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Secure Fisheries
Secure Futures

BIOECONOMIC ANALYSIS OF THE KAPENTA FISHERIES LAKE KARIBA - ZIMBABWE & ZAMBIA

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INDIAN OCEAN COMMISSION

Cover photograph courtesy of Lionel Kinadjian

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Bioeconomic Analysis of the Kapenta Fisheries

Lake Kariba
Zimbabwe & Zambia

GCP/RAF/466/EC SmartFish Project

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Executive summary

FAO supports a joint management process and the development of fisheries on Lake Kariba between Zimbabwe and Zambia. The 4th Technical Consultation Meeting, held in Kariba in 2010, recommended the development of bioeconomic modelling of Kapenta fishery (*Limnothrissa miodon*).

In support of this recommendation, a first field mission was conducted in November 2012 with the support of the SmartFish project. The objective of this mission was to meet with key stakeholders in the public and private sectors involved in the Kapenta fishery in the two countries in order to:

- inform them about the bioeconomic assessment exercise to be carried out on the Kapenta fishery;
- underline the importance of their collaboration, in particular the provision of reliable data to fit the model;
- find out more about the Kapenta fishery and current challenges;
- gather key documents and information required for the bioeconomic modelling;
- assess the quality of information requested for the bioeconomic modelling and identify any gaps;
- draft the Terms of Reference for National Consultants who will be responsible for the collection of additional information after the mission.

Based on meetings with key officials in charge of the management of the fisheries and with leaders of fishing enterprises in the two countries, the main results of the mission indicate that:

- The fishing capacities in the Kapenta fishery have greatly increased since the early 2000s, from approximately 600 rigs allowed on the lake in 1999 to 1,098 in 2012 (5th Technical Consultation Meeting, 2012). There are also an unknown number of unregistered and unlicensed rigs (illegal, unreported and unregulated fishing);
- The fishing effort, reported by the fishing companies, has subsequently increased dramatically (40 percent increase between 2000 and 2011);
- The management system in the two countries is based on a licensing system and the payment of an annual fee for access to the fishery, as well as several technical management measures (mesh size, zoning, and brief closures based on the lunar calendar). The industry is also obliged to record and transfer to the management authorities monthly data on their catch and fishing effort. In practice, it seems that there are no real access controls and poor enforcement of regulations. Thus, the fishery currently appears to be open and free for all.

- The harvesting systems and the technical productivity of fleets in the two countries are relatively homogeneous. Catches per unit of effort have fallen by 35 to 50 percent since 2005;
- Qualitative indicators based on the situation of fishing enterprises show that the Kapenta fishery is overfished and revenue from resources is widely dissipated;
- Statistical data available on effort, catch and CPUE, as well as scientific knowledge on biological parameters of the Kapenta stock suggest that only a biological modelling based on a surplus production model (such as Schaeffer, Fox, etc.) is possible;
- There is an important shortage of economic data on time series concerning ex-vessel prices, costs related to the activities of fishing enterprises, their investment, and their profitability. Consequently, the work of two national consultants to support this process will mainly be focused on the collection of economic data in order to estimate an average cost per unit of effort (night fished per rig) in each country and for each fishing zone.

Key documents for the bioeconomic modelling were collected before and during the mission (or just after). A complete list of these documents can be found in Annex C. These key documents and references will form the basis of bibliographical references for the modelling exercise.

A questionnaire was developed to collect missing information for the bioeconomic modelling exercise (Annex E). This information was obtained from a field survey and from a sample of fishing companies of different sizes and operating in different fishing areas (Basin/Stratum) in the two countries. A sampling plan was made on the basis of data from the frame survey undertaken with FAO support in 2011. However, it is strongly suggested that this economic fieldwork will be conducted in close cooperation with those responsible for the Kapenta producer organizations in Zambia and Zimbabwe; on one hand for the selection of those companies to be interviewed and to facilitate contacts, and on the other hand, to ensure the quality of data to be collected and transmitted.

Forthcoming steps for the continuation of the process leading to the bio economic modeling workshop were also defined, as well the format of the workshop.

Résumé exécutif

La FAO appuie un processus de développement et de gestion conjoint des pêcheries sur le Lac Kariba entre le Zimbabwe et la Zambie. La 4ème réunion de Consultation technique tenue à Kariba en 2010, a recommandé de réaliser un exercice de modélisation bioéconomique de la pêcherie de Kapenta (*Limnothrissa miodon*).

En appui à cette recommandation, une première mission de terrain a été réalisée en novembre 2012 avec le support du Projet SmartFish. L'objectif de cette mission était de rencontrer les principales parties prenantes des secteurs public et privé impliqués dans la pêcherie du Kapenta au niveau des deux pays afin de :

- les informer de l'exercice d'évaluation bioéconomique qui sera réalisée sur les pêches Kapenta ;
- souligner l'importance de leur collaboration, en particulier la mise à disposition de données fiables pour développer et ajuster un modèle ;
- prendre connaissance de la situation de la pêcherie et de ses enjeux ;
- recueillir les documents de référence et qui seront nécessaire pour la modélisation bioéconomique clés ;
- évaluer la qualité des informations demandées pour la modélisation bioéconomique et d'identifier les lacunes ;
- enfin rédiger les termes de référence des consultants nationaux qui seront chargés de la collecte d'informations complémentaires après la mission

Sur la base des rencontres avec les principaux responsables en charge de la gestion de la pêcherie et avec des dirigeants des entreprises de pêche dans les deux pays, les principaux résultats de la mission indiquent que :

- La pêcherie de Kapenta a connu un très fort niveau développement des capacités de pêche depuis le début des années 2000, passant d'environ 600 plates-formes autorisées sur le Lac en 1999 à environ 1098 en 2012 (5ième Consultation technique). Il y a, par ailleurs, un nombre inconnu de plates-formes non enregistrées et sans permis (pêche illicite, non déclarée et non réglementée (INN)) ;
- L'effort de pêche déclaré a consécutivement énormément augmenté (+ 40 pourcent entre 2000 et 2011) ;
- Le système de gestion est basé dans les deux pays sur un système de licence et le paiement d'une redevance annuelle pour l'accès à la pêcherie, ainsi que plusieurs mesures techniques de gestion (maillage, zonage, et période de fermeture avec le calendrier lunaire), y compris l'obligation de transmission mensuelle des données de captures et d'effort de pêche.

Dans les faits, il n'y a plus de de véritable régulation de l'accès et de respect de la réglementation : la pêcherie se trouve actuellement dans une situation de quasi accès libre et gratuit ;

- Les systèmes d'exploitation et la productivité technique des flottilles au niveau des deux Pays sont relativement homogènes. Les rendements dans la pêcherie ont chuté de 35 à 50 % depuis 2005 ;
- Des indicateurs qualitatifs sur la situation des entreprises de pêche montre que la pêcherie est surexploité sur le plan économique et que la rente de la ressources est largement dissipée ;
- Les données statistiques disponibles (effort, captures et CPUE) et les connaissances sur les paramètres biologiques de Kapenta permettent d'envisager une modélisation biologique sur la base d'un modèle de surplus de production (du type Shaeffer, Fox, etc.)
- Il y a un déficit important en données économique sur les séries des prix au débarquement, sur les coûts liés à l'activité des entreprises de pêche, et donc sur leur rentabilité. En conséquence les travaux des deux Consultants nationaux en appui à ce processus devront principalement être centrés sur la collecte des données économiques afin de pouvoir estimer un coût moyen par unité d'effort (nuit pêchée par ponton) dans chacun des deux Pays et pour chaque zone de pêche.

Les documents de référence pour la modélisation bioéconomique ont été collectés avant et pendant la mission (ou juste après). La liste complète de ces documents est présentée dans le rapport (annexe C). Ces documents clés seront la base des références bibliographiques pour l'exercice de modélisation bioéconomique.

Un questionnaire a été élaboré afin de recueillir les informations manquantes et nécessaires à la modélisation bio économique (annexe E). Ces informations seront obtenues lors d'une enquête de terrain auprès d'un échantillon d'entreprise de pêche de différentes tailles, opérant au niveau des différentes zones de pêche (Bassin/Strate) dans les deux Pays. Un plan d'échantillonnage sera effectué sur la base des données de l'enquête cadre réalisée avec l'appui de la FAO en 2011 ; il est fortement suggéré que cette enquête économique de terrain soit réalisée cependant en étroite collaboration avec les responsables des Organisations de Producteurs de Kapenta en Zambie et au Zimbabwe pour, d'une part effectuer le choix des entreprises à interviewer et faciliter les contacts, et d'autres part, pour s'assurer de la qualité des données qui seront transmises.

Les éléments pour la poursuite du processus devant conduire à l'atelier de modélisation bio économique ont également été définis, ainsi que le format de cet atelier.

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Acronyms and abbreviations

CASS	Centre for Applied Social Sciences University of Zimbabwe
CPUE	Catch Per Unit of Effort
DOF	Department of Fisheries (Zambia)
FAO	Food and Agriculture Organization of the United Nations
KFA	Kapenta Fishers Association
KPA	Kapenta Producers Association
IKPA	Indigenous Kapenta Producers Association
IUU	Illegal, Unreported and Unregulated fishing
MAL	Ministry of Agriculture and Livestock
MSY	Maximum Sustainable Yield
NGO	Non-Government Organization
LKRFI	Lake Kariba Research Fisheries Institute
ZPWMA	Zimbabwe Park and Wildlife Management Authority
ZRA	Zambezi River Authority
VPA	Virtual Population Analysis
WG	Working Group

1. Background

For several years, the FAO has been supporting a joint process of fisheries management between Zimbabwe and Zambia on Lake Kariba. In this context, regular technical consultation meetings have been held between the two riparian countries. In addition, a Technical Committee for Fishery Management, created under Article 3 of the Economic and Technical Cooperation Protocol between Zimbabwe and Zambia concerning the management and development of fisheries resources on Lake Kariba and the transboundary waters of the Zambezi River, was set up in October 2012.

During recent consultation meetings between the two riparian countries, the development of a bioeconomic modelling of the Kapenta Fishery was recommended. This bioeconomic modelling exercise will be developed through a process involving the various public and private stakeholders of this fishery. The main objective of this bioeconomic modelling will be to examine some distinct scenarios regarding fishing effort allocation and to provide advice on the optimum number of rigs that should be licensed in Zambia and Zimbabwe. It will be also an opportunity for the various stakeholders to discuss general issues concerning the management of this fishery.

As part of this process, an initial field mission was held from 12 to 23 November 2012 in both Zambia and Zimbabwe. This document is the report of this first field mission, which was carried out by Mr Lionel Kinadjian.

2. Mission details

2.1 Objectives

The main objective of this first mission was to meet the key stakeholders (public and private sector) involved in the Kapenta Fishery in order to:

- inform them about the bioeconomic assessment exercise that will be carried out on the Kapenta fisheries;
- underline the importance of their collaboration, in particular the provision of reliable data to fit the model;
- find out more about the Kapenta Fishery and its current situation from their point of view;
- gather key documents and information which will be necessary for the bioeconomic modelling;
- assess the quality of information requested for the bioeconomic modelling and identify any gaps;
- draft the Terms of Reference for National Consultants who will be responsible for the collection of additional information after the mission.

2.2 Itinerary

International travel

- 12 November 2012: Montpellier – Paris
- 12 November 2012: Paris - Dubai
- 13 November 2012: Dubai - Harare (via Lusaka)
- 23 November 2012: Harare – Dubai (via Lusaka)
- 24 November 2012: Dubai – Paris
- 24 November 2012: Paris – Montpellier

Field mission

Conditions for the mission, in terms of logistics and security, were very good. The mission was undertaken in the company of Mr Newman Songore, a Fishery Officer at the FAO Sub regional Office for Southern Africa and Mr Tererai Makuvire, a driver.

I seized the opportunity to thank them for the effectiveness of their support and their friendliness. Furthermore, the field mission was carried out as initially planned and agreed with the Zimbabwean and Zambian authorities:

- 16 November: Harare – Kariba by car
- 18 November: Kariba – Siavonga by car
- 19 November: Siavonga – Chilanga/Lusaka by car
- 21 November: Chilanga/Lusaka – Harare by car

On arrival in Chilanga, the Zambian authorities expressed the wish that the mission also includes a visit to Sinazongue, where the Kapenta Fishery is well established and has some special features. Due to the remoteness of this area, time constraints and the administrative procedures necessary to change the itinerary, it was not possible to visit Sinazongue during the course of this mission. However, it was agreed that this area would be included in the National Consultants' field mission.

2.3 Persons met

The mission met with officials from institutions of the fishery management system both in Zimbabwe and Zambia namely: the Parks and Wildlife Management Authority (PWMA), the Lake Kariba Fisheries Research Institute (LKFRI) in Zimbabwe and the Department of Fisheries (DOF) in Zambia.

The mission also met with the Chairpersons of the Kapenta harvester organizations in both countries: the Kapenta Producers Association (KPA [1]) and the Indigenous Kapenta Producers Association (IKPA[2]) in Zimbabwe and the Kapenta Fishers Association (KFA[3]) in Zambia.

[1] Twenty-one companies are members of the KPA (originally there were 27 members but some companies closed down)
[2] The IKPA consists of 17 members, mainly cooperatives

Meetings were also organized with Kapenta harvesters, affiliated and/or non-affiliated to these organizations.

The mission also had the opportunity to meet two economists, Mr. Kefasi Nyikahadzoi, (Senior Lecturer, Economist, Centre for Applied Social Sciences) in Zimbabwe and Mr Charles Mwula, (Principal Planner, Economist, Ministry of Agriculture and Livestock) in Zambia who have been assigned as focal points by their respective countries to support the bioeconomic modelling process. These economists have been identified as potential consultants for the collection of additional information as part of future missions (see 5.2.1. Terms of Reference for National Consultants).

A complete list of all persons met can be found in Annex A.

The mission would like to thank all the people in Zimbabwe and Zambia who gave up their time to provide information, which led to a thorough understanding of the realities of the Kapenta Fishery in a relatively short period of time.

2.4 Documents collected

A list of the necessary information and data for the bioeconomic modelling performance had been prepared before the mission (Annex B). This list was transmitted to the stakeholders prior to the mission.

Key documents for the bioeconomic modelling were collected during the mission (or just after). A complete list of these documents can be found in Annex C. These key documents and the references indicated in this present report will form the basis of bibliographical references for the modelling exercise.

The mission also collected other data for the bioeconomic modelling process. Data collected are presented and analysed in section four.

3. Overview and recent trends of the Kapenta Fishery in Zimbabwe and Zambia

3.1 Catches, fishing effort and catch per unit of effort

Discussions with private operators in Kariba and Siavonga indicated a decrease in catches, over the last 5 years. The catch per unit of effort (CPUE) has seen a decline of 35 to 50 percent since 2005.

All operators mentioned that 2012 has been a very bad year (for all stakeholders - old/new - in both countries).

[3] Twenty-two members were registered in 1990; nowadays the number of member companies stands at around 31. A total of 151 companies operating under the Kapenta Fishery are registered in Zambia (frame survey, 2011).

During the mission (mid-November 2012), the CPUE in Zimbabwe was approximately 50 kg/night/boat and the yield in Zambia was about 30 – 35 kg/night/boat. Apparently there is a difference in yield of about 30 to 40 percent between Zimbabwean and Zambian rigs.

These figures do not appear to be consistent with statistical trends on the CPUE of recent years. In fact, according to the national statistics, yields from rigs in Zambia should be higher than those in Zimbabwe. Further basin analysis needs to be carried out by the National Consultants on this issue.

Another observation is the dramatic increase of nominal fishing effort mainly due to the appearance of new players in the fishery over these last 5 years (increased number of registered and licensed boats). 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)).

Private operators indicated that a rig operates between 21 to 26 nights per month (i.e. between 252 and 312 nights per year). This figure is consistent with the information in previous Kapenta Fishery studies. The fishing effort was 240 nights fished per year in 1992 (bioeconomic workshop, 1992) and 236 nights per year in 1997 (bioeconomic working group, 1997). However, there are a number of rigs that only operate occasionally due to management issues (insufficient cash flow) and/or low catch levels.

It is worth noting that there are a lot of other parameters that should also be taken into consideration in order to properly assess fishing effort such as those that help detect fish (boat and engine characteristics, fish finding devices...) and catch them (number of bulbs used to attract fish, size of the lift net, number of fishing operations per night...). For more detailed information on the evaluation of increased effective fishing power due to technological development, see the work of Chifamba, 1991.

3.2 Harvesting system

In the Kariba and Siavonga areas, fleet characteristics and fishing techniques are, for the most part, homogenous. The harvesting system consists of rigs operating with dip net (see photos in Annex D). The main factors that can have an effect on the efficiency of fishing operations and their costs are:

- concentration and type of fishing rigs/companies and type of landing site;
- the size of the crew per rig (usually 2 crew in Zimbabwe versus 3 to 4 crew in Zambia);
- type of remuneration (mainly incentives in Zimbabwe and fixed salary + incentive in Zambia);
- the level of investment in the fishing boat (including engine). It appears that new players invest in the cheapest rigs and engines (less powerful);

- mechanization (hydraulic winch for the dip net versus manual);
- number of bulbs to attract fish;
- specific equipment to detect fish.

These factors need to be verified for the other main fishing areas in the lake both in Zambia and Zimbabwe.

3.3 Management system

The management system in both countries mainly consists of:

- A fishing licence system to regulate access to the fishery. Licences are allocated to fishing companies to operate a limited number of rigs. Licence fees are paid annually by the fishing companies when licenses are issued;
- Various conservation measures related to prohibited fishing areas (shallow waters to protect breeding grounds or close to holiday resorts); as well as the minimum net mesh size (net mesh size should not be less than 8 mm when stretched);
- Monitoring of catch and effort: data collection with regards to the Kapenta Fishery is carried out with the collaboration of the Kapenta operators. In fact, licence holders are required to submit monthly catch and effort returns to the respective management authorities in Zimbabwe and Zambia.

3.3.1 Access: a quasi-open access system

Although there is a licensing system in place, it appears nowadays that the Kapenta Fishery operates as a quasi-open access system.

- There has been a drastic increase in fishing capacities over the past 5 years. Figure 1. below shows the trend in fishing capacities of the Kapenta Fishery since the early 1980's (number of rigs registered by the fisheries management authorities). In the 1990's the number of registered rigs remained stable, between 400 and 600, however, nowadays, the number of officially registered rigs totals over 1,000.

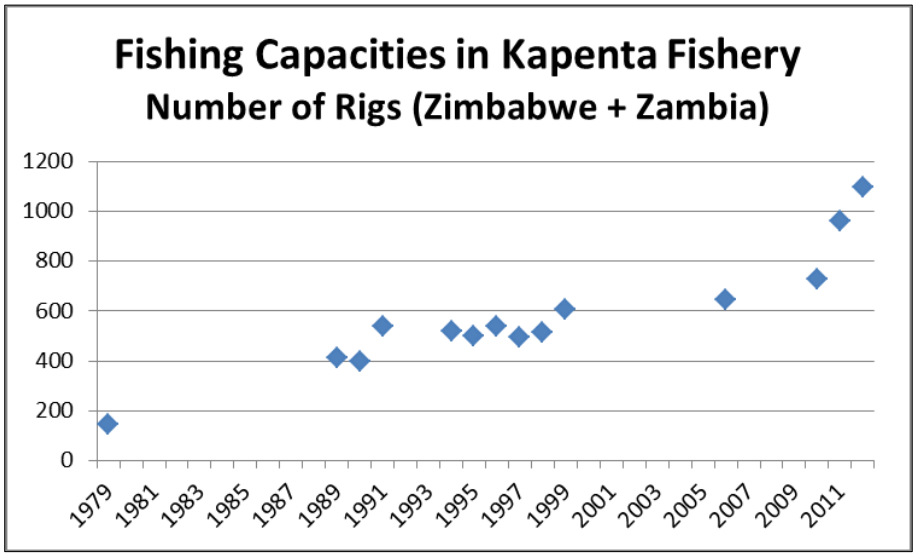
  In addition, an unknown number of unregistered, unlicensed rigs are operating in the fishery (frame surveys, 2010). It should be noted that operating with a distinct lack of security and exclusivity encourages greater exploitation of resources by private operators.

- Previously, licence fees for access to the fishery were very low compared to the wealth of the resource (Kapenta). As a result, it has not been possible to limit overcapitalization in the Kapenta Fishery (rent extraction), or to ensure an appropriate/equitable share of the fishery's wealth between the public and private sectors (in particular to cover fishery management costs).

The Kapenta Fishery management system has therefore remained weak with little regard for enforcement of regulations.

- Furthermore, economic competition for resources that are becoming more and more rare does not facilitate compliance with regulations either. Private operators mention poor compliance prohibited fishing regulations in breeding areas; as well as the respect of mesh size (frame survey, Mwera and Mugwagwa, 2010). Such practices could also contribute to improper harvesting of the resource (e.g. growth of overfishing) and substantial economic impacts.

Figure 1: Evolution of fishing capacities (number of rigs) in the Kapenta Fishery



Sources: Economic Assessment (Palferman A. & Lovland J.,1992), Bioeconomic WG Report 1997, FAO Technical Consultation Meeting Reports

3.3.2 Monitoring, control and surveillance: poor enforcement and significant illegal, unreported and unregulated fishing

Due to the size of the Kapenta Fishery, which stretches across the entire lake (300 km long over an area of 5,300 km^2) and the managing body's lack of human, technical and financial means, monitoring, control and surveillance operations are difficult to implement effectively. Consequently this leads to:

- Illegal fishing in the Fishery by non-registered rigs;
- Lack of compliance with technical management measures (mainly zoning and net mesh size);
- Poor compliance with regard to the submission of monthly catch returns by the industry;
- Illegal trading on the lake at night. The private operators encountered indicated that boat crews sell part of their catch during the night.

- These operators estimate that at least 50 percent of their boats' catch is sold illegally on the lake at night, either to other rigs or to operators in small dug-out canoes that come out specifically to buy Kapenta on the lake at night. These canoes are equipped with 25 hp outboard motors (Picture 13, Annex D).

  It should be noted that this is not a recent phenomenon; this was already reported in the 1990's in the 2nd Working Group Assessment Report and in the Economic Assessment of the Kapenta Fishery. However, illegal sales of 50 percent represent a very large volume that does not appear in the catch declarations made by the industry. This could lead to a significant underestimate of the real volume of catches in the lake. It is necessary to explore this issue further in the context of economic surveys that will be carried out by National Consultants, or within the framework of any other work[4] on monitoring, control and surveillance systems for fishing activities on Lake Kariba.

Within this same context, some large operators in the Kapenta Fishery have developed their own strategy to fight against IUU fishing and illegal trading by providing their own boats to patrol and control their rigs; this obviously comes at a cost.

3.4 Rapid assessment of the Fishery's economic situation: several indicators show that the rent of the resource is rapidly disappearing

Several indicators show that rent of the resource is rapidly disappearing meaning that the Kapenta Fishery is over exploited from an economic point of view. These indicators are primarily:

- The quasi-open access system to the Kapenta Fishery over the few last years, consequently doubling the fishing capacities;
- The increase in IUU fishing (fishing in prohibited areas (breeding grounds), use of illegal net mesh size…). This reflects, among other things, greater competition on resources that are becoming increasingly scarce;
- A lack of means to pay for the licence fees in full (in both Zimbabwe and Zambia); arrangements are sometimes made for licence fees to be paid quarterly;
- Poor management of capital and difficulties even to repair the rigs when damaged (insufficient cash flow for some small-scale operators);
- Insufficient remuneration: it sometimes happens that remuneration for fishing activities is less than the opportunity cost of labour.

[4] The 2nd and 3rd Technical Consultation Meetings in 2004 and 2006 discussed the issue of IUU fishing and recommended the development of a Regional Plan of Action (RPOA-IUU) for Lake Kariba. It was also noted and recommended during these meeting that each member country (Zimbabwe and Zambia) need to develop a National Plan of Action (NPOA) for IUU.

Some operators mentioned that this happens when the catch is so poor that the wages of the fishing crew are below that of day labourers;

- Bankruptcy, closure or the withdrawal of some fishing companies;
- Rental opportunities: some operators prefer to rent out their fishing licence and rigs instead of fishing themselves. Rental costs are approximately US $500 to $800 per month. The last frame survey (2010) highlighted that 13 percent of rigs in Zimbabwe are rented. This gives an overall idea of the amount of rent that remains in the Kapenta Fishery.

At present (2012), not only the rent of the resource is disappearing, but also it is clear that most operators will not generate sufficient profits to ensure the sustainability of their business over the long term. The Kapenta Fishery is currently in a situation where potential wealth creation is largely mortgaged.

4. Data available for bioeconomic modelling and rapid quality assessment

Over the course of stakeholder meetings during the mission, it was emphasized that modelling would be a simplified representation of reality (situation of the Kapenta Fishery). It was also stressed that if the quality of input data is poor, the output (results) will never be useful or relevant for decision-making for whatever model is developed. Particular emphasis was placed on economic data that will be collected from the industry to feed the model.

4.1 Biological and environmental data

Kapenta was introduced in Lake Kariba in 1967 and was able to colonize the whole lake in a very short time from a very limited parental stock. The main scientific knowledge available concludes that the Kapenta stock is distributed equally between Zimbabwe and Zambia and is not limited by distance or depth.

The productivity of the Kapenta stock is primarily influenced by environmental factors. Additionally, it is recognized that the risk of recruitment overfishing is very low due to the bio ecological characteristics of Kapenta (a species with very high fecundity, rapid growth, a short lifespan, and the capacity to colonize the whole lake from a very limited parental stock).

4.1.1 Biological data

Several projects have supported fisheries management activities on Lake Kariba. Research work was conducted as part of these projects to estimate key biological parameters for stock assessment and modelling.

Key biological parameters include estimates of growth parameters (linear and weight) and mortality rates. Mortality rates have been estimated from the last biomass assessment that was conducted in 1994. Uncertainties however, still remain as to the estimation of total mortality (and thus natural mortality).

However, these parameters have not been updated since the last working group assessment of Kapenta in 1996. There is no regular monitoring of length frequencies in the fishery and no accurate data exists on the catches, size and age structure. Therefore it is not possible to estimate the recruitment rate through virtual population analysis (VPA). It was noted that work on size frequency is currently being undertaken at the Lake Kariba Research Fisheries Institute (LKFRI).

4.1.2 Environmental data

During the working groups held in 1992 and 1996, for the assessment of Kapenta, it was demonstrated that there are important links between environmental factors and CPUE. Recent research (Hill, T.; Mashonjowa, E.; Ndebele-Murisa, M.R., 2011) suggests that both climate (maximum temperature in particular) and nutrients, which are influenced by water levels, are the primary determinants of Lake Kariba's Kapenta production.

Indeed, all the private operators encountered recognized the influence of environmental factors on the fishery. Above all else, they all cited climatic factors as having a significant impact on the Kapenta Fishery.

The results from such analyses are important for bioeconomic evaluation and for the management of the fishery, which will have to take into account risk evaluation and the impact of abiotic factors on the productivity of the Kapenta stock.

The Zambezi River Authority (ZRA) regularly collects environmental data on the lake level, catchment inflows… The availability such data will be key in assessing the correlation between environmental factors and Kapenta productivity.

It might be useful to find a way to request the ZRA to kindly supply the time series of environmental parameters they collect. To this end, the Lake Kariba Fishery Research Institute could send an official request to the ZRA.

4.2 Fishing statistics (catches, effort and CPUE)

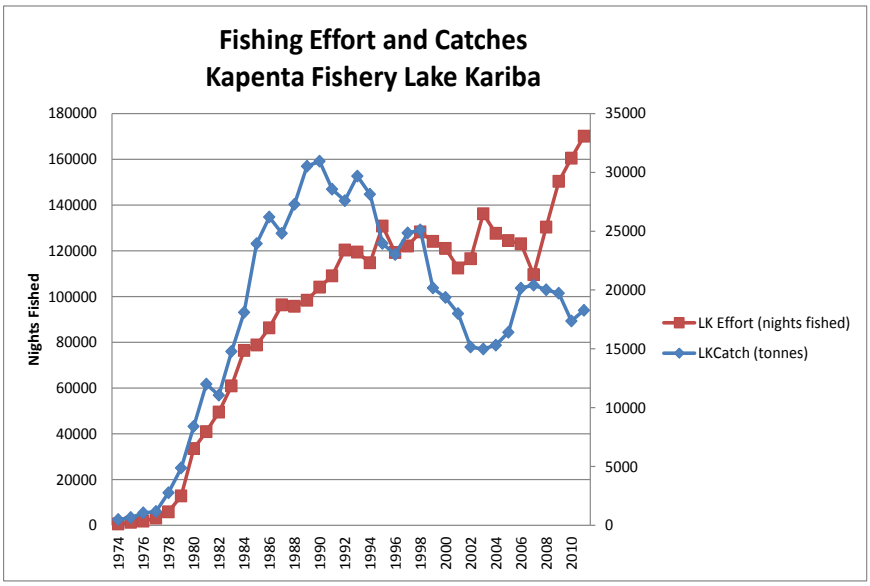
The Kapenta Fishery is subject to regular monitoring of the level of fishing effort and catches through voluntary declarations of fishing companies authorized to harvest. From the data of catch and effort (in nights fished), a cpue can be easily calculated. These CPUE can be considered as an index of abundance of Kapenta in the Lake.

The fishery started in 1974 in Zimbabwe and 1982 in Zambia.

The mission was able to collect the time series of catches, fishing effort and CPUE since the start of the fishery in both countries up until 2011. Figures 2 and 3 below show the evolution of total catches, fishing effort and the evolution of the CPUE in both countries.

Catches of Kapenta rose steadily with increasing fishing effort until the late 1980's. The maximum annual catch was observed in 1990 (31,000 MT).

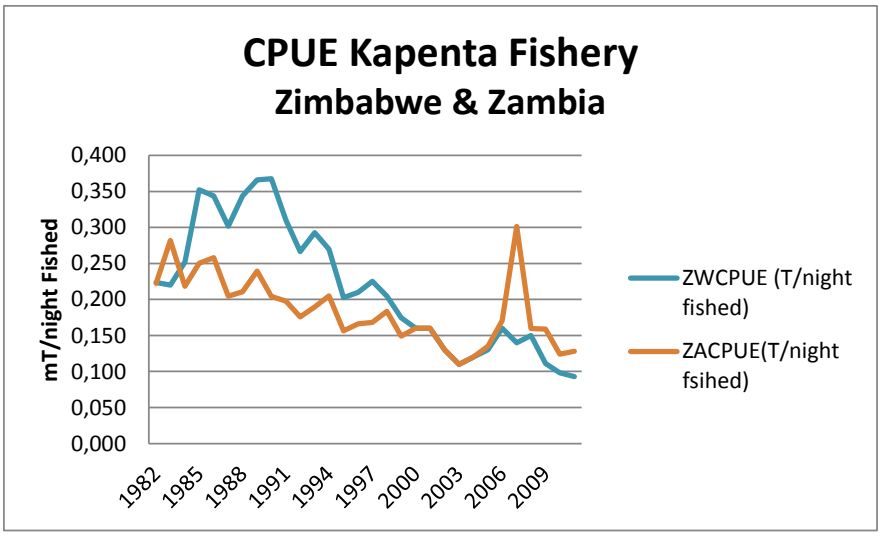
Figure 2: Evolution of fishing effort (nights fished) and catches (MT) of Kapenta Fishery.



The continued increase in fishing effort in the early 1990's was accompanied by a steady decline in production until early 2000. In 2003 production reached an all-time low of 15,000 MT (half that of 1990). The decline in fishing effort over the period 2003 to 2007 was simultaneously accompanied by an increase of the total catch. Since 2007, fishing effort increases on average by more than 10% per year and catches are once again declining.

Although abiotic factors are known to play a major role in the productivity of Kapenta stock, it also appears that fishing effort probably has an effect on the dynamic of the stock.

Figure 3: Evolution of Catches per Unit of Effort (CPUE) of Kapenta Fishery (Zimbabwe and Zambia)



At the beginning of the Kapenta Fishery, the yields of the Zimbabwean fleet were significantly higher than those of Zambia. However, the gap between the CPUE of the two fleets has gradually reduced over time.

In the early 2000s, the two fleets had exactly the same fishing yields. Since 2006 however the trend reversed, with the Zambian fleet having a higher CPUE than Zimbabwe. These trends will need to be discussed in more detail during the Bio Economic Working Group, particularly possible explanatory factors such as:

- biomass distribution in the lake;
- improved efficiency of the Zambian fleet;
- any other factors.

The issue of grossly underestimated catch quantities (main species and bycatches[5]) and fishing effort was also raised in discussions with Kapenta Fishery stakeholders. The main causes, as previously mentioned are:

- under-reporting of the fishing activities of registered and licensed vessels by fishing companies (an estimated 40 percent of companies in Zambia and 20 percent in Zimbabwe do not provide any statistical records);
- illegal catch sales on the lake at night which are not included in the catch estimates of registered companies;
- IUU fishing in both countries.

The National Consultants should try to estimate the order of magnitude of the total production of Kapenta caught from lake and compare this estimate with current reported catches.

If necessary, the statistical series of catches, fishing effort and CPUE will be corrected and approved by the working group to feed the model with data that is as consistent as possible.

4.3 Economic data

Most of the work on the Kapenta Fishery shows that this fishery is driven mainly by financial incentives, namely the profitability of fishing vessels operating in the fishery. However, despite the importance of the economic dimension of the management of this fishery, it seems that there is little economic data routinely collected on ex-vessel prices or regular monitoring of the costs of production and the profitability of fishing units.

[5] Based on discussions with stakeholders, it appears that Tigerfish, which are the main predators of Kapenta (along side human beings), are the main bycatch of the fishery. Currently, there are no detailed statistics on this issue, however, historical data indicates that at the beginning of the fishery in Zimbabwe in the mid 1970's, Tigerfish represented up to 10% of the total catch of rigs in the Kapenta Fishery.

Through discussions with private operators, it was possible to collect some economic data during the mission.

4.3.1 Prices

As ex-vessel prices are not regularly recorded, there are no official statistics for ex-vessel prices of Kapenta. The prices known correspond to dried Kapenta, which is 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.

Discussions with stakeholders highlighted price sensitivity based on the level of production and supply of Kapenta on the market. Price ranges given by stakeholders are presented in Table 1. below.

During periods of low production (as at the time of the field mission), the price of dried Kapenta in Zimbabwe (Kariba) is US $6.00/kg (i.e. about US $2.00/kg for fresh fish); in Zambia (Siavonga), the price is ZMK 42,500/kg for dried fish, or ZMK 14,200/kg (US $2.68) for fresh fish. These prices are roughly halved when Kapenta is highly abundant.

Table 1: Price ranges given by stakeholders in the Kapenta Fishery (2011/2012)

		Lowest price/kg	Highest price/kg
ZIMBABWE (Kariba)	Dried Kapenta	US $3.00	US $6.00
	Fresh Kapenta	US $1.00	US $2.00
ZAMBIA (Siavonga)	Dried Kapenta	ZMK 12,500 (US $2.40)	ZMK 50,000 (US $9.50)
	Fresh Kapenta	ZMK 4,200 (US $0.80)	ZMK 16,700 (US $3.15)

Exchange Rate US $1.00 = ZMK 5,280

The estimated average ex-vessel price for 2011 is about US $1.33/Kg in Zimbabwe (Kariba) and ZMK 8,300/kg (equivalent to US$1.57/kg) in Zambia (Siavonga).

Private operators also indicated that Kapenta bought illegally on the lake at night is usually sold at the lower price; this also probably affects market prices.

The economic survey that will be conducted by National Consultants will provide a better idea of price sensitivity over the last three years, especially for the main production areas in Zimbabwe (Basins) and Zambia (Stratum).

In the absence of detailed data on prices and knowledge of the main factors that determine demand (price of products, the price of product substitutes, consumer income and purchasing power, seasons, market...), it will not be possible to develop a detailed demand model in the bioeconomic model. However, a sensitivity analysis will be achieved by taking into account the different prices: minimum price, maximum price, average price, current price, import price of Kapenta from Cahora Bassa, etc.

This will enable the impact of price sensibility on the economic performance of the fishery and fishing companies to be assessed.

4.3.2 Costs

The main production costs revealed by stakeholders during the mission are the following:

Variable costs:

- Fuel and lubrication;
- Maintenance and repairs;
- Supplies;
- Crew wages;
- Taxes (import, property).

Fixed costs:

- Depreciation;
- Interest;
- Insurance;
- Administration salaries, administration supplies (management costs);
- Licence fees.

Investment costs:

- Boat/rigs including hull, engine (drive unit), generator for lighting, fishing equipment (dip net);
- Drying racks.

Fishing operators in the Kapenta Fishery only use rigs equipped with dip nets. Although harvesting operations seem quite homogeneous, some differences in costs can come from other factors, namely:

- The country where fishing is practiced: it seems that fishing in Zimbabwe is more mechanized (two man crew per rig with hydraulic winch to lift the gear) compared to Zambia (3-4 man crew per rig who haul in the fishing gear manually);
- Shore location within a given country: there are five basins on the Zimbabwean side and IV stratum on the Zambian side. The difference between fishing activities in remote areas compared to neighbouring the cities of Siavonga in Zambia and Kariba in Zimbabwe could have an impact on operating costs;
- Scale of activities: on one hand, there are operating costs which are shared according to the number of rigs owned by a fishing company, e.g. transportation costs on the lake for crews, fish and fuel.

On the other hand, a company that owns several rigs might have management costs that a small company with only a few rigs would not have. According to the industry, the scale effect starts with the ownership of four rigs;

- Power of the boat: the power of the engine has a significant impact on fuel consumption. Fuel consumption is one of the major costs of fishing operations. The trend seems to be to invest in smaller engines (one cylinder versus four cylinders).

One of the main objectives of the economic survey, which will be carried out by National Consultants, will be to estimate the above-mentioned production costs.

This will enable standard operating costs to be established alongside estimates of the average cost of fishing per night (unit of effort). Particular attention will be given to estimated costs for fuel and payroll, which probably represent the bulk of operating costs. The diversity of the above-mentioned situations will be taken into account in the sampling plan of the economic survey (See Annex E).

Discussions with stakeholders confirmed that there are currently no subsidies in the Kapenta Fishery.

4.3.3 Other economic data

Other economic data were collected during the mission: guaranteed minimum wage, interest rates, risk-free rate, depreciation rates, etc. These data will be validated with the National Consultants and some of the macro economic data (time series of exchange rate, inflation rate...) will be completed.

5. Conclusion and the way forward

5.1 Conclusion

This first mission was very helpful; it took place under very good conditions and allowed most of the stakeholders of the Kapenta Fishery to be met. Thanks to the rich discussions and information gathered, it has also allowed for a better understanding of the status of the fishery and its challenges.

It appears that the Kapenta Fishery is very important both for Zimbabwe and Zambia in terms of food security issues and local economic development (creation of employment, revenue and wealth). However, statistics show that the level of production in recent years is now an average of 36 percent lower than that of the late 1980s - early 1990s, the level of fishing capacities has increased by 100 percent over the same time interval. Moreover, a rapid assessment indicates that the fishery rent seems to disappear quite fast.

Analysis of the data available for bioeconomic modelling indicates that:

- In terms of the biological component of the model: it will be possible to use the Global Production Model (type Schaeffer, Fox...). Data that will be used for the biological component include the time series of fishing effort, catches, and CPUE. If necessary, these data will be corrected and validated by the Working Group. An important assumption of these models is that the stock dynamic is mainly driven by fishing mortality (fishing affects biomass in proportion to the effort expended). However, previous biological work and stock assessment on Kapenta showed that abiotic factors also influenced the productivity of the stock. If data on the environmental factors that potentially affect stock productivity are available, it will be possible to develop a Global Production Model in order to test the effects of the environment. These models will allow us to estimate some management targets (e.g. the Maximum Sustainable Yield (MSY)) and to also determine various production levels at equilibrium according to different levels of fishing effort. These production levels will be then used to estimate the Kapenta Fishery's revenue (turnover).
- In terms of the economic component of the model: this will be a simple input-output microeconomic model. The prices of Kapenta will be used to calculate the value of the catch (fishery turnover). Different prices could be entered in the model to carry out a sensitivity analysis (e.g. minimum price, maximum price, average price, current price, import price of Kapenta from Cahora Bassa...). The average cost per rig, per night of fishing, will be estimated from the data collected through the economic survey. The main outputs will be the estimate of value added and rent of the fishery (and per rig). Other outputs could be developed if required (employment estimates, estimated value of fishing rights...).

The model will be developed in an Excel file in order to facilitate use and enable further changes and improvements if necessary.

5.2 The way forward

5.2.1 National Consultants: Terms of Reference

This first field mission allowed some information that will be needed for bioeconomic modelling to be collected and identified gaps.

In order to collect additional useful information after this mission, it is proposed that two consultants, experienced in fisheries economics, be recruited to lead economic field surveys in Zambia and Zimbabwe.

Two people, assigned by their respective countries as focal points for economic issues were met during the mission and were identified as potential consultants:

- Mr. Kefasi Nyikahadzoi, Senior Lecturer, Economist, Centre of Applied Social Sciences, University of Zimbabwe (CASS), in Zimbabwe (knyaka@gmail.com). As a scholar, Mr. Nyikahadzoi has already carried out economic studies on the Kapenta Fishery in the past. He is experienced in investigative fieldwork particularly in this fishery and knows the major stakeholders, namely the fishing companies. Finally, Mr. Nyikahadzoi also participated in the last bioeconomic Working Group, which was held in 1997 in Zambia.
- Mr. Charles Mwula, Principal Planner, Economist at the Ministry of Agriculture and Livestock (MAL) in Zambia (Charles1963mvula@yahoo.com). Previously, Mr. Mwula was the Fishery Economist at the Department of Fisheries in Zambia. His current position as Principal Planner would no doubt be of assistance in advocating for a strengthening of the economic approach in fisheries management within the Ministry of Agriculture and Livestock.

When the two National Consultants are appointed, regular communication will take place by email or Skype in order to prepare the field survey (validation of the questionnaire) and to analyse the results. Within this framework, an Excel file will be designed to input the data from the economic survey and to provide a pre-analysis of the main results.

In order to facilitate access to information, the National Consultants should first make contact with the Chairpersons of Harvester Organizations in both countries and to ensure their full collaboration with this work (organizing meetings with producers, awareness of the importance of providing reliable data…). Mr. Newman Songore, Fishery Officer at the FAO Sub regional Office for Southern Africa, who participated in this first field mission, could also play an important role in supporting the work of the two consultants.

The results of this economic survey will be presented at the bioeconomic Working Group. The main data collected on prices and costs in the Kapenta Fishery will be used to feed the bioeconomic model that will be developed.

5.2.2 Bioeconomic Working Group

Appointments taken during the mission with the fishery management Authorities in Zambia and Zimbabwe, gave us the opportunity to discuss the design of the forthcoming Working Group on bioeconomic modelling of the Kapenta Fishery.

The objectives of the Working Group were discussed and agreed upon during the Fifth Technical Consultation Meeting (5TCM) held in Siavonga in September 2012 (see Report of Fifth TCM and Working Document SFS/DM/KARIBA/12/ 5, Bioeconomic analysis of the Lake Kariba Kapenta Fishery).

The agenda will include the following items:

- Introduction to bioeconomic modelling and methods;
- The Kapenta Fishery: current situation, a review of biological and economic data and their validation;
- Presentation of the bioeconomic model and development of the various scenarios of fishing effort allocation;
- Evaluation and discussion on results obtained;
- Recommendations and the way forward.

A provisional detailed agenda and a prospectus for the workshop will be prepared.

The workshop is planned for early 2013. A date needs to be fixed in accordance with the development of the work of the National Consultants.

The location for the workshop has not yet been decided; this has to be done in accordance with the practices followed by the two countries as part of the joint management process of the Lake Kariba Fishery.

The Working Group is expected to take place over one week. It is suggested that the workshop is split into two phases:

First phase (3 days): a Technical Committee Meeting with selected resource people. The mandate of this Committee will be to:

- discuss and validate the data and information on the Kapenta Fishery that will be used to run the bioeconomic model. Some additional data might need processing.
- fit and run the model in order to develop the different scenarios; if necessary, refine the model;
- discuss the results and provide recommendations.

Second phase (2 days): a Management Meeting where:

- the interest of bioeconomic modelling as a tool for fishery management will be presented (with specific focus on the Kapenta Fishery)
- the previous bioeconomic assessments of the Kapenta Fishery and the preliminary results of the current assessment and its potential uses for fisheries management will be presented and discussed.

Participants

The Technical Committee Meeting will involve technical staff and industry representatives (Professional Harvester Organizations). An indicative list is given below:

- LKRFI: 2 people (Officer in Charge, LKFRI + one other scientist);
- One person from the Zimbabwe Park and Wildlife Management Authority in Kariba;
- One Economist from the Centre of Applied Social Sciences University of Zimbabwe (CASS) designated as focal point and National Consultant (to be confirmed);
- The two professional Harvester Organizations (IKPA and KPA);
- One person from the Research Institute in Sinazongwe, DOF/MAL;
- One Statistician, DOF/MAL
- One Planner Economist, from the MAF designated as focal point and National Consultant (to be confirmed);
- One person from Siavonga DOF;
- The two professional Harvester Organizations (KFA and KAMIDA);
- One person in charge of information systems/statistics at the Zambezi River Authority (ZRA)[6];
- One resource person from Harvest Help (NGO), Zambia[7];
- FAO staff.

The Management Meeting will involve participants of the Technical Committee Meeting as well the fisheries managers and relevant decision makers concerned by the management of the fishery. An indicative list is given below:

- One person from ZPWMA Headquarters;
- The Director of the Department of Fisheries/MAL;
- Local authorities (Councils);
- Traditional leaders;
- The Ministry of Finance;
- The Lake Navigation Control, Zimbabwe;
- Ministry of Works (maritime), Zambia.

[6] The ZRA collects data and provides statistics on certain environmental parameters which potentially affect the productivity of the Kapenta resource. Thus, the ZRA is considered an important stakeholder in the support of the management process of the fishery. The participation of this institution at both the Technical Committee and Management Meetings is therefore important.

[7] This NGO was primarily established to help with the resettlement of migrant people after the flooding of the Gwembe Valley for the construction of the dam. Harvest Help has been increasingly active in the Kapenta Fishery; its experience and knowledge could be very useful for the Working Group.

The participation of the Ministries of Finance of both countries is important for several reasons. Firstly, it is widely recognized that the Kapenta Fishery is primarily driven by economic factors. Secondly, a rapid assessment suggests that this fishery has significant economic potential in terms of wealth creation if managed with such a vision. Finally, procedures in Zimbabwe are being put in place to increase the cost of licence fees in Kapenta Fishery, to cover some of the management costs. The Zimbabwean Ministry of Finance is directly involved in this process alongside the ZPWMA and stakeholders in the industry; the bioeconomic modelling could serve as a useful tool for decision-making support on such issues.

5.2.3 Other

During the coming weeks, communication will be maintained by Skype or email with Mr. Newman Songore, Fishery Officer at the FAO Sub regional Office for Southern Africa, Harare, for additional documents and pending data.

There will also be regular contact with Mr. Itai H. Tendaupenyu, the Officer in Charge and Senior Ecologist at LKFRI in Zimbabwe and Mr. Mweemba Chijoka, Fisheries Statistician, DOF/MAL in Zambia, to discuss any questions regarding the data required for modelling. This concerns, in particular, catch and effort data and CPUE, but also the needs for data on environmental factors that could be obtained from other institutions (e.g. Zambezi River Authority).

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Bioeconomic modelling

Report of the Sub regional Workshop on Fishery Bioeconomic modelling. RAF/87/099-TD/43/92 (En). 17-21 February 1992, Kariba, Zimbabwe, Benoît Horemans, Economist, IFP Project. IFIP Project, 1992.

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The Economic Development of the Kapenta Fishery, Lake Kariba (Zimbabwe/Zambia). Thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in International Fisheries Management. Norwegian College of Fishery Science University of Tromso. Loveness Madamombe, 2002.

Sustainability and Management of Lake Kariba, the Institute for Policy Studies (IPS). A report submitted to the Zambia National Farmers Union (ZNFU). Funded by KFA H. G. Mudenda, 2010.

Other documents on Lake Kariba Fishery

The Kapenta Fishery of Lake Kariba and its Contributions to Food Security in Zimbabwe (technical paper to be published by the FAO). Zimbabwe Parks and Wildlife Management Authority. Lake Kariba Fisheries Research Institute. Nobuhle Ndhlovu & Itai Hilary Tendaupenyu.

The Status and Management of the Lake Kariba Fisheries (Zambia and Zimbabwe) UNDP/FO Regional Project for Inland Fisheries and Planning (IFIP). Machena C, 1990.

Annex A. Lists of persons met

Zimbabwe

Name	Function	Institution	Date	Place	E-mail
Mr Aubrey Harris	Senior Fisheries Officer	FAO /SOSA	15 Nov. 2012	Harare, Zimbabwe	aubrey.harris@fao.org
Mr Newman Songore	Fisheries Officer	FAO / SOSA	15 Nov. 2012	Harare, Zimbabwe	newman.songore@fao.org
Dr H. Madzikanda	Chief Ecologist	ZPWMA	15 Nov. 2012	Harare, Zimbabwe	hmadzikanda@zimparks.co.zw
Mr Kefasi Nyikahadzoi	Senior Lecturer, Economist	CASS	15 Nov. 2012	Harare, Zimbabwe	knyaka@gmail.com
Mr Itai Hilary Tendaupenyu	Officer in charge Senior Ecologist	LKFRI	16 Nov. 2012	Kariba, Zimbabwe	itaihilary@yahoo.co.uk
Ms Nobuhle Ndhlovu	Senior Ecologist	LKFRI	17 Nov. 2012	Kariba, Zimbabwe	nobuhle07@yahoo.com
Dr Leopold AJ. Nagelkerke	Lecturer in fish biology and fisheries	Wageningen University	17 Nov. 2012	Kariba, Zimbabwe	leo.nagelkerke@wur.nl
Mr Nesbert Mapfumo	Chairperson KPA, and Director Mash Fishing Enterprises	KPA	17 Nov. 2012	Kariba, Zimbabwe	nmapfumo@zol.co.zw
Mr Cephos Shoniwa	Chairperson IKPA	IKPA	17 Nov. 2012	Kariba, Zimbabwe	
Mr Brighton Mackenzie	Kapenta Producer	Member of IKPA	17 Nov. 2012	Karia, Zimababwe	brightonmackenzie@gmail.com

Zambia

Name	Function	Institution	Date	Place	E-mail
Mr Patrick Ngalande	Director	MAL/DoF	20 Nov. 2012	Chilanga, Zambia	pngalande@yahoo.co.uk
Mr Mbamwai Mbewe	Principal Fisheries Research Officer/Data	MAL/DoF	19 Nov. 2012	Chilanga, Zambia	mbamwai@yahoo.com
Mr Charles Mwula	Principal Planner, Economist	MAL	20 Nov. 2012	Lusaka, Zambia	charles1963mvula@yahoo.com
Mr Mweemba Chijoka	Fisheries Statistician	MAL/DoF	19 Nov. 2012	Chilanga, Zambia	chijokam@gmail.com
Mr Ian Habulewbe	Fisheries Economist	MAL/DoF	20 Nov. 2012	Chilanga, Zambia	ianfish2011@yahoo.com
Mr Mebew Wamulume	Fisheries Officer	MAL/DoF	18 Nov. 2012	Siavonga, Zambia	mebewwamulume@yahoo.com
Mr Mainza K. Kalonga	Regional Officer SmartFish	C/o DoF		Chilanga, Zambia	mainza.kalonga@coi-ioc.org
Mr David John Dunn	Chairperson KFA, and Operations Director Siavonga Kapenta Industries Ltd	KFA	18 Nov. 2012	Siavonga, Zambia	daviddum267@gmail.com
Ms Gladys Pieterse	Kapenta Producer	Member of KFA	18 Nov. 2012	Siavonga, Zambia	thepieterses@gmail.com
Ms Yvonne Mutenta Vantra	Kapenta Producer	Member of KFA	19 Nov. 2012	Siavonga, Zambia	yvonnevantra@yahoo.com
Mr Edward Tembo	Kapenda Producer	Independent, Kwezit Fisheries Enterprise	19 Nov. 2012	Siavonga, Zambia	etembo16@gmail.com
Ms Dorothy Jere	Programme Officer	FAO Zambia	20 Nov. 2012	Lusaka, Zambia	dorothy.jere@fao.org

Annex B. List of minimum information required for the bioeconomic modelling of the Kapenta Fishery

Minimum data and information required for the theme: Biology and Production

- Catches (time series since the start of the fishery if possible) in both Zimbabwe and Zambia;
- CPUE (time series since the start of the fishery if possible) and catch composition by boat (main species and bycatch if any) in both Zimbabwe and Zambia;
- Fishing effort (time series since the beginning of the fishery if possible): number of registered and licensed rigs; fleet characteristics; number of nights fished both in Zimbabwe and Zambia;
- The largest time series of abundance indices (e.g. results of acoustic surveys);
- Parameters of linear growth (Von Bertalanffy) and weight gain. For the equation of linear growth: size range of the sample that was used to determine the equation of Von Bertalanffy and number of individuals used;
- Length frequencies of annual catches by fleet and year;
- Estimated mortality rates (Fishing Mortality and Natural Mortality);
- Biological modelling already undertaken in Kapenta Fishery as well as existing work on the bioeconomic modelling on this fishery;
- Time series of abiotic factors (rainfall patterns, lake levels, catchment inflow…).

Minimum data and information required for the theme: Economic Structural Analysis of the Fleets

- Prices and quantities (monthly time series), price per size (if different prices exist according to the size of the product) in both countries;
- The market, export and destination;
- Employment (total and by boat) in both countries and by nationality (national, expatriate);
- Fleet characteristics (description) including property of the boats, in both countries;
- Number of fishing nights per boat per annum in both countries;
- Remuneration system in the fishery in both countries (fixed salary or sharing system of the added value between fishermen and boat owners);
- Some anonymous (without the name of the company for confidentiality reasons) operating accounts of some Zimbabwean and Zambian boats over recent years (last three years);
- Estimation of production costs: (i) variable costs (fuel and lubrication, supplies, maintenance and repairs, crew wages, taxes (import tax, land property tax…), (ii) fixed costs (depreciation, interest, insurance, administration salaries, administration supplies, licence fees, other costs);
- Estimation of investment (boat, including engine, fishing equipment…);

- Minimum wage guarantee, interest rate, risk-free rate of return of capital, inflation rate, exchange rate (US $), etc.

Minimum data and information for the theme: Regulatory Systems, <u>in both countries</u>

- Description of the management system (political, institutional and legal frameworks);
- Review of technical conservation measures (fishing equipment, net mesh size, closing periods, prohibited areas…);
- Review of the fishing rights allocation system (licensing system) and amount of royalties paid for access;
- Subsidies (fuel, others…) if any;
- Royalties, taxes on profits (or income), licence fees paid for access, are licence fees used to support the management system? (e.g. control/surveillance, research, etc.).

Annex C. Key documents and information gathered during the mission

Policy, regulation, management

- Protocol on the economic and technical cooperation between the Government of the Republic of Zimbabwe and the Government of the Republic of Zambia concerning the management and development of fisheries on Lake Kariba and the transboundary waters of the Zambezi River;
- Zimbabwean and Zambian Fisheries policy documents (drafts);
- Fisheries regulations, Zimbabwe (Licence) and Zambia (Fisheries Act);
- Experiences in Research and Management of Shared Inland Fisheries Resources. Workshop proceedings 12 – 14 July 1999. Cutty Sark Hotel, Zimbabwe.

Biology and stock assessment

- A Comprehensive Analysis of Maximum Entropy and Analytical Models for Assessing Kapenta Stocks in Lake Kariba, Itai Hilary Tendaupenyu, Hee-Dong Pyo & Chang-ik Zhang (draft);
- Working Group on the Assessment of Kapenta in Lake Kariba. Zambia/Zimbabwe SADCC Fisheries Project Report N°41.

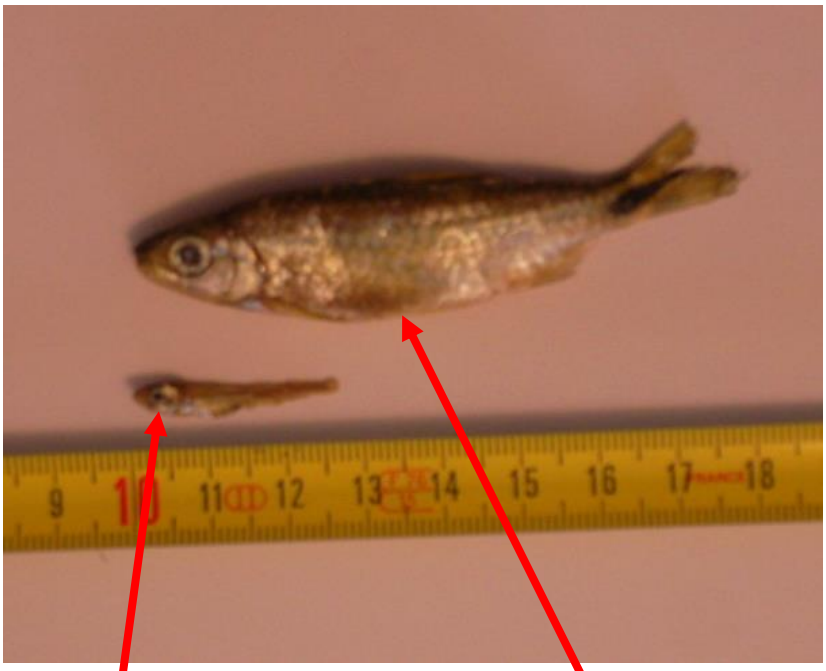
Economy and bioeconomic modelling

- 2008 Statistical and Economic Analysis of Kapenta Catches in Lake Kariba, Itai H. Tendaupenyu, LKRFI;
- Standardized operating account from KPA operators, prepared within the framework of the on-going process to revise licence fees, Zimbabwe, 2013;
- An Economic Assessment of the Lake Kariba Fishery in Zambia and Zimbabwe. Zambia/Zimbabwe SADCC Fisheries Project Report N°14. 1992. Andrew Palfreman & Jarle Lovland;
- Working Group on the Bioeconomic Assessment of Kapenta (*Limnothrissa miodon*) in Lake Kariba and Zimbabwe. Zambia/Zimbabwe SADCC Fisheries Project Report N°50. 11-19 July 1997, Kafu River Hotel;
- Sustainability and management of Lake Kariba. H. G. Mudenda, Institute for Policy Studies (IPS). A report submitted to the Zambia National Farmers Union (ZNFU), funded by KFA.

Annex D. Photos

Photo 1. Different sizes of Kapenta caught in the lake

2,5 cm or less **4 cm** **6 to 7 cm**



Dried Kapenta

Brycinus lateralis. A bycatch found in the sales of dried Kapenta. This fish is a predator that it is usually found in shallow areas of the lake. Finding it in catches proves that fishing took place in shallow areas (Newman Songore, 2012).

Photo 2. Different types of rigs; importance of number of bulbs as a parameter of fishing effort

A rig with five bulbs

A rig with four bulbs

A rig with three bulbs

Photo 3. Daily operational planning of rig activities - Mash Enterprise

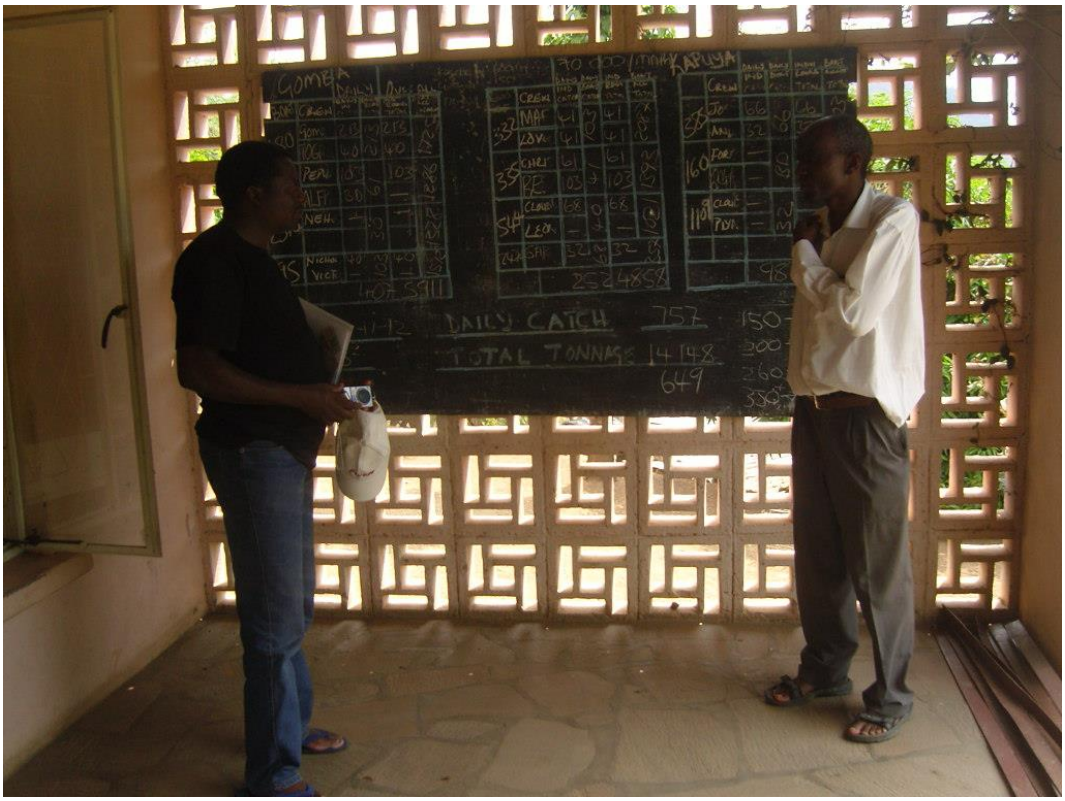


Photo 4. The dip net

Photo 5. Motorization of the rig and the winch

Photo 6. Landing of Kapenta in 20kg boxes

The number of boxes of Kapenta caught and salted per night, per fishing boat, has sharply declined in recent years from 17 boxes, to 11 boxes, and currently stands at 9 boxes per night per rig. During a mission (mid-November 2012), the yield in Zimbabwe was approximately 50 kg per night per boat and 30 to 35 kg per night per boat in Zambia.

Photo 7. Storage of dried Kapenta in 20kg bags

Wholesalers purchase dried Kapenta directly from harvesters at landing sites. Storage at the producer level is generally limited

It also happens that the Kapenta is weighed at the landing sites and purchased directly by the wholesaler who, then takes care of the drying process (picture below from a site in Zambia).

Photo 8. Maintenance of rigs and fishing equipment

Photo 9. Investment in a new rig

Photo 10. Investment in a boat to support (logistics, security) and control (illegal trading) rig activity

Photo 11. Drying racks for Kapenta and day labourers

Photo 12. Sale of Kapenta in the market on the shores of the lake

Photo 13. Small canoes ('banana boats') equipped with 25hp outboard motors; these boats are known to practice illegal trading on the lake at night.

Annex E. Guidelines/questionnaire for the economic survey

Main objective: establish standard operating costs for each segment of the fleet.

The main production costs to be estimated for one rig are the following:

Variable costs:

- Fuel and lubrication;
- Maintenance and repairs;
- Supplies;
- Crew wages
- Taxes (import, property).

Fixed costs:

- Depreciation;
- Interest;
- Insurance;
- Administration salaries, administration supplies (management costs);
- Licence fees;
- Other costs.

Investment cost:

- Boat/rigs including hull, engine (drive unit), generator for lighting, fishing equipment (dip net);
- Drying racks;
- Other costs.

Fishing operators in Kapenta Fishery only use rigs equipped with dip nets. Although harvesting operations seem quite homogeneous, differences in costs can come from other factors:

1. The country where fishing is practiced: it seems that fishing in Zimbabwe is more mechanized (two man crew per rig with hydraulic winch to lift the gear) compared to Zambia (3-4 man crew per rig who haul in the fishing gear manually);
2. Shore location within a given country: there are five basins on the Zimbabwean side and IV stratum on the Zambian side. The difference between fishing activities in remote areas compared to neighbouring the cities of Siavonga in Zambia and Kariba in Zimbabwe could have an impact on operating costs;

3. Scale of activities: on one hand, there are operating costs which are shared according to the number of rigs owned by a fishing company, e.g. transportation costs on the lake for crews, fish and fuel. On the other hand, a company that owns several rigs might have management costs that a small company with only a few rigs would not have. According to the industry, the scale effect starts with the ownership of four rigs;

Proposed sampling plan

Zimbabwe:

Basins 1, 2, 3 and 4.

From within each basin:

- two companies with less than four rigs and;
- two companies with more than four rigs.

Total: 16 companies

Zambia:

Statum I:	three companies with less than four rigs and three companies with more than four rigs
Stratum II (Sianazonwe):	four companies with less than four rigs and four companies with more than four rigs
Stratum III (Chipepo):	two companies with less than four rigs and two companies with more than four rigs
Stratum IV (Siavonga):	two companies with less than four rigs and two companies with more than four rigs

Total: 22 companies

Questionnaire

Country: ZIMBABWE: ☐ ZAMBIE: ☐ Date of visit: _____

Name of company _____ Contact person _____

How long have you been working in the Kapenta fishery (months or years) _____

How many rigs do you currently own? _____(1)

Do you own a landing and processing site: YES: ☐ NO: ☐

What are the key events that have affected the Kapenta Fishery? (Please indicate the type of event and date)

1. _____date _____
2. _____date _____
3. _____date _____
4. _____date _____

How long have illegal sales during night fishing been going on?

_____

Average volume of Kapenta **wet fish kg** caught/rig/year (over the last 3 years: **2009-2010-2011**): 2009:_____ 2010:_____ 2011:_____

Average catch of Kapenta **wet fish kg** caught/rig/per night (over the last 3 years: **2009-2010-2011**):

2009:_____2010:_____ 2011:_____

What are the main species of bycatch in the Kapenta Fishery? _____

_____

What is the average volume of bycatch **kg** caught/rig/night? _____

Is the bycatch:	kept and sold by the crew	☐
	Kept by the crew but not sold	☐
	kept and sold by the company	☐
	discarded alive	☐
	discarded dead	☐
	do not know	☐

What is the average price/**kg** of the main species caught as a bycatch: _____

Average sales of Kapenta **dried fish kg**/year (over the last 3 years **2009-2010-2011**):

2009:_____ 2010:_____ 2011:_____

Average price of Kapenta over the last 3 years **2009-2010-2011** (**value per kg** - dried fish): **2009:** _____ **2010:** _____**2011:**_____

VARIABLE COSTS

Fuel & lubrication

Price of fuel/litre: _____

Average fuel consumption, **litres**/rig/night for fishing operations: _____

Average fuel consumption, **litres**/rig/night for lighting: _____

Average oil consumption/rig/month (litres):

OR average oil consumption for all rigs (litres): _____

Price of oil/**litre:** _____

Maintenance and repairs

What are the main **recurrent maintenance and repairs** to be done per rig?

Main issues (e.g. paintwork, engine overhaul, oil change, change bulbs, maintenance of fishing equipment…)	Frequency (e.g. every month, every year…)	Unit cost of specific maintenance and repairs
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Has there been a change in the frequency of recurrent maintenance and repairs operations during the past 5 years: YES ☐ NO: ☐ If yes, Why?

_____

What are the main regular supplies (other than fuel and oil) purchased for fishing and processing activities?

Description (e.g. salt, bulb, fishing gear, etc.)	Unit (Kg, Nb, etc.)	Frequency (e.g. every month, every year…)	Cost per unit
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Wages

Number of fishermen per rig: _____

Crew wages:

a) Fixed salary/month: YES: ☐ NO: ☐

If yes, what is the amount/month for the:

Captain: _____

Fishermen: _____

b) Incentives (e.g. payment related to catch): YES: ☐ NO: ☐

If yes, what is the incentive (e.g. amount paid per kg of wet fish caught) for the:

Captain: _____

Fishermen: _____

c) Bonuses (e.g. amount paid related to catch objectives/month):

Captain: _____

Fishermen: _____

d) Other (please specify):

_____

e) Insurance:

Is there any form of insurance (health, ...) paid for the crew YES: ☐ NO: ☐

If yes, please indicate the cost per person/year: _____

What is the current average salary of the captain/month: _____

What is the current average salary of a fisherman/month: _____

Are crew wages higher than the minimum wage guarantee: YES: ☐ NO: ☐

Crew experience:

More than 20 years ☐

5-20 years ☐

3-5 years ☐

1-3 years ☐

0 years of experience (mostly new crew each season) ☐

Daily labourers/processing workers' wages

There are no daily labourers, fish processing is done directly by the wholesaler who buys the production ☐

Number of daily labourers at the landing site for the whole company: _____ (2) and average per rig: _____ (2)/(1)

Do the wages of daily labourers include: a fixed amount ☐, incentives ☐, bonuses ☐,

other ☐, please specify: _____,

Is there any form of insurance (health,...) paid for the daily labourers? YES: ☐ NO: ☐

If yes, please indicate the cost per person**/year**: _____

What is the average salary of a daily labourer**/month**: _____

Are the wages of daily labourers higher than the minimum wage guarantee: YES: NO: ☐

Taxes - Taxes (import, property)

Import taxes YES: ☐ NO: ☐ If yes average amount per **year**: _____

Taxes for on-shore properties YES: ☐ NO: ☐ If yes, average amount per **year:** _____

Other taxes: please specify: _____Average amount per **year:** _____

FIXED COSTS

Investment costs

Description	Main specifications	Cost	Depreciation (Year)
Rig (hull)	Length		
Engine (drive unit)	Number of cylinders		
Generator	HP:		

Fishing equipment			
Drying racks			
Other			

Source of investment capital:

Personal ☐

Unsecured business loans from banks or venture capital ☐

Secured business loans from banks ☐

Loans from banks secured by personal (not business) assets ☐

Government subsidized private lending ☐

Government-run loan programmes ☐

International aid agencies ☐

Micro credit ☐

Family/community-based lending ☐

If you have a loan: could you please indicate the borrowing rate (%) on loans made for the fishery industry: _____

Loan repayment period (number of years): _____

Age of facilities/functionality of capital

Average age of the key durable harvesting capital unit

Harvesting capital unit	Quantity	**Average Age**
Rigs	(e.g. 3 rigs)	< 5 years
Rigs		5<Years<10 years
Rigs		10<Years<20 years
Rigs		> 20 years
Total		

What is the average number of nights fished per rig/month:_____

Insurance

Do you insure your assets? YES: ☐ NO: ☐

If yes, what is the cost of the insurance per rig per year? _____

Licence fees

Cost of licences fees: _____

Do you pay your license fees up front before the fishing season: YES: ☐ NO: ☐

If no, how many payments for the licence fees are made during the fishing season?

Management costs

Number of managers: _____ (3)

Number of managers/rig: _____ (1)/(3)

What is the average wage for a manager/month: _____

Number of secretaries: _____(4)

Number of secretaries/rig: _____(1)/(4)

What is the average wage for a secretary/month: _____

Estimated amount for other management costs/month (office rent, telephone, office supplies, other…): _____

OTHER INFORMATION

Do you rent out some of your rigs? YES: ☐ NO: ☐

If yes, how many: _____ How long have you been doing this for? _____

What is the average rent/month? _____

As an investor, what was (is) the expected return on the capital invested in the fishery (rate of profitability of invested capital in %): _____

SmartFish is a regional fisheries project managed by the Indian Ocean Commission, funded by the European Union and co-implemented by the Food and Agriculture Organization of the United Nations. SmartFish, which operates in 20 countries throughout the East and Southern Africa - Indian Ocean region, focuses on fisheries governance, management, monitoring, control and surveillance, trade, and food security.

For several years, the FAO has been supporting a joint process of fisheries management between Zimbabwe and Zambia on Lake Kariba. Following various meetings between the two riparian countries, the development of a bioeconomic modelling of the Kapenta Fishery was recommended. This bioeconomic modelling will be developed through a participatory process that will involve various public and private stakeholders of this fishery.

This report documents the results of the first phase of a bioeconomic modelling exercise that will be carried out to examine distinct scenarios concerning fishing effort and to provide advice on the optimum number of fishing rigs that should be licensed in Zambia and Zimbabwe.

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