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The impact of fishing pressure on Kapenta (*Limnothrissa miodon*) production in Lake Kariba, Zambia: A case study of Siavonga District

Matthews Chali[1], Confred G. Musuka[2], Bright Nyimbili[2]

[1]Ministry of Finance and National Planning, P. O. Box 50062, Lusaka, Zambia
[2]The Copperbelt University, School of Natural Resources, P. O. Box 21692, Kitwe, Zambia

Email address

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

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Abstract

The purpose of the study was to assess the impact of the fishing pressure on Kapenta (*Limnothrissa miodon*) production in Lake Kariba situated in the Southern province of Zambia. The study revealed that there was an increase in fishing effort from 423 fishing rigs in 2009 to 800 fishing rigs in 2013. The Kapenta stocks had been greatly overexploited considering that the CPUE had decreased from 0.187tons/boat/night in 2000 to 0.085 tons/boat/night in 2012. Kapenta catches averaged three crates per rig/night (which was equivalent to 60kg (0.06 metric tons) while in the past, catches could go up to as much as ten crates or more per rig/night (about 0.2 metric tons). It was therefore, observed that fishing effort was the major contributing factor towards poor catches being experienced due to high influx of cheaper vessels.

Keywords

Fishing Pressure, Kapenta, Impact, *Limnothrissa miodon*, Production

1. Introduction

Lake Kariba fishery, situated in Southern Province of Zambia and shared with Zimbabwe is a creation through damming of the Zambezi River for the purpose of hydro-electricity power generation, artisanal and subsistence fishing, industrial (Kapenta) fishing, tourism, water supply, and lake transport (Karenge and Kolding, 1995; Bourdillon *et al.,* 1985; Losse, 1998; Paulet, 2013). Lake Kariba (277 km long; 5364 km2; 160 km^3; 29 m mean depth and 120 m max. depth) is located on the Zambezi River between latitudes 16 28' to 18 04'S and Longitudes 26 42' to 29E 03'E (Madamombe, 2002). It stretches for 320km with an average width of 19.4km although the widest portion is 40km (Chipungu, 1993). The shoreline is approximately 2,164km (Chipungu, 1993; Paulet, 2013). At maximum height, the lake holds 157million cubic metres of water with an average depth of 29m. The lake is 486m above sea level (Chipungu, 1993; Paulet, 2013). It was the largest man-made reservoir in the world at the time of construction, and is today the second largest reservoir in Africa by volume (Madamombe, 2002). The catchment area covers 663 817 km^2 extending over parts of Angola, Zambia, Namibia, Botswana and Zimbabwe (Losse, 1998; Madamombe, 2002).

The introduction of fish species into fresh waters is common practice around the World (Cowx 1997). Following Jackson's recommendation, *Limnothrissa miodon*, locally known as the kapenta, (a small pelagic clupeid, which in Kariba reaches a size of around 5 cm), was introduced into Lake Kariba at Sinazongwe about 150km upstream and southwest of the dam between 1967 and 1969 from Lake Tanganyika by the Zambian government (Chipungu and Moinuddin, 1994; Madamombe, 2002; Magadza *et al.*, 2006). The introduction of kapenta (*Limnothrissa miodon*) into Lake Kariba from Lake Tanganyika and Lake Kivu was one example of well-defined successes (Cowx, 1997). Kapenta production increased significantly after its initial introduction into the lake and developed into a million dollar industry

(Kolding, 1994; Kolding, *et al.*, 2003).Within 5 years after their introduction the fish completely colonized the lake (Magadza, 2006) because the kapenta stock is known to move all over the lake without being limited by distance and depth (Chipungu and Moinuddin, 1994). The pelagic kapenta fishery is license-controlled, highly mechanised and performed by light attraction and lift nets from pontoon rigs (Ndebele-Murisa *et al*., 2011). The fish now supports a large and viable fishery for Zimbabwe and Zambia who share the lake (Madamombe, 2002) and contributes to the economy and livelihoods of fishing communities on the shores of Kariba and fish traders in most urban and rural Zambia (Magadza, 2006).

In 1997, a bio-economic study conducted to assess the productivity and profitability of the kapenta industry concluded that the maximum sustainable yield of the kapenta stood at 25,000t while the standing biomass was 30,000t (Mbewe, *et al.*, 2011; Paulet, 2013). However, another hydro-acoustic survey of the lake was planned for the near future in order to set the total allowable catches and effort limits (Paulet, 2013).

Kapenta fish catches have been declining in Lake Kariba since the early 1990s (LKFRI, 2010), and it is possible that this is a consequence of climate changes (Ndebele-Murisa *et al*., 2011), which necessitated an agreement, during the Zambia/Zimbabwe SADC Fisheries Project, that management of the Kapenta fishery be conducted jointly with agreed harvest levels (Chipungu and Moinuddin, 1994; Paulet, 2013). This study investigated the impact of the fishing pressure on Kapenta (*Limnothrissa miodon*) production in Lake Kariba of Southern Province in Zambia.

2. Materials and Methods

2.1. Study Site

This study was conducted in Siavonga, although Lake Kariba is surrounded by: Sinazongwe, Gwembe and Siavonga itself, which are all well known for Kapenta fishing (Figure 1).

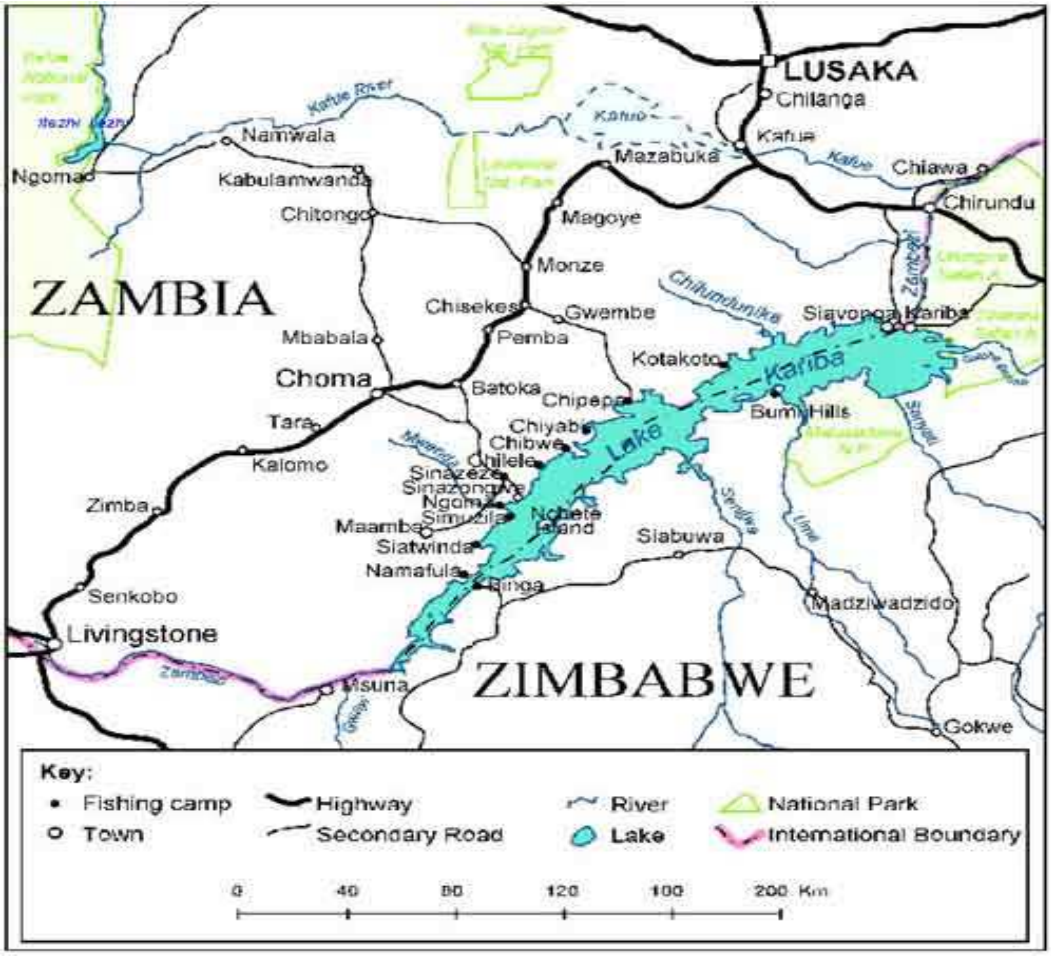

Figure 1. *Position of Lake Kariba in Southern Province. (Source: http://maps.google.co.zm/maps).*

2.2. Sampling Method and Sample Size

A simple random sampling method was used to select thirty-one fishing companies to be interviewed using questionnaires, from the total number of fifty two kapenta fishers in Siavonga district. One institutional questionnaire was also administered to the Department of Fisheries personnel, at both Chilanga (headquarters) and Siavonga district offices.

2.3. Data Collection

Both primary and secondary data were collected.

2.3.1. Primary Data

The primary data was collected through questionnaires, face-to-face interviews and through personal observation.

2.3.2. Secondary Data

Existing literature, fisheries journals, educational magazines, internet services and books from the library and other book sources were used for the collection of the secondary data.

2.4. Data Analysis

Data on the Kapenta monthly returns was analyzed using the Microsoft excel 2013 to generate the graph on the kapenta Production, Effort and CPUE while others were analyzed using Statistical Package for Social Sciences (SPSS) software version 16.

3. Results and Discussion

3.1. Results

The study noted poor participation of women in the sector, as 72% of the companies were owned by males, 6% by females, while 22% were owned by both genders (Figure 2). Similarly, Figure 3 shows that the majority (75%) of the Kapenta companies were owned by indigenous Zambians, 19% by Zambians of foreign origin while 6% only were owned by those with resident permits.

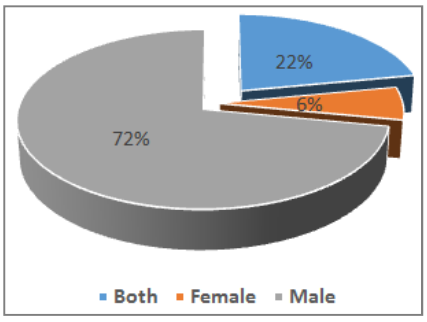

Figure 2. *Company ownership by Gender*

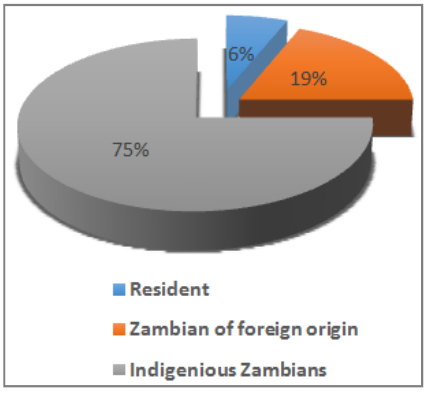

Figure 3. *Kapenta company ownership by origin*

Two types of fishing rigs (Monohaul or Pontoon) were used for catching Kapenta on Lake Kariba. The results show that 116 rigs were Monohaul type, which represented about 91% while only 12 rigs or 9% were of Pontoon type (Figure 4). The Pontoon rigs were used mostly as transporters to and from the fishing sites. Similarly, about 98% of the rigs were wholly owned while only 2% were rented or hired from others (Figure 5).

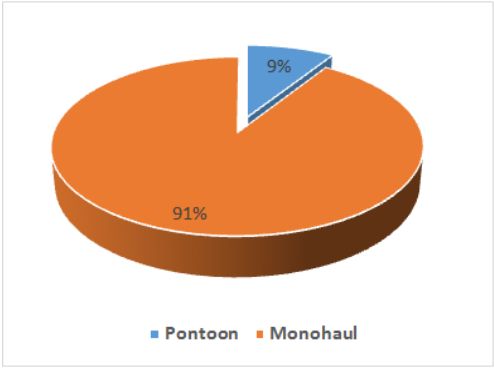

Figure 4. *Rigs by type*

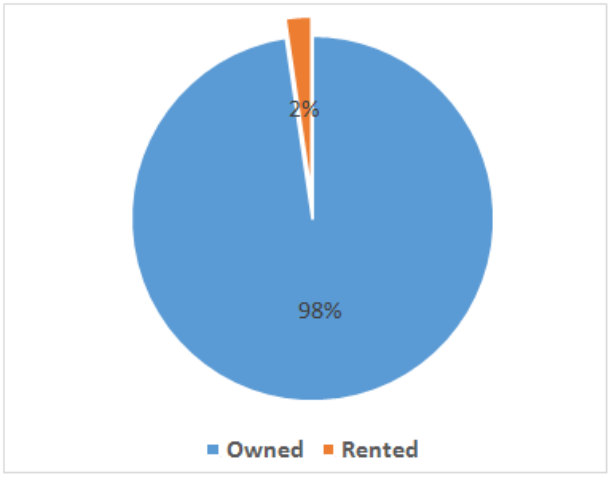

Figure 5. *Rig Ownership*

Plate 1. *Pontoon Rig used as transporter.*

Plate 2. *Monohaul Rig used for fishing.*

Results of the study indicated that, 66% of the rigs were manually operated, while 34% were motorized (Figure 6). At the same time, 19% of the rigs had fish finders installed, which were used to locate adequate fish (kapenta) stocks, while 81% did not have any on them (Figure 7).

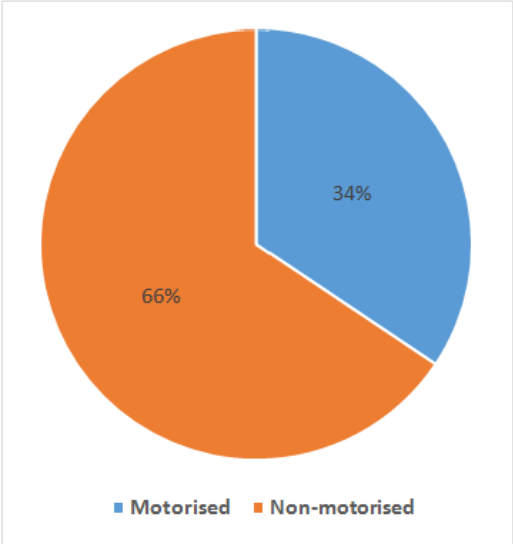

Figure 6. *Results showing the motorized and non-motorized rigs*

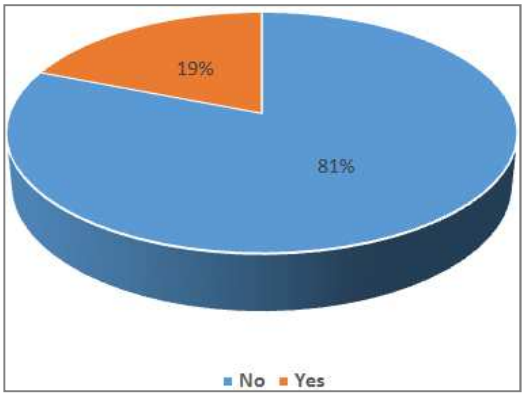

Figure 7. *Usage of fish finders on the rigs*

The study further revealed that most of the rigs (73%) used manually operated winches to lower and lift the nets into and out of the water when fishing the kapenta, while only 27% were of hydraulic type (Figure 8).

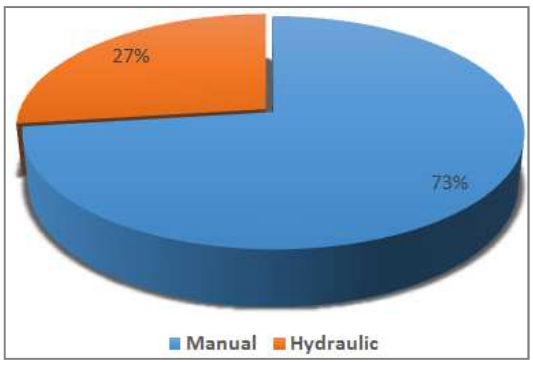

Figure 8. *Operation of winches on the rigs*

According to the study, 41% of the companies had been operating for more than five years, 25% had been operating between 3-4 years and 34% for less than two years (Figure 9). Meanwhile net mesh sizes used on the rigs operating in the district fell in the range of 5mm to 12 mm; while nets of up to 9mm represented 31% and 10 to 12mm nets, represented 69% (Figure 10).

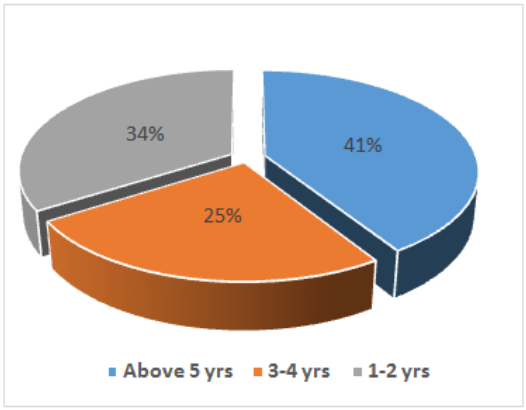

Figure 9. *Operation of companies over the years*

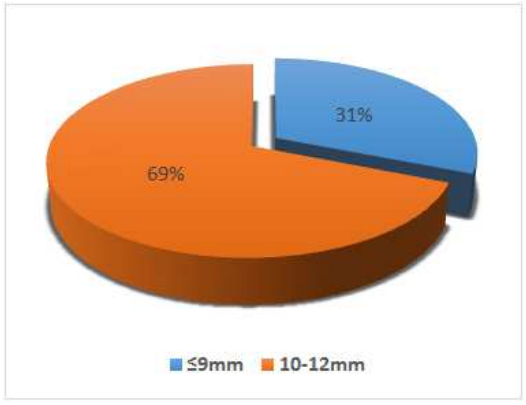

Figure 10. *The results showing the mesh sizes used fo Kapenta fishing nets*

Figure 11, shows the performance of the Kapenta industry on the Zambian side of Lake Kariba.

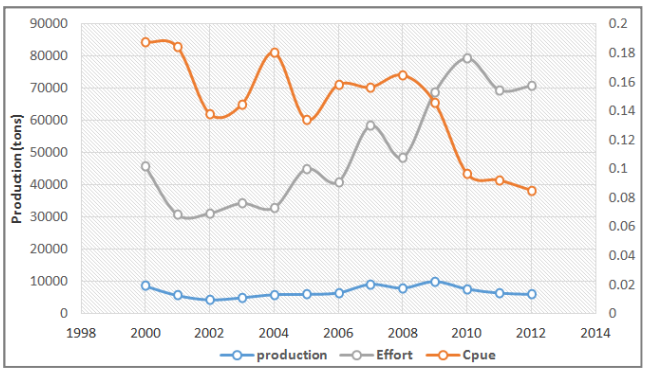

Figure 11. *Performance of the Kapenta fishery*

Figures 12 and 13 shows the number of companies as well as rigs on Lake Kariba.

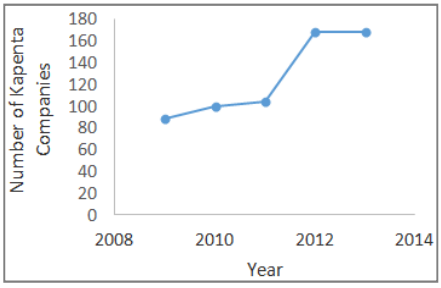

Figure 12. *Number of Kapenta fishing Companies on Lake Kariba*

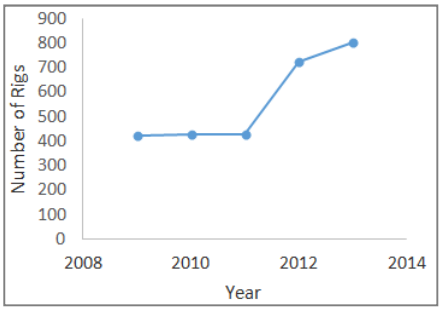

Figure 13. *Fishing rigs between 2009 and 2013*

Similarly, Figure 14 has also shown that, 47% of the fishers considered the catches of Kapenta to be poor, 41% indicated that the catches were very poor while 12% indicated that the catches were just average and none of the responded indicated that the catches were good.

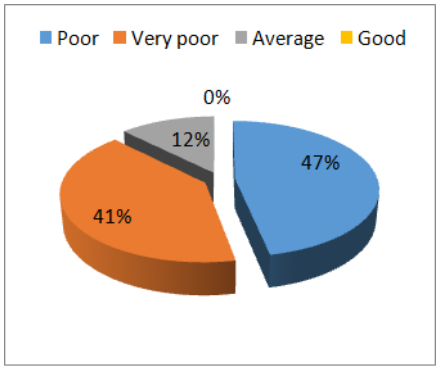

Figure 14. *The perception of fishers*

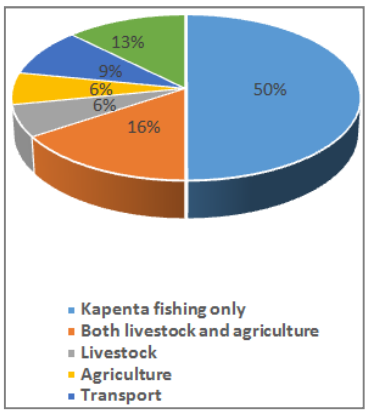

Figure 15. *Other economic activities of fishers*

Results of the study in Figure 15 however, shows other economic activities fishers were involved in, which indicated that, 50% of the fishers were not involved in any other activity apart from fishing, 6% kept one form of livestock or the other, 16% were involved in both livestock keeping and agriculture, 6% were involved in agriculture, 9% were involved in transportation business while 13 % took part in various activities (i.e. Grocery, shop ownership, engineering and others).

According to Figure 16, 44% of the Kapenta fishers indicated that the demand for Kapenta was good, 25% very good, 22% average and only 9% felt that the demand was poor.

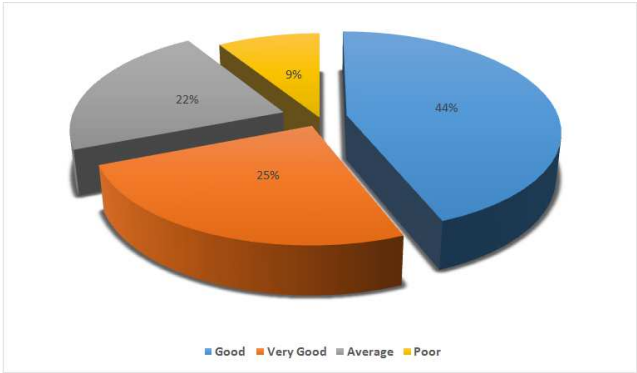

Figure 16. *Demand for Kapenta on the market*

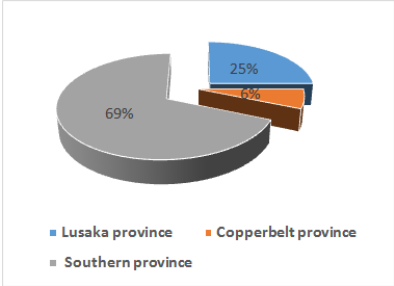

Figure 17. *The most preferred market*

Figure 17, shows the most preferred Kapenta markets and Figure 18, indicates disposal of the catch in accordance with the market demand. The study revealed that, 69% of the Kapenta fishers sold their catches within Southern Province,

mostly to the traders who in turn took the fish to be sold elsewhere. Only 6% of the fishers took their catch to the Copperbelt, 25% sold in Lusaka and also along the line of rail. At the same time, 47% of the catch was sold in dry form, 22% in fresh form, 19%, both as fresh and dry and 12% as frozen Kapenta.

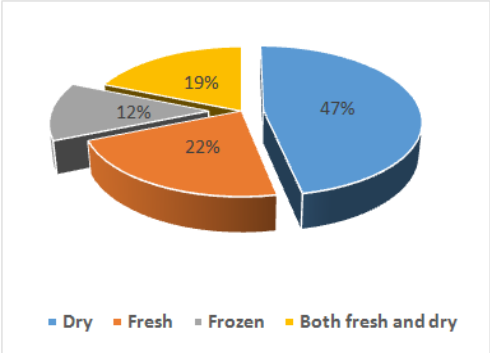

Figure 18. *Results showing the forms used to dispose off the Kapenta*

Plate 3. *Drying of Kapenta on Racks*

Plate 4. *Kapenta for sell being weighed*

3.2. Discussion

The Kapenta industry was one sector which was largely dominated by males (Figure 2), which could be attributed to lack of information and sensitization among the women folks. Most women were discouraged from joining as they felt inferior and considered the industry to be a male dominated one. Other than that, financial capacity could also be a contributing factor that deters most women to venture into the industry. For example, one rig costs slightly over $13,500 (ZK70, 000.00). According to FAO 2012 report, the involvement of women in fisheries activities had been very negligible as a result of a combination of variety of reasons. The major challenges that discourage women to actively get involved in the industry included: limited access to fishing permits, access to capital, cultural hindrances which prohibit women to fish; gender stereotypes which considered women as weaker vessels; fear on the part of women and security risks associated with fishing in the lake. Instead, women were mostly involved in post-harvest activities such as fish marketing, drying and processing. Kwesiga, *et al.,* (1999) also observed that there was evidence that female headed households and women in male-headed households had less access to resources such as land and capital, hence their low participation in the fishing, fish farming activities and were therefore crippled in decision making. The authors indicated that, it was also clear that females had different values, needs and strategies from men and that affected their perception about active participation in fishing and hence the acquiring of rigs (Kwesiga, *et al.,* 1999). From the results obtained, it was however, observed that 6% of the women usually participated as shareholders alongside their male counterparts.

Currently, the majority of the indigenous Zambians are increasingly becoming aware of the need to invest and own their own companies. As such, they were slowly assuming prominent roles in the day to day running of the sector and were participating fully in all aspects of the enterprise, largely due to the availability of cheap fishing vessels (rigs), which previously they were unable to purchase. Moreover, today, more and more indigenous Zambians had improved standards of living compared to the past when the Kapenta fishing industry was mainly run by foreign entrepreneurs (Figure 3).

As earlier stated there were two types of fishing rigs, Monohaul or Pontoon that were used on Lake Kariba (Figure 4). The Monohaul rigs were used in the actual fishing of Kapenta while the Pontoon type was used as transporter (Figure 5). In most cases the rigs that were used for Kapenta fishing had two types of engines on board, one for propulsion and the other for generating light. Because not all companies had rigs that had engines for propulsion and as such they simply towed some of their fishing vessels to the fishing grounds instead of having all their rigs motorized and they did that with the help of motorized Pontoon or Monohaul rigs. The transporter rig, could on average tow at least five other rigs. However, the observation made during the study was that most small scale Kapenta fishers conserved fuel by transporting non-motorized rigs using one or two motorized ones to their designated fishing grounds (Figure 6). In the same vein some fishers installed fish finders on the transporters, which enabled them locate abundant kapenta sites. That way, they were assured of placing these non-motorized rigs correctly, which in turn helped in avoiding too

much movements, consequently reducing on the cost of fuel. However, only 19% of the rigs had fish finders while 81% did not have them. Fish finders were mostly fitted on the transporters of foreign origin (whites) owned companies. Based on that observation one maybe misled to believe that the majority of the kapenta fishers who were still operating at small scale level were unable to afford to use sophisticated equipment such as fish finders to improve on their catches because they were quiet expensive (Figure 7). That perception could however, not hold because not everything that the whites were able to do, people of other races could not do them either.

All the rigs surveyed used winches to both lower and lift the nets into and out of the water when fishing Kapenta (Figure 8). The majority of the rigs had winches that were operated manually compared to those operated using hydraulic. The hydraulic winches were very efficient and had the potential of reducing the number of persons on the rigs from the average 6 to 4 or less.

The commonly used fishing gear on the kapenta rigs included: Ring nets, Catamaran, top and under water lights. The fishers on Lake Kariba used a wide range of mesh sizes ranging from 5mm to 12mm (Figure 10). During the study none of the rigs had the mosquito nets which were capable of capturing fish of all sizes, including the juvenile kapenta which in turn had the potential of affecting the recruitment of the subsequent stocks.

As shown in Figure 11, kapenta production on Lake Kariba decreased from 9,993 tons in 2009 to 6004 tons in 2012. Kinadjian (2012) reported that catches of kapenta rose steadily with increasing fishing effort until the late 1980's. The author however, indicated that maximum annual catch was observed in 1990 (31,000 metric tons), which was accompanied by a steady decline in production until early 2000. Ndebele-Murissa *et al*., (2011) reported that kapenta fish production had decreased significantly since 1974 at an average rate of 24.19 metric tons per year. In 2003 production reached an all-time low of 15,000 metric tons (half that of 1990). The catches per-rig-per night on the Zambian side had over six years ranged from 0.302 to 0.124 metric tons per-rig-night and continued to decline as the number of players and actual rigs continued to increase year by year (FAO Report, 2012). According to Barson (2010), using the maximum sustainable yield model (MSY), there was a decline in production from 0.9t/night to 0.1t/night per rig. The decline began in 1988 and was accompanied by increase in fishing effort/pressure. Currently, Zimbabwe and Zambia were producing 19 000t/year wet weight (or 6000t/year dry weight) of kapenta. The author further indicated that Zambia was harvesting 70% of the fish and Zimbabwe 30%, and FAO was in the process of facilitating dialogue between the two countries to reduce fishing effort and attain an agreed balance of 55% : 45% (Zimbabwe : Zambia) (Barson, 2010).

Magadza (2008) attributed the decline to a number of factors, which included the effect of climatic change, fishing effort and the nutrient inflow from the running waters from lakeside community. The effect of climate change was evidently shown to play an active role by the study which showed that low Kapenta production coincided with the dry years (1983, 1988 and 1992). The author further revealed that the breaking point in the decline of the Kapenta was 1987, which was one of the hottest years experienced in the region with the second highest yearly average evaporation rates; while the lowest recorded rainfall years around Kariba, was in 1995 (Magadza, 2008).

Other authors (Coche 1968; Balon and Coche 1974; Moreau 1997) reported that Kapenta production also depends on the nutrient inflow from the running waters from the lakeside hills. As a result of the summer input of nutrients, biological production in the epilimnion increases, consequently the quantity of nutrients brought in by the Zambezi and other inflowing rivers during the rainy season (November-April) determine the productivity of the lake (Marshall, 1992). However, the lake has a large outflow of 50-65km^2 $year^{-1}$ relative to its volume (160km^2), which implies that significant amount of these nutrients are lost each year (Marshall, 1992). Coupled with that, Poor management of the fishery mainly on the Zambian side has also contributed to the overexploitation of the Kapenta stocks (Malasha, 2003; Jul-Larsen, 2003).

The effort on the other hand increased from 68,734 boat/night in 2009 to 70,706 boat/night in 2012, but started to decrease in 2010. The decline in fishing effort over the period 2003 to 2007 was simultaneously accompanied by an increase of the total catch (Kinadjian, 2012). Catch per unit of effort (CPUE) also decreased from 0.145 kg/boat/night to as low as 0.085 kg/boat/night in 2012. Kinadjian (2012), reported that during the mission (mid-November 2012), the CPUE in Zimbabwe was approximately 50kg/night/boat and the yield in Zambia was about 30 – 35 kg/night/boat. The author noted an apparent difference in yield of about 30 to 40 percent between Zimbabwean and Zambian rigs. The fishing effort was 240 nights fished per year in 1992 and 236 nights per year in 1997. However, there were a number of rigs that only operated occasionally due to management issues (insufficient cash flow) and/or low catch levels (Kinadjian, 2012).

Paulet (2013), survey revealed the huge extent of overfishing of Kapenta that was occurring on the Zambian side of Lake Kariba and the rate at which the problem was expanding. The author further recommended for rapid action to be taken to prevent further collapse of the kapenta fishing industry and observed that it was therefore important to highlight the lack of enforcement and the lack of resources within Local Government and Department of Fisheries (DOF) to police these waters. The lack of enforcement was identified to be one of the leading problems, the author said (Paulet, 2013).

In order to maintain and enhance the productivity of kapenta in Lake Kariba and ensure that kapenta fishing remained profitable, the Zambia/Zimbabwe SADC Fisheries Project set maximal limit of 500 Kapenta fishing rigs for the Lake; apportioned as follows: 230 on the Zambian side and

270 for Zimbabwe (Mbewe, *et al.*, 2011; FAO, 2012). Meanwhile, the information obtained from the Department of Fisheries in Chilanga, indicated that the number of the fishing companies doubled from 86 in 2009 to 168 in 2013 (Figure 12). In 2009 there were 423 rigs and this increased to about 800 rigs in 2013. According to Paulet (2013), there were at least 950 boats but more likely over 1000 on the Zambian side of Lake Kariba, which was four times the number of vessels estimated to keep fishing at the original maximum sustainable yield. The author reported further that due to a lack of monitoring, policing and joint meetings between the two countries, the number stood at 632 rigs for the Zambian side alone in 2011 and subsequent water-based survey counted 962 vessels which was very similar to the aerial survey of 852 and 950 rigs, a massive increase in the number of Kapenta rigs since then (Paulet, 2013). Similarly, Kinadjian **(**2012) observed that in 2012, there were more than 1,000 rigs operating on the lake; the number of rigs in 2005 was around 600 and in 1990 they numbered 470; additionally, there are an unknown number of unregistered and unlicensed rigs (Illegal, Unreported and Unregulated fishing (IUU)). The study revealed that the number of fishing rigs was increasing correspondingly to the number of companies (Figures 12 and 13). The increase in the number of both the fishing companies and the number of the rigs implied that the fishing effort would continue to increase and impact negatively on the recruitment of the kapenta stocks. This is consistent with the information in previous kapenta fishery studies (Kinadjian, 2012), which significantly affected kapenta catches (Figure 13).

There were many factors that could possibly attribute to the increase in the number of the fishing rigs and subsequently fishing effort. One of which could be that all the districts that surrounded the Lake were hilly and the soils were very poor to support both agriculture and livestock activities. As such most of the local people resorted to fishing as their only means of earning income. Therefore, what can be deduced from this is that the number of new entrant was exceptionally overwhelming, thus increasing fishing pressure on the kapenta beyond the sustainable exploitative levels in the Lake, which in turn had the potential of depleting the stocks. Private operators indicated that a rig operates between 21 to 26 nights per month (i.e. between 252 and 312 nights per year). The end result showed a decline in kapenta catches, which was a concern for everyone involved in the business (Figure 14).

The other contributing factor for the increase in the number of the kapenta fishers could be that of the good profit that was realized from catching kapenta thus encouraging more players to join the industry and thus subsequently increasing the fishing pressure. It could be deduced from the study that kapenta fishing forms one of the major economic activities in the district although other organization do exist.

The study revealed that the demand for kapenta was very good in Siavonga and the rest of the country. The prices known correspond to dried Kapenta, which was usually sold by harvesters in 20 kg bags. To estimate the ex-vessel price of fresh fish, a ratio of three is usually used; the ex-vessel price is obtained by dividing the price of dried kapenta by three (Kinadjian, 2012). The increase in price was attributed mainly due to high demand from the consumers. According to the author, during periods of low production, the price of dried kapenta in Zimbabwe (Kariba) was US $6.00/kg (i.e. about US $2.00/kg for fresh fish); in Zambia (Siavonga), the price was ZMK 42,500/kg for dried fish, or ZMK 14,200/kg (US $2.68) for fresh fish. These prices were roughly halved when kapenta was highly abundant (Kinadjian, 2012).

It was noted that there was a need to address the acute deficit in kapenta production as prices have now soared to as high as $10/kg (retail) and $6/kg (producer). Imports however increase in summer (from Mozambique) and prices decline slightly at that time. The present import data from ZimStat is probably a gross underestimation (Barson, 2012).The results further revealed that most of the kapenta fisher's preferred to sale their kapenta to traders who in turn transported the product to other parts of the country where the demand was very good.

Despite fishing effort being the major contributing factor for the poor performance of the fishery, there are other factors that could contribute or impact negatively on the Kapenta production and this could include change in seasons, rainfall pattern, climate etc. If the summer rains for example were poor there would be less food for kapenta, which means that there would be fewer kapenta for the fishers and the change in seasons also depicted the production and hence the catches, for example during summer (September to March) the sardine move inshore to protected bays in order to breed and the open water population is depleted. Commercial catches rise again after March as adults return to open waters (Mambo, 2013).

However, the challenge faced in the effective implementation of the management regulation on Lake Kariba was the lack of co-operation between the Zambian and the Zimbabwean fisheries officers. The challenge arose due to the weakness in the implementation of the co-management strategies on the Zambian side which failed to address the issues which had been a source of conflict and which contributed to the unsustainable exploitation of the resource. These included the number of nets each fisher may possess, the minimum size of nets that could be employed and the number of players who should be involved in kapenta fishing and also the introduction of the quota system given that there were more Zambian fishers on Lake Kariba than their Zimbabwean counterparts (Malasha, 2005). From a practical point of view it was recognized that the only way to address the issue was through the designation of a part of the basin as a 'commons' while at the same time protecting the interests of other more economically influential fishery actors. The issue of the commons will have to take into consideration the organizational capacity of fishers for it to operate effectively and it will also have to be legally organized within the context of the Joint Fisheries Technical Committee (Malasha, 2005).

Fish value addition was important for preservation both

during storage and transportation to markets. Most of the kapenta fishers preferred to sale fresh kapenta to traders who in turn sun dried it for preservation to be sold at a higher price elsewhere in the country. Sun drying on the racks was the most common efficient method of preservation as it was very cheap considering that Siavonga was very hot and the Sun was always available (Plate 3). Kapenta was easy to store without being spoiled when it was in dry form. The proportion of kapenta that was frozen was very low due to limited refrigerating facilities in the district.

A consumer survey report by FAO (1995) revealed that about 35% of rural respondents and only 15% of urban respondents reported buying dried kapenta. It was however, noted that for rural consumers, availability was also an important reason, as dried kapenta was one of the few fish products which was readily available in rural areas. Variety and storage advantages were also more important for rural consumers. Frozen kapenta was the next most purchased fish in urban areas as it was quiet cheap and taste (Figure 18)..

Due to poor catches of kapenta most fishers were very much frustrated to an extent that most of them were contemplating stopping or simply putting their rigs to rest until there was a sign of improvement in the catches or strategically fish during seasons when the catches were better. Some fishers were also involved in other economic activities (Figure 15). This is in agreement with Mbewe *et al*., (2011) who observed that, although kapenta fishing may be considered to be "a lucrative" venture going by the numbers entering the business, these fishers are also involved in other economic activities.

4. Conclusion

It was evident that the kapenta production was greatly being affected. The study revealed that both the CPUE and the kapenta production were decreasing significantly. Kapenta production decreased from 9993 tons in 2009 to 6004 tons in 2012 while the CPUE decreased from 0.145 kg/boat/night in 2009 to 0.085 kg/boat/night. The effort also increased from about 68734 boat/night in 2009 to 70706 boat/night in 2012. Since the CPUE was an indirect measure of the abundance of a target species, a decreasing CPUE indicated overexploitation. As such it could be deduced that the kapenta stocks had been greatly overexploited. Conversely, it was also clear that the low levels of productivity of kapenta in the fishery was attributed to the increasing number of the fishing rigs on the Lake which had gone beyond the recommended sustainable number of 500 rigs on the Zambian side.

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