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Assessment of the White Volta Fishery at Pwalugu in Ghana Before Impoundment

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Abstract
The study was carried out at the White Volta stretch in the Pwalugu area to assess the fish and fisheries of the river. A monthly assessment of fish catches from commercial fishers was conducted for 12 months. The catch per unit effort (CPUE) was generally low over the entire study period, as the highest and lowest CPUEs were recorded in March, 2020 and May, 2020 respectively. The river was low in fish fauna as only 39 species belonging to 27 genera and 13 families were encountered during the study period. Three species namely, *Auchenoglanis occidentalis*, *Marcussenius senegalensis*, and *Heterobranchus bidorsalis*, were identified as the major commercial fish species in the area. The widely used fishing gears in the area included gillnet, trap, cast net, hook-and-line, and spear. Fishing activities on the river stretch were unreported and unregulated. It was recommended that the Fisheries Commission in the Upper East Region, Bolgatanga, should be resourced with logistics and personnel to monitor and ensure compliance with fisheries regulations on the river.

Keywords
Catch per unit effort; fish species; Pwalugu; river impoundment; White Volta

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Contents

1. Introduction

The fisheries sector is an important source of income, nutrition and food for millions of people in the world (Bartley et al., 2015; FAO 2020). In Ghana, fish is an important resource that contributes significantly to the country's economy. The fisheries industry contributes to poverty alleviation which is in connection with United Nations Sustainable Development Goal number one. According to Mapedza et al. (2024) and FAO (2016), the fisheries sector alone generates more than one billion Ghana Cedis to the country's economy which accounts for 4.5 % of its gross domestic product. Data from the Ministry of Fisheries and Aquaculture Development (MOFAD) of Ghana indicate that Ghana consumes over 950,000 metric tons of fish annually although its production is less than 600,000 metric tons (USDA, 2022). Ghana, therefore imports about 550,000 metric tons of fish annually to complement the fish it produces. In 2021 alone, Ghana imported $290 million worth of fish and fish products (USDA, 2022), as fish accounts for about 60 % of animal protein in Ghanaian diet (MOFAD, 2017).

The White Volta is a major sub-basin of the Volta River basin and is found in three countries (Ghana, Togo and Burkina Faso). The White Volta emanates from the North of Burkina Faso and flows south-eastwards to the border of Ghana. It has a total area of about 106,742 km² with 49,225.5 km² lying in Ghana, 1,088 km² in Togo and

56,428 km² in Burkina Faso. It contributes annually an average of 20 % of the inflow to the Volta Lake, and hence, an important element for capture fisheries, aquaculture, and hydropower generation at Akosombo Dam and Kpong power stations in the lower Volta River system (Water Resources Commission, 2008). The economic livelihood of people and communities living around the White Volta is impacted by the water body as it plays a role in agriculture, forestry and fishery. Agriculture, fishery, forestry and hunting together make up the main economic activity in the basin. Irrigation systems (medium and large scale) in the White Volta basin can be found in Tono and Vea, both in the Upper East Region, and Bontanga, also in the Northern Region of Ghana (Mul et al., 2015).

Despite the enormous benefits of the White Volta to livelihoods, the unsustainable use of the resource (White Volta) is seriously putting the river under threat. The removal of the top soil along the banks of many sections of the White Volta for the purpose of crop cultivation is increasing the risk of siltation as upland erosion is possible and the subsequent transport of sediment into the water courses (Water Resources Commission, 2008). According to Akrasi (2011), the mean annual specific suspended sediment yield for the White Volta area in Ghana is 32.56 t /km2/yr. Again, it has been reported that the main cause of pollution on the Volta River is improper fertilisation and the heavy use of pesticides for agriculture; the growing use of fertilisers and pesticides for agricultural purposes and unregulated use of chemicals affect the water quality (World Bank, 2015).

The Pwalugu area of the White Volta has been earmarked for the construction of a multipurpose reservoir for power generation, irrigation development, flood control, and integrated water resource management of the White Volta basin (VRA, 2014). Sod was cut for the 993-million-dollar project to begin on 29th November 2019 by the President of Ghana, Nana Addo Dankwa Akufo-Addo (Joynews, 2019). The basic threat to the world's freshwaters is river impoundment as it has the tendency to modify natural hydrological regimes (Zarfi et al., 2015). The impact of river damming (impoundment) on sediment deposition, fish migration, hydrological structure and potential earthquake has long been a worry (Gu et al., 2014; Zhong et al., 2012; Hoeinghaus et al., 2009). Loss and degradation of habitat, water abstraction for agriculture, drainage of wetlands, dam construction, pollution and eutrophication, often acting.

The performance of policies and regulations in Africa's fisheries sector has been poor over the years and fishery resources continue to degrade against the background of unsustainable fisheries laws and regulations (FAO, 2010). Some researchers attribute the poor performance of fisheries policies and regulations in Africa to the lack of reliable and accurate fisheries data. According to Welcomme (2011), the accuracy of reported catch trends is often difficult to assess. Due to this trend, data on inland fisheries are usually incomplete and difficult to trust. Allan et al. (2005) reported that fish harvest from some major rivers account for only 30 – 50 % of actual catch. This affirms to the suggestion that fish catches have long been underestimated. It is however important to note that fishery managers depend on these unreliable and incomplete data (information) to formulate policies and regulations governing the inland fishery subsector, and since the data do not reflect the true nature in the inland fishery subsector, policies and regulations generally show a poor performance and thus, negatively affecting the inland fishery subsector. This study, focusing on the Pwalugu area of the White Volta, sought to provide baseline data before the construction of the Pwalugu multipurpose reservoir. The study determines the catch per unit effort (CPUE), identifies species composition and relative abundance as well as evaluates the fishing gears used in the area.

2. Materials and Methods

2.1 Study area

The study was carried out on the White Volta in Pwalugu area of the Upper East Region of Ghana (Figure 1). The study area is located on latitude 10° 36' 18" North and longitude 0° 51' 32" West. Pwalugu is located in the Talensi District of the Upper East Region. The White Volta is one of the four tributaries of the Lake Volta in Ghana. It flows through Northern Ghana from Burkina Faso into the Volta Lake at Yeji in the newly created Bono East Region of Ghana. The vegetation of the Pwalugu area is guinea savanna which is dominated by short grasses, shrubs and relatively short trees.

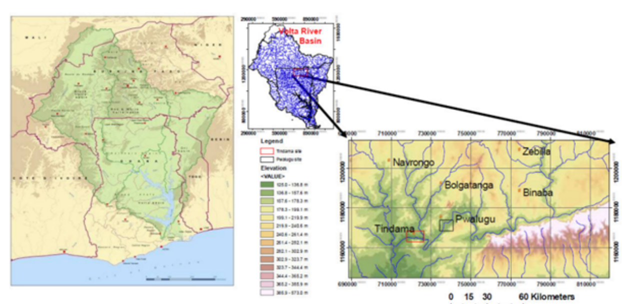

Figure 1. Pwalugu stretch of the White Volta catchment within the Volta Basin (Kasei et al. 2013)

The people at Pwalugu are predominantly farmers and others engage in fishing. The White Volta plays a vital role in the lives of the people in this area. Crop farmers along the banks use the water body as a water source for the irrigation of their crops. However, in the rainy season, most farmers lose their crops as a result of flood, which has become a common problem over the past few years. The river also serves as a water source for livestock farmers as they do send their animals to the river to drink from it. In the dry season, the availability of water in the Northern sector of the country becomes a problem; the river is sometimes used by locals for domestic purposes such as drinking, cooking and washing.

2.2 Data collection

Data were collected through monthly visits to the White Volta at Pwalugu from July, 2019 to June, 2020. Fish samples from canoes that landed were taken using systematic random sampling method from two major landing sites. Fish landings were very low, so the total catch from each sampled canoe was assessed for species, number and weight. Fish species collected during each visit were counted and weighed and readings recorded for each fish species and family in order to determine the relative abundance of fish species and family by number and weight. Fish samples were identified using taxonomic identification guides from Dankwa et al. (1999) and Paugy et al. (2003) as was done by Alhassan et al. (2015) and Abobi et al. (2014). Morphological features such as colour of eyes and tails, presence of scales and lateral lines, shape and position of mouth were carefully monitored during the identification process. A mobile phone camera was used to capture images of fish collected from the study area for the purpose of identification and further studies of features of the fish species.

Information on the preferred fish species (commercial species) was gathered with the use of semi-structured interviews. A total of twenty fishermen (14) and fishmongers (6) were randomly selected from the two landing sites of the White Volta area in the Pwalugu area. The sample size represented more than half of the population of each active group for purposes of accuracy, representativeness, and reliability of the results. Sampling more than half ensures greater diversity within the sample, thus enhancing representativeness (Lohr, 2010). Fishing gears were identified during each sampling visit with the aid of FAO (2010) list of gears. Fishing gears identified were grouped into passive and active gears. The fishing gear of five randomly selected fishermen who landed were inspected and the name and mesh sizes of gears determined in the case of fishing nets.

2.3 Data analysis

Data collected from the study area were entered into Microsoft Excel 2010 and averages and percentages computed where necessary. Relative abundance of fish species and families, characteristics of fishing gears were presented using graphs, pie charts tables. Catch per unit effort (CPUE) was determined as catch per canoe per day (kg/canoe/day) as done by Nunoo and Asiedu (2013). Thus, CPUE was computed from the formula:

$$CPUE = \frac{Total\ kilograms\ of\ sampled\ fish}{Total\ number\ of\ sampled\ canoes/days} \quad (1)$$

Relative abundance of fish species and family by weight and number was computed using the following expressions (Win and Myint, 2020):

Relative abundance of fish species by number =

$$\frac{number\ of species\ counted}{total\ number\ of\ all\ sampled\ fish} \times 100 \quad (2)$$

Relative abundance of fish species by weight =

$$\frac{Total\ weight\ of\ each\ species}{Total\ weight\ of\ all\ sampled\ fish} \times 100 \quad (3)$$

Relative abundance of fish family by number =

$$\frac{Number\ of\ species\ counted\ in\ a\ family}{Total\ number\ of\ all\ sampled\ fish} \times 100 \quad (4)$$

Relative abundance of fish family by weight =

$$\frac{Total\ weight\ of\ species\ in\ each\ family}{Total\ weight\ of\ all\ sampled\ fish} \times 100 \quad (5)$$

3. Results

3.1 Catch per unit effort (CPUE)

Over the one year period of the study (July, 2019 – June, 2020), the catch per unit effort of the fishermen (Figure 2) in the Pwalugu area of the White Volta was highest in March, 2020 (13.68 kg/canoe/day) followed by October, 2019 (11.82 kg/canoe/day) and November, 2019 (10.52 kg/canoe/day). May, 2020 recorded the least catch per unit effort (6.73 kg/canoe/day).

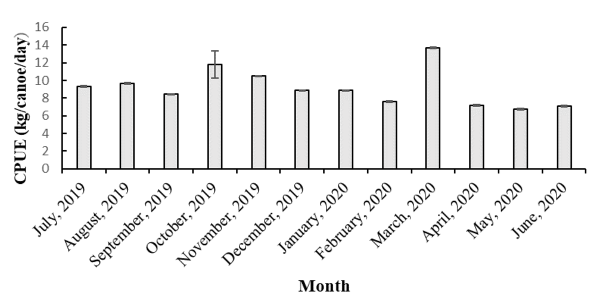

Figure 2. Catch Per Unit Effort over the period of study

3.2 Fish composition and relative abundance

A total of 13 fish families belonging to 27 and 39 genera, and species, respectively were identified on the White Volta area at Pwalugu from July, 2019 to June, 2020 (Table 1). In terms of species representations of each family in the Pwalugu area of the White Volta, the family Mormyridae had 8 species belonging to 6 genera, which include *Brienomyrus brachyistius*, *Marcusenius senegalensis*, *Mormyrops anguilloides*, *Mormyrus hasselquisti*, *Mormyrus macropthalmus*, *Mormyrus rume*, *Petrocephalus bovei*, and *Pollimyrus isidori*.

Table 1. Fish families, genera, and species identified over the study period (July, 2019 – June, 2020)

Fish family	Genus	Species
Alestidae	*Alestes*	*Alestes baremoze*
		Alestes dentex
	Brycinus	*Brycinus macrolepidotus*
		Brycinus nurse
	Hydrocynus	*Hydrocynus forskali*
Bagridae	*Bagrus*	*Bagrus bajad*
		Bagrus docmak
Cichlidae	*Hemichromis*	*Hemichromis fasciatus*
	Oreochromis	*Oreochromis niloticus*
	Sarotherodon	*Sarotherodon galileaus*
	Coptodon	*Coptodon zillii*
Citharinidae	*Citharinus*	*Citharinus citharus*
Clariidae	*Clarias*	*Clarias gariepinus*
		Clarias anguillaris
	Heterobranchus	*Heterobranchus bidorsalis*
		Heterobranchus longifilis
Claroteidae	*Auchenoglanis*	*Auchenoglanis occidentalis*
	Chrysichthys	*Chrysichthys auratus*
		Chrysichthys nigrodigitatus
Cyprinidae	*Labeo*	*Labeo coubie*
		Labeo senegalensis
	Leptocypris	*Leptocypris niloticus*
	Barbus	*Barbus macrops*
Latidae	*Lates*	*Lates niloticus*
Malapteruridae	*Malapterurus*	*Malapterurus electricus*
Mochokidae	*Synodontis*	*Synodontis bastiani*
		Synodontis clarias
		Synodontis schall
Mormyridae	*Brienomyrus*	*Brienomyrus brachyistius*
	Marcusenius	*Marcusenius senegalensis*
	Mormyrops	*Mormyrops anguilloides*
	Mormyrus	*Mormyrus hasselquisti*
		Mormyrus macropthalmus
		Mormyrus rume
	Petrocephalus	*Petrocephalus bovei*
	Pollimyrus	*Pollimyrus isidori*
Polypteridae	*Polypterus*	*Polypterus endlicheri*
Schilbidae	*Schilbe*	*Schilbe intermedius*
		Schilbe mystus

The relative abundance of fish families determined in terms of number revealed Mormyridae (25 %) as the highest and Polypteridae (< 1 %) as the lowest. and weight (Figure 3). In terms of weight, the most abundant fish families were in the order; Cyprinidae (24 %), Mormyridae (22 %) and Clariidae (17 %).

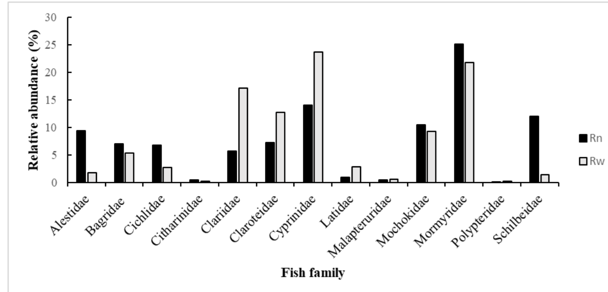

Figure 3. Relative abundance of fish families by number (Rn) and weight (Rw)

3.3 Relative abundance of fish species by number and weight

The relative abundance of fish species determined in terms of number (Figure 4) showed that the most abundant fish species was Marcusenius senegalensis (9 %), followed by Schilbe intermedius (7 %), and Auchenoglanis occidentalis (6 %).

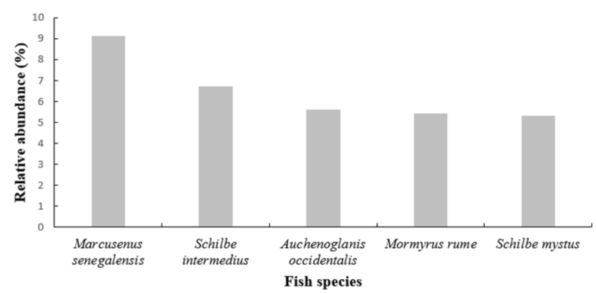

Figure 4. Relative abundance of the most abundant fish species in terms of number

In terms of weight (Figure 5), the most abundant fish species was Labeo coubie (11 %), followed by Heterobranchus bidorsalis (10 %), and Auchenoglanis occidentalis (9 %). The least abundant fish species in terms of weight and number was Polypterus endlicheri recording less than 0.5 % each.

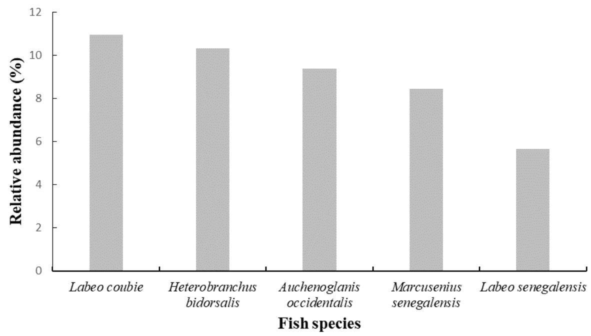

Figure 5. Relative abundance of the most abundant fish species in terms of weight

3.4 Major commercial fish species

The interview session with the fishers showed that *Auchenoglanis occidentalis*, *Marcusenius senegalensis*, and *Heterobranchus bidorsalis* are the three most preferred commercial fish species in the Pwalugu area of the White Volta.

3.5 Fishing gears

Seventy-nine (79) fishing gears were encountered in the Pwalugu area of the White Volta. It was noted that more than two fishermen sometimes owned a fishing gear as they all contributed to purchasing the gear. Figure 6 gives information on the major fishing gears identified. Gillnet (33 %) was the most dominant gear. The least dominant fishing gear was the spear (5 %).

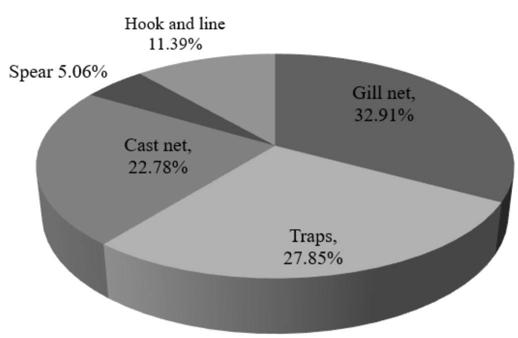

Figure 6. Fishing gears identified in the Pwalugu area of the White

Gillnets identified on the White Volta area in Pwalugu had mesh sizes ranging from 3.1 – 11.6 cm (Table 2). In the case of cast nets, mesh sizes ranged from 2.5 cm – 5.4 cm.

Table 2. Characteristics of gillnets and cast nets identified at the Pwalugu area of the White Volta

Mesh size range (cm)	Number
Gillnets	
0.0 – 4.9	14
5.0 – 9.9	10
10.0 – 11.6	2
Cast nets	
0.0 – 4.9	16
5.0 – 5.4	6

4. Discussion

4.1 Catch per unit effort (CPUE)

The CPUE of the White Volta area in Pwalugu was generally low, implying a reduced fish population density or availability, indicating several potential ecological issues. It could suggest overfishing, habitat degradation, or poor water quality, all of which reduce fish abundance or limit their ability to reproduce. Rahman et al. (2024) noted that low CPUE reflects ecosystem stress and can be linked to reduced fish recruitment due to environmental changes. Tikadar et al. (2021) highlighted that declining CPUE is often a result of anthropogenic impacts, including fishing gear efficiency, habitat loss and pollution. The low CPUE of this study compared with the findings of Nunoo and Asiedu (2014) from the Small London and Kpong fishing communities may be due to differences in the resources (canoes, boats and gears) at the disposal of fishermen. In the Pwalugu area of the White Volta, 24 active canoes were encountered along the river stretch in the area over the entire period of study and more than 10 canoes were in a bad state whereas Nunoo and Asiedu (2014) reported an average of 101 and 68 active canoes in the Small London and Kpong fishing communities respectively.

The implication is that as more resources are invested in to fishing, a high CPUE is recorded. A fishing gear is owned by more than two fishermen in the Pwalugu area of the White Volta. What this suggests is that, as one fisherman is using the gear, the other has to wait for him to land before he can also use the gear. CPUE is an indicator of fishery performance despite its well-documented shortcomings as it is used in assessing fish populations with strict proportionality assumed between CPUE and abundance (Nunoo and Asiedu, 2014). Many researchers are reluctant to accept the accuracy of CPUE as being proportional to abundance. Beverton and Holt (1957) asserted that CPUE does not necessarily give evidence of changes in abundance. Therefore, it must be noted that CPUE recorded in this study is not proportional to abundance.

The current study noted a direct proportional relationship between water level and CPUE. This indicates that floodplain connectivity during high water levels leads to increased fish availability due to expanded habitat. Similarly, rising water levels boost habitat complexity and food availability, resulting in higher CPUE. The finding of this study is similar to the finding of Alhassan et al. (2016) who reported the same relationship on the Black Volta near the Bui Dam. Several studies (Blay and Asabere-Ameyaw, 1993; Amarasinghe 1987; Quarcoopome et al., 2008) have reported this phenomenon. However, this finding is in contrast to the findings of Abobi et al. (2013) who reported that, increasing CPUE was characterised by higher water levels on the lower reaches of the White Volta at Yapei.

4.2 Fish composition and relative abundance

A total of 39 fish species belonging to 27 genera and 13 fish families were identified on the White Volta area in Pwalugu during the 12 months of study suggesting a poor species diversity of fish fauna in the river, which could be due to reasons related to ecological disturbance as a result of anthropogenic activities. Similar studies on the White Volta in Nakambe (Burkina Faso), Yapei (Ghana) and Nawuni (Ghana) led to the identification of 61 fish species belonging to 16 families (Stranzl, 2014), 52 species belonging to 16 families (Abobi et al., 2014) and 43 species belonging to 17 families (Obodai and Laweh, 2009) respectively. Species richness is undoubtedly a key attribute of the Volta River system as many researchers have identified and reported a considerably high number of fish species, genera and families. Alhassan et al. (2015) reported 63 species of fish belonging to 17 families on the Black Volta at Bui. Denyoh (1969) and Roberts (1967) were reported to have identified 108 and 112 fish species on the Volta River respectively. This gives credence to the allusion that, the Volta River System is indeed rich in fish fauna.

The Volta River is reported to be Ghana's most important inland fishery resource accounting for about 90 % of the total fish produced in the inland sector (Barry et al., 2005) and as a tributary to the Volta Lake, it will only be fair to say that, the White Volta River has contributed its fair share to national development apart from alleviating poverty and dealing with malnutrition in many communities including Yapei, Nawuni and Pwalugu. Despite the numerous contributions of the White Volta to national development, poverty alleviation and malnutrition, its full potential is yet to be realised.

Comparing the number of fish species and families identified in different areas of the White Volta in Ghana, Pwalugu recorded the least as Abobi et al. (2014) and Obodai and Laweh (2009) reported 52 and 43 species for Yapei and Nawuni respectively. This may be attributed to so many scientific and logical reasoning. Fishing activities in the Pwalugu area is on the low side compared to other areas of the White Volta such as Yapei and Nawuni. This therefore suggests that, more resources are invested in these areas than Pwalugu. The Pwalugu area of the White Volta is not well defined compared to Yapei and Nawuni and thus characterised by a few numbers of fishermen, fishing gears and canoes. Defined areas of the White Volta in Yapei and Nawuni are much larger compared to defined areas in Pwalugu which are usually not well defined as landing sites. With few resources (in terms of number/type of fishermen and fishing gears), this often leads to few areas of the river being covered during fishing and thus few species encountered and caught. It is common to have larger numbers of species in larger areas of habitats and empirically, the relative numbers seem to follow systematic mathematical relationships. And since the defined areas of Nawuni and Yapei are much larger than Pwalugu, it is only reasonable that much species will be recorded in these areas than Pwalugu.

Fish is said to travel against water current and in the Volta River System, fish is believed to travel from the Volta Lake to its tributaries. Fish traveling against water current from the Volta Lake to the White Volta therefore reach the White Volta areas at the downstream (Yapei and Nawuni) before migrating to the upstream areas such as Pwalugu. Along the way, some migrating fish are being caught by fishermen, some carried away by flood, others become weak and die whiles some settle when they find the environment favourable. Those that continue the journey choose joining the Nasia River or moving to the White Volta area in Pwalugu at Janga. It is therefore logical to say that, these migrating fish species reach the White Volta area in Pwalugu in few numbers. This could be the reason why few species were recorded in Pwalugu compared to the downstream areas (Yapei and Nawuni) of the White Volta River. It is therefore common to record a certain number of species in one area of a water body and record a different number of species in another area of the same water body. Migration of fish is therefore a great contributor in the distribution of fish in any water body.

Relative abundance by fish family calculated in terms of number over the 12 months of study revealed that the most abundant fish family was Mormyridae, recording a relative abundance of 25.14 %, followed by Cyprinidae and Schilbeidae recording relative abundances of 14.05 % and 12.07 % respectively. The abundance of mormyrids in rivers is primarily due to their ability to exploit diverse habitats, their specialised feeding mechanisms, and their electro-sensory system, which helps them navigate and forage efficiently in turbid waters (Welcomme, 2001). Findings in this study were however similar to Nsor and Obodai (2016) as they reported Mormyridae as the most abundant fish family on two distinct seasons among wetlands of the Northern Region of Ghana.

The finding of the relative abundance in terms of weight is in contrast to studies carried out on the downstream areas of the White Volta in Yapei (Abobi et al.,

2014) and Nawuni (Obodai and Laweh, 2009), as these studies reported Alestidae and Cichlidae as the most abundant fish families respectively. Stranzl (2014) identified three most abundant fish families at Nakambe in Burkina Faso namely Cyprinidae (26.42 %), Cichlidae (24.90 %) and Mormyridae (15.60 %) which is similar to the findings of this study. The findings confirms that Stranzl (2014) assertion as both study areas are the headstreams of the White Volta River.

The family Alestidae was represented by 5 species and 3 genera which include *Alestes baremoze*, *Alestes dentex*, *Brycinus macrolepidotus*, *Brycinus nurse* and *Hydrocynus forskali*. This is similar to the findings of Abobi et al. (2014) and Stranzl (2014) as they both recorded high species representation for Mormyridae and Alestidae at Yapei (Ghana) and Nakambe (Burkina Faso) respectively. Abobi et al. (2014) recorded a species representation of 9 and 6 for fish families Mormyridae and Alestidae respectively whiles Stranzl (2014) reported a species representation of 10 and 11 for fish families *Mormyridae* and *Alestidae* respectively. It can therefore be deduced that the White Volta River is very rich in fish families *Mormyridae* and *Alestidae*. *Mochokidae* had the highest species representation in Obodai and Laweh (2009) findings on the White Volta area in Nawuni, recording 7 species that belong to one genus followed by Characidae (Alestidae) and Cichlidae that recorded 6 species each belonging to 3 genera and 5 genera respectively.

4.3 Relative abundance of fish species by number and weight

The most dominant fish species in terms of number was *Marcusenius senegalensis* in this study. The abundance of *Marcusenius senegalensis* in rivers is primarily due to its adaptability to varied water conditions, its electrolocation abilities for efficient foraging and predator avoidance, and its successful breeding strategies in fluctuating environments. Similar findings were reported by Suleiman et al. (2018) in the Challawa George Dam in Karaye Local Government of the Kano State in North-western Nigeria. The relative abundance of fish species calculated in terms of weight over 12 months also indicated that the most abundant fish species was *Labeo coubie*. This is different from the findings of Abobi et al. (2014) as they reported *Alestes baremoze* as the most abundant fish species on the White Volta in the Yapei area.

The abundance of some fish species and families over others can be attributed to many logical and scientific reasons amongst which the availability of food cannot be left out. Many vegetable and crop farms are situated on the banks or edges of the White Volta River in Pwalugu as farmers seek to have a cheap source of water to irrigate their vegetables and crops. The washing away of some of the farm products such as plant parts and seeds either through the activities of rain or wind serves as food for fish species that feed mainly on plant materials and thus enhancing their growth, reproduction and subsequently dominating other species. The family Cyprinidae and species *Labeo coubie* were the most abundant fish in terms of weight in this study. According to Dankwa et al. (1999), fish species in the family Cyprinidae, most precisely those belonging to the genus *Labeo* and some *Barbus* predominantly feed on vegetable debris, and since vegetable farms are situated on the banks of the White Volta River area in Pwalugu, it is not strange recording Cyprinidae and *Labeo coubie* as the most abundant fish family and species respectively.

4.4 Major commercial fish species

Auchenoglanis occidentalis, *Marcusenius senegalensis*, and *Heterobranchus bidorsalis* were identified as the three most preferred (commercial) fish species in the Pwalugu area of the White Volta. The reason for their preference could be that these species tend to grow to larger sizes, providing more meat per fish, which is economically advantageous for both consumers and sellers. Kuebutornye et al. (2019) identified *Auchenoglanis occidentalis*, *Oreochromis niloticus*, *Sarotherodon galilaeus*, *Brycinus imberi* and *Marcusenius abadii* as the major commercial fish species on the Libga Reservoir in the Savelugu District of the Northern Region of Ghana. Akongyuure and Edziyie (2020) identified *Sarotherodon galilaeus*, *Oreochromis niloticus*, *Coptodon zillii*, *Clarias gariepinus* and *Auchenoglanis occidentalis* as commercial fish species in the Tono Reservoir in the Upper East Region of Ghana.

It is noted from previous studies that *Auchenoglanis occidentalis* has been identified as a commercial fish species in the White Volta at the Pwalugu area, Libga and Tono Reservoirs respectively, all in Northern Ghana. It may therefore be deduced that, *Auchenoglanis occidentalis* is one of the most important fish species in the inland fishery sector in the whole of the northern part of Ghana and perhaps the whole of Ghana and West Africa. According to Ikongbeh et al. (2013), *Auchenoglanis occidentalis* is a fish species with economic importance and highly valued in Africa and this has threatened the species as it is a primary target for many fishermen. *Marcusenius senegalensis* was also identified as a species with commercial and economic importance in the White Volta area at Pwalugu. According to Adjibade et al. (2020), *Marcusenius senegalensisisis* was observed amongst the African freshwater fishes with high fishery and economic importance and was also noted as the most dominant Mormyrid in the Niger River in Northern Benin. *Heterobranchus bidorsalis* which was also identified as a species with economic importance in the White Volta River in the Pwalugu area is preferred by fish buyers for its flesh. According to Owodeinde (2012), the intensification of the aquaculture industry in Nigeria should be a major objective for Nigerians as fish demand is not being met. He encouraged the culture of acceptable fish species such as *Heterobranchus bidorsalis* to meet fish demands citing reasons such as; the ability of *Heterobranchus bidorsalis* to survive in unfavourable environments, its efficiency in utilizing locally prepared fish feed, its resistance to disease and most importantly its economic and commercial importance to fish farmers.

4.5 Fishing gears

For effective fisheries management, there is the need to know fishing gears. Five fishing gears were encountered on the White Volta in Pwalugu; gillnet was the most dominant. Gillnets have been reported to be the most dominant fishing gear used in rivers due to their simplicity, effectiveness, and versatility in catching various fish species. They are relatively easy to deploy and can simultaneously target multiple species of different sizes, making them highly efficient for small-scale and artisanal fisheries. Gillnets can be used in various water depths and conditions, and their passive nature allows fish to entangle themselves by their gills, maximizing catch rates with minimal effort (Pauly, 1983). Additionally, the low cost of gillnets compared to other fishing methods makes them accessible to fishers in many regions (Sparre & Venema, 1998).

The results of this study conform to the findings reported by Akongyuure et al. (2014) and Alhassan et al. (2014). Akongyuure et al. (2014) identified four fishing gears on the Oti River at Agbasakope in the Krachi East District of the Volta Region of Ghana. In their study, gillnets were identified as the most dominant fishing gear in the area. Similarly, Mustapha et al. (2016) and Alhassan et al. (2014), reported that gillnets were the most widely used fishing gear on the Sissili-Kulpawn River Basin and Bontanga Reservoir respectively. Gillnets can therefore be considered as the most widely used fishing gear in the inland fishery sector in Ghana. The selection of a fishing gear is considered taking into consideration certain important factors such as; depth of the water body the gear is set to be used as well as seasonal fluctuations. The annual fluctuations in water levels constrains fishermen in using various types of fishing gear at different times of the season and periods within a year. He further suggested that a fisherman will be forced to use fishing gears other than cast net when water levels of a river or dam are high.

According to Akongyuure et al. (2014), the dominance of gillnets over other gears may be attributed to the ability of gillnets to target a wide range of fish species as it is constructed in specific sizes and thus preferred by many fishermen since the effort in operating the gear is less compared to other gears. Of the 26 gillnets identified on the River stretch, 53.85 % (14 gillnets) fell below the authorised mesh sizes of 5.0 cm for multifilament and 7.5 cm for monofilament fishing nets to be used in Ghana waters (Fisheries Regulations, 2010, L.I. 1968). Out of the 22 cast nets identified, 72 % (16 cast nets) also fell below the authorised mesh sizes of 5.0 and 7.5 cm for fishing nets to be used on Ghana waters. The use of these undersized mesh nets could cause growth overfishing, where juvenile fish are caught before they grow to their optimal size for economic or ecological value. This leads to the depletion of fish stocks, as the fish are harvested before they start to reproduce. Over time, this can reduce the population size of target species, undermining the sustainability of the fishery. Consequently, the depletion of fish stocks due to the use of undersized mesh nets can lead to reduced catches for fisheries, affecting the livelihoods of fishermen. According to Obodai and Laweh (2009), the use of unauthorised fishing nets could pose a serious threat to the fishery resources of the White Volta River. This therefore should be a concern to the Ministry of Fisheries and Aquaculture Development as well as the Fisheries Commission as the law needs to be enforced to sustain the fishery resources. Studies by Mustapha et al. (2016) and Obodai and Kwofie (2001) on the Sisili-Kulpawn River and Bontanga Reservoir respectively have made similar reports of fishermen not complying with the regulation that mandates the use of authorised mesh sizes.

5. Conclusion

The low CPUE and fish species diversity recorded in this study could be a sign of stock reduction due to overfishing caused by unauthorised fishing methods and habitat degradation caused by anthropogenic activities along the river. The modified habitat favoured omnivores which might account for the abundance of fish in the family Mormyridae. Worryingly, many of the fishing gears had mesh sizes smaller than the 5.0 cm minimum mandated by the Fisheries Commission of Ghana for inland fisheries, which could further cause growth overfishing and recruitment overfishing. Additionally, the issue of annual flooding in the region remains a significant challenge, causing the loss of farms, property, and lives each year. It was therefore recommended that the government expedite its collaboration with the contractors of the Multipurpose Dam Project to ensure its timely completion, to mitigate these recurring floods and safeguard the livelihoods and well-being of local communities. The findings of this study underscore the need for improved fisheries management and enforcement of regulations to ensure the long-term sustainability of the White Volta fisheries.

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References

[1] ABOBI, S. M, ALHASSAN, E. H., ABARIKE, E. D., AMPOFO-YEBOAH, A., ATINDANA,

S., & AKONGYUURE, D. N. (2014). Species Composition and abundance of freshwater fishes from the lower reaches of the White Volta at Yapei, Ghana. Journal of Biodiversity and Environmental Sciences, 4(4), 1 – 5.

[2] ABOBI, S. M., EKAU, W., WOLFF, M., BLAY, J., & CAMPION, B. B. (2013). Catch per unit effort (CPUE) and water level variations in the lower reaches of the White Volta River (Yapei), Ghana. African Journal of Agriculture Resources, 8, 2870 – 2876.

[3] ADJIBADE, K. N., ADITE, A., ARAME, H., CHIKOU, A. AND ABOU, Y. (2020). Aspects of life – history of Marcusenius senegalensis (Pisces: Osteoglossiformes: Mormyridae; Steindachner, 1870) from Niger River in Northern Benin. International Journal of Forest, Animal and Fisheries Research, 4(1), 1 – 13.

[4] AKONGYUURE, D. N., & EDZIYIE, R. (2020). Population characteristics of five major commercial fish species of the Tono Reservoir in Northern Ghana. Lakes and Reservoirs: Science, Policy And Management For Sustainable Use, 25(2), 157-166.

[5] AKONGYUURE, D. N., AYIKU, S., ALHASSAN, E. H., AMPOFO-YEBOAH, A., ABARIKE, E. D., ABOBI, S. M., & ATINDANA, S. A. (2015). Fishing Gear and Fish catch Assessment along the Oti River at Agbasakope in Krachi East District of Volta Region, Ghana. UDS International Journal of Development, 2(1), 31 – 44.

[6] AKRASI, S. A. (2011). Sediment discharges from Ghanaian rivers into Sea. West African Journal of Applied Ecology, 18, 1 – 13.

[7] ALHASSAN, E. H., ADURI, E. AND AKONGYUURE, D. N. (2014). Frame survey and fish catch assessment of the Bontanga reservoir in Northern Ghana. Journal of Biodiversity and Environmental Sciences, 4(6), 349 – 356.

[8] ALHASSAN, E. H., OFORI-DANSON, K. P., & NUNOO, F. K. E. (2015). Fish Abundance and Diversity during the Pre- and Post-Impoundment Periods of the Black Volta at Bui, Ghana. Journal of Applied Sciences Research, 11(5), 42 – 49.

[9] ALHASSAN, E. H., OFORI-DANSON, P. K., & NUNOO, F. K. E. (2016). Modelling catch per unit effort of the Black Volta near Bui Dam in Ghana. African Journal of Ecology, 55, 126 – 133.

[10] ALLAN, J. D., ABELL, R., HOGAN, Z., REVENGA, C., TAYLOR, B., WELCOMME, R. L., & WINEMILLER, K. (2005). Overfishing in inland water. Bioscience, 55(12), 1041 – 1051. AMARASINGHE, U. S. (1987). Status of the fishery of Pimburettewa Wewe, a man-made lake in Sri Lanka. Journal of Aquaculture and Fisheries Management, 18, 375 – 385.

[11] BARRY, B., OBUOBIE, E., ANDREINI, M, ANDAH, W., & PLUQUET, M. (2005). The Volta River Basin: Comprehensive Assessment of Water Management in Agriculture. Comparative Study of River Basin Development and Management. Retrieved September 20, 2020, from: http://www.iwmi.cgiar.org/assessment/files_new/research_projects/river_basin _development_and_management /VoltaRiverBasin_Boubacar.pdf

[12] BARTLEY, D. M., DE GRAAF, G. J., VALBO-JØRGENSEN, J., & MARMULLA, G. (2015). Inland capture fisheries: Status and data issues. Fisheries Management and Ecology, 22(1), 71–77. https://doi.org/10.1111/fme.12104

[13] BEVERTON, R. J. & HOLT, S. J. (1957). On the dynamics of exploited fish population. United Kingdom: Springer Dordrecht.

[14] BLAY, J. JR., & ASABERE-AMEYAW, A. (1993). Assessment of the fishery of a stunted population of the cichlid, Sarotherodon melanotheron, in a closed lagoon in Ghana. Journal of Applied Ichthyology, 9, 1 – 11.

[15] DANKWA, H. R., ABBAN, E. K., & TEUGELS, G. G. (1999). Freshwater fishes of Ghana: Identification, distribution, ecological and economic importance. Belgium: Royal Museum for Central Africa.

[16] DEGRAAF, G., & GARIBALDI, L. (2014). FAO – The value of African Fisheries. FAO Fisheries and Aquaculture Circular. No. 1093. Rome, FAO, 76 pp.

[17] DENYOH, F. M. K. (1969). Changes in fish population and gear selectivity in the Volta Lake. Ecosystem services of large tropical rivers: Embodied energy and market value of artisanal fisheries. Conservation Biology, 23(5), 1222–1231. FAO (2010). The State of World Fisheries and Aquaculture 2010. FAO, Rome.

[18] FAO (2016). Fisheries and aquaculture country profiles. Country profile fact sheets. In: FAO Fisheries and Aquaculture Department (online). Retrieved April 20, 2018, from http://www.fao.org/fishery.

[19] FAO (2018). The State of World Fisheries and Aquaculture 2018. Meeting the Sustainable Development Goals. Rome. Licence: CCBY-NC-SA 3.0IGO.

[20] FAO (2020). The State of World Fisheries and Aquaculture 2020. In The State of World Fisheries and Aquaculture 2020. FAO. https://doi.org/10.4060/ca9229en

[21] FISHERIES REGULATIONS (2010). Government of Ghana. GPCL, Assembly Press, Accra.

[22] GU, Q., DENG, J., WANG, K., LIN, Y., LI, J., GAN, M., MA, L., & HONG, Y. (2014). Identification and assessment of potential water quality impact factors for drinking-water reservoirs. International Journal of Environmental Research and Public Health, 11(6), 6069 – 6084. https://doi.org/10.3390/ijerph110606069

[23] HOEINGHAUS, D. J., AGOSTINHO, A. A., GOMES, L. C., PELICICE, F. M., OKADA, E. K., LATINI, J. D., KASHIWAQUI, E. A. L., & WINEMILLER, K. O. (2009). Effects of river impoundment on ecosystem services of large tropical rivers: Embodied energy and market value of artisanal fisheries. Conservation Biology, 23(5), 1222 – 1231.

[24] HOLDEN, M., & REED, W. (1972). West African fresh water fish. London: Longman Group Limited.

[25] IKONGBEH, O. A., SOLOMON, S. G., & OGBE, F. G. (2013). Seasonal numerical abundance and determination of size distribution of Chrysichthys nigrodigitatus from Lake Akata, Benue State, Nigeria. Academic Journal of Agricultural Research, 1(10), 187 – 192.

[26] JOYNEWS (2019). Akufo-Addo cuts sod for $993m Pwalugu Dam and irrigation project. Retrieved August 27, 2021, from: https://www.myjoyonline.com/akufo -addo-cuts-sod-for-993m-pwalugu- dam-and-irrigation-project/.

[27] KASEI, R. A., AMPADU, B., & SAPANBIL, G. S. (2013). Relationship between Rainfall-Runoff on the White Volta River at Pwalugu of the Volta Basin in Ghana. Journal of Environment and Earth Science, 3 (11), 92 – 99.

[28] KUEBUTORNYE, F. K. A., AKONGYUURE, D. N., & ALHASSAN, E. H. (2019). Morphometric characteristics and feeding habits of five commercial fish species of the Libga Reservoir in the Northern Region of Ghana. International Journal of Oceanography and Aquaculture, 3(2).

[29] LOHR, S. L. (2010). Sampling: Design and Analysis (2nd ed.). Cengage Learning.

[30] MAPEDZA, E., BUISSON, M.-C., ZANE, G., APPIAH, S., ASMAH, R., AHIAH, L., & MENSAH, E. (2024). Review of fisheries and aquaculture policies in Ghana: technical report. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Initiative on Aquatic Foods. 32p.

[31] MINISTRY OF FISHERIES AND AQUACULTURE DEVELOPMENT (MOFAD) (2017). Annual report 2016, Ministry of Fisheries. Accra, Ghana.

[32] MUL, M., OBUOBIE, E., APPOH, R., KANKAM-YEBOAH, K., BEKOE-OBENG, E., AMISIGO, B., LOGAH, F. Y., GHANSAH, B., & MCCARTNEY, M. (2015). Water resources assessment of the Volta River Basin. Colombo, Sri Lanka: International Water Management Institute (IWMI). 78pp. IWMI Working Paper 166.

[33] MUSTAPHA, U. F., AKONGYUURE, D. N., ABAGALE, F. K., ALHASSAN, E. H., ABARIKE, E. D. (2016). Fish and fisheries of the Sisili-Kulpawn river basin in the Northern region, Ghana. Journal of Biodiversity and Environmental Sciences, 9(3), 112 – 119.

[34] NSOR, C. A., & OBODAI, E. A. (2016). Environmental determinants influencing fish community structure and diversity in two distinct seasons among wetlands of Northern Region (Ghana). International Journal of Ecology, 10.

[35] NUNOO, F. K. E., & ASIEDU, B. (2014). An investigation of fish catch data and its implications for management of small-scale fisheries of Ghana. International Journal of Fisheries and Aquatic Sciences, 2(3), 46 – 57.

[36] OBODAI, E. A., & KWOFIE, J. E. (2001). Fish species composition and efficiency of selected gillnets used in Bontanga Reservoir. Interfaculty Journal of the University for Development Studies, 1(1), 4 – 10.

[37] OBODAI, E. A., & LAWEH, M. A. (2009). A survey of fish species diversity and abundance in the White Volta at Nawuni, Northern Region, Ghana. International Journal of Biological and Chemical Sciences, 3(2), 378 – 385.

[38] OWODEINDE, F. G. (2012). Optimum growth determination of Heterobranchus bidorsalis in earthen pond. Journal of Biological Sciences, 12(3), 168 – 173.

[39] PAUGY, D., LEVEQUE, C., & TEUGELS, G. G. (2003). The fresh and brackish water fishes of West Africa, (Vol. 1). Belgium: Royal Museum for Central Africa.

[40] PAULY, D. (1983). Some Simple Methods for the Assessment of Tropical Fish Stocks. FAO Fisheries Technical Paper No. 234. Food and Agriculture Organization.

[41] PRESTON, F. W. (1962). The canonical distribution of commonness and rarity: Part I.

[42] QUARCOOPOME, T., AMEVENKU, F. Y. K., & ANSA-ASARE, O. D. (2008). Fisheries and limnology of two reservoirs in northern Ghana. West African Journal of Applied Ecology, 12, 25 – 32.

[43] RAHMAN, B. M. S., RAHMAN, Md. K., ALI, A., LIMA, R. K., MIA, Md. L., & MAHMUD, Y. (2024). Catch composition, catch per unit effort

(CPUE) and species selectivity of fishing gears on multi-species Kaptai Lake in Bangladesh. Heliyon, 10(10).

[44] ROBERTS, T. (1967). A preliminary checklist of the freshwater fishes of the Volta Basin, with notes on species of possible economic importance. Volta Basin Research Project Tech. Report, 10 p.

[45] SPARRE, P., & VENEMA, S. C. (1998). Introduction to Tropical Fish Stock Assessment. FAO Fisheries Technical Paper No. 306/1. Food and Agriculture Organization.

[46] STRANZL, S. (2014). Quantification of human impacts on fish assemblages in the Upper Volta catchment, Burkina Faso. Master thesis, Institute of Hydrobiology and Aquatic Ecosystem Management (IHG), University of Natural Resources and Life Sciences, Vienna, Austria.

[47] SULEIMAN, N., YOLA, I. A. & AHAMED, I. M. (2018). Biodiversity and condition factor of fish species from Challawa Dam. International Journal of Fisheries and Aquatic Sciences, 6(3), 112 – 117.

[48] SUURONEN, P. & BARTLEY, D. M. (2014). Challenges in managing inland fisheries – using the ecosystem approach. Boreal Environment Research, 19, 245 – 255.

[49] TIKADAR, K, K., KUNDA, M., & MAZUMDER, S. S. (2021). Diversity of fishery resources and catch efficiency of fishing gears in Gorai River, Bangladesh. Heliyon, 7(12). USDA (United States Department of Agriculture) (2022). Ghana Seafood Report. Global Agricultural Information Network. Report No. GH2022-0005. 4 p.

[50] VOLTA RIVER AUTHORITY (VRA) (2014). Environmental and social impact assessment (ESIA). Pwalugu Multipurpose Dam Project Final Scoping Report, 176 pp.

[51] WATER RESOURCES COMMISSION (2008). White Volta River Basin – Integrated water resources management plan. Retrieved August 27, 2021, from https://www.wrc-gh.org/dmsdocument/19.

[52] WELCOMME, R. L. (2011). An overview of global catch statistics for inland fish. ICES Journal of Marine Sciences, 68, 1751 – 1756.

[53] WELCOMME, R. L. (2001). Inland Fisheries: Ecology and Management. Wiley-Blackwell.

[54] WIN ML, MYINT TT (2020). Species composition, seasonal occurrence and abundance of freshwater fishes in Ayeyarwady River segment, Sagaing region, Upper Myanmar. IOP Conference Series Earth and Environmental Science, 416: 1–19.

[55] WORLD BANK (2015). International Bank for reconstruction and development project appraisal document on proposed grants to the Volta Basin Authority from the cooperation in International Waters in Africa Trust Fund in the Amount of US 3.5 Million and the Global Environment Facility in the Amount of US 7.2 Million for a Volta River Basin Strategic Action Programme Implementation Project. Retrieved August 20, 2021, from https://documents1.worldbank.org/curated/en/443971468171858975/pdf/PAD1287-PAD-P149969-GEF-R2015-0009-1-IDA-R2015-0101-1-Box391422B-OUO-9.pdf

[56] ZARFI, C., LUMSDON, A. E., BERLEKAMP, J., TYDECKS, L., & TOCKNER, K. (2015). A global boom in hydropower dam construction. Aquatic Sciences, 77, 161 – 170.

[57] ZHONG, Y., & POWER, G. (1996). Environmental impacts of hydroelectric projects on fish resources in China. Regulated Rivers: Research and Management, 12(1): 81 – 98.