift gill net, seine net, lines; See Table 1 for complete lists of gears; Tick: Recorded; Absence of tick: Not recorded; **: Most frequently occurring fish family; Estimated Similarity Index (SIM) for species at Kpong and Small London = 36/39 = 0.9 (formula: section (fish catch composition and diversity)

Table 3: List of marine fish species encountered at Elmina and Ahwiam (January 2009 to December 2010)

Family	Fish species	Common name*	Elmina	Ahwiam
Acanthuridae	*Acanthurus monroviae*	Monrovia doctorfish	√	√
Albulidae	*Albula vulpes*	Bonefish	√	
Alopiidae	*Alopias superciliosus*	Bigeye thresher	√	
Ariidae	*Carlarius heudelotii*	Smooth mouth sea catfish		√
Balistidae	*Balistes capriscus*	Grey triggerfish	√	√
	Balistes punctatus	Bluespotted triggerfish	√	√
Belonidae	*Ablennes hians*	Flat needlefish	√	√
Bothidae	*Bothus podas africanus*	Wide-eyed flounder		√
Carangidae****	*Alectis alexandrines*	Alexandria pompano	√	√
	Caranx crysos	Blue runner		√
	Caranx hippos	Crevalle jack	√	√
	Chloroscombrus chrysurus	Atlantic bumper	√	
	Decapterus rhonchus	False scad/Mackerel scad	√	√
	Decapterus punctatus	Round scad	√	√
	Selene dorsalis	African moonfish	√	√
	Selar crumenophthalmus	Bigeye scad		√
	Trachinotus teraia	Shortfin pompano	√	
	Trachurus trachurus	Atlantic horse mackerel		√
Clupeidae	*Engraulis encrasicolus*	European anchovy	√	√
	Ilisha africana	West African ilisha	√	√
	Ethmalosa fimbriata	Bonga shad	√	√
	Sardinella aurita	Round sardinella	√	√
	Sardinella maderensis	Madeiran sardinella/Flat sardinella	√	√
Congridae	*Paraconger notialis*	Guinean conger		√
Coryphaenidae	*Coryphaena hippurus*	Common dolphin fish	√	
	Coryphaena equiselis	Pompano dolphinfish	√	√
Cynoglossidae	*Cynoglossus senegalensis*	Senegalese tonguesole	√	√
Dactyloperidae	*Dactylopterus volitans*	Flying gurnard	√	√
Dasyatidae	*Dasyatis margarita*	Daisy sting ray	√	√
Drepaneidae	*Drepane africana*	African sicklefish		√
Elopidae	*Elops lacerta*	West African ladyfish		√
Exocoetidae	*Fodiator acutus*	Sharpchin flyingfish	√	√
Gempylidae	*Ruvettus pretiosus*	Oilfish	√	√
Haemulidae	*Brachydeuterus auritus*	Bigeye grunt	√	√
	Pomadasys incisus	Bastard grunt	√	√
	Pomadasys jubelini	Sompat grunt	√	
	Plectorhinchus mediterraneus	Rubberlip grunt		√
Hemiramphidae	*Hemiramphus brasiliensis*	Ballyhoo halfbeak	√	
Istiophoridae	*Istiophorus albicans*	Atlantic sail fish	√	
Labridae	*Coris juris*	Rainbow wrasse		√

Table 3: (Continued)

Family	Fish species	Common name*	Elmina	Ahwiam
	Diastodon speciosus	Black bar hogfish		√
	Xyrichthys novacula	Pearly razorfish		√
Lethrinidae	*Lethrinus atlanticus*	Atlantic emperor	√	√
Lutjanidae	*Apsilus fuscus*	African forktail snapper	√	√
	Lutjanus agennes	African red snapper	√	√
	Lutjanus fulgens	Golden African snapper	√	√
	Lutjanus goreensis	Gorean Lagoon snapper	√	√
Mugilidae	*Mugil cephalus*	Fatherhead grey mullet	√	√
Mullidae	*Pseudupeneus prayensis*	West African goatfish		√
Myliobatidae	*Manta birostris*	Giant manta	√	
Octopodidae	*Octopus vulgaris***	Common octopus	√	
Paralichthyidae	*Syacium micrurum*	Channel flounder	√	
Palinuridae	*Panulirus regius****	Royal spiny lobster	√	√
Penaeidae	*Penaeus notialis****	Pink shrimp	√	√
	*Penaeus kerathurus****	Caramote prawn	√	
	*Parapenaeus longirostris****	Deepwater rose shrimp	√	
Polynemidae	*Galeoides decadactylus*	Lesser African threadfin	√	√
	Polydactylus quadrifilis	Giant African threadfin	√	
Pomacentridae	*Chromis lineatus*	Striped chromis	√	√
Priacanthidae	*Priacanthus arenatus*	Atlantic bigeye	√	√
Psettodidae	*Psettodes belcheri*	Spottail spiny turbot		√
Rhinobatidae	*Rhinobatos albomaculatus*	Whitespotted guitarfish	√	
	Rhinobatos rhinobatos	Common guitarfish	√	√
Sciaenidae	*Argyrosomus regius*	Meagre	√	√
	Pseudotolithus brachygnathus	Law croaker	√	√
	Pseudotolithus senegalensis	Cassava croaker	√	√
	Pseudotolithus typus	Longneck croaker	√	√
	Pteroscion peli	Boe drum	√	√
	Umbrina canariensis	Canary drum		√
Scombridae ******	*Euthynnus alletteratus*	Atlantic little tuna	√	√
	Auxis thazard	Frigate tuna	√	
	Scomber japonicus	Chub mackerel	√	√
	Scomberomorus tritor	West African Spanish mackerel	√	√
	Sarda sarda	Atlantic bonito	√	
	Katsuwonus pelamis	Skipjack tuna	√	
	Thunnus albacares	Yellowfin tuna	√	
	Thunnus obesus	Bigeye tuna	√	
Sepiidae	*Sepia officinalis*	Common cuttlefish	√	√
Serranidae	*Cephalopholis taeniops*	Blues potted seabass	√	√
	Epinephelus aeneus	White grouper	√	√
	Epinephelus goreensis	Dungat grouper	√	√
Soleidae	*Bathysolea albida*	Rock sole	√	√
Sparidae	*Dentex angolensis*	Angolan dentex	√	√
	Dentex canariensis	Canary dentex	√	√
	Dentex congoensis	Congo dentex	√	√
	Dentex gibbosus	Pink dentex	√	√
	Pagellus bellottii	Red pandora	√	√
	Pagrus caeruleostictus	Blue spotted seabream	√	√
Sphyraenidae	*Sphyraena sphyraena*	European barracuda	√	√
Stromateidae	*Stromateus fiatola*	Blue butterfish	√	
Tetraodontidae	*Ephippion guttifer*	Prickly puffer	√	
	Lagocephalus laevigatus	Smooth puffer	√	√
Trichiuridae	*Trichiurus lepturus*	Largehead hairtail	√	
Triglidae	*Lepidotrigla carolae*	Carol's gurnard		√
Xiphiidae	*Xiphias gladius*	Swordfish	√	
Total 48			79	71

*: FAO common name (http://www.fishbase.org, July, 2011); **: Cephalopods; ***: Crustaceans; For major key gears including; purse seine net, lines, gill net; See Table 1 for complete lists of gears; Tick: Recorded; Absence of tick: Not recorded; ****: Most frequently occurring fish family at Ahwiam; *****: Most frequently occurring fish family at Elmina; Estimated Similarity Index (SIM) for species at Elmina and Ahwiam = 110/150 = 0.7 (Formula: section (Fish catch composition and diversity)

all study sites. Types of fishing gears encountered are presented in Table 1:

- **Freshwater habitat**: At Small London and Kpong (Kpong reservoir), a total of 21 fish species belonging to 11 taxonomic families and 16 genera were encountered (Table 2). Specifically, 18 fish species, 10 taxonomic families and 14 genera were encountered at Small London. Cichlidae was the most frequently occurring fish family in catches at both Small London and Kpong, representing 22 and 29%, respectively.
- **Marine habitat:** At Ahwiam, a total of 71 fish species belonging to 38 taxonomic families and 60

genera were encountered. At Elmina, a total of 79 fish species belonging to 39 taxonomic families and 64 genera were encountered (Table 3). Crustaceans make up of 2.8 and 5.1% of species encountered at Ahwiam and Elmina, respectively. Cephalopods make up of 1.3% of species encountered at Elmina. There were no cephalopods encountered at Ahwiam. Carangidae was the most frequently occurring fish family in catches at Ahwiam representing 11%, while Scombridae was the most frequently occurring fish family in catches at Elmina, representing 10%.

Figure 2 to 5 show species composition by weight of most dominant fish species in catches at all the four sampling stations. The most dominant fish species represents 48 to 69% of the total catch.

The top three dominant fish species by weight at Small London were: *Chrysichthys auratus* (Golden Nile catfish) 68%; *Chrysichthys nigrodigitatus* (Bagrid catfish) 15% and *Synodontis schall* (Wahrindi) 10%. The top three dominant fish species by weight at Kpong were: *Tilapia zilli* (Redbelly tilapia) 51%; *Chrysichthys auratus* (Golden Nile catfish) 29% and *Tilapia guineensis* (Guinean tilapia) 14%.

At Ahwiam, the top three dominant fish species by weight encountered were: *Dentex congoensis* (Congo dentex) 16%; *Carlarius heudelotii* (Smoothmouth sea catfish) 15.7%; and *Pagrus caeruleostictus* (Bluespotted seabream) 14%. At Elmina, the top three dominant fish species by weight encountered were: *Sardinella aurita* (Round sardinella) 52%; *Brachydeuterus auritus* (Bigeye grunt) 8%; and *Scomber japonicus* (Chub mackerel) 7%.

Estimated Similarity Index (SIM) for species encountered at Kpong and Small London was 0.9, suggesting greater similarity (values range from 0 to 1, with the higher value suggesting greater similarity). Estimated Similarity Index (SIM) for species encountered at Elmina and Ahwiam was 0.7, suggesting greater similarity (values range from 0 to 1, with the higher value suggesting greater similarity).

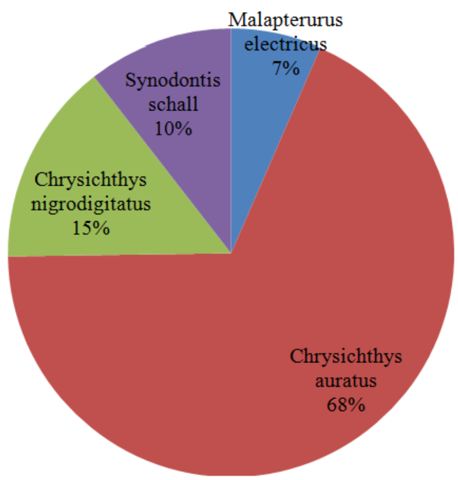

Fig. 2: Species composition by weight of most dominant freshwater fish species at small London

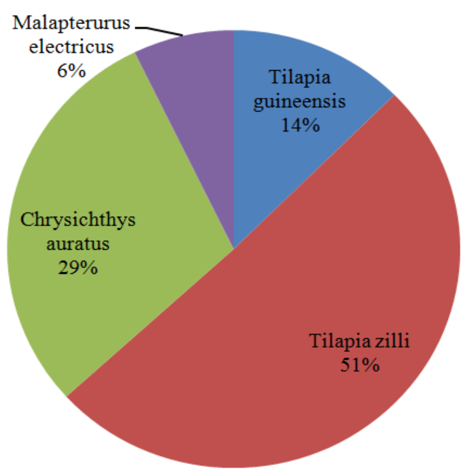

Fig. 3: Species composition by weight of most dominant freshwater fish species at Kpong

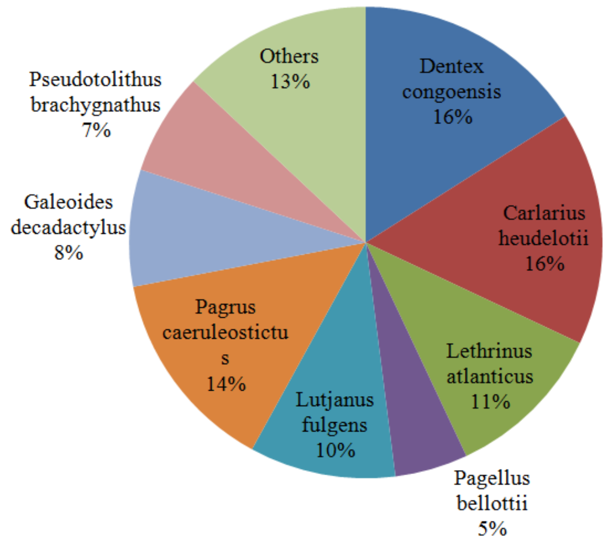

Fig. 4: Species composition by weight of most dominant marine fish species at Ahwiam

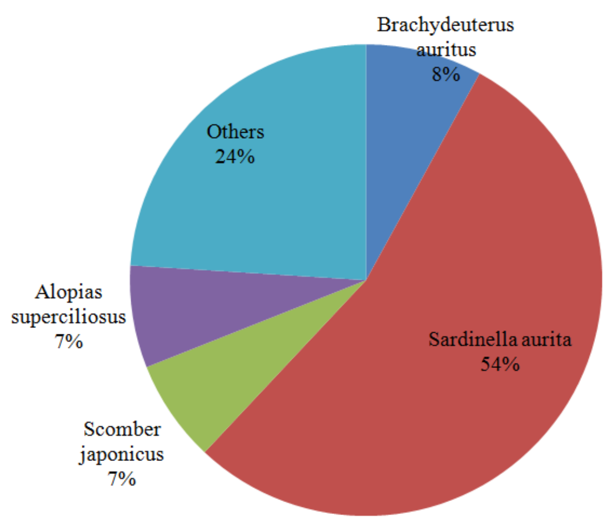

Fig. 5: Species composition by weight of most dominant marine fish species at Elmina

Catch per Unit Effort (CPUE) and annual fish catch: Trends of mean monthly CPUE in all sites are presented in Fig. 6 (freshwater habitat) and 7 (marine habitat):

- **Freshwater habitat:** CPUE declined by 30% in Small London and virtually remained the same in Kpong between 2009 and 2010. The average CPUE for 2009/2010 were; 22.72 and 10.57 for Small London and Kpong, respectively (Fig. 7). CPUE increases around the period of socio-religious festivities (namely, Easter and Christmas). There were significant differences in CPUE between Small London and Kpong (ANOVA, df = 1, $p<0.05$) for the period 2009 and 2010. The CPUE at Small London was relatively difficult to predict (larger mean and standard error, see error bars in Fig. 6) as compared to Kpong. Annual fish catch was estimated from CPUE data. Table 4 shows estimated annual fish catch at Small London (716.04 tons) and Kpong at (186.68 tons).
- **Marine habitat:** CPUE declined by 59 and 71% for Ahwiam and Elmina, respectively, between 2009 and 2010. The average CPUE for 2009/2010 were; 44.28 and 133.81 for Ahwiam and Elmina, respectively (Fig. 8). A low CPUE indicates low abundance and a high CPUE indicate high abundance. There were significant differences in CPUE between Elmina and Ahwiam (ANOVA, df = 1, $p<0.05$) for the period 2009 and 2010. The CPUE at Elmina was relatively difficult to predict (larger mean and standard error, see error bars in

Table 4: Estimated annual fish catch at small London and Kpong (freshwater)

Site	Average No. of active canoes per day	Average No. of fishing days/week (based on interviews)	CPUE daily (±S.E.) (kg/canoe/day)	No. of fishing weeks (based on interviews)	Catch per week (tons)	Catch per year (tons)
Small London	101	6	22.72 (3.96)	52	13.22	716.04
Kpong	68	5	10.57 (0.30)	52	3.59	186.68
Total					16.81	902.72

Table 5: Estimated annual fish catch at Ahwiam and Elmina (marine)

Site	Average No. of active canoes per day	Average No. of fishing days/week (based on interviews)	CPUE daily (±S.E.) (kg/canoe/day)	No. of fishing weeks (based on interviews)	Catch per week (tons)	Catch per year (tons)
Ahwiam	57	5	44.28 (18.48)	50	12.62	630.99
Elmina	141	5	133.81 (73.70)	50	94.34	4716.80
Total					106.96	5347.79

Formula: Catch per week = CPUE * average number of active canoes per day * average number of fishing days per week; Catch per year = CPUE * average number of active canoes per day * average number of fishing days per week * number of fishing weeks per year

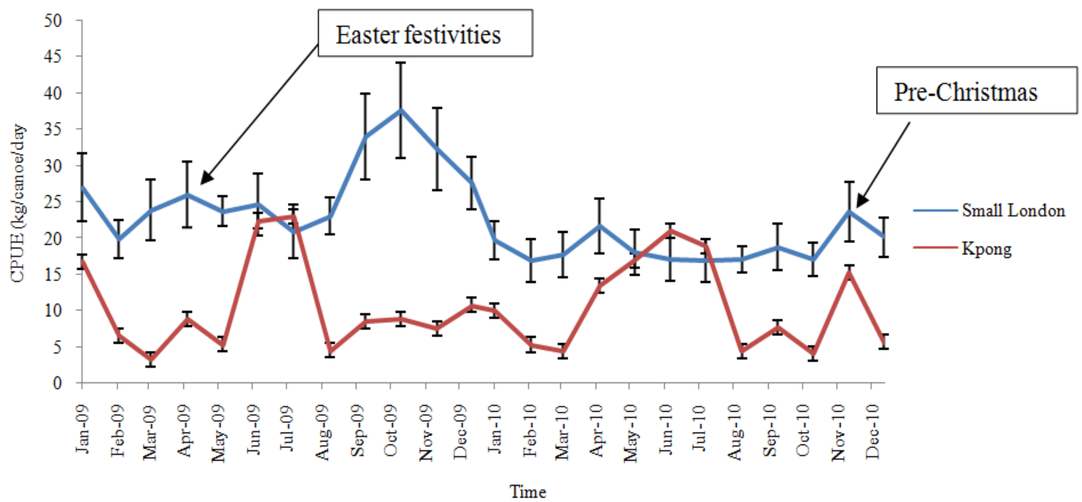

Fig. 6: Estimated mean monthly catch per unit effort at small London and Kpong (2009-2010)
Vertical bars indicate Standard Error (S.E.) of mean

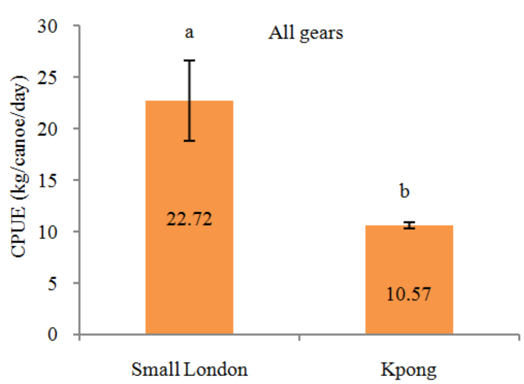

Fig. 7: Mean CPUE (all gears) at Kpong and Small London
Vertical bars indicate S.E. of mean; Different letters above bars indicate significant differences at 0.05 level (one-way ANOVA)

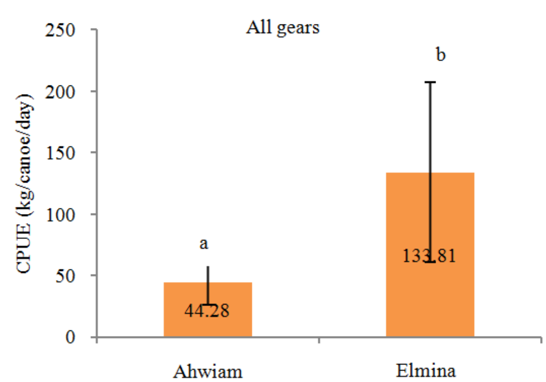

Fig. 8: Mean CPUE (all gears) at Elmina and Ahwiam
Vertical bars indicate S.E. of mean; Different letters above bars indicate significant differences at 0.05 level (one-way ANOVA)

Fig. 9) as compared to Ahwiam. The high CPUE encountered at Elmina compared to Ahwiam is due to the high level of motorization in Elmina (91%) than Ahwiam (50%). The CPUE trend corresponds to the upwelling phenomenon around the coast of Ghana. Annual fish catch estimated from CPUE data shows the following: Elmina (4716.80 tons) and Ahwiam (630.99 tons) (Table 5).

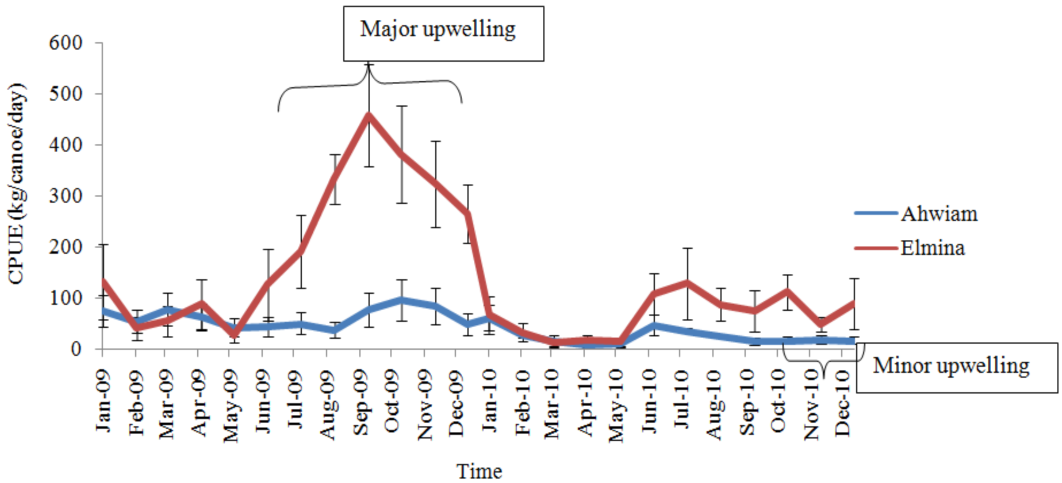

Fig. 9: Estimated mean monthly catch per unit effort at Ahwiam and Elmina (2009-2010)
Vertical bars indicate Standard Error (S.E.) of mean

DISCUSSION

Catch composition:

- **Freshwater habitat:** 50 fish species were identified in the Kpong dam area of the Volta River before impoundment (Vanderpuye, 1982). Dankwa (1982) identified 46 species one year after impoundment, while Antwi and Ofori-Danson (1993) identified 39 species eight years after impoundment. The present study concentrated on only two landing sites while previous studies concentrated on the entire reservoir, thus, accounting for differences in the number of species encountered (Table 2). Dominant species by weight (i.e., *Tilapia zilli* Redbelly tilapia, *Chrysichthys auratus* Golden Nile catfish and *Chrysichthys nigrodigitatus* Bagrid catfish) encountered at the Kpong reservoir (Small London and Kpong) contradicts Dankwa (1982) study that found African bonytongue (*Heterotis niloticus*, Osteoglossidae) as the most dominant fish by weight next to the Bagridae. Antwi and Ofori-Danson (1993) believed that, fishing pressure on the fish by local fishers might have resulted in its decline. The use of inappropriate fishing gears and destructive fishing practices such as use of dynamite, 'beating of water surface' and mesh sizes >25.4 mm (25 mm is the recommended mesh size, Fisheries L.I. 1968 (2010) might also be contributory factors. The dominance of cichlidae in commercial catches of fishers also confirmed the observation made by Quarcoopome *et al*. (2011). *Sierrathrissa leonensis* (West African pygmy herring) is a delicacy and has generated a lot of commercial activities (the nature of the market can greatly influence fish catch). However, serious attention is required in terms of its method of fishing. Local fishers use smaller mesh-size nets including mosquito-proof nets for fishing. This type of net collects indiscriminately small sized fishes including fry, larvae and eggs, thereby, endangering the stock in the reservoir and lowering fish recruitment (Quarcoopome *et al*., 2011; Antwi and Ofori-Danson, 1993).
- **Marine habitat:** According to FAO (2004), over 300 different species of commercially important fish, 17 species of cephalopods, 25 species of crustaceans and 3 turtle species are caught from marine sources in Ghana. The most important marine resources are small pelagics. The sardinella fishery is one of the most important economic activities in the small pelagic fisheries (as observed in Fig. 5, *Sardinella aurita* 54% by weight in Elmina).

However, there have been variations in the landings of sardinellas, reaching point of near collapse between 1973 and 1978 and subsequently increasing from mid-1980s (Mensah *et al*., 2006). According to Bard and Koranteng (1995), the resources appear to be going through a phase of decline that most pelagics worldwide experience from time to time which is linked among other things to changes in the marine environment (for instance, the low upwelling index of 14.7 in 2010). Reports also suggest that the demersal fishes (example, *Pagellus bellottii*, *Penaeus notialis*, *Trachiurus lepturus*) have been operating under stress during the last decades, with annual landings of about 50,000 mt annually exceeding the potential yield (Koranteng, 1998; Stromme, 1983). The variation in landings and under-performance of the marine fisheries is likely to have severe consequences on the fishing communities, the country and sub-region as a whole in terms of food security, employment, GDP contribution, economic insecurity, conflict and underdevelopment.

The current catch composition information would be useful in formulation of management strategies, such as regulating fishing pressure, effort and conservation measures to sustain utilization of the fishery resources.

Catch per Unit Effort (CPUE) and annual fish production: Despite its well-documented shortcomings, the Catch-per Unit-Effort (CPUE) is used in the assessment of fish populations, with strict proportionality between CPUE and abundance frequently assumed (Harley *et al.*, 2001). CPUE is an important indicator of fishery performance. CPUE is easy to implement and inexpensive when it comes to Fisheries Management (FM).

However, it has long been recognized that CPUE may not accurately reflect changes in abundance (Beverton and Holt, 1957). Reasons why CPUE might not be proportional to abundance have been investigated by simulation (Swain and Sinclair, 1994) and through examination of empirical data (Rose and Leggett, 1991; Crecco and Overholtz, 1990):

- **Freshwater communities:** Results from this study indicate that CPUE decreased over 30% between 2009 and 2010, an indication of depleting fish stocks, excessive fishing pressure and effort. This trend in CPUE decline is likely to increase the level of poverty, marginalization, vulnerability, food insecurity, poor rural development among others in the fishing communities. Declining fish stocks is also likely to hamper the region's ability to meet the targets of the UN Millennium Development Goals (MDG's) by 2015. Annual fish catch was estimated from data on catch-per unit-effort. Annual catch per canoe at Kpong and Small London were; 3 and 7 tons respectively, compared to an average of 7.1 tons for Lake Volta (the largest contributor of inland fish production in Ghana) (World Bank, 2011). Generally, information on production and performance of inland capture fisheries in Ghana is poor (Ofori-Danson, 2011 personal communication). World Bank (2011) gives total fish production from inland capture fisheries as 150,000 and 3,000 tons from aquaculture production. The annual fish production estimated for Small London and Kpong were 716.04 and 186.68 tons, respectively.
- **Marine communities:** CPUE declined by 59 and 71% for Ahwiam and Elmina, respectively, between 2009 and 2010. Annual catch per canoe at Elmina and Ahwiam were; 33.5 and 11 tons respectively, compared to the national average of 28.6 tons (for marine motorized canoes), 17 tons (for marine non-motorized canoes) (World Bank, 2011). These figures indicate that catches by the small-scale fisheries is declining and overfishing cannot be ruled out, which may adversely affect the income and poverty level of fishers. The slightly high annual catch at Elmina is probably due to high level of motorization (91%) and "*Ali Poli Watsa*" (APW) activities. With outboard motors, fishers are able to catch large quantities of fishes (greater catching power) without increase in number of canoes or crew sizes, thereby, increasing the fishing pressure and impeding efforts in attaining successful fisheries management. "*Ali Poli Watsa*" which is known for catching large quantities of fish was more employed at Elmina (65.7%) compared to Ahwiam (23.3%). In addition, fishers at Elmina targeted species of high value compared to fishers at Ahwiam, thus, the desire to maximize profit is likely to influence fishing activities and intensity.

In reality, records at the national level show that CPUE has been declining, even in the face of improved fishing techniques (MFRD, 2011, unpublished). Over the last decade, the catch per unit effort for all types of canoe fishing has been declining. This provides a good indication of excessive exploitation of Ghana's fishery resources. This is largely due to increase in effort (more canoes and greater catching power by each canoe) and poverty. Ofori-Danson (1999) asserted that, the forces of poverty have profound effect on increasing trend in fishing effort. It should be noted that, declining CPUE and high fishing pressure are usually the first indicators of overfishing and ultimately stock depletion. Therefore, the declining CPUE needs to be addressed urgently. This could be done through reduction in excess effort (illegal) and increase (legal) catch, capping canoe numbers, poverty reduction, provision of incentives and alternative livelihoods, aligning fishing capacity effort to sustainable catch levels. These measures will enhance the management of the fishery resources of Ghana and the sub-region in the long run.

Ghana's annual marine catch by canoe has been fluctuating between 186,816.02 tonnes (in 2007) and 198,936.48 tonnes (in 2010). A MFRD (2011) report suggests that, the unstable climatic regimes being experienced coupled with a lower upwelling index of 14.7 (in 2010) are contributory factors. The decrease in the use of light attractants in fishing could also be a contributing factor due to the enactment and minimal enforcement of the Fisheries Regulations L.I. 1968 of 2010.

CONCLUSION AND RECOMMENDATIONS

The present study confirms the views in the past decade that catch per unit effort (kg/canoe/day) are in decline both in the freshwater and marine habitats in Ghanaian waters. Annual fish catch per canoe estimated were 11-33 tons (marine habitat) and 3-7 tons (freshwater habitat). It is worth mentioning that, decisions to control how much effort (e.g., number of canoes or number of fishermen) would likely have far-reaching political and social implications. Therefore, fair basis for control should involve consultation with the relevant stakeholders (i.e., policy-makers, managers, fishers, researchers and Non-Governmental Organizations).

In view of the findings made on fish catch in the small-scale fisheries of Ghana, the following recommendations and strategies are presented for their implementation to enhance management of the small-scale fisheries of Ghana:

- Attempts should be made in controlling the declining CPUE, increasing fishing pressure and effort by provision of alternative livelihood options that fishers possessed the required skills. Alternative livelihoods will be the best option to help and encourage fishers dependent on fishery resources to move away from unsustainable harvesting practices and reduce fishing effort.
- The need to urgently involve fishers in the management of fishery resources in every phase (from planning to implementation/evaluation). Fishers knowledge and behavior are crucial in the management of the small-scale fisheries.
- Fishing regulations should be enforced (i.e., the existing catch and net size limits, monitoring, control and surveillance) and resourcing of regulating agencies (e.g., Fisheries Directorate and Community Based Fisheries Management Organizations).
- Appropriate regional database management system (comprising frame survey database; catch assessment database; socio-economic database; fish-processors database and publication database) should be developed within the short to medium term by Fisheries Commission and other relevant stakeholders. At the end of the day, routine and accurate fishery catch statistics are fundamental for the sustainable management of small-scale fisheries.

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