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The diversity of fish species in Ngwerere Stream of Chongwe District in Lusaka Province, Zambia

Ketani Phiri[1], Confred G. Musuka[2, *]

[1]K. Phiri, Little Gem Farm, P. O. Box 31707, Lusaka, Zambia
[2]The Copperbelt University, School of Natural Resources, P. O. Box 21692, Kitwe, Zambia

Email address

cgmusuka1962@gmail.com (C. G. Musuka), beshiyamba@yahoo.com (C. G. Musuka), confred.musuka@cbu.ac.zm (C. G. Musuka)

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Abstract

A study to assess the diversity of fish species, using 5 different mesh sizes of multifilament gillnets was conducted along Ngwerere stream, at sites closest to Kalimba, Diamondale and Chortonel farms. Questionnaires were also administered to randomly selected respondents. Results indicated eleven different species that were captured from the stream over a stretch of twenty Kilometres. It was clearly observed during the study that this stream could support so many fish species due to the abundance of fauna and flora. It was further observed that the cichliidae family dominated the catch with five species, followed by *clarias spp* and cyprinids. Among the cichlids, *O. niloticus* was the most dominant although the local fishers indicated that the species started to show up in 2009 after the collapse of Zambia National Service (ZNS) dam. *O. niloticus*, comprised 22% of the overall catch, implying that it had the potential of colonising and displacing the indigenous species in the stream. The fact that the species was hardy and a mouth brooder like many of the indigenous *Oreochromis* species, such that it may have started crossbreeding with other species. Furthermore, *O. niloticus* was perceived to be of commercial importance to the local communities because of the large size it attained in the stream. It was also observed that there was little conservation awareness among the local people. The use of mosquito nets as fishing gear had become so rampant in the area, especially during the rainy season when there were floods. This method of fishing though seemingly rewarding to those practicing it; was one of the most destructive way of fishing. Most of them believed that the fish resource was inexhaustible; therefore, any method of catching the stock could be applied as over time the fish population seemed to regenerate. The stream community was also faced with the challenge of cultivating along the banks, water poisoning through pesticides and sewerage discharges.

Keywords

Assessing, Diversity, Ngwerere, Chongwe, Stream, Lusaka

1. Introduction

The diversity of fish species is influenced by factors of the environment such as temperature and pH of the water as well as biological factors such as predation and resource availability (FAO, 2012). Diversity can be described as a variety of something (Encarta dictionaries, 2009). When the water becomes too acidic, the diversity declines such that only those that can tolerate acidic conditions will survive. This is true with many streams, especially those that pass through large industrialised cities and those passing through agriculture communities due to the pollution caused by industries and fertilisers.

Biodiversity is simply the composition of various organisms in a particular habitat and in this case, the composition of various fish species in a water body. Numerically, valid scientific descriptions exist for approximately 27,977 living species of fishes in 515 families and 62 orders (Nelson, 2006). However, about four hundred and nine (409) fish species among the 27,977 fish have also been identified in Zambia (Skelton, 2001; Utsugi and Mazingaliwa, 2002). This shows that the country is really diverse in fish resources. Like many other streams in the

country, the water in Ngwerere stream is used by farmers for irrigation and for fish farming. It has been endowed with an abundant fauna and flora. This stream also contains an abundance of fish resources that needed to be assessed. It had become of great concern to both scientist and researchers in the recent past to study the biodiversity of species in a particular habitat. Changing climatic and environmental conditions as well as industrialisation and agriculture activities in the country had contributed either positively or negatively to the diversity of fish species in the water bodies. For sustainability of these resources, an adequate knowledge of species composition, diversity and relative abundance of the water bodies required understanding and vigorous pursuit to determine the present state of fish stocks in the stream and to find ways of preserving them.

2. Materials and Methods

2.1. Study Site

A study was conducted between July and August, 2013, to assess the diversity of fish species, using 5 different mesh sizes of multifilament gillnets was conducted along Ngwerere stream, at sites closest to Kalimba, Diamondale and Chortonel farms; with codes represented by numbers (i.e. 1, 2 and 3) respectively. Questionnaires were also administered to randomly selected respondents.

Ngwerere stream acted as a drainage system for Lusaka town. It has its origin somewhere near ZESCO headquarters in Lusaka and flows northwards along the rail line for about 20 km before turning eastwards. It then flows eastwards for about 23 km where it enters Kasisi dam and then continues to flow into Chongwe River. The stream was perennial, having its maximum flow in the months of January and February. It was known in Lusaka to be a source of water for most of the commercial agriculture activities being undertaken by Kalimba fish farm, Ellensdale and Galaunia farms. From the total length of the stream (not known) only about 20 Km was studied. This whole study site was situated between 15°16'25.53" S 28°26'04.12" E and 15°16'02.64" S 28°28'27.80" E.

2.2. Sampling Design and Procedure

Data was collected in a stratified sampling design, which involved dividing Ngwerere stream into three study sites: Kalimba Fish farm, Diamondale Farm and Chartonel farm, covering a distance of approximately 22 km.

The multifilament gillnets with the view of catching as many fish sizes as possible, with a total individual length of 25m and mesh sizes of 25mm, 37mm, 50mm, 63mm and 76mm were used. The nets were held vertically in the water column by a series of floats attached to their upper edge (float-line) and weights attached to their lower edges (sink-line). These floats and sinkers were fastened at regular interval and the nets set across the stream. As the fish were passing, they were caught by the gill region, hence the name stationary gill nets. The nets at each sampling site were set around 17:30hrs and stayed in water overnight because according to King (2007), fish were caught when there was less light. At each site, sampling was done two to three times a week. Questionnaires were also administered to randomly selected respondents.

2.3. Collection and Preservation

The procedure for collection and preservation of the spacemen applied in the study was adopted from Skelton, 2001. Fish of different sizes were collected and identified using a Complete Guide to Zambian Fishes, Plankton and Aquaculture by Utsugi and Mazingaliwa (2002) and a Complete Guide to the Freshwater Fishes of Southern Africa by Skelton (2001). After capture, specimens were handled with care to avoid damage as they struggled. Some of the fish specimens collected were preserved. Formalin obtained from a pharmacy was used as a fixative agent. Small specimens were killed by euthanasia or placed directly into 37% formalin. Specimens larger than 150mm SL were injected with 37% formalin in order to allow for effective penetration of the preservative.

2.4. Labels

All samples collected were labelled using the appropriate materials. The following details were available on the label; collectors name, locality, stream name and area around the stream where the samples were collected.

2.5. Photographs

Not all specimens collected were preserved. For some specimens, only photographs were used. These photographs were taken using a 12.0 mega pixels camera before the fish died.

2.6. Data Analysis

Data analysis was done using SPSS version 16 for windows 8 and the tables generated from SPSS were then transferred to Microsoft Excel office 2013 to come up with graphs and pie charts.

3. Results

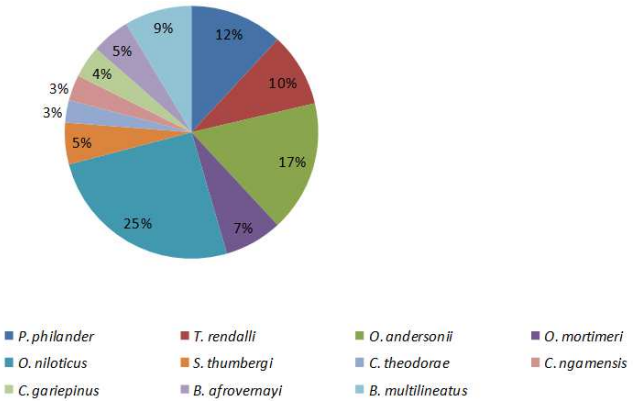

Figure 1. *Fish species composition in Ngwerere stream.*

According to Figure 1, eleven species were captured from the stream during the study.

3.1. Fish Distribution

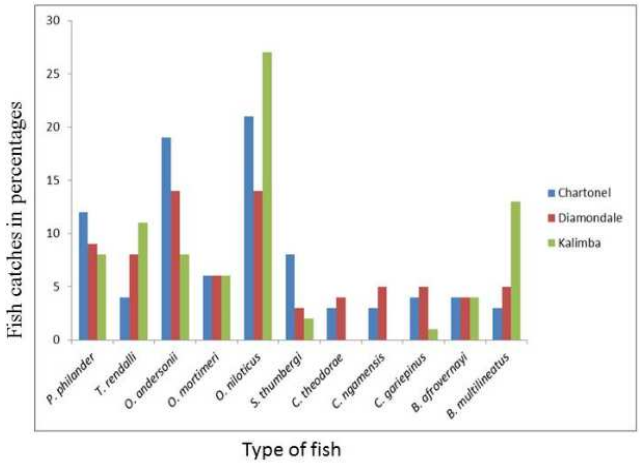

Figure 2. *Fish species distribution at each sampling station*

From the results obtained, it was evident that most of the species were widely distributed in Ngwerere stream as they were present at almost all sampling stations based on the catch (Figure 2).

3.2. Abundance of Fish Species

3.2.1. Chartonel

Figure 3 shows that *O. niloticus* at Chartonel was represented by 24% followed by *O. andersonii* with 22%. The species which were less abundant at the sampling stations were those from the Clariidae family.

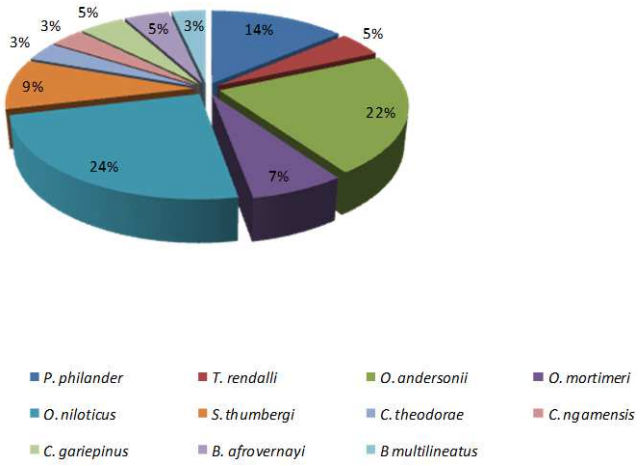

Figure 3. *Abundance of fish species at Chartonel*

3.2.2. Diamondale

Meanwhile Figure 4 indicates that *O. andersonii* and *O. niloticus* were equally represented at Diamondale, implying that they were the two most dominant species (18%) at the sampling site while *S. thumbergi* was the least dominant (4%) species.

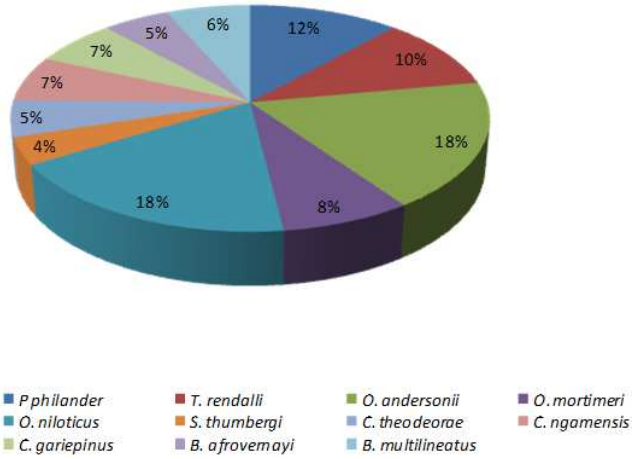

Figure 4. *Abundance of fish species at Diamondale*

3.2.3. Kalimba

According to Figure 5, this sampling station recorded the second highest number of fish species. The dominant species at this sampling station was *O. niloticus* (34%), followed by *B. multilineatus* (16%).

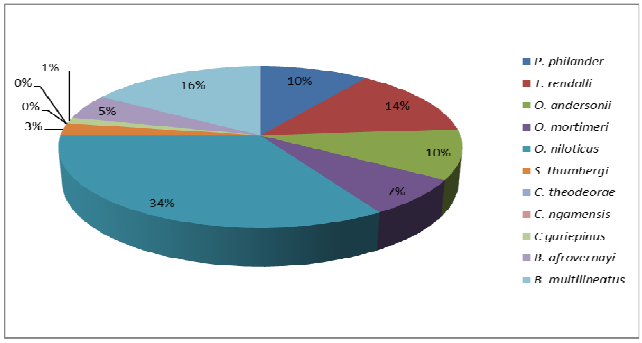

Figure 5. *Abundance of fish species at Kalimba*

3.3. Catches from Different Mesh Sizes

It was observed that almost 40% of the fish were caught in a 25mm gillnet, which according to the Fisheries Act, was an illegal gear (Figure 6).

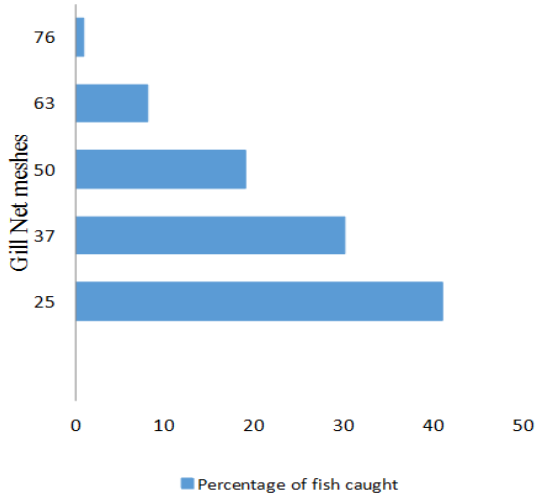

Figure 6. *Catches from Multifilament gill nets of different mesh sizes*

3.4. Threats to Fish

According to Figure 7, threats posed to the fish in Ngwerere stream included: poisoning and cultivation along banks at 30%, illegal use of mosquito nets at 25%, drying up at 10% and damming was the least at 4%.

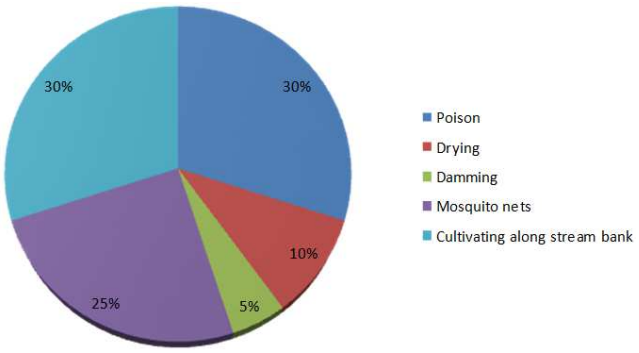

Figure 7. *Threats experienced by fish in Ngwerere stream.*

4. Discussion

At the time of the study, it was noted that there was no information available from the Department of Fisheries (DoF), regarding the population and diversity of fish species of Ngwerere stream. During the study, a total of eleven 11 species belonging to different fish families were identified in Ngwerere stream. From the look of things it could be confirmed that there was diversity of fish species in Ngwerere stream. The Cichlidae family dominated the catch with five species, which was followed by Claridae and cyprinidae (Figures 1 and 2) in descending order. From this study, it can therefore be confirmed that the species from the Cichlidae family were in much more abundance than other species.

Like many other water bodies in Zambia that were infested with invasive exotic species, Ngwerere stream was not being spared either. An invasive species according to Helfman *et al.,* (2009) was a species from one water body into another of which it did not occur naturally. The introductions of invasive species had a devastating effect on the native species. The presence of *O. niloticus* in the stream, a species thought to have escaped from a nearby Zambia National Service (ZNS) dam when it collapsed due to heavy rainfall, was a clear indication of the invasion. *O. niloticus* was the most dominant species in the stream, which according to the local fishers started showing up in 2009. Since then, it became quite clear that *O. niloticus* was more abundant than other fish species in the stream. The species was more dominant at all the sampling stations (Chartonel, Kalimba and Diamondale) (Figures 3, 4 and 5). The presence of *O. niloticus* had the potential of colonising and displacing the indigenous species in the stream. The presence of introduced *O. niloticus* in the Kafue River, and its hybridization with at least to native *spp* (*Oreochromis andersonii* and *Oreochromis macrochir*) has been documented, with genetic analysis (Deines *et al*., 2014). As a consequence, the release of Nile tilapia into non-native aquatic ecosystems may result in competition for food and space, thereby damaging native species (Vicente and Fonseca-Alves, 2013). The fact that the species was hardy (this is a reason why it was preferred in both pond and cage aquaculture) and a mouth brooder like *O. andersonii,* an indigenous species, *O. niloticus* may have started cross breeding with the local species which may explain why it was much more abundant (i.e. 24%. of the entire sample catch) than other species. Several reports indicate that in many freshwater systems in Africa where Nile tilapia has been introduced and has established itself and is productive, it has completely eliminated the native *Oreochromis* species (Shipton *et al*., 2008). *O. niloticus* was viewed to be very profitable to the local fishers as it was mostly caught in abundance, especially in the cold season. According to Bbole *et al*. (2014), the fishermen in Kafue fishery claimed that the introduction of *O. niloticus* has reduced their sales of native tilapia which are one of the most preferred fish in Zambia, which also fetch a higher cost. The results of their study suggested that the presence of *O. niloticus* in Kafue flod plain had an impact on the indigenous *Oreochromis* species (Bbole *et al.,* 2014).

Oreochromis andersonii came second (representing 22% of the catch) in terms of dominance in all the three sampling stations and was equally viewed to be of commercial importance to the local communities because of the large size that it attained in the stream. However, *C. theodorae* and *C. ngamensis* were not captured from Kalimba sampling station. It was observed that the possible reason why these two species were absent could be attributed to the fact that they preferred vegetated habits in swamps and riverine floodplains (Skelton, 2001) which was not the case with Kalimba, where the water had a higher velocity, low turbidity and low depth.

During the study, it was also discovered that most of the species that were being caught were of smaller sizes, which could be attributed to inadequate large sized fish, hence the rampant usage of small meshed (25mm) gill nets and mosquito nets (Figure 6). The reduction in the size of fish being caught, called for enforcement measures to be put in place to curb the illicit use of illegal gears to save the fish from being depleted. Another possible threat to the fish was the usage of mosquito nets as seine nets by the fishers, which was very destructive to the fish as it caught all species regardless of their sizes. In a report by Simumba (2007), the author highlighted that the usage of illegal fishing gear including mosquito nets, potato bags and shading netting material have continued to be used in most of the fisheries in Central, Luapula, Lusaka, Northern and Western Provinces of Zambia. Due to resource constraints such as lack of manpower, financial and inadequate support to carryout patrols on water bodies, the Department of Fisheries (DoF) in almost all the fishery areas was not regular to stop fishing using illegal gear (Simumba, 2007). According to the Fisheries Act of 2011, it was illegal for any person to use fishing gears with mesh size that did not provide for smaller fish to escape. Proper fishing gear was not only emphasised in the Fisheries Act of Zambia, but was also available in the

FAO Code of Conduct for Responsible Fisheries. Article 6.6 in the code stated that "*Selective and environmentally safe fishing gear and practices should be further developed and applied, to the extent practicable, in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems and protect fish quality. Where proper selective and environmentally safe fishing gear and practices exist, they should be recognized and accorded a priority in establishing conservation arid management measures for fisheries. States and users of aquatic ecosystems should minimize waste, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species*" (FAO, 1995).

Water was an important resource in Zambia and Ngwerere stream in particular, where currently; more than 10 commercial farmers used its water for irrigating crops such as flowers, vegetables and wheat during the dry season. Kalimba farm, for example, used the water from the stream for fish farming. In order for each and every farmer to have adequate water at least cost, the stream was dammed to allow the water to flow to the farm in a furrow through gravitation means. The aspect of damming was considered a good idea as that enabled farmers to have continuous water supply to their farms; however, that had some impact on the fishing community. Damming brings about degradation of spawning grounds, changes the flooding pattern and water quality downstream (Adams, 2000). Such changes reduce fish species biodiversity (Welcomme and Halls, 2004). High levels of fishing too can lead to reduced fish diversity (Jennings *et al*., 2001). According to the World Commission on Dams (2010), the effects of damming streams and rivers to the ecosystem have failed to balance because there are more negatives than positive effects. Smith (2003) also reported that construction of the Aswan High Dam, which impounded 50–80% of the Nile River's flow, caused a 77% reduction in annual landings of sardines, *Sardinella aurita* in the South-eastern Mediterranean. It was clear from these two researches that these dams have affected the migration of fish species from one point to the other, thereby affecting their diversity.

Like all other ecosystems in the world, Ngwerere stream was considered to be heavily polluted with pesticides and fertilizers, while upstream it suffered from sewer discharges such that its water was rarely drunk. The study confirmed that indeed the stream was affected by pesticide pollution, either from agricultural activities or through direct application of poisonous substances by the local people to kill fish, especially in the hot and dry season. However, the impact of pesticides on the fishing community was not assessed. According to Darwall *et al.,* (2008) the most important source of pollution in most of African lakes and Rivers were pesticides and fertilizers from Agricultural activities. Furthermore, Food and Agriculture Organisation (FAO, 2013) reported that all national fishery laws generally prohibited poisons but enforcement was often inadequate. The aforementioned was true with Ngwerere stream, where there was neither enforcement nor awareness of the dangers of poisoning, considering that it was not even a gazetted fishery area (Figure 7).

Other challenges that impacted on the fishes of Ngwerere stream had to do with the drying up, which was as a result of damming and in some instances, due to low rainfall (Figure 7). According to Lake (1980), droughts led to damaging consequences of stream fauna and flora and also lead to fragmenting the continuity of streams and rivers, which have not been well studied. However, in Ngwerere stream it was observed that when the stream fragments, people use that as an opportunity to catch the fish in the fragmented pools. That in itself, posed a threats to the survival of the various fish species, thus drastically reducing their diversity in the stream. Other effects included the deterioration of water quality, high water temperatures (Cowx *et al.*, 1984), and a reduction in the amount of dissolved oxygen (DO) available for the fish.

5. Conclusion

Ngwerere stream had 11 fish species, which were widely distributed over the whole stretch of the study area due to the abundance of vegetation which were as a result of commercial agricultural activities. At the time of the study, eleven different species were caught along the whole stretch of the stream although only eight were preserved.

Most of the people, however, did not understand conservation of the fish and the reason why fish species were to be conserved. The local communities' believed that the fisheries resource was inexhaustible; therefore, any method of catching fish could be applied since after some time the fish population seemed to regenerate. The use of mosquito nets as fishing gear had become so much rampant around the study area, especially during the rainy season when there were floods in the area. This method of fishing though seemingly rewarding to those practicing, it was one of the most destructive way of fishing as it disturbed the fish during spawning in the flood plains. The stream also suffered from challenges of water poisoning, a trend most of the people were unhappy about.

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