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Ichthyofauna diversity of Lake Asejire: Ecological implications

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The natural diversity of most aquatic systems has witnessed various changes in stock diversity and abundance resulting from structural changes in habitat, food composition and uncontrolled exploitation. These have altered the ecology of the fish resources with the disappearance of some species and dominance of others. This study seeks to identify the ecological implication of the stock diversity and abundance in Lake Asejire. Lake Asejire is a 525 ha man-made lake on river Osun one of the major rivers that drain the western part of Nigeria. Fish samples were collected for a period of 24 months using gillnets of between 25 and 187.5 mm mesh sizes. Data obtained were analyzed using inferential statistics and descriptive analysis of means, frequencies and percentages. Seventeen families identified and grouped into trophic levels. Herbivores were 63.03 and 60.35%; carnivore 31.05 and 30.65% and omnivores were 5.91 and 8.99% by biomass in the first and second year respectively. The herbivores were dominated by the cichlids, heterotis and cyprinids; carnivores by bagrids, characids, channids and *Lates* while mormyrids, synodonts and clarids constitute the omnivores. Seasons had no effect on the population and number of the carnivores. The carnivore to herbivore ratio (F/C) was 1.33 and 0.9 by number and 1.7 and 1.33 by biomass; this is of concern as this could pose a threat to ecological balance. It is recommended among others that fishing pressure should be increased on carnivores and more herbivores be injected to the environment to prevent the collapse of the fisheries.

Key words: Fishing pressure, trophic levels, diversity, ecological balance, lake.

INTRODUCTION

Many authors have observed the rich diversities of African fish resources (Olaosebikan and Raji, 1998; Idodoh-Umeh, 2003; Ogutu-Ohwayo, 2005). Species diversity within a natural community is in part a reflection of the diversity in the physical environment. According to Smith (1966), the greater the variation in the physical environment the more numerous are the species since there are more numerous microhabitats available and more niches to fill.

The natural aquatic systems have witnessed changes in stock diversity and abundance, genetic structure and age composition of stocks resulting from structural changes in habitat, food composition and uncontrolled exploitation (Ita, 1982; Tobor, 1990; Ogutu-Ohwayo, 2005). Causes of changes in fish diversity have been identified as water quality, food composition and exploitation.

Changes occur in fish diversity in the course of development of a lake after impoundment of rivers as a result of changes in the physical environment which affect water quality and consequently the type and population of food organisms that evolve. There is usually an increase in biomass, number and species composition because of increase in nutrient and food organisms from decayed materials at the first stage; reduction sets in

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when the system reaches dynamic equilibrium among the various populations in the reservoir (Berka, 1989).

Organisms within a community are affected by trophic diversity, the abundance of some organisms that are specialized to feed at certain trophic levels and on specific organisms are affected when there are changes in the availability of their specific food (Ogutu-ohwayo, 2005).

Most changes in natural ecosystems are caused by human activities such as pollution, habitat degradation, introduced species and overfishing. Exploitation, that is fishing, is a major tool responsible for alterations in the diversities of resources in a community. Fishing alters food webs; modify trophic structures and species interactions (Tobor, 1990; Brander, 2009). Committee on Ecosystem Effects of Fishing Phase II of NRC (2006) in summarizing various articles on fish population dynamics noted that fishing is expected to cause changes in food web interactions because it can reduce the abundance of one or more components of food web, simultaneously altering the interactions among species and also the duration of the interactions. Fishing could either release lower trophic levels from predation or reduce the availability of prey for higher level predator, thus causing “unbalanced population”. Balayut (1983) inferred that if fishing is not adjusted in such situation, further reduction in annual potential yield and consequently destruction of commercial fishery will result.

Unfortunately the cascading effects of over fishing on trophic levels are not often very obvious and management action may not yield expected result. Two processes identified as underlying cause for reduction in mean trophic level landings in many of the world’s ocean have been identified by the Committee on Ecosystem Effects of Fishing Phase II of NRC (2006) as fishing down the food web which is described as fishing whereby lower levels are harvested due to depletion of the higher level predators and fishing through the food web which means that multiple trophic levels are fished simultaneously. The causes of decline in mean trophic level landings among world oceans have been identified as climate change and other human activities such as pollution, habitat degradation, introduced species and overfishing (Brander, 2009). The inland resources contribute significantly to domestic fish production in tropical countries. It accounts for 100% of domestic production in landlocked countries. The resources have also been dwindling with a down ward trend in productivity and size of individual fish across the globe. Fluctuations in species composition was identified in Lake Kainji (Ita, 1984), Lake Victoria (Reynolds and Greboval, 1988) and South East Asian reservoirs. These changes were attributed to changes in environmental factors, uncontrolled exploitation and stress caused by introduction of exotic species.

Brander (2008) hypothesized that measures that reduce stresses due to human activities will benefit fish populations. However, management strategies that may give close to expected result could only result if the specific situation associated with each of the water bodies are studied and the causes of the decline for each are identified.

The relative abundance of organisms within a community is very important because it gives indication of the trophic relationships between the organisms. There is an upper limit to the density of a population within a unit area imposed by size and trophic level. The larger the size or the higher the position of an organism on the trophic level the less its numerical density. This study aimed to identify the ecological implication of the standing stock diversity and fish abundance in Lake Asejire.

MATERIALS AND METHODS

The lake was partitioned into upper, middle, and lower sections (courses) for sampling. This covered both the open water and the littoral zones. Fish species were sampled using monofilament gillnets of various stretched mesh sizes ranging between 25 mm and 185 mm for a period of 24 months covering two dry and two wet seasons. Morphomeric data were collected on the species. Data were analyzed using descriptive statistics, frequency count and percentages as well as inferential statistics of t-test at 0.05 alpha level.

RESULTS

Twenty-seven species belonging to 13 families were identified. The relative compositions of the species by weight for the first and second year are presented on Tables 1. The cichlids ranked first (61.41 and 58.07%, respectively) and were mostly dominated by *Tilapia zilli, Sarotherodon galilea* and *Oreochromis niloticus* in that order. The bagrids were second (18.38% and 20.29%, respectively), third were the mormyrids (5.17% and 7.2%, respectively). Fourth in the first year were the characids (4.35%) followed by the channids (4.26%). However in the second year the centropomids (4.29%) ranked fourth followed by the channids (2.43%). Other families sampled in the first year were Centropomidae, Schlibeidae, Cyprinidae, Claridae, Osteoglossidae and Hepsetidae. The mochokids were very minor with mean weight of 0.20 g in the first year.

The relative numerical abundance (Tables 2) followed similar trend as relative ichthyomass in the first and second year. The cichlids ranked highest (53.85 and 46.25%, respectively) followed by bagrids (22.31 and 34.42%, respectively) third were schlibeids (8.33 and 5.03%, respectively).

Trophic groupings

1. Primary consumers: The herbivores were 10 species,

Table 1. Relative Biomass of fish families and their trophic levels.

Family	Year 1		Year 2	
	Weight (kg)	%	Weight (kg)	%
Herbivore				
Cichlidae	649.48	61.41	2267.26	58.07
Cyprinidae	11.98	1.13	17.81	0.45
Osteoglossidae	-	-	61.10	1.56
Citharinidae	-	-	10.52	0.27
Total	666.61	63.03	2356.69	60.35
Carnivores				
Channidae	45.06	4.26	94.70	2.43
Characidae	46.00	4.35	48.42	1.24
Hepsetidae	4.61	0.44	50.93	1.30
Bagridae	194.43	18.38	782.38	20.29
Centropomidae	19.15	1.81	169.45	4.29
Schlibeidae	19.10	1.81	42.87	1.10
Total	328.35	31.05	1196.75	30.56
*Omnivores				
Mormyridae	54.74	5.17	282.20	7.20
Mochokidae	0.20	0.02	44.17	1.13
Claridae	7.64	0.72	24.72	0.64
Total	61.58	5.92	151.29	8.97
Total sample	1057.53	100.00	3904.73	
Forage carnivore ratio (F/C)	1.71		1.33	

*Grouped with carnivores in F/C estimation.

represented mainly by the cichlids (T*ilapia zilli, Sarotherodon galilea*,*O. niloticus* and *Heterotis.niloticus*), Cyprinids *(Barbus occidentalis*, *Labeo senegalensis*) and Citharinids (*Distichodus rostratu*s and *Citharinus latus)*.

2. Secondary consumers: Eight out of the 27 species are highly predatory their food materials range from insects, crustaceans to other fish species. They are *Lates niloticus*, *Hydrocynus vittalus*, *Alestes macrolepidotus*, *Hepsetus* sp., *Channa obscura*, *C. nigrodigitatus, Auchenoglanis Occidentalis* and *Schleibe mystus*.

3. Omnivores: These are opportunistic feeders with wide ranges of food items from both plant and animal sources. This group includes the mochokids (*S. membraneous* and *S. nigrita*) and the claridae (*C. gariepinus* and *Heterobranchus bidorsalus*).

Trophic relationship

The relative abundance of the species and their trophic levels are presented on Tables 1 and 2. The herbivores weighed 666.61 kg representing 63.03% in the first year 2356.69 kg representing 60.35% in the second year. Their total number was 2485 fish (55.78%) in the first year and 7468 fish (47.79%) in the second year. The carnivores weighed 328.35 kg (31.05%) in the first year and 1196.75 kg (30.65%) in the second year, while their total number was 1788 fish (40.14%) and 7390 fish (47.29%) in the first and second year, respectively. The omnivores weighed 61.58 kg (5.91%) and 351.09 kg (8.99%) in the first and second year, respectively and accounted for 182 fish (4.09%) and 769 fish (4.92%) by number. Forage to carnivore ratio (F/C) by weight was 1.71 in the first year and 1.33 in second year; while the numerical ratio was 1.3 in the first year and 0.9 in the second year.

T-test analysis show no significant differences in seasonal weights ($t = 0.35$, $p > 0.05$) and numbers ($t = 0.8$, $p > 0.05$) of the carnivores (Tables 3 and 4). The carnivores maintain their proportion in both seasons.

DISCUSSION

Twenty-seven species belonging to 13 families were identified. Akinyemi et al. (1986) however identified 36 species which means about 9 species were missing in the current study. The species were either not susceptible to the gears used or have disappeared. The disappearance of fish in Lake Victoria were attributed to

Table 2. Relative numerical abundance of fish families and their trophic levels.

Family	Year 1		Year 2	
	Number	%	Number	%
Herbivore				
Cichlidae	2399	53.85	7228	46.3
Cyprinidae	78	1.75	150	1.0
Osteoglossidae	8	0.18	33	0.21
Citharinidae	-	-	57	0.4
Total	2485	55.78	7468	47.9
Carnivores				
Channidae	152	3.41	369	2.36
Characidae	207	4.65	313	2.0
Hepsetidae	19	0.43	3.7	1.96
Bagridae	994	22.31	5378	34.42
Centropomidae	45	1.01	237	1.52
Schlibeidae	371	8.33	786	5.03
Total	1788	40.1	7390	47.29
*Omnivores				
Mormyridae	145	3.25	484	3.1
Mochokidae	19	0.43	44	0.28
Claridae	18	0.40	241	1.55
Total	182	4.09	769	4.92
Total sample	4455	100	15627	100
Forage carnivore ratio (F/C)	1.3		0.9	

*Grouped with carnivores in F/C estimation.

Table 3. T - test analysis on weight of carnivores.

Group 1 vs. Group 2	μ Dry season	μ Wet season	t-value	δ Grp1	δGrp 2	Df	p- level
Dry vs Wet	60.01	68.38	-0.35	52.51	60.00	22	0.71

$P < 0.05$.

Table 4. T - test analysis on number of carnivores.

Group 1 vs Group 2	μ Dry season	μ Wet season	t-value	δ Grp1	δGrp 2	Df	p- level
Dry vs Wet	461.6	329.71	0.82	514.51	268.46	22	0.42

$P < 0.05$.

open access nature of the fisheries, unregulated fishing effort coupled with the use of small mesh size gears by fishermen who were desperate to increase their catch and the introduction of alien species (Ogutu-Ohwayo, 1990, 2005).

Going by Swingle (1950) definition of a balanced population which is ideal for best production as ‘one that has forage to carnivore ratio of between 3-6’ and Smith (1966) assertion that ‘there is an upper limit to the density of a population within a unit area imposed by the trophic levels; the higher its position on the trophic level, the less the numerical density of such an organism’. Therefore, the fish population of Lake Asejire cannot be said to be balanced. The forage species basically the cichlids were probably the most targeted species as is common to most water bodies especially in the developing world (Ita, 1987; Reynolds and Greboval, 1988; Ogutu-Ohwayo, 2005).

The herbivores feed on plant materials ranging from microscopic algae as in cyprinids to higher plants as in *T.*

zilli and *Heterotis* sp*.* Most of the carnivore species are pelagic (Holden and Reeds, 1972; Idodo-Umeh, 2003) while many of the omnivore species are benthic feeders (Ipinmoroti and Olasunkanmi, 2004; Adesulu and Syndenham, 2007). Alteration of natural diversity by introduction of non-native species can threaten the stability of ecosystem since no species can succeed except at the expense of another (Czech, 2005). Studies show that increase in number of predators (carnivores) coincides with decrease in the number of their herbivorous prey as in the disappearance of *Haplochromis spp.* following the introduction of *Lates niloticus* in Lakes Victoria and Khoya (Ogutu-Ohwayo, 2005).

The high population of fish in the upper trophic levels (high abundance of carnivorous and omnivorous species) has been viewed as a threat to fish population (Reynolds and Greboval, 1988). The situation as it is, has deteriorated beyond the numerical forage to carnivore ratio of 2.2 and 1.7 observed in earlier studies on the same lake by Akinyemi et al. (1986). In a normal situation the biomass making up a trophic level is approximately 10% of the biomass making up the next-lower trophic level (Begon et al., 1996).

Fisheries managers, the fishing industry and dependent communities have to learn how to adapt to environmentally driven changes (Hamilton et al., 2003).

Conclusion

The high population of fish at the upper trophic level calls for serious concern and urgent steps has to be taken to arrest the situation. The dangers posed by this condition include reduction in domestic fish production and supply, unemployment, loss of genetic viability, trophic cascade as well as other problems associated with ecological imbalance.

RECOMMENDATIONS

Though management has to be lake specific, the following are general recommendations for the salvation of situations of ecological imbalances:

1. Reduction in fishing effort through restriction of fishermen's population by licensing, gear ban and mesh size regulation.
2. Introduction of native species, in this case, juveniles of forage species such as cichlids, cyprinids and heterotis to boost the forage population of the fish community.
3. Reintroduction of some of the species that have disappeared from the lake; these could be sourced from neighboring water bodies.
4. Closure of breeding seasons and areas.
5. Introduction of fisheries guards to serves as enforcement agents.

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