African Journal of Economic Review, Volume 1I, Issue 2, July 2014

Fishing Business Arrangements and Sustainability in Lake Victoria Fishing

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Abstract

Fishing is an important activity for communities living adjacent to rivers and lakes—it is an economic activity that generates income and provides sustenance to those engaged in fishing as an occupation. Majority of the crewmembers of the fishing vessels, though small scale, are not the owner of the vessels. Majority are hired and their payment is made in-terms of the share of the catch. The main fish species are Tilapia, Nile perch (*sangara*), Dagaa, *nembe*, *gogogo* and *furu*. In this article an attempt is made to analyse the existing production relations between the owners of the vessels and the crewmembers and the concern for sustainability. Our results found that the existing sharing system in Lake Victoria poses a big challenge in as far as sustainability is concerned. Some of the system such as the percentage of catch after deducting operation costs are to some extent seems to be exploitative since majority of the owner of the fishing vessels assign high costs. Hence large percentage of the catch will go to the owner of the fishing vessels. Thus, fishermen are compelled to use any means to ensure that they have enough catch. The most favoured sharing model is the ratio in days, in which case each fishing unit is assigned a day, that's owners' day, crews day, and vessels day. Regression results further shows that type of fishing gears, in particular mesh size, net length, Boat size, method of propulsion significantly influence the value of catch and the quantity harvested. Mounting of fishing nets is found to negatively influence the quantity of catch in each fishing trip. Suggesting that given the current stock mounting of nets is not an efficient way of catching large quantity of fish.

Keywords: Lake Victoria, Inland Water, Sustainability, Overfishing

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1.0 Introduction

Lake Victoria basin is Africa's largest inland water and the second largest in the world, hosting more than 300 endemic fish species (NBI, 2006). It draws 20 per cent of its water from the Kagera, Mara, Simiyu, Gurumeti, Yala, Nyando, Migori and Sondu-Miriu rivers. The remaining 80 per cent is from rainfall. The Basin is located in the upper reaches of the Nile River basin. It occupies an area of about 251,000 km2 in the lake area and is shared by Kenya, Uganda, and Tanzania. Furthermore, the basin is endowed with a wealth of natural resources consisting of land, forest resources, minerals, fish wildlife, rivers and streams, wetlands and other biological resources, which provide unique opportunities for socio-economic development. Like in other places, the natural resources found in this basin offer avenues mostly to the poor to undertake economic activities for poverty reduction and sustainability of livelihoods (Chambers, 1992; Rennie and Sigh, 1996; McCartney, 2006; Lokina *et al* 2012). The lake Victoria Basin is important to the region and beyond in terms of water fishing sanctuary and water transports for the five East African countries. It is a source of water for domestic, industrial and commercial purposes; it is a major climate modulator and rich in biodiversity. The fishery resources from the Lake are directly or indirectly, a source of livelihood to more than 5 million people engaged in subsistence, artisanal and commercial fishing. Fishing is undertaken for both subsistence and commercial gain. Lake Victoria basin contributes about 83% of all freshwater fishes or 70 % of fishery in Tanzania (LVFO, 2012). However the fish catch is declining due to increased fishing pressure and the increasing use of illegal fishing methods.

Fisheries are important sources of high-quality food and provide a relatively cheap source of protein in a diet, especially for the poor. Fisheries in most developing countries predominately involve subsistence fishing in which individual, often part-time fishermen land their catch in small multipurpose boats. Such fisheries are difficult to manage centrally because of the highly scattered nature of landings and the difficulty of enforcing regulations in remote areas (Sterner 2003). The concern for sustainable resource use becomes more and more important due to continuing migration of people to the Lake zone coupled with the overall growth in population, which increases the pressure on Lake Victorias' resources. The problems are further aggravated by the fact that Lake populations include some very poor members of the community, artisanal fishers, landless etc. The accessibility of the lake resources make the area become a focus settlement by the poor who their main goal is to utilize it.

Nile perch is the major commercial fishery in Lake Victoria, contributing more than 60% of Tanzania fish export. Figure 1 shows the quantity of Nile perch exported for the period 2007 and 2011. In general the quantity of exports is declining and this could be attributed by the decreased availability of fish catch in the lake. The catch was highest in the 2007 of about 50,000tons; however, since then the trend has been declining to as lower as about 25,000tons by 2011.

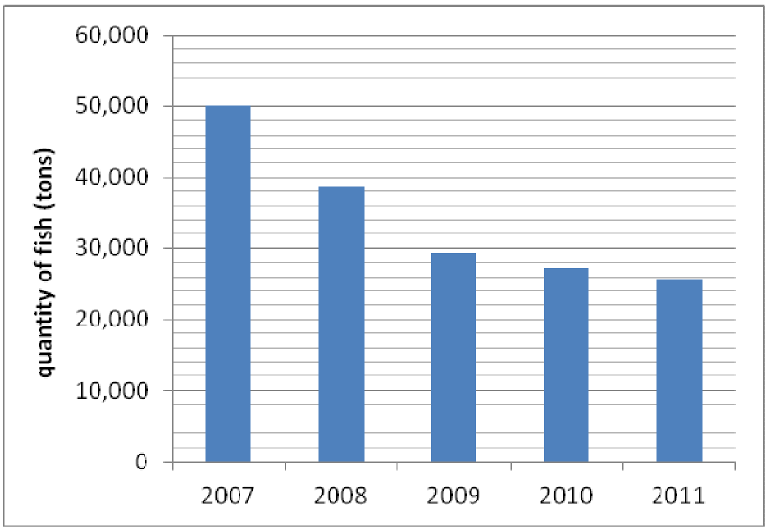

Figure 1 Nile Perch exported for the period 2007 and 2011

1.1 Ecological Interaction of the species:

The biological cause of the change of Lake Victoria fisheries is disputed. The Nile perch introduction happened in the 1950's, but it is was not until late 1970's that the population of the Nile perch erupted. Because of this introduction, in combination with fishing pressure and eutrophication stemming mainly from runoff, the lake was transformed from mult-species lake to one in which there are basically three commercially important species (Brundy and Pitcher 1995). Namely Nile Perch, one specie of Tilapia (*Oreochromis niloticu*) called Nile Tilapia and the sardine-like *Dagaa* (Rastrineobola argentea).

The Haplochromine species, which formed about 42% in species composition in total landings up to the late 1970s, are small, bony, and mainly disliked by the local population. In most cases when fished is sold to fishmeal factories. Analyses of data from 1960-2003 we found that this was the main specie that was preyed upon by the Nile perch and as is evidenced from Figure 2, as Nile perch was exploding in the early 1980's the catch composition of Haplochromines was declining at a very fast rate. As the data shows by 1987 when Nile perch reached its peak, Haplochromines was somewhere less than 1% in the species composition from the total landings (See Figure 2). The Nile perch is important predator in the lake. It preys on Dagaa as well as Haplochromines together with other species. With the declining stock of the "preferred" Haplochromines species, it is obvious that Dagaa now appears to be the main target prey. Therefore there is a high pressure on Dagaa from two predators, Nile perch and from human fishing pressure for domestic and industrial use. Due to predation rate is one of the possible theory explaining the disappearances of some of the species. However, this alone cannot explain everything as a lot of ecological change has taken place in this lake for the past 4 decades. Concurrent with the Nile perch eruption scientist have observed depletion in the level of dissolved oxygen in the water. Most biologists had believed that Nile perch caused this change by eating plant-eating fish; which led to greater overall biomass and greater oxygen depletion when all this biomass rotted (Brundy & Pitcher, 1995). However, other studies have also suggested that run-off from agriculture and sewage caused the drop in levels of dissolved oxygen. This in turn made a certain shrimp, a preferred Nile perch food more available. Thus, ecological change might have favoured the rapid growth of the Nile perch and at the same time working against other species.

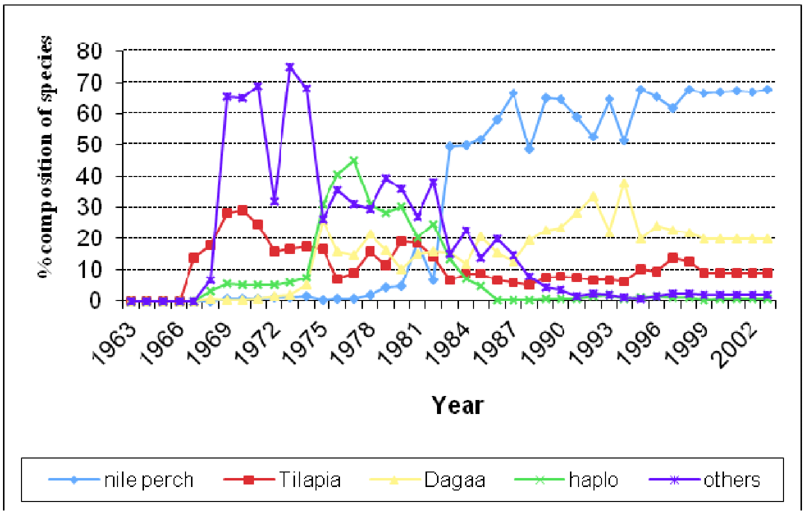

Figure 2: Trend in Catch Composition in Lake Victoria

From analysis of data from 2005-2011, we see a different trend in catch composition. As the stock of Nile Perch and Nile Tilapia is declining it is observed that there are increasing landing of other minor species such as Haplochromines, clarias and others species which are less important commercially. Figure 3, which is based on data from 2005-2011, can clearly tell the situation of how the species composition has been declining year after year, and the trend being reversed. Also from the survey result it is only 24 fishermen out of 498 interviewed who were fishing Tilapia as their main species target. This is about 4.8% of the entire sample population. The reason levelled against is not because there is no good market for Tilapia but rather majority admitted that it is hard to get enough Tilapia in many parts of the lake. The average price of Nile perch is Tsh. 2000 (appr. 1.5 US$) per kg while that of Tilapia is Tsh 1700 per kg. The price difference is not of big margin, given the fact that fishing gears for Nile perch are also relatively expensive compared to that of Tilapia. So this price difference might not be the only factor to the current pressure on the Nile perch, but rather the disappearance of other species has led majority of the existing effort to be directed toward harvesting the specie.

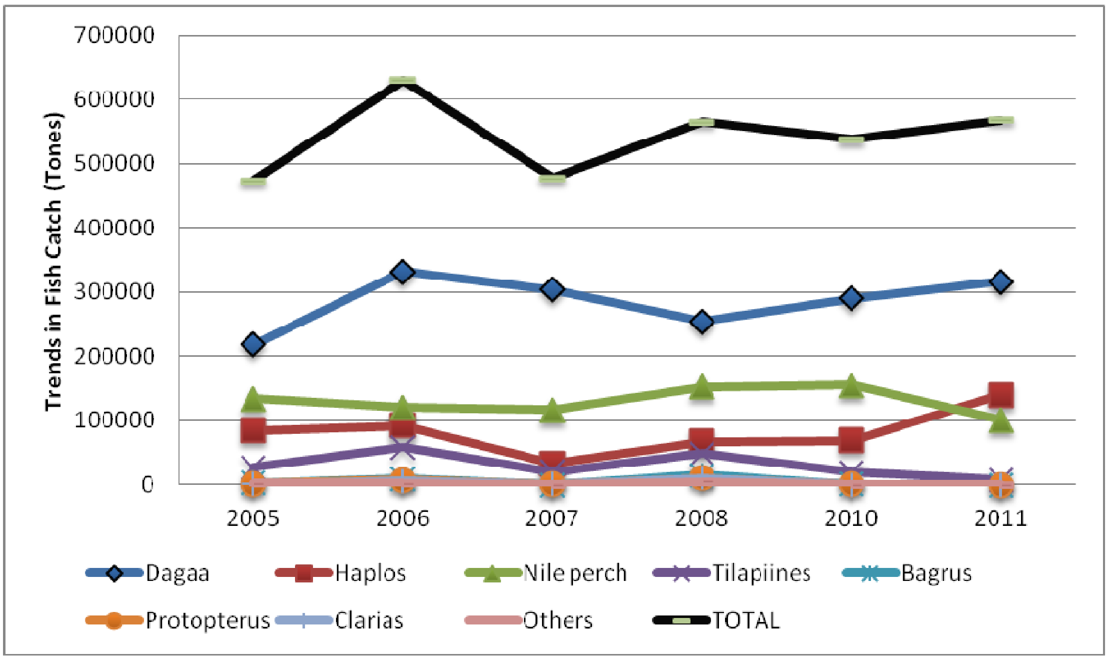

Figure 3 Lake Victoria Catch Trend 2005-2011

1.2 Evidence of Overfishing

There is no dispute that the fisheries in Lake Victoria are overfished. The fundamental reason is that valuable resources have been treated as open access resources -anyone willing to pay a moderate license fee can harvest as much as desired. There is also no dispute that the Nile-perch (*Lates niloticus*) is the predator for many species heretofore harvested with simple technology sold locally. The most serious problem facing lake Victoria fisheries is that of overfishing through the use of destructive fishing gears especially small meshed gillnets, cropping of fish before they reproduce and a general increase in the fishing effort (LVEMP 1999; Lokina et al 2012). The overfishing phenomenon in lake Victoria fisheries can be explained in terms of both quantitative and qualitative overfishing. However, because of the unreliability of the data that are available, it can be extremely difficult for one to come up with the conclusion that there is overfishing problem in the lake. Quantitative overfishing occurs when its total landings decline progressively every year. This calls for a series of yearly data. However, if we can base our investigation on the poor data that are available, we can still conclude that there is overfishing in the lake. Looking at this data from the frame survey of 2005-2011, which shows specie composition, we can observe that there is a general decline in many of the species, compared to the level recorded in 1980's. The trend has completely reversed from what was observed in 1980's, the catch for 2010 and 2011 of Haplochromines surpassed that of Nile Perch (See Figure 3). The figure also suggests that there is a continuous increase in the aggregate catch. However, the explosion of other minor species in the mid 2005s, and also to a large extent the relatively stable trend of Dagaa has led the aggregate catch to remain relatively stable. Thus the increase in other formerly minor species and Dagaa catch is more than offset the impact of the declining of Nile Perch and Nile Tilapia.

Qualitative over fishing can be said to occur in a fishery when one or more of the following events are observed. Decline in the average size of the fish caught, appearance of juvenile or immature fish among the catches in large quantities. And the progressively disappearances of some species or a group of species from the catch. By looking on the historical data this situation is quite evident. We can see from Figure 3 that species composition has changed dramatically beginning the late 2000. As the stock of Nile perch was declining the stock of all other minor species that were formerly regarded as have disappeared started to be caught in large quantity. The species that is still caught in relatively large quantity is the Dagaa which is however, preyed upon by Nile perch.

Also during the survey on the Tanzanian side of the lake we were able to notice the size of the fish catch especially for Nile perch and Nile Tilapia to be relatively small. And this was supported by the fishermen interviewed and some fisheries officer that size of the catch comprises of quite immature fish. This is one of the main reasons that have forced the government to introduce the mesh size regulations. Still however, large quantity of immature fish is caught. For example, in one beach we were able to witness one fisherman bringing about 30 kg of Nile perch but to find that only 5 kg was accepted as legal size fish. So the rest has to be sold to the fishmonger at a very low price. Following the massive decline of the fish catch, some of the factories have closed down and those currently in operation are operating hardly 50 percept of their full capacity.

We can basically say that two main things can attribute to the overfishing problem, which is currently being experienced in the lake. First is the increasing in fishing pressure resulting from the rapid growth in the population of fishermen (see Figure 4), followed by a gradual increase in both quantity and capacity wide of the fishing crafts and gears. In the earlier 1990 there was a gradual modernization of the fishing vessels from plank canoe to boat with and without engine. This trend was further accelerated by the expansion of the processing factories, which went further into extending credits to the fishers, which enabled them to acquire even more powerful fishing vessels and gears. This transformation ensured long distance travel and big capacity of carriage as well as stability in the water because of the frequency change in the weather condition.

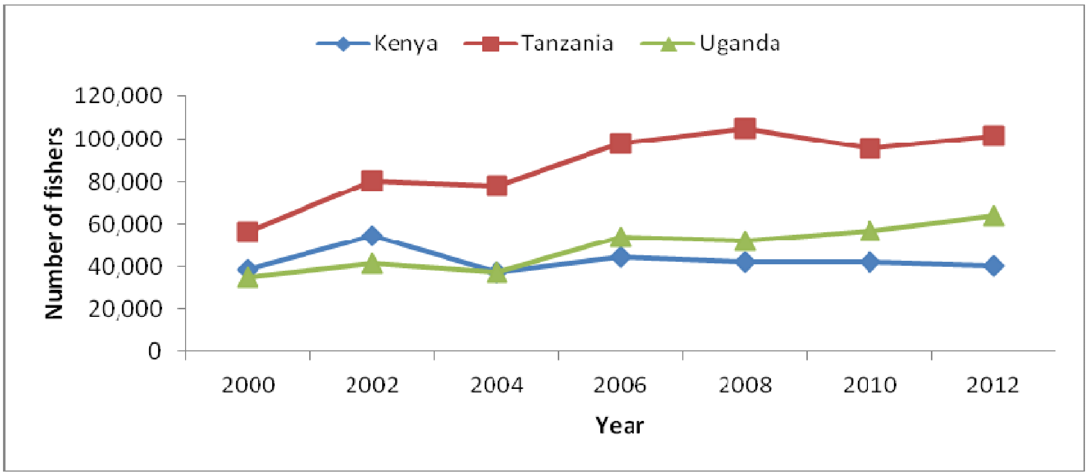

Figure 4: Trends in the Number of Fishermen in Lake Victoria Fisheries

Also in the late 1990 and earlier 2000 we saw the introduction of a more powerful fishing vessel for Dagaa- catamaran. A frame survey done from 2005 to 2011 in the Tanzanian section of the Lake showed that catch per net declined by almost 60% (URT, 2012). As a response to this there has been a gradual shift from gillnets of appropriate mesh size to those with smaller mesh size as a coping strategy. Also fishers are reported to charging the fishing techniques from active gillnetting to triple mounting of nets, two to three and sometimes up to six nets are joined vertically so as to cover the whole water column. Such mounted nets are also tied on boats with engine and towed slowly over a large distance. Also fishers in Lake Victoria are reported to be using even chemical poisoning as a fishing technology (Mkumbo, 2003). Use of inappropriate technology has substantially contributed to overfishing by not only recruiting fish into the fishery that have not reproduced but also by destroying fish breeding grounds through abrasive and other forces. It is reported that mesh size for inshore nets are catching immature Nile perch, a practice that can lead to variance in recruitment leading to instability and possible population collapse (URT 2012),(See Figure 5). That the effort has grown phenomenally notwithstanding the inaccuracy of its estimates is unequivocal. Secondly, is the general ecological change of the lake.

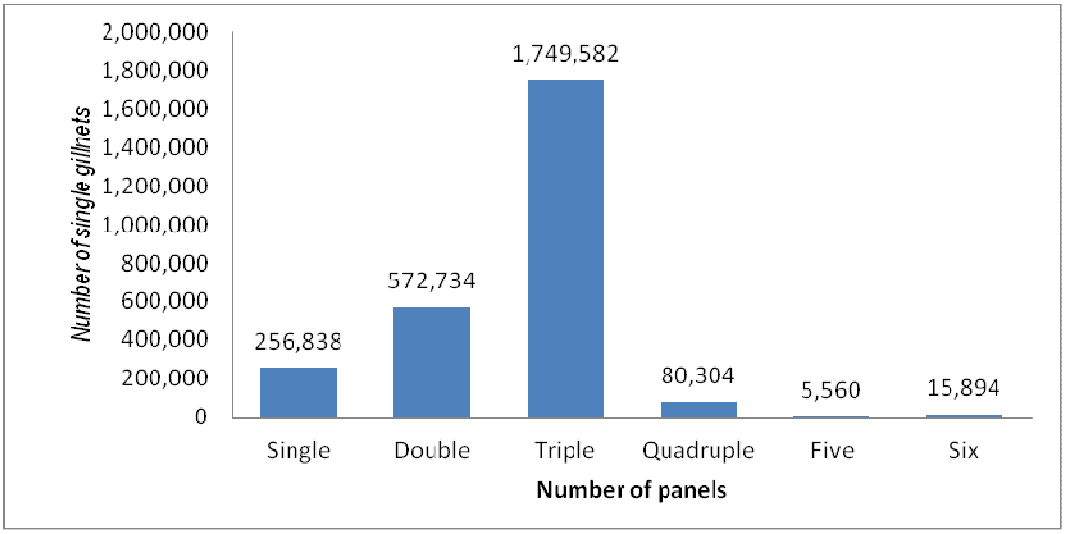

Figure 5: Distribution of the fishing nets arrangement

Thus combining all these phenomenon and in pursuit of appropriating high profit in the short period there has been a gradual shifts from gillnets of legal mesh size to those with small mesh size and from gillnets, longlines and traditional gears such as traps in favour of destructive technology such as mosquito nets, beach seining and other illegal (See Figure 6). The use of destructive gears has substantially, contributed to overfishing since not only recruit fish into the fishery that have not reproduced but also systematically by destroying fish breeding grounds through abrasive and other forces. This phenomenon continues to prevail due to poor enforcement of regulations, existent of markets for almost every fish caught, rampant theft of legal technology and the open access nature of the fisheries.

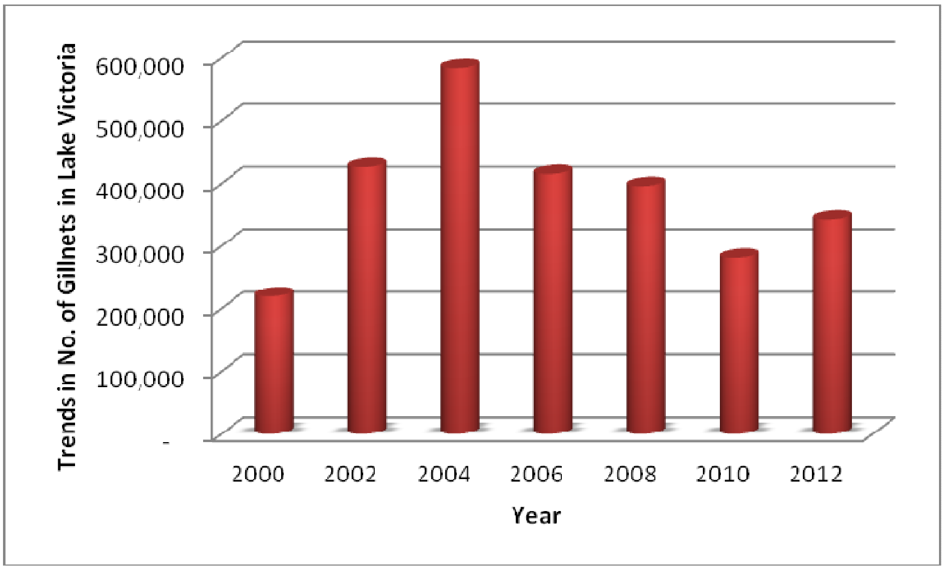

Figure 6: Trends in Fishing Gillnets in Lake Victoria

There are four major types of fishing units on the lake; namely Nile perch gillnets, loglines, and Dagaa seine. Hook and lines are also common in some places especially those targeting Nile Tilapia. Nile perch are fished with gill nets, multi-hook longlines and sometimes by hook and line. Gill nets are like huge tennis nets suspended in the water and catch the fish because their gill get stuck in the net. Nets are placed late in the afternoon and retrieved earlier in the morning. Because of the concerns with the theft, fishers often stay out with the net, sleeping in their boats. Table 1 report the distribution of the various fishing gear on the sample by region from the sampled beaches. Long lines are fishing lines to which large numbers of hooks have been attached. When targeting Nile perch they are usually baited with Haplochromines, in case there is a shortage of it then Dagaa can also be used as an alternative or any other small fish. But the main bait to majority of longliners is Haplochromines. With longlines, fishers are able to catch very larger Nile perch that are too larger to be caught by gill nets.

Table 1: Gear Type Distributions by Region

Region	Gear type	Frequency	% of the region
	Longlines	48	27.4
	Beach seine	1	0.57
	Dagaa seine	14	8
Mwanza	Nile Perch Gillnets	99	56.6
	Hurry-up and Scoop nets	13	7.5
	Total	**175**	**100.07**
	Longlines	23	13.8
	Dagaa seine	9	5.4
Mara	Nile Perch Gillnets	120	71.8
	Hurry-up	15	8.9
	Total	**167**	**99.98**
	Hook and line	4	2.7
	Dagaa seine	3	2.0
Kagera	Nile Perch Gillnets	116	77.3
	Hurry-up and Scoop net	4	2.7
	Total	**150**	**99.97**

Dagaa are fished at night when the moon is dark using pressure lamp to attract them. They are caught with several types of gear. Dagaa seines and mosquito nets are the most common (17.4%) but scoop nets (10.2%) are also used (See Figure 7). On the vessels side there is a growing number of catamarans, i.e. the boat with twin hulls in parallel, which is special for Dagaa fisheries and appears to be common in one beach which is dominated by *Ha* tribe from Kigoma, the western part of Tanzania in Lake Tanganyika which infact is where these catamaran are originated.

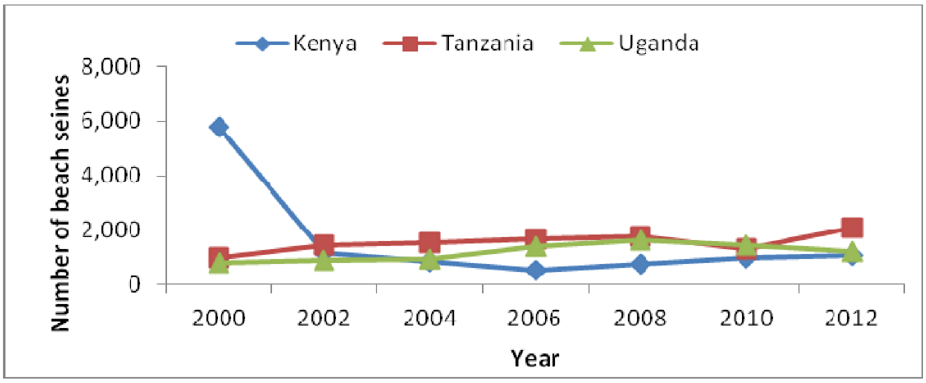

Figure 7: Trends in the Beach Seines in Lake Victoria Fisheries

A few boats target Tilapia and other minor species. Tilapia is mainly caught with hook and lines, and small mesh gill nets (4 inches). The lakeside population mainly uses this species for consumption.

1.3 Production Relation and Fisheries Regulation

Another phenomenon of this new development in Lake Victoria fisheries is the loss of control of the resource among the small-scale fishers. The loss of control over the means of production as well as processing, pricing and marketing by local fishers to industrial investors has generated substantial costs. There is diminished access among small-scale fishers due to investments in such modern technologies as outboard motors and a lot of fishing equipment and hired fishers to do the fishing. The fish processing factories finance the successful fisher with the large fishing fleets over 100 boats with 80 to 120 triple joined nets in each boat. The set-up in the fishing industry in Lake Victoria has changed remarkably. Less successful fishers are either turning to species other than Nile perch or are operating as labourers for the successful ones financed by or directly fishing for the Nile perch fish processing factories. Now days it is quite common to find hired crews and skippers in Lake Victoria fisheries. Some of the less successful fishers are now fully engaged in the beach seining, mostly at night, or to exploit Nile perch by long lines. In pricing, local fishers has no say because of lack of storage facilities, the perishability of fish and the pressure of credit relationships. In addition, each local fisher accounts for an insignificant portion of total fish supply and is therefore a price taker. In the processing and marketing sectors, large actors with a lot of capital have edged out traditional sellers and processors.

Small-scale fishing boat generates almost all of the fishing effort on the lake. These fishers use small boats taking a total crew of 2 to 6. The average crew number in the boat is 3. In a few occasional especially in a very remote beach, owner of the vessels is also involved in the fishing, however, this is very rare phenomenon in the more commercialised beaches like those which are close to the processing factories. This is clearly supported by the data, in which case about 3% of the owner are involved in actual fishing in Mwanza region which many of her beach are well connected with the processing factories. While there are about 8% and 10% of the owner are involved in actual fishing in Mara and Kagera respectively. From the whole sample we found only 34 vessels owners were involved in actual fishing; this is equivalent to 7%. Increasingly, small-scale fishers are receiving loans from the factory agent as a means of binding them to sell the daily catch to them at an agreed price. This is clearly evident in many of these beaches where you can notice price difference even within the same beach. In many of these beaches vessel owners or their relatives are the one in charge of daily sell of fish in the beach.

Being small-scale fisher one would expect them to be flexible in switching between species according to season variations and fish availability. In which case we would suggest a more flexible regulation policy. However, this is not clear evidence in this fishery. The switch is however, possible between Nile perch and Nile Tilapia fishing in some cases. But not between Nile perch and Dagaa which are the two main commercial specie that are now widely available. The two species i.e. Nile perch and Dagaa, need quite different gears and might need different fishing expertise. From the survey about 78% said they don't switch between species and their main argument is the long experience they have and prices they can get in the type of the fisheries they are involved be it Nile perch fishery or Dagaa fishery. Other indicated that they don't switch because they don't believe they can get more fish in the other fisheries. And that they are assured of market and high price even if is little they can get. Similar evidence was shown in Eggert and Lokina (2007) which suggests that, many fishers are more risk averse in trying to invest in other type of fisheries Especially if they know that they can still earn something in the current fishery. Table 2 summarizes the responses from the interview.

Table 2: Respondents reasons for not switching between species

Reason	**Frequency**	**Percentage**
High price and market availability of the specie	170	38.0
Long fishing experience in the species that I fish and gears	180	40.3
Fish Availability and Market	85	19.0
Others	12	2.7
Total	**447**	**99.98**

Despite being less flexible in switching between species they are however, quite flexible within their fishing unit. That is they can respond to adjust their fishing gears in response to low catch or the regulation. For example, as a coping strategies to mesh size regulation which majority found getting less and less catch in each trip, they have come up with another modification of the nets in which case nets are co-joined not only length wide but also width wide (Lokina, 2008, see also Figure 5).

In the face of stock declining due to both overfishing and ecological change in the lake the Government responded by instituting some management measures as a way of curbing the situation. Among these measures include, banning of some of fishing technology that seem to be destructive. These included beach seine, regulating mesh size for different fishing unit, that's Dagaa nets are set at not less than 10mm while Nile perch are set at mesh of not less than 127 cm or 5 inches and for Nile Tilapia the legal mesh size is a minimum of 4 inches. Also there is a requirement of fishing boat registration and acquisition of fishing licence to every boat owners.

Generally the use of illegal fishing gears in Lake Victoria as whole is not declining. The problem is still rampant across the landing beaches. And with the declining stock of the majority of the commercially important species in particular Nile perch and Nile Tilapia there is not hope that the use of illegal gears will be contained in the near future. Figure 8 summarize the frame survey from 2000 to 2012 data which shows a general raising trends in the use of illegal fishing gears across the Lake.

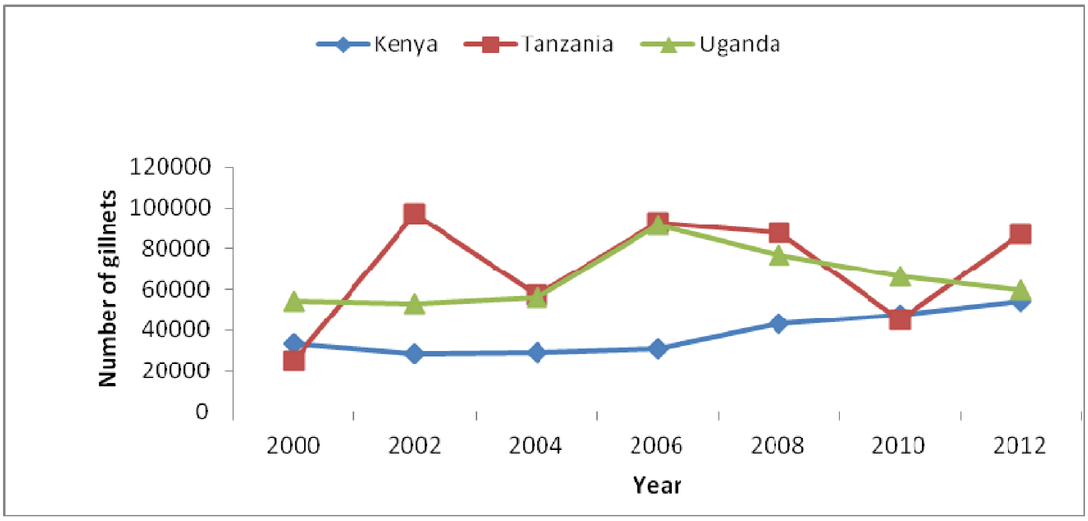

Figure 8: Illegal gillnets <5 inches mesh size

Other regulations in place also included the closed seasons and closed areas. In some of these they restrict certain type of gear to be used during the closed season in a particular area. Thus, it seems that the area though declared as a closed area but in real sense is closed by restricting certain type of gears. For example mosquito net used for Dagaa fisheries is not allowed to be used during the closed season in a closed area. The closed areas are places that are believed to be important breading ground such as sandy shores and shallow weed beds for Tilapia, river mouths for such species as clarias etc. and swamps and wetland for protoptrus and clarias.

Trawling in the lake is also banned. Also another policy in place is minimum size of the recruited fish that allowed to be sold to the factories. The aim of this regulation is to reduce or eliminate that market for immature fish especially the one going to the factories. This can in one way or another make the fisher, especially those targeting the factories for their daily catch, to comply with the mesh size regulation since the factories agent will not accept if they catch the undersized fish. To ensure this is implemented the government has placed fish inspectors in all of the factories, who assess all the trucks bringing the fish from various beaches, and if found any illegal size the whole consignment is confiscated and taken to the government institutions such as prisons, schools or hospitals. And that means a loss to the factory owner. In that way the agent are very strict on the size of the fish they buy.

Another policy in place is the requirement to have a fishing licence if you own a fishing vessel. Acquisition of licence is looked more like a source of revenue to the local government than as a regulation tools. The licence fee, which is supposed to be paid annually, is very low that it just takes a day trip to make over and above the licence requirements for the whole year. It is approximately 10US$ per year, while a fisher who can get an average catch of 27kg per day trip, means is able to get about 27US$ per day[27]. Thus, a day trip is more than enough to pay the annual license fee. So this cannot be seen as a barrier to entry in this fishery. Moreover, there is no specific policy of limiting access the number of participants in the fishery, any one interested in joining the fishery requires only fishing capital. This fishery therefore can be viewed as classical example of regulated open access fishery sort of.

In general fishermen compliance with the regulations is extremely poor, with the most violated regulations being the use of small mesh size nets and fishing in the breeding areas. The reason for this is the fact that these nets and these areas guarantee higher catches and because small meshed size nets are easier to acquire. The poor compliance can also be due to the bad attitude fishers have towards some of the regulations. For example, it was reported in one study that, seine owners say that banning seines might improve fishing but the improvements would only benefit those who use engines and gill nets further offshore. Also lack of knowledge to different regulation is a limiting factor, for example in one study Medard (2000) found that majority of the crew members are not aware of the different laws and regulations governing the lake fisheries. On the other hand however, the boat owners were quite knowledgeable with the laws and regulations. It appears that it is up to the boat owners to instruct the crewmembers on these laws and regulations. The question is do they do so? This is a big problem since the one who is getting the licence is the one who is furnished with the regulation but is not the one who is going to do the actual fishing.

Also it was observed during the survey that the extent of knowledge of fisheries regulations was dependent on its area of application and consequently the type of fishery associated with the regulation. For example it was found that Nile perch fishers knew more about the restrictions on the gill nets of less than 127 mm than did the Dagaa fishers.

1.4 Production Relations and Sharing System

There are quite a big gap between the owning and the labouring classes within the industry. Crews who do not own shares in boats or gear do most of the actual fishing. Table 3 shows that approximately 66% of the sampled boats were operated by hired skipper and crewmembers, with 94% of them targeting Nile perch and only 16% were operated by the owner of the boats, in which about 85% are targeting Dagaa. Thus Dagaa fishing is seen more as a family business, or subsistence activities while Nile perch fishing are seen as commercial fishing. About 6% of the boats are owned by the boat renter who in most cases is not involved in actual fishing and approximately 13% are jointly owned by crew/skipper together with an individual outside the fishery. Thus the phenomenon of absentee fishers is widespread. The fishers in turn are controlled through credit relationships. The local fishers has thus, lost control of the means of

[27] The exchange rate used is 1 USD = 1620 TZs as of October 2012.

production and hence the sense of ownership of the resource, thus posing a big challenge in as far as sustainability is concerned.

Table 3 Distribution of Vessel Ownership

Item	Ownership system	Frequency	% Of the total
1	An individual who is outside the fishery	325	65.7
2	A crew member who is a skipper	79	15.9
3	Boat renter	29	5.9
4	Joint ownership by crew	62	12.6
	Total	495	100

Fisher almost always also farm, and this is supported by our survey data, which shows that only 28 depends entirely (i.e. 100%) on fishing activities to meet their daily household expenditures. And close to 18% depend by 50% or less on fishing activities. Basing on the regional sub-samples, we found 39%, 20% and 21% from Mwanza, Mara and Kagera respectively, to depend by 100% on fishing activities for their daily household requirements. On the other hand for the whole sample about 58% of the crews depend on fishing activities for more than 50% but less than 100% of their daily household expenditure. This suggests that fishing activities still play a significant role in the household income despite the fact that the stock is declining.

Crews are almost always paid with a share of the catch. The more commercialised boats make more money per trip and in some cases have smaller number of crews but again a higher percentage of the catch goes to owners of the boats and engine. Boat with engine get an average catch of 27 kg and 208kg per trip for Nile perch and Dagaa fisher respectively. While boat without engine fetch an average of 18.3 kg and 198.1 kg for Nile perch and Dagaa respectively. The main reason for this is the fact that, with motorized boat they can go far and in rich fishing grounds; be able to patrol against theft, can save a lot of time in setting nets and also they can have quite a large number of nets.

The mode of sharing system varies from one region to another, with some region favouring a particular mode than others. Figures 7 & 8 show different sharing system from one region to another. The options are (1) a share system with a fixed amount, (2) a different share system in percentage after deducting the daily running cost, (3) equal share after deducting daily running cost, (4) ration in days and (9) other share systems.

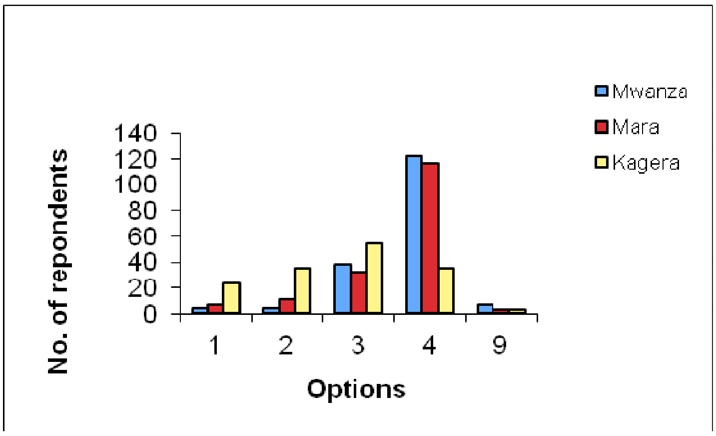

Figure 9 Share system between boat owner & Crews

The sharing system goes like this, share system often assigns engines and gear substantial maintenance and depreciation payments that are deducted before or after the proceedings of the catch is shared depending on the agreements. These payments reduce actual crew shares. The increased skill level of crew who work with engine, however, translate into relatively higher pay in comparison to boat without engines, and the higher pay on motorized boats more than offsets the deduction.

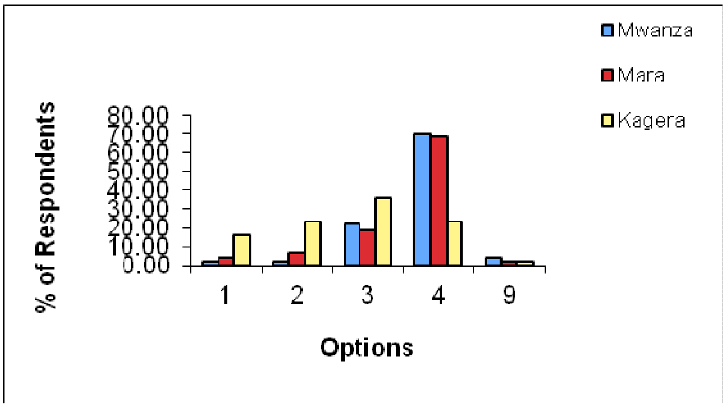

Figure 10: Share system into %

There are quite many forms of sharing system. However, in this survey we tried to summarize them and grouped into 4 categories of share systems; First is the share system with fixed amount, this means whatever is realized is divided among the crews and the owner before deducting the daily running cost. Secondly, is the different share system in percentage, in this case the daily proceedings is shared in percentage after deducting cost. This can be 60/40 or 70/30 or 50/30/20 for owner, crews and boat respectively, depending on the agreements of the owner and the crewmembers. The first and second sharing systems are regarded by many as more exploitative than the other two forms. The most striking difference between the two systems is that crew members (including skippers) who receive their share of revenues after running costs are deducted face the risk of no income at all (Lokina, 2008). And many of the crew interviewed seem to dislike it as large part of the daily catch is accrued by the boat owners. This is the form, which is quite common in Kagera region. The third form is, equal share after deducting running cost this can be 50/50. The fourth system is the ratio in days, in this case they can count say five days of operation, and the ratio can go like 2:2:1 or 3:2:1 or 3:1:1, that's owners day, then crew day, and boat day. Some also can take 7 or 10 days etc. That means that after every five days the circle starts again, until the end of the month. Many of the crew are infavor of options 3 and 4 that is equal share after deducting cost or ratio in days. This is the form practiced by many of the boat owners in Mwanza and Mara regions compared to Kagera region (See Fig. 7 & 8).

This production relation and sharing system is creating a big gap between the owner and the crewmembers and impose a big challenge as for as conservation is concerned. And is not giving them a hope to become the owner of their own vessels given what they can realize in their daily trip. Many of them admitted that what they get is only enough to eat in the household and buy some few household items. From the crew leaders interviewed about 45% are able to own a bicycle; 70.5% own a radio and 65.2% stay in their own house. However, many of these houses are of poor quality. From the perspective of managing the fishery, the growing economic and cultural alienation of crewmembers from their employers and their communities is not good news to the management point of view. The danger is that they will loose any sense of ownership or long-term commitment towards the resources. Since they don't see any prospect of the future long-term benefits to come forth.

1.5 Market Arrangement for Fish and Fish Price determination

In Lake zones fishers can sell their catch through various market arrangements, some predetermined through agreement, others dictated by prevalent liberalised market conditions. These include selling through beach landing auctions in the event there are multiple buyers and more often directly to middlemen, buying agents, who can then sell to fish processing plants and others directly to fish processing plants among others. Middlemen on their part spend time waiting on shore for the fishers to return from fishing grounds, buy fish and sell at the beach landing or take their purchase to the processing plant. All these depend on the existing arrangement between the fisher and the processing plants or the middlemen whom in most cases are the one who provide fishing boats and other fishing gears. At the landing beach, the mode of fish sales may be through pre-agreed arrangement with provider of the boats/fishing gears or bargaining for those operating their own fishing vessels/gears. If the fishing group rents vessel and fishing gear, they more often find themselves selling to the owner of the vessel and gear. This arrangement has its advantages and disadvantages. The advantages are that fishers will always be guaranteed of selling their fish. However, they may be earning relatively less due to the normal practice of lower price setting by the buyer relative to that prevailing at the market.

In all these arrangements, a variation of prices will exist depending on a number of factors including the number of buyers at the landing beach, number of sellers and the quantity of harvested fish in the market in that particular day. Like any other market situation, usually the prices are relatively lower during peak season.

Due to unreliability of market situation, lack of storage facilities, limited market options and other factors, fishers prefer to sell to established buyers even if they offer the lower price, thus avoid risk of losing quality. Due to lack of capital, fishers find themselves obligated to sell to their creditors and owners of fishing gear and vessels. Although this kind of arrangement may seem to be relatively exploitative, the alternative is a more threatening option in terms of one's security of livelihood and property represented by the conditions for borrowing from the well-established financial institutions particularly with respect to the risk and uncertainty inherent in the activity for which the loans are taken

In lake regions therefore fish catch is used for both generations of cash income and also for subsistence. It is been pointed out that on average, about 90% of the catch is for sale and the rest is for home consumption. The average price of 1 piece of Nile perch (of 2kg or more than 52cm) is varying between Tshs 1,500 to 4, 000. Normally, fishes are sold at the landing site where by fish agents buy from fishermen and take them to sell elsewhere in town markets or to Fish processing industries. On the other hand, other petty traders buy and sell them at the village centres and the nearby villages.

2.0 Data and Data Sources

2.1 Sampling procedure.

This description is based on the data that was collected between November and December 2011. From 22 randomly selected fish-landing sites, to be known as Beaches throughout the rest of the paper, on the Tanzania side of the Lake Victoria. The data were collected through the field observation by administering the questionnaire. Focus group discussion was conducted to confirm some of the individual information. A group of five to six key informants from each of the landing sites were involved in the discussion. The survey was done in three regions bordering the lake, namely, Mwanza, Mara and Kagera regions. In total we sampled 9 districts from the three regions an average of 3 districts from each region. And from these districts 22 beaches were covered.

Beaches and fishermen were sampled randomly from the 9 districts. The sampling of beaches was done under the help of district fisheries officers. The sampling was based on the accessibility of the beaches since the data was collected during the rain season some of the beaches were not easily accessed. And many of these were Dagaa fisheries. This however, is not expected to bias our result since the important variation of fisher's characteristics and behaviour is captured through the regional differences. A total number of 497 fishing unit were surveyed out of the planned 500 fishing units. This is an average of 166 from each of the three regions. The sample consists of Nile perch and Nile tilapia fishers, which constitute about 80% of the sample population and Dagaa fisher constituting about 17.3%. The remaining sample is of other assorted type of species.

The beach selection was based on two stratifying dimensions: the ecological zones reflecting geographical differences on the lake, that's Dagaa and Nile perch/ Tilapia fisheries; and to ensure an adequate sample from the small number of larger beaches, we used the number of boats on the beach. The sampling unit is thus the fishing boat. From each region we sampled approximately 10 beaches in which a number of 17 fishers are singled out for interview. Hence, the selection of the beach was based on the requirement that there must be at least 17 fishing boats. In a situation where there were exactly 17 boats then all of them was selected. For each boat we were interested with the skipper of the boat. The results therefore were expected to present a total number of 170 fishers from each region.

The data that we collected represented the two days fishing trips. That is 24 hours fishing recall. In this case the fisher were asked to state they catch and prices for yesterday trip and today's trip. In additional we had asked them to indicate the two days operation costs. Especially the fuel usage for those using engine and kerosene consumption for those using pressure lamps. Table 3 gives a summary statistics of some of the variables. The variables, *net length*, *vessel length*, and *vessel width* are measured in meters; *the mesh size* is measured in millimetres. The distance travelled by the unit (*Dist1 & Dist2*) is approximated by hours, since it was found difficult to have accurate measure of nautical miles, which is the standard unit used when measuring the distance travelled in water. Thus majority were able to state the hours travelled from the shore to the fishing ground. The intensity of fishing is approximated by the number of hours spent fishing (*fishedh1 & fishedh2*), i.e. gears stay in the water before retrieve.

Table 2: Summary Statistics of the Variables

Variable	Description	Mean	Std. Dev.	Min	Max
Region	Regional variables	1.95	0.81	1.0	3
District	District Variables	5.63	2.48	1.0	9
Age(Yrs)	Age of the respondents	30.30	8.63	17.0	82
Exp(Yrs)	Years of Experience of the skipper	10.89	7.44	1.0	48
tripn	Number of Trips per month	24.53	7.14	4.0	30
shareo	Share of the catch taken by the owner	64.13	12.17	50.0	91
sharec	Share of catch taken by the crew	35.87	12.17	9.3	50
Dist1(Hrs)	Distance travelled in hours in day 1	1.60	1.12	0.1	6
Dist2(Hrs)|	Distance travelled in hours in day 2	1.65	1.16	0.1	6
fishedh1	Number of hours spent fishing in day 1	9.47	3.61	2.0	24
fishedh2	Number of hours spent fishing in day 2	9.55	3.62	2.0	24
Wgt1(KG)	Amount of catch in kg in day 1	58.23	131.70	2.0	1290
Wgt2(KG)	Amount of catch in kg in day 2	56.59	141.33	3.0	2107
Vage(Yrs)|	Number of years of the vessels used	2.90	2.41	1.0	19
Vesselw(m)	Vessels width in meters	1.58	0.29	1.0	4
vessel(m)	Vessels length in meters	7.86	7.86	4.0	14
GRT(Tones)	Gross registered tones of the vessel	0.99	0.61	0.2	3
HP	Horse power of the engine	15.04	6.49	5.0	40
netlen(M)	Net length in meters	1840.99	1420.36	7.0	9450
msizem(mm)	Mesh size of the fishing nets in millimeters	94.68	57.18	1.1	175

In most cases crewmembers are younger than owners and renters, but they are not for the most part itinerant youths. Many of them are teenagers, and few are children, but the average age of the crew leader is 30 and majority have families. 73.4% are married and have an average of 4 dependent children and an average of 1 older person in the household. Majority of the fishers spend about 2 hours to travel from the shore to the fishing ground and about 10 hours doing the actual fishing. On average the catch stands at 57kg per day trip of 12 hours

2.2 Econometric Results and Discussion

In Table 4 and 5 we estimated the value of the two days catch on several explanatory variables. The value of the catch is obtained by taking the average price of the two days fishing trips multiplied by the aggregate of the two days fish catch. In Tables 4-6, the inputs considered are gross registered tones of the vessel (GRT), number of crew members in the vessels including the captain (*Crewn*), the net length (*netlen*) measured in meters, the vessel length (vessel) also measured in meters and vessel mesh size (*msizem*) of the nets measured in millimetres. All of the variables are in log form. In this analysis we also included the age and experience of the skipper and other dummy variables.

Table 3: OLS estimates of the Log of Value of Catch

variables	Coef.	Std. Err.	t	P>|t|
lgrt	0.019	0.058	0.33	0.743
lcrewn	0.154	0.132	1.16	0.245
lnetlen	-0.162***	0.035	-4.66	0.000
lvessel	0.042	0.183	0.23	0.82
lmsizem	-0.134***	0.033	-4.75	0.000
lage	-0.318***	0.110	-2.89	0.004
Kagera	-0.171	0.122	-1.4	0.164
Mwanza	0.261***	0.093	2.8	0.005
noeduc1	-0.086	0.081	-1.06	0.292
vtype3	0.234	0.172	1.36	0.175
distr7	0.434***	0.115	3.76	0.000
distr8	0.252**	0.103	2.44	0.015
propm1	-0.065	0.115	-0.56	0.573
propm2	0.103	0.113	0.91	0.364
propm3	0.055	0.130	0.42	0.675
Constant	12.633***	0.639	19.78	0.000
No. of Obs.		468		
R-squired		0.21		
Adjusted R-squired		0.19		

In Table 4 we have the dummy variable for region, education, district and method of propulsions, that's whether the unit is using boat with engine, sail, peddled or fleet pulled boat. For the inputs case the only significant variable are the net length, this is highly significant but is carrying a negative sign. Suggesting that the unit with long fishing nets are getting less valuable fish species!. Theoretically one should expect the net length to be positively correlated with the value of the catch, since with long nets means you are able to cover larger area and potentially getting more catch and valuable one. One of the possible explanation to this could be the fact that the fisheries is highly overexploited and that covering the large area it doesn't add anything other than adding the operation cost of the unit. It seems that, what is important in this fishery is the ability of the skipper to target the patch with relatively abundant stock. The mesh size is significant in explaining the catch value and is carrying the negative sign. Indicating that increasing mesh size you are increasing the probability of getting less valuable fish species. And this can be true to the lake Victoria fisheries where there are highly valued fish species, the Nile perch, which is caught by relatively large mesh size (5") and the relatively less valued fish specie, the Dagaa, which again is caught using the relatively small mesh size (10mm). The regional dummies are *Mwanza Mara* and *Kagera*. The dummy variable for Mwanza region is found to be significant and positive. Mara is a reference region. *District 7* and *8* are found to be highly significant and positive. These are *Bukoba rural* and urban in Kagera region and *Tarime* district in Mara region.

In Table 5, we estimated the weight of the aggregate catch of the two days fishing trip. In this case most of the inputs included are found to be significant, except vessel length. GRT, number of crew are all-positive suggesting that the bigger the vessel, the more crewmembers are, which finally translate into high catch. This also suggests that with a big vessel size the unit is able to go far, and without fear of bad weather. It was reported during the survey that the unit can opt to stay offshore if the weather is very bad, as they have a been a lot of incidence of number fisher to be drowned after their vessel capsized due to bad weather. Vessel type 3, which is the Catamaran, is highly significant and positive. This vessel is mainly used for Dagaa fishing. It is high significant level can be supported by the fact that in terms of kilos it can catch relatively large quantity of Dagaa but of less value compared to Nile perch. And that's why the variable is found to be significant but negative in the value regression. The variable mesh size of the nets is found to be negative. Suggesting that the larger the mesh size the less the catch in terms of kilos. This can partly support the argument of over fishing in lake Victoria, because of the prevalence of more of juveniles and other small fish in total catch. Thus by increasing mesh size there is a high possibility that they will get less and less catch in each trip.

Table 4: OLS Estimates of the log of Total Weight in KG.

Variables	Coef.	Std. Err.	t	P>|t|
lgrt	0.110*	0.062	1.790	0.074
lcrewn	0.341***	0.132	2.590	0.010
lnetlen	-0.345***	0.037	-9.340	0.000
lvessel	0.076	0.195	0.390	0.696
lmsizem	-0.096**	0.035	-2.770	0.006
lage	-0.242**	0.117	-2.060	0.040
rdmy2	0.058	0.098	0.600	0.551
noeduc1	-0.063	0.087	-0.730	0.464
vtype3	1.265***	0.184	6.890	0.000
distr7	0.199***	0.098	2.030	0.043
distr8	0.158	0.110	1.440	0.151
propm1	0.040	0.118	0.340	0.734
propm2	0.136	0.121	1.130	0.260
propm3	0.030	0.139	0.220	0.829
Constant	7.116***	0.667	10.670	0.000
Total No. Obs.		468		
R-Squared		0.48		
Adjusted R-Squared		0.46		

3.0 Conclusion

There are various fishing restrictions and regulation which are good and are emphasizing on proper use, management and conservation of the Lake Victoria Basin like those using Beach seine, poison and dynamites. In addition, there are restrictions on such species as *gogogo*, and *furu,* as they are considered to be the main food for the bigger species such as Nile perch and tilapia. However, fishermen and community in general have raised the concern that restricting from catching these species it means denying community from benefiting from fishing. These are species that are commonly used and available to them. Furthermore, with the dwindling stock of the commercially important species, it would suggest that fishermen would largely depend on these seeming unimportant species for their livelihood. The Nile perch are mostly harvested taken directly to industries leaving the local community without fish to eat. This is posing an issue of concern on how to strike a balance between community welfare, business development and the conservation matters.

Our results further suggest that the existing sharing system in Lake Victoria also poses a big challenge in as far sustainability is concern. Some of the system such as the percentage of catch after deducting operation costs are to some extent seems to be exploitative since some of the owner of the fishing vessels assigns high costs. Hence large percentage of the catch will go to the owner of the fishing vessels. Thus, fishermen are compelled to use any means to ensure that they have enough catch. This could partly explain the increased use of illegal fishing gears out of desperation. It is therefore important that a proper sharing system is designed that could as well benefits the crewmembers. The most favoured sharing model is the ratio in days, in which case each fishing unit is assigned a day, that's owners' day, crews day, and vessels day.

It is also evident from the paper that the stock of the commercially important species; Nile Perch, and Nile Tilapia are continuing to decline year after year. Most of the processing industries are now operating below their established capacity some by less than 50%. This posses a big danger not only interms of employment and loss of revenue to the government but also the huge capital invested. Therefore, measures should be taken to rescue the stock from total collapse. This should include intensifying enforcement measure of the governing rules and regulations. Also, efforts should be taken to encourage fish farming as the best alternative to the dwindling stocks

In terms of implantation of the restrictions, the enforcement is made by the established beach management units (BMUs) supported by the police. However, there is general concern on the way the enforcement is being conducted. To majority of the fishermen they feel that measures should also target the manufacturer and traders instead of the fishermen who are basically the end users. Majority have the opinion that, instead of concentrating chasing fishermen with small size nets, let the concerned management deal with the industries those manufacturers and the suppliers (traders of the nets).

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