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Morphometric and Growth Diversity of Fish Landed by Artisanal Bait Fishers in Yelwa Lake at Ardo-Kola Taraba State

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ABSTRACT

Between May –August 2021, a study on the morphometric and growth diversity of fish landed by artisanal bait fishers at Yelwa Lake was conducted. Fifty-five (55) fish were gathered every month for four months, and the type of bait and fishing gear used were analysed. A total of 220 individuals from 16 genera, 12 families and 24 species were seen. Although the morphometrics of artisanal commercial and net fisher's landings have gained attention, the morphometrics of bait fisher landings have gotten less attention. Despite the relevance of such data in inferring fished stock growth and developmental condition in order to prevent excessive removal of young and highly fecund fish, this is the case. This study compares fish species, size and weight, and derived fish condition, Gonadosomatic and Fishing Indices, between hook and line gear trap baited with lumbricina and gastropoda. The results show that Corn offal landed the heaviest fish weight while gastropod landed the lightest weight. Lumbricina bait used on hook landed the most species while corn offal bait used in trap landed the fewest. It was also discovered that fishermen landed over 20 fish species with identical condition, GSI below unity and fishing index below 35%. The variation in growth indicators was largely attributed to species differences. Participatory effort controls, such as closure, alternative livelihoods, and voluntary release of immature, combine with limiting the use of small mesh traps and hooks, may reduce immature harvesting and lead to improved future landings and fishery sustainability.

INTRODUCTION

Morphometric and meristic studies are key rigorous method distinguishing closely related species of organism with high similarity indices of characteristics (Fagbuaro, 2015). Morphometric characteristic are important not only for understanding taxonomy, but also for a understanding species health and reproduction in a habitat. Artisanal fishermen account for a considerable portion of global fish landing (Cheunpagdee *et al.*, 2006). Along the Nigeria coastline, artisanal fishermen land 90% of fresh water fisheries landing with hook and line, with basket trap fishers accounting 40 to 60%. Tropical artisanal fishers utilize a variety of gears to target a diverse array species of fish using non-motorized craft (Van der Elst *et al.*, 2005). Various nets (e.g. seines, cast net etc.) hooks (e.g. handline and logline) and traps (e.g. basket traps, weirs, fence trap etc), have been mentioned in the literature. While the morphometric of fish landed using net by artisanal fishers along the Nigerian coast and elsewhere have been documented, those landed by bait fishers (hook and trap fishers), have received less attention, which is why study this was conducted.

For example, descriptions of tropical artisanal bait fisheries include the mention of unidentified baits, such as worms, squid, octopus and tiny fish, for hook fishers, and seaweeds, urchin, mollusks and octopus for trap fishers with no information on the species they target (Samoilys *et al*., 2011). Wambiji *et al*., (2008) report tropical baited trap fish landing in general, however bait utilization is inadequately described in the research. Fishery condition factor (k) is derived from the morphometric indicator that infers the health of a fishery with high K associated with fishery specializing in large healthy and plumpy fish stocks. Gonadosomatic index (GSI) is an indicator that indicates the fish fertility, spawning and fecundity (Nandikeswan and Ananda 2013), and it has been demonstrated that fish condition and GSI fluctuate with season diet and fish shape (Kihia *et al*., 2015). The condition factor is 0.2 to 1.2, with values near close to or above unity denoting fish in excellent condition (Agembe *et al*., 2010; Mbaru *et al*., 2010). Depending on the fish species and sex, a GSI cut off of 1 to 10% is recommended to signify mature individuals. Seasonal changes in nutrition and breeding pattern have an impact on both condition factor and gonadal maturity. In fisheries with poor morphometric indicators, it is critical to demonstrate the potential harm to the resource and ecosystem to both managers and users prior to implementing changes. Size at first maturity of targeted fish is also an important parameter that informs resource managers whether the fishery target sub-adult or mature fish. A relevant index can be calculated by comparing landing morphometric to typical adult dimensions recorded elsewhere and measuring departures (Kihia *et al*., 2015). As a result, the purpose of this study is to look at the morphometric and developmental aspect of fish caught by artisanal bait fishers. The findings of this study may be valuable to resource managers to identifying and designing targeted interventions for unsustainable bait fisheries.

MATERIALS AND METHODS

Study Area

Yelwa Lake, located on latitude 8.8036 and Longitude 11.1671, is a village located 25.4Km North of Ardo-kola local government area of Taraba State that has been in existence since 1964. Yelwa lake covered an area of 31.6Km consisting of shrubs, sugarcane farm, mostly dominated by rice farm (figure 1). The lake surrounding village has a population of around 5000 people who are actively involved in fishing and small-scale businesses. Seasonal migrants from Sokoto, Katsina and Maiduguri also fished at Yelwa Lake from May to August 2021.

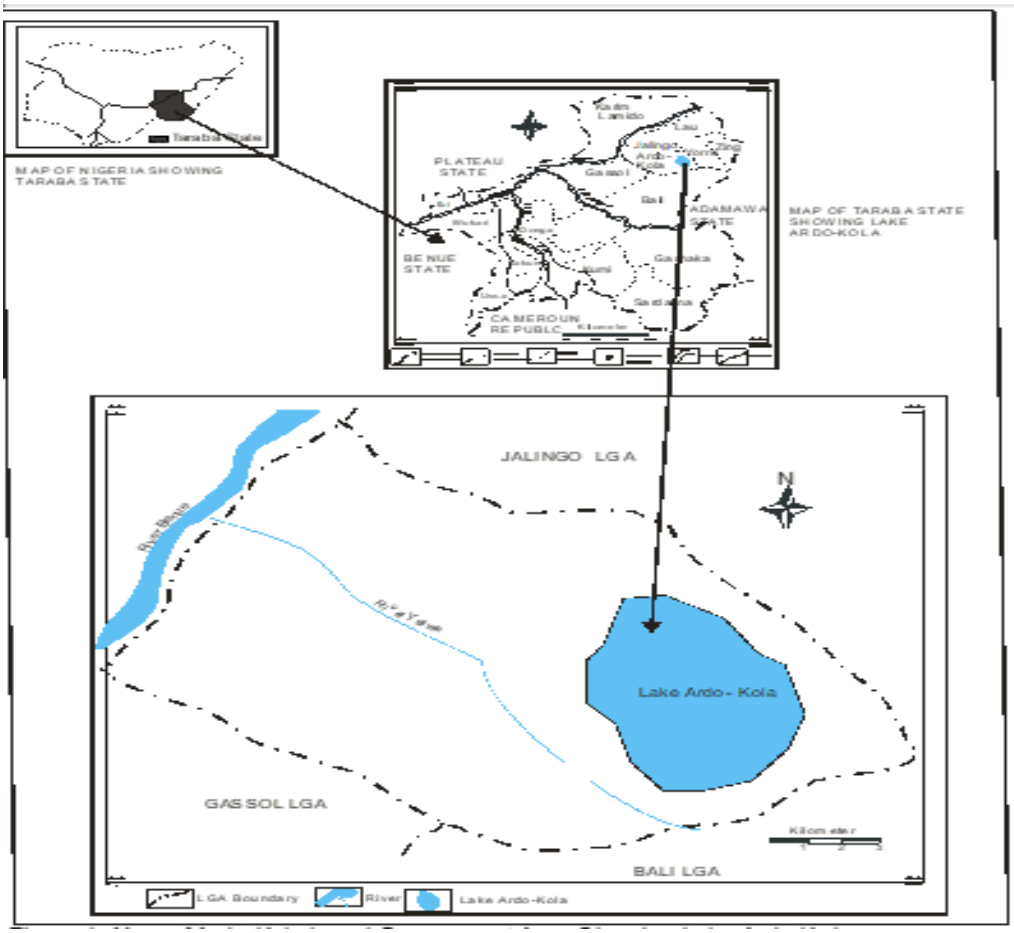

Figure 1: Map of Yelwa Lake showing sites
Source: Geographical Information System Laboratory, Ministry of Survey Jalingo, Taraba State

Taking Fish Samples

From May to August 2021, the main fishing season in Yelwa lake, 55 fish samples were collected every month participant fishers were identified and monitored over a period of ten days during each sampling occasion, approximately 60 fishers are monitored (10 per day for 6 days), the type of bait used, as well as the gear and fish landed were evaluated. The obtained fish samples were labeled and promptly stored in ice for transit and further refrigeration. In the laboratory, the persevering specimen was thawed, identified and employed in morphometric analysis.

Trap Fishing on Yelwa Lake

The Malian trap used in this study was made from lianas and nylon netting material (2ply10d) with dimensions of 72 cm in width, and 100cm in depth, with two non-return entrance valves of diameter 10cm in both ends made of stronger netting material with mesh size 25mm, allowing for the capture of a variety of fish. The top includes a loose hanging net that may be opened for baits placement and fish retrieval. The traps are baited with (corn-offal,) gathered from various sources Trap fishers insert 5 to 15 pieces of corn offal within the traps, each traps fisher owns and operates between four and five traps, the traps are weighted with stones and gravels and the traps are retrieve after overnight soaking in the water.

Hook Fishing on Yelwa Lake

Bait used by hook Bait fishers in Yelwa lake is either earthworm (*Lumbricina* species) or snail (*Gastropoda* species) or sometimes they used fish trash or live small fish to lure bigger fishes, hook fishers at Yelwa lake preferred earthworm and snail, on the other hand snail are gotten mostly in dammed environment. Hook fishers attach appropriate bait to one or most hooks of size 8 to 18; and to a line, sinkers and Styrofoam float, hook fishing occurred from a dugout canoe and the line is reeled in by hand, and catch placed at the bottom of the canoe.

Determination of Morphometric Parameters.

1. Condition Factor

The Standard length of fish were taken using a measuring board, as distance from the tip of snout to the tip of the caudal fin, while height was taken as

distance at widest part of the fish samples. Excess moisture is removed prior to weight determination with a sensitive balance, precision for the size and weight determined is 0.1cm and 0.01g respectively. Data obtained was utilized to calculate condition factor (B) using the modified foulton condition factor, as used by Richter *et al.,* (2000)
It was assumed that fish had isometric growth due to correction factor by inclusion of height in the original Fulton condition. Condition factor data were compared between gear and bait.

2. Gonadosomatic Index

The gonad of each fish was dissected out and the weight determined. Data obtained was used to calculate the Gonadosomatic index (GSI) using the following equation:

$$\mathbf{GSI}=\frac{wg}{wf}\times 100$$

Where GSI- Gonadosomatic index
Wg = weight of gonad
Wf = weight of the fish
Data obtained were used to compare between different gears and bait used by fishers.

3. Fishing Index

Fishing impact was assessed using fishing index (f1)

$$\mathbf{F1}=\frac{100lf}{ls}$$

Where F1=fishing index
Lf =size of landed fish
Ls =size of adult
Data on fishing index were used to compare between gear and bait.

Statistical Analysis

By measuring independent replicates, the results were expressed as mean values with standard error of mean (SE). The Statistical Package for Social Sciences (SPSS) software was used for the analysis.

RESULTS

Fish Species Composition

Table 1. shows the effect of bait type, gear used and species on morphometric parameters of fish landed by fishermen at Yelwa lake. 220 individuals from 12 families, 16 genera and 24 species were seen over the study period from May to August, 2021, utilizing various gears and bait. *Clariidae, Arapaimidae, Mormyridae, Cichlidae, Amphiliidae, Araceae, Lemuridae, Distichodontidae, Protopteridae, Cichlidae, Mochokidae and Cyprinidae* are among the families represented. The family *Clariidae* had the most species landed, while the families *Aracea, Chichlidae* and *Mochokidae* had the fewest.

Variation in condition factor, Gonadosomatic index and fishing index of the gear used, as well as the bait types used, different fish species.

Mormyrus rume (1.50±5.22), *C. gariepinus* (1.21±0.37), *Protopterus annectance* (1.20±0.90) had the highest condition factor, whereas *Patricephalus ansorgei, P. bovei, and P. simus* (0.04±0.00) had the lowest. Among the bait anglers, corn offal has the highest condition factor (1.31±1.02), while *Lumbricina* had the lowest (0.65±0.21). *Mormyrus rume* (4.77±0.58), *P. ansorgei*, (4.45±4.55), and *P. simus* (4.30±15.99) had the greatest GSI among the fish species, whereas *T. mariae* (0.37±0.06) had the lowest. *C. anguillaris* had the greatest score among gastropoda fishers, while *Protopterus annectance* had the lowest. *Mormyrus rume* was the most abundant corn offal fisher, while *Synodontis schall* was the least abundant. Except *C. anguillaris* and *C*. *gariepinus*, which landed above 30% in all three (3) baits employed, the hook and trap gears landed less than 20%. When the fishing index of different bait types was compared, it was discovered that corn offal fishers had the highest fishing index up to 35%, while *lumbricina* fisher had the lowest fishing index of 30%.

Table 1. The effect of bait type, gear used and species on the morphometric diversity of fish caught by fishermen at Yelwa lake.

Treatment	Parameter	Number	Condition factor	Gonadosomatic index	Fishing index
Bait	***Lumbricina***	90	0.65±0.21	0.50±1.04	30.20±7.47
	Gastropoda	80	0.80±0.26	0.25±1.68	32.96±8.38
	Corn offal	52	1.31±1.02	0.31±1.00	35.97±9.80
Gear	***Hook***	170	0.52±0.16	0.44±0.96	22.14±5.59
	Trap	52	0.31±1.02	0.97±1.00	19.97±9.80
Species	*C. anguillaris*	32	0.30±0.33	2.84±0.92	20.43±12.61
	C. gariepinus	24	1.21±0.37	3.17±1.90	24.37±3.20
	H. Bidorsalis	35	0.04±0.46	3.09±1.25	19.64±3.12
	H. isopterus	20	0.08±0.32	3.56±1.76	30.01±3.12
	H. longifilis	25	0.29±0.48	4.07±1.63	36.76±6.14
	Heterotis niloticus	2	0.67±0.33	1.29±0.04	23.50±21.50
	Mormyrus rume	10	1.53±5.22	4.77±0.58	25.04±10.48
	O. niloticus	9	0.46±0.52	1.79±0.90	23.88±9.49
	P. ansorgei	2	0.04±0.00	4.45±4.55	30.00±4.00
	P. bovei	2	0.04±0.00	4.08±1.11	30.50±89.50
	P. simus	2	0.44±0.00	4.30±15.99	24.50±18.5
	Petrocephalus bovei	1	0.21±0.00	2.66±0.00	32.00±0.00
	Phago loricatus	3	0.66±0.21	2.66±1.08	33.66±19.19
	Protopterus annectance	3	1.20±0.90	3.92±0.40	22.45±189.66
	S. galilaeus	1	0.02±0.00	2.66±0.00	28.00±0.00
	S. macrocephala	1	0.33±0.00	3.10±0.00	22.00±0.00
	Synodontis clarias	1	0.74±0.00	1.40±0.00	35.00±0.00
	Synodontis nigrita	4	0.73±0.18	2.01±0.39	35.75±4.32
	Synodontis robbianus	4	0.40±0.07	1.16±0.19	25.75±2.09
	Synodontis schall	7	0.25±0.06	1.54±0.13	17.85±43.20
	Synodontis sorex	13	0.40±0.04	0.85±0.09	38.15±2.91
	Synodontis vermiculatus	9	0.25±0.03	1.24±0.35	31.66±2.88
	T. guineensis	8	0.21±0.65	0.93±0.62	15.00±12.70
	T. mariae	4	0.84±0.35	0.37±0.06	18.50±8.58

Mean values ± standard error (S.E) mean of replicate

Variation in Fish Landing Based on Bait Types

The bar chart in figure 2 depicts the various species of fish and numbers landed by Yelwa lake fishers, with *lumbricina* bait fishers catching the most (18) and maize offal bait fishers catching the fewest (10) fish. The Clariidae (*H. bidorsalis*) were the most common fish caught with *lumbricina* bait, while *Mormyridae* (*Patricephalus bovei), Distichodontidae (Phago loricatus), Cichlidae (S. galilaeus,), Cyprinidae (S. macrocephala),* and *Mochokidae* (*Synodontis clarias)* were the least common. The family *Clariidae (C. anguillaris)* caught the most gastropoda bait, whereas and the family *Protopteridae* (*Protopterus annetance)* caught the least. The *Mormyridae* (*Mormyrus rume*) family has the most fish among corn offal bait anglers.

Variation in Fish Landing Depending on Gear Used

Figure 3 depicts the various species and numbers of fish caught using various gears. Hook fishermen catch the most *H. bidorsalis* species, whereas hook fisher catch the least *Petrocephalus bovei S. galilaeus, S. macrocephalus, and Synodontis clarias* species.

Mormyrus rume fish are the most common species taken by trap fishermen in Yelwa lake, while *Synodontis schall* fish are the least common. Ninety percent of the fish caught using all gears and bait types were juvenile. *C. bidorsalis* was the most developed fish type landed, reaching up to 70% of adult size.

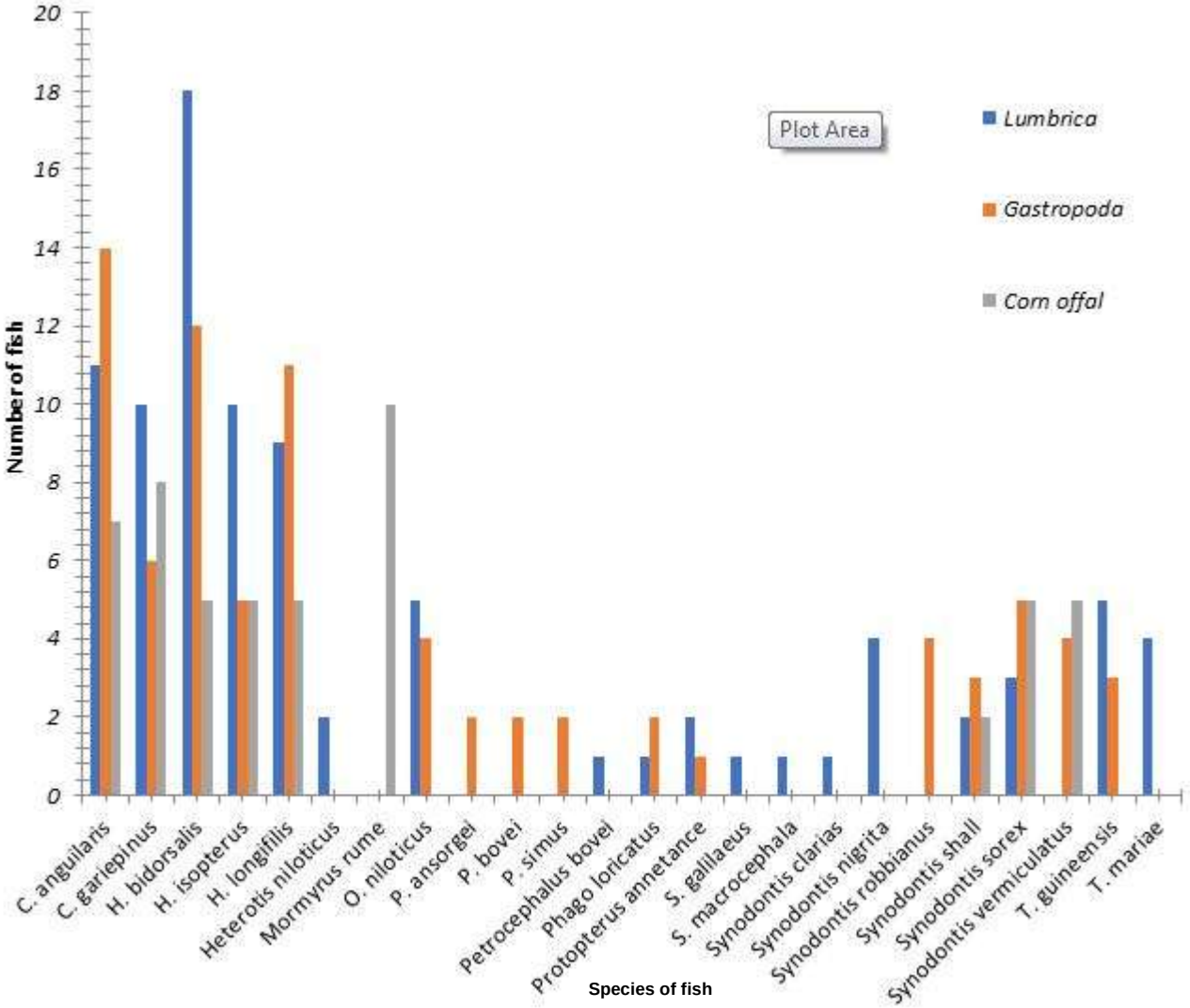

Figure 2. Variation in fish landing with bait type at Yelwa Lake Ardo-kola, Taraba state.

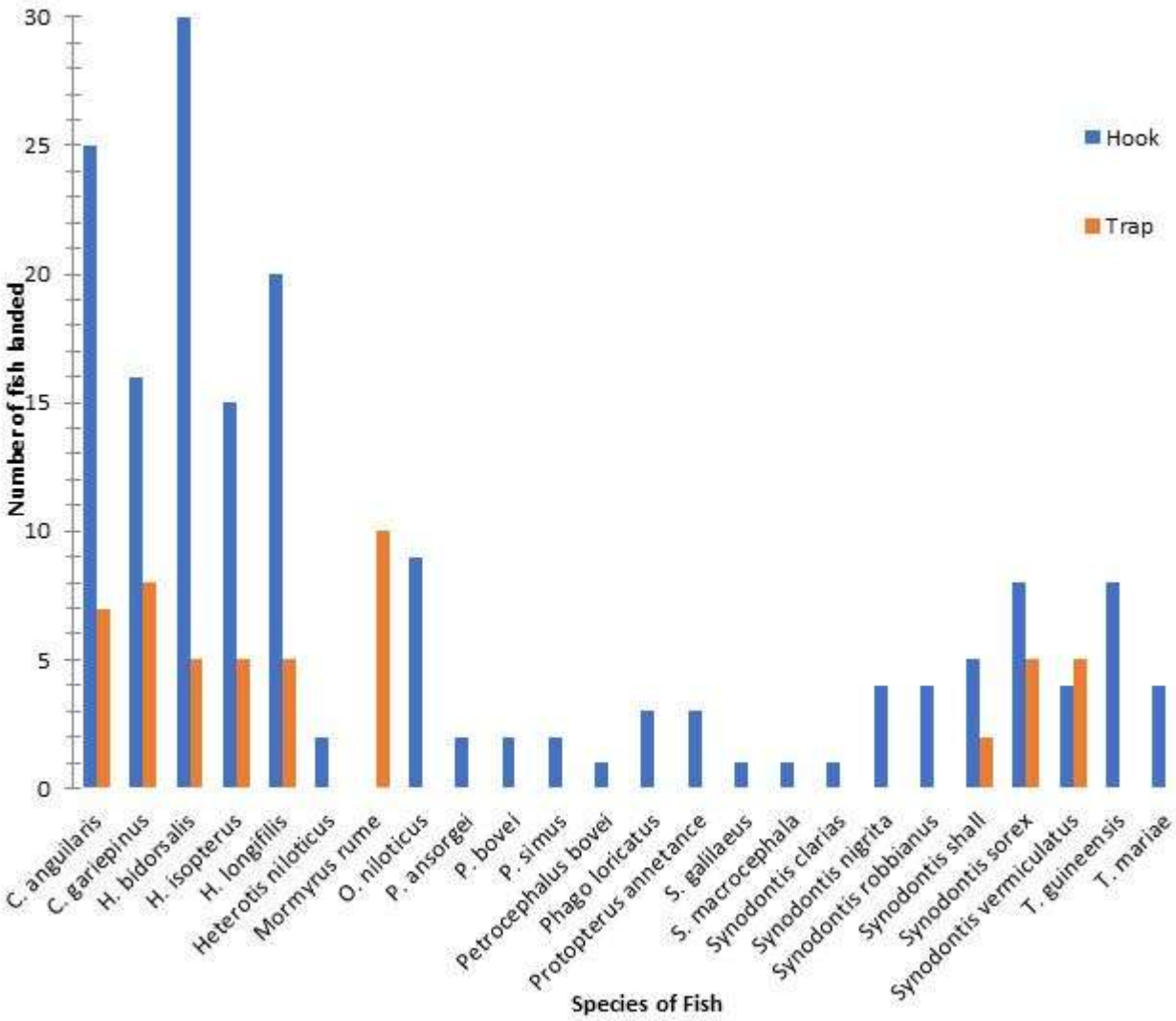

Figure 3. Variation in fish landing with gear employed at Yelwa Lake Ardo-kola, Taraba State.

DISCUSSION

The variation in fish composition observed in this study is due to the fact that these species constitutes the major fisheries of Nigeria inland water, as stated by Olaosebikan and Raji, (2013), as well as the relative abundance of these species in northern Nigeria, as reported by Adeosun *et al*., (2011), who reported *Mormyridae, Cichlidae, Mochokidae, Characidae, Bagridae* and *Clariidae* to be more dominant in northern Nigeria. Allison and Okadi (2013) also discovered six families of fish during their research on the lower River Nun.

Landed fish with low condition factor in Yelwa lake did not agree with the findings of Wambiji *et al*., (2008) while Agembe *et al*., (2010) found greater condition factor of 0.9 to 1.2 for *Siganids* fish caught employing basket and other gears in Kenya south coast. Mbaru *et al.* (2010) on the other hand, reported condition factors of 0.01 to 0.4 for *L. lentjan* and *L. fulviflamma* caught using nets, which are lower than values obtained in this work. The gonadosomatic index (GSI) discovered in this investigation is consistent with the findings of Fryer *et al*., (2002) who reported a GSI of between 4.2 and 3.6g.

In this study, there is a fluctuation in gonadal development; fish landed by bait fishers in Yelwa Lake were of moderate to poor condition and GSI. The fish were caught after reaching around 35% of their potential adult size. As a result, the Yelwa fishery focuses on immature subadult growth phases of rather large tropical fish from over 23 species. This experiment shows that excessive harvesting of young fish may result in the collapse of the Yelwa Lake fisheries due to failure to recruit new cohorts. According to Kihia *et al*., (2015), increasing fishing effort among jobless local resident will exacerbate the current scenario.

Although larger fish are landed using maize offal bait, there is uniformity in the condition, gonadal development and fishing index among the bait types evaluated. This suggests that artisanal fishers' baits attract and catch fish with similar morphometric traits. This contrast with the findings of Kihia *et al*., (2015) in a

long line bait fishery in Mida Creek, Kenya which revealed a variation in catch rates across the bait tested. However, Jacobsen and Joensen (2004) report a higher catch using whelk bait than squid bait in long line fishery. Fish types landed by bait fishers at Yelwa have similar condition factor, indicating that the majority of the fish landed by bait fishers at Yelwa lake are in a sub-optimal condition. It is crucial to note that GSI levels vary greatly with seasonal breeding patterns, hence the results on GSI changes reported here should only be interpreted as an indicative of prospective consequences.

The found species differences in condition factor, GSI, and fishing index could imply that the species use different habitats. Allowing local baits fishers to move into different fishing location may boost landings while lowering pressure from the immature lake fish population. However, more evidence is required before such interventions may be implemented.

The gathering of immature high value fish by bait fishers may limit the earning potential because such little fish have a low market value. The reported landing of juveniles' fish is the result of a combination of fishing within fish nursery areas and overfishing. Landing of small immature fish may be an indicator of overfishing pressure, according to Gajdjzik *et al.*, (2014). According to Kihia *et al*., (2015), the cause of heavy immature fishing may be the use of long line for this species at vegetated shores areas where juvenile fish grow, and thus the use of this poor size selective fishing gear in areas where immature fish are abundant (shore area) enhances immature fishing (Bertrand, 1988). While trap fishers land substantially larger fish, there were no significant variation in condition factor, GSI, or fishing index among the gears used. This means that trap gear lands larger fish, and that the fish health and developmental stages were similar to hook gears. The difference in fish sizes and taxa landed may be attributable to gear selection and fish habitat usage. The netting of the malian traps allow smaller fish to escape, but the traps are also drenched overnight and fish retrieved live, giving smaller fish more opportunity to escape.

The similarity in fish morphometric indexes may be related to the fish use of interconnected mangrove forest seagrass beds and coral reefs habitats (Garrison *et al*., 2004; Gajdjzik *et al*, 2014). Knowledge of exploited species reproduction and habitat utilization techniques may provide more insight on this aspect. Similarly, the use of small mesh malian traps and small hooks must be assessed and regulated. While some resource poor fishers may object at first, future enhanced earnings within participatory management frameworks, may be critical to sustaining livelihoods in the semi-enclosed Yelwa lake basin. Inadequate administrative authority policing of remote areas may necessitate concerted local community participation via stronger Lake Management Units.

CONCLUSION

The study found that bait fishers at Yelwa lake use Malian traps filled with corn offal and hooks baited with *gastropoda* and *lumbricina* to catch identical young fish with moderate to low condition factor, GSI and fishing index. This is the first record describing the characteristics of fish landed using certain types of bait in Yelwa lake tropical multi-bait fishery. The observed disparities in landed fish features are mostly related to overfishing, species specific growth diversity and habitat usage patterns. Reducing fishing pressure, through voluntary catch and release of juveniles and immature fish, as well as identifying alternative fishing grounds and livelihoods, may allow for improvement in morphometrics of landings and provide respite and sustainability to the Yelwa lake fishery.

RECOMMENDATION

There is a need to educate the artisanal bait fishers about the dangers of overfishing, as well as provide them alternative means of livelihood, alternative fishing grounds, catch and release of immature fish, mesh size restriction for sustainable fisheries in Yelwa lake.

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