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Assessment of catch, diversity and abundance of ichthyofauna in the Tono Reservoir, Northern Ghana

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Abstract
Fish catches from the Tono Reservoir have been reported to decline significantly over the past decade. To investigate this problem, monthly fish samples were obtained from artisanal commercial fishermen and the use of experimental gillnets of stretched mesh sizes 5 cm and 7 cm from January 2015 to December 2016. Fish diversity was assessed using Margalef index (D) of species richness and Shannon-Weiner index (H) of evenness. The mean catch per unit effort for the period of study was 3.89 ± 0.48 kg/canoe/day and the mean annual catch was 1,431.7 ± 15.09 kg. Eighteen (18) fish species and 15 genera belonging to eight (8) families were recorded. The study indicated a low species diversity (D = 1.37). Regarding biodiversity, eight (8) fish species were classified as rare species. The fish catch and fish diversity were low, thus proactive management measures are required to conserve the ichthyofauna in the Tono Reservoir.

Keywords: Cichlids, fish catch, rare species, reservoir fisheries, Tono

1. Introduction

The fishing sub-sector in Ghana for a long time has supported livelihood and provided jobs for over 2.0 million individuals(BNP, 2009; World Bank, 2011) [1, 2], that is almost 10% of the total population(FAO, 2016) [3]. In the worldwide, fish offers about 3.0 billion people with almost 20% of their animal protein intake, and 4.3 billion people with about 15% of such protein (FAO, 2012) [4]. It has been reported that Ghanaians consume almost 1,000,000 metric tonnes of fish annually with about 400,000 metric tonnes only being produced within the country and imports up to 600 000 metric tonnes of fish worth over USD 200 million annually (FAO, 2016) [3]. The fishing sub-sector in Ghana contributes 4.5% of Gross Domestic Product (GDP), 12% of agriculture GDP and 10% of the manpower. There is high preference for fish as the main source of animal protein in Ghana and almost 75% of fish produced is consumed within the country, accounting for nearly 60% of animal protein in the average Ghanaian diet and a mean per capita fish consumption of nearly 26 kg representing 22.4% of household food expenditures (FAO, 2016) [3]. Fish is relatively affordable than many animal sources of protein (FAO, 2000) [5].

In Ghana as well as in many parts of the world, the ever increasing efficiency of fishing technology with modernised gear and new methods to detect fish has led to rapid decline of stocks. For example, in areas of Lake Malawi, fishery observers in the past have reported the elimination of an entire assemblage such as groups of cichlid species (Turner, 1977) [6]. Reservoir impoundment poses inevitable effect on aquatic fauna and flora including a shift in species composition and abundance with extreme explosion of some species and decline or even elimination of others (Dudgeon, 2000) [7]. The response of aquatic fauna to hydrological modifications induced by reservoirs are not well understood in the tropical faunal realm (Nelson, 1994) [8] despite intensive damming.

Fishers in the Tono Reservoir have been experiencing decline in fish catches for over ten years but scientists have done little to arrest the situation to avoid total collapse of the fishery that supports the livelihoods of riparian communities**.** There is completely inadequate current data for management to rely on for the implementation of pragmatic measures to safeguard the fishery which contribute significantly to the livelihood of fishers in the area. The only current information on the Tono Reservoir fishery was about preliminary observations on fishing activities (Obodai and Waltia, 2003) [9] carried out more than a decade ago. Related studies have been undertaken on other reservoirs in Ghana such as the Bui (Alhassan *et al*., 2016) [10], Owabi (Nunoo *et al*., 2012) [11], Kpong (Quarcoopome *et al*., 2011) [12], Weija (Quarcoopome and Amevenku, 2010) [13], Bontanga (Kwarfo-Apegyah and Ofori-Danson, 2010) [14] and Libga (Quarcoopome *et al*., 2007) [15] Reservoirs. Previous studies on the other reservoirs in Ghana have mostly dwelled on fish species composition but have failed to indicate specifically, fish species which are rare, few, common, abundant and dominant which generally echoes a caution of biodiversity loss. A careful study of literature reveals over 36 fish species in the Tono Reservoir during the period of impoundment (Directorate of Fisheries, 1980) [16]. However, the reservoir fishery has since undergone significant changes. Results of this study will not only be helpful in identifying fish species that are gradually lost but will also aid in re-directing management efforts in understanding specific ways that biodiversity loss affects ecosystem structure and function. This study will make available information to authorities for policy and programmes direction concerning the Tono. The specific objectives of this study were to: i) Determine fish catches of the Tono Reservoir, ii) Assess the diversity and abundance of fish species of Tono Reservoir, and iii) Assess and identify fish species that are rare, few, common, abundant and dominant in the Tono Reservoir.

2. Materials and Methods

2.1 Study area

Tono reservoir is situated in Kassena-Nankana West District on latitude 10º 52´ North and longitude 1º 08´ West of Ghana (Figure 1). The current surface area of the reservoir is 12.5 km^2 and the mean depth is 7.7 m. It has water storage capacity of 93 x 10^6 m^3. The mean annual rainfall is 950 mm whereas the mean temperature is 29 ℃. The mean relative humidity is 80% (Ghana Statistical Service, 2014) [17].

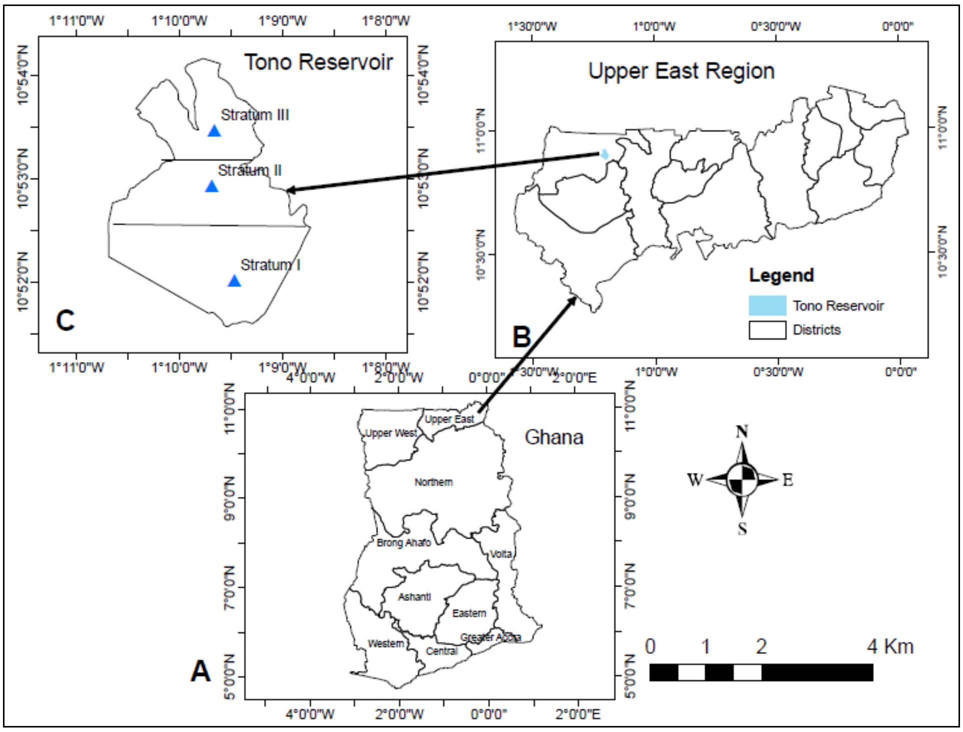

Fig 1: Map of Ghana (A), Kassena-Nankana West District (B) and Tono Reservoir (C) divided into 3 strata

2.2 Sampling design

To obtain a full understanding of the whole Tono Reservoir fishery, a three level stratified random sampling methodology was employed and data was collected for two years. The first stratum was the lower region characterised by broad, deep and lake-like basin (Lacustrine zone) (Figure 1). The second stratum was the middle region of the reservoir characterised by a broader and deeper basin (Transitional zone). The third stratum, on the other was the upper region of the reservoir characterised by a narrow and channelised basin (Riverine zone) Thornton *et al*., 1996) [18]. Two designated hydrological seasons: dry season (January, February, March, April, November and December) and wet season (May, June, July, August, September and October) was employed for data collection.

2.3 Fish sampling and catch assessment

Fish samples were obtained from the landings of commercial fishermen and experimental gillnets once every month and assessed from January, 2015 – December, 2016. The experimental gillnets (5 cm and 7cm laterally stretched knot-to-knot mesh size) were 200 m long and 400 m^2 surface area each. The fishermen used gillnets with mesh sizes ranging from 1.0 – 11.5 cm stretched mesh sizes, cast nets (2.5 cm mesh size), wire-gauze traps (2.0 – 4.0 cm mesh size) and hooks-and-lines. Fish samples were collected using systematic random sampling from the most active landing sites namely Bay 1, Bay 2, and Bay 5 representing lower reach, middle reach and upper reach of the reservoir respectively. When available, fish samples were obtained from 20 canoes representing between 90 and 95% of sampling accuracy in a small population (Stamatopoulos, 2004) [19]. Fish samples were recorded from every second landed canoe until the twentieth canoe once every month.

The total fish catch from each landed canoe was recorded using a 20-kg capacity balance scale. All individuals from each landed canoe were subsequently sorted into species and weighed *in situ*. The standard body length/total body length (cm) and weight of fish (g) in the sample of 50 randomly selected individuals per species were measured using a measuring board to the nearest 0.1 cm and an electronic scale to the nearest 0.1 g respectively. The type of gear used/mesh size of nets and number of fishermen per canoe per day were recorded. Also, the total number of active and inactive canoes was noted during sampling. Fish specimens obtained were identified up to species using freshwater identification guide by Paugy *et al*. (2003ab) [20] and Dankwa *et al*. (1999) [21].

2.4 Data analysis
The catch per unit effort (CPUE) was determined as catch per active canoe per day (kg/canoe/day). The total catch (kg) per day was determined as:

Mean CPUE $\times$ No. of active canoes/day
The monthly fish catch (C) was estimated using:
C = Mean CPUE $\times$ Fishing days
Full days of the months were used in the estimation because fishermen work all seven (7) days in a week. Fish length data were organised into length-frequency distribution. Monthly length frequency (total length (TL) cm) data was compiled from sampled fish length measurements and the distribution determined at 1.0 cm length intervals. Trends in monthly fish catches with standard errors were presented in bar chart with standard error using Microsoft Excel 2010. Seasonal variation of catches was determined using Mann-Whitney U (Wilcoxon rank-sum) test at 95% confidence level ($p < 0.05$) after the data failed normality test. One-way ANOVA was used to determine the differences in fish species along the lower, middle and upper reaches of the reservoir after log-transforming ($\log_{10} X + 1$) the data to meet normality requirement. A mean separation test of the reaches were done using Tukey's test at $\alpha = 0.05$ significance level.
Checklist of fish species was generated from identification of monthly samples. Two diversity indices were used to describe and compare the diversity of the fish species in the reservoir. These were: (i) Margalef's Index (D) for species richness (Margalef, 1968) [22],

D = $S - 1/\ln N$

where S = number of species and N = number of individuals
(ii) The Shannon-Wiener's Index (H') of species evenness (Shannon and Wiener, 1963) [23],

H' = $-\sum Pi^{\ln} Pi$

where Pi is the proportion of the total number of individuals occurring in species i. Pi = ni/N; ni = Number of individuals of each species in the sample. N = Total number of individuals of all species in the sample.
The percentage composition of each species was calculated over the total for the sampling period. The percentage composition or relative abundance (% A_i) of fish species *i* in the Tono reservoir was calculated as follows:

$$\%A_i = \frac{\sum S_i}{\sum S_t} \times 100$$ [25]

where S_i is the sample number of fish species *i*, and S_t is the total number of all species. Abundance score of the species were estimated using the criteria of Allison *et al.* (1997) [24], as shown in Table 1.

Table 1: Abundance score of fish species

Number of individual species per year	Interpretation
1 – 50	Rare
51 – 100	Few
101 – 200	Common
201 – 400	Abundant
>400	Dominant

Source: Allison *et al.* (1997) [24]

3. Results
Results for monthly fish catches, fish species abundance and diversity are presented in this section.

3.1 Fish catch
Figure 1 shows the monthly mean catch per unit effort (CPUE) of Tono Reservoir for 2015 and 2016. The mean CPUE for the study period was 3.89 ± 0.48 kg/canoe/day. The annual mean CPUE for 2015 and 2016 were 2.69 ± 0.59 kg/canoe/day and 5.08 ± 0.61kg/canoe/day. Monthly mean CPUE ranged from 0.68 to 7.11 kg/canoe/day for 2015 and 9.13 – 0.98 kg/canoe/day for 2016. An increasing trend of CPUE from January to December was observed for both years. The peak CPUE was noted in October for the wet season and December for the wet season in both years.

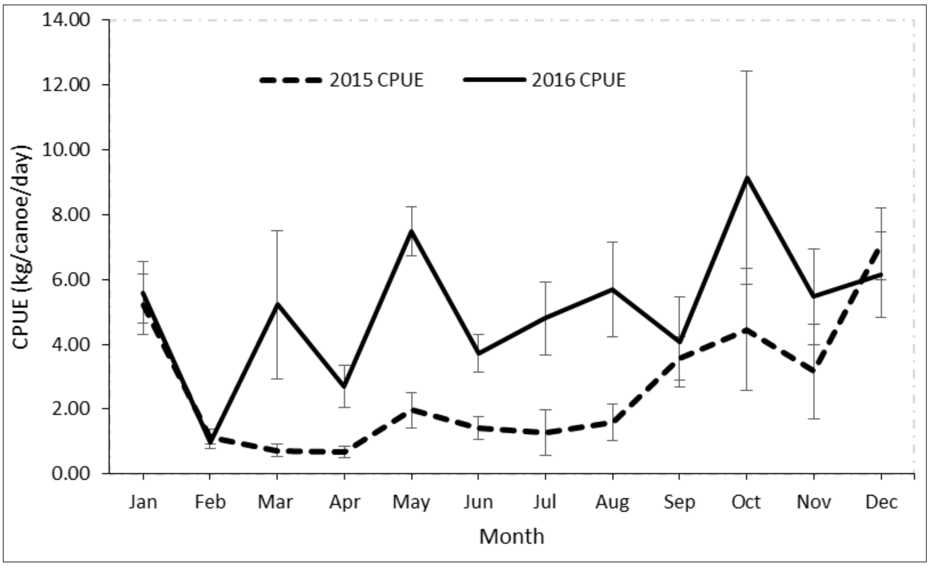

Fig 2: Monthly mean CPUE with standard error bars for 2015 and 2016 of Tono Reservoir, Ghana

The monthly fish catches for 2015 and 2016 are presented in Figure 2. The results generally showed an increasing trend of fish catches from January to December for both years. Mean monthly catches ranged 20.32 – 220.26 kg for April – December respectively in 2015 whilst in 2016 catches ranged 27.44 – 283.17 kg for February – October respectively. The mean monthly catch for 2015 was 82.57 ± 18.27 kg and that for 2016 was 156.05 ± 19.32. The annual total fish catch for 2015 and 2016 were estimated at 990.84 kg and 1,872.58 kg respectively.

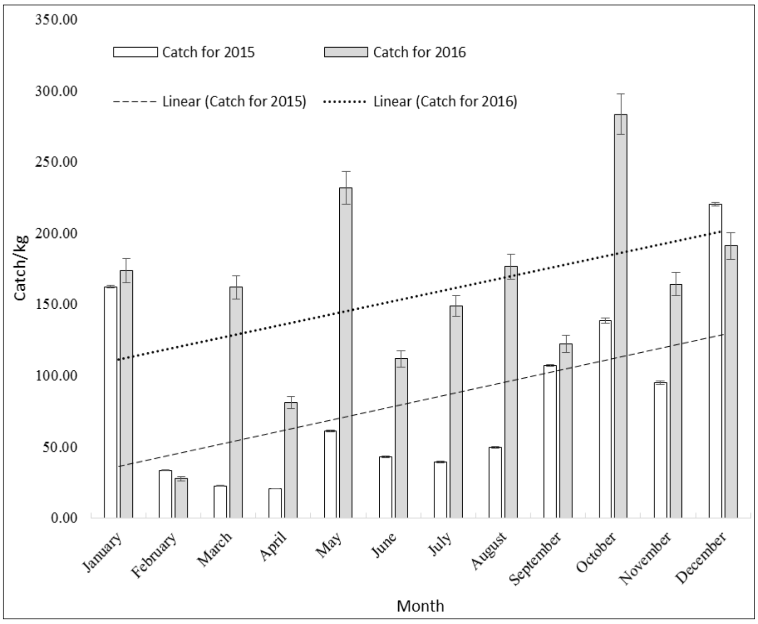

Fig 3: Monthly mean fish catches with standard error bars for 2015 and 2016 of Tono Reservoir, Ghana

3.2 Species diversity and relative abundance

Table 2 shows a checklist of fish families/species and their seasonal occurrence recorded during the study. A total of 8,248 specimens were sampled comprising 18 species, 15 genera belonging to 8 families were noted. Cichlidae was the dominant family with 5 species. Fifteen (15) species were encountered in 2015 whereas 18 species were recorded in 2016. The results indicated a higher abundance of species caught in the dry season than wet season.

Table 2: Checklist and seasonal presence-absence of fish families and species collected during the study in 2015 – 2016 from the Tono Reservoir, Ghana.

	2015		2016	
Taxa (Authority)	**DS**	**WS**	**DS**	**WS**
Claroteidae				
Auchenoglanis occidentalis (Valenciennes, 1840)	+	+	+	+
Chrysichthys auratus (Geoffroy Saint-Hilaire, 1808)	-	-	+	-
Clariidae				
Clarias gariepinus (Burchell, 1822)	+	+	+	+
Cichlidae				
Hemichromis bimaculatus (Gill, 1862)	+	-	+	+
Hemichromis fasciatus (Peters, 1852)	+	+	+	+
Oreochromis niloticus (Linnaeus, 1978)	+	+	+	+
Coptodon/Tilapia zillii (Gervais, 1848)	+	+	+	+
Sarotherodon galilaeus (Günther, 1903)	+	+	+	+
Cyprinidae				
Labeo coubie (Rüppell, 1832)	+	-	+	-
Mormyridae				
Marcusenius senegalensis (Steindachner, 1870)	+	+	+	+
Marcusenius ussheri (Günther, 1867)	+	-	-	+
Pollimyrus isidori (Valenciennes, 1848)	+	+	+	+
Clupeidae				
Odaxothrissa mento (Regan, 1917)	+	-	+	+
Pellonula leonensis (Boulenger, 1916)	+	+	+	+
Sierrathrissa leonensis (Thys van den Audenaerde, 1969)	+	+	+	+
Distichodontidae				
Paradistichodus dimidiatus (Pellegrin, 1904)	-	-	+	-
Schilbeidae				
Schilbe intermedius (Rüppell, 1832)	+	+	+	+
Schilbe macropogon (Trewavas, 1943)	-	-	-	+

DS: dry season
WS: wet season
Plus sign (+) indicates presence
Negative sign (-) indicates absence

Table 3 presents seasonal and yearly diversity indices of fish species during the study. The results showed a low species diversity in the Tono Reservoir. Generally, a higher number of species (i.e. species richness) were recorded in the dry season (D = 1.90) than in the wet season (D = 1.66) for the two years study period. In contrast, the diversity or relative abundance of each species (i.e. species evenness) was generally higher in wet season (H = 1.50) than in the dry season (H = 1.27) for the study period. There was higher number of species recorded in 2016 (D = 1.96) than in 2015 (D = 1.79) whereas the relative abundance of each species (diversity) was higher in 2015 (H = 1.43) than in 2016 (H = 1.31). Table 4 presents the length and weight characteristics of fish species in the Tono Reservoir for the two years study period. Their total length ranged 3.5 – 71.0 cm and the weight ranged 1.0 – 1600.0 g. The modal total length ranged 4.8 – 28.0 cm and weight ranged 2 – 18 g.

Table 3: Diversity indices of fish species in the Tono Reservoir, Ghana in 2015 and 2016

Diversity index	**2015**		**2016**		**Overall**	
	Dry season	**Wet season**	**Dry season**	**Wet season**	**2015**	**2016**
Taxa_S	15.00	11.00	16.00	15.00	15.00	18.00
Margalef_D	1.85	1.61	1.94	1.71	1.79	1.96
Shannon_H	1.24	1.77	1.29	1.23	1.43	1.31

Table 4: Morphometric characteristics of fish species in the Tono Reservoir, Ghana in 2015 – 2016.

	Total length (cm)				**Weight (g)**			
Species	Range	Median	Mode	S.D.	Range	Median	Mode	S.D.
A. occidentalis	9.0 – 48.6	24.8	24.0	8.097	8 – 1600	163.0	163	388.998
**C. auratus*	12.0	-	-	-	35.1	-	-	-
C. gariepinus	13.0 – 71.0	25.0	28.0	9.295	16 – 300	103.0	18	80.432
H. bimaculatus	6.3 – 7.5	7.0	7.5	0.453	7.0 – 10.0	8.5	10	1.211
H. fasciatus	5.8 – 21.0	11.0	10.0	3.799	7.0 – 108	29.0	18	26.714
O. niloticus	5.0 – 32.5	15.0	15	3.384	4.0 – 386	67.0	35	48.650
C. zillii	4.6 – 16.0	10.6	9.0	2.576	3.0 – 88.0	26.0	13	16.466
S. galilaeus	7.2 – 25.0	14.0	12.0	2.884	8.5 – 248	56.0	65	33.416
**L. coubie*	16.0	-	-	-	48.0	-	-	-
M. senegalensis	7.0 – 23.0	12.8	-	7.655	8.0 – 222.0	47.5	-	87.347
**M. ussheri*	23.9	-	-	-	181.0	-	-	-
P. isidori	4.0 – 6.5	5.0	-	0.951	1.0 – 5.0	2.0	-	1.581
O. mento	4.5 – 5.0	4.8	4.8	0.170	2.0 – 2.0	2.0	2	0.000
P. leonensis	4.7 – 8.0	5.0	5.0	0.907	1.5 – 7.0	2.0	2	1.487
S. leonensis	5.5 – 6.5	6.0	6.0	0.378	2.0 – 3.0	2.0	2	0.535
**P. dimidiatus*	5.1	-	-	-	3.4	-	-	-
S. intermedius	3.5 – 19.2	14.4	14.0	2.699	5.0 – 65.0	23.5	22	12.464
S. macropogon	15.5	-	-		25.0	-	-	-

- Indicates not applicable; S.D. is standard deviation; *Indicates species which were encountered only once

Table 5 depicts seasonal abundance of major fish species encountered during the study period. The most abundant species in terms of biomass (40.4%) and numbers (38.3%) was *S. galilaeus* and the second was *O. niloticus* with biomass of 36.3% and numbers of 33.5% for the study period. A biomass of 118.04 kg was recorded in the dry season higher than 62.95 kg in the wet season in 2015. Similarly, the higher numbers of fish were obtained in the dry season (2,014) than wet season (1,811) in 2015. In 2016, wet season registered the higher quantity in both biomass and numbers. However, Mann-Whitney U (Wilcoxon rank-sum) test revealed no significant difference (p = 0.810) between dry and wet seasons for both biomass and number for 2015 and 2016. In the same way, there was no significant difference (p = 0.411) in spatial abundance (in terms of numbers) for the study period as shown in Table 6.

Table 5: Seasonal abundance of major fish species in the Tono Reservoir, Ghana in 2015 – 2016

2015								
	Weight (kg)				**Number**			
Fish species	Dry	%	Wet	%	Dry	%	Wet	%
A. occidentalis	9.18	7.77	9.75	15.49	65	3.23	27	1.49
C. gariepinus	13.54	11.47	1.93	3.06	61	3.03	11	0.61
O. niloticus	34.12	28.90	17.40	27.64	625	31.03	296	16.34
S. galilaeus	58.45	49.52	19.55	31.05	1144	56.80	538	29.71
C. zillii	1.63	1.38	6.02	9.57	53	2.63	607	33.52
Others	1.13	0.95	8.31	13.19	66	3.28	332	18.33
Total	118.04	100.00	62.95	100.00	2,014	100.00	1,811	100.00
2016								
A. occidentalis	16.06	7.90	29.69	10.97	160	5.05	109	2.69
C. gariepinus	4.48	2.20	18.68	6.91	12	0.38	89	2.20
O. niloticus	108.41	53.32	78.11	28.87	1586	50.08	1188	29.36
S. galilaeus	64.15	31.55	122.36	45.22	243	7.67	2303	56.91
C. zillii	4.43	2.18	13.51	4.99	112	3.54	162	4.00
Others	5.80	2.85	8.22	3.04	1054	33.28	196	4.84
Total	203.33	100.00	270.58	100.00	3,167	100.00	4,047	100.00

Table 6: Spatial relative abundance (in numbers) of fish species of Tono Reservoir during the study period of 2015 – 2016.

Source of variation	DF	SS	MS	F	*p*-value
Factor	**2**	**0.195**	**0.098**	**0.94**	**0.411**
Part of reservoir	**Mean ± Standard error of mean**				
Lower reach	0.85 ± 0.101				
Middle reach	1.08 ± 0.134				
Upper reach	0.93 ± 0.129				

Means are not significantly different at $\alpha = 0.05$

Table 7 shows the abundance score which classifies the fish species under *rare*, *few*, *common*, *abundant* and *dominant* taking into consideration their numbers encountered during sampling. Out of the 18 species recorded in this study, 8 of them representing 44.4% were considered rare species. Only one species was classified as common and had the lowest number (5.5%).

Table 7: Abundance score of the ichthyofauna in the Tono Reservoir, Ghana in 2015 – 2016

Fish species	Status	% Score
Hemichromis bimaculatus *Chysichthys auratus* *Labeo coubie* *Marcusenius senegalensis* *Marcusenius ussheri* *Paradistichodus dimidiatus* *Pollimyrus isidori* *Schilbe macropogon*	Rare	44.4
Clarias gariepinus *Hemichromis fasciatus* *Auchenoglanis occidentalis*	Few	16.7
Coptodon/Tilapia zillii	Common	5.5
Odaxothrissa mento *Schilbe intermedius* *Sierrathrissa leonensis*	Abundant	16.7
Oreochromis niloticus *Pellonula leonensis* *Sarotherodon galilaeus*	Dominant	16.7

4. Discussion
4.1 Fish catch
Catch per unit Effort (CPUE) is an essential management tool used in the evaluation of fish populations because it is assumed to have a linear relationship with abundance (*Harley et al*., 2001) [25]. The results of the current study showed about 30.7% increase in mean CPUE between 2015 and 2016. This increase was attributable to relatively higher rainfall (922.7 mm) recorded in 2016 than 2015 (859.8 mm). Flood waters following high rainfall increase nutrient inputs and availability of food for fish in water bodies. Years of high rainfalls following inundation resulted in significantly increased relative abundance of fish in Lake Naivasha, Kenya (Oyugi *et al*., 2011) [26]. The blend of decaying submerged terrestrial vegetation and the increased fluvial input of nutrients triggers an increased production of detritus, phytoplankton, periphyton and zooplankton (Weyl, 2007) [27]. Additionally, Britton *et al.* (2009) [28] noted that production of tilapia species increased in response to the flood and increased food resources in the Tono Reservoir. High growth rate and recruitment success after flood events have particularlybeenreportedincichlidpopulations(Weyl,2007) [27]. The significant impact of floods due to high rainfall explains why the post-flood months (September - December) recorded relatively higher fish catch in both years in this current study.
The annual fish catch (averagely 1,431.7 kg or 1.4 tonnes) recorded in this study was far lower than the estimated annual potential yield of 22,500 kg (22.5 tonnes) as reported by FAO (2016) [3]. The mean annual catch recorded in this study represented 6.36% of the annual potential yield indicating that the fish stocks are probably under pressure as a result of over fishing. It is clear that co-management measures coupled with enforcement of existing fisheries regulations ought to be activated to avert the poor fish production situation of the Tono reservoir. Low fish production was also observed in Black Volta gillnet fishery near the Bui dam dam (Alhassan *et al*., 2016) [12]. The total annual capture fisheries production in Ghana was about 298,000 tonnes in 2013; around 24% of this output (90,000 tonnes) emanated from inland capture fisheries mostly based on Lake Volta, the largest man-made lake in Africa (FAO, 2016) [3]. Hence, the contribution of the Tono Reservoir fishery to total inland fisheries production in Ghana is insignificant. The observed absence of big size fish of major commercial species could be due to less selectivity of gears operating in the reservoir. This however, calls for the enforcement of the Ghana's Fisheries Regulations which restrict the use of non-selective gears and allow nets of 7.5 cm minimum stretched mesh size (Fisheries Regulations, 2010) [29] to be used in riverine systems.

4.2 Species diversity and relative abundance
Diversity indices present vital statistics about rarity and commonness of species in a community. This study showed a decline in the number of species inhabiting in the Tono Reservoir. Technical reports from the Directorate of Fisheries, Navrongo indicated that there were over 36 fish species in the reservoir during the impoundment (Directorate of Fisheries, 1980) [16]. This decline from over 36 to only 18 fish species within a period of 36 years could be partly linked to the increase in fishing efforts and use of illegal gears including under-sized mesh (less than 7.5 cm minimum mesh size) gillnets resulting in increased pressure on the fisheries resource. Consequently, this pressure on the fisheries resource might be a reason for the low species richness and relative abundance.
Species diversity (species heterogeneity) is a typical characteristic of community structure. High species diversity means a highly complex community which allows wide range of interaction among species. When the community is not disturbed, various complex interactions such as energy transfer (food webs), predation, competition and niche apportionment among species of the population usually occur (Brower and Zar, 1977) [30]. High species diversity is likely to occur in communities with less disturbances.
In this present study, cichlids dominated by biomass and number especially *S. galilaeus* and *O. niloticus* and this might be due to low population of predators, food availability in the reservoir and successful reproduction. Similar observations have been reported in other reservoirs in Ghana that tilapias (especially *S. galileus*) formed the major group of the fishery (Nunoo *et al*., 2012; Quarcoopome *et al*., 2007) [11, 15]. It is worth noting that current illegal fishing practices might have contributed to the reduction in numbers of *H. bimaculatus, C. auratus, L. coubie, M. senegalensis, M. ussheri, P. dimidiatus, P. isidori, S. macropogon* causing them to become rare species. Additionally, construction of reservoirs over rivers seriously affects the aquatic fauna by causing changes in the abundance and composition of species, with reduction or even local elimination of some populations (species) and a marked

increase of others that find favourable conditions in the new environment (Fukushima *et al*., 2007) [31].

5. Conclusion

The low catch, abundance and diversity of fish species registered in this current study implies that the Tono Reservoir fishery resource may not be viable anymore to support livelihood. Additionally, the dominance of relatively small-sized fish observed in the catch indicates that the fish species are under intense fishing pressure. This is alarming since so many fishermen compete to catch the same depleting resource of which will eventually end up in the collapse if no immediate management schemes are introduced. It is recommended that co-management committee be instituted and resourced to help arrest the deteriorating nature of the fishery resource and conserve the biodiversity of the Tono Reservoir.

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