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Temporal Variatiton in Fish Species Abundance in Relation to Gear Selectivity, in Tagwai Lake, Minna, Nigeria

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ABSTRACT: The need for cost-effective fishing in in-land fresh water lakes informed this study, which assessed the abundance of fish species in relation to vulnerability to fishing gears in Tagwai Lake, Minna, Nigeria. Three types of gears namely, cast net, gill net and hook-and-line, were deployed in the lake during 16 consecutive weeks for collection of fish samples. The results indicated the presence of seven fish species, in order of decreasing relative abundance: *Tilapia zilli* > *Auchenoglanis occidentalis* > *Tilapia galilaea* > *Clarias gariepinus* > *Alestes lesciscus* > *Bagridae chrysichthys* > *Mormyrus rume*. While, the *Tilapia* species and *A. lesciscus* were vulnerable to cast and Gill nets, *M. rume* was collected only by the former type of net gear. Likewise, the Cast net was the only gear sensitive to *A. occidontalis*, *B. chrysichthys* and *C.gariepinus*. The Cast net was by far the most productive gear, with six fish species and >90% of all specimens collected, while hook-and-line yielded no catch. The dominant species in cast net collections was *T. zilli* (41.13%) while, that of Gill net was *A. lesciscus* (61.61%). Temporal distribution in fish abundance within and among the species varied significantly ($p<0.05$), with most species reducing significantly in abundance after the 10th week of specimen collection. Cross-correlation analysis revealed strong positive associations, especially, between the *Tilapia* species and with *C. gariepinus* ($r>0.60$). the findings of this study should fast-track cost-effective and sustainable exploitation of inland freshwater fishery.

Keywords: Cast net, *Clarias*, Fishing gear, Fishery, Freshwater and *Tilapia*.

INTRODUCTION

Fish and fishery products constitute the cheapest sources of animal protein (Mickiewicz and Wolos, 2012), but according to Balogun (2005), they constitute only 40% of the diet of an average Nigerian. Anko and Eyo (2003), reported that Nigeria has vast potentials for fisheries development, being endowed with marine areas of 46,300km, an exclusive economic zone (EEZ) area of 210,900km^2 and inland waters of 12.5 million ha. Amazingly, inspite of the huge endowment, the current production level of 400,000 metric tons is at a 50% deficit to meet Nigeria's fish need per annum of at least 1.5 million metric tons. According to Boulenger (1995), fisheries resources are on the decline in Nigeria due to over exploitation and inadequate management of her coastal waters. For sustainability of these resources, an adequate knowledge of species composition, diversity and relative abundance of her water bodies must be understood and vigorously pursued (Nwadukwe, 1995; Lawson and Olusanya, 2010).

In many parts of Nigeria, Niger state inclusive, demand for fish has continuously out-weighed supply. Fish activities in these water bodies are intense all-year-round, with fishermen using different types of fishing gears to increase their catches

(Idodo-Umeh, 2003). Seasonal changes, both in species distribution and abundance, necessitate the deployment of varied gears at different times of the year. Thus, different gears are used by different fishermen depending on the season and period of the year (Ita, 1978; Idodo-Umeh, 2003). Fishing gears commonly used in Nigeria include, cast net, drift net, seine net, gill net, basket trap and long line.

A thorough study of the type of fishing gears used in different localities and their contribution to fish landing, will not only serve for conservation purposes but in addition will provide information on abundant and distribution of the species. This study was, therefore, carried out to determine the abundance of fish species in Tagwai Lake, Minna, Niger State in Nigeria, and ascertain the different types of gears used by the fishermen.

MATERIALS AND METHODS

Description of Study Area

The study site, i.e., Tagwai Lake, is located in the outskirt of Minna, the Capital city of Niger State in Northcentral Nigeria. Minna covers a land area of 88km^2 (The Nigerian Congress, 2007). The area has tropical climate, with mean annual temperature of 30.20°C, relative humidity of 61% and annual rainfall of 1334mm. The vegetative cover reflects that of Savannah zone, dominated by grass but with scattered tree species. There are two distinct seasons in the area namely, a rainy season between April and October, and dry season between November and March. The rainfall pattern of this area like other areas of the state is characterized by peaks usually in May and August.

Tagwai Lake is located within longitudes 6° 39'E and 9°44'E and latitudes 9° 34'N and 9° 37'N in Minna. The Dam, impounded in the rainy season of 1978, is 25m high and 1.8km long. The reservoir has a capacity of 28.3 million cubic meters, and serves purposes of fisheries, recreation, wild life conservation and social upgrading of the project area. The occupation of people living around the Lake is principally fish farming. Fishing activities in the Lake is characterized by use of different fishing gears.

Collection of Fish Specimens

Routine sampling of fish from Tagwai Lake was conducted bi-weekly, for four months. The following types of nets: Cast nets, Gill nets and Hook-and-line, were deployed for specimen collection. Fish caught were identified to species level using standard taxonomic keys (Reid and Syndeham, 1999; Bankole and Mbagwu, 2000).

All fish species collected were counted to determine species abundance. The relative abundance of the species was estimated using the formula:

$$RA = \frac{NS}{NA} \times 100\%$$

Where,
RA = Relative abundance of a species (%)
NS = Number of a Species collected
NA = Number of all fish specimens collected

And also, Chi square was used to determine the productivity of the Gear. Along side, questionnaires were abundance to the local fishermen, to access the gear type used, portion of the Lake where fish were caught and how long they have been in the profession. (Meye and Ikorni, 2012)..

RESULTS AND DISCUSSION

Results

The species composition and gear-sensitivity to the fishes collected from Tagwai Lake, Minna, are presented in Table 1. On the whole, seven fish species were encountered in the Lake including Alestes lesciscus, A. occidentalis, Bagridae chrysichthys,. Claris gareipinus, Mormyrus rume, Tilapia galilae and T. zilli. Three of the species: A. lesciscus, Tilapia galilae and T. zilli were vulnerable to collection with the two sensitive to both gears deployed namely Cast and gill nets. On the other hand, while Gill nets was the only gear sensitive to only one fish species, i.e. M. rume was absent in collections made with Cast net. While, Cast net was the most sensitive gear, with 6 fish species; followed by Gill net (i.e., 4 species), the hook-and-line was not sensitive to any of the fish species collected during the study. With respect to productivity, significantly ($p<0.05$) higher numbers of fishes were collected by Cast net (Mean=707.68±165.41) than the Gill net (63.01±26.31 fishes/week). The proportions of fish species collected by a particular gear varied significantly. While, the dominant fish species collected by Cast net were T. zilli (41.13%), A. occidentalis (17.69%), Tilapia galilae (15.49%) and C. gariepinus (11.69%); that of the Gill net was predominantly A. lesciscus (61.61%).

Table 1. Fish species composition and gear sensitivity in Tagwai lake, Minna, Nigeria

Fish Species	Gear Type		
	Cast Net	Gill Net	Hook-and-line
Alestes lesciscus	38.13±11.30 (5.39)^{b*}	38.75±16.45 (61.61)^{d}	0.00±0.00
Auchenoglanis occidontalis	126.38±37.48 (17.69)^{d}	0.00±0.00^{a} (0.00)^{a}	0.00±0.00
Bagridae chrysichthys	55.25±8.62 (7.74)^{b}	0.00±0.00^{a} (0.00)^{a}	0.00±0.00
Clarias gariepinus	83.50±27.58 (11.69)^{c}	0.00±0.00	0.00±0.00
Mormyrus rume	0.00±0.00 (0.00)^{a}	2.38±1.53 (3.78)^{b}	0.00±0.00
Tilapia galilae	110.67±38.55 (15.49)^{cd}	10.00±3.74 (15.90)^{c}	0.00±0.00
Tilapia zilli	293.75±41.88 (41.13)^{e}	11.88±4.59 (18.89)^{c}	0.00±0.00
Aggregate	707.68±165.41$_{b**}$ (100.00)	63.01±26.31$_{a}$ (100.00)	0.00±0.00

* Values followed by similar superscript alphabets, in a column, are not significant different at P = 0.05.
** Values followed by different subscript alphabets, in the row, are significant different at P = 0.05

Temporal distribution of the fish species in the Lake during the study period is highlighted in Table 2. Significantly ($p<0.05$), T. zilli was the most abundant species (52.55%) encountered in the lake, while the densities of the remaining species ranged significantly from 0.23% M. rume to 15.13% T. galilae. The individual fish species showed distinct patterns of temporal distribution. While, the densities of the Tilapia species and C. gariepinus decreased significantly after the 10th week, those of A. occidentalis, A. lesciscus and Bagridae spp varied within narrow limits during the period of fish collection. M. rume was very rare in the collections, been encountered only in the 12th week.

Table 2. Temporal distribution and relative abundance of fish species from Tagwai Lake, Minna, Nigeria

Fish Species	Weeks								Mean		
	2	4	6	8	10	12	14	16			
Tilapia zilli	8.83 ±0.17^{b*}	8.15 ±0.29^{b}	8.10 ±0.06^{b}	6.15 ±0.03^{b}	7.15 ±0.03^{b}	3.00 ±0.29^{a}	0.73 ±0.02^{a}	2.32 ±0.15^{a}			5.55±2.90 (52.55)^{d}
Tilapia galilaea	2.67 ±0.330^{c}	2.64 ±0.02^{c}	2.00 ±0.29^{c}	1.80 ±0.03^{bc}	2.25 ±0.03^{c}	0.91 ±0.02^{b}	0.50 ±0.03^{b}	0.00 ±0.00^{a}			1.60±0.94 (15.13)^{c}
Auchenoglanis occidontalis	0.23 ±0.12^{a}	0.20 ±0.01^{a}	0.73 ±0.01^{a}	1.05 ±0.03^{a}	0.63 ±0.01^{a}	0.72 ±0.03^{a}	0.17 ±0.02^{a}	0.56 ±0.01^{a}			0.54±0.29 (5.12)^{b}
Clarias gariepinus	0.94 ±0.01^{ab}	1.62 ±0.01^{b}	0.28 ±0.01^{a}	1.50 ±0.03^{b}	1.34 ±0.02^{b}	0.55 ±0.03^{a}	0.16 ±0.20^{a}	0.31 ±0.02^{a}			0.84±0.55 (7.94)^{b}
Mormyrus rume	0.00 ±0.00^{a}	0.00 ±0.00^{a}	0.00 ±0.00^{a}	0.00 ±0.00^{a}	0.00 ±0.00^{a}	0.16 ±0.00^{b}	0.00 ±0.00^{a}	0.00	±0.00^{a}		0.02±0.05 (0.23)^{a}
Alestes lesciscus	1.52 ±0.28^{b}	0.39 ±0.21^{a}	0.15 ±0.03^{a}	2.50 ±0.03^{b}	0.32 ±0.01^{a}	2.00 ±0.58^{b}	0.53 ±0.01^{a}	0.72	±0.01^{a}		1.01±0.82 (8.63)^{b}
Bagridae spp	1.40 ±0.21^{a}	0.72 ±0.15^{a}	0.89 ±0.01^{a}	2.72 ±0.01^{b}	0.53 ±0.01^{a}	1.27 ±0.15^{a}	0.37 ±0.01^{a}	2.03	±0.01^{b}		1.24±0.75 (11.77)^{c}
Aggregate	2.22 ±2.82^{c}	1.96 ±2.67^{b}	1.74 ±2.67^{b}	2.25 ±1.80^{c}	1.75 ±2.31^{b}	1.23 ±0.90^{b}	0.35 ±0.24^{a}	0.84 ±0.88^{a}			10.80±6.31 (100.00)

* Values followed by similar superscript alphabets, in a row for the weeks, are not significant different at P = 0.05
** Values followed by similar superscript alphabets, in the mean column, are not significant different at P = 0.05

Table 3 shows cross-correlation coefficients among temporal distribution of the fish species. Significant and positive correlations were limited to those of between the Tilapia spp, Tilapia vs C. gariepinus and A. lesciscus vs Bagridae spp.

Table 3. Cross-correlation among temporal distribution of fish species from Tagwai lake, Minna, Nigeria

	Tilapia zilli	Tilapia galilaea	Auchenoglanis occidontalis	Clarias gariepinus	Mormyrus rume	Alestes lesciscus	Bagridae spp
Tilapia zilli	1.00						
Tilapia galilaea	0.95*	1.00					
Auchenoglanis occidontalis	0.04	-0.09	1.00				
Clarias gariepinus	0.61*	0.71*	0.13	1.00			
Mormyrus rume	-0.33	-0.28	0.24	-0.20	1.00		
Alestes lesciscus	-0.09	-0.05	0.49	0.24	0.45	1.00	
Bagridae spp	-0.02	-0.18	0.62*	0.18	0.01	0.74*	1.00

Discussion

Seven fish species were sensitive to two of the gears (i.e., Cast and gill nets) deployed in Tagwai Lake, Minna, during the study period. This result is similar to those reported by Vigg (1981) from Nevada, but differed considerably from those of Degan, (1998) who encountered several more species in Lake Agmon, Israel. The number of fish species (i.e., 7) encountered in Tagwai Lake is, thus, relatively low. This may be due to the fish habitat modifications and intense anthropogenic activities, resulting in poor biota adversity, often associated with artificial lakes (Araoye and Owolabi, 2005).

The insensitivity of hook-and-line fishing gear to any of the species caught by other two gear types, may be due to the feeding behaviour and restricted period of activity which, perhaps, do not favour encounter and/or attraction to the baits of hook-and-line. The most ubiquitous species were A. lesciscus and the Tilapia fishes, as they were collected in relatively large proportion by the sensitive gears. This finding probably indicates abundance and intense 24-hour activities of these fish species in the lake. Equally, the reverse may explain the vulnerability of M. rume, A. occidontalis, B. chrysichythys and C. gariepinus, to only one of the sensitive gears.

The Cast net was the most sensitive to fish species and also accounted for more than 90% of fish individuals collected during the study period. This finding is instructive, as Cast nets are not as popular as gill nets among peasant fishermen, for reasons including high costs and laborious operational demands of the former than latter gear type. While, the dominant species in Cast net collections was T. zilli that of Gill net was A. lesciscus, this result may be due to the traditional mechanisms of action of Cast and Gill nets (Ayanwale, 2013); further supported by the considerable differences in biology and behaviour of Tilapia and Alestes species, and here differential vulnerability to fishing gears with varying trapping mechanisms (Chinda and Osunkpe, 1994).

Tilapia species, Clarias gariepinus, and A. occodontalis were the dominant species in Tagwai Lake. Incidentally, these are economically important fish species (Mickiewicz and Wolos, 2012), with widespread acceptance in Nigeria. Thus, with sustainable management and exploitation, Tagwai lake may serve as 'fish basket' for its immediate environs and beyond. Temporal distribution within and among fish species varied significantly. This finding indicate spatio-temporal habitat and /or niche partitioning among the fish species, and suggest a need for better understanding of the bio-ecology of the species, for informed sustainable exploitation. The significant positive correlation among the species of Tilapia and C. gariepinus indicates close evolutionary relationships, as well as, suggests similar bio-ecological requirements.

CONCULSION

Relatively low fish species diversity, probably occasioned by human-induced habitat modifications, characterizes Tagwai Lake, Minna. However, wild-fishing in the lake will be optimally rewarding if targeted at *Tilapia* species, *C. gariepinus,* and *A. occodontalis*; been the most abundant and vulnerable to the sensitive gears. Also, deployment of Cast net in the Lake will produce the greatest fish harvest in terms of numbers of species and individuals. Yet, Cast net is not popular among peasant fishermen, due to limitations imposed by high costs of acquisition and operation of this gear type. This, therefore, necessitates subsidy intervention on the part of stakeholder-Governmental and Non-governmental bodies. The findings of this study should assist the Managers of fresh Lakes in optimizing sustainable exploitation of such fishing grounds.

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