UNIVERSITY OF CAPE COAST

SOCIO-ECONOMIC AND BIOLOGICAL ASSESSMENT OF FISH TRANSHIPMENT (*SAIKO*) AT ELMINA, GHANA

JENNIFER ESHILLEY

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BY

JENNIFER ESHILLEY

Thesis submitted to the Department of Fisheries and Aquatic Sciences of the School of Biological Sciences, College of Agriculture and Natural Sciences, University of Cape Coast, in partial fulfillment of the requirements for the award of Master of Philosophy degree in Integrated Coastal Zone Management

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature …….. Date ……

Name: Jennifer Eshilley

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature: ..... Date: .....

Name: Prof. Denis W. Aheto

Co-Supervisor's Signature: ..... Date: .....

Name: Dr. Noble K. Asare

ABSTRACT

Fish transhipment has grown rapidly in recent years due to its lucrative nature in some coastal communities in Ghana. It is increasingly gaining grounds due to weak monitoring, regulatory enforcement and the profitability of the trade. However, it is prohibited under certain conditions in the Fisheries Act 625 Section 132 of Ghana. The aim of this research is to contribute to scientific knowledge for law enforcement on illegal, unregulated and unreported fishing practices with specific reference to *Saiko* in Elmina. The study sought to assess catch composition, growth parameters catch per unit effort, the economic viability of this business, and develop a market map of the *Saiko* trade. Twenty-four (24) fish slabs of approximately 11 Kg per slab were sampled for the biological assessment over a period of six (6) months from November, 2016-June 2017. Also, the study employed a descriptive survey design based on interviews, targeted at *Saiko* fishers and processors within the population. In all eighteen (18) *Saiko* fishers and forty-nine (49) fish processors engaged in the *Saiko* trade were interviewed following the snowball method. The study revealed that the small pelagics constituted 55% of the fish landings, the family Carangidae dominated the species landed with *Decapterus punctatus* (17%) and *Decapterus rhoncus (24%)* having the highest proportions. It was deduced that there is a positive correlation between quantities of fish landed and canoe size. It was observed that the trawlers not only encroach in the inshore zone but also landed juvenile pelagic species in the range of 3.0-26.0cm of which most were below the legal size limits for those species as stated by the Fisheries Act 625, 2002. It was concluded also that body weight highly correlated with standard length and all specimens studied, exhibited an isometric growth pattern. There was at least five members in a crew, who spent at least 12 hours at sea, use at least 76 gallons of fuel per trip and on average go to the sea two times per week. *Saiko* trade was a capital intensive enterprise but very profitable with fishers making GH□91,000.00 a year. It was established that Elmina is the hub of *Saiko* fishery. Again, *Saiko* fishes are traded mostly within the southern to middle part of Ghana and Wa was the only point of sale far from the coast. It was recommended that there should be efforts to engage more *Saiko* fishers in the research to help curtail the problem. Also efforts should be made to reduce legitimacy of the *Saiko* operations.

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DEDICATION

I dedicate this work to Mr Daniel Ebo Hagan.

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ABBREVIATIONS

BNI	Bureau of National Investigations
CBFMC	Community-Based Fisheries Management Committees
CCM	Centre for Coastal Management
CCRF	Code of Conduct for Responsible Fisheries
CRC	Coastal Resources Centre
DOF	Directorate of Fisheries
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
FC	Fisheries Commission
FEU	Fisheries Enforcement Unit
GCLME	Guinea Current Large Marine Ecosystems
GDP	Gross Domestic Product
GITA	Ghana Inshore Trawlers Association
GSS	Ghana Statistical Service
IMCS	International Monitoring, Control, and Surveillance
IPOA-IUU	International Plan of Action on Illegal, Unregulated and Undocumented Fisheries
IUU	Illegal, Unregulated and Unreported Fishing
KEEA	Komenda – Edina – Eguafo – Abrem
MCS	Monitoring, Control and Surveillance
MoFAD	Ministry of Fisheries and Aquaculture Development
MRAG	Marine Resource Assessment Group
OECD	Organization for Economic and Co-operation Development
UN	United Nations

UNCLOS	United Nations Convention on the Law of the Sea
US$/USD	United States Dollar

CHAPTER ONE

INTRODUCTION

Background of Study

Fish constitutes the major source of animal protein in Africa. It has the most balanced amino acid profile and its consumption cuts across cultural and religious barriers, hence the high demand for its consumption worldwide (Ogundiran et al.,2014). Twenty-one percent of global fish output is consumed by Africans who contribute the lowest to global fish output (FAO, 2013). The Ghanaian coastal waters, which is part of the Guinea Current Large Marine Ecosystems (GCLME), is endowed with abundant fishery resources (Mensah & Quaatey, 2002; Mehl et al., 2005). In Ghana, fishing and its related activities serves as a source of livelihoods for many coastal dwellers and also plays an important role in its socio-economic development (Atta-Mills et al., 2004; Nunoo et al., 2015). In terms of the overall contribution to the economy, the fisheries sector accounted for at least 4.5 percent of GDP in 2015 (Kucukvar et al., 2015). It is estimated that, the fisheries industry in Ghana generates about US$1 billion in revenue each year. In terms of foreign exchange from export of fish and fisheries products, the sector generates US$250 million to the Ghanaian economy. Additionally, the sector support's 135,000 fishers in the marine sub-sector and indirectly support the livelihoods of 2.6 million people or 10 percent of Ghanaian population (MoFAD, 2015; Nunoo et al., 2015).

Fish production in Ghana comes from two main sources: marine, which contributes 85 percent of the total fish landings whereas the inland also accounts for about 15 percent. The marine fishery sector is divided into three main

categories: industrial, semi-industrial, and artisanal or canoe fishery (Nunoo & Asiedu, 2013).

The artisanal fisheries also known as small scale marine fisheries offer an important source of food and income to coastal populations worldwide. Millions of people around the world find their source of income and livelihood in the fisheries and aquaculture sectors. Current estimates indicate that 56.6 million people were engaged in the primary sector of capture fisheries and aquaculture in 2014 (FAO, 2016). Though small scale fishing boats are individually able to catch fewer fish than their large-scale counterparts, small scale marine fisheries reportedly accounted for 40 percent of the marine fish used for human food (FAO, 1998). Unlike the large-scale industry, targeted at providing high-valued species (e.g. tuna) to the international market, artisanal fishers tend to supply local markets with lower-valued fish and invertebrate catches (King, 1991). Small scale fisheries products provide an important source of protein to people throughout the developing world (King, 1991; Nickerson-Tietze, 2000).

In Ghana, artisanal fleet consists of both motorized and non-motorized dugout canoes. According to Amador et al. (2006), the artisanal fleet consists of approximately 11,213 canoes and employs about 124,229 fishermen operating actively from over 300 landing sites located along the entire 550 km stretch of the coastline of Ghana. About 50 percent of these canoes are powered by outboard motors with engine power of up to 40 horse power (hp). The artisanal fleet accounts for 70-80 percent of the marine fish landings in Ghana (Mensah et al., 2006). This type of fishery is practiced in nearshore areas in the form of inshore canoe and beach seine fisheries (Aggrey-Fynn & Sackey-

Mensah, 2012). The small scale fisheries sector in Ghana typically comprises a wide variety of target species, gear types, landing areas, and marketing routes, making it almost impossible to collate reliable and comprehensive statistics for the bulk of fisheries (King & Lambeth, 2000).

The Food and Agriculture Organization's report on the State of World Fisheries and Aquaculture (2014), indicates that, the proportion of evaluated marine fish stocks fished within biologically sustainable levels exceeded 70 percent (71.2 percent) in 2011 (this figure was 90 percent in 1974), while 28.8 percent of fish stocks were overfished.

Ghana's rich coastal ecosystems have supported a massive increase in fish yields since the 1970s, yet there are strong signs that it is increasingly under stress. Prominent fish species have declined; most remarkably those high in the food web, as is often the case in heavily exploited systems (Pauly et al., 1998).

Overfishing in the world's oceans has reached catastrophic levels. Many major fish stocks are in decline. Some species are being pushed towards extinction. Illegal, Unregulated and Unreported fishing (IUU) is heavily implicated in overfishing.

Unregulated and Unreported Fishing or "pirate" fishing is a worldwide phenomenon with significant environmental, economic and social repercussions. The global losses due to IUU fishing alone are estimated to be between US$10 billion and US$23.5 billion per year with West African waters judged to have the highest levels of IUU fishing in the world and, signifying up to 37 percent of the region's catch (Agnew et al., 2009). By exhausting fish stocks, IUU fishing severely compromises the food security and livelihoods of coastal communities and is also a danger to marine biodiversity and the marine

environment. The lack of accurate data makes it more difficult to trail progress in the control and management of IUU fishing and to even determine how much of the fish traded internationally is derived from IUU fishing.

Problem Statement and Justification

Ghana has a long tradition of an active fishing industry that has made giant strides over the years, developing from a principally traditional canoe fleet to a mix of traditional and modern fleet, including industrial trawlers (Koranteng, 2004). Conversely, the sector is faced with the challenge of declining fisheries resources culminating from weak governance that has tolerated wasteful over-capacity, conflicts and pervasive unsustainable and harmful fishing practices among others. Some fishermen have adopted the use of unsustainable fishing methods including but not limited to light fishing, Carbide, Cyanide, Dynamite fishing, use of insecticides and other obnoxious substances (Coastal Resources Centre, 2013; MoFAD, 2015). According to the CRC (2013) report, the situation has led to significant decreases in capture fisheries notably the dwindling of *Sardinella* species. Thus, IUU fishing is now an issue of concern currently attracting considerable attention in Ghana's fisheries management arena and it is recognised that significant amounts of catches both in terms of small and large-scale fisheries are not reported and hence do not appear in official statistics (Finegold et al., 2010). It is also increasingly recognised that, the open access fisheries i.e. unregulated fisheries with no entry restrictions in Ghana had already led to overfishing. IUU fishing is often related with a large quantity of by-catch as fishers do not comply with regulations, chiefly the use of small mesh size. Transhipping of fish which is forbidden in some West African countries, including Senegal, Cote d'Ivoire and

Guinea. It is authorized in Ghana under a special approval and can only take place in port under the supervision of an agent of the Fisheries Commission. In recent years, a new form of transhipment has developed between industrial vessels and the artisanal canoes, with the canoes buying frozen by-catch from trawlers at sea. Though it is deemed illegal and prohibited under the Fisheries Act 625 of 2002 (Section 132), the business has grown exponentially due to its lucrative nature in many coastal communities of Ghana. This practice which is known as '*Saiko*' fishing is widely practiced in some landing sites in the Central, Western and Greater Accra Regions.

As one by-catch collector puts it, "with *Saiko*, harvest is always assured". The problem of *Saiko* is compounded by overfishing, poor public education, greed and weak fisheries law enforcement mechanisms (Hɛ n Mpoano, 2015a).

IUU fishing violates conservation and management measures currently in place in many developing countries of which Ghana is not an exception. It is recognized as a serious threat to sustainability of capture fisheries due to its damaging impact on the ecology of the oceans and economy of fishing nations. As suggested by FAO (2007), this situation does not allow conventional centralised fisheries management frameworks to produce the desired outcomes relative to sustainability.

Developing countries are particularly vulnerable to IUU fishing. In West Africa, for example, IUU fishing accounts for 40 percent of fish caught, posing serious environmental, social, and economic challenges to countries and communities that rely on fish for food, employment and revenues. (Seto et al., 2017).

Nunoo and Evans (1997) and Nunoo (1998), observed discarding of catch by industrial shrimpers in the coastal waters of Ghana. Discards were in large quantity, with varying number of species relative to targeted species. Much of the composition of the discards were juveniles, and those that cannot be sold because they are not considered fit for human consumption or a delicacy or had been disfigured through poor handling, had no market value (this fish is termed trash fish). In Nigeria, the supposed trash fish of commercial operators are collected by government selected 'collector vessels' for sale in the markets. Likewise, discards are not considered to be trash fish in Ghana but handled in a different way from that in Nigeria. Trash fish is converted into a tradable product, which generates revenue to operators of industrial trawlers, pair trawlers, shrimpers, inshore vessels and artisanal fishers operating in Ghana's waters (Nunoo, 2009).

In Ghana, the trash fish business is centred predominantly in four fish landing beaches, namely, Elmina, Apam, Tema and Axim, in order of importance. It has become the preferred trade among fishers in these towns and their environs since it is observed to be more lucrative than the 'seek and capture' fishing done by artisanal fishers. Industrial trawl vessels fishing in the high seas transfer catches that are not targeted to small canoes at sea for a fee or barter for subsequent onward sale on land. This trade among operators of large vessels and artisanal fishers, at least, avoids wastage of fish by-catch. Fish is made much more available to help improve the food security and nutritional status of the people, especially those in inland areas. However, there is the concern that if the trash fish trade continues, Ghana's long-standing traditional fishing vocation, where it is ranked among the best in West Africa (Atta-Mills

et al., 2004a) may be lost. Also the non-target fish would become target fish because of increase in demand. Therefore, there is the need for such a study to be conducted since it will provide in-depth information on the state of our fish stocks as against the illegal fishing activities: thus, landings of the *Saiko* vessels, the valuation of gains of *Saiko* operators in order to address the poverty situation in fishing communities as well as open up an opportunity for the sustainability of coastal fisheries in general (Marquette et al., 2002).

Aim of the Study

The aim of this research is to contribute to knowledge on illegal, unregulated and unreported fishing practices among selected fishermen of Ghana by assessing the socio-economic and biological implications of fish transhipment practices.

The specific objectives of this study were to:

i. assess catch composition of common fish landed by the *Saiko* canoes,
ii. assess growth parameters of common fish landed by the *Saiko* canoes,
iii. examine catch per unit effort by the *Saiko* canoes,
iv. assess the profitability of the *Saiko* trade, and
v. develop a market map of the *Saiko* trade within the sub-region.

Delimitation of the study

This study focused on only Elmina *Saiko* landing site and gives a snapshot of the activities of the *Saiko* fishery in Elmina. The study also assessed quantities of fish landed and catches composition of fish landed by the *Saiko* canoes, the profitability of the *Saiko* trade, and development of a market map of the *Saiko* trade within the sub-region.

Limitations of the Study

All research work has peculiar challenges and this study is no exception. The challenges faced during the study included hostility and lack of cooperation by some of the respondents who regarded the researcher as an outsider and undesirable intruder. They attributed this to the problems they always encounter with the marine police in their bid to enforce the law. Non-cooperation was also encountered with by-catch association leaders who sought to protect their information. Some respondents failed to disclose information with the fear of being reported to media houses and the Bureau of National Investigations (BNI).

Definition of Key Terms

This section provides the operational definition of terms as used in this study.

Saiko: *Saiko* fishing is an illegal fishing practice where packaged frozen fish is transferred from trawlers to artisanal canoes at sea and brought ashore for sale to buyers who wait on standby.

Hustlers: Hustlers are versatile persons who help loading and offloading fish slabs fish at the landing site. Their characteristic feature is that they always carry screw drivers on them

Enterprise budget: An enterprise budget is a listing of all estimated income and expenses associated with a specific enterprise to provide an estimate of its profitability.

Processors: These are people are directly engaged in processing the *Saiko* before its get to the consumers.

Fishers: Fishermen who go directly go to sea to buy the *Saiko* Fish from the Trawlers.

Organisation of the Study

This thesis is organized into six main chapters. Chapter one comprises the background to the study, the statement of the problem, the purpose of the study, significance of the study, the delimitation and limitations of the study, and the definition of key terms as used in the study. Chapter two is made up of a review of relevant literature including the marine fishery sector of Ghana, artisanal fisheries, inshore or semi-industrial fisheries, industrial fisheries, fisheries management in Ghana, economic underperformance of fisheries, decline of fish stocks and damage to the marine environment, illegal unregulated unreported (IUU) fishing, drivers and factors influencing IUU fishing, by-catch and discards, the reasons for discards and the problems of by-catch and discards. Chapter three presents the research methodology which includes the study areas, research design, population, sample and sampling techniques, research instruments used, pilot study to pre-test the instruments, data collection and analysis procedures. Chapter four and five presents the results and discussion of the analysed data respectively based on the specific objectives of the study. Finally, chapter six provides summary, conclusions and the recommendations based on the findings of the study.

Chapter Summary

The chapter was an introduction to the thesis which focused on the background to the study, stated the problem, and outlined the objectives that guided the research. It also stated the significance, limitations and delimitations of the study, and showed the outline or organisation of the study.

CHAPTER TWO

LITERATURE REVIEW

Introduction

The purpose of this study was to assess the biological and socioeconomic implications of the *Saiko* trade at Elmina, Ghana. This chapter of the study reviews current literature of related works gathered through published journals articles and books. The topics covered include, overview and structure of small scale fisheries in Ghana, current challenges facing the sector, type of management regimes available for monitoring. It also considers the effects of IUU fishing in the world. It explores the concept of value chain and its implications in fisheries, the profitability of the fisheries trade and a market map of the *Saiko* trade.

Fishery in Ghana

Fish is one of the most valuable agricultural commodities traded by Ghana internationally. Annual sales from fish export is valued at nearly US$ 209 million and growing each year (Fisheries Commission, 2014). For a developing country such as Ghana, fish exports to markets in developed countries, mainly in Europe, are a key source of foreign exchange revenue, and aid the country to derive maximum benefits from its fisheries. Fish and fishery products are now Ghana's most important non-traditional exports accounting for over 50 percent of earnings from non-traditional exports and increasing each year (Breisinger & Thurlow, 2009). Approximately 50,000 tonnes of fish products are exported from Ghana to the European markets. The canned tuna industries are highly developed targeting the European markets. Tuna sales account for 14 percent of non-traditional exports from Ghana and are the single

largest contributor. Locally, the canneries in Tema as well as the industrial fish smoking companies provide considerable employment for a large female workforce (Failler et al., 2014). Overfishing in the world's oceans has reached catastrophic levels. Many major fish stocks are in decline. Some species are being pushed towards extinction. IUU fishing is heavily implicated in overfishing. As much as one fifth of the world's fisheries catch may originate from IUU activity, linking consumers in Europe, the United States and Asia with a practice that is fuelling a global tragedy of the commons – a tragedy that is leading to the overexploitation of a common resource. Western Africa is at the epicentre of this tragedy

The region's coastal waters include some of the world's most abundant fishing grounds that act as a magnet for commercial vessels that supply Europe and rapidly growing markets in Asia. The profits generated are substantial (Barlow & Clarke, 2003). However, as highlighted by the former UN Secretary-General Kofi Annan in the 2014 Africa Progress Panel report, *Grain, fish, money,* the overexploitation of West Africa's fishery resources has produced devastating social, economic and human consequences (Africa Progress Panel, 2014). The livelihoods of artisanal fishing people are being ruined, a vital source of protein is being lost, and prospects for the development of regional production and trade are disappearing. Recent years have seen a renewal of international efforts to fight overfishing and IUU activities. Reinforced regulatory frameworks have been introduced for monitoring and reporting through Port State Measures. Legislation and voluntary codes of conduct in importing countries are creating strengthened incentives for compliance with sustainable fishery practices. These moves are promising but they are

inadequate to tackle IUU fishing problems. Far too many governments in Europe and in emerging markets subscribe to encouraging principles at international meetings, but fail to legislate the policies at home (Daniels, Gutiérrez, Fanjul, Guereña, Matheson & Watkins, 2016).

Fish is a major source of animal protein for Ghanaians, with a *per capita* consumption of about 26 kg which represents 60 percent of all animal protein (Sarpong et al., 2005). It is usually a cheaper and an appreciated source of protein (Odotei, 1992). Globally, small scale fishers operate in some of the biologically rich and most productive waters on earth, often in tropical coastal zones (Schorr, 2005).

Coastal communities engaging in artisanal fishing, use traditional methods which are often but not always intensive compared to modern industrial fishing techniques (Demuynck, 1994). The activities of such communities are often targeted at providing fish and fishing products to local and domestic markets and also for household consumption (FAO, 2003). The sector offers both direct and indirect employment to millions of individuals. FAO in 1998 stated that 98 percent of fishing jobs worldwide originated from small scale fishing (Schorr, 2005). In most developing countries including Ghana, fish provides about 60 to 70 percent of the protein intake (FAO, 2005). In addition to nutrition, small scale fishing activities in Africa play a crucial role in some economic activities including trade (Marquette et al., 2002). The rudimentary technologies used by artisanal fishers in Africa distinguish them from large-scale commercial fishing operations. Artisanal fishers have usually smaller boats and gears, and land smaller quantities of fish than large-scale commercial fishing boats.

Marine Fishery Sector of Ghana

The socio-economic importance of the fisheries sector is particularly pronounced in many coastal communities in developing countries. It has been estimated that 90 percent of those dependent on fisheries for their livelihood outcomes working as fishers, processors, traders or in other ancillary activities live in developing countries (Béné et al., 2007). Over 70 percent of the world's total reported catch is from developing countries (FAO, 2008).

Artisanal Fisheries

The artisanal fishery is characterized by the use of several gears. These include purse seine nets, beach seine net, set nets, drifting gillnets and hook and line. These gears are operated from dug-out canoes. There are over 13,500 canoes and more than 124,000 fishers operating actively from over 300 landing sites located along the entire 550 km length of the coastline. About 50 percent of these canoes are powered by outboard motors with engine power of up to 40 hp (Amador et al., 2006). Different artisanal gears target different resources: the artisanal purse seines and beach seines are exploiting mainly small pelagics. Purse seines are used to exploit chub mackerel during the upwelling periods, when these species move into coastal waters to spawn. During the non-upwelling periods, anchovies and juvenile fish in coastal waters are targeted with this gear. Beach seines are operated from the beach and exploit adult, during the upwelling periods and anchovies and juvenile during the non-upwelling periods (Quaatey, 1997).

The artisanal fleet accounts for 70-80 percent of all marine fish landings in the country (Mensah et al., 2006; Bank of Ghana, 2008). The artisanal fishing occurs in the nearshore areas in the form of inshore canoe and beach seine

fisheries (Aggrey et al., 2012). Historically, the small scale fisheries sector in Ghana typically involves a wide variety of target species, gear types, landing areas, and distribution routes, making it virtually impossible to collect reliable and comprehensive statistics for most fisheries (King & Lambeth, 2000).

Some of the hook and line canoes have facilities for storing ice to preserve fish and are therefore capable of staying up to three days at sea. They target seabreams (mainly *Dentex gibbosus, Pagrus caeruleostictus* and *Dentex canariensis*) snappers (*Lutjanus fulgens, Lutjanus goreensis*) and groupers (*Epinephelus aeneus*). The beach seine exploits both adult and juvenile demersal fish but mainly juvenile fish. Some of their target species include burrito (*Brachydeuterus auritus*), red snapper (*Lutjanus fulgens*), grey snapper (*Lethrinus atlanticus*), mullet (*Pseudupeneus prayensis and Mugil spp*.) and ribbonfish (*Trichiurus lepturus*) (Nunoo et al., 2015). The artisanal sector accounts for about 50 percent of total demersal fish landings annually. Drifting gillnets are used offshore to exploit mainly large pelagics such as sharks (*Carcharhinus* spp.) tunas (*Thunnus albacares, Thunnus obesus*) sailfish (*Istiophorus albicans*) and swordfish (*Xiphias gladius*).

Artisanal gears are also used to exploit molluscs and crustaceans. Until 1983, the beach seines were the main exploiter of cuttlefish in Ghanaian waters; accounting for over 60 percent of landings annually. Currently, the industrial trawlers account for over 80 percent of landings annually. Beach seines are used to exploit shrimps mainly *Parapenaeopsis atlantica* and *Penaeus kerathurus* (both adult and juvenile) and juvenile *Penaeus notialis* as they move from the estuaries into marine waters. Lobster set nets target the spiny lobster, *Panulirus regius* on rocky bottoms and in depths of about 40 m. Worth mentioning are the

Lagas canoes which are motorised canoes and specialise in hook and line, using insulated containers and ice to preserve high valued fish. Some of these canoes are equipped with electronic fish finding devices such as echo sounders (FAO, 2007).

Inshore or Semi-Industrial Fisheries

The semi-industrial or inshore fleet consists of approximately 230 locally built wooden vessels fitted with inboard engines of up to 400 hp and have lengths ranging between 8 and 37 m. Vessels with lengths less than 12 m are referred to as small-sized while those between 12 and 22 m are referred to as medium sized vessels (Quaatey, 1997).

The vessels are multipurpose and are used for both purse seining and bottom trawling. The inshore vessels operate as purse seiners during the upwelling periods and switch to bottom trawling for the rest of the year. The purse seiners target chub mackerel and other *Carangidae* species. They fish in the same coastal waters as the artisanal fleet during the upwelling seasons.

The small-sized trawlers target triggerfish (*Balistes capriscus*), while medium size net also exploit seabreams (mainly *Pagellus bellottii*, *Pagrus caeruleostictus* and *Dentex canariensis*), snappers (*Lutjanus fulgens and L. goreensis*), red mullet (*Pseudupeneus prayensis*), cassava fish (*Pseudotolithus senegalensis*), burrito (*Brachydeuterus auritus*) and groupers (*Epinephelus aeneus*). Bottom trawling is done in waters greater than 30 m depth.

The semi-industrial vessels use ice for preserving fish at sea and a fishing trip usually varied between 3 and 5 days. The disappearance of *B. capriscus* from Ghanaian waters in the late 1980s has affected greatly the

performance of the sector. Researchers have linked their disappearance to overfishing (Quaatey, 1997).

Industrial Fisheries

The industrial fleet is currently made up of 48 trawlers, 7 pair trawlers, 2 shrimpers, 26 tuna bait boats and 10 tuna purse seiners. The vessels operate from Tema and Takoradi where there are deep-water ports. The trawlers and shrimpers exploit demersal and semi-pelagic species. As deep-sea vessels, these trawlers are required by law to operate in waters deeper than 30 m. The industrial fleet has freezing facilities for preserving fish at sea and can stay for months at sea. It is reported that the industrial fleet has undergone a radical expansion in numbers since 1984 when the policy of the Government of Ghana targeted industrial fishing as a mechanism for promoting non-traditional exports (Quaatey, 1997; Nunoo & Asiedu, 2013). Trawlers are normally over 35 m in length and have engines of over 600 hp, while the shrimpers are up to 30 m in length with engines of over 350 hp. Originally, the trawlers fished off the west and south-west coast of Africa particularly from Sierra Leone to Mauritania and in Angola and Namibia area. These vessels have been forced out of these waters by the enforcement of the 200-nautical mile EEZ law by these countries. Commercial shrimpers are restricted by law to operate between latitude 1^{o}45'W to 2^{o}30'W and 0^{o}15'E to 1^{o}12'E and in waters with a greater depth than 30 m. These vessels target mainly pink shrimp (*Penaeus notialis*). All shrimps caught by these vessels are exported. The by-catch of these shrimpers consists of finfish which include soles, cassava fish, seabreams, cuttlefish and red mullet. The industrial trawlers by law are to operate in waters greater than 30 m deep. However, the bottom beyond the 75 m depth-contour is untrawlable, limiting

their operational area. The industrial fleet has undergone radical expansion in numbers since the launching of the Ghana Economic Recovery Programme in 1984. The aim of the Programme, among other things, was to promote non-traditional export to earn foreign exchange for the country. The number of operating trawlers has increased from 10 in 1984 to 33 in 1995. These vessels target species such as cuttlefish, seabreams, groupers, snappers, soles and cassava fish for export. Commercial shrimping also resumed in 1986 with two vessels and the number increased to 18 in 1996. There are two shrimpers operating in Ghana at present. The industrial vessels have freezing facilities for preserving fish on board and can stay for months at sea (Samey, 2015).

Fisheries Management in Ghana

The regulation of Ghana's fishing industry is by the government through the Ministry of Fisheries and Aquaculture Development (MoFAD), Fisheries Commission (FC) and its technical divisions under the Directorate of Fisheries (DOF). However, global trends and innovations in fisheries management have influenced the adoption of the co-management approach since 1997; hence the establishment and operation of Community- Based Fisheries Management Committees (CBFMC). Fisheries co-management' programmes are arrangements where the responsibility for fishery resources management is shared between the government and user groups (Wilson et al., 2010). Currently there are two main fishery management regimes in Ghana: formal and traditional management systems (Nunoo et al., 2015).

According to the Fisheries Management Plan, the formal fisheries management system aims at attaining two important objectives. One is limiting fishing effort of industrial vessels (especially trawlers and shrimpers) by

limiting entry into the fishery through licensing the vessels for fishing; and the other is prescribing the mesh sizes to be used in any fishery to limit the exploitation of juvenile or immature fishes (including shellfishes and molluscs) (MoFAD, 2015). However, to conform to global fishing policy, this management establishment include ensuring responsible fishing under the FAO Code of Conduct for Responsible Fisheries (CCRF). The Fisheries Enforcement Unit (FEU) of the Monitoring, Control and Surveillance (MCS) division of the DOF was established in 2013 to help ensure compliance with fisheries regulations and thereby attaining responsible fisheries.

The traditional fisheries management regime also aims at regulating access to marine fisheries in Ghana through local authorities. For example, in almost every fishing village, there is observed a non-fishing day in the week on which fishers maintain gear and equipment, resolve conflicts, rest and carry out other social activities. In some fishing communities or ethnic groups there is a total ban on fishing activities for various periods (up to two weeks) (Nunoo, 2009), prior to and during annual festivals. Both management regimes lack the ability to administratively monitor fishing behaviour (areas where they are supposed to fish when at sea) and fishing zones, therefore, making planning and implementation of the current laws less effective.

There is a worldwide perception that modern fisheries management strategies are failing to address the overexploitation of fishery resources. Stocks that are managed by both modern and traditional fisheries are improving globally (Hilborn & Ovando, 2014). Fisheries experts now recognize that a fishery cannot be managed effectively without the cooperation of fishers to make laws and regulations work (Yamamoto, 1995). As recognised by Nunoo

et al. (2015), there is inadequate understanding of traditional fisheries management practices in Ghana by both the formal managers, scientists, researchers, and the general populace. This has resulted in formulation of unsustainable and ineffective policies and management plans which sometimes lead to conflicts and mistrust between fisheries officers, fishers and fishing communities.

Fisheries are complex and dynamic systems, representing a source of income and livelihood worldwide (FAO, 2010). Fishing affects not only fish stocks but also marine ecosystems (Grafton, 2010), representing one of the possible threats to the integrity and sustainability of marine resources (Ye et al., 2012). However, fishing vessels do not fish randomly in the distributional area of the target species (Ellis & Wang, 2007; Stelzenmüller et al., 2008; Poos et al., 2010); instead, they search for areas where fish concentrate (Paloheimo & Dickie, 1964).

This situation therefore calls for monitoring and control of activities of fishers to enhance management. The fisheries Act 2002 of Ghana in the quest to enhancing proper management of the Ghanaian fishery, established the Monitoring, Control and Surveillance Unit. The Unit is responsible for monitoring, control and surveillance of all fishing operations within the Ghanaian waters by whatever appropriate means, including the management and running of a satellite base station for using satellite communications for data transmission relating to the activities of foreign fishing vessels licensed to operate within the EEZ and the enforcement of the Act, Regulations made under the Act and any other enactment relating to the regulation of fishing activities (Fisheries Act, 2002).

The Act empowers the Minister to request personnel from other Departments, agencies of State and other competent bodies or organizations to assist the Enforcement Unit, which comprises personnel from the Ghana Navy, Ghana Air Force and the Secretariat of the Fisheries Commission. These personnel are given Police and other powers under the Act both within the Ghanaian (Kwadjosse, 2009). They are also given full insurance coverage for the duration of their sea duties, as well as indemnity from prosecution for acts done in good faith in the performance of their functions under the Act (Fisheries Act, 2002). Duties of authorized officers of the Enforcement Unit towards masters and crew of vessels and vice versa, the compliance of masters and crew with directives of authorized officers, as well as penalties for contraventions to the directions are set out by the Act (Kwadjosse, 2009).

Economic Underperformance of Fisheries

As a renewable natural resource, fish stocks can generate a sustainable flow of benefits to society. However, fisheries may be operating below their economic optimum even if they are managed effectively at their biological maximum production. The 80 percent of global fish stocks that are fully exploited, overexploited, depleted or recovering are underperforming economically, with an estimated annual loss of USD 50 billion to the global economy (World Bank & FAO, 2009). This loss is the result of two main factors: depleted fish stocks mean that there are fewer fish available to catch and the costs of catching are greater than they could be; and the overcapacity in the fishing fleet means that the potential benefits are dissipated through excessive fishing effort. The current marine catch could be achieved with approximately half the current level of fishing effort. Subsidies to the global

fishing fleet, estimated at USD30–34 billion per year, represent a further cost to society, which in many cases continue to support unsustainable fishing practices and are important factors in the overexploitation of fish stocks (Suuronen et al., 2012).

Decline of Fish Stocks and Damage to the Marine Environment

Several research findings including Agnew et al. (2009), FAO (2009), and Garcia and Rosenberg (2010) have highlighted the increasing problems that global fisheries face. Some 28 percent of stocks are overexploited, depleted, or recovering; most `of the world's fishing fleets are overcapitalised; approximately 10 million tonnes of fish are discarded; 11–26 million tonnes (worth USD 10–23 billion) are lost to IUU fishing. Underperformance due to inefficient operations. Illegal, unreported and unregulated fishing (IUU), estimated to catch 11–26 million tonnes of fish worth USD 10–20 billion annually (Agnew et al., 2009), puts further pressure on fish resources and undermines management efforts. Over half of all fish stocks are fully exploited, producing catches at or close to their maximum sustainable limits. Of these, 19 percent are overexploited, 8 percent depleted and 1 percent recovering, yielding less than their potential (FAO 2009; Garcia & Rosenberg, 2010); and only about 20 percent are moderately exploited or underexploited with a possibility of producing more (FAO, 2009). The percentage of overexploited, depleted and recovering stocks has tripled since the 1970s. Over the last 30 years there has been a pattern of serial depletions of fish stocks with fleets targeting different stocks or new, previously unmarketable, species such as deep-water species, estimated now to contribute 4 million tonnes (Garcia & Rosenberg, 2010).

Transhipping at sea makes it a challenge to hold IUU fishers to account. By transhipping illegal catches to another vessel at sea, vessels operating in an illegal manner avoid port controls. The illegal catches can be mixed with legally caught fish and then legally commercialised. In West Africa, for instance, most IUU fishing vessels do not land in countries in the region. As the majority of catches are exported, fishers use at-sea transhipment to "launder" the fish and send it directly to the final destination or to "ports of convenience" (Martini, 2013). There is evidence that corruption takes many forms and facilitates IUU fishing in Africa throughout the fisheries chain. From the payment of bribes to use of prohibited fishing gear or to continue fishing in illegal areas without punishment, to conflicts of interest between law enforcement officials and IUU fishers, corruption is hampering law enforcement in Africa and allowing IUU fishers to operate to the detriment of small scale fishers, the environment and citizens in general (Martini, 2013).

Illegal Unregulated Unreported (IUU) Fishing

IUU fishing as a term was first introduced in 1999 by the FAO at the FAO Ministerial Meeting on the Implementation of the Code of Conduct for Responsible Fisheries (Bray, 2000). In 2001, the term got coined when the FAO started to implement the International Plan of Action on Illegal Unreported and Undocumented fisheries, also known as IPOA-IUU. It was then that the FAO urged all the UN members to implement the IPOA-IUU (FAO, 2001). The term IUU since then has been on the forefront in fisheries management agenda and academia (Falaye, 2008; Daniels et al., 2016, Bondaroff, 2015; FAO, 2001).

The term IUU was created to shed light on the scale of "off -the-books" fisheries (Pauly, 2017). The IUU can be useful to address and act upon problems

related to fisheries as the case in Thailand (van der Geest et al., 2015). The term IUU has often been used as a synonym for 'illegal', consequently it has conflated criminal activities with fisheries management issues including perfectly legal fisheries which are non-reporting (Pauly, 2017). In practice, the framing of IUU can result in fisheries being associated with a different degree of legality and urgency (Pauly, 2017). Over the years the term IUU has led to several problems. In his presentation (Globalization of Fisheries conference 2017, Texel, The Netherlands), Andrew Serdy indicated several problems the term IUU has led to through the years (personal communication, February 5, 2017). IUU can lead to exaggerating the scale of the phenomenon *"Illegal operators too are subject to the tragedy of the commons"* (A. Serdy, personal communication, February 5, 2017). Furthermore, the term IUU has led to absurdities "Absurdities like the call at the World Summit on Sustainable Development to "eliminate subsidies that contribute to IUU fishing" since all subsidies either decrease or inflate actions against unregulated fishing (Ibid.).

Illegal fishing occurs if the fishing activity is against the law. When considering fisheries, it is necessary to understand why something is illegal. Unreported fishing occurs where legal instruments are present yet the requirements for reporting, or penalties for non-reporting are non-existing (Sander et al., 2014) If is rather a management issue then a question of illegality (Serdy, 2011). Unregulated fishing takes place where legal instruments are non-existing, not applied, or inadequate (Sander et al., 2014). Criminality is unfit for unregulated fisheries as it rather is a management issue then a question of illegality (Serdy, 2011).

Making distinctions between Illegal, Unreported, and Unregulated fisheries instead of grouping them together under IUU brings more nuance to the debate, and makes it possible to unveil the real problems, which are not always a matter of law enforcement. However, when discussing illegal, unreported, and unregulated fisheries we must be aware that these different forms of fisheries can influence each other and can be interrelated.

IUU fishing according to IMCS Network (2014) refers to any of the following activities: Fishing in waters under the jurisdiction of a state without permission or in violation of applicable laws: Fishing conducted by vessels flying the flag of states that are parties to a relevant regional fisheries management organisation but are operating in contravention of its conservation and management measures. Fishing that has been unreported or misreported to the relevant national authority or regional authorities, in contravention of applicable laws. Fishing conducted by vessels without nationality, flying the flag of a state not party to the regional organisation governing the relevant fishing area or species, or fishing on stocks with no applicable conservation or management measures in place (IMCS Network, 2014). IUU fishing violates conservation and management measures currently in place in many countries. IUU is recognized as a serious threat to sustainability of capture fisheries due to its negative impact on the ecology of the oceans and economy of fishing nations. Global losses due to IUU fishing alone is estimated between US$10 billion and US$23.5 billion per year with West African waters deemed to have the highest levels of IUU in the world, representing up to 37percent of the region's catch (OECD, no year). This is estimated at US $ 100,000 per day, in addition to damage of artisanal equipment in the marine waters of West Africa. While much

of the IUU fishing in the region is believed to be conducted by foreign vessels fishing in the EEZ of coastal West African States, in Ghana, a large part of the IUU fishing problem can be attributed to the Ghanaian fishing fleet.

Drivers and Factors Influencing IUU Fishing

IUU fishing is a low risk, high reward activity. Demand for and prices of overexploited and protected species are high, and the actual chance of getting caught or being punished is low, particularly because IUU fishing often takes place in countries where enforcement is weak and impunity related to IUU fishing is rampant. Companies involved in illegal fishing are either not punished or receive sanctions that are too weak to have a deterrent effect. Studies suggest that penalties would have to be increased by 24 times to have a real deterrent effect on illegal fishing activities (Love, 2010). In addition, in many countries, fines are established based on the company/fisher's ability to pay. As in the majority of cases the actual owner is hidden behind a beneficial one, fishermen who themselves often work in very poor conditions and receive very low salaries, are the ones arrested and who pay the fines. Overcapacity is also seen as one of the drivers of IUU fishing. There are too many fishing fleets for the number of fish available. Therefore, competition and the depletion of fish populations are driving fishermen to protected areas (Stiles, 2013).

By-catch and Discards

The concept of "discarded catch" often also referred to as "discards" refers to the part of the fish being caught during the fishery and thrown away or thrown back into the sea (Clucas, 1997). Most fishing gears do not allow for catching targeted fishes only, therefore a percentage of the fish or non-fish species will be discarded and does not matter if the catch is dead or alive (FAO,

2010). To simplify the term, Alverson et al. (1994) define discarded catch as "the portion of the catch returned to the sea as a result of economic, legal, or personal considerations". The FAO further specifies this to include fish slipping away from the net back into the water after being caught (FAO, 2010). The discarded part of the catch is not retained in any form or shape. In Figure 4 the total worldwide catches are shown per fisheries sector when discards are being included (Pauly & Zeller, 2016)

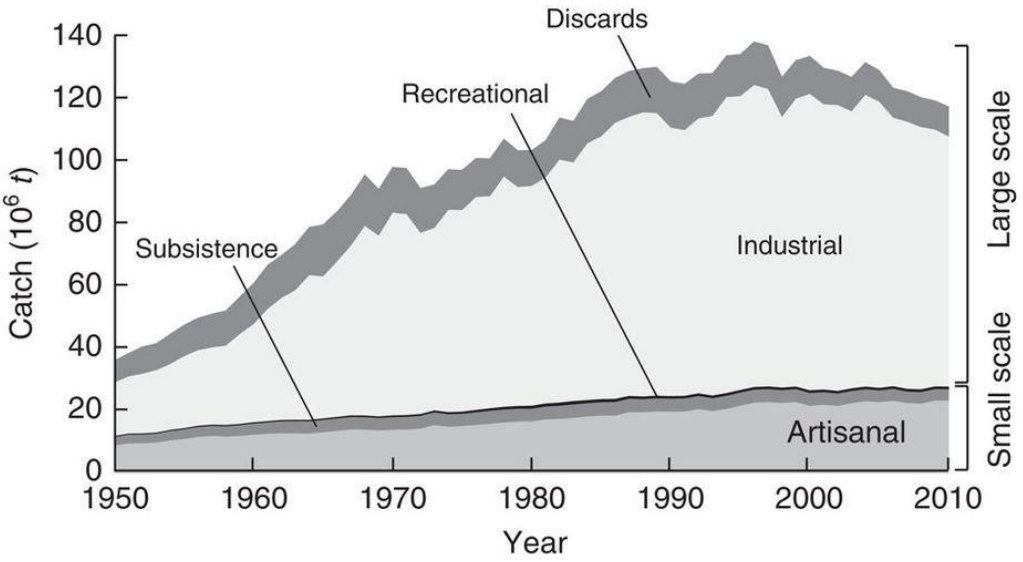

Figure 1: Reconstructed catches for all countries in the world, plus High Seas, by large-scale (industrial) and small scale sectors (artisanal, subsistence, recreational), with discards (overwhelmingly from industrial fisheries) presented separately (Pauly & Zeller, 2016).

The concept and term by-catch, also called "by-product", often leads to confusion and is used in multiple ways both in academia and in practice and differs greatly between fishery and geographical location. The term by-catch therefore asks for a more thorough explanation and understanding than discards. Alverson et al. (1994) state that the term can be, and is being, explained in three different ways. First, by-catch as a term is used to differentiate between catches of target species and non-target species which are retained and sold (Alverson

et al., 1994). Secondly, by-catch can be used to refer to species, sizes or sexes of fish that are being discarded. It is here that discards and by-catch as terms often get mixed up and used interchangeably with dead discards (Alverson et al., 1994; Horsten & Kirkegaard, 2002). Third, the term by-catch is being used to describe all the non-targeted species which are retained and sold, in this case this is in addition to the discarded catches (Alverson et al., 1994).

Due to the different definitions of by-catch leading to confusion the FAO (2010) came up with a standard international definition of by-catch; "*Catch that a fisher did not intend to catch, did not want to catch, did not choose to use, or which should not be caught for whatever reason"* (FAO, 2010). However, when discussing by-catch, the different definitions used for the term are still necessary to keep in mind, as they are being used by different scientists, policy makers and practitioners all over the world.

Reasons for Discards

If a fishing vessel decides to land or discard the caught fish depends on many reasons. Having absolutely zero by-catch or discards is almost impossible (Nunoo et al., 2014). High or low amounts of by-catch and discards depend on the nature of the fishery and on the selectivity of the fishing gear used. The industrial fisheries in Africa often have high amounts of discards while the artisanal fisheries in Africa are assumed "to have low or negligible discards unless information to the contrary is available" (Kelleher, 2005). In West Africa, the discards of artisanal fishers are also low or negligible. This could be explained through the high population in these coastal states combined with a high demand for fish and fish products (Kelleher, 2005).

There are many scenarios by which the amount of by-catch and discards generated can grow or be significantly reduced (Horsten & Kirkegaard, 2002). However, the nature of the fishing gear is not the only reason why certain fisheries have low or high levels of by-catch and discards. The discard rates depend on several factors such as value, place and time, the skill of the fishermen and the weather conditions (Alverson et al., 1994; Horsten & Kirkegaard, 2002). Understanding why some portions of the by-catch are discarded or kept is key to understanding the choices made in a certain fishery.

Problems of By-catch and Discards

By-catch and discards can result in unsustainable resource use and can have a severe impact on the environment. The consequences include the depletion of sea-life, further endangering sea life and fish stocks. This is due to the undiscriminating nature of the practice, i.e. catching juvenile fish undermining the basis of a fish stock (FAO, 2010). Furthermore, discards are often considered wasteful acts because of the 'dumping' of unwanted catches into the sea. However, it must be stated that some fishers claim high survival rates in some conditions (Kelleher, 2005). By-catch contributes to exacerbate the global issue of overfishing and threatens effective management of fisheries around the world. According to the FAO (2010) “By-catch is of concern when it comprises a significant proportion of the capture in a specific fishery, or when, across all fisheries, it comprises a large proportion of the catch in a fishery”.

By-catch may either be discarded or retained and landed, this also means that not all by-catch is per se undesirable (Horsten & Kirkegaard, 2002). The part of the unintended catch which is not undesirable catch is retained and sold, while the undesirable catch is discarded back to the sea. Unintended catch,

holding a commercial value, can therefore even cover the costs of a fishing trip and result in profits for the fishing endeavour (Clucas & Teutscher, 1999). This in turn can lead to targeting former undesirable catch and less selective fishing, leading to further resource depletion. Kelleher (2005) identifies four related issues derived from the 'discard problem': (1) Policy and ethical issues; (2) Fisheries management issues; (3) Ecological issues; and (4) Technical and economic issues (Kelleher, 2005).

First, discards appear to be often seen as the reverse of responsible stewardship, a waste of natural resources and an unsustainable way to utilize marine resources. This has led to conflicts between small scale fishers and industrial fishers (Kelleher, 2005). The second issue identifies the difficulties in fisheries management. How can fisheries prevent discards or limit the potential discarded catch while at the same time implement a management regime which focuses on the social, economic, and biological objectives. (Kelleher, 2005). The third issue recognizes the potential negative impact discards may have on the marine ecology and biology (Kelleher, 2005). The fourth issue deals with the technical and the economic problems. Technical problems are problems related to gear selectivity. The economic problems are related to by-catch reduction while at the same time increasing the utilization of by-catch by increasing the by-catch landings (Kelleher, 2005).

CHAPTER THREE

METHODOLOGY

Introduction

This chapter describes the procedures and techniques used to collect and analyse data for this study. It captures the study area, research design, the population, the sampling procedure, the sample size, the research instrument, data collection, data processing and analysis that were used as well as the rationale behind choosing these techniques for the study.

Research Design

This study employed a mixed research approach (qualitative and quantitative) using cross-sectional survey design. The approach was deemed to be better based on the objectives of this study. According to Aliaga and Gunderson, as quoted in Muijs (2004, p.1), quantitative research is "explaining phenomena by collecting numerical data that are analysed using mathematically based methods (in particular statistics)". Qualitative research, on the other hand, involves the collection of extensive, narrative data (i.e. non-numerical data) on many variables over a period of time in order to gain insights into phenomena of interest. However, according to Sarantakos (1993), qualitative research is conducted under clear methodological approaches based on diverse theoretical principles, involving methods of data collection and analysis that are non-quantitative and aiming toward exploration of social relations, attitudes, knowledge and practice of a group of respondents about certain issues. Its main objective is to describe the variation in a phenomenon, situation or attitude experienced by the respondents. These two approaches were used because the study sought to collect both qualitative and quantitative data.

Usually, surveys "gather data at a particular point in time with the intention of describing the nature of existing conditions; or identifying standards against which existing conditions can be compared; or determining the relationships that exist between specific events" (Cohen, Manion & Morrison, 2005). This was considered appropriate since the study sought to describe the *Saiko* fishery in Elmina.

Study Area

The study was conducted at Elmina (5°5□0□N 1°21□0□W), a major coastal fishing community in the Komenda-Edina-Eguafo-Abrem (KEEA) Municipality in the Central Region of Ghana (Figure 2). The Municipality is bounded on the East by the Cape Coast Metropolis, the North by the Twifo-Hemang-Lower Denkyira District, the West by the Mpohor-Wassa East District and the South by the Atlantic Ocean (Gulf of Guinea). It is located between longitude 1^0 20' W and 1^0 40' W and latitude 5^0 05' N and 15^0 N. The District covers an area of 372.45 kilometres square (919.95 square miles). The Komenda-Edina-Eguafo-Abrem (KEEA) Municipality is made of four traditional areas or states, which have been put together to constitute a political district. The Komenda-Edina-Eguafo-Abirem District was carved out of the then Cape Coast Municipal Council in 1988. The Municipality has Elmina as its municipal capital, which was the first point of contact with the Europeans to this country. This town therefore witnessed a lot western civilization and influence as well as other economic activities over the centuries.

Elmina presents an ideal site for this investigation. Being a historic fishing community where fishing dates back to the 1400s (Odotei, 2002) the Elmina fish landing harbour which is built along the bank of the Benya lagoon

provides a very good landing site for all types of canoes and small semi-industrial boats engaged in traditional fisheries. With a population size of 32,819 (World Gazetteer Online, 2012). Elmina serves as the centre for several other fishing-related and commercial activities. A canoe frame survey in 2004 found that there were 2632 fishermen and 231 canoes operating in the town (Amador et al., 2006). Some semi-industrial vessels are also involved in the fishing operation. Furthermore, the Elmina 2015 Strategic report reveals that about 75 percent of the estimated population of Elmina derive their livelihood directly from fishing or other activities that depend on it such as processing and trading of fish and canoe building (KEEA Report, 2015). Elmina was purposively selected, the reason being that it is the largest *Saiko* site in Ghana.

The Elmina fishing harbour in the Central Region is the third largest fish landing site in Ghana after Tema and Sekondi harbours (Ghana Statistical Service, 2014). The fisheries activities at Elmina are largely artisanal. Regardless of the artisanal nature of fisheries activities in Elmina, it contributes about 15 percent of the country's total fish output (Hɛ n Mpoano, 2015). Therefore, Elmina significantly contributes not only to local livelihoods and economy of Elmina, but also to the national fisheries GDP of Ghana (Ghana Statistical Service, 2010). Along the coastal zone of the study area is a series of lagoons and wetlands, the largest of which include the Benya, Brenu, Susu, Abrobi and Ankwanda lagoons. These lagoons support a vibrant salt industry. The slopes and hills are quite steep in the inland areas. In between the hills, are valleys of various streams, which drain into the coastal lagoon and the Atlantic Ocean.

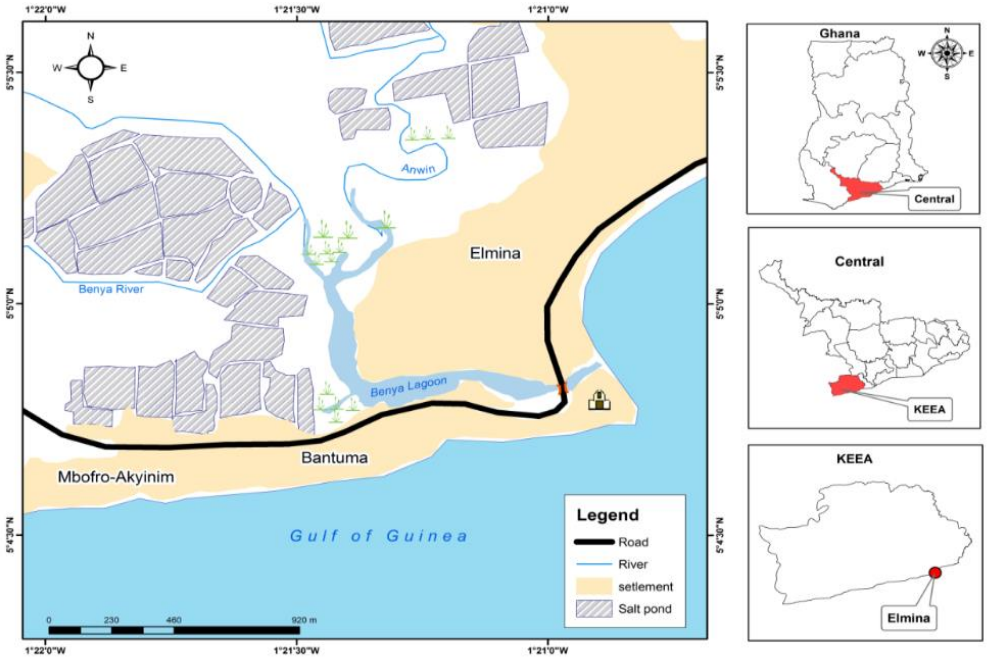

Figure 2 – Map of study Area Elmina

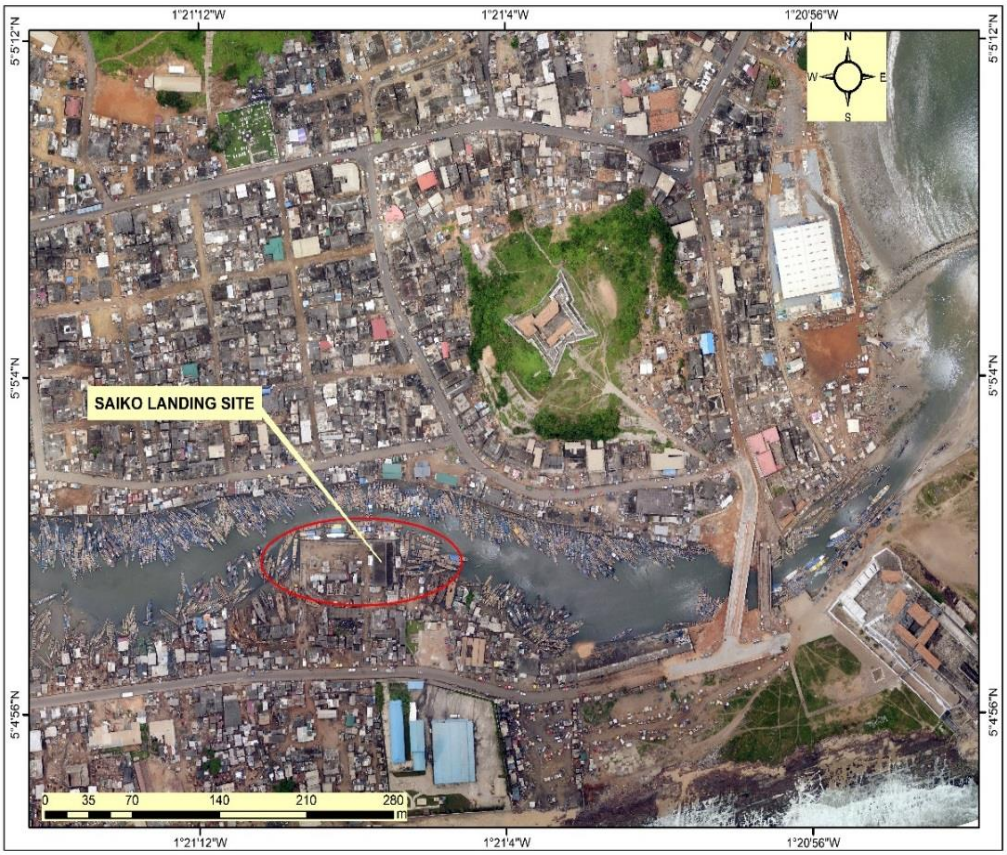

Figure 3 – An aerial photo of Elmina Landing Site (CCM-UCC, 2016)

Population

The target group about which the researcher is interested in gaining information and drawing any conclusion is what defines a population. Hence the target population used in this study was of two (2) different sets. They include:

1. All fishers in the Elmina who are currently into *Saiko* business. It was realized that many of the fishers in the study area are also into artisanal fishing and so the study needed the responses of only fishers who were active in the *Saiko* business. The reason for this decision is that those who were still in the business were perceived to have enough information about situation on the ground needed to enrich the study.
2. All fish processors in the study area who either buy the *Saiko* fishes from the fishers or get them from their husbands and process them for the final consumers. It was deemed appropriate to find what they also know about the *Saiko* fishery in order to get a holistic view on *Saiko* business.

Sample and Sampling Procedures

The study intended to use a census since the target population was about 50 fishers and about 70 fish processors which were not too huge to be studied. However, at the end of the data collection only 18 fishers and 49 fish processors were available and were used for the study. The snowball sampling technique was used for this study. This method was considered appropriate since those involved in the *Saiko* business since they know themselves and could direct the enumerators or the researchers to one another.

Data Collection Instrument

The major instrument for the study was the structured interview schedule and observation guide. The interview-schedule was used because most people in the target group were illiterates or did not have any formal education and also to enable the researcher explain the instrument vividly to get relevant detailed information. The instrument contained both open and close-ended questions. The questions were based on the specific objectives of the study to ensure that the relevant variables were included. Here, two separate structured interview-schedule instruments were used (one for fishers and the other for fish processors).

The instrument for the fishers was divided into three sections (section A, B, and C). The first section covered the background characteristics of the respondents; second section addressed the catch per unit effort and the final section covered the perception of fishers on *Saiko* business, input use and revenue (profitability related variables). The second instrument for processors was divided into two (2) sections. The first section was on socio-demographic characteristics of fish processors, the second contained items 10-38 which covered information on the processing and market channels.

A pilot test of the structured interview schedule was conducted using ten (10) respondents with similar characteristics such as age, gender, knowledge and experience. The use of the sample size of 10 was in line with the view posited by Baker (1994) who recommended a range of 10-20 percent of the total sample size for a pilot testing. The pilot testing was done to enable respondents to provide feedback about whether the questions and response categories were clear and also to assess the time it takes them to complete the questionnaire. It

was discovered during the pilot that some respondents did not respond to a few statements, perhaps, they did not understand them because they felt they were slightly ambiguous and some sentences being quite long for them. Such statements were noted and later restructured. The data gathered through the use of the close-end questionnaires were coded into the Statistical Product for Service Solutions (SPSS 21.0).

Data Collection Procedure

Prior to the data collection an introductory letter was taken from the Department of Fisheries and Aquatic Sciences to facilitate the collection of data. The relevance of the introductory letter was to seek approval from the By-catch Collectors Association so as to allow the *Saiko* fishers to participate in the survey. The respondents were also given assurance of anonymity as research ethics demand.

Interview

Face-to-face interviews were conducted after the researcher had met the respondents to explain the purpose of the study. Individual fishers and fish processors were interviewed using the structured interview schedule. The interview was conducted by literal translation of the questions to the local dialect (Fante) common to the respondents since most of the respondents could neither speak nor understand English language. This was done to ensure better communication and retrieval of reliable and accurate responses. The data were collected by the student researcher and another trained assistant. The assistant was trained in order to understand what was meant by every aspect of the instrument. Individual fishers and fish processors who agreed to be part of the study were interviewed upon agreeing to respond to questions the researcher

asked. Some of them were interviewed while mending their nets, others while in their cold stores or processing site, others while relaxing at the beach, some while coming from fishing and others, appointments were scheduled to meet them in their houses and shops. Each interview lasted for approximately thirty-five (35) minutes. The data was collected from February 2017 to April 2017. This method of data collection was considered appropriate since it gave room to elicit more responses from the respondents for further explanation to the closed-ended items.

Key Informant Interviews (in-depth interview)

In all, a total of 18 *Saiko* fishers and fish mongers or processors were involved in an in-depth interview in order to generate additional data to explain the quantitative data collected in the first phase. The chief advantage of in-depth interviews is that they provide much more detailed information than what is available through other data collection methods, such as surveys. This was used to complement data gathered from the closed-ended questionnaires. The researcher involved 18 respondents along the *Saiko* value chain. Details of the interview guide can be seen in Appendix A.

Observation

Observation is one of the instruments often used to collect qualitative data. Using this instrument gives researchers the opportunity to interact with participants in their natural settings, see things for themselves and determine the data to collect on them (Denscombe, 2008). Bell (2008) also believes that observation is useful in determining what people actually do or how they actually behave in their context. Looking at these benefits associated with observation, it was used to assess the sites of *Saiko* operators, the methods used,

how work is done, those involved and the impact of *Saiko* activities in the communities.

Collection of Biological data in the Laboratory

Some preparation was done prior to the collection of the biological data. Two slabs of *Saiko* fish were bought from the fishers at Elmina landing site every two weeks for the study period. Sampling of the fish species was done twice a month. In all 24 slabs of fish were sampled. On each sampling occasion, catches of individual fishers were identified and sorted into species using identification manuals. In the laboratory, fish identification was done using external morphological characteristics and identification keys including Schneider (1990) and, Kwei and Adu-Ofori (2005).

Parameters such as the length and the weight were taken through measurement and weighing respectively. The average length and weight of fish landings for the entire sampling period were taken and documented. Fish slab weights were taken using a 20 kg capacity top pan scale. Fish bio-data including information such as total length (TL), standard length (SL), fork length (FL) and weight (W) of fish were measured to the nearest 0.1 cm, counted and recorded separately. This helped to determine the length frequency distribution, condition factor and length-weight relationships. Standard Length was measured from the tip of the fish snout to the point of the caudal fin while the total length was measured from the base of the fish's snout to the most posterior part of caudal fin using a measuring board. Each fish species was weighed separately to the nearest 0.1 g using a 700 g scale.

The daily fish landed and their corresponding number of canoes were estimated during the six months study period between November, 2016 and

June 2017. However, February and March were closed season of the fishery as such no fish data were collected in these months.

Data Processing and Analysis

The data collected form the survey were thoroughly cleaned to free it from any unwanted material or information after which the coding manual was developed. The carefully cleaned data was critically organized and coded for statistical analysis. Using the Statistical Package for Service Solution (SPSS) computer software, version 20.1, the data were then analysed according to the research objectives or questions as follows.

The socio-economic characteristics of the respondents were analysed using descriptive statistics such as central tendencies, frequencies, and percentages, ranges results and presented in tables and figures. The qualitative data was transcribed and those that need to be coded were done. Following these steps, logical and comprehensive outcomes were obtained which helped to explain the quantitative data.

Assessment of Catch Composition of Common Fish Landed by the *Saiko* Canoes

Frequencies and percentages as well as pie charts were used to depict the species abundance and composition of *Saiko* fish landings. Variation in the composition and structure of the community were investigated using:

Shannon's diversity (number of individuals) $H' = -\sum(i=1)^{s} [Pi (lnPi)]$ (1)

(Krebs, 1999),

where *Pi* is the proportion of individual species *i* in the community.

The richness of diversity was determined using Margalef's richness index given as:

$$D = (S-1)/\ln N \quad (2)$$

where *S* is the number of species and; *N* is the total number of individuals in the samples.

The evenness of diversity was calculated using Pielou's index (Pielou, 1966) given as:

$$J' = H'/Hmax \quad (3)$$

where Hmax = lns.

Following Krebs (1999), the degree of similarity between the fish communities in the sampled species was determined using:

$$Cs = \frac{2j}{a + b} \quad (4)$$

where Cs is Sorensen's index which ranges from 0 (dissimilar) to 1 (completely similar); *j* is the number of species common to the water bodies and; *a* and *b* are the number of species occurring in either of the water body.

Assessment of Growth Parameter of Common Fish Landed by the *Saiko* Canoes

Length weight and length frequency data were also estimated and the relationships between the lengths and weights of samples were used to assess the well-being of individuals within the population. To establish the length-weight relationship, the common power regression was applied (Ricker, 1975; Quinn & Deriso, 1999),

where W is the weight (g), L is the total length (or height) in cm, 'a' is the intercept (condition factor) and 'b' is the slope (relative growth rate). The

parameters *a* and *b* were estimated by least squares linear regression on log-log transformed data using $\log_{10}W = \log_{10}a + b\log_{10}L$. The coefficient of determination (r^2) was used as an indicator of the quality of the linear regression (Scherrer, 1984). Additionally, the 95percent confidence limits of parameter *b* and the statistical significance level for r^2 were estimated. Following Ighwela et al. (2011), the Length-Weight Relationship (LWR) was estimated using the equation:

$$W = aLb \quad (5)$$

Where W = the weight of fish in grams, and L = the standard length of fish in centimetres.

The log transformed data gives a regression equation as:

$$\text{Log } W = \log a + b\log L \quad (6)$$

where: a = constant describing the rate of change of weight with length (the intercept of the regression line on the Y axis), and b = the regression co-efficient which is a measure of the allometric or isometric growth patterns of a fish.

The condition factor (K) of the species was be calculated as the ratio between the body weight (BW) and standard length (L). The *K* values were obtained monthly using Fulton's equation:

$$K = BW/ L3 \times 100 \text{ (Nash, Valencia \& Geffen, 2006)} \quad (7)$$

Estimation of Catch Per Unit Effort By The *Saiko* Canoes

Frequencies and percentages were used to describe the fleet size, crew size, number of days per trip and quantity of fuel used per trip whereas means, minimum and maximum were used to describe number of fishing trip per week. The quantities of slabs landed by *Saiko* fishers were estimated by counting numbers of slabs landed by the various canoes during the period of the study.

Averages, minimum and maximum quantities for the various months were calculated and the corresponding slab weights were measured with a 20 kg top pan balance to ascertain the weight per slab.

Assessment of Profitability of the *Saiko* Business

Enterprise budget analysis was used to assess the profitability of *Saiko* business. Efficient management of a *Saiko* business can make the difference between profits and losses, even in years with unfavourable prices and costs. Fishery management involves more than just taking care of the biological processes involved; it includes paying close attention to economic and financial measures of the fishery also. A practical overview of economic and financial indicators and analyses help better understand the performance of the *Saiko* business.

In the present study, enterprise budget was used to evaluate the profitability of *Saiko* fishery at Elmina, Ghana. An enterprise budget predetermines the profitability of the indicated venture, in a representative year or specified period (Engle & Neira, 2005). The budget compares revenues to costs for the stipulated period, using typical or average values and prices.

For the analyses of budgets, actors in the *Saiko* business in Elmina were identified with the help of the Fishery officer at Elmina. Questionnaire were used to solicit information from *Saiko* fishers, processors and hustlers from Elmina to gain insights into the initial capital needed to start the business among other things. Data collected was then summarized in Microsoft Excel 2013.

An enterprise budget was done to determine the profitability of the *Saiko* business. Enterprise budgets based on the survey data were developed for the fishers who land 2500 slabs (packaged frozen fish) a day and processors for a

one-year operation. Straight-line depreciation and interest were applied to fixed cost like the canoe; in terms of useful life and the salvage value. Variable costs included cost of fish slabs, transportation premix fuel, and firewood among others. Unforeseen expenses of 3percent of operating costs were added for any expenditure that might not have been captured by the survey for both fishers and processors.

Secondary data on variables such as Bank of Ghana's Interest Rate and US Dollar ($) – Ghana Cedi (GH¢) exchange rate, were obtained from secondary sources (Bank of Ghana, 2016; Trading Economics, 2016). All reported rates are for December 2016.

Development of market map of the *Saiko* trade within Ghana and the sub-region

This was done by using graphical presentation to describe the fish market for the *Saiko* trade within Ghana and in the sub-region.

Ethics Consideration

When doing research, one should always look at the ethical dimensions and pitfalls. In this research ethics are of even greater concerns due to the illegal nature of *Saiko* operations. In this research, some ethical principles were followed. The first is that no harm will be done to participants in any form. This includes, but by no means is only limited to, physical harm, harm to the development of participants, loss of self-esteem and stress (Bryman, 2012). However, in practice, one must acknowledge that sometimes this is outside of the researcher's reach. A researcher cannot decide how people will use the outcomes of this research and therefore in theory it can harm participants. During the fieldwork period, the assurance was given to respondents that, the

information solicited would not harm participants in anyway. This in theory could generate consequences by *Saiko* owners, colleagues, and the by-catch collector association. Furthermore because of the sensitive nature of this research the participants involved in *Saiko* were not named in this research or appendix.

The second area of ethical principle concerns the full disclosure of reasons, motives and/or observations, to the respondents (Bryman, 2012). By doing so this allows the respondents to make an informed decision about participating in the study.

The third ethical principle which has been considered is the invasion of privacy (Ibid.). When respondents refused to answer any question on whatever grounds, they feel is justified, this was accepted and respected.

The fourth ethical principle concerns deception (Ibid). Before the respondent agreed on participating the goals and methods were clearly explained, hereby attention was paid to the focus being on the true underlying goals and methods.

CHAPTER FOUR

RESULTS

Introduction

This chapter presents the findings of the study. These areas entail the activities of the *Saiko* fishery covering biological and socio-economic data on fishery. Information about fish landings including quantities, composition and growth parameters of fish species landed over the study period are also presented. Again, the economic benefits, market channels and the role of various actors in the *Saiko* industry are outlined here.

Socio-Economic Characteristics of Respondents

Table 1 presents the socio-economic characteristics such as the, educational levels, marital status, family size, place of origin, duration of stay Elmina, as well as the main and alternative occupation. A total of 67 respondents made up of 18 *Saiko* fishers and 49 *Saiko* processors were used for this study. The latter was made up 4 (8percent) males and 45 (92percent) females.

From Table 1, it clear that the literacy rate among the people engaged in the *Saiko* fish trade at Elmina landing site was very low since majority (9 fishers and 27 processors) have had education up to the Junior High School (JHS) level and about 16 of both fishers and processor had no formal education. The result also revealed that, only few fishers 3 (17percent) and fish processors 1 (2percent) have had tertiary education. Exactly 55percent of processors have up to Junior High School education. About 17 percent of the fishers who have tertiary education work as clerks, who handle the finances of the *Saiko* operations.

Again, from Table 1, most of the fishers (72percent) as well as the fish processors (84percent) were married with few respondents being single.

About 95 percent of both fishers and processors family size ranging from one to twelve. The result also shows that about 90 percent of the respondent have a number of children ranging from one to six with majority having between one (1) and four (4) children. It is also noteworthy that only three (3) fishers do not have any child with only two fishers having children between ten (10) and twelve (12).

The result on the place of origin of the respondents revealed that a little over three-quarters (76percent) of both the fishers and the processors are migrants or settlers with a quarter (24percent) of them being natives of Elmina.

On the duration of respondents' residence, it was observed from the result that the respondents have lived at Elmina for at least two (2) years and at most 50 years. The longest duration each have lived in the area was between 31 to 50yrs for both fishers (22.3percent) and processors (38.9percent). However, a little over half of the fishers population surveyed (60.1percent) have lived in Elmina for between eleven (11) and to thirty (30) years. The findings indicate a portion of the respondents were migrants from various coastal communities in Ghana who have moved to Elmina mainly because of fishing or fishing related activities.

Table 1 – Socio-economic Characteristics of Respondents

Variable		Respondents	
		Fishers	Processors
Educational Level	Primary	7(39percent)	12 (24percent)
	JHS	2(11percent)	15(31percent)
	Secondary	2(11percent)	7(14percent)
	Tertiary	3(17percent)	1(2percent)
	None	2(11percent)	14(29percent)
Marital status	Single	5 (28percent)	4 (8percent)
	Married	13(72percent)	41(84percent)
Number of children	0	3(16.7percent)	-
	1-3	7(38.9)	30(61.2percent)
	4-6	6(33.3percent)	17(34.7percent)
	7-9	-	2(4.1percent)
	10-12	2(11.1percent)	-
Place of Origin	Natives	8 (44percent)	8 (16.3percent)
	Foreigners	10 (56percent)	41(83.7percent)
Duration of residence	2-10 years	3 (16.7percent)	6 (12.2percent)
	11-20 years	3(16.7percent)	11(22.4percent)
	21-30 years	8(44.4percent)	13(26.5percent)
	31-50 years	4(22.3percent)	19(38.9percent)
Main Occupation	*Saiko* fisher	9 (50percent)	4(8.2percent)
	Fish processor	-	44(89.8percent)
	Nurse	-	1(2.0percent)
	Boat construction	9 (50percent)	-
Alternative Occupation	Artisanal fisher	3(16.7percent)	30 (61.2percent)
	Boat repairer/Carpenter	2(11.2percent)	-
	Saiko fisher	1(5.6percent)	-
	Fish processor	1(5.6percent)	-
	Others (Driver, footballer)	2(11.2percent)	-

Source: Field survey, Eshilley (2017)

The study also sought to find the primary occupation of the respondents. Majority (90percent) of the processors indicated that their primary source of livelihood is fish processing. Some of the fishers were found to engage in fish

processing (8percent). The study also found a professional nurse (2percent) who was actively engaged in Saiko fish processing as their primary occupation.

Nevertheless, the fishers indicated that they alternatively engage in artisanal fishing, boat construction and repair work, fish processing during their off days for income. About 11.2 percent of the fishers were engaged in other livelihood occupations such as driving and football whereas about 30.5 percent of the processors are involved in other livelihood activities as petty trading, football, dressmaking, hairdressing and gari processing.

Figure 4 depicts that a greater proportion (39percent) of the fishers interviewed were aged between 16 and 29 years and between 30 and 45 years, whereas those of the fish processors were 30 to 45 years. The findings also reveal that more than half of the processors were between 30 and 45 years. Nonetheless, only few of the respondents are within the age group between 61 and 75 years.

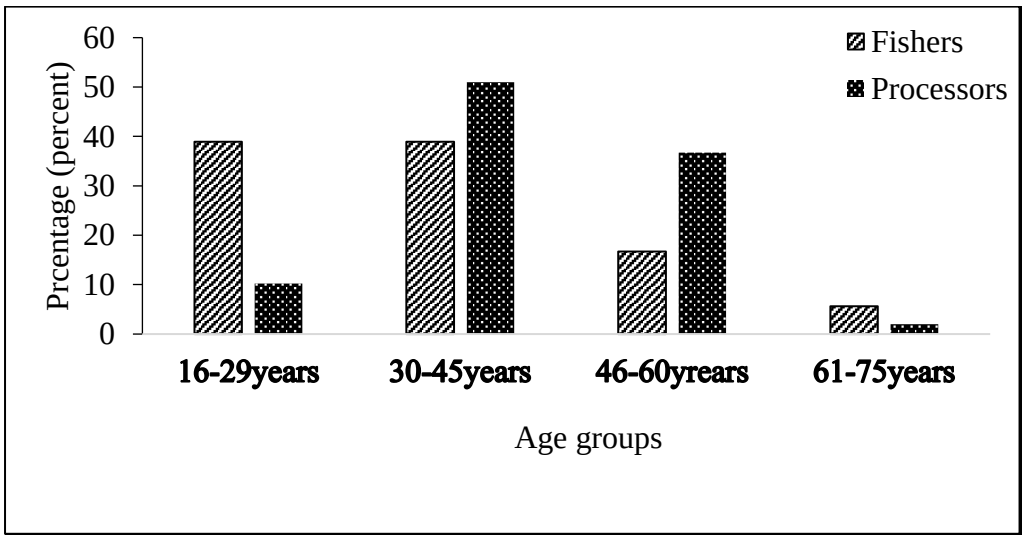

Figure 4: Age classes of individuals in the *Saiko* Fishery at Elmina Landing Site

Correlation Matrix

Table 2 presents the correlation matrix of the socio-economic background of respondents and how it influences the *Saiko* trade. The coefficient values reveals

that the socio-economic characteristics including age of fishers and their educational level did not influence the trade patterns of the Saiko trade. However the quantities of slabs of Saiko fish landed strongly correlated with number of days spent at sea (r=084) which also strongly influence the amount of fuel used (.078).

Table 2: Matrix of Pearson Correlation Coefficient for Fishing Effort and Productivity

Pearson Correlation	Age	Edu	Occu.	No. of Children	Crew size	Fishing days/ Per Trip	Fuel used/ Per Trip	Qty fish slabs bought per trip
Age	1							
Education	.020	1						
Occupation	-.246	-.106	1					
Number of Children	-.214	.243	.506*	1				
Size of Crew	.398	-.014	-.217	.060	1			
Fishing days/ Per Trip	.183	.126	-.140	.000	.258	1		
Qty of Fuel Per Trip	-.381	-.078	.020	-.153	-.009	-.094	1	
Qty of fish slabs bought per trip	-.437	.187	.344	.209	.015	.084	.078	1

Species abundance and composition of *Saiko* fish landings

Sixty-nine (69) species belonging to 44 families were identified from 4,715 individuals of fish during the study period. The dominant species encountered include *Decapterus punctatus* (39percent), *Decapterus rhonchus* (27percent), *Sardinella aurita* (13percent), *Pagellus bellottii* (11percent) and *Chromis cadenati (*10percent) as shown in Figure 5. A total of 36 species were found during the study period and these include *Dibranchus atlanticus,*

Miccochinus ocellalus, *Mystriophis rostellatus*, *Octopus mactopus*, *Parakuhlia macrophthalmus*, among others. Details of all species encountered during the sampling period is listed in Appendix 3, which is at the last pages of this thesis.

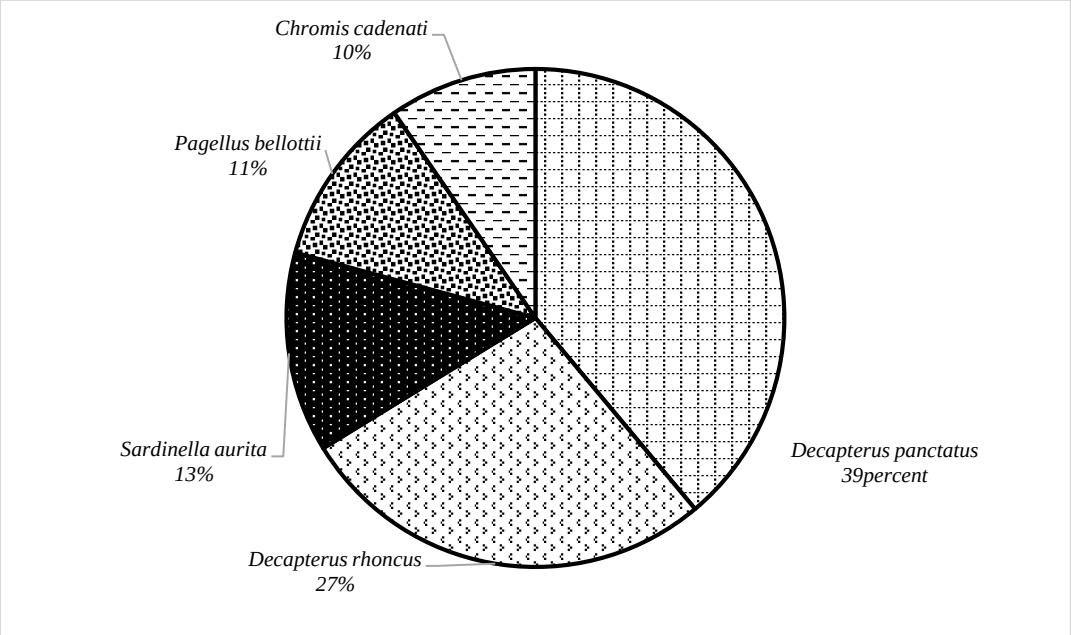

Figure 5 – Species composition by weight of most dominant *Saiko* fish species landed

Ecological indices

Table 3 presents the ecological indices of the monthly fish landed. The monthly trend of Shannon-Weiner Index can be described as following (highest to lowest) the order of December, June, January, May, November and April respectively. The maximum (2.406) value of fish species diversity was recorded in December whereas the lowest (0.808) was recorded in April 2016. Dominance was in the order of April, May, January, December and June whereas the least species dominance was recorded for was in November. Maximum and minimum species recorded were 1139 and 380 species per month for the month of April and November respectively as shown in Table 2. The highest species richness was obtained in January whereas the least was found in

November. Species richness index revealed that, April recorded that highest value was recorded in April whereas the least species was found in November.

The Equitability or Evenness Index (J) was highest (0.6681) in December and least (0.5745) in October. The top three highest species equitability indices were found to be in the order of December, June and November while the least three were reported in May, April and January. A similar trend was recorded for species heterogeneity with the highest value found in December (0.8519), followed by June, April, January, May and November whereas the Simpson's Index was 0.6731 for May.

Table 3 – Ecological Indices of the Saiko Fish Landings

Month	Species Count	Fish Abundance by Number	Dominance Simpson (D)	Shannon Weiner Index (H)	Equitability Index (J)	Species Heterogeneity (Simpson_1-D)
November	10	380	0.3054	1.482	0.6437	0.6946
December	34	787	0.1481	2.406	0.6681	0.8519
January	25	929	0.2429	1.804	0.5883	0.7347
February	-	-	-	-	-	-
March	-	-	-	-	-	-
April	39	1139	0.1914	0.8086	0.5828	0.7571
May	23	1029	0.3269	1.613	0.5745	0.6731
June	28	720	0.1632	2.214	0.6645	0.8368

Source: Field Survey, Eshilley (2017)

Growth Parameter of Commonly Landed Fish Species

The relationship between Standard Length (SL) and Body Weight (BW) of the dominant species such as *Decapterus panctatus* (39percent), *Decapterus rhoncus* (27percent), *Sardinella aurita* (13percent), *Pagellus bellottii* (11percent) and *Chromis cadenati* (10percent) encountered is shown in Figure 6 – 10.

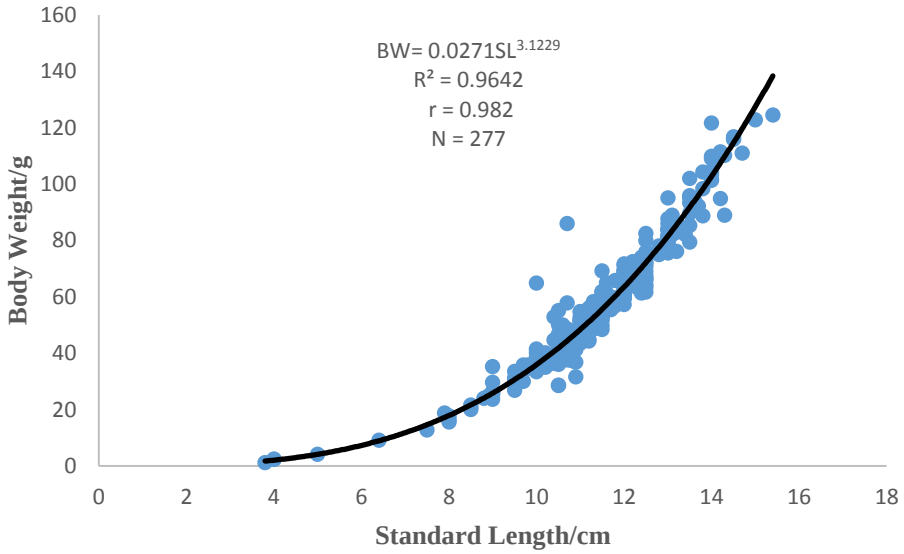

Figure 6 – Length-weight relationship of *Chromis cadenati*

The relationship between Standard Length (SL) and Body Weight (BW) of *Chromis cadenati* indicated a significant exponential relationship (BW= 0.0271 SL $^{3.1229}$, P□ 0.05). The correlation analysis indicates that there is a positive relationship between Standard Length and Body Weight and the coefficient of correlation *r* (r=0.982) in Figure 6 indicates a strong positive association between the two variables. The regression coefficient *b* was not significantly different from hypothetical value 3.0, indicating that *Chromis caddenati* stock exhibited isometric growth (*b* = 3.1229 ± 0.053; P > 0.05).

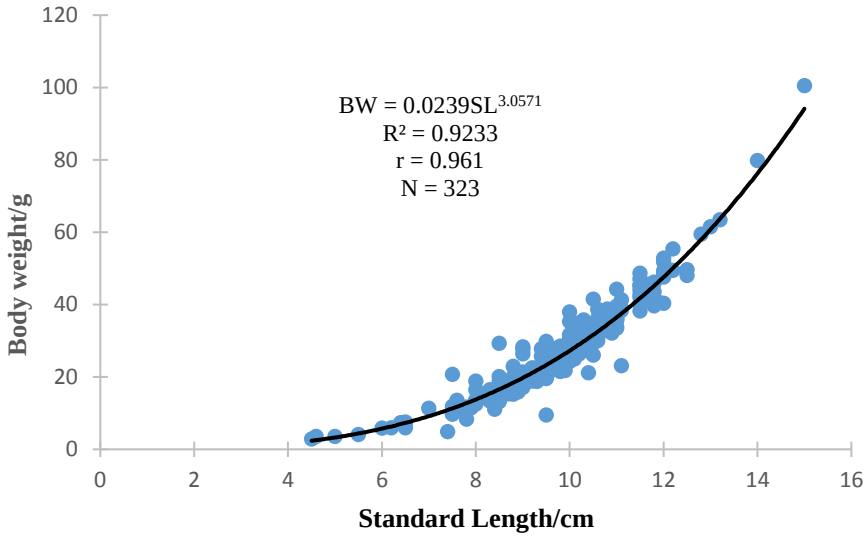

Figure 7 – Length-weight relationship of *Pagellus bellottii*

Figure 7 shows the association between Standard Length (TL) and Body Weight (BW) of *Pagellus bellottii* indicated a significant exponential relationship (BW= 0.0239 SL $^{3.0571}$, P□ 0.05). The correlation analysis also indicates that there is a positive relationship between Standard Length and Body Weight and the correlation coefficient (r=0.961) in Figure 7 means a strong positive association between the two variables under consideration. The regression coefficient *b* was not significantly different from hypothetical value 3.0, indicating that *Pagellus bellottii* stock also exhibited an isometric growth (*b* = 3.0571 ± 0.053; P > 0.05).

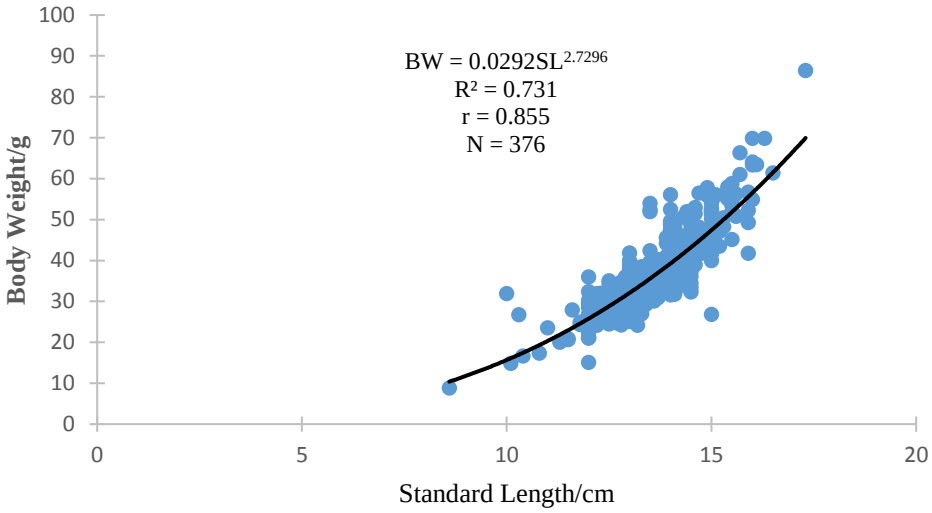

Figure 8 – Length-weight relationship of *Sardinella aurita*

From Figure 8, the relation between Standard Length (SL) and Body Weight (BW) of *Sardinella aurita* similarly indicated a significant exponential relationship ($BW = 0.0292SL^{2.7296}$, P□0.05). The correlation coefficient likewise exhibited a strong correlation (r = 0.855). The regression coefficient *b* was not significantly different from hypothetical value 3.0, indicating that *Sardinella aurita* stock revealed isometric growth ($b = 2.7296 \pm 0.053$; $P > 0.05$).

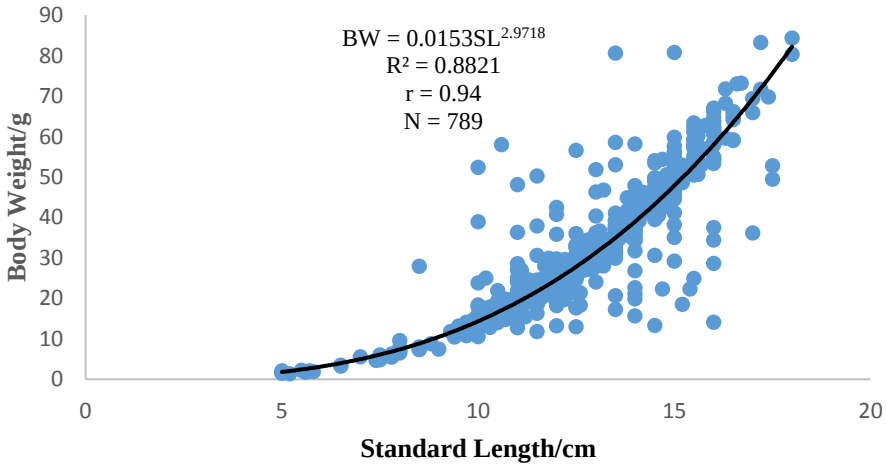

Figure 9 – Length-weight relationship of *Decapterus rhoncus*

In Figure 9, there exists a significant exponential association (BW= 0.0153 $SL^{2.9718}$, P□ 0.05) between Standard Length (SL) and Body Weight (BW) of *Decapterus rhoncus*. Again, the correlation analysis revealed a strong positive correlation looking at the correlation coefficient (r = 0.94). From the regression analysis, the coefficient *b* was not statistically significantly different from hypothetical value 3.0, indicating that the stock of *Decapterus rhoncus* exhibited an isometric growth (*b* = 2.9718 ± 0.053; P > 0.05).

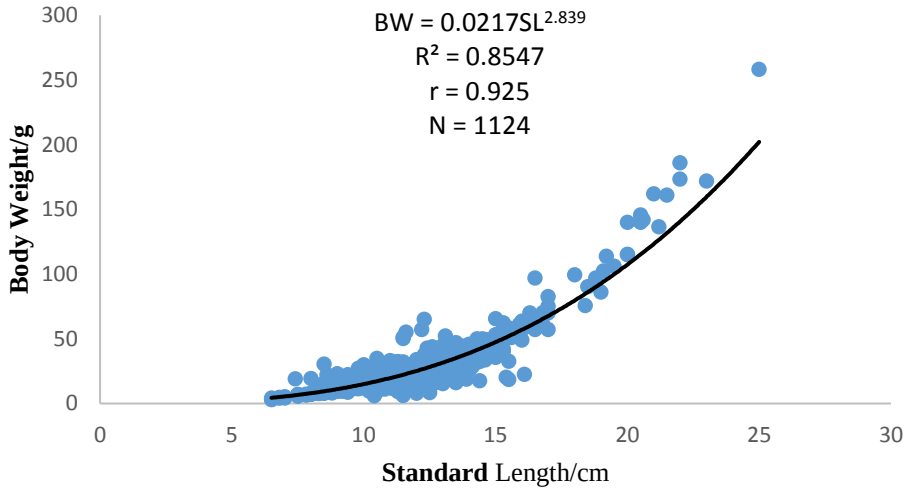

Figure 10 – Length weight relationship of *Decapterus punctatus*

The correlation between Standard Length (TL) and Body Weight (BW) of *Decapterus punctatus* indicated a significant exponential relationship (BW= 0.0217 $SL^{2.839}$, P□0.05). The correlation coefficient (r = 0.925) shows that there is a strong and positive correlation between the two parameters. The regression coefficient (*b* = 2.839 ± 0.053; P > 0.05) was not significantly different from hypothetical value 3.0, indicating that *Decapterus punctatus* stock exhibited isometric growth.

Length frequency distribution of dominant species landed

Length frequency distribution of *Decapterus punctatus* is presented in Figure 11. The finding showed a unimodal frequency distribution with a modal length of 10.0 – 11.9 and it recorded 455 individuals which represent 40.5 percent. The class size with the lowest percentage frequency was 24.0–25.9 and this recorded one individual representing 0.1 percent. The class size 12.0 – 13.9 had the second highest frequency.

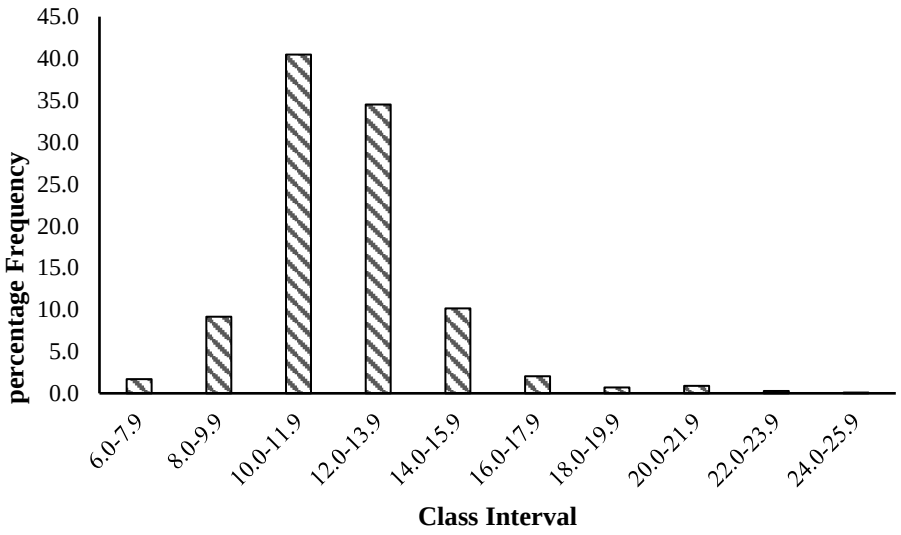

Figure 11 – Length frequency distribution of *Decapterus punctatus*

Figure 12 presents the length frequency distribution of *Sardinella aurita.* The modal class size was 14.0–14.9 and it recorded 113 individuals which represents 38.8 percent. The maximum length was observed to be between 17 and 17.9 whereas the minimum length was found to be between 8.0 and 8.9. The result also shows that the class sizes that recorded the least percentage were 8.0–8.9 and 17.0–17.9 which had recorded one individual each representing one percent.

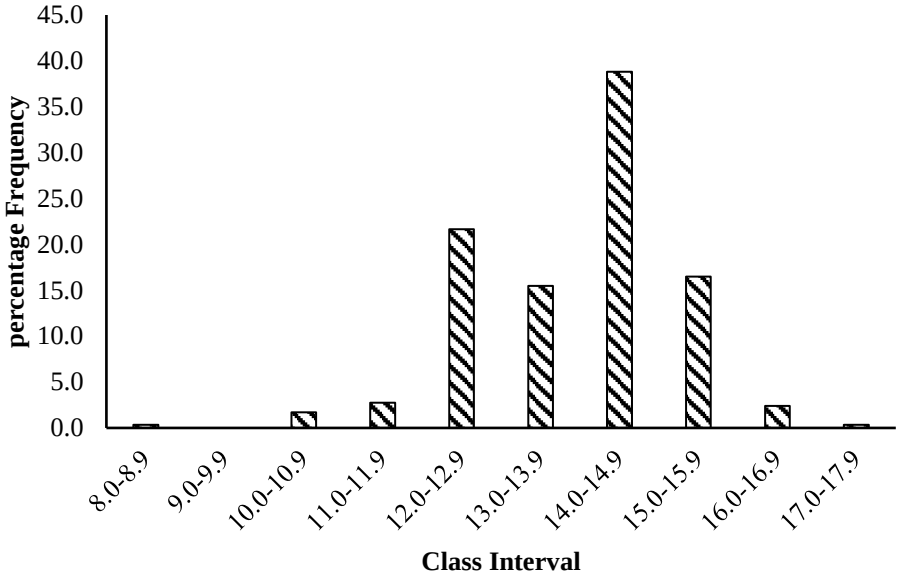

Figure 12 – Length frequency distribution of *Sardinella aurita*

Length frequency distribution of *Chromis cadenati* is as shown in Figure 13. The modal class size was 9.0–11.9 and it recorded 148 individuals which represents 53.4 percent whereas the least class size was 15.0–17.9 recorded 2 individuals which represents 0.7 percent.

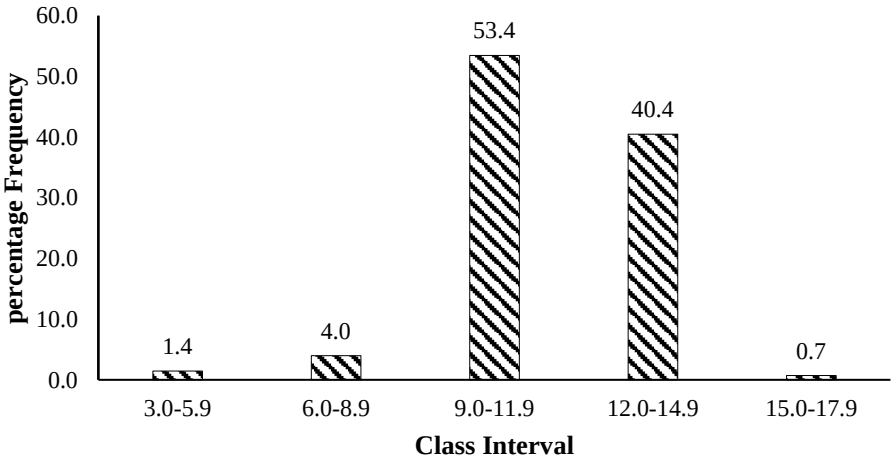

Figure 13 – Length frequency distribution of *Chromis cadenati*.

The fisgure below presents the length frequency distribution of *Decapterus rhoncus.* The modal class size was 11.0–13.9 cm and it recorded 412 individuals which represents 52.2 percent whereas the least class size was 17.0–19.9 cm recorded 10 individuals which represents 1.3 percent.

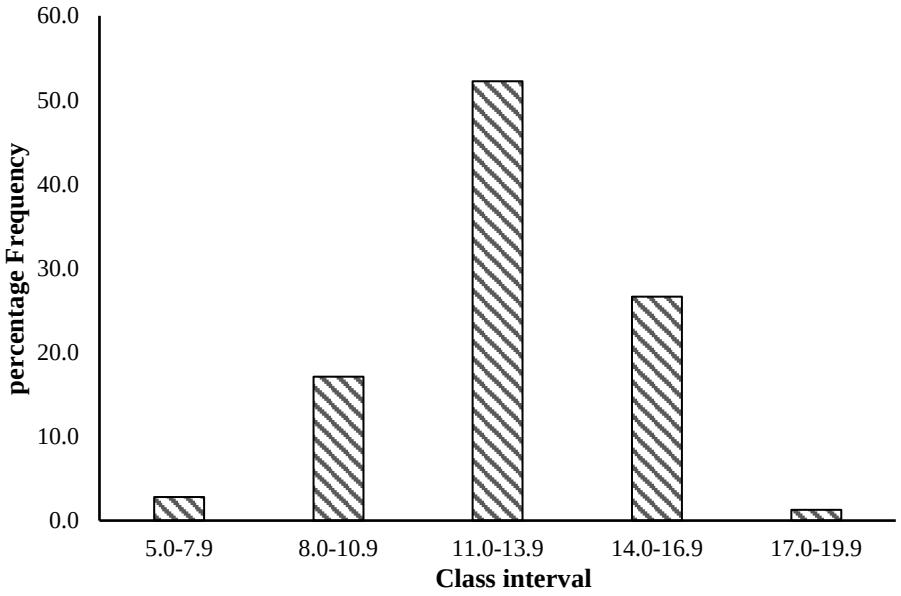

Figure 14 – Length frequency distribution of *Decapterus rhoncus*

TheLength frequency distribution of *Pagellus bellottii is presented in Fifure 15.* The modal class size was 11.0–11.9 cm and it recorded 145 individuals which represents 44.9 percent whereas the least class size was 14.0–15.9 cm recorded 2 individuals which represents 0.6 percent.

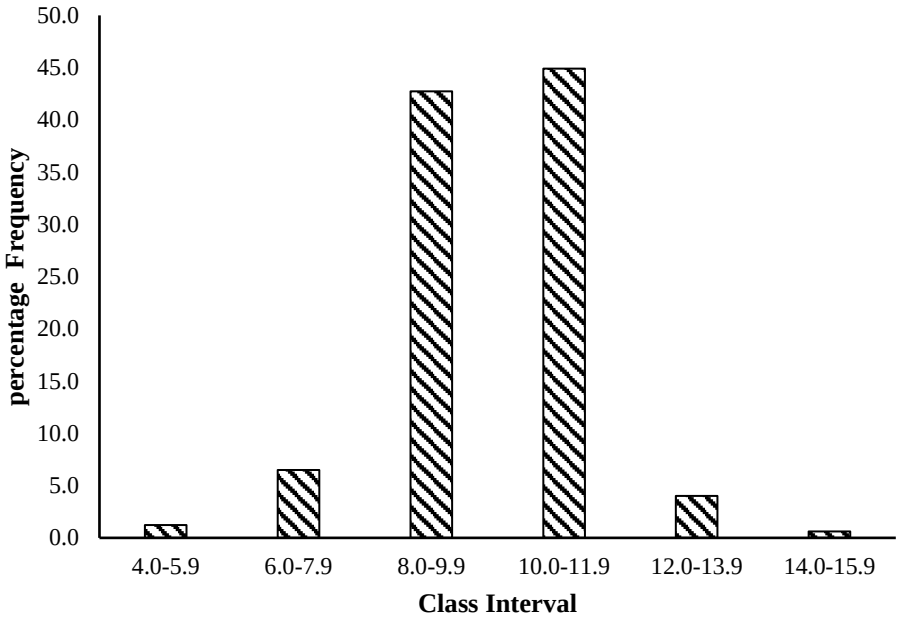

Figure 15 – Length frequency distribution of *Pagellus bellottii*

Size at First Maturity (L50)

The size at first maturity (L_{50}), defined as the size at which 50 percent of all individuals are mature, was used to determine both for males and females, through the equation of the sigmoid curve of percentages (P) of sexual maturity based on size classes (SL). Sigmoid curve computed according to the following formula:

$P = (e^{(\alpha+\beta TL)})/(1- e^{(\alpha+\beta TL)})$ where α and β are parameters of the model. The logarithmic transformation of the previous formula corresponds to the following: in $[P/(1-P)] = \alpha + \beta TL$, and by substituting P = 50percent in the equation, L_{50} will be obtained by the formula: $L_{50} = -\alpha/\beta$. Statview (version 1992-98) was used to calculate the observed proportion of mature fish, the estimated proportion and the coefficients α and β of the model.

Length at first maturity of dominant species encountered

Most of the species encountered were juveniles based on the length at first maturity from literature, with the exception of *Brachydeuterus auritus*. Individuals of *Pagellus bellottii* species encountered 323, 97percent were juveniles and 3percent were mature (Figure 16).

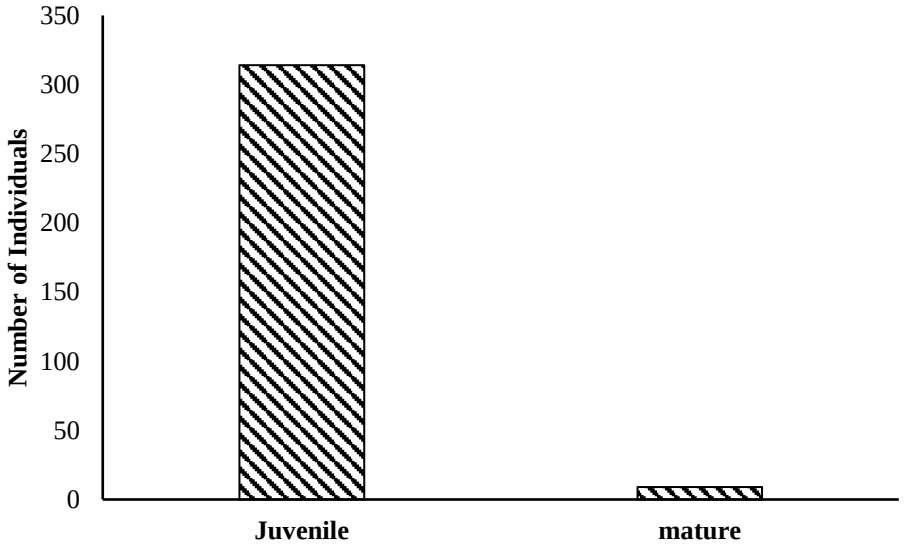

Figure 16 – Proportion of juveniles to mature species of *Pagellus bellottii* landed at Elmina

Out of the total number of *Sardinellla aurita* species encountered were 375, 72percent were juvenile and 28percent were mature (Figure 17).

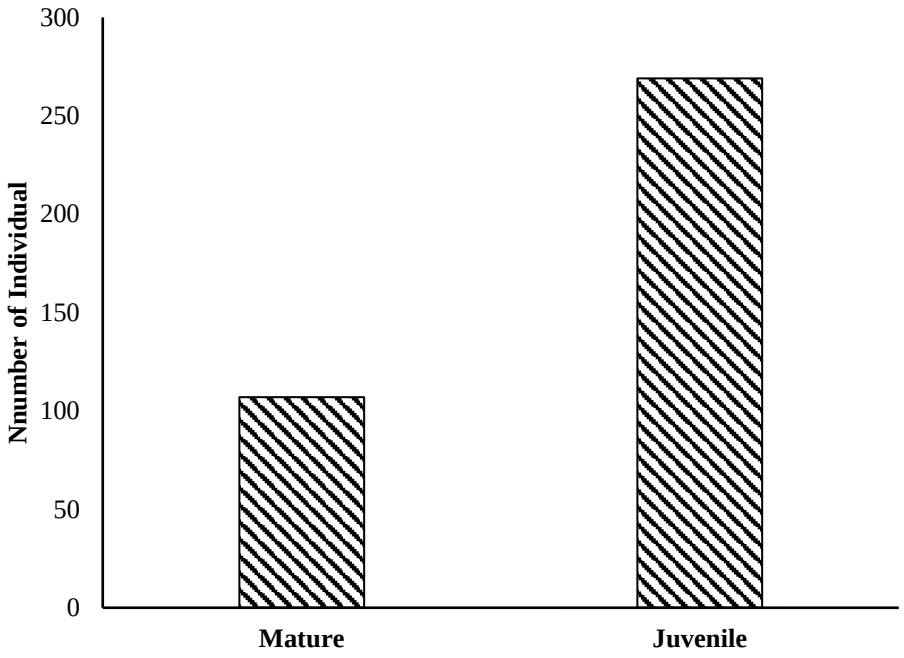

Figure 17 – Proportion of juveniles to mature species of *Sardinella aurita* landed at Elmina

A total of 56 *Brachyduterus auritus* species were encountered 53 were mature, and 3 were juveniles but this species was landed scarcely during the study period (Figure 18).

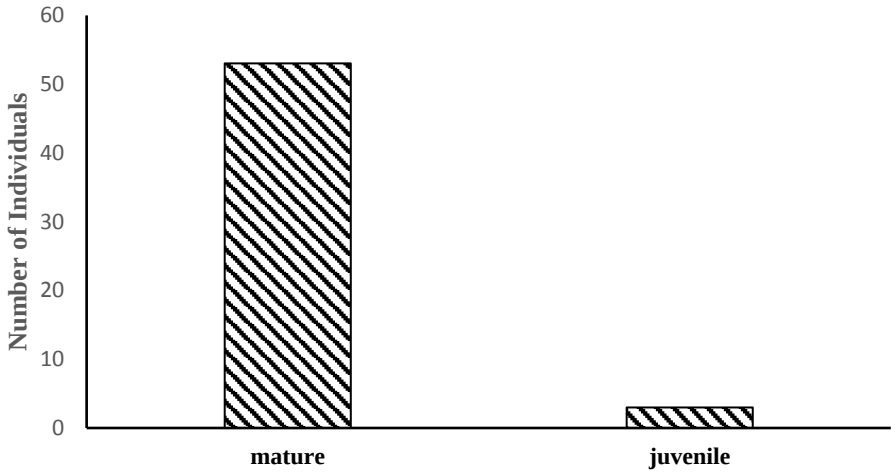

Figure 18 – Proportion of juveniles to mature species of *Brachydeuterus auritus* landed at Elmina

Determination of Catch per Unit Effort

This section covers the crew size, canoe carrying capacities, days spent per trip, gallons of fuel used, fleet size, and quantity of fish landed in a month. These are presented in separate sections.

***Saiko* fishing activities in the study area**

Table 4 presents the summary of *Saiko* fishing activities including the crew size, number of days per trip and quantity of fuel used per trip at Elmina. More than half of the fishers (55.6percent) indicated they had crew size between six (6) and ten (10) and the rest between 11 and 15 members.

Table 4 – Summary of Saiko Fishing Activities or Efforts

Variables		**Frequency**	**percentage**
Crew Size	6-10	10	55.6
	11-15	8	44.4
Number of days per trip	1-2	13	72.2
	3-4	4	22.2
	5-6	1	5.6
Quantity of fuel per trip (gallons)	76-100	5	27.8
	101-125	1	5.6
	126-150	5	27.8
	151-175	5	27.8
	>175	2	11.1
Number of fishing trip per week	Minimum	Maximum	Mean
	1	4	2.33

Source: Field Survey (2017)

On the number of days spent per trip, the results indicate that about three-quarters (72.2percent) of them indicated they spent between one and two days whiles about 22 percent spent between three and four days with one person spending between five and six days per trip. In addition, majority of the respondents spent between 76 and 100 gallons, 126 and 150 gallons and, 151 and 175 gallons per trip as the quantities of fuel used. Nevertheless, few of the

respondents (11percent) spent more than 175 gallons per trip. Number of fishing trip per week was also found to be between one and four times per week with the average being two (2) times per week.

Fleet Size and Quantity of *Saiko* Fish Landed

The fleet sizes at Elmina are shown in the graph in Figure 19 and Table 5 also presents the fleet sizes and corresponding quantities of fish landed at Elmina. Canoe fleet were mostly used for Saiko fishing business. From Figure 19, fleet sizes ranged from 35–60 (ft). However, the most commonly used canoe size measured 55 ft. followed by 40 ft. while the least frequently used fleet size measured 37 ft. and 48 ft.

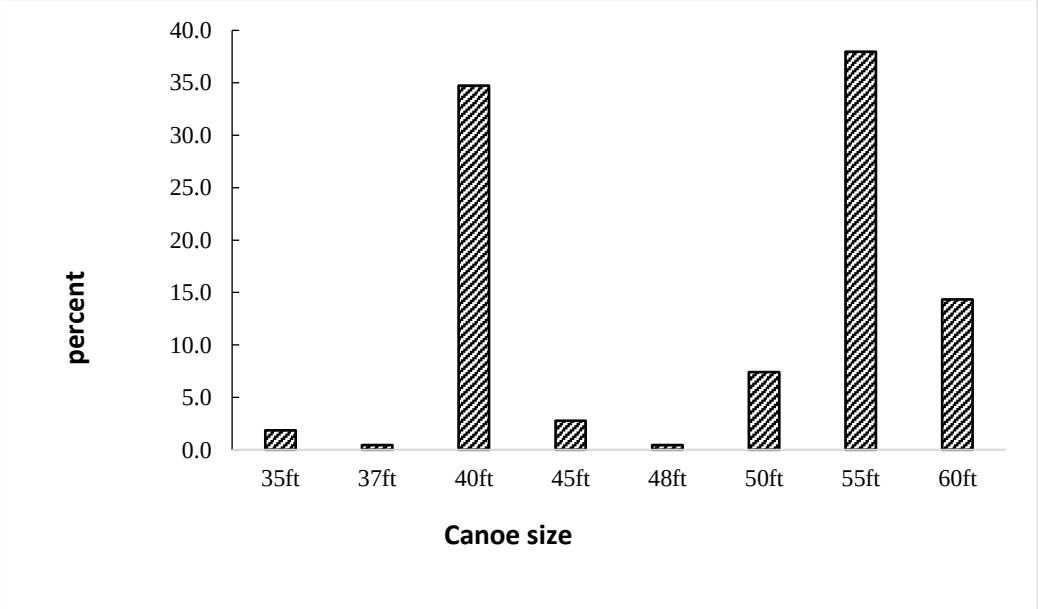

Figure 19 – Canoe sizes used in *Saiko* fishing in Ghana

It was observed during data collection that the number of canoes that land fish at Elmina daily ranges from one to twenty-eight (28) with Mondays and Wednesdays recording the highest number of canoes. The quantum of fish landed by each canoe size depends on the volume of the canoe. For instance, canoes with size of 60 feet landed an average of 3111 ±139 kg slabs whereas

canoes with the smallest volume (35m) recorded the least number of fish slabs (650 ± 87 kg). The result also shows that, fleet size 60 ft. and 50 ft. landed the same maximum slabs (3500) however, 60 ft. landed more minimum slabs (2500) than the 50 ft. fleet size (1500 slabs).

Table 5 – Fleet Size and Quantity of Saiko Fish Slabs Landed at Elmina

Fleet Type (feet)	Maximum No. of Slabs	Minimum No. of Slabs	Mean Slabs
60	3,500	2,500	3,111 ±139
55	3,500	1,500	2,600 ± 126
50	3,000	1,500	2,333 ± 211
45	3,200	1,300	2,200 ± 389
40	2,500	100	1,550 ± 125
35	800	500	650 ± 87

Source: Field Survey (2017)

Monthly Volumes of Fish Transhipped to Elmina

Table 6 presents an inventory of canoes engaged in the *Saiko* business as well as the volumes of fish transhipped from sea. The average number of canoes encountered during the study period was forty-five (45). The results show that April recorded the highest tonnage (8,019.89 tonnes) of fish landed and January recorded the lowest (7,82.73 tonnes). During February and March, no *Saiko* trading activity was noted due to government policy to pilot the closed season system as a management option to improve fisheries in Ghana.

Table 6 – Inventory of Canoe Used and Weight of Slabs Landed

Month	Total Number of Canoes	Total Number of Slabs	Weight of Fish (kg)	Weight (tonnage)
Dec. 2016	51	99,500	1,114,400	1,228.42
Jan. 2017	35	63,400	710,080	782.73
Feb. 2017	-	-	-	-
March 2017	-	-	-	-
April 2017	32	76,500	7,275,520	8,019.89
May 2017	98	24,0800	2,696,960	2,972.89
June 2017	97	24,9450	2,793,840	3,079.68

Profitability of "*Saiko*" Fishing Business (Fishers and Processors)

The "*Saiko*" business comprises of fishermen who act as retailers of fish slabs from trawlers and processors of the frozen fish slabs. Enterprise budgets analysis was used in determining the profitability levels of this type of fishery. In the analysis of the two businesses (fishers and processors), two different enterprise budgets as presented in Tables 7 and 8 were developed for the average "*Saiko*" fisher and processor in Elmina.

Profitability of *Saiko* fishery for the fishers

An average *Saiko* canoe owner purchases about 2,500 slabs from the trawlers in a day at sea. On average, a *Saiko* canoe owner lands about 30,000 kg (300 tonnes) of *Saiko* fish slabs in a month. According to data collected from respondents (fishers) in *Saiko* fishery, there are 60 *Saiko* canoes engaged in

Saiko fishery in Elmina. Resultantly about 150,000 slabs (1,500 tonnes) of *Saiko* fish slabs are landed per day on an average at Elmina (should all 60 canoes land fish in a day). In a representative year, about 2,700 tonnes of fish worth about GH□8 million is landed at the Elmina beach.

Out of the total quantity fish landed, about 20 tonnes which represent 1percent of total fish purchased is given out in kind form either to business partners or family members in a year. A slab of fish purchased from the trawlers cost GH□25.00. The average quantity of fish slabs sold by *Saiko* canoes at Elmina was estimated at about 267,840.00 weighing about 2,680 tonnes in a year.

Total cost of production for an average *Saiko* canoe owner totalled about seven million cedis (GH□7,000,000.00) a year. Canoe owners however require GH□ 70,000.00 to start business owing to the fact that canoe and other fixed assets are available for rent. Also, most *Saiko* fishers were already into fishing before retrofitting their canoes to suit the *Saiko* business. Out of the aforementioned sum, most canoe owners borrowed about 50percent from banks, family or cash lenders. The total cost of producing 2,700 tonnes of fish in *Saiko* fishery requires about GH□7 million a year and about GH□ 200,000.00 a week (Table, 7). This shows that *Saiko* fishery is capital intensive.

The highest contributor to production cost in *Saiko* fishery was the cost of fish slabs (GH□ 6.7m) which represented about 91percent of the cost of production. This shows that any increase in selling price of fish slab would profit as other cost contributors are minimal. Gross revenue from the sale of fish slabs amounted to about GH□8m a year. Out the total revenue received, only 10percent represented profit in a year. An average *Saiko* canoe owner makes

about GH□8m year and about GH□91,000.00 a month, signifying the lucrativeness of the *Saiko* business.

Table 7 – Enterprise Budget for "Saiko" Fishers Operating for 1 Year (9 Months).

Category	Average Quantity	Unit Price (GH□)	Total (GH□)
GROSS RECEIPTS			
Fish Slabs	267,840	30.00	8,035,200.00
VARIABLE COST			
Cost of fish slabs	270,000	25.00	6,750,000.00
Canoe Lining	20	15.00	300.00
Transportation (Fuel)	14,040	15.00	210,600.00
Gloves	360	1.00	360.00
Lamp	4	30.00	120.00
Labour (Owner)	1	21,600.00	21,600.00
Labour (Clerk)	1	10,800.00	10,800.00
Labour (Watchman)	1	7,020.00	7,020.00
Labour (Navigator)	1	10,800.00	10,800.00
Labour (Engineer)	1	6,480.00	6,480.00
Labour (Hustlers)	4	3,780.00	15,120.00
Interest on operating capital	140,664.00	0.25*	35,166.00
Unforeseen expenses (2percent of TVC)	1	141,367.32	141,367.32
A. Total Variable Cost			***7,209,733.32***
FIXED COST			
Equipment depreciation			1,683.08
Equipment interest			3,200.06
B. Total Fixed Cost			***4,883.15***
C. TOTAL COST			**7,214,616.47**
Returns on Variable Costs			825,466.68
Net Returns			*820,583.53*
Returns Per Month			91,175.95
Breakeven yield above TV			240,324.44
Breakeven yield above TC			240,487.22
Breakeven price above VC			26.92
Breakeven price above TC			26.94

*Ghana interest rate is 25percent (Bank of Ghana, 2016)
*Exchange rate as at December 2016 (1GH = US .4185)

Profitability of *Saiko* fish processor

Table 8 presents the enterprise budget used as a proxy for profitability for fish processors. The average cost of a slab of fish from the fishers was about GH□30.00. The total variable cost and total fixed cost were estimated to be GH□506,644.07 and GH□4,662.50 respectively given a total cost (investment) of GH□511,306.57 per year. It was also observed that the highest component of their cost was the capital or money to buy the fish slabs from fisher followed by fuel wood used for processing the fish. Fish processors' return on the total variable cost was estimated to be GH□33,355.93. Again, the total gross returns on investment were GH□540,000.00 per year all things being equal and GH□511,306.57 was the total cost or the investment made. The total profit or the net returns on the investment made by the fish processors was GH□28,693.43. They are also required to invest GH□142.03 as breakeven cost in order to gain GH□3,408.71 as return on that investment.

Table 8– Enterprise Budget for "Saiko" Processor Operating For 1 Year

Category	Quantity	Unit Price (GHC)	Total (GHC)
GROSS RECEIPTS			
Basket	3,600	150.00	540,000.00
VARIABLE COSTS			
Fish Slabs purchased	14,400	30.00	432,000.00
Fuel wood	7,200	5.00	36,000.00
Basket	200	4.00	800.00
Labour			
Owner's labour (Opportunity cost)	9	400.00	3,600.00
Smokers	3,600	0.50	1,800.00
Transportation			
To processing site	72	10.00	720.00
To marketing destination	1,800	4.00	7,200.00
Processor to market centre	18	100.00	1,800.00
Salt	4.50	150.00	675.00
Interest on operating capital	48,459.50	0.25	12,114.88
Unforeseen expenses (2percent of TVC)	1.00	9,934.20	9,934.20
A. Total Variable Costs			506,644.07
NET RETURNS above TVC			33,355.93
Breakeven price above variable costs			140.73
Breakeven production above variable costs			3,377.63
FIXED COST			
Equipment depreciation			2,260.63
Equipment interest			2,401.88
B. Total Fixed Cost			4,662.50
TOTAL COSTS			511,306.57
NET RETURNS ABOVE TC			28,693.43
Breakeven price above Total costs			142.03
Breakeven production above Total costs			3,408.71

*Ghana interest rate is 25percent (Bank of Ghana, 2016)
*Exchange rate as at June 2017 (1GH = US .4185)

Comparative profitability Analysis of *Saiko* Fishery for Fishers and Processors

Percentage profit returns on investment using a graph (Figure 20) was used to compare the two enterprises. Comparing the profitability of the *Saiko* business for fishers and processors in Elmina Ghana, it was realized that there were positive net returns for both groups. An average *Saiko* canoe owner makes about GH□800,000.00 which represented about 11percent returns to investment in a year whiles the average *Saiko* processor also makes 6percent (about GH□ 29,000) returns on investment; signifying that the average *Saiko* fisher makes higher returns on investment than the processor in Ghana.

Middlemen (hustlers) also drain some of the profits of the processors (especially small scale) if fish slabs are not sold directly to them by the fishers.

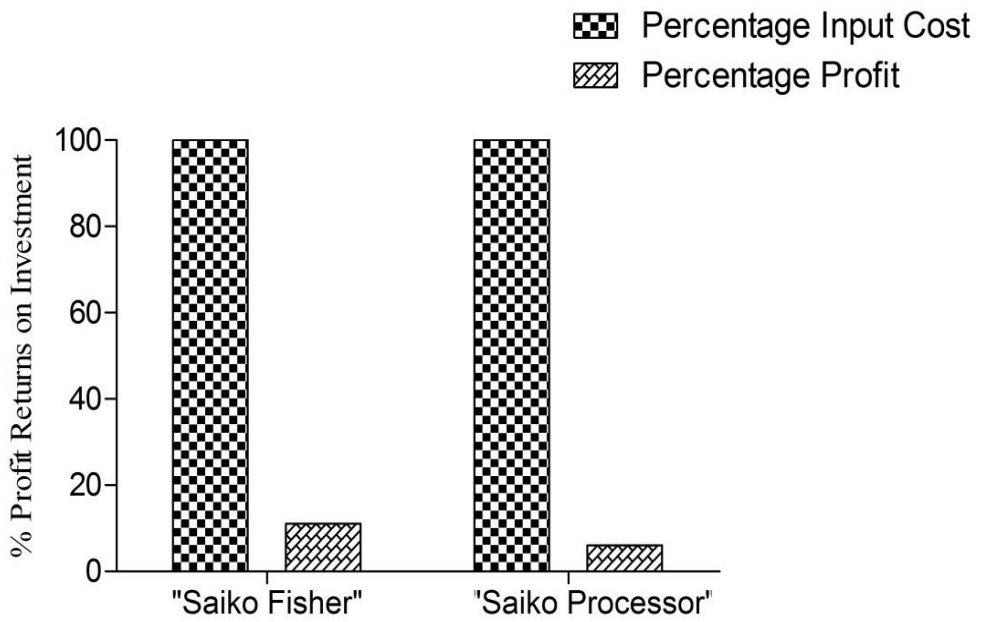

Figure 20 – Comparison of the percentage profit returns of "*Saiko*" fisher and processor

Development of Market Map for *Saiko* Fish

Saiko fish processing and marketing

The study found out that the fishes purchased from the trawlers are landed and sold at Elmina landing site. It was also observed that a slab of fish is usually priced by the canoe owner (GH□35/slab) Middlemen and processors are usually the market target for the canoe owners. However, majority of the fish landed are purchased by the processors. It was also observed that pricing of fish was done at the landing site by the *Saiko* fishermen whiles pricing at the market centres are determined by the women. The fish is usually sold at the various local markets in Ghana and on few occasions sold outside of the borders of the country (Figure 21 and 22).

Local market map of *Saiko* fishery

Figure 21 presents the various market routes and destinations of the *Saiko* fish in Ghana. It was observed that major *Saiko* markets in Ghana are Elmina (biggest), Apam, Axim, Sekondi and Tema. Other market centres for *Saiko* fish (processed and unprocessed) are Tarkoradi, Bogoso, Agona-Nkwanta, Prestea and Sefwi (Western Region); Mankesin, Agona Sweduro, Twifo Praso, Kasoa, Winneba and Assin Foso (Central Region); Oda (Eastern Region); Obuasi and Kumasi (Ashanti Region); Aflao and Denu (Volta Region); Sunyani and Techiman (Brong-Ahafo Region); and Wa in the Upper-West Region of Ghana.

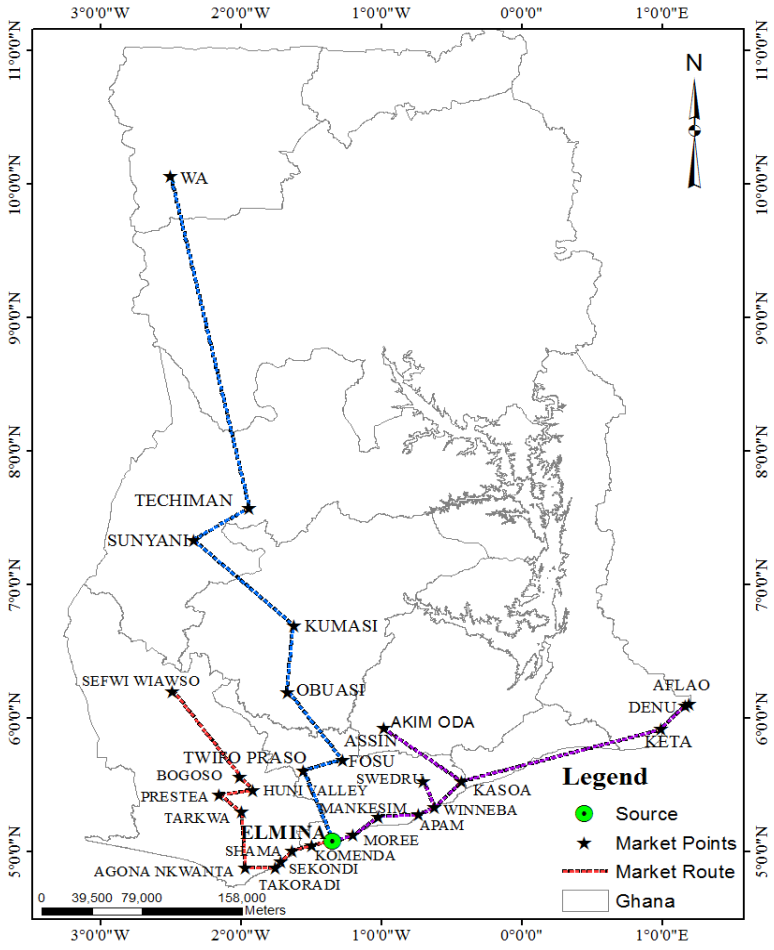

Figure 21 – Market map of the *Saiko* trade in Ghana

International Trading of *Saiko*

The route through which *Saiko* fishes from Elmina are marketed or distributed is shown in Figure 22. Fish from Elmina travel as far as about 1,539 km to Nigeria through the markets at Denu and or Aflao, Togo and Benin.

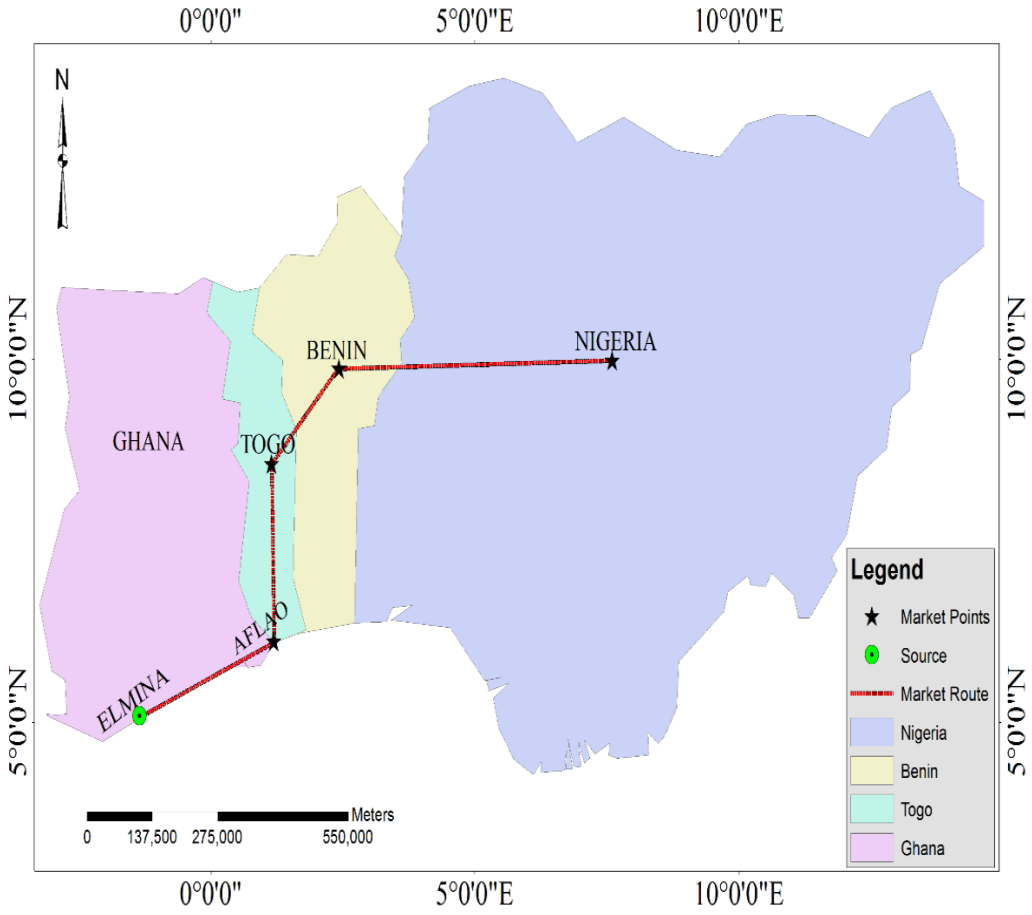

Figure 22 – Market map of the *Saiko* trade in West Africa

CHAPTER FIVE

DISCUSSION

Introduction

This chapter discusses the findings of this study. The chapter is organised into six sections. Following this introduction, the second section deals with the socio-economic characteristics of the respondents. In the third and fourth sections, the fleet size and estimated quantities of fish landed and catch composition such as the growth parameters of the commonly landed fish species are respectively discussed. The profitability of the *Saiko* business in Elmina are discussed in the fifth section. The final section focuses on the development of a market map of the *Saiko* trade within the sub-region.

Socio-economic Characteristics of Respondents

This section discusses the socio-economic characteristics of the respondents such as the age, educational levels, among others. A total of 67 respondents made up of *Saiko* fishers (18) and *Saiko* processors (49) participated in the research. All the fishers were males but the processors were dominated by females.

The findings indicated clearly that the literacy rate among the people engaged in the *Saiko* fish trade at Elmina landing site was very low since fifty percent (50percent) have had education up to only the Junior High School (JHS) level and about 16 of both fishers and processors had no formal education. The result obtained is similar to the findings of Nsiah (2012) which indicated fishermen in the Central and Western Regions have some form of education but very low since majority had only basic education and this could be attributed to several reasons such as teenage pregnancy, child labour, etc for the high

dropout. The result also revealed that most of the respondents had primary education or no formal education since only few fishers and fish processors have had tertiary education. More than half of processors had up to Junior High School education indicating that a majority of them are school drop outs looking at the number that get to the tertiary level. The findings also show that some of the fishers work as clerks, who handle the finances of the *Saiko* operations, have had their tertiary education and this could be attributed to the lucrative nature of the fishery. The result confirm findings of Hen Mpoano (2015) which indicates that in Elmina, only few of the executives of the By-Catch Association had secondary education, and few regular fish processors had primary education and the rest never went to school. Hence, those engaged in *Saiko* have low formal education. Again, the result confirms that there are more married couples among the respondents.

Almost all fishers and processors have family size ranging from one to twelve. However, ninety percent (90percent) of the respondents have number of children ranging from one to six with one (1) to four (4) dominating. This suggests that the respondents have a lot of responsibilities hence their engagement in a lucrative venture like *Saiko*. It is however also noteworthy that only few fishers (16.7percent) do not have children. Nonetheless, Hen Mpoano (2015a) reported that family sizes for those involved in *Saiko* at Elmina varied between 4 and 12, those in Apam had family size between 6 and 13 and those at Axim had family sizes were between 5 and 15. This shows that most of the respondents have a lot of dependents who rely on fishing for a living. This mirrors the situation at the national level where an appreciable proportion of the Ghanaian population (about 10percent) is estimated to depend on coastal fishing

for their livelihoods (FAO, 2004). The large household sizes of the respondents may be due to low literacy levels among the fisher folks and also ignorance of the consequences or negative aspect of having many children.

The findings on the place of origin of the respondents revealed that 76 percent of the respondents were migrants or settlers with few being natives of Elmina. On the duration of respondents' residence, it was observed from the result that all the respondents had lived at Elmina for at least two (2) years and at most 50 years. This finding could be to the fact that, these migrants had worked in their capacity as fishers for a long time in the area but shifted their attention to engage in *Saiko* operations due to dwindling marine fish production and increasing input cost. The current findings suggest that more fishers are likely to migrate to destinations where this illegal fishing takes place in the wake of decreasing trends in marine fisheries stock which urgently needs government interventions. The result also shows that nine out of ten respondents have lived at Elmina between two and ten years and almost quarter of them had lived there for between 30 and 50 years. However, a little over half of the respondent has lived at Elmina for eleven (11) to thirty (30) years.

The findings on the age of respondents depicts that a greater proportion of the fishers were aged between 16 and 45 years whereas more than half of the processors were between 30 and 45 years. This means that most of the people in the *Saiko* business were in their youthful age. However, Hen Mpoano (2015a) reported that the ages of the *Saiko* fish folks in Elmina ranged from 41 to 69 years, whiles those at Apam ranged from 39 to 79 years and fish processors at Axim were between the ages of 30 and 75 years. The results here confirm the findings of Nsiah (2012) and Mbroh (2014) who found that majority of the

fishers in Axim and Saltpond were in their active years (between the ages 15 and 55).

The findings from this study corroborate with that reported by Mbroh (2014) who found that fishers in some coastal areas of Ghana engage in other income generating activities such as farming, petty trading, and operating drinking bars, among others. In this study, majority of the processors indicated that their primary source of livelihood is fish processing and few have other professions as their primary occupation. However, half of the fishers have building construction as their main occupation whiles the other half are mainly fishers. Whereas majority of the processors indicated artisanal fishing as their alternative source of occupation, fishers on the other hand indicated that they engage in artisanal fishing, boat construction and repair works, fish processing during their off days as an alternative source of income. There are few of the fishers who engage in livelihood occupation such as driving and playing footballer whereas some processors are involved in other livelihood activities as petty traders, footballers, seamstress, hairdressers and gari processors for alternative income.

Catch Composition

This section discusses the species abundance and composition of *Saiko* fish landings as well as the ecological indices such as the Shannon-Weiner Index (H), Simpson's Index (D) Species Heterogeneity or Simpson's Index of Diversity (1–D) and Equitability Index or Evenness (J).

Species abundance and composition of *Saiko* fish landings

In the study period, different fish species were observed in the study area. In this study sixty-nine (69) species belonging to 44 families were identified from 4,715 individual fishes landed during the study period, November 2016 to June 2017. This study recorded five dominant species with *Decapterus punctatus* being the most dominant specie followed by *Decapterus rhonchus*, *Sardinella aurita*, *Pagellus bellottii* and *Chromis cadenati* (Figure 5). Nevertheless, a greater proportion of the species (36 species) recorded were landed occasionally (largely insignificant in terms of numbers) – ranged from one (1) to six (6) individuals (Appendix 3). The occurrence of 69 fish species indicates good fish diversity and their presence in Ghanaian waters might be due to the suitable water quality that provides proper breeding ground for fish. However, the existence of few dominant species may be due the overfishing of those species over the years thereby reducing the abundance of most species encountered during the study period. Over fishing within the Ghanaian fishing arena had been attributed to over capacity of the fishery, use of illegal fishing methods, inefficient law enforcement scheme etc.

The findings as presented in the correlation matrix indicates that, fishers were likely to get more fish from the vessels if they travel farther compared to others. In such instances, the amount of fuel used increases which ultimately affect the price per slab sold at the market. The findings also suggest that the price determination for a particular day may depend on the availability of saiko fish landed daily.

Ecological indices

The findings show that fish abundance during the study period increased from November 2016 up to April 2017 and started declining. April 2017 recorded higher fish abundance followed by May 2017. It is also worth noting that there were no data for February and March 2017 as observed in Table 2 because this period marks the closed season for fishers in Ghana and so no active sampling was carried out during the period.

Shannon-Weiner Index encompasses species evenness, richness, and diversity indices (Shannon & Weaver, 1949) and Simpson Index (Simpson, 1949) were used to evaluate the fish species diversity. Shannon-Weiner Index assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample. Shannon diversity is a very widely used index for comparing diversity between various habitats (Clarke & Warwick, 2001). It was calculated in order to know the species diversity in different habitats based on the abundance of the species. The presence of one individual of a species is not necessarily indicative of the species being present in a large number. The value of Shannon-Weiner Diversity Index usually falls between 1.5 and 3.5, only rarely it surpasses 4.5 (Bibi & Ali, 2013). A value near 4.6 indicates that the numbers of individuals are evenly distributed between all the species. From the result obtained in this study, most of the Shannon-Weiner Diversity Index values are within the right range of values except that of April which was not within the range of the standard. The results indicate that there is less diversification of species in the fish landed by the fishers for all the months. However, it could be seen from Table 3 that April had the least fish species diversification followed by

November. December had the most fish species diversification followed by June.

Simpson's Index (D) measures the probability that two individuals randomly selected from a sample will belong to the same species. The findings from this study indicate that 15 to 33 percent of two individuals sampled at random from an assemblage or landings during the study period will be of the same species. In other words, there is high probability that two individuals sampled at random from an assemblage or landings during the study period will be of the same species.

Species heterogeneity or Simpson's index of diversity (1–D) is based on the notion that diversity is inversely related to the probability that two individuals sampled at random from an assemblage will be of the same species (Kwak & Peterson, 2007). From the results in Table 3, it was revealed that there was high probability (about 67 – 85percent) that two individuals sampled at random from an assemblage or landings during the study period will be of different species.

Equitability Index or Evenness measures the equitability in relative abundance among fish species. The result in Table 2 revealed that the evenness of the species landed during the study period (November 2016 to June 2017) are within the acceptable range (0–1.0) indicating even distribution of the individuals among different species. The relative abundance of fish species might be related to the availability of food, habitat condition and breeding season of the species. It was appropriate to report richness, diversity, and evenness when describing fish assemblage structure or fish composition

because reporting only diversity as an assemblage structural index confounds the effects of species richness and evenness (Kwak & Peterson, 2007).

It is important to note that Shannon-Weiner's diversity index is sensitive to changes in rare species in the community and is considered a type I diversity index, whereas Simpson's index is influenced to a greater extent by abundant species and is a type II index (Peet, 1974; Krebs, 1998). Again, Shannon's, Simpson's, and other diversity indices have been represented by various forms that are based on the original theory proposed (Pielou, 1975; Washington, 1984; Krebs, 1998), so investigators should report the exact algorithm used to compute the index rather than simply citing a reference (Kwak & Peterson, 2007).

Determination of Catch Per Unit Effort

This section discusses the *Saiko* fishing activities (crew size, canoe carrying capacities, days spent per trip, gallons of fuel used), fleet size, and quantity of fish landed in a month.

***Saiko* fishing activities in the study area**

This section discusses the summary of *Saiko* fishing activities including the crew size, number of days per trip and quantity of fuel used per trip at Elmina. More than half of them had crew size between 6 and 10 and the rest between 11 and 15 members and this was confirmed by the in-depth interview (IDI) which indicated that crew size ranged between 6 to15 people. Nonetheless, Hen Mpaono (2015b) found that the crew size was 6-10 at Axim, 20-25 at Elmina and 15-24 at Apam. The crew composition usually consists of the canoe owner (sometimes), clerk, navigator (Jumper), watchman, hustlers, engineer (outboard engine operator) and a driver.

On the number of days spent per trip, the findings indicated they spent between one and six days (12-144 hours) but majority spent one or two days (12-96 hours) depending on the proximity of the industrial trawlers to the shoreline. Similar finding (fishers spent between 12 to 72 hours) was recorded during the IDI and Hen Mpaono (2015) also reported 5-24 hours at Axim, 12-72 hours at Elmina and Apam. Mostly, the expedition is done at night and by morning the crew would be at shore to sell their fish.

On the quantities of fuel used, majority of the respondents spent between 76 and 175 gallons per trip. This finding is comparable to what Hen Mpaono (2015) reported which says that number of gallons of fuel used per trip was 50-90 at Axim, 50-140 at Elmina and 40-140 at Apam. Nevertheless, few of the respondents spent more than 175 gallons per trip. It is also important to mention that the amount of fuel used daily depends on the size of canoe and distance travelled. The transhipment activities usually occur several miles away from the coast. They also indicated that before the transhipment, the fishermen use gadgets such as mobile phones, torchlight and whistle to communicate or locate the trawlers when at sea. How effective they do this also affect the hours and quantities of fuel used per trip.

The number of fishing trips per week was also found to be between one (1) and four (4) times, with the average being two (2) times per week however, Hen Mpoano (2015b) reported that in Axim they do once in a month and 12 times in Elmina and Apam.

Fleet Size and Estimated Quantities of Fish Landed

It can be inferred from the finding that depending on the volumes of slabs available to be discharged by the industrial trawlers, these *Saiko* fishers

either use a bigger, medium or smaller canoe for collection. The results in Table 5 indicated that, the maximum number of slabs landed was dependent on the fleet size. Estimate of the maximum, minimum and mean number of slabs landed per month depicts a picture where fleet size correspond to the quantities of fish landed. The result indicates that the volume of *Saiko* fish landed depends on the carrying capacity of the canoe fleet and vice versa.

The findings indicated that the highest tonnage of landed fish was recorded in April and the least was in January 2017. It was also observed that though April had the least number of canoes yet recorded the highest tonnage of fish landed. This could be attributed to large size of fleet or canoe compared to the fleets landed in other months as well as the weight of fishes landed during the time. There were no data for February and March 2017 as observed in Table 4 because this period marks the closed season for fishers in Ghana. The closed season was introduced by the MoFAD in November 2016 and in February and March 2017. This was done based on the Fisheries Management Plan of Ghana which seeks to help reduce fishing capacity and aid in revamping the fish stocks. The closed season had a big toll on both *Saiko* business and artisanal sector as lamented by fishers.

Furthermore, an in-depth interview conducted confirms the result from the quantitative data collected and this is seen in the following revelations. The transhipment activities usually occur several miles away from the coast. The maximum number of slabs traded was found to be between 3000 and 3500 whereas the minimum number of slabs transhipped to smaller canoes also ranged from 2,000 to 2,500 slabs per day. This is similar to a report by Hen

Mpoano (2015) which indicates the carrying capacity of canoes at Elmina and Apam were between 1000 and 4000 slabs, and 20 and 500 at Axim.

It was also observed that mostly, the expedition is done in the evenings and by morning the crew should be at shore to sell their fish. *Saiko* has a ready market all the time and more especially in the lean season. During data collection, it was also observed that the *Saiko* value chain is made up of the canoe owners, the crew members, the hustlers, the head porters, the transport agents, the fish mongers, up to the end user or consumer. It is also important to state that each member of the value chain has a unique role they play in the fishery though some roles overlap for some members.

Growth Parameter of Commonly Landed Fish Species

This section discusses the length-weight relationships and length frequency distribution of five dominant species landed.

Length-weight relationships of dominant species landed

The relationship between growth parameters such as length-weight relationships gives information on the condition and growth patterns of fish. It is said that fish exhibits isometric growth when length increases in equal proportions with body weight from constant specific gravity. There was a significant correlation between body weight and standard or total length of all specimens in this study, indicating that increase in length resulted in corresponding increase in weight. In other words, the findings on the relationship between the Standard Length and Body Weight (BW) of all the species used in this study indicates that as the length of the fishes increases their weight also increases which suggest that length correlates with weight. However, comparing the dominant species shows the strength of the

relationship between the two parameters decrease in this order *Chromis cadenati* (r = 0.982), *Pagellus bellottii* (r = 0.961), *Decapterus rhonchus* (r = 0.94), *Decapterus punctatus* (r = 0.925) and *Sardinella aurita* (r = 0.855).

The estimated *b* values (figures 6-10) were within the normal, expected range (*b*=2.5–3.5) for fish (Froese, 2006). Bagenal and Tesch (1978) also suggested that when the value of *b* is between 2.8 and 3.2, growth is considered to be isometric; in other words, growth of all body parts is consistent and proportional throughout development. Based on *t*-test results, estimated *b* values were not significantly different from the hypothesized value of 3.0 (Figure 6-10), indicating isometric growth for these fish species. It has been reported that values of the exponent *b* can be influenced by statistical procedure and sample size (Bolger & Connolly, 1989), as well as by variations associated with size range, maturation, sex and time of year (Cone, 1989). Kerkich, Aksissou and Casal (2013) also reported that the variations could be attributed to differences in age, maturity, sex, geographic location and associated environmental conditions such as seasonality, stomach fullness, disease and parasite loads can also affect the values of *b*.

It has been reported by several authors including Bagenal and Tesch (1978) and Moutopoulos and Stergiou (2002) that length-weight relationship provides information on the condition and growth pattern of fish. The length-weight relationships for *Sardinella aurita* was exponential and the relation can be described mathematically as $BW = aSL^b$. Where BW is the body weight, SL is the Standard Length, *a* is a constant and *b* the exponent.

Asabere-Ameyaw and Blay (1999) reported the exponent of the length-weight relationship (b = 3.15; $BW = 0.0099SL^{3.15}$) of *Pagellus bellottii*

estimated in the Cape Coast - Elmina and surrounding waters shows isometric growth in the species. The finding of this study (BW= 0.0239 SL $^{3.0571}$, P□ 0.05) is similar to that of Asabere-Ameyaw and Blay (1999) and that reported by Rijavec (1973) for the species in Ghanaian waters.

Fishbase (2014) found that *Decapterus punctatus* from Cape Verde waters exhibit isometric growth (b = 2.990 ± 0.053; P > 0.05) which agrees with the findings of this study. However, Fishbase in the same year reported positive allometric growth (b>3) for this species in United States (b = 3.190 ± 0.053; P > 0.05). Nonetheless, it has been reported that other *Decapterus species* also exhibited isometric growth just like *D. punctatus*. For instance, Ashwini, Benakappa, Anjanayappa, and Akshay (2016) and Jaiswar, George, Gulati and Swamy (1993) reported on length and weight relationship of *Decapterus russelli* and stated W = 0.0098777SL$^{3.0765}$ and W=0.00312SL$^{3.00}$ respectively which indicates the isometric growth of the fish.

Moreover, Hart and Abowei (2007), Abowei (2010), Aggrey-Fynn (2009) and Salem, El-Aiatt and Ameran (2010) have all reported this relationship in fish. *S. aurita* had a significant relationship and a strong correlation between standard length (SL) and body weight (BW). Additionally, the exponents of *S. aurita* (b = 2.7296 ± 0.053; P > 0.05) did not differ significantly from 3.0, and so such a fish is said to grow isometrically, and Bagenal and Tesch (1978) described such growth pattern as maintaining the same shape throughout the life of the fish.

The finding agrees with Anonymous (1976) who reported that *S. aurita* stock in waters of Ghana and Ivory Coast all exhibit isometric growth. However, in Nigerian waters, Lawson and Doseku (2013) found the same species to

exhibit negative allometric growth. Tsikliras, Torre and Stergiou (2005), Salem et al. (2010) and Mehanna and Salem (2011) have all reported that, in the Mediterranean Sea, *S. aurita* stocks showed positive allometric growth. However, other species like *S. maderensis* has also been reported by Djama, Gabche and Youmbi-Tienctheu, (1989) to have isometric growth of stock in Cameroonian waters. Nonetheless, Bagenal and Tesch, (1978); and Kraljevic, et al., (1995) have indicated that variation in the growth of the same species could come about as a result of difference in sex, maturity stage and season as well as differences in geographical locations and associated environmental conditions.

Length frequency distribution of dominant species landed

The length-frequency distribution of all the specimens showed a unimodal size distribution (Figure 11-15). Comparing the recorded size range (4.0-25.9 cm) of the fish specimens with majority falling between 9.0 cm and 15.0 cm, it is obvious that most of the fishes that are landed at the Elmina by *Saiko* fishers are juveniles, and this calls for management plans as this may affect recruitment of adult to the fish stock and possibly future collapse of the fishery in Ghana. Again, when the recorded size range (4.0-25.9 cm) is compared with the size at first maturity of the specimen (Figure 16-18) suggests that most of the fishes that are landed can be described as juveniles. The findings in this study are similar to what Aggrey-Fynn et al. (2013) reported for *Sadinella aurita*.

The maximum length of *Sardinella aurita* was observed to be between 17 cm and 17.9 cm which far below what has been reported in literature. For example, Brainerd (1991) reported 25 cm as the maximum size observed in the

Ivorian-Ghanaian waters and >30 cm for the Congo-Angolan, Senegal and Mauritania populations. Schneider (1990) reported that the species grows up to 35 cm but commonly up to 18 cm in the Gulf of Guinea.

Again, the estimated maximum length in this study is likewise less than the observed maximum length of 25.50 cm reported by Tsikliras et al., 2006 in the Mediterranean Sea off Algeria and 27.35 cm in Tunisian waters. Chesheva (1998) recorded a maximum length of 39.10 cm for the Mauritanian stock. The differences in length here could be attributed to the differences in the age or maturity stage of the fishes as well as differences in temperature and availability of food during those years and currently which guarantee continuous growth in tropical fish. According to Bannerman and Cowx (2002), it can be inferred that since 1980s the maximum size of fish has reduced with a shift towards smaller length groups which may be due to shift in fishing patterns of local fishers.

Profitability of *Saiko* Business

This section discusses the profitability (enterprise budget) of the *Saiko* business in Elmina. It has been divided into subsections for fishers and processors.

Profitability of *Saiko* fishery for the fishers

This part looks at the fishers' enterprise budget analysis used a a proxy for profitability of *Saiko* fishery. In this study 60 canoes were documented to have been involved in the *Saiko* industry at Elmina. This number represents a 50percent increase of what was reported by Hen Mpoano (2015) recorded to be 30. This suggests that the number had doubled within three years. According to the estimations done in the results section, about 150,000 slabs (1,500 tonnes) of *Saiko* fish slabs would be landed per day at Elmina if all the 60 canoes land

fish in a day. However, this was not the reality because fishers have agreed to land fish in batches to prevent losses. As a result in a representative year, about 2,700 tonnes of fish worth about GH□8 million is landed at the Elmina beach. Again, the findings show that about 20 tonnes of total fish purchased at sea are given out in kind form either to business partners or family members in a year indicating that about one percent of total fish landed are not sold but are either consumed or given as gift.

The findings also suggest that fishers make an average profit of GH□5.00 on each slab of fish purchased from the trawlers which cost GH□25.00 since a slab of fish is sold at GH□30.00 on average. The total cost of producing 2700 tonnes of fish for an average *Saiko* canoe owner was about seven million Cedis (GH□7,000,000.00) a year and about GH□200,000.00 a week (Table 6). Again, GH□70,000.00 is required to start *Saiko* business in addition to canoe and other fixed assets. This shows that *Saiko* fishery is capital intensive and so most *Saiko* fishers borrowed about 50percent out of the aforementioned sum of money from banks, family or cash lenders. The highest contributor to production cost in *Saiko* fishery was the cost of fish slabs (GH□6.7 million) which represented about 91percent to cost of production. This confirms the fact that it is capital intensive and require huge capital to start such a business. Hen Mpoano (2015) reported similar findings and stated that fishers require between GH□15,000 and GH□35,000 to acquire a canoe and GH□10,000 and 16,000 to acquire an outboard motor in addition to other initial capital to start a *Saiko* business. It also means that if the cost of a slab is increased by the trawlers it will in turn increase the amount of money one needs in order to start business. Gross revenue from the sale of fish slabs amounted to

about GH□8m and this could be the reason why those into *Saiko* business cannot leave this business since they see huge sums of money. It is worth mention however that about 10percent of the total revenue received is the profit made which is about GH□8m a year and about GH□ 91,000.00 a month signifying the lucrative nature of the *Saiko* business in Ghana. *Saiko* fishers earn between GH□3,500 to GH□6,800 for every 500 slabs of fish sold, and one could earn up to GHC28,000 per trip depending on the carrying capacity of the canoe, the purchasing power and unavailability of regular artisanal landed fish (Hen Mpoano, 2015). The income generated from *Saiko* fishery does not vary with seasons. However, the patronage depends on the unavailability of regular artisanal fish since it is not preferable in abundance of "fresh fish".

Profitability of *Saiko* Fish to the Processor

In this section enterprise budget used as a proxy for profitability for fish processors was presented in Table 8 and it was realized that the fishers normally sell a slab of fish to the processors at an average price of GH□30.00. This means that the fishers make GH□5.00 gross profit per slab of fish sold to the processor. However, it was realised that the selling price could go up (between GH□33 and GH□40) if there are middlemen between the fishers and the processors. Cold store operators were mainly the middlemen in this business. The total cost (investment) was GH□511,306.57 per year, that is, GH□506,644.07 as the total variable cost and GH□4,662.50 as total fixed cost. This is an indication that *Saiko* is a capital-intensive enterprise which requires huge sums of capital to start hence processors borrowing from several sources similar to that of the fishers. It was also observed that the highest component of their cost was the capital or money to buy the fish slabs from the fisher followed by fuel wood

used for processing of the fish. These two cost components are considered as important parts of the enterprise that the processors cannot start the business without and would require the processors to look for enough funds before going into fish processing especially on a large scale. The estimated return on the total variable cost only was GH□33,355.93 however, the gross returns on investment were GH□540,000.00 per year, all things being equal, indicating a positive return on their investment. The total profit or the net returns on the investment made by the fish processors was GH□28,693.43. They are also required to invest GH□142.03 as breakeven price in order to gain GH□3,408.71 as return on that investment per trip.

Development of a Market Map of the *Saiko* Trade within the Sub-region

This section gives a brief description of the activities of the *Saiko* fishery value chain and the local and international market map within the country and in the sub-region.

Description of activities in the *Saiko* fishery value chain

Normally, *Saiko* fish comes in frozen form, in varying shapes depending the type of fishing vessel, shape of pans they used in freezing the fish. It usually comes in rectangular or square shapes. With the rectangular shape, some are more elongated than others hence they are given the name “Pen drive” by those in *Saiko* business. The average weight of a fish slab is about 10 kilograms. Again, the fish landed comes in various species; ranging from small pelagics to demersals depending on the type of vessel these fishers buy from. However, most often, the commonly abundant catches are the small pelagics and largely made up of the families Carangidae and Clupeidae. It was also observed that a

slab of fish can have only one species of fish or up to ten different species of fish.

The study found that some fishers deal with vessels that work outside Ghanaian waters including vessels from Liberia, Gambia, Sierra Leone and Ivory Coast.

Generally, most *Saiko* fishers go out to purchase fish on the sea when the vessels inform them of an available catch and so Elmina *Saiko* fishers normally meet the vessel in Elmina waters, others meet at Saltpond, Apam, Axim, Sekondi, Tema, Ada and Half-Assini. According to the respondents the vessels usually meet the *Saiko* canoes in the inshore zone usually as low as 12 fathom depths to about 45 fathom depths to offload fish to these canoes. It is also important to note that there is high possibility of these vessels engaging in fishing activities in these inshore zones though it is prohibited by law. The respondents indicated that there are about 50 fishers involved in the *Saiko* business but about 20 of them are more permanent whiles the rest (30) engage in the practice on transient or temporary basis. A common practice that was noticed was that some fishers have registered with some Chinese companies in Tema where they pay monies to their accounts and later collect fish with chits at sea. Hence, the *Saiko* business is more or less a cashless business inshore. On the hand, the temporary or 'hit and run' mostly carry physical cash on them to sea to buy fish from vessels. This practice is rather risky business because sometimes they return without fish since vessel usually serves canoes with chits first before selling, if any, surplus fish to the ephemeral often referred to as "hit and run buyers". The study also found that one vessel can supply as many as six *Saiko* canoes with fish.

With respect to capital for this business, one needs a minimum of GH□2,000.00 – GH□2,500.00 to be able to set out for a single *Saiko* trip (excludes the money for the purchase of the fish). This makes *Saiko* business very capital-intensive business to be engaged in by poor people. As a result, most people start the business with loans with varying payment plans and interest rates. At Elmina, there are about four main fishing companies that deal in *Saiko* business. These are *Nasaaa*, *Presson*, *Ok* and *Afashandor* and of these the *Nasaaa* and *Presson* have the largest market – they usually land the small pelagic and mid water fish species. The *Ok* and *Afashandor* usually land benthic fish species.

The study found out that the fishes purchased from the trawlers are landed and sold at Elmina landing site. It was also observed that the canoe owners usually do the pricing of fish landed and usually the price is about GH□35.00 per slab of fish. According to the canoe owners, middlemen and processors are usually their targets however, majority of the fish landed are purchased by the processors. Women were also seen to have a significant role in *Saiko* fish processing and marketing. Whiles pricing of fish was done at the landing site by the *Saiko* fishermen or canoe owners, prices at the market centres are determined by the women usually processors. The fishes are usually sold at the various local markets in Ghana and on few occasions sold outside of the borders of the country.

Local and international market maps of *Saiko* fishery

In an attempt to map out the market centres for *Saiko* fishes in Ghana, it was observed that Elmina is the hub of *Saiko* business and largest market in Ghana followed by Apam, Axim, Sekondi and Tema. The last three sales points

are not as vibrant market as Elmina and Apam market centres. It must also be stated that at times canoes from Apam land at the Elmina site due to the high market demand at Elmina. It was observed that *Saiko* fishery business has dwindled at Sekondi beach due to the increased marine police patrol in attempt to enforce of the laws against *Saiko* fishery, since it is an illegal activity in Ghana.

Other market centres for *Saiko* fish (both processed and unprocessed) identified in the Western Region were, Takoradi, Bogoso, Agona–Nkwanta, Prestea, Sefwi Wiawso and other major Sefwi communities. In the Central Region, Mankessim, Agona Swedru, Twifo Praso and Assin Fosu were the major market centres identified. In the Eastern Region, Akim Oda was the major market centre identified, whereas Obuasi and Kumasi were identified in the Ashanti Region. The rest identified were Aflao and Denu in the Volta Region, Sunyani and Techiman in the Brong-Ahafo Region and Wa in the Upper-West Region of Ghana.

With regards to the international market *Saiko* fish were traded as far as Nigeria which is about 1,539 km from Elmina.. In fact, the fishes from Elmina (Ghana) that find their way and get sold in Nigeria are not intended to be taken there but are actually meant for the markets at Denu near Aflao, a border town between Ghana and Togo. Nevertheless, international fish marketers who come to Denu purchase the processed fish and or products to Nigeria via Togo and Benin. The mode of transportation for these marketers to these international market centres is usually by road. That notwithstanding, majority of the *Saiko* fish landed in Elmina are sold in Ghana at the respective market centres as stated in Chapter four.

Legal Implications of the *Saiko* Trade

According to Section 132 (1) of the Fisheries Act 625, 2002 transhipment may be undertaken under the condition that it is supervised. "Unless authorised in writing by the Commission, no fishing vessel shall be used for transhipment of fish in the fishery waters without the supervision of an authorised officer or under such other arrangement and conditions as may be approved in advance by the Commission". Again, Regulation 33 (5), states that "a person shall not transfer fish from one canoe to another canoe or from a semi- industrial vessel to canoes except in a verifiable emergency situations". The above stated conditions are not met by the *Saiko* fishers and the blatantly ignore the above regulation without recourse to the law.

Also according to the Fisheries Regulations, 2010, L.I. (1968) Regulation 33 (2), a person shall not tranship fish from a Ghanaian industrial vessel to a semi-industrial vessel or to canoes or vice-versa. Thus saiko activities are illegal hence measures should be put in place to curtail or streamline their operations.

Ecological and Social Impacts of the *Saiko* Fishery

The study reveals that the *saiko* landings constitute more than 50 percent of pelagic fish species, which goes to confirm the assertion that the trawlers are targeting small pelagics and are also encroaching in on the inshore zone which is illegal as stated by the Fisheries Act 625, 2002.

Again, aside the fact that these trawlers are landing mostly small pelagics, most of the species landed are juveniles which is very alarming because if juveniles are exploited it will affect recruitment and replenishment of the stocks and this may lead to collapse of the fish stocks.

On the average a *Saiko* fisher lands 30,000 Kilogram/300 tonnes of fish per month. Considering the volumes of fish landed that goes unaccounted for on monthly basis of which more than fifty five (55percent) percent are small pelagics and are mostly juveniles, the state of the small pelagic fishery is at tipping point to a collapse if not an extinction. This pervasive practice if not addressed, can aggravate the already existing poverty situation in coastal communities where the practice is dominant since artisanal fisheries are being threatened with collapse.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This Chapter presents the summary, conclusions and recommendations of the study. Summary of the results and conclusions have been organized based on the specific objectives and the research questions of the study. This section also presents some recommendations based on the conclusions drawn from the study and suggested areas for further research.

Summary

Overview of the study

Over the years, Ghana has enjoyed a long tradition of an active fishing industry that has made giant strides, developing from a principally traditional canoe fleet to a mix of traditional and modern fleet – industrial trawlers. This sector is currently faced with the challenge of declining fisheries resources culminating from weak governance that has tolerated wasteful over-capacity, conflicts and pervasive unsustainable and harmful fishing practices among others. Recently, a new form of transhipment has developed between industrial vessels and the artisanal canoes, with the canoes buying frozen by-catch from trawlers at sea.

This practice (commonly known as *Saiko* fishery) has grown exponentially due to its lucrative nature in many coastal communities (Central, Western and Greater Accra Regions) of Ghana, even though it is illegal and prohibited under the Fisheries Act 625. Therefore, this study was conducted to provide in-depth information on the state of our fish stocks as against the illegal fishing activities thus, landings of the *Saiko* vessels, the valuation of gains of

Saiko operators in order to address the poverty situation in fishing communities as well as open up opportunity for the sustainability of coastal fisheries in general. Specifically, the study sought to (i) assess catch composition of common fish landed by the *Saiko* canoes, (ii) assess growth parameters of common fish landed by the *Saiko* canoes, (iii) examine catch per unit effort by the *Saiko* canoes, (iv) assess the profitability of the *Saiko* trade, and (v) develop a market map of the *Saiko* trade within the sub-region.

The study was conducted at Elmina, a major coastal fishing community in the Komenda-Edina-Eguafo-Abrem (KEEA) Municipality in the Central Region and employed a descriptive and cross-sectional survey design using a mixed research approach (quantitative and qualitative approaches). The target population were *Saiko* fishers and processors at Elmina and therefore census was used. The total respondents used in the study were made up 18 fishers and 49 fish processors and were obtained using snowball sampling technique. The major instruments for the data collection were the structured interview schedule, observation guide and top weighing balance and a rule. Face-to-face interviews, in-depth interview and observation were the methods used to collect the data from February, 2016 to April, 2017 for the survey data and November, 2016 to June, 2017.

Using SPSS computer software, version 20.0, socio-economic characteristics of the respondents, species abundance and composition, catch per unit effort, length frequency, and length-weight relationship were analysed using descriptive statistics, chats and regression. Ecological indices were used to describe the fish diversity in the study area. The qualitative data was transcribed and enterprise budget analysis was used to assess the profitability of

Saiko business. Graphical presentation was used to describe the fish markets for the *Saiko* trade within Ghana and in the sub-region.

The findings on the socio-economics characteristics revealed a low literacy rate among respondents; family size ranges from one (1) to twelve (12) members; most of them were migrants or settlers with few being natives of Elmina; majority have lived at Elmina for at least two (2) years and at most 50 years; a little over half of the respondent have lived at Elmina for eleven (11) to thirty (30) years; most fishers were aged between 16 and 45 years whereas more than half of the processors were between 30 and 45 years; processors indicated that their primary source of livelihood was fish processing and few have other professions as their primary occupation; and half of the fishers indicated construction as their main occupation whiles the other half are mainly fishers.

The study identified 69 species belonging to 44 families from 4,715 individual fishes landed during the study period and recorded five dominant species. However, a greater proportion of the species (36 species) recorded were landed occasionally. The occurrence of 69 fish species indicates good fish diversity. Most of the Shannon-Weiner Diversity Index values found were within the right range of values (1.5–3.5) apart from April which was not within the range of the standard. However, the findings indicate that there is less diversification of species in the fish landed by the fishers for all the months studied. The findings also indicate that 15 to 33 percent of two individuals sampled at random from an assemblage or landings during the study period will be of same species. As a result, there was high probability (67–85percent) that two individuals sampled at random from an assemblage or landings during the study period will be of the different species. The evenness of the species landed

during the study period was within the acceptable range (0–1.0) which can be described as even distribution of the individuals among different species.

Again, half of fishers had crew size between 6 and 10 and the rest between 11 and 15 members with the crew composition consisting of the canoe owner (sometimes), clerk, navigator (Jumper), watchman, hustlers, engineer (outboard engine operator) and a driver. It was also found that the respondents spent between one and six days (12-144 hours) at sea but majority spent one and two days (12-96 hours) depending on the proximity of the industrial trawlers. It was also found that they spent between 76 and 175 gallons per trips, and number of fishing trip per week was also found to be between one and four times per week with the average being two (2) times per week. The maximum, minimum, and mean number of slabs landed per month estimates showed that fleet sizes correspond to the quantities of fish landed and the highest tonnage of landed fish was recorded in April and the least was in January 2017. It was observed that though April had the least number of canoes yet recorded the highest tonnage of fish landed. There were no data for February and March 2017 because this period marks the closed season for fishers in Ghana.

There was a strong and significant correlation between body weight and standard length of all specimens in this study, indicating that increase in length resulted in corresponding increase in weight. The estimated *b* values were within the normal and expected range (b=2.5–3.5) for fish and their growth patterns can be considered to be isometric. Based on *t*-test results, estimated *b* values were not significantly different from the hypothesized value 3.0, also indicating isometric growth for these fish species. Comparing the recorded size range (4.0-25.9 cm) of the fish specimens (with majority falling between 9.0 cm

and 15.0 cm) it was obvious that most ofz fishes that were landed at the Elmina by *Saiko* fishers were generally juveniles.

The enterprise budget analysis used as a proxy indicate that about 150,000 slabs (1,500 tonnes) of *Saiko* fish slabs would be landed per day at Elmina if all the 60 canoes land fish in a day. Again, about 2,700 tonnes of fish worth about GH□8 million is landed at the Elmina beach. The findings also suggest that fisher makes an average profit of GH□5.00 on each slab of fish purchased from the trawlers and *Saiko* fishers earn between GH□3,500.00 to GH□6,800.00 for every 500 slabs of fish sold, and could even earn up to GHC28, 000.00 per trip. The total profit or the net returns on the investment made by the fish processors was GH□28,693.43 per season. They are also required to invest GH□142.03 as breakeven price in order to gain GH□3,408.71 as return on that investment per trip.

Elmina is the hub of *Saiko* business and largest market in Ghana followed by Apam, Axim, Sekondi and Tema, all found in the coastal part of the country. Other market centres for *Saiko* fish (both processed and unprocessed) identified in the Western Region were Takoradi, Bogoso, Agona–Nkwanta, Prestea, Sefwi Wiawso and other major Sefwi communities. In the Central Region, Mankessim, Agona Swedru, Twifo Praso and Assin Fosu were the major market centres identified. In the Eastern Region, Akim Oda was the major market centre identified, whereas Obuasi and Kumasi were identified in the Ashanti Region. The rest identified were Aflao and Denu in the Volta Region, Sunyani and Techiman in the Brong-Ahafo Region and Wa in the Upper-West Region of Ghana. With regards to the international market, *Saiko* fishes were traced to as far as Nigeria which is about 1,539 km from Elmina. It

was found that the fish from Elmina (Ghana) that find its way and gets sold in Nigeria are in fact not intended to be taken there but are actually meant for the markets at Denu near Aflao, a border town between Ghana and Togo. However, some market women in Ghana eventually transport the fishes to Nigeria.

Conclusions

The following conclusions were drawn from the findings based on the specific objectives:

It can be concluded that though species of fish landed at Elmina were diversified, only few were dominant species. In addition, the distribution of the individual fishes among different species can be described as even. It was also ascertained that the *Saiko* operations land a lot of the small pelagic stocks which is contributing to the decline of Ghana's artisanal fishery sector.

It was also concluded that a crew had at least five members, spent at least 12 hours at sea, use at least 76 gallons of fuel per trip and on average go to the sea two times per week. It can also be deduced that the number of slabs landed per trip is dependent on the fleet size and so there is a positive correlation between quantities of fish or number of slabs landed and fleet or canoe size.

It can also be concluded that body weight highly correlated with standard length and all specimens studied exhibited an isometric growth pattern.

It is concluded that the *Saiko* trade is very capital intensive but profitable for both fishers and processors involved in the practice. Indeed, the processing and marketing of *Saiko* fish are mainly done by women. It was also concluded that 55percent of the fish species landed were small pelagics and mostly juvenile species; again the trawlers encroach on the inshore zone during their fishing operations. It has been established that Elmina is the hub of *Saiko* fishery.

Again, *Saiko* fishes are traded mostly within the southern to middle part of Ghana with Wa being the furthest point of sale inland. Internationally, it is also traded within the West African sub-region, specifically in Togo, Benin and Nigeria.

Recommendations for Policy

It is recommended that the outcomes of this study be implemented by the fisheries law enforcement agencies to safeguard the already declining fish stocks.

The Fisheries Commission should work towards reducing legitimacy of the *Saiko* operations through sensitization and law enforcement measures.

Recommendations for Further Study

There should be efforts to engage more *Saiko* fishers in research to help curtail the problem. First, entry points including drivers or the compelling reasons why persons go into the practice need to be studied for management of the practice. Secondly, it is proposed to extend the study to other coastal districts where the practice is prevailing.

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APPENDICES

Appendix 1

SOCIO-ECONOMIC AND BIOLOGICAL ASSESSMENT OF "*SAIKO*" FISHING AT ELMINA FISH LANDING SITE

FISHERS

Dear respondent,

You have been contacted to participate in this research survey because you are a stakeholder in the fishing industry in Ghana. Your participation is voluntary. Please understand that your responses will be used for academic research purposes only while ensuring that your anonymity is preserved.

Please take out time to answer the questions as appropriate as possible. Thank you for your time.

Date: …….. Time: ……

A. DEMOGRAPHIC INFORMATION

1. Age: up to 15yrs [ ] 16-29yrs [ ] 30-45yrs [ ] 46-60yrs [ ] 61-75yrs [ ] >75 [ ]
2. Gender: Male [ ] Female [ ]
3. Educational status: Primary [ ] JHS [ ] Secondary [ ] Tertiary [ ] None [ ]
4. What is your primary occupation? ……
5. Do you have any alternative occupation? .....
6. Marital status: Married [ ] Single [ ] Divorced [ ] Separated [ ]
7. Number of children: 1-3[ ] 4-6 [ ] 7-9 [ ] 10-12 [ ] 13-15 [ ] 16-19 [ ] >20 [ ]
8. Place of origin (hometown)…….

9. How long have you stayed in Elmina? Up to one year [ ] 2-5 years [ ] 6-10 years [ ] 11-15years [ ] 16-20years [ ] 21-25 years [ ] 26-30 years [ ] 31-35 years 36-40years [ ] 41-45years [ ]

   46-50 years [ ] > 50 [ ]

B. CATCH PER UNIT EFFORT

10. What is the size of your crew?

    1-5 [ ] 6-10 [ ] 11-15 [ ] 16-20 [ ] 21-25 [ ] 25-30 [ ] >30 [ ]

11. What is the length of your canoe (in feet)?

    Up to 35 [ ] 36-45 [ ] 46-55 [ ] 55-60[ ] 61-65 [ ] >65 [ ]

12. Do you own a canoe? Yes [ ] No [ ]

13. If Yes, how many canoes do you own? 1[ ] 2[ ] 3 [ ] 4[ ] 5 [ ]

    6[ ] > 6[ ]

14. How many days do you spend on a trip?

    1-2 days [ ] 3-4days [ ] 5-6 days [ ] one week [ ] > one week [ ]

15. How much premix fuel (number of gallons) do you use on each trip?

    Up to 25 [ ] 25-50 [ ] 51-75 [ ] 76-100 [ ] 101-125 [ ] 126-150 [ ] 150-175 [ ] >175 [ ]

16. Do you usually buy from more than one vessel per trip? Yes [ ] No [

17. If yes, how many? 2 [ ] 3 [ ] 4 [ ] 5[ ] >5[ ]

18. How many slabs of fish do you buy per trip?

    < 100 [ ] 101- 200 [ ] 201-300 [ ] 301-500 [ ] 501-1000 [ ] 1001-1500 [ ] 1501-2000 [ ]

    2001-2500 [ ] 2501-3000 [ ] 3001-3500 >3500 [ ]

19. Does it take you more than 12 hours to meet up with a vessel?

    Yes [ ] No [ ]

20. At what depth (fathoms) does your vessel dock? ……

21. Which community do you sail from? .....

22. Which of the following do you use in locating the trawling vessel?

i. Mobile phone [ ]

ii. Whistle [ ]

iii. Torchlight [ ]

iv. Megaphone [ ]

v. GPS [ ]

vi. Eco- sounder [ ]

vii. Other …….

23. What is the price per fish slab from the trawling vessel? .....

24. How many fishing trips do you make in a week? 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ] 7 [ ]

25. Where else do you land your fish? Apam [ ] Secondi [ ] Axim [ ] Tema [ ]

26. How often do you land your fish elsewhere? .....

Never [ ] once a week [ ] once in two weeks [ ] once a month [ ] other [ ]

27. What are the common fish species you land? .....

28. What are some of the species you rarely land? .....

29. How long does it usually take to sell off a trip of fish? One day [ ] two days? [ ] three days [ ] four days? [ ] five days [ ] six days [ ] one week [ ] > one week [ ]

30. What are the sizes (cm) of fish you usually land?

Up to 5[ ] 6-10 [ ] 11-15[ ] 16-20 [ ] 21-25 [ ] 26-30 [ ]

31-35 [ ] 36-40 [ ] 41-45 [ ] 46-50 [ ] < 50 [ ]

31. What percentage of the catch is usually sold? 100percent [ ] 99-90percent [ ] 89-80percent [ ] 79-70percent [ ] 69-60percent [ ] 59-50percent [ ]

32. What percentage is given out in kind? Up to 5[ ] 6-10 [ ] 11-15 [ ]

33. What challenges do you face in the *Saiko* fishery? Fuel shortage [ ] Risk involved [ ]

Unavailability of safety gears [ ] Difficulty in locating trawlers [ ] Destruction of canoes by the vessel [ ] others……

34. Do you engage in any other Fishery? Yes [ ] No [ ]

35. Have you participated in any other fishery in the past? Yes [ ] No [ ]

36. Do you know where the sold fish is mostly taken to? Yes [ ] No [ ]

37. If yes where? ……

C. PERCEPTION OF FISHERS

38. How do the quantity of fish you purchase compare to that of ten years ago?

    Same [ ] Increased [ ] Decreased [ ]

39. If increased, by what proportion in terms of number of slabs? …….

40. If decreased, by what proportion in terms of number of slabs? .....

41. How long (in years) have you been in the *Saiko* fishery? Up to 1 [ ]

    2-5 [ ] 6- 9 [ ] 10-12 [ ]

    13-15 [ ] 16-19 [ ] >20 [ ]

42. Are you getting the same sizes of fish as five years ago? Yes[ ] No[ ]

43. If No, what is the reason for the increase in sizes in your opinion? .....

44. What accounts for the decrease in sizes in your opinion? .....

45. Do you have concerns about the fisheries resources in terms of dwindling stocks? Yes [ ] No [ ]

46. If Yes express……

Appendix 2

SOCIO-ECONOMIC AND BIOLOGICAL ASSESSMENT OF "*SAIKO*" FISHING AT ELMINA FISH LANDING SITE

PROCESSORS

Dear respondent,

You have been contacted to participate in this research survey because you are a stakeholder in the fishing industry in Ghana. Your participation is voluntary. Please understand that your responses will be used for academic research purposes only while ensuring that your anonymity is preserved.

Please take out time to answer the questions as appropriate as possible. Thank you for your time.

Date: …….. Time: ……

A. DEMOGRAPHIC INFORMATION

1. Age: up to 15yrs [ ] 16-29yrs [ ] 30-45yrs [ ] 46-60yrs [ ] 61-75yrs [ ] >75 [ ]
2. Gender: Male [ ] Female [ ]
3. Educational status: Primary [ ] JHS [ ] Secondary [ ] Tertiary [ ] None [ ]
4. What is your occupation? ……
5. Do you have any alternative occupation? Yes [ ] No [ ]
6. Marital status: Married [ ] Single [ ] Divorced [ ] Separated [ ]
7. Number of children: 1-3[ ] 4-6 [ ] 7-9 [ ] 10-12 [ ] 13-15 [ ] 16-19 [ ] >20 [ ]
8. Place of origin (hometown)……..……

How long have you stayed in Elmina? Up to one year [ ] 2-5 years [ ] 6-10 years [ ] 11-15years [ ] 16-20years [ ] 21-25 years [ ] 26-30 years [ ] 31-35 years 36-40years [ ] 41-45years [ ]

46-50 years [ ] > 50 [ ]

C. VALUE CHAIN ANALYSIS OF THE MARKET CHANNELS

10. Where do you buy your fish? ……..

11. What is the price of an unprocessed fish slab? .....

12. What species of fish do you normally sell? .....

13. Normally how many slabs of unprocessed fish do you sell per week? .....

14. How do you store your unprocessed fish? .....

15. Do you encounter losses through spoilage of unprocessed fish?

Yes [ ] No [ ]

16. If yes, how often? …….

17. How many slabs do you normally lose? .....

18. What do you do with the fish that goes bad? .....

19. Do you process fish before selling? Yes [ ] No [ ]

If No, move to question 30

20. If yes, how do you process the fish? Drying [ ] salting [ ] frying [ ] smoking [ ] other……

21. How much does it cost to process per slab? .....

22. How do you store processed fish? ……

23. How many slabs of processed fish do you sell per week? .....

24. Do you encounter losses through spoilage of processed fish? ……

25. If yes, how often? ……

26. How many slabs do you lose on each occasion? …….

27. Do you encounter losses through any other means? …….

28. If yes, please explain the mode of loss ……...

29. What would you expect as returns on a slab of fish? .....

30. Do you take your fish outside this town for sale? Yes [ ] No [ ]

31. If Yes, where? …….

32. What is the price of unprocessed fish per slab at destination market?

……..……..

Appendix 3

Table 8 below indicates the various species encountered, their habitats and percentage (percent) composition, during the study

Families	Species	Common Name	Habitat	Frequency	percent Composition
ACANTHURIDAE	***Acanthurus monronviae***	Monrovia doctorfish	Demersal	4	0.1
APOGONIDAE	***Affinis apagon***	**	Demersal	17	0.4
ARIOMMATIDAE	***Arioma bondi***	Silverr-rag driftfish	benthopelagic	7	0.1
BALISTIDAE	***Balistes panctatus***	Bluespotted triggerfish	Demersal	2	0.0
BALISTIDAE	***Ballistes capriscus***	Grey triggerfish	Demersal	4	0.1
BATHYSAURIDAE	***Bathysaurus ferox***	**	Bathydemersal	10	0.2
BATRACOIDIDAE	***Halobactrachus didactylus***	Lusitanian toadfish	Demersal	4	0.1
BOTHIDAE	***Bothus guibei***	Guinean flounder	Demersal	233	4.9
BOTHIDAE	***Bothus podas***	Wide-eyed flounder	Demersal	175	3.7
BOTHIDAE	***Monolene helensis***	moon flounder	Demersal	72	1.5
BOTHIDAE	***Monolene mertensi***	Marten's moonflounder	Demersal	218	4.6
BOTHIDAE	***monolene microstoma***	smallmouth moonflounder	Demersal	10	0.2
CARANGIDAE	***chloroscombus chrysurus***	Atlantic bumper	benthopelagic	1	0.0
CARANGIDAE	***Decapterus Panctatus***	Round scad	Pelagic	1124	23.8
CARANGIDAE	***Decapterus rhoncus***	Falsescad/Mackerel scad	pelagic	789	16.7
CARANGIDAE	***Trachurus tracae***	Cunene horse mackerel	pelagic	106	2.2
CARCHARINIDAE	***Carcharhinus altimus***	Bignose shark	pelagic	1	0.0
CHAETODONTIDAE	***Chaetodon robustus***	Butterfly fish	Demersal	3	0.1
CICHLIDAE	***Chromis cadenati***	Stripped chromis	reef associated	277	5.9
CLUPEIDAE	***Sardinella aurita***	*Round sardinella*	pelagic	375	8.0

Cynoglossidae	***Cynoglossus senegalensis***	Senegalese tonguesole	Demersal	1	0.0
Dactyloperidae	***Dactylopterus volitans***	Flying gurnard	reef associated	97	2.1
ENGRAULIDIDAE	***Engraulis encrasicolus***	European anchovy	pelagic-neritic	85	1.8
FISSURELLIDAE	***Fistularia tabacaria***	Blespotted cornetfish	Reef associated	3	0.1
Haemulidae	***Brachydeuterus auritus***	Bigeye grunt	Semi pelagic	56	1.2
Kuhliidae	***Parakuhlia macrophthalmus***	Dara	Neritic	1	0.0
LOLIGINIDAE	***Allotethus africana***	African Squid	Demersal	15	0.3
Luttjanidae	***Apsilus fuscus***	African forktail snapper	Demersal	4	0.1
Merlucciidae	***microchirus ocellatus***	four-eyed sole	Demersal	1	0.0
MONOCANTHIDAE	***Aleuterus heudoloti***	Dotterel filefish	Demersal	1	0.0
MONOCANTHIDAE	***Alusterus schoepfii***	**	Demersal	3	0.1
MONOCANTHIDAE	***Canthethines pullus***	**	Demersal	1	0.0
MONOCANTHIDAE	***Stephanolepis hispisdus***	**	Demersal	13	0.3
MULLIDAE	***Pseudupeneus prayensis***	West African goatfish	Demersal	18	0.4
Muraenesocidae	***Cynopticus ferox***	Guinean pike	Demersal	1	0.0
Octopodidae	***Octopus mactopus***	White-spotted octopus		1	0.0
Ogcocephalidae	***Dibranchus atlanticus***	Atlantic batfish	Bathydemersal	1	0.0
Ophichthidae	***mystriophis rostellatus***	African spoon-nose eel	Demersal	1	0.0
Ophichthidae	***osphisurus serpens***	Serpent eel	Demersal	1	0.0

Appendix 5: Picture of *Saiko* operations