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Growth, Mortalities and Exploitation Rates of *Alestes baremoze* (Joannis, 1835), *Brycinus nurse* (Rüppell, 1832) and *Schilbe intermedius* (Rüppell 1832) from the lower reaches of the White Volta River (Yapei), Ghana

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A six-month study was conducted from October 2011 to March 2012 to assess the biology and state of exploitation of three major species namely *Alestes baremoze, Brycinus nurse* and *Schilbe intermedius* from the lower reaches of the White Volta River (Yapei), Ghana. Routines in FAO-ICLARM Stock Assessment Tools II (FISAT II) were used to determine the growth and mortality parameters and exploitation rates (E) from the length-frequency data generated from the landing surveys. *Alestes baremoze* had asymptotic length (TL_∞) of 46.73cm and growth rate (K) of 0.94 year^{-1}. *Brycinus nurse* had TL_∞=28.38 cm, K= 1.10 year^{-1} whereas *Schilbe intermedius* had TL_∞=27.93 cm, K=0.95 year^{-1}. *Brycinus nurse* which was the third most abundant species among landings composition was being exploited at a rate of 0.77, above the optimal exploitation rate ($E_{0.5}$). *Alestes baremoze* which was the most abundant species had exploitation rate of 0.30 whilst *Schilbe intermedius* had the exploitation rate (E) of 0.36. Both species populations in the lower reaches of the White Volta River are thus under exploited.

Keywords: White Volta River, biology, exploitation, length-frequency, asymptotic length, species and population.

INTRODUCTION

The Lake Volta and its tributary Volta Rivers which form the most important inland fishery area in Ghana have in the last four decades undergone great changes in its ecology, limno-chemistry and socio-economy. Increased pressure on land along the banks has led to high rates of deforestation. This has resulted in increased soil erosion leading to the transportation of high loads of silt and nutrients through rivers into the lake, thereby contributing to its eutrophication. Furthermore, wetlands bordering the lake are being converted to agricultural land or grazing land, and therefore may not be able to act as natural filters for nutrients and silt, and now do not provide breeding grounds for many fish species [1].

As a result of these problems, the Lake Volta Research and Development Project (VLR&DP) was undertaken under the Food and Agricultural Organization (FAO) and United Nations Development Programme during the first decade of the lake's existence [2-3]. These studies came to an end in 1978. Since then, systematic data collection from the Lake Volta and Volta Rivers natural resources has been lacking. There have been calls for renewed studies to facilitate their management due to declining catches. Growth, mortality and exploitation rates are of great importance to fisheries management and modeling.

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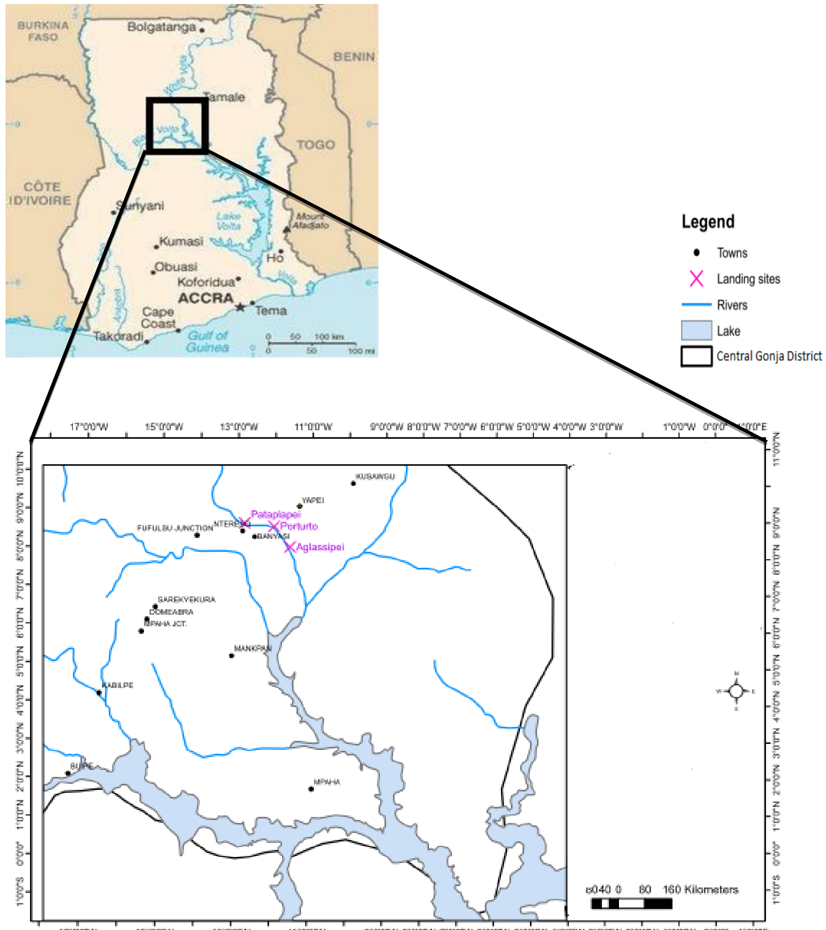

Figure1. Map of Ghana with an insert of the detailed study area showing Yapei, and the three landing sites; Pataplapei, Porturto, and Aglassipei.

This study was conducted in response to the calls for renewed studies to provide relevant data for sustainable management of the Volta fisheries.

Alestes baremoze, Brycinus nurse and *Schilbe intermedius* are very abundant from October to March in the Yapei stretch of the White Volta River. During this period, these fishes constitute a significant part of the fish diet of the local inhabitants. In this way, they provide a source of animal protein. Subsequently, the importance of the Yapei fishery cannot be underestimated. Yapei is 52km from the Northern regional capital Tamale. Tamale is the third largest city in Ghana with a population of 537,986 [4]. Yapei is easily accessible as it is on the Accra-Kumasi-Tamale trunk road. Yapei is one of the nine main sources of smoked fish to the Tamale Central Market [5]. The Tamale Central Market is the largest market center in the metropolis and majority of the inhabitants buy their food stuffs from this market. It thus makes Yapei an important supplier of fish especially smoked fish. Fishermen at the Yapei stretch of the White Volta River practice unregulated and unselective harvesting of fish, with fishermen harvesting all sizes of fish without regard to the sustenance of the fishery. These practices are targeted at more catches for more income. Fish can only be harvested at the maximum sustainable yield (MSY) when all the biological parameters are known.

The study was therefore conducted to provide relevant information on the growth parameters, the mortalities and exploitation rates of *Alestes Baremoze*, *Brycinus Nurse* and *Schilbe Intermedius* from the lower reaches of the White Volta River (Yapei), Ghana.

MATERIALS AND METHODS

Study Area

This study focuses on the lower reaches of the White Volta River around Yapei. Yapei together with Bupei (where the Black Volta passes) form the main commercial fishing areas in the stratum VIII of the Lake Volta. Yapei is located within the Central Gonja District of the Northern Region of Ghana. It lies within latitudes 9° 10′ 0″ N, 1° 10′ 0″ W (Figure 1). According to Abban *et al.* [6] there are four main seasons that can affect fishing in the

Volta basin namely; dry season, January –March (lowest water level); pre flood season, April-June (water level rising); flood season, July-September (highest water level); and post flood season, October-December (water level drawdown).

The study was done during post flood and dry seasons and along 8.84 km stretch of the lower reaches of the White Volta River at Yapei. Three non-overlapping landing sites namely Pataplapei, Porturto and Aglassipei were selected (Figure 1) to provide a representative overview of the fisheries in the Yapei stretch of the lower reaches of White Volta River. Porturto is the biggest and most important landing site along the stretch. It is central and it is right in the Yapei Township and for the purpose of this study it is considered as midstream.

Porturto serves as the main landing point not only for its fishers but also for other fishers and fish traders from neighboring landing sites and villages. Pataplapei is upstream, 4.8 km from Porturto whilst the landing site Aglassipei is downstream, 4.04km from Porturto (Figure 1). Pataplapei lies within latitudes N 09° 08. 555', W 001° 12.166'; Porturto within N 09.08.427', W 001° 09.547' whilst Aglassipei lies within N 09° 06.724', W 001° 07.710'.

Fish Sampling and Measurement

Fish sampling and landings survey were done once in month in each of the three landing sites and it spanned over the study period (October 2011-March 2012). The fish sampling and landing surveys were conducted on the days of visit between 6:00 am and 12:00pm GMT. The samples were taken from the local fishermen's catches and examined for their species composition using keys provided by [7-8]. The total lengths of samples of selected species for detail study were recorded to the nearest 0.1 cm using a fish measuring and grouped into 1cm total length (TL) class interval and their mid-lengths were used for length frequencies distributions samples.

Data Analysis

Growth and Mortality

The analysis of the population parameter estimates was done using the routines in the FAO-ICLARM Stock Assessment Tools II, FISAT II [9]. Due to limited time of the study and a small sample size of the selected species, the possibility of artificially improving the sample size by pooling the FISAT data over two months was explored. This gave a better outlook of the data than the non-pooled six months data. The estimates of the von Bertalanffy growth parameters, the asymptotic length (L_∞) and the growth coefficient (K), were obtained using the ELEFAN I routine of FISAT II [10].

The estimates of L_∞ and K were used to compute the mortalities in FISAT II. Total mortality (Z) was derived from linearised length-converted catch curve [11]. Natural mortality (M) was derived through the empirical equation of [12] using the lower reaches of the White Volta River mean surface habitat temperature of 28.8°C measured during the period of the study and as described below:

$$\mathrm{Log}_{10}\, L_\infty\, M = -\, 0.00066 - 0.279\, \mathrm{Log}_{10} L_\infty + 0.6543\, \mathrm{Log}_{10}\, K + 0.463\, \mathrm{Log10}\, T.$$

The fishing mortality rate (F) was calculated from the equation; F= Z– M and the rate of exploitation (E) from E = F/Z [13]. The exploitation rate assesses if a stock is over fished or not, on the assumption that optimal value E (E opt) is equal to 0.5. The use of E or 0.5 as optimal value for the exploitation rate is based on the assumption that the sustainable yield is optimized when F= M [14].

Setting the Initial Values in Elefan I Routine

The length-frequency data was carefully scrutinized using steps outlined in FISAT II (User's guide). Under the ELEFAN I routine, growth curve that "best" fits a set of length-frequency data, using the value of R_n as a criterion was used. Two of the options provided by identifying the "best" growth curves of the species.

FISAT II namely K-scan and response surface analysis were mainly used for Data Points Selection Procedure in the Length-Converted Catch Curve Routine of Fisat Ii

The growth parameters (K and L_∞) as obtained from the ELEFAN I routine were inputted in the first tab of length-converted catch curve routine, the data points were then computed by clicking the "Compute Data Points" which subsequently plotted results of the length-converted catch curve and displayed in the second tab. The default selected points presented under the second tab of the length-converted catch curve routine were changed by clicking on the "Reset Selections" command button. The final selection of the data points was achieved after visually inspecting the catch curve presented under the second tab of the routine and identifying better sequence of points.

In some cases, a series of trials of changing the selected default points and reselecting other points and comparing the goodness of the statistical results of the regression analysis which were presented in the third tab of the routine were very helpful in achieving the final selection.

The final selection was followed by clicking the command button "Extrapolate Prob.," which displayed the User interface to compute natural mortality (M) from Pauly's empirical equation when the mean annual habitat temperature is entered. The value of M was encoded directly and used in extrapolating points of the catch curve. The Estimates of Z, F, M, and E were all obtained.

RESULTS

Growth

As calculated by FISAT II, the growth function plots and

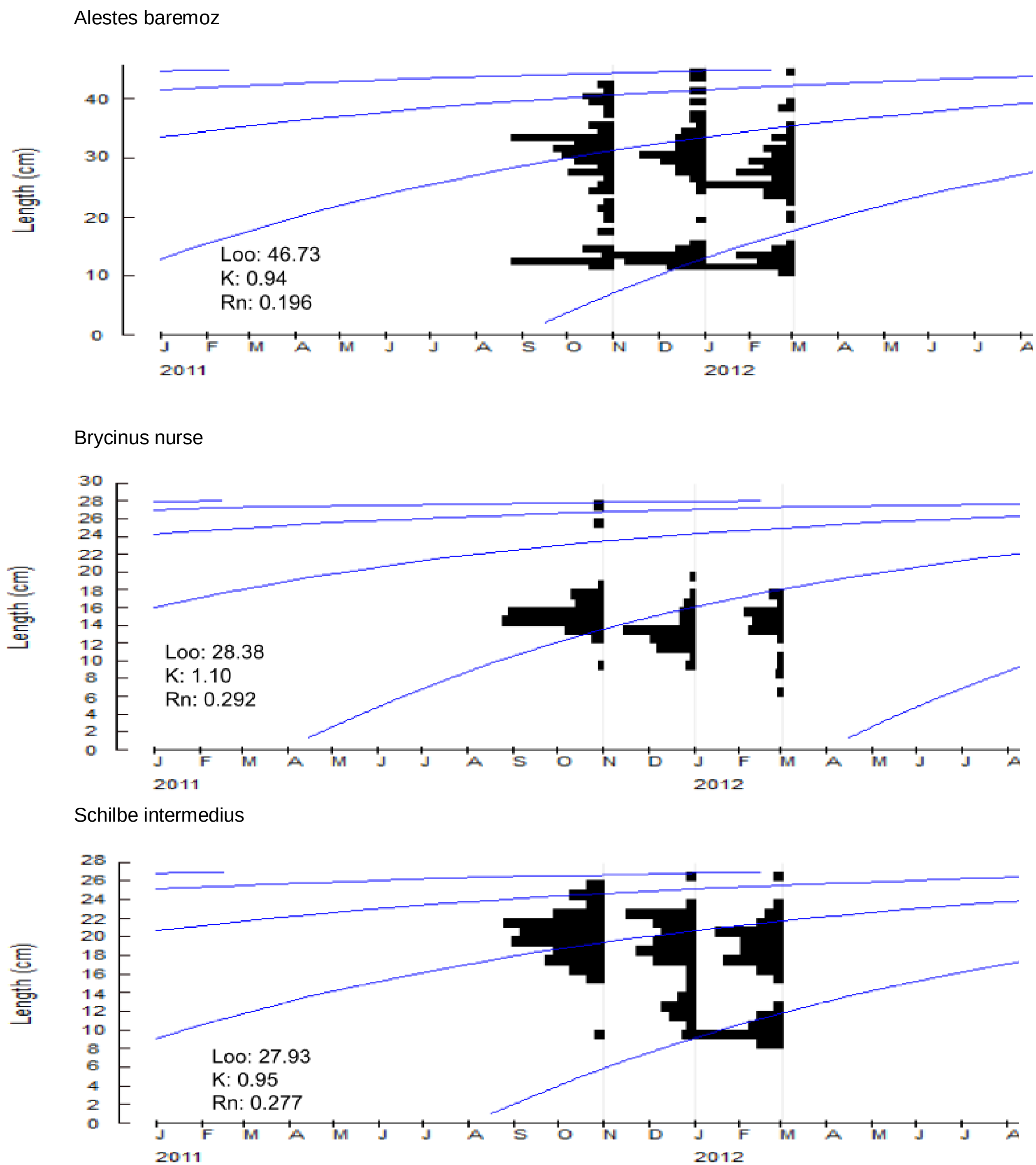

Figure 2. von Bertallanfy growth function plot and length frequencies for the three species in the lower reaches of the White Volta River during the period of study (October 2011-March 2012).

length frequencies of *Alestes baremoze, Brycinus nurse* and *Schilbe intermedius* in the lower reaches of the White Volta River are shown in Figure 2. *Alestes baremoze* had the largest asymptotic length ($L\infty$) of 46.73 cm. It is followed by *Brycinus nurse* with asymptotic length (L_∞) of 28.83cm. *Schilbe intermedius* had the least asymptotic length ($L\infty$) of 27.93cm.

However, on growth coefficient (K) *Brycinus nurse* got the highest of 1.1 year^{-1}. The growth coefficient (K) of 0.95year^{-1} and 0.94year^{-1} were obtained in *Schilbe intermedius* and *Alestes baremoze* respectively. These population growth parameters are estimates obtained as the result of the FISAT II analysis on the species obtained during the period of the study.

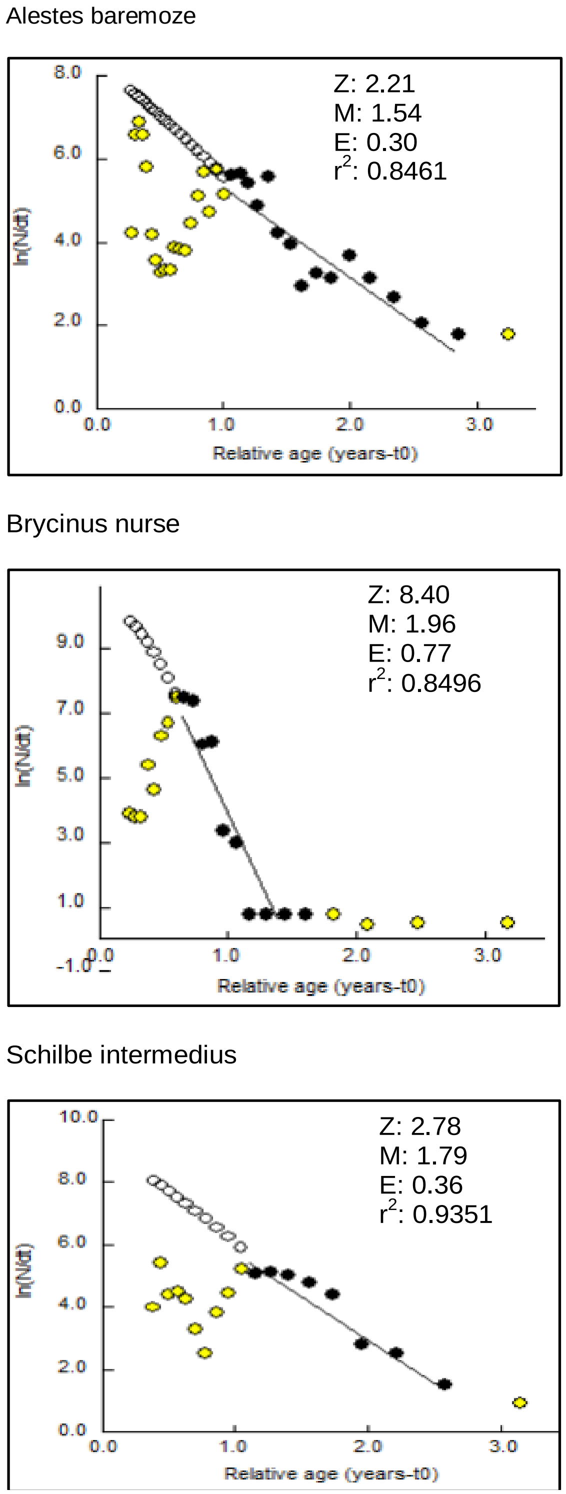

Figure 3. Length-converted catch curves for the three species in the lower reaches of the White Volta River during the period of study (October 2011-March 2012).

Mortalities and Rate of Exploitation

The length-converted catch curves for the three species are shown in Figure 3 together with the computed total mortality (Z), natural mortality (M) and rate of exploitation (E). Among the three species, *Brycinus nurse* had the highest Z, M, and E estimates. *Alestes baremoze* had the lowest estimates of all the parameters (Z, M, and E)

Table 1. Growth and mortality parameter estimates and exploitation rates reported in different fishing areas in the West Africa including the estimates of the present study.y^{-1} means per year.

Species	Fishing area	TL_∞,(cm)	$K(y^{-1})$	$Z(y^{-1})$	$M(y^{-1})$	$F(y^{-1})$	E=F/Z	Reference
Alestes baremoze	Volta-Yapei, Ghana	46.73	0.94	2.21	1.54	0.67	0.30	This study
	Jebel Aulia, Sudan			0. 53	0.151	0.379	0.72	[26]
	Kosti Reservoir, Sudan			0.258	0.151	0.107	0.41	[26]
	Niger Delta, Nigeria		0.26	1.6	1.43	0.17	0.1	[16]
	Bagré , Burkina Faso	32.5	0.64		1.29	0.35		[17]
	Lake Chad, Chad	34.8	0.60		1.16			[18]
Brycinus nurse	Volta-Yapei, Ghana	28.38	1.1	8.84	1.96	6.44	0.77	This study
	Bontanga, Ghana	20.5	0.52	2.54	1.3	1.24	0.49	[20]
	Tanguiga, Burkina Faso	21	0.90					[21]
	Bandama, Cote d'Ivoire			2.33	1.57	0.76	0.33	[28]
	Lake Chad, Chad			1.63	1.56	0.07	0.04	[28]
Schilbe intermedius	Volta-Yapei, Ghana	27.93	0.95	2.78	1.79	1.0	0.36	This study
	Volta-Yeji, Ghana	30	0.8	4.49	1.59	2.9	0.65	[22]
	Cross river, Nigeria	27.5	0.29	1.85	0.81	1.04	0.56	[15]
	Lake Kainji, Nigeria	33.6	0.11					[23]

among the three species from the lower reaches of the White Volta River.

DISCUSSION

Growth Characteristics

Alestes baremoze

Assuming that the fish grows throughout its life, asymptotic length L_∞ (cm) is the largest theoretical mean length that it could attain in its natural habitat and K is the speed with which it grows towards this final size [15]. Against this backdrop, in comparing the growth of the species, both the growth rate (K) and the asymptotic length of the species were taken into consideration.

Alestes baremoze estimated growth rate (K) of 0.94 $year^{-1}$ and asymptotic length L_∞ (Total Length cm) of 46.73cm obtained in this study is higher and different from the K of 0.26 $year^{-1}$ Abowei and Hart [16] observed on the species in Niger Delta, Nigeria. Furthermore, it was higher than K= 0.64 and TL_∞ = 32.5 that Villanueva *et al*. [17] reported on the species in the Bagré reservoir, Burkina Faso as well as the K= 0.60 and TL_∞ = 34.8 reported by Froese and Pauly [18] on the species in Lake Chad, Chad (Table 1). It implies that this species may be growing at a faster rate in lower reaches the White Volta River. *Alestes baremoze* had two cohorts growing in the lower reaches of the White Volta River within the period of the study (Figure 2). This shows that the species can be quite resilient and may have a faster and high rate of the population doubling, contrary, to medium resilience; with minimum population doubling time of 1.4 - 4.4 years that Musick [19] estimated on the species. The observed high resilience/ productivity of the species also explain why the relative age of catch of the species in this study is between 1 and 3 years, again an indication of high resilience.

However, it is worth noting that this might have possibly resulted from methodological challenges of gear selection. Taking samples from different fishermen, who use different unregulated and unclassified fishing gears, particularly gillnets of different mesh sizes for fishing may have confounded the work and hidden the true size range. The low sample size and the short duration of the study can also be the reasons why two cohorts are visible. It is likely that when more significant number of samples of the species is measured over a longer period of time, a different trend of size distribution of the species can be realized. This may require a closer study; month to month studies of the species over 2 or more years can yield statistically significant results.

Brycinus nurse

Both the estimated growth rate (K= 1.1) and the estimated asymptotic length (L_∞ =28.38 cm) of *Brycinus nurse* in the lower reaches of the White Volta River during the period of the study were higher than (K= 0.52; L_∞ =20.5cm) that Kwarfo-Apegyah *et al*. [20] reported on the species in the Bontanga reservoir, Northern Region of Ghana (Table1). Moreover, Baijot and Moreau [21] observed K= 0.90; and L_∞ =21cm on this species in Tanguiga reservoir, Burkina Faso. The authors' values are also lower than the K and L_∞ values estimated on the species in this study. The species is known to be of high resilience [19], and as such its high growth rate was not uncharacteristic. It was however, striking that only one cohort of the species was observed in the lower reaches of White Volta River during the study period. An indication that, contrary to the species reported and observed high resilience and high growth rate, it may not be very resilient to fishing pressure in the lower reaches of the White Volta.

This cohort representation could be due to the small sample size. Notwithstanding, there was slight indication that, there might been another cohort that was facing out during the post flood season (October-December) whereas as in the dry season (January-March), there was an emergence of a new group, suggesting that new cohort was coming into the population as observed in the length frequencies distribution in Figure 2. The observations which were visible in the landing site Aglassipei (downstream) imply that the site may be a ground for the species spawners during the February-March and as such juveniles of the species are concentrated at that site during those months. It is also possible that the juveniles may have moved out of the upstream and midstream which were relatively dry and shallow during the dry season to the downstream that had more water and thus offered more stable conditions for them.

Nevertheless, it was observed during the study that, the landing site Aglassipei had a lot of fishermen who used a lot of gillnets with small mesh sizes (less than 25mm). This apparently presupposes that the juveniles (new cohort) may have been at all the landing sites, but Aglassipei with its notable use of gillnets of small mesh sizes had the new emerging cohort captured or selected whilst the other two landing sites due to their use of relatively gillnets with large mesh sizes did not. The highlight is that, the methodological constraints of having the samples not split according to different mesh sizes from which they were caught might have likely influenced the results and as such typical size distribution of the species may be limited in this study.

Schilbe intermedius

The growth rate (K: 0.95 year^{-1}) and the asymptotic length length (L_∞: 27.93cm) obtained on the species from this study are comparable and similar to those (K: 0.8 year^{-1} and L_∞: 30.0cm) that Ofori-Danson [22], observed on the species at the Yeji sector of the same Volta reservoir. It is therefore likely that the species are growing in similar pattern in both areas of the Volta reservoir over time.

Etim *et al*. [15] estimated K of 0.29 year^{-1} and L of 27.5cm on the species from Cross River, Nigeria; and Olatunde [23] reported L_∞ = 33. 6 cm and K= 0.11 year^{-1} from Lake Kainji, also in Nigeria. The asymptotic length of these two previous works from Nigeria and this current study are similar and comparable.

However, the growth rates (K) of these two previous works from Nigeria are far lower than the growth rate (K) from this study on the species. This may be as a result of temporal difference between those studies and this study. It could as well be as result of some spatial or regional differences in climatic conditions such as temperature that can affect the rate of growth differently among the locations (White Volta River-Yapei, Ghana, and Cross River and Lake Kainji, both in Nigeria).

Moreover, when compared with *Schilbe mystus* which is a species that belong to the same genus as *Schilbe intermedius,* TL_∞ on *Schilbe intermedius* from this study was far below that of *Schilbe mystus* ($L\infty$ =52.63cm) [24]. One cohort of the species was observed in the study area during the period of study. This cohort when compared those of the previous two species (*Alestes baremoze* and *Brycinus nurse*) was quite broad in size range and spanned over 8cm. This widely spreading cohort suggests that *Schilbe intermedius* likely have high tendency for growing at different rates and therefore exhibited such a wide size range. It is imperative that, the nature of growth of the species is factored into further analysis and future studies on this species in the lower reaches of the White Volta River. The emerging cohort during the dry season (January-March) when the water levels were lowest may mean that the season with its dry warm weather conditions impacted on spawning of the species and as such the low water levels might not have adversely affected the juvenile fishes survival.

This can however, be supported only when further studies on effects of temperature and water levels changes on the species spawning and survival rate or chances of the early stages of the species are undertaken in the lower reaches of the White Volta River.

Fisheries Mortalities and Exploitation

Alestes baremoze

The instantaneous total mortality coefficient (Z) from the length-converted catch curve method and the natural mortality coefficient (M) estimated using Pauly's empirical formula (1980b) for *Alestes baremoze* in the lower reaches of the White Volta River were higher than those observed four years ago on the species at nearby Niger

Delta, Nigeria [16] (Table 1). The fishing mortality (F) which was also derived from the length-converted catch curve method was equally higher in this study than what was obtained from the Niger Delta, Nigeria.

This denotes that fishing pressure on the species in the lower reaches of the White Volta River were higher during the period of the study than what was observed in Niger Delta, Nigeria in 2009. Since there is no reference or benchmark on the fishery in lower reaches of the White Volta at Yapei to determine whether there has been an increase or decrease in fishing pressure , one can only speculate with the work done by Abowei and Hart [16] in nearby Niger Delta, Nigeria, that there might be more fishing pressure on the species now than before especially, when considering the fact that, tilapia species were previously known to dominate catches in the entire Volta reservoir as reported by Braimah [25], whereas from this study, the species *Alestes baremoze* was the most predominant species in catches in the lower reaches of the White Volta River.

Moreover, Villanueva *et al*. [17] had M=1.29 and F=0.35 on *Alestes* spp in Bagré reservoir in Burkina Faso. These coefficients are also below those obtained on *Alestes baremoze* in this study. It thus imply that the *Alestes baremoze* population in the lower reaches of the White Volta River, were under higher mortalities during the period of the study when compared to the above two previous works in the near locations in the West Africa. It should, however, be noted that 70% of the estimated mortality was due to natural causes (Z=2.21, M= 1.54 and F=0.67), and thus suggesting that the high mortalities of the *Alestes baremoze* population in the lower reaches of the White Volta is not necessary be as result of fishing but rather due to natural causes. A look at the exploitation rate of 0.3 on *Alestes baremoze* populations in the lower reaches of the White Volta River during the period of the study confirms this under fishing or less fishing pressure assertion of the specie.

This $E_{0.3}$ result on the species makes this study on the basis of exploitation rate similar and comparable to the $E_{0.1}$ Abowei and Hart [16] reported on the species in Niger Delta, Nigeria (Table 1). Both studies had exploitation rate below the optimal exploitation rate value of 0.5 and therefore suggests that the *Alestes baremoze* population in the lower reaches of the White Volta River were being under fished or underexploited in this study just like it was observed in the nearby Niger Delta, Nigeria.

However, this $E_{0.3}$ on the species from this study should be regarded more as speculative. This is because, substantial fishing of the species was observed in the area and also this species was the most abundant species and represented 17.5% of all catches assessed during the period of study and as such a higher rate of exploitation was expected. This $E_{0.30}$ obtained from the analysis is equivocal and probably due to the small sample size and also the limited period of the study. Nevertheless, it was in line with below optimal exploitation values both Yousif [26] and Abowei [16] observed on the species in Kosti, Sudan and Niger Delta, Nigeria respectively (Table 1). In contrast, another work done by Yousif and Ahmad [26] on Jebel Aulia reservoir, Sudan realised exploitation rate (E) of 0.72, implying that the species populations there were being overfished at that location.

Moreover, according to Akinyi *et al*. [27], regionally *Alestes baremoze* faces different threats. The species is currently overfished in Eastern African whereas in Western Africa the species is locally threatened by pollution and agricultural development leading to habitat loss and degradation. Two different scenarios can be suggested here. Firstly, it is possible that in a like manner; this species population in the lower reaches of the White Volta is threatened by pollution and as such the high natural mortality obtained. The other likelihood is that, the species may be overfished just like it has happened to the species populations in the Eastern Africa. Both scenarios are complete assertions and it is only with further studies preferably in different habitats within Volta Basin that any of the assertions can be supported.

Brycinus nurse

The Z, M. F coefficients of *Brycinus nurse* from this study were much higher than those reported by Kwarfo-Apegyah [20] from a nearby Bontanga reservoir which also in the Northern region of Ghana. Again, the coefficients were far higher than those [28] estimated on the species from Bandama, Cote d'Ivoire and Lake Chad, Chad (Table 1).

The fishing mortality (F) in particular was extremely higher (between 5.2 $year^{-1}$ and 6.37 $year^{-1}$ higher) than those reported from the other previous studies on the species. This meant that there was more fishing pressure on the species in the lower reaches of the White Volta River during the period of the study. The exploitation rate of *Brycinus nurse* in the lower reaches of the White Volta River during the period of the study was above the optimal $E_{0.5}$ and also higher than the $E_{0.49,}$ $E_{0.33}$ and $E_{0.04}$ reported on the species in the Bontanga reservoir by Kwarfo-Apegyah [20], in Bandama, Cote d'Ivoire and in Lake Chad, Chad both by Moreau [28].

As evident in the rate of exploitation (E) and the Fishing mortality (F), the exploitation state of this fishery in the lower reaches of the White Volta River is thus one of overfishing. The overfishing of *Brycinus nurse* above the optimal exploitation rate may be probable as it was the third most abundant species with 6.0 % representation of all catches. Nevertheless, it should be noted that, this state of the fishery exploitation is quite equivocal as the distribution points in the length-converted catch curve analysis in FISAT II was inadequate and the regression statistic of selection with the r^2 showed that only 85% of the variance could be due to the fit. This is merely potential indication that the *Brycinus nurse* populations in the lower reaches of the White Volta River may be overexploited and not a substantive conclusion.

Schilbe intermedius

Schilbe intermedius total mortality (Z) and natural mortality (M) coefficients of this study were lower than those reported on the species in the Yeji sector of the Volta Lake [22]. The Z and M coefficients were, however, higher than those observed on the species in the Cross River, Nigeria by [15], (Table 1). The fishing mortality (F) of 1.0 $year^{-1}$ observed in this study is comparable to 1.04 $year^{-1}$.

Etim *et al.* [15] reported on the species in the Cross River, Nigeria. It was however, lower than the F=2.9 $year^{-1}$ had on the species in the year 2005 at the Yeji sector of the same Volta reservoir [22]. It presupposes that there might more fishing of the species at lacustrine Yeji sector of Volta reservoir than the lower reaches of the White Volta River. The fishing of *Schilbe intermedius* was below optimal exploitation ($<E_{0.5}$).

This is however; contrary to the above optimal exploitation ($E_{0.65}$) observed by Ofori-Danson [22] on the species at the Yeji sector of the Lake Volta. Again, Etim *et al*. [15] observed that *Schilbe intermedius* populations in in the Cross River, Nigeria had exploitation rate ($E_{0.56}$) slightly above the optimal $E_{0.5}$. Regardless of E above 0.5 of these two studies (Table 1), the low exploitation of the species as observed in this study is possibly a true reflection of the state of the species exploitation in the lower reaches of the White Volta River as the species length-converted catch curves had best selection and the best statistical results (r^2: 0.9351) among the three species (Figure 3).

CONCLUSION

Brycinus nurse population in the lower reaches of the White Volta River is under threat of overfishing with exploitation rate of 0.77. It means that 77% of the species population in the lower reaches of the White Volta River is being exploited. It was the third most abundant species in catches with 6% of all catches being *Brycinus nurse*. Although, fish landings are most dominated by *Alestes baremoze* which made up 17.5% of all catches, from the FISAT II calculation, the species population in the lower reaches of the White Volta River is under exploited ($E_{0.3}$).

An intensive *Alestes baremoze* fishing was observed, and as such this low rate of exploitation is considered as theoretical and speculative rather than empirical. The state of exploitation of *Schilbe intermedius* was also that of under exploitation ($E_{0.36}$). The length-converted catch curve analysis of *Schilbe intermedius* had the best selection and statistical results among the three species and therefore the result on the species exploitation rate is a true reflection of the state of the species fishery.

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