# THE INFLUENCE OF GEAR –VESSEL COMBINATION ON ARTISANAL FISHERY CATCH COMPOSITION: A CASE STUDY OF KIGAMBONI MUNICIPAL COASTAL AREA

**EVODIUS ALFRED BUBERWA**

**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PROJECT MANAGEMENT**

**DEPARTMENT OF MARKETING AND ENTREPRENEURSHIP**

**THE OPEN UNIVERSITY TANZANIA**

**2022**

## CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the Open University of Tanzania a dissertation titled: **"The Influence of Gear – Vessel Combination on Artisanal Fishery Catch Composition: A Case Study of Kigamboni Municipal Coastal Area"**, in partial fulfilment of the requirements for the degree of Master of Projects Management (MPM) of the Open University of Tanzania.

……………………………………….

Dr. Salum Soud Mohamed

(Supervisor)

………………………………........

Date

## COPYRIGHT

## DECLARATION

I, **Evodius Alfred Buberwa**, declare that, the work presented in this dissertation is original. It has never been presented to any other university or institution. Where other people's works have been used, references have been provided. It is in this regard that I declare this work as originally mine. It is hereby presented in partial fulfillment of the requirement for the Degree of Master of Project Management (MPM).

…………………..……..………..

Signature

…………………………………

Date

# DEDICATION

I dedicate this work to my daughter Amorette Evodius Buberwa, my young brothers Erasmus Alferd Mulokoz, Maximini Alferd Mulokozi, whom, I would like to see take course in scientific marine researches in their future academic endeavours and finally my wife Irene Msuya, whose time and financial resources has been traded off in support of this great accomplishment.

## ACKNOWLEDGEMENT

I thank almighty God for the good physical and mental health that he has granted me in my life, and because of that I am hereby, proudly about to receive and count another blessing as the fruit of his priceless graces.

I extend my gratitude's to my supervisor Dr. Salum Soud Mohamed for all the professional support he has given me, by providing timely responses and instructions that has helped me in wrapping up this work. May almighty God protect and bless you abundantly sir. I also thank all officers working in the Finance and Business Management department at the Open University of Tanzania for their academic instructions which enabled me accomplish this work.

I further extend my gratitude's to Magdalena Marunda the Head of Election Unit at Kigamboni Municipal for bearing with my absence during the time when she needed me most, as I was in preparations and in attendance of examination sessions at the Open University of Tanzania

Special thanks should go to fisheries officers working at Kigamboni Municipal Livestock and Fisheries department for supporting me in securing the resources need for this study.

Last but not least I congratulate myself for not losing focus and in keep pushing forward towards achieving this great accomplishment.

**''*Ora et labora*''**

## ABSTRACT

The study assessed the influence of gear-vessel combination on catch composition in artisanal fishery, which is characteristically multi-specie and multi-gear. Such complexity comes with major issues in managerial perspective. The study used secondary data recorded within twelve months (Feb 2020 to Feb 2021) from two landing sites (Mjimwema, and Buyuni). The study found prevalence Mean Trophic Level (MTL) of 3.8 that suggested possible trophic cascades when related to other studies conducted in the western Indian Ocean. ANOSIM and PERMANOVA significant results ($p < 0.05$) suggested difference in catch composition. Location was also found to influence catch composition of Artisanal fisheries at the coast of Kigamboni Municipal. However in this study some limitations were observed in the analysis of seasonality carried by the use of ANOVA, one outliers were observed through the stem- and- leaf diagram, also Leven’s test of homogeneity of variance was found to be significant, moreover due to lack of sufficient data, Kimbiji was removed from the study hence narrowed the research area. Nevertheless the study concluded that catch composition is attributable to the use of different combination of fishing gear and vessels also the denuded assemblage of fish communities observed in the secondary data with a lot of zeros can be attributable to excessive fishing pressure exerted in the coral reef fish species. The study recommends TAFIRI, should emphasize and put up supportive infrastructures to private organization interested in conducting fisheries research; whereas suggested areas for further research include studies on environmental gradients that can also influence the catch composition together with documenting and understanding the mean trophic level (MTL) trend of Kigamboni artisanal fisheries.

**Keywords:** Catch composition, Mean Trophic Level, Artisavnal Fisheries and Gear-vessel

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| ANOVA | Analysis of Varience |
| ANOISM | Analysis of Similarities |
| BCS | Baja California Sur |
| BRD | By-Catch reduction device |
| BTS | Biomass Trophic Spectrum |
| BMU | Beach Management Unit |
| CBD | Convention for Biological Diversity |
| CPUE | Catch Per Unit Effort |
| eCAS system | Tanzania Fisheries Information System |
| FAO | Food and Agriculture Organization |
| FiB | Fish –in- Balance |
| MSY | Maximum Sustainable Yield |
| MTI | Marine Trophic index |
| MTL | Mean trophic Level |
| NEM | North East Monsoon |
| PERMANOVA | Permutation Analysis of Variance |
| PERMDISP | Permutational Analysis of Dispersion |
| PCO | Principle component analysis |
| SIMPER | Similarity of Percentage |
| SEM | South East Monsoon |
| SWIO | South-western Indian Ocean |
| TL | Trophic level |
| TED | Turtle excluder Divice |

| | |
|---|---|
| TAFIRI | Tanzania Fisheries Research Institute |
| WIO | West Indian Ocean |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Problem

FAO defines artisanal fisheries as traditional fisheries, which involve households that use relatively small amount of capital and energy, relatively small fishing vessels, making short fishing trips, close to shore, mainly for local consumption (Biniyam, 2011). Small – scale fisheries and Artisanal fisheries are undeniably importantly globally, representing half of the world fishing efforts, and over one quarter of the catch in volume (Rousseau et al., 2019). Small scale fisheries represent about 90% of all fishing jobs worldwide (Chande et al., 2019).

In Tanzania Fishery resources account for a significant source of proteins to nearly 9 million people in coastal villages and make valuable economic contributions to local communities involved in fisheries activities along the 850 km stretch of Tanzania coastline and numerous islands (Jiddawi & Ohman, 2002; Robertson et al., 2018; Chande et al., 2019). Small- scale artisanal fishery accounts for the majority of fish catch produced by more than 43,000 fishermen in Tanzania, mainly operating in the continental shelf within the shallow waters (Jiddawi & Saleh, 2002).

These fisheries (SSF) are characterized by being multispecies and multi-gear a fact that posse's management and conservation challenges to this critical natural capital (Chande et al., 2019; Freire & Pauly, 2010). However there is limited information on the catch composition, trophic interaction and selectivity of different fishing gears in the Tanzanian artisanal fisheries (Chande et al. 2019), hence supports the fact that

African artisanal fishing lacks depths in appraising fishing gears and their use (McClanahan & Mangi, 2004). That being the case, understanding the selectivity of fishing gears combined with traditional values could be particularly important for management because gear will influence catch composition and the size frequency of target species (McClanahan & Mangi, 2004).

Furthermore, the mean trophic level has been shown to decline throughout the world an assertion that implies high- trophic- level fishes are being removed from the ecosystem faster than they can restore themselves (Freire & Pauly, 2010; Caddy & Garibaldi 2020; Clausen & York, 2008). An observation from FAO dataset, shows declining in mean trophic level was caused by ‘‘fishing down marine food webs’’ that is removing top predators’ first thus releasing predatory pressure on lower trophic levels (caddy & Garibaldi, 2000). Furthermore, Freire and Pauly (2010); Pellowe and Leslie (2017) argues that a loss of biodiversity and reducing a population of top-trophic-level taxa may diminish ecological restoration and in turn resilience of the human communities relying on the natural system.

Therefore Freire and Pauly (2010), suggested that local studies would test that fact, by considering that, fishing in temperate zones are to a greater extent mono-specific, their food webs are relatively simple and thus their management cannot be generalized nor applied to tropical fisheries where food webs are complex and include high number of interactions many of which are still unknown.

## 1.2 Statement of the Research Problem

African artisanal fishing lacks depths in appraising fishing gears and their use (McClanahan and Mangi 2004). Also little is known on the catch composition, trophic interaction and selectivity of different fishing gears in the Tanzanian artisanal fisheries (Chande et al., 2019). As gears become more complex it requires updating of vessels in size power and design (Eyo & Akpati, 2012). Thus fishing gear and vessel are crucial in the variation of catch (Biniyam, 2011).

Furthermore due to the nature of artisanal fisheries to be characteristically multispecies and multigear (Chande et al., 2019). Freire and Pauly (2010), suggested tropical fisheries food webs are complex and include high number of interactions many of which are still unknown. Thus posses' management and conservation challenges to this critical natural capital (Chande et al., 2019; Freire & Pauly, 2010). That's being the case since McClanahan and Mangi, (2004) expounded that gear type and use can affect efficiency of fish capture, selectivity and composition of fish resources, this study aims at assessing to what extent fishing gears as combined with respective vessel influence catch composition of artisanal fisheries.

The study aligns with Tanzania national fisheries and aquaculture research agenda (2020-2025) which suggests more research priority to be directed into sustainable capture fishery catch assessment, fishing gear technology and craft combined with fish ecology, as Tanzania is embarking on the principles of blue economy.

## 1.3 Objectives of the Study

### 1.3.1 General Objective

The general objective of the study is to assess the influence of gear–vessel combination on artisanal fishery catch composition.

### 1.3.2 Specific Objectives

(i) Assessing the influence of mean trophic level (MTL) on artisanal fishery catch composition.

(ii) Assessing the influence of seasonality on artisanal fishery catch composition

(iii) Assessing the influence of fishing location on artisanal fishery catch composition.

## 1.4 Research Questions

### 1.4.1 General Research Question

What is gear-vessel combination influence on catch composition of artisanal fishery at the coastal of Kigamboni Municipal?

### 1.4.2 Specific Research Question

(i) What is the mean trophic level (MTL) influence on the artisanal catch composition

(ii) What is seasonality influence on artisanal fishery catch composition

(iii) What is fishing location influence on artisanal fishery catch composition

## 1.5 Significance of the Study

The results of this study will enable examining the effects of different gear vessel combination on catch composition, species diversity, sizes and specie selectivity in tropical fisheries as such information is necessary for managerial purposes in assessing the impact of the artisanal fishing gear vessel to the fishery in the coast of Kigamboni Municipal and Tanzania at large. Furthermore, the obtained value of mean trophic level (MTL) from catches, will enable detecting any shifts from high-level predators to low-trophic level invertebrates and plankton feeders, with the assumption that catch MTL (mean trophic level) measures changes in ecosystem and biodiversity, this is so because mean trophic level can be used as an index of sustainability in multi-species fisheries.

Also the study will provide more information on the unknown trophic interactions and food web chain in the study area, dominance of particular fish groups in catch composition will imply trophic cascading effects that are likely to be influenced by fishing pressure. The study will further identify seasonality variations as it directly affects fished taxa since many fishers rely on different taxa in different seasons and thus enhancing the understanding of seasonal direct impact on the socioeconomic resilience of the coastal communities. The study will contribute in information needed for making decisions for National Fisheries Policy development, particularly in issues related to marine ecology and biodiversity. Finally, this study will be a partial fulfilment requirement for accomplishing a Master Degree in Project Management at the Open University of Tanzania.

## 1.6 Scope of the Study

The study assesses the influence of gear vessel combination on artisanal catch composition at the coastal of Kigamboni Municipality by making use of secondary data retrieved from eCAS system (A systems designed to store fisheries data in Tanzania) within twelve months from February 2020 to February 2021 where as a sample of sixty (60) gear-vessel combination was randomly selected for data analysis. The study made use of PRIMER and SPSS statistical software's to compute

PERMANOVA, ANOSIM, PERMDISP and ANOVA in analysing the secondary data obtained.

The study constituted two landing sites Mjimwema and Buyuni located at Kigamboni Municipal coastal areas. A semi-structured interview using open-ended-questionnaires was used to collect primary data from the groups of interest, them being employees working at Kigamboni Municipality Livestock and fisheries Department, Respondents from the beach Management Units (BMU) and Fishers. The study did not work on the environmental gradient factors such as amount of dissolved oxygen, salinity, PH, temperature of the surface water and Habitat as they may somehow influence catch composition of artisanal fisheries.

## 1.7 Organization of the Study

This study is organized in to five chapters. Chapter one captures the background to the problem, statement of the problem, objectives of the study, significance and scope of the study. Chapter two deals with the literature review related to the study both theoretical and empirical literature, and conceptual framework, chapter three presents the methodology of the study, sample size, population of the study, methods of data collection, validity & Reliability of data and data analysis techniques. Chapter four presented the results of the study, interpretations and discussions. Finally, chapter five presented the conclusions, recommendations and limitations of the study.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter was aimed at shedding light to the main concepts related small scale artisanal marine fisheries by giving definitions to terms and concepts that appeared throughout this study. Here within theoretical review and empirical review of the study provided meaning and understanding to the variables that were used in the study. The discussion is set as such to make room and to set a common ground to understand how different phenomenon occurring in capture fishery as practiced in the inshore areas by the use of numerous gear and vessel combination, with their respective catch composition which can be measured and provide insight on management of this natural resource to ensure maximum sustainable yield (MSY), while preserving the marine ecology. This review finally identified the gap that justified this study.

## 2.2 Conceptual Definitions

This sub topic of the study shaded light on major concepts to further the understanding of concepts by defining major terms that constantly appeared in the study.

### 2.2.2 Gear- Vessel Combination

Gear- Vessel combination is defined as matching vessels with gears (Eyo & Akpati, 1995). As gears become more complex it requires updating of vessels in size power and design (Eyo & Akpati, 2012). Fishing gear and vessel are crucial in the variation of catch (Biniyam, 2011).

### 2.2.3 Artisanal Fisheries

FAO defines artisanal fisheries as traditional fisheries, which involve households that use relatively small amount of capital and energy, relatively small fishing vessels, making short fishing trips, close to shore, mainly for local consumption (Biniyam, 2011; Gomez, 2021).

### 2.2.4 Trophic levels (TL)

Further Pavluk and De vaate, (2018); Pauly et al., (2005) defines Trophic Level (TL) as the position of an organism in the food chain and ranges from a value of 1 for primary producers to 5 for marine mammals and humans.

## 2.3 Theoretical Literature

### 2.3.1 Conceptualization of 'Top –Down Regulation of Diversity' (Theory of Trophic- Dynamic Aspect of Ecology/Top – Down Theory)

In this sub chapter introduction is made to the main theories that provide an assertion of how catch composition in relation to gear vessel combination is linked to the theoretical concepts of 'top – down regulation of diversity' and thus provide grounds for the rest of this study. That's being the case, phenomenon such as predation; species diversity and trophic cascades were briefly unfolded.

The Theory was developed by Dr. Raymond Lindeman and submitted as a manuscript in the year 1941 as the final chapter for his PHD thesis at the University of Minnesota, which was finally published by Eugene Odums' *Fundamentals of ecology* in the year 1953 (William & College, 1993). In this theory Lindeman suggests that the trophic dynamic emphasizes the relationship of trophic which is based on the transfer of energy from one part of the ecosystem to another he explains that all life within an ecosystem depends upon the utilization of an external source of energy that is solar radiation of which portion of this energy is used by phytoplankton and autotrophic plants through the process of photosynthesis to synthesize complex organic substances from simple inorganic substances and accumulate it (Lindeman, 1942).

After the Publication Lindeman work gained popularity among energy researchers and nutrient recycling in aquatic and terrestrial ecosystems (William & College, 1993). Lindeman (1942), postulates that organisms within an ecosystem may be grouped into a series of more or discrete trophic levels as producers, primary consumers, secondary consumer's etc, however unequivocally he pointed that food circles rarely have more than five trophic levels. The theory suggests that since small primary consumers can increase faster than larger secondary consumers and are so able to support the latter, the animals at the base of the food chain are relatively abundant while those towards the pinnacle are progressively fewer in number hence the size and number arrangement forms the pyramid of numbers by Elton, famously known as ''Elton pyramid''.

He further explain that, the weight of all predators must always be much lower than that of all food animals and the total weight of all food animals much lower than that of plant production. It is further elucidate that the more remote an organism is from the initial source of energy (solar energy) the less probability that it will be dependent solely upon the preceding trophic level as energy source. This theory laid grounds for the top – down regulation of diversity as emanated from the 'Keystone species concept' developed by an American ecologist Robert T. Paine in the seminar paper

‘’Food web complexity and species diversity’ in the year 1966. Whereas Paine idea was developed upon Lindeman trophic-dynamic of ecology who once pointed in his paper that, predation displays its importance in restricting the number of trophic levels in a food circle (Lindeman, 1942; Abrams, 1983). With that fact Paine, (1966) hypothesized that ‘‘local species diversity is directly related to the efficiency with which predators prevent the monopolization of the major environmental requisites by one species. In summary Paine (1966) removed predatory (top trophic level organism) sea stars (*Pisaster ochraceus*) from the rocky intertidal and watched the key prey species, mussels (*Mytilus californianus*), crowd out seven subordinate primary space – holding species (Lafferty & Suchanek, 2016; Terborgh, 2015).

Most ecologists cite Paine (1966) to uphold a statement that predation increases diversity by interfering in competition. Although it wasn’t easy to convince some ecologists, the paradigm that predation increase diversity spread by 1991 (Lafferty & Suchanek, 2016). Elton (1958) epitomized that reasoning by an intuition that, many species of enemies and parasites are ready to turn on any specie that starts being unusually numerous and by a complex system of check and buffers, control them down.

Keystone predation has a unique much broader concept of the trophic cascades whereas removing one trophic level (usually the top most) can trigger the state of change in the entire system (Terborgh, 2015). Terborgh, (2015) further argued that the direct way to test ‘paine effect’ was to conduct predator removal experiment and thus witness the intensification of competition with resultant decrease in prey diversity in response to removal or reduction in predator. Paines work influenced the course of ecology and conservation practices also the media started to depict predators as noble than villainous as a result workers in other systems such as MacArthur was a big fan of Paines work (Lafferty & Suchanek, 2016). To that end by 1970 public perspective had changed to the extent that United States Endangered species Act protected wolves and brown bears for their intrinsic value and latter by 1991 the ‘‘ Food Web Complexity and Specie Diversity’’ was considered a classic ecological paper (Lafferty & Suchanek, 2016).

### 2.3.2 Model of Marine Trophic index (MTI)

Marine trophic index is one among eight indices that reflect the complexity of trophic relationship between organisms (Pavluk & De Vaate, 2018; Pauly et al., 2005). The index provides a reliable indicator of the integrity of an ecosystem as derived from the differences in the trophic level of selected groups of species. The modern definition of trophic level (TL) originates with the classics of Elton, (1927) and Lindeman (1942) (as cited by Pauly et al., 2005) also as expressed by ‘‘Eltonian’’ or ‘Lindeman’’ pyramids shown in Pauly et al., (2005) who expound that Rigler (1975) criticize the qualitative approach which treated the trophic level (TL) and as a response Odum and Heald (1975) published a mathematical computation of (fractional) trophic level (TL) of a consumer from a mean trophic level of its prey plus one, which starts from the primary producers defined with trophic level ‘1’.

In summary the method to compute the trophic level of a consumer is to add one level to the mean trophic level of its prey (Pavluk & De vaate, 2018). Latter in 2004 the *convention for Biological Diversity* (CBD) endorsed the use of Mean Trophic Level (MTL) as Marine Trophic Index (MTI). The redefined TL became a property of organisms similar to human body temperature, which can vary over time given the underlying health status, thus considered to serve as an indicator of that state of health. The equation corresponding to a species trophic level calculation is given below.

$$TL_i = \sum TL_j \times DC_{ij} \quad \text{..............................................................} \quad \textit{Equation } (1)$$

Where; $TL_j$ is the fractional trophic level of the prey $j$ and $DC_{ij}$ is the fractional of prey $j$ in the diet of species $i$. It is moreover explained that TL (trophic levels of most fishes and other aquatic consumers can take any value between 2.0 and 5.0 (Pavluk & De vaate, 2018; Pauly et al., 2005). Pavluk and De vaate, (2018) explains that annual fishery database can provide sufficient information for marine trophic index computation; hence the mean trophic level for year $k$ may be computed by a formula

$$MTL_k = \frac{\sum_i (TL_i) \times (Y_{ik})}{\sum_i Y_{ik}} \quad \text{....................................Equation (2)}$$

Where; $Y_{ik}$ is the landing (catch) of species (group) $i$ in the year $k$ and $TL_i$ is the trophic level of species (group) $i$ (Pauly et al.,2001; Pauly et al., 2005; Pavluk & De Vaate, 2018). It is important to note that, the mojor source of TL (Trophic Levels) values for fish species in marine fisheries can be found in **Fishbase** that contains TL estimates of species based on respective diet composition (Pauly et al., 2005).

## 2.4 Empirical Literature Review

### 2.4.1 Empirical Literature Review Worldwide

A study by Purcell et al., (2018) in Australia with an objective of understanding factors affecting difference in catch composition among fishers, used PERMANOVA analysis and SIMPER analysis to asses variance in species catch composition across two geographical scales and in fishing modes respectively, the study revealed a significant difference in 22 sea cucumber species catch composition, captured by fishers who gleaned and those who did not.

Also a significant difference was found between fishers who used SCUBA diving and those who did not. Another interesting result in this study is that data analysis indicated that 14 % of the overall variation in catch composition was explained by the fishing methods, 18% by location and 18% by differences between villages. The study recommended that regulatory measures that control one fishing mode will probably affect fishers in different locations to varying extents within small-scale fisheries. This study illustrates that even within a small-scale multispecies fishery, fishing modes can vary greatly among locations and genders.

In Australia another study conducted by Dolder, Thorson and Minto, (2018) on understanding how spatial community and fishery dynamics interact to determine species and catch composition, made use of spatial dynamic factor analysis that applied correlations and covariance, whereas the method estimated correlation in catches for multiple species at each fishing location and used the results to draw inference on the fishery community dynamics, findings of the study was such that, catch distribution from a ‘typical’ otter trawl gear and beam trawl fishing at three distinct locations accentuated the differences fishing gear makes on catches, whereas trawl gears were more effective for round fish species while beam trawl gears were more effective for flatfish species. On top of that the differences in catch composition between gears at the same location indicated how changing fishing methods affect catch. The study recommended a framework, which will provide a viable route on reducing complexity in, mixed fisheries and thus enhances informed managerial decisions.

Another study in Mexico carried by Pellowe and Leslie (2017) examined seasonal variability in the small-scale fisheries of Baja California Sur, Mexico based on 13 years of government fisheries data. The study had an objective of investigating four fisheries indicators (landed biomas, taxon richness, proportion of landed biomas that is made of top-trophic level taxa, taxon composition) with direct relevance to ecological resilience magnitude and variance of landed fish biomass. Taxon richness and the proportion of top trophic level taxa in total catch were observed to vary within and among years and at multiple spatial scales. The study applied ANOVA in its data analysis to assess the spatial variability in variance in biomass and seasonality. The study found that high taxon diversity of catch may be related to gear diversity whereas diverse gears give fishers more chances to target a greater variety of Taxa. The study recommended that fisheries should be managed at finer spatial scales and emphasized on the importance of matching scales of human activity and environmental dynamics in respect to sustainable marine fisheries.

Another study by Campbel and Pardede, (2006) in Indonesia with the objective of studying the reef fish structure and cascading effects in response to artisanal fishing pressure made use of liner regression to test for relationships between live coral covers and other substrate variables, findings were such that there was a significant negative relationship between fishing pressure from all gear combined on two reef fish families, further the results enunciated that hand spears and nets are capable of catching fish at low trophic levels also other gear types such as gillnets and muro-ami fishing were also shown to target invertivores (e.g., Balistidae, Diodontidae, Haemunilae, Labridae, Lethrinidae, Mullidae and Nemipteridae) which is a trophic group consisting of a range of families that reside on coral reefs. The study recommended that both non-selective gears and selective fishing practices are capable of structuring reef fish population and thus require active management controls.

Together with catch composition studies, biodiversity indicators provide a vital gauge on the state of the planet together with guiding policy development and management. That's being the case the most widely adopted marine indicator is mean trophic level (MTL) from catches, aimed at detecting shifts from high-level predators to low-trophic level invertebrates and plankton feeders, with the assumption that catch Mean Trophic Level (MTL) measures changes in ecosystem and biodiversity (Trevor et al., 2010).

For instance, in Mexico the study by Sala et al., (2004) with an objective of identifying fishing down coastal food webs in the coast of California, made use of principle component analysis (PCI) to investigate the changes in the structure (species composition and abundances) of the fish community and examining changes in Mean Trophic Level (MTL) of the catch overtime, results found that mean trophic level of the catch data in Baja California Sur (BCS) decreased from 4.2 in the 1970's t0 3.8 in 2000's, with the greatest decline in 1980's thus explain that, the most important organisms caught were large individuals such as sharks and large size groupers while as per today the most important targets are medium size benthic feeding fishes. It is further expounded that, the early impacts of fishery are reduction in abundance and size of species of interest because small individuals are likely to have lower trophic levels relatively to large adults. The study recommended that, coastal fisheries in the Gulf of Baja California Sur are unsustainable and their management needs to be re-evaluated with sound regulatory measures that prevent further degradation of coastal food webs and the concurrently inefficiency of artisanal fishing.

Another study in India by Bhathal and Pauly, (2008) focused on using Marine indices; Marine Trophic Index (MTI) and Fishing-in-Balance (FiB) in evaluating the status of marine fisheries in India from 1950's to 2000's. Results found that fishing down marine food webs is occurring in the Indian Ocean waters on the east and west coast whereas the phenomenon is more conspicuous on the west coast as it contributes 72% of India's total catch. Mostly important in this study, species with lower trophic level than 3.25 were excluded from the computation of the mean trophic levels (MTL) of the total catch which implies that the fishing down phenomenon is neither due to bottom-up effect nor ''successive addition'' of low trophic species to the catch composition exploited by fishers.

The study recommended that Indian fisheries are not in a sustainable trajectory and that the catch increases of the 1980 and 1990s were due to a spatial (offshore) expansion whereby the deep waters around India cannot be expected to be as productive as the shelf waters. Thus fisheries policies, which emphasized expansion on fisheries, needed reconsideration to avoid serious food security and other economical implication likely to happen in the near future.

Moreover a study in China by Liang and Pauly, (2017) explored the masking effect on fishing down of the taxonomic coarseness of the catch data, of assuming that individual sizes remain constant after intensive fishing and the geographical expansion of the fisheries. The study analysed the trend of Marine Trophic Index (MTI) namely Mean Trophic Level (MTL) from 1979 to 2014 in analysing catch data. Findings suggested a strong fishing down effect in East China Sea, whereas the taxa of the catch data associated with mean trophic level was decreasing from over 4.0 to bellow 3.8 from 1979 to 2014. Also the body size correlated positively with the trophic level therefore accounting for decreasing body size due to increasing fishing pressure and intensified decline of trophic level from 1979 to 2014.

It was further recommended that MTI is an index of the biodiversity of large, high-tropic level predators, and that a low MTI, in a given marine ecosystem, suggest that top-down control has been replaced by bottom-up control. Moreover besides indices of marine biodiversity, seasonal variability is often easier for fishers to observe than longer-term changes; therefore it is directly relevant to everyday experiences and strategies adapted in the coastal communities (Pellowe & Leslie, 2017; Purcell et al., 2018).

The study in Mexico by Pellowe and Leslie, (2017) on examining seasonal variability in the small-scale fisheries of Baja California Sur, applied ANOVA to test for seasonality for variables, with month as ordinal independent variable for each dependent variables (taxon richness, biomas and proportional of top-trophic level taxa) findings evidenced seasonality to affect directly fished taxa as many fishers rely on different taxa in different seasons and thus reflect a direct impact on the socioeconomic resilience of the coastal communities whereas in some instances seasonality affected fishers travelling to different locations in the BCS area. Thus the results of the study found significant intra-annual variation in taxon richness and top trophic level taxa that made a proportional of total landings. The study recommended on recognizing, matching the scales of human activity and environmental dynamics as vital for sustaining marine fisheries.

Furthermore another study by Abdullah et al., (2019) in the bay of Bangladesh carried a study on assessing the structural variability and composition of fish communities from monsoons 2014 to pre monsoons 2015. The study applied Multivariate analysis such as SIMPER to rank species contribution to the average Bray-Curtis similarity among three stations during the four seasons .The study found monsoon winds to influence estuarine and marine fish communities' abundances in seasonal basis.

Further the study found seasonal variations of ecological parameter to be predominant in the study area and so was the case for the entire area of Bay of Bengal, Bangladesh. Unequivocal the study imply that seasonal variations of environmental parameters of the study area were directly or indirectly driven by monsoon activities of the Bay of Bengal. It was further recommended that fish communities in Kohelia channel showed significant structural variability among the four seasons.

Another study by Tokeshi et al., (2013) in Indonesia had an objective of assessing the seasonality of artisanal fisheries in terms of catch patterns based on different fish taxa. The study applied ranking pattern analysis of taxawise relative catch statistics to examine seasonality in multispecies catch patterns. Findings suggests that tropical waters are subjected to different forms of seasonality mostly defined by monsoons, however the strength of seasonal climatic signatures differ from one area to another and the impact of the seasonal variability in small-scale fisheries are poorly known. In this study the catch data demonstrated that the numerical importance of fish species varied from the wet to the dry season thus demonstrating the seasonally variable nature of target taxa in reef fisheries. Recommendations suggests that because reef habitats in the tropics are under increasing threat from different forms of anthropogenic and natural disturbances, various approaches to detecting changes in artisanal fisheries based on multispecies assemblages are required.

### 2.4.2 Empirical Literature Review- Africa

A study by Gomez, (2021) in southern Kenya on assessing gear selectivity between traditional and gated traps in a multi-species and multi-gear artisanal fishery within a marine reserve in Southern Kenya, studied catch composition between two fishing traps, The study applied Multivariate statistical analysis (correspondence analysis) to determine the degree of similarity of catch composition among trap type and location also Mean Trophic Level (MTL) of the catch for each gear type was calculated, findings indicated both gated traps and traditional ones selected species of low mean trophic level between (2.3 -2.5) since they mainly target herbivorous species.

Gomez, (2021) further expound that despite the species diversity the catch was dominated by only five (5) families that constituted a total of 85% of the total catch and further argues that these results are typical for East Africa tropical multispecies fisheries and it’s a prima facie of trap gear selectivity researches conducted in Southern Kenya. Finally the study recommended that a large-scale and continuing decline in coral reef health will seriously impact the livelihood of poor coastal communities and there is an urgent need to refine management strategies to effectively support the coral reef ecosystem, its fisheries and the people that depend on them.

Furthermore another study by Munga et al., (2014) was conducted in Kenya with overall objectives to evaluate the conflict between the artisanal and bottom trawl fisheries in terms of overlapping catch composition and assumed there were significant differences in catch composition between inshore trawling and artisanal catches, In this study ANOVA was applied to compare between samples of artisanal and trawl catches (inshore and Offshore) for NEM and SEM seasons also the species that contributed most towards dissimilarity were identified by using Two-way SIMPER analysis. Findings confirmed trawling to be less selective than artisanal gear.

Trawl nets was confirmed to catch most organisms in their path, whereas some artisanal gear, such as hook and line, seine or gillnets, are more likely to select specific species or size classes (Munga et al., 2014; McClanahan & Mangi, 2004). It was further expounded that trawl nets retain smaller fish than those usually caught by artisanal fishing gears and thus negate the hypothesis that juveniles are more abundant during Southeast monsoons (SEM) when they are caught in abundance by trawlers. The study recommended that the seven fish species most exploited demonstrated resource overlap thus emphasized on the management enforcement of Turtle excluder devices (TED) and By-catch reduction devices (BRD) to further mitigate conflict between artisanal and trawl fishing sector.

As for marine trophic indices, In coastal east Africa Fishery is showing signs of overexploitation (Chande et al,.2019). With limited catch composition information and unknown trophic interactions (Chande et al,.2019). Gomez, (2021) explains that mean trophic level can be used as an index of sustainability in multi-species fisheries. In West Africa, trophic spectra and long time series of mean trophic level for demersal fish communities were examined by Laurans et al., (2004) with an objective of detecting shifts in the ecosystem structure in response to increasing fishing pressure.

The study used linear models to investigate the annual variations of Biomas Trophic Spectrum (BTS) whereas in Guinea and Senegal a substantial and statistically significant changes in the trophic structure of the ecosystems were observed, particularly the decreased biomass of the high trophic levels whereas the lower trophic levels displayed a relative stability or an increase and thus presaging a "top-down" fishing effect due to a release of predation on the lower trophic levels of the demersal fish community, it was further expounded that Such decrease was also observed for the coastal demersal biomass in Guinea finally fishing down marine food web effect was shown in West Africa for the first time.

In its recommendations the study criticized the monospecific approach used in fisheries science because it neglects important ecological issues that should be integrated in fishery management conversely it emphasized on the multispecific approaches combined with a consideration of the trophic composition of the species, specifically demersal fish community which seems to be strongly associated with the rapid evolution of the fishing effort in West Africa.

Seasonality influence on catch composition can be explained by Munga et al., (2014) after carrying a study in Kenya with an overall objective to evaluate the conflict between the artisanal and bottom trawl fisheries in terms of overlapping catch composition, whereas seasonality factors appeared in such a way that catches in artisanal were higher in North East Monsoon (NEM) when most fishing takes place than in South East Monsoon (SEM) samples, thus reflecting the effects of adverse sea conditions during SEM on fishing activities that rely on small craft. Conversely Trawling by catch was found to be more diverse in SEM likely due to eutrophication factors cause by Tana and Sabaki rivers during the rainy SEM and thus cause increase in species composition (Munga et al., 2014).

Furthermore Temple et al., (2019) conducted a study on understanding of marine mega fauna catch in Southwest Indian ocean (SWIO – Kenya, Zanzibar and Northern Madagascar) Small-scale fisheries, with an objective of assessing mega fauna catch and composition in hand line, long line, bottom-set and drift gillnet fisheries of the South-western Indian Ocean. In this study patterns in fisheries effort data by gear type were assessed using Generalized Additive Mixed Modelling (GAMM) with landing site as a random –effect variable, Inter alia, seasonal findings indicate that wind direction significantly influenced driftnet and hand line fishing efforts; however wind speed had no impact on fishing effort of any gear as expected. NEM (November – March) were observed to impact positively the peaks of long line and drift net catches in the SWIO region.

Furthermore the season is associated with the increase in migratory oceanic species such as yellow fin tuna which are targeted species for long lines and drift gillnet gears, concomitantly evidence from fishers suggested reduction in gillnets use in the phase of brightest moon because it is said the ‘fish can see the nets’, implying similar pattern in long line gear, However hand line gear follows an inverse pattern.

Another study by_Biniyam (2011) in Eritrea with the main objective of identifying determinants of fish level in artisanal fishery, Inter alia, findings suggests seasonality to affect fishing activities whereas the seasonal pattern of the wind defines the two seasons characterized by hot season North-Westerly winds (May –September) and a cold season extending October to April, in a nutshell it is elaborated that during summer, fish resources remain in deep waters and in distant fishing grounds.

Nevertheless in winter the high wind velocity imposes hindrance in artisanal craft however there is no official closure of artisanal fishery but there is for commercial fisheries. The study indicated seasonality to have significant effects on catch level. The study recommends that the unsatisfactory performance of fishing as compared to the maximum sustainable yield is mainly due to the majority of Houri boats which are relatively traditional and less resourceful outboard petrol engine with restricted fishing expedition around the inshore predominantly during winter fishing season.

### 2.4.3 Empirical Literature Review – Tanzania

In Tanzania, Chande et al. (2019) conducted a study with an objective of assessing catch composition and effects of three major fishing gears namely handline, gillnets and traps using data collected from 2008 to 2011 along Kilwa- Mafia sea scape in Tanzania. The study applied One-Way ANOVA to test for differences in species richness and catch rates among gear types also PERMANOVA was used to test for the differences in fish catch composition between two sites and among three gears, findings suggested presence of gear selectivity on individual species, whereas there were significant differences in catch composition among gear types with traps showing high overlapping in species composition as compared with other gears, followed by gillnets and lastly handlines.

In this study the gears sampled were selective. Traps had catches primarily composed of herbivorous also the predominance of reef-associated fishes in the catch composition proved the assertion that fishing is carried within the shallow coastal waters. The study also found that gillnets and hand-lines targeted high valuable carnivorous species with trophic level $\geq 3$. The study recommended that local communities should be involved in decision to monitor, protect and conserve the resources, it was further expounded that local community participation in resource conservation can be achieved by the establishment of small reserves that are managed primarily by the communities themselves.

Robertson et al., (2018) carried a study on fishery characteristics in Pangani and Rufiji with an objective of determining if BMU catch assessment survey can provide information on the fishing characteristics of small–scale fishing communities in Tanzania, the study made use of landing data from 2014 to 2017 from BMUs in fourteen villages in two spatially, socially and ecological distinct (Pangani and Rufiji).

The study use descriptive statistics, ANOVA, t-tests and the Tukey Honest Significance difference post-hoc test to analyse single variables and their interactions, findings indicated fishing specialization whereas specifically two villages in Pangani district landed octopus and parrotfish almost exclusively; such phenomenon suggests potential trophic cascades after many years of overexploitation, as fish communities move towards low trophic level in response to release of predation in overfished grounds. Also the study found significant weight differences among the taxa examined in the study, which further imply size differences between two districts. For instance sharks were larger in Rufiji than Pangani while jacks and grunts were larger in Pangan relatively to Rufiji.

However the large size observed individuals suggested having a healthier reef than expected since overfished reefs would provide small amount of large individuals with high trophic level. Conversely the study recommended that both districts focused fishing efforts on invertebrates rather than finfish, since Prawns, groupers and crabs were the most commonly caught taxa in Rufiji and in Pangani district octopus, parrotfish and crabs were the most common.

Moreover another study by Jiddawi, Thyresson and Crona, (2012) carried in Zanzibar aimed at examining the reef-associated fish value chain in Zanzibar and how it links to functional groups of fish and maturity stage of fish within these groups. The study made use of ANOVA on the log transformed price data in analysis, results found test for homogeneity in variance to be significant at 0.04 indicating that variance are not homogenous across the four markets (local consumers, small-scale traders, town markets and hotels) mainly caused by lower price variance in the hotel category which prefers high-trophic-level fish to serve consumers with high purchasing power and thus lower purchasing power consumers go for lower-trophic-level fish, the pattern of preference provide market for both high and low trophic level fish leaving no segment of the fish assemblages free from pressure.

The study apprehend that this kind of pressure on both higher and lower trophic level fish at all maturity stages can have negative impact on the ecosystem and the high pressure on high trophic level fish can concomitantly destabilize the coastal food webs by declining top-down control effect.

Sekadende et al., (2020) show significant variation in artisanal fisheries catch composition due to seasonality driven by West Indian Ocean (WIO) monsoon winds. For instance prawn fishery in Tanzania is seasoned within three months; December to Mach, (Jiddawi & Ohman, 2002). In some areas Fishermen migrate from their hometown grounds to camp and fish in other areas whereas this movement is famously known as ***dago*** movement, which is strongly influenced by seasonally reversing monsoon winds (Jiddawi & Ohman, 2002). This mode of fishing is further illustrated in Gomez (2021) whereas migrant foreign fishermen from Pemba and mainland Tanzania usually exploit local marine resources in the southern Kenya as the resources establish themselves in the near shore villages as per seasonal monsoon winds.

## 2.5 Research Gap

There is insufficient information on the catch composition, trophic interaction and selectivity of different fishing gears in the Tanzanian artisanal fisheries Chande et al., (2019), hence African artisanal fishing lacks depths in appraising fishing gears and their use McClanahan and Mangi, (2004), that being the case, understanding the selectivity of fishing gears combined with traditional values could be particularly important for management because gear will influence catch composition and the size frequency of target species (McClanahan & Mangi, 2004).

Furthermore there are still controversial findings to be cleared on the specific causes of apparent changes in the trophic composition of the marine harvests, caddy and Garibaldi, (2000) show the need for more studies to be conducted in shelf and reef ecosystems in both temperate and tropics region to enable understanding of whether top-down theories or bottom-up theories are attributable to trophic changes of world marine harvests.

Also Tokeshi et al., (2013) suggests that tropical waters are subjected to different forms of seasonality mostly defined by monsoons, however the strength of seasonal climatic signatures differ from one area to another and the impact of the seasonal variability in small-scale fisheries are poorly known, On the other hand Freire and Pauly, (2010); Caddy and Garibaldi, (2000) show aggregation of data by FAO to limit and mask the dubbed ‘fishing down the marine food webs’ effect and thus recommend local studies to justify such phenomenon. Therefore this research is aimed at adding valuable information to bridge the gaps of knowledge as shown above

## 2.6 Conceptual Framework

The conceptual framework in Figure 2.1 illustrates the relationship between the independent and dependent variable. The independent variable includes background and intermediate variables, which influence the dependent variable. The background variables (seasonality and available habitat) influence catch composition directly. Whereas the independent variable (type of vessel) in combination with the intermediate independent variables (type of gear and fishing location) also influence the artisanal fish catch composition.

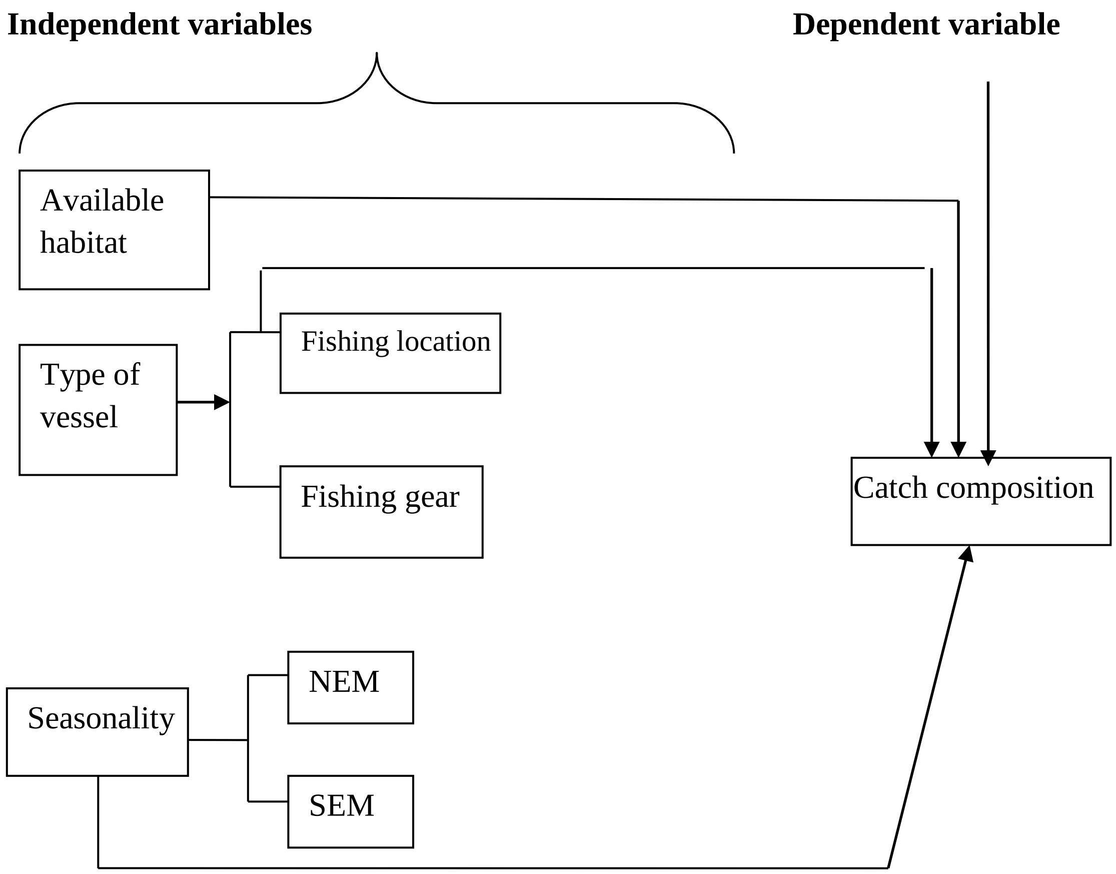


**Figure 2.1: Conceptual Framework**

Source: Researcher (2021)

## 2.7 Conceptual Framework Variables

Factors influencing fish catch composition have been identified by the use of secondary data as obtained from the eCAS system also through literature review and practical observation during the visibility study.

### 2.7.1 Independent Variables

Fishing gear and vessel type are important factors that explain variation in catch (Biniyam, 2011). Also as gears become more complex it requires updating of vessels in size power and design Eyo and Akpati, (2012). McClanahan and Mangi, (2004) expound that gear type and use can affect efficiency of fish capture, selectivity and composition of fish resources. Hence in this study gear-vessel combination is assessed among the independent factors that influence catch composition. Moreover Gear types and fishing modes can also vary between genders and religion where the same species are being targeted (Purcell et al., 2018).

However fisheries under the study area is dominated by men also since artisanal fishery is done near the coastal environment, the area which is historically dominated by Muslims, both religion and gender factors were not included in the analysis though they are somewhat true under different locations (Biniyam, 2011). Habitats (such as coral reefs, mangrove creeks, sea grass beds and sand banks) utilized by fishers McClanahan and Mangi, (2004); Purcell et al., (2018); Jiddawi and Ohman, (2002) tend to influence variation in species composition and catch rates, however although literature reviews support habitat influence on catch composition, due to lack of relevant data in the area under study this factor is not included in the analysis.

Seasonality in tropical waters as defined by monsoons (NEM and SEM) is insinuated to influence artisanal fisheries in terms of catch patterns based on different taxa (Tokeshi, Arkaki, Daud & JRP, 2013). In this study seasonality factor defined by two seasons of Monsoon winds (NEM and SEM) is included in the analysis to assess its influence on catch composition. Fishing location as an independent factor is also included in the analysis to assess its influence on catch composition.

### 2.7.2 Dependent Variable

Catch composition, is used as a dependent factor since its variation is assumed to be affected by the variation of the independent factor unfolded above.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter was aimed at presenting, the research design, and area of the study, population of the study, sampling design and sample size, methods of data collection, data collection tools, reliability and validity of data, data analysis and expected research findings.

## 3.2 Research Design

The study applied both inferential and descriptive statistics. In inferential statistics (PERMANOVA and ANOSIM) was used to analyse secondary data to harness necessary information required for decision making, Descriptive statistics (Histograms) were applied on primary data which was obtained in a cross sectional-survey at two landing sites, namely Mjimwema and Buyuni which were selected representatively for the purpose of this study at Kigamboni Municipality coastal area.

## 3.3 Area of the Study

The study was conducted at two landing sites namely, Mjimwema and Buyuni each representing all artisanal fisheries that apply same gear-vessel combination at the coast of Kigamboni Municipal as observed in the eCAS system.

## 3.4 Population of the Study

The study was targeted to the small scale fishers, BMU operating in two landing sites located at Kigamboni Municipality coastal, namely; (Buyuni and Mjimwema) and the fisheries officers working at Kigamboni Municipal livestock and fisheries Department.

## 3.5 Sampling Design and Sample Size

### 3.5.1 Sampling Design

For primary data, random sampling was applied in data collection, whereas each sampling unit in the population has an equal chance of being selected for data collection. Whereas for secondary data, this study constituted two sites Mjimwema and Buyuni. These sites are representative each with specific types of gear-vessel combination data, collected from them.

| Site | vessel | gear |
|---|---|---|
| Mjimwema | Dugout Canoe (DC) | – Handline (HL) |
| Buyuni | Boat (BT) | - Stick/spear (SP) |
| | Mashua (MS) | - Shark net (SN) |

A sample size of twenty (n=20) gear –vessel combination was selected per each treatment/group, whereas the gear-vessel combination was treated as a grouping/treatment factor. Also to account for seasonality ( NEM, i.e. November - February and SEM, i.e. April - September) ten (10) gear-vessel combination per each treatment was selected from the NEM and the other 10 gear-vessel combination was selected from data collected during the SEM. Making a total of 20 observations per group. The three (3) treatment/groups (DC-HL, MS-SN and BT-SP) each with n=20 forms total sample size N=60 that was used in a one –way – PERMANOVA balanced design and in ANOSIM.

### 3.5.2 Sample Size

Kelly et al., (2015) in a study of power and sample –size estimation for microbiome studies using pair wise distances and PERMANOVA applied the boot power command three times, to assess PERMANOVA power with either 5, 10 or 20 subjects per group and found that a sample size of 10 subjects per group (30 total subject) likely affords adequate statistical power for the primary outcome measure. However Anderson, (2001) illustrated how PERMANOVA and Pillai's trace remained almost constant in scenarios where dispersion/heterogeneity was introduced among groups and the number of groups increased from 2 to10 for balanced data while a total sample size was kept constant at N=60. Whereas its supplement ANOSIM rejection rate increased when introduced to similar scenarios, (rejection rate set at $\alpha$=0.05 threshold).

In respect of that, in this study a sample size on n=20 and N=60, balanced designed was analysed by choosing Bray-curtis as a distance measurement. As for primary data, since qualitative information is what is needed it has been recommended that a minimum sample size of at least 12 respondents can reach data saturation (Clark & Braun, 2013; Guest, Bounce & Johnson, 2006). Therefore in this study a sample size of twenty two (22) respondents was obtained for primary data collection.

## 3.6 Methods of Data Collection

### 3.6.1 Primary Data

Data was collected in a semi-structured interview by using open-ended-questionnaires whereas groups of interests, them being employees working at

Kigamboni Municipality Livestock and fisheries Department, Respondents from the beach Management Units (BMU) and Fishers were interviewed.

### 3.6.2 Secondary Data

Secondary was selected from a range of data collected in-between february 2020 to February 2021 comprised of twelve (12) months. Data was extracted from eCAS-system, where daily data of abundance and biomas was recorded by the use of special form.

## 3.7 Data Collection Tools

Interviewer completed (semi-structured questionnaires) was used to collect primary data. The proposed questionnaire is attached with this dissertation.

## 3.7 Reliability and Validity of Data

### 3.7.2 Reliability of Data

Given the nature of this study reliability tests were not conducted but the results found in this study can be further assessed and approved or criticised in yet more studies to be conducted at the coast of Kigamboni Municipal.

### 3.7.3 Validity of Data

Primary data was collected in the afternoon hours the time when fishers have already sold their catch as it is assumed that, at this time the fishers were at ease and relaxed and thus provide relevant information. The researcher expected to interview 30 respondents to enhance effectiveness and efficiency of the data. Catch data collected from the two landing sites of Mjimwema and Buyuni have been collected by trained individuals, data was aggregated in the eCAS system direct from the landing sites by the use of a special form filled by data collectors, data was collected in ten days within a month and was  collected from three vessels which were randomly selected per each day of data collection, the whole catch was sampled and recorded at species level whereas respective weight of species was recorded in kilograms (kg) , also due to representation, catch data collected by a particular gear-vessel combination at one landing sites was not collected elsewhere among the selected landing sites. Furthermore the methods used in collecting and analysing secondary data has also been used by other researchers such as (Chande et al., 2019; Purcell et al., 2018). Also the trophic levels of species that was used in calculating Marine Trophic Index (MTI) i.e. Mean Trophic Level (MTL) in this study was obtained from fishbase, which is a global information system on fishes.

### 3.8 Data Analysis

SPSS was used in performing two ways ANOVA with repeated measurements in assessing seasonality. PRIMER was used in computing PERMANOVA (Permutation Analysis of Variance) and ANOSIM (Analysis of Similarity) to Test for difference in fish catch composition among gear vessel combination. ANOVA was used to test for differences of catch volume among seasons as defined by monsoon winds. Descriptive statistics was used to analyse primary data to further the understanding ‘of inference as brought about by the aforementioned inferential statistics techniques.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter presents the general findings, by the use of tables and different figures as appropriate together with explanations that justify the application of the techniques used in analysing the data.

## 4.2 General Findings

A total of 1069 fish individuals were counted from a total sample of 60 gear-vessel combination, the total of 24 Species found belongs to 13 orders, 19 families. With ablennes hians (gongora), gymnasarda unicolor (jodari meno) and istiophorus platypterus (nduwaro) being sepecies with high trophic level (4.5) whereas Siganus argenteus (Tasi) being the specie with the lowest trophic level (2).

The percentage of species abundance was calculated from the totals of the respective species individuals as counted across all gear vessel combination, divided by the total count of individuals (1069) observed across all the gear-vessel combination samples (N=60) and multiplied by 100. The species composition and respective cumulative percentage was given in the Table 4.1.

As seen in the Table 4.1, the first eight species constituted more than 85% of the total catch, these species are amphioctopus aegina/ octopus cyanea (36.8%), lethrinus borbonicus (12.4%), lethrinus lentjan (10.9%), panulirus penisillatus (6.7%), netuma thalassina (6.1%), ablennes hians (5.1%), panulirus ornatus (4.2%) and panulirus homarus (4%). These eight species formed cumulative percentage equal to 86.2% of the total.

**Table 4.1: Percentage and Cumulative Percentage of Catch**

| Catches from total samples {n=60} units of gear-vessel combination | | | | |
|---|---|---|---|---|
| **S/N** | **Specie** | **Abundance** | **Percentage (%)** | **Cumulative (%)** |
| 1 | amphioctopus aegina/ octopus cyanea | 393 | 36.8 | 36.8 |
| 2 | lethrinus borbonicus | 133 | 12.4 | 49.2 |
| 3 | lethrinus lentjan | 116 | 10.9 | 60.1 |
| 4 | panulirus penisillatus | 72 | 6.7 | 66.8 |
| 5 | netuma thalassina | 65 | 6.1 | 72.9 |
| 6 | ablennes hians | 55 | 5.1 | 78 |
| 7 | panulirus ornatus | 45 | 4.2 | 82.2 |
| 8 | panulirus homarus | 43 | 4 | 86.2 |
| 9 | caranx tille | 36 | 3.4 | 89.6 |
| 10 | Siganus argenteus | 23 | 2.2 | 91.8 |
| 11 | lethrinus harak | 22 | 2.1 | 93.8 |
| 12 | uroteuthis duvaucelli | 19 | 1.8 | 95.6 |
| 13 | negaprion acutidens | 16 | 1.5 | 97.1 |
| 14 | rhinoptera javanica | 6 | 0.6 | 97.7 |
| 15 | aetobatus ocellatus | 6 | 0.6 | 98.2 |
| 16 | lobotes surinamensis | 4 | 0.4 | 98.6 |
| 17 | Diagramma pictum | 4 | 0.4 | 99 |
| 18 | sepia mirabilis | 3 | 0.3 | 99.3 |
| 19 | Scombridae | 2 | 0.2 | 99.4 |
| 20 | gymnasarda unicolor | 2 | 0.2 | 99.6 |
| 21 | acanthocybium solandiri | 1 | 0.1 | 99.7 |
| 22 | rachycentron canadum | 1 | 0.1 | 99.8 |
| 23 | maculabatis ambigua (BOCHO) | 1 | 0.1 | 99.9 |
| 24 | istiophorus platypterus | 1 | 0.1 | **100** |
| | **Total** | **1069** | **100** | |

## 4.3 Assessing the Influence of Gear Vessel Combination on Artisanal Fisheries Catch Composition

Since the general objective of this study is focused on assessing compositional difference in samples across different gear vessel combinations, Bray-Curtis resemblance measure of similarity was applied as a resemblance measure of choice. Prior computation of PERMANOVA other computations on assumptions behind PERMANOVA were tested on the data.

Furthermore the data used, had a lot of zeros so the choice of proper transformation of data was done by first visualizing the effects of different transformation techniques by running an nMDS graph on 2$^{nd}$ STAGE analysis on the resemblance matrix computed under different transformations. All computations were done by the use of PRIMER 7. The transformations compared under 2$^{nd}$ STAGE analysis were, square root transformation, 4$^{th}$ root transformation, Log (x +1) transformations and finally presence/absence transformation was adopted as a suitable technique for data transformation.

Prior to computation of PERMANOVA, the main assumptions of exchangeability of samples and homogeneity of dispersion were tested. PERMDISP, analysis for multivariate dispersion under Bray-Curtis similarity, a test analogous to Leven's test for univariate homogeneity of variance, was computed to test for homogeneity of dispersion within and among samples grouped in gear vessel combination. PERMDISP was calculated by first computing PCO (Principle Component) analysis on the Presence/absence resemblance distance matrix, it was so done because when using the semi metric Bray–Curtis measure, a simple average across replicates of samples would not correspond to the 'central location' in multivariate Bray–Curtis space Anderson, (2006), The solution to that caveat was obtained by placing the inter point dissimilarities among sample units into a Euclidean space so as to preserve all of the original inter-point dissimilarities, this was achieved through Principle Component (PCO) analysis (Anderson, Clarke & Gorley 2008). The results of PERMDISP were significant p = 0.001 at α = 0.05, among gear vessel combination with an F ratio (F=27), also pair wise test between groups were significant at α = 0.05 as shown in the Table 4.2.

**Table 4.2: PERMDISP Pair Wise Comparison of Groups, Significance Level p < 0.05****

| **Groups** | **t statistics** | **P(Perm)** |
|---|---|---|
| HL-DC , SN-MS | 5.2071 | 0.001** |
| Hl - DC , SP - BT | 6.4427 | 0.001** |
| SN-MS , SP - BT | 3.2739 | 0.009** |

By looking at the PERMDISP table of results, it is seen that the dispersion of samples in each gear vessel combination is different in contrast to one another. However Anderson, Clarke and Gorley (2008), suggest that possibly PERMDISP will detect difference in dispersions that are not substantial in many cases to amount to inflate the error rate of PERMANOVA, mainly due to robustness of PERMANOVA under scenarios of heterogeneity. Hence a significant result in PERMDISP should not stop the computation of PERMANOVA.

To further visualize and understand the relationship between gear vessel combination and species under each gear vessel combination, a Non-Metric multidimensional scaling (nMDS) was performed on the presence/absence resemblance matrix whereas a graph with 0.08 stress was obtained as shown in the Figure 4.2. A graph with 0.08 stress value gives a guaranteed go ahead in interpretation of the relationship among gear vessel combinations.

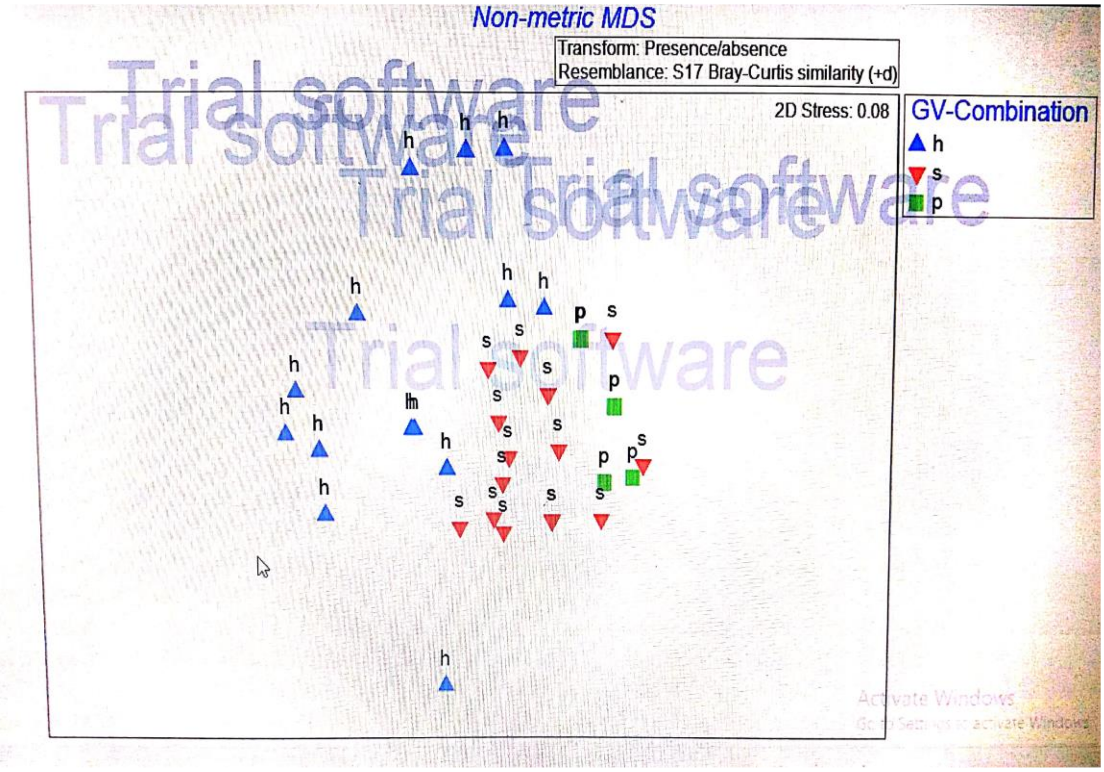


**Figure 4.1: nMDS Graph, where as;** Blue triangles (h) = Handline – Dugout canoe
Red triagles (s) = Sharknets – Mashua
Green squares (p) = Spear/stick - Boat

In PERMANOVA the results of the main effects, were significant $p = 0.001$ at $\alpha=0.05$ with an F ratio of 8.6251 as seen in the Table 4.3. Also to find specifically where the significant difference lies, pair wise group comparison was computed and was significant as shown in the Table 4.3. Further the t test statistics used in pair wise comparison of contrast groups was obtained by simply doing the square root of the pseudo F ratio obtained by permutation during comparison of two groups Anderson, (2006).

**Table 4.3: PERMANOVA Table of Results for Main Effects Significance (p < 0, 05) ****

| Factors | df | SS | MSE | Pseudo f | P(Perm) |
|---|---|---|---|---|---|
| Gear vessel combination | 2 | 18679 | 9339.3 | 8.6251 | 0.001** |
| Residuals | 57 | 61720 | 1082.8 | | |
| Totals | 59 | 80399 | | | |
| **Pair wise comparison of contrast groups of gear vessel combination, significance p < 0.05**** | | | | | |
| Gear vessel combination | | | | t | P(Perm) |
| Handline –Dugout Cannoe | Sharknets - Mashua | | | 2.5912 | 0.001** |
| Handline –Dugout Cannoe | Spear/Stick – Boat | | | 3.4787 | 0.001** |
| Sharknets – Mashua | Spear/Stick – Boat, | | | 2.6724 | 0.001** |

The significant effects is interpreted as difference of centroids among groups, which further means the existence of differences in catch composition among different gear vessel combination. A pair wise comparison shows a significant difference in catch composition of p = 0.001, t = 2.5912 between samples associated with Handline - Dugout canoe and Sharknets – Mashua; a significant difference in catch composition of p = 0.001, t =3.4787 between samples associated with Handline – Dugout canoe and Spear/Stick – Boat and also a significant difference in catch composition of p = 0.001, t = 2.6724 was found between samples associated with Sharknets – Mashua and Spear/Stick – boat.

Furthermore a rank based ANOSIM was computed on the presence/absence resemblance matrix and results were such as presented in table 4. Moreover note that, ANOSIM tests do not give regard to homogeneity of variance and does not require it for validity (Anderson, Clarke & Gorley, 2008). The overall model result was significant p = 0.001** at $\alpha = 0.05$, the overall global R statistic for the model was estimated at 0.36 with no permuted R value larger than 0.36.

**Table 4.4: ANOSIM Pair Wise Results, under p/a Transformation and Zero - Adjusted Bray – Curtis Similarity on Kigamboni Artisanal Catch Abundance**

| Pair wise tests | | R statistic | Significance level | No of R > observed (0.36) |
|---|---|---|---|---|
| Handline–Dugout canoe | Shark net- Mashua | 0.343 | 0.001** | 0 |
| Handline–Dugout canoe | Spear/stick - Boat | 0.432 | 0.001** | 0 |
| Sharknet – Mashua | Spear/Stick - Boat | 0.247 | 0.001** | 0 |

ANOSIM pair wise comparison shows a significant rank average difference p = 0.001, R = 0.343 in of catch composition between samples associated with Handline - Dugout canoe and Sharknets – Mashua; a significant rank average difference p = 0.001, R= 0.432 in catch composition between samples associated with Handline – Dugout canoe and Spear/Stick – Boat, also a significant rank average difference p = 0.001, R= 0.247 in catch composition was found between samples associated with Sharknets – Mashua and Spear/Stick – boat.

Thus the overall global significant dissimilarity p = .000 R= 0.365 among samples in different gear vessel combination is explained by the significant $p < 0.05$, dissimilarities between all contrast sets of comparison of species in different samples as grouped in respective gear vessel combination.

## 4.4 Assessing Mean Trophic Level (MTL) of Artisanal Catch Composition

The theoretical narration of the mean trophic level has been discussed in the theoretical review section of this study, to expound on that given the species available in this research study; marine trophic level was computed as follows;

*TL (octopus cyanea) × biomas (octopus cyanea) + TL ( Lethrinus borbonicus ) × biomas (Lethrinus borbonicus) + TL ( Lethrinus lentjan) × biomas (Lethrinus lentjan) +TL(panulirus penisillatus) × biomas (panulirus penisillatus) + TL(netuma thalasina) ×biomas (netuma thalasina)................. TL (istiphorus platypterus ) × biomas (istiphorus platypterus ) /* biomas (octopus cyanea) + *biomas (Lethrinus borbonicus) + biomas (Lethrinus lentjan) + biomas (panulirus penisillatus) + biomas (netuma thalasina) +..................._biomas (istiphorus platypterus )*.............. (equation 3)

Mean trophic level for each gear-vessel combination was calculated from the species caught in each gear-vessel combination as in the formula stipulated in equation 4.

$$MTL_j = \frac{\sum_i (TL_i) \times (Y_{ij})}{\sum_i Y_{ij}}$$ ..........................................................Equation (4)

Where; $Y_{ij}$ is the landing (catch) of species (group) *i* in the gear-vessel *j* and $TL_i$ is the trophic level of species (group) *i* (Chande et al., 2019)

The mean trophic level (MTL) was computed by the use of total catches of each species, weighted in kilograms (kg) and Trophic levels of each species, which were taken from fishbase, Pauly et al., (2001); Pauly et al., (2005) and Sala et al., (2004). The overall mean trophic level was found to be 3.8. The computation of mean trophic level for specific gear vessel combination was such that, mean trophic level for handline - Dugout canoe was 4.1, mean trophic level for Sharknet - Mashua was 4.0 and the mean trophic level for spear - boat was 3.4. These results imply that Handlines- Dugout canoe and Sharknets - Mashua, selects individuals with high trophic levels whereas spear/stick - Boat selects individuals with relatively lower trophic levels.

This study however could not conclude that there is declining in mean trophic level of artisanal catches at Kigamboni coastal areas simply because the study was in form of a cross-sectional survey but the overall mean trophic level of 3.8 could be implying the declining in mean trophic level when correlated with other studies as outlined in this context.

The result of this study found that 36.8% of the total catch to be composed by amphioctopus aegina/ octopus cyanea which is a relatively lower trophic level (3.4) specie, with a very huge drop to the second leading species lethrinus borbonicus with a higher trophic level (3.5) which constitute 12.4% of the total species composition across all gears. These findings can imply likely trophic cascades to be prominent in the Kigamboni coastal marine ecosystems.

## 4.5 Assessing the Influence of Seasonality on Artisanal Fishery Catch Composition

Assessment of seasonality on catch composition was executed by the use of two ways ANOVA with replication whereas two independent variables were categorical and one dependent variable was numerical / continuous as seen in the Table 4.5. The whole analysis was done by the use of SPSS software.

Normality test sharpio -wilk and normal Q-Q plots were computed across respective subjects in all groups levels, at $\alpha = 0.05$, significance level and results were not significant (p > 0.05,) across all groups in a factorial design meaning that, the dependent variable values are a simple random sample from a normal distribution across all the groups in a factorial design.

**Table 4.5: Variables used in Assessing Seasonality on Artisanal Catch Composition**

| 1st independent variable | Groups of 1st variable | Levels of 1st variable | 2nd independent variable (B) | Groups of 2nd variable | Level of 2nd variable | Dependent vatiabe (Continuous) |
|---|---|---|---|---|---|---|
| Gear-vessel combination | HL-DC | categorical | seasonality | NEM | categorical | Biomas (kg) |
| | SN-MS | | | SEM | | |
| | SP-BT | | | | | |

The test of homogeneity of variance on the continuous variable was however was tested by leven's test of equality of error variance and was significant p(.000< 0.05), meaning that the error variance in the dependent variable is not equal across all groups. Two outliers were also found by the use of stem-and- leaf plots. However due to the robustness of ANOVA models in scenarios of heterogeneity, much weight was not given to the violation of the two assumptions underlying factorial ANOVA design, the main effects were tested. Post hoc Turkey's HSD test was computed on pair wise comparison, and results were as shown in Table 4.6 and Table 4.7, for main effects and pair-wise effects respectively.

**Table 4.6: SPSS Output of Two Ways ANOVA with Repeated Measures for Main Effects Sig (p<0.05)****

| **Factors** | **df** | **Mean Square** | **F** | **Sig. (p<0.05)**** |
|---|---|---|---|---|
| SEASON | 1 | 376.752 | 1.059 | .308 |
| GVCOMB | 2 | 4991.757 | 14.035 | .000** |
| SEASON * GVCOMB | 2 | 260.268 | .732 | .486 |

As seen in the Table 4.6, there wasn't a significant interaction between gear vessel combination and season, whereas interaction was not significant (p = 0.486, F=0.732), this was further illustrated graphically in the Figure 4.3 of the estimated marginal means graph, where the seasonality lines of NEM and SEM do not cross and would not cross each other.

These results suggested that there was no significant effects (p = .308) of seasonality on catch composition in terms of the total catch as measured by biomass of species accounted per unit sample across the two seasons (North East Monsoons and South East Monsoons). However a significant (p = .000) effect across the independent factor gear vessel combination was found among gear vessel combination as illustrated in the Table 4.7. A post hoc test was not done on season factor because the factor had two groups.

**Table 4.7: Tukey's HSD Pair-Wise Test on Gear Vessel Combination Factor, Significance Level α = p<0.05***

| Gear –vessel combination | | Standard error | Significance level |
|---|---|---|---|
| HL –DC | SP-BT | 5.964 | .005** |
| SN-MS | HL-DC | 5.964 | .000** |
| SP-BT | SN-MS | 5.964 | 0.126 |

Conversely to the overall results which found no significant difference (p = .308) of catch composition across the two seasons of North East Monsoons (NEM) and South East Monsoons (SEM), a significant (p = .000) difference was found in gear -vessel combination, whereas there was an overall difference in catch levels among gear vessel combinations across seasons. Results show a significant (p=0.005) difference of catch composition between catch in handline -Dugout canoe and Spear – Boat, a significant (p=0.000) difference between handline -Dugout canoe and Sharknets – Mashua. Conversely there was no significant (p=0.126) difference between Sharknets – Mashua and Spear – Boat gear vessel combinations as seen in the Table 4.7 of results.

The Figure 4.3, is a graph of marginal means, whereas, Gear-vessel combination in the horizontal Axis, Vertical axis is the dependent variable measured in Biomas (kg) and two lines represent levels of season factor (North East Monsoons and South East Monsoons).

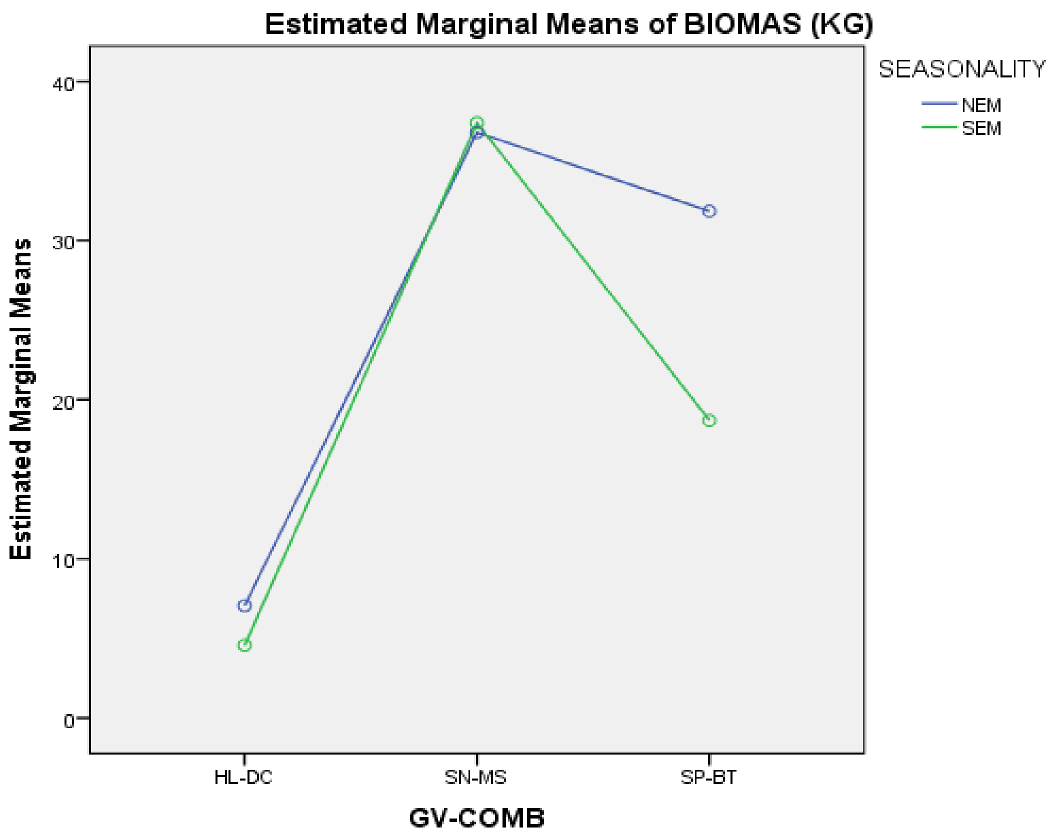


**Figure 4.2: Estimated Marginal Means Graph Generated from SPSS**

The graph of marginal means illustrate the relatively small difference between the two lines that indicate seasonality, also there is visible big difference in biomas between samples in handline-dugout canoe and the rest of the gear vessel combinations. Also there is a relatively smaller difference in biomas between samples of Sharknets – Mashua and those of Spear-Boat. these defferences illustrated graphically, resonates with results observed in the pair wise post hoc test results in Table 7.

## 4.6 Assessing the Influence of Fishing Location on Artisanal Fishery Catch Composition

Locations visited by artisanal fishers at Kigamboni municipality includes, Mapanya, Sinda, Kisiwa cha sukuti, Mwamba mkuu, Korongo, Mwamba mdogo, Kimbulumbulu, Muhuri, Chana , Kikuri and Nyororo. The frequency with which the sampled population visited the respective fishing location is given in the Figure 4.3(A). Also Figures 4.B, 4.C and 4.D. illustrate graphical composition of species in percentage (%) at the major three locations observed in the secondary data.

Descriptive statistics was used in illustrating and analysing the species composition found in the first three major fishing location as observed in the data. These first three fishing locations includes; Mapanya (41.7%), Sinda (18.3%) and Kisiwa cha sukuti (11.7%). The percentage (%) shown explains the percentage number of times that fishing location has been observed to be visited by fishers for fishing activities, as observed in the secondary data

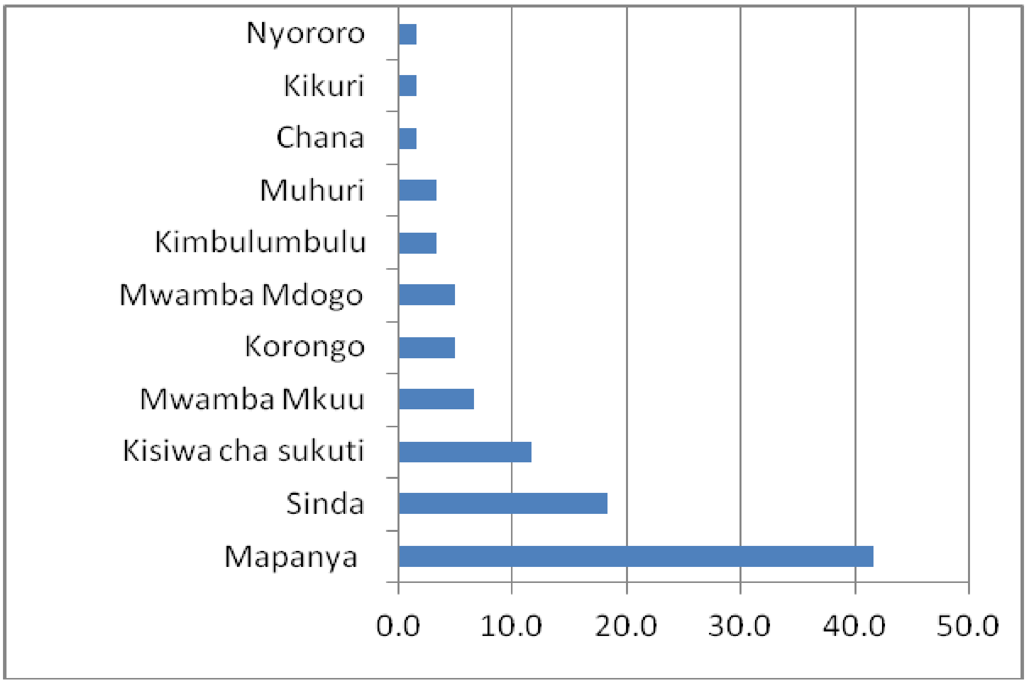


**Figure 4.3(A): Percentage (%) Illustrating Frequency Visitation of Fishers at different Fishing Location at Kigamboni Municipal Coastal Area**

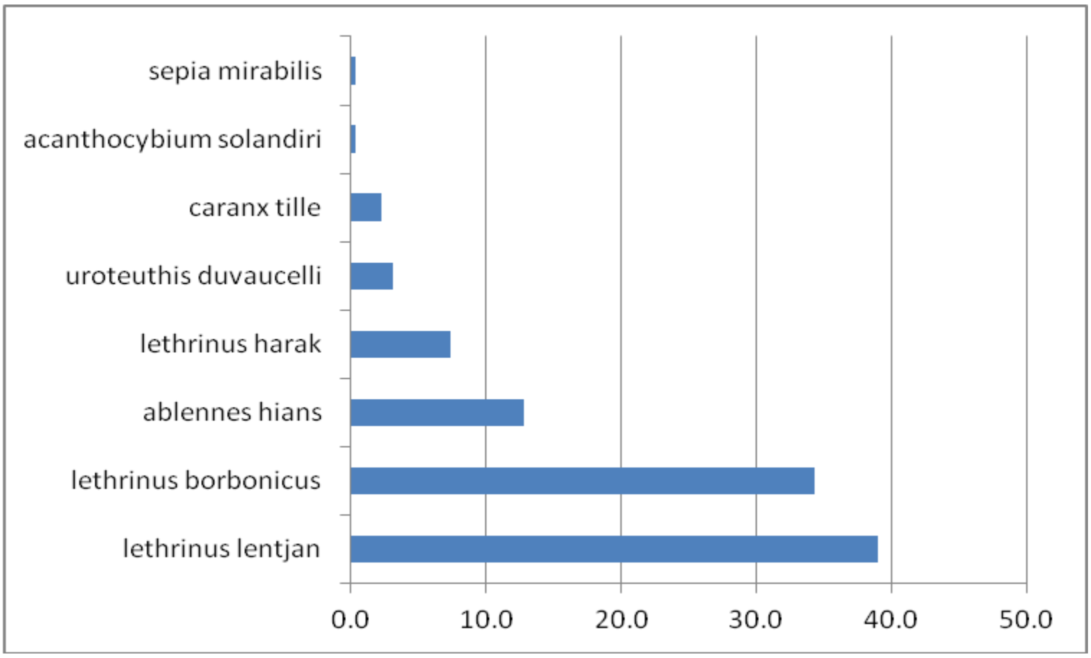


**Figure 4.3(B): Percentage (%) Explaining Species Composition at Sinda Fishing Location**

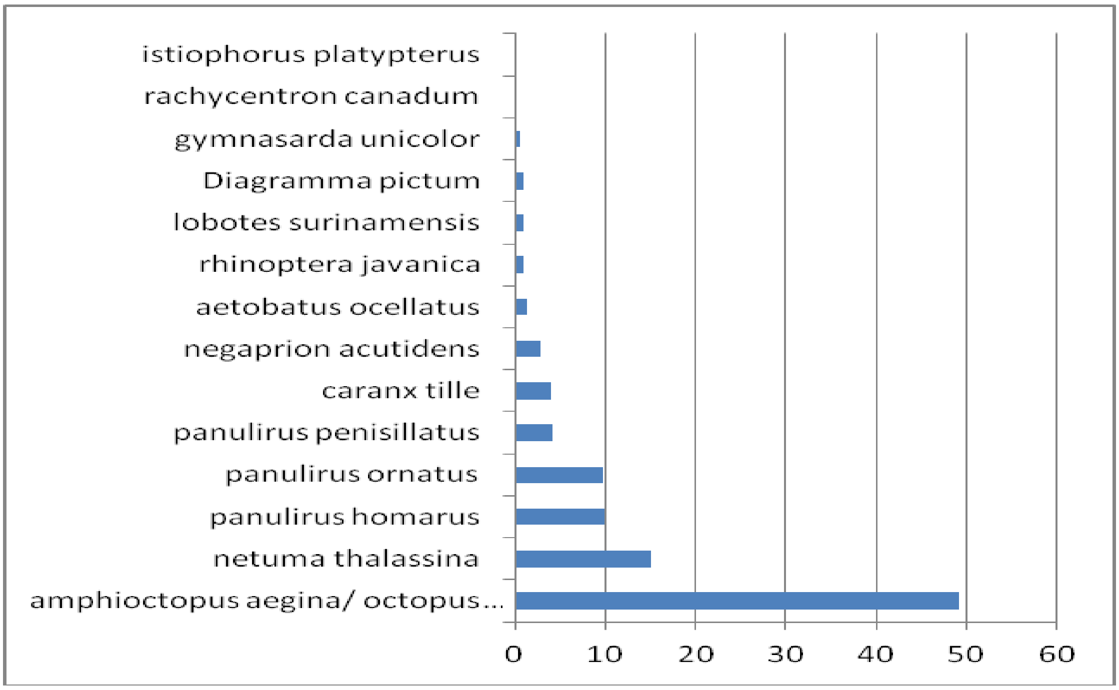


**Figure 4.3(C): Percentage (%) Explaining Species Composition at Mapanya Fishing Location**

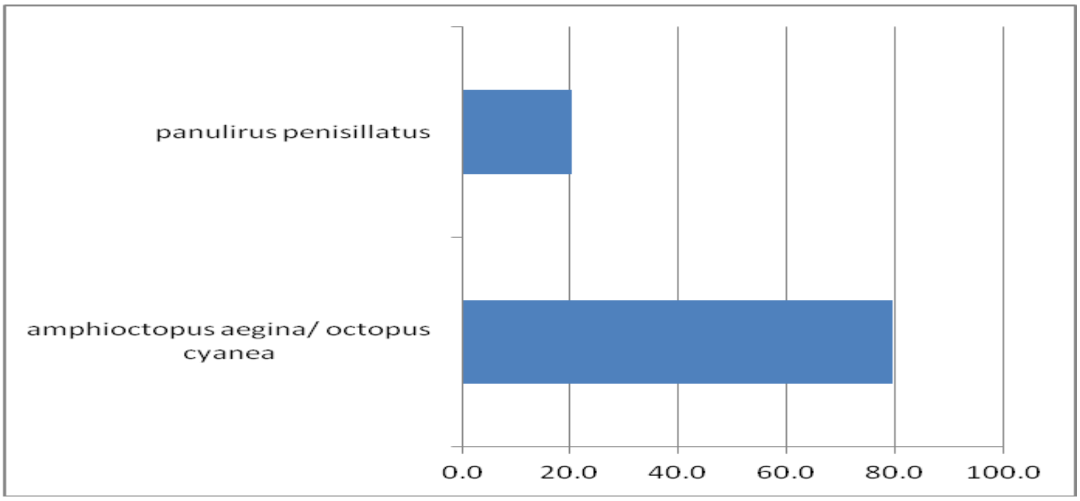


**Figure 4.3(D): Percentage (%) Explaining Species Compositing at Kisiwa cha Sukuti**

As observed in the Figures above, Mapanya constitutes species that are not found at Sinda location, the only specie that is shared between these two locations is caranx tille, and further more Sinda does not share any specie with Kisiwa cha Sukuti, while at the same time Kisiwa cha Sukuti share species with Mapanya, likely because these two fishing locations are easily reached from the same landing site that is Buyuni landing site.

### 4.7 Discussion of the Findings

General findings are such that, the first 86.2 composition of catch is constituted by eight species only out of the twenty four species observed in this study. This means that there are few species communities that constitute the majority of the assemblages residing at Kigamboni coastal area, this finding corresponds to that of Gomez, (2021) conducted in Kenya, who argued that despite the species diversity, the catch was dominated by only five (5) families that constituted a total of 85% of the total catch and such results are typical for East Africa tropical multispecies fisheries.

The assessment of gear vessel combination influence on catch composition was done by first examining an nMDS graph in Figure 4.2, whereas there was a clear separation in samples associated with Handline -Dugout Canoe and the rest of the gear vessel combination (Sharknets - Mashua and Spear/stick - Boat). This result can be seen by looking at the clear separation of the blue triangles to the rest of the symbols used representing different gear vessel combination. This result also correlate with findings in Hicks and Macclanahan, (2012) who found the composition of spears and beach seines clustered loosely together and were distinct from handline and trap. Further the nMDS graph visualize a loosely interaction between samples associated with (Sharknets - Mashua and those with Spear/Stick – Boat) gear vessel combinations.

These results correspond to that of Mcclanahan and Mangi, (2004) who found that gill nets/ shark nets, spears together with big traps landed the largest individuals and thus proving their selectivity and similarity in some of their catch composition. The ANOSIM significant (P= 0.001) result gives an indication that there is significant difference in samples among different gear vessel combinations at Kigamboni artisanal catches. The results of the general ANOSIM model means the average rank dissimilarity of samples within gear vessel combination is smaller in comparison to the average rank dissimilarity of samples among gear vessel combination (Anderson and Walsh, 2016). This is a prima facie that catches composition differs among different gear vessel combination. This result keep supporting the prior results obtained under PERMDISP and PERMANOVA that there is difference in catch composition among gear vessel combinations.

Furthermore the fairly clustering of samples as observed in nMDS in Figure 4.2 in samples of Sharknets – Mashua and those in Spear/Stick – Boat can be explained by their significant smaller dissimilarity/weaker separation of R = 0.247 in ANOSIM pair wise comparison results. Also the relatively larger dissimilarity R= 0.432 in ANOSIM pair wise comparison, between samples of Handlines – Dugout cannoe and those samples of spear/stick – Boat is observed by a proper and defined delineation between these samples in nMDS, see the separation between the blue triangles clustering and the green squares. This kind of interpretation by relating ANOSM and nMDS results was also observed in Mwandya et al., (2010), who observed a weak separation of samples among sites within the creeks of Kiwani and Mapopwe and the patterns were illustrated in the nMDS ordination plots.

When assessing the mean trophic level (MTL) the computation of mean trophic level included individuals with trophic levels less than 3.25, contrary to Bhathal and Pauly,

(2008) who suggested removing from computation of mean trophic level individuals with trophic level below 3.25. This was so done because percentage composition of species with trophic level less than 3.25 was below 1% hence negligible to affect the overall mean trophic level computation. The results of relatively higher trophic level found in Handlines- Dugout canoe (4.1) and sharknets – Mashua (4.0), suggests these gear vessel combination, selects individuals with high trophic levels in realation to spear/stick - Boat which selects individuals with relatively lower trophic levels. The results of relatively higher mean trophic level found in Handlines – Dugout canoe and Sharknets - Mashua corresponds to that found by Chande et al. (2019) who also suggested that gillnets/sharknets and handlines targeted high valuable carnivorous species with trophic level ≥ 3. Chande et al., (2019) observed higher mean trophic level in handlines and gillnets 3.9 and 3.6 respectively, and thus recommended that, these gear-vessel combinations select high level predator species.

The results of relatively lower mean trophic level found in spear/stick – boat, gear vessel combination corresponds to that of Campbel and Pardede, (2006) in Indonesia who also noticed that hand spears and nets are capable of selecting fish at low trophic levels. Furthermore the overall trophic level of 3.8 computed in this research study, corresponds to that of Sala et al., (2004) who found that mean trophic level of the catch data in Baja California Sur (BCS) decreased from 4.2 in the 1970's to 3.8 in 2000's, also corresponds to that of Liang and Pauly, (2017) whose Findings suggested a strong fishing down effect in East China Sea, whereas the taxa of the catch data associated with mean trophic level was decreasing from over 4.0 to bellow 3.8 from 1979 to 2014.

Results of the study were such that leading specie in abundance amphioctopus aegina/ octopus cyanea (36.8%) far outweigh the second leading species in abundance, lethrinus borbonicus (12.4%). Such results imply possible trophic cascades at Kigamboni coastal area whereas; species of lower trophic level outweigh by far individuals with relatively higher trophic level. This result concur with findings of Robertson et al., (2018) who found that two villages in Pangani district landed octopus and parrotfish almost exclusively; such phenomenon suggests potential trophic cascades after many years of overexploitation, as fish communities move towards low trophic level in response to release of predation in overfished grounds.

When assessing seasonality, we examined closely Figure 3 which illustrate the huge seasonal variation of catch biomas in Spear - boat which is a gear-vessel combination associated with selecting species of relatively lower trophic level, whereas for handlines-Dugout canoe and sharknerts – Mashua, which are gear vessel combinations associated with species of high trophic level, there was a negligible difference of total catch in both seasons (NEM and SEM) illustrated by a small distance between the two season lines in (HL-DC) and (SN-MS).

The graph of marginal means indicate these differences by showing the seasonal lines (NEM and SEM) to be very close in Handlines-Dugout canoe and in Sharknets-Mashua and beng highly separated across the two seasons (NEM and SEM) in Spear-Boat, gear vessel combination. These results elucidate that, species associated with Handlines-Dugout canoe and Sharknerts-Mashua, gear vessel combinations are available at almost stable quantities throughout the whole year contrary to species of relatively lower trophic level.

This result corresponds to that of Pellowe and Leslie, (2017) who observed that, at San Carlos, which is the most productive LFO, Top Taxa exihibited low seasonality indicating availability to fishers throughout the whole year. Furthermore the same consistent results across seasons that was observed in Handline -Dugout canoe was also found in Temple et al., (2019), who found that, handlines had an inverse relationship with other gears (longlines and drifting gill nets) which were highly affected by seasonality. Conversely, Pellowe and Leslie, (2017), in Santa Rosalia which is the second most productive LFO exhibited seasonal variability upon the top – trophic- taxa.

Nevertheless even though significant difference in biomas was not found across the two seasons, descriptive statistics computed in SPSS show a higher mean value of biomass 25.24 kg during the North East Monsoons season and a relatively lower biomass 20.22 during the South East Monsoons season, these results correlate with findings by Munga et al., (2014) whereas seasonality factors appeared in such a way that, catches in artisanal were higher in North East Monsoon (NEM) when most fishing takes place than in South East Monsoon (SEM) samples, thus reflecting the effects of adverse sea conditions during SEM on fishing activities that rely on small craft.

In assessing location**,** the observation that Sinda does not share majority of its species with Mapanya and Kisiwa cha suguti can also be explained by the geographical distance between the three locations located at two different landing sites, that is Mjimwema and Buyuni. Sinda can easily be reached from Mjimwema while Kisiwa cha Suguti can be easily reached from Buyuni landing centre. That’s being the case the species composition in this study is likely to be influenced by the fishing location. A similar result has been found by Purcell et al., (2018) in Australia whose result was such that that 18% of the overall difference in catch composition was explained by location differences between villages. The difference in catch composition among locations is also associated with the use of different gears in different location. The observed result in this study indicate that species found in Mapanya and Kisiwa cha sukuti which are locations nearest to Buyuni landing site differ from those species found in Sinda location which is nearer to Mjimwema landing site. Given the fact that samples taken from these two different landing sites come from different gear vessel combination proves that difference in catch composition among locations is attributable to the use of different fishing gears and vessel combination. This result correspond to that of Dolder, Thorson and Minto, (2018) who found that catch composition, catch distribution from a ‘typical’ otter trawl gear and beam trawl fishing at three distinct locations accentuated the differences fishing gear makes on catches.

# CHAPTER FIVE

# SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This chapter presents the summery of the findings, conclusion and recommendations, implication of the findings, recommendations, limitations and areas for further research

## 5.2 Summary of the Main Findings

A total of 1069 fish individuals were counted from a total sample of 60 gear-vessel combinations, the total of 24 Species found belongs to 13 orders, 19 families. The location visited by artisanal fishers at Kigamboni municipality includes, Mapanya, Sinda, Kisiwa cha sukuti, Mwamba mkuu, Korongo, Mwamba mdogo, Kimbulumbulu, Muhuri, Chana , Kikuri and Nyororo. Also in this study, the difference in catch composition among locations was also associated with the use of different gears in different location.

These results suggested that there was no significant effects (p = .308) of seasonality on catch composition in terms of the total catch as measured by biomass of species accounted per unit sample across the two seasons (North East Monsoons and South East Monsoons). Furthermore the study found no significant interaction between gear vessel combination and season. Conversely to the overall results which found no significant difference (p = .308) of catch composition across the two seasons, a significant (p = .000) difference was found in gear -vessel combination, whereas there was an overall difference in catch levels among gear vessel combinations. Also descriptive statistics computed in SPSS show a higher mean value of biomass 25.24 kg during the North East Monsoons season and a relatively lower biomass 20.22 during the South East Monsoons season.

The overall mean trophic level was found to be 3.8. The computation of mean trophic level for specific gear vessel combination was such that, mean trophic level for handline - Dugout canoe was 4.1, mean trophic level for Sharknet - Mashua was 4.0 and the mean trophic level for spear - boat was 3.4.

Furthermore, results indicate likely significant strong differences in catch composition among different gear vessel combination, as PERMANOVA results were signicant ($p = 0.001$) with an F ratio of (8.6251). A PERMANOVA pariwise comparison shows a significant difference in catch composition of ($p = 0.001$, $t = 2.5912$) between Handline - Dugout canoe and Sharknets – Mashua; a significant diffrerence in catch composition of ($p = 0.001$, $t =3.4787$) between Handline – Dugout canoe and Spear/Stick – Boat; and also a significant difference in catch composition of ($p = 0.001$, $t = 2.6724$) was found between Sharknets – Mashua and Spear/Stick – boat. PERMDISP results were significant ($p = 0.001$) among gear vessel combination with an F ratio ($F=27$), also PERMDISP pair wise test between groups was significant at ($p=0.001$, $t= 5.20$) for Handline- Dugout canoe and Sharknet – Mashua, it was also significant at ( $p= 0.001$, $t=6.4427$) between Handline- Dugout canoe and Spear – Boat, it was also significant at $p=0.009$,$t=3.2739$) between Sharknet – Mashua and Spear – Boat. A Non-Metric multidimensional scaling (nMDS) was performed on the presence/absence resemblance matrix whereas a graph with 0.08 stress was obtained.

ANOSIM overall model result was significant at (p = 0.001), with the overall R statistic for the model estimated at 0.36 with no permuted R value larger than 0.36 indicating difference in assemblages of species in samples among different gear vessel combinations in Kigamboni artisanal catches. ANOSIM pair wise comparison shows a significant rank average difference of (p = 0.001, R = 0.343) in of catch composition between Handline - Dugout canoe and Sharknets – Mashua; a significant rank average difference (p = 0.001, R= 0.432) in catch composition between Handline – Dugout canoe and Spear/Stick – Boat, also a significant rank average difference (p = 0.001, R= 0.247) in catch composition was found between Sharknets – Mashua and Spear/Stick – boat. All results were computed at significance level (α = 0.05).

### 5.3 Implications of the Findings

The large biomas of amphioctopus aegina/ octopus cyanea landed in comparison to other catch landings implies possible trophic cascades whose further repercussions will be observed by the damage of marine biodiversity, institutions mandated with formulating marine policies should enhance many empirical researches to unveil and disseminate necessary information to enable making of informed decision with respect to how these marine resources should be maintained and improved, also this study adds more evidence of gear selectivity as observed in difference of catch composition among gear vessel combination. This selectivity informs that no uniform gear- vessel regulations will have the same impact in all species and locations.

Therefore policies and regulations should be developed and enforced for specific zones as per specific requirements as unveiled by the help of empirical researches in different marine zones. This study recommends that those institutions in Tanzania responsible for marine research TAFIRI specifically, should emphasize and put up supportive infrastructures to private organization interested in conducting fisheries research. Since as the only available fisheries research institute it cannot work alone in a country like Tanzania which is naturally endowed with plenty of water bodies scattered all over the country.

### 5.4 Conclusion

Following the results and discussion of results it is enough to conclude that the catch composition of artisanal fishery is attributable to the use of different combination of fishing gear and vessels. Also the observed denuded assemblage of fish communities observed in the secondary data with a lot of zeros can be attributable to excessive fishing pressure exerted in the coral reef fish species. The excessive pressure is also caused by the use of local methodologies in fishing, especially the use of small local vessels like Dugout canoe and Mashua to mention a few which cannot go further off shore to target large and valuable catch, like Tuna and tuna like species. The limitation brought about by the use of local artisanal methodologies is manifested by the drop of catch biomas of species during the South East monsoon winds, a period characterized by strong winds and high waves hence forcing the artisanal fishers to reduce trips to the ocean in order to avoid possible fatalities which can be associated with the strong winds.

This study argue financial institutions and stake holders in the fishing industry to project finance artisanal fishery so as to realize its full potential. The results shed light on the good news that species of high trophic levels are constantly available throughout the year and thus can be yielded throughout the year and hence advantageous for fish oriented business firms. Also trophic cascades are likely to be happening and can be observed at glance, on the number of individuals and biomas of amphioctopus aegina/ octopus cyanea landed in comparison to other catch landings.

To this end, This study emphasize on the government to put More emphasis on the local governments and build capacity for fisheries officers in these institutions so as to enable them conduct thorough researches in respect to fish and marine ecology at large. It is evidenced by other researchers that there are few scientific and empirical studies yet conducted in Tanzania with respect to small scale fisheries and marine ecology at large.

## 5.5 Limitations of the Study

In spite of the fact that, the study research was conducted by adhering to all academic rules, there are some caveats, which have been observed. To start with, in the analysis of seasonality carried by the use of ANOVA, two data point were observed to be outliers through the stem- and- leaf diagram, also Leven's test of homogeneity of variance was found to be significant, violation of these two assumptions in this univariate analysis may render the results become somehow not perfect. However due to robustness of ANOVA under scenarios of heterogeneity the analysis results are ought to be valid fair enough. Also due to lack of sufficient data, Kimbiji was removed from the study and therefore limited the prospected wide range of data.

## 5.6 Further Areas of Research and Recommendations

The research in question has shaded light to some of the factors that influence catch composition of artisanal fishery. Nevertheless there are other factors called environmental gradients such as Temperature, salinity, depth from the ocean floor to mention a few that can also influence the catch composition of artisanal fisheries. Therefore this study recommends further research to be directed in those variables independently or in combination to further shed light on knowledge on variables surrounding the artisanal fishery catch composition. Also the observed overall mean trophic level (MTL) could not be assessed over years to observe the general trend of this important Marine Trophic Index due to lack of sufficient data over years. This study argue more researches and data keeping necessary to compute and observe the trend of the mean Marine Trophic Level (MTL).

## REFERENCES

Al-Mamun, A., Akhtar. A., Kamal, A. H. M., Rahman. M. F., Islam, S., Alam. D., & Hoque, M. N. (2019). Structural variability and composition of fish communities in the northern continental shelf of the bay of Bengal, Bangladesh, *Indian journal of fisheries, 66*(4), 11-19.

Abrams. P. (1983), The theory of limiting similarity. *Annual Review of Ecology and Systematics.14(34),* 359-379.

Anderson M. J., (2001), A new method for non-parametric multivariate analysis of variance, *Austral ecology 26* (1), 32- 46.

Anderson, M. J., & Walsh, D. C. I. (2016). PERMANOVA, ANOSIM, and the Mantel test in the face of heterogeneous dispersions: What null hypothesis are you testing? *Ecological Monographs*, 83(4), 557-574

Anderson, M. J., Gorley R. N., & Clarke K. R. (2008). PERMANOVA+ for PRIMER: Guide to Software and Statistical Methods. PRIMER-E: Plymouth, UK.

Biniyam, A. (2011). Determinants of Fish Catch Levels in Artisanal Fishing in Eritrea, (Unpublished) M. A. Thesis of Arts in Development Studies, Institute of Social Studies, Asmara, Eritrea.

Bhathal, B., & Pauly, D. (2008). Fishing down marine food webs and spatial expansion of coastal fisheries in India, *Fisheries research. 91(3),* 26-34. https://doi.org. 10.1016/j.fishres.2007.10.022

Caddy, J. F., & Garibaldi. (2000). *Apparent* changes in the trophic composition of world marine harvests: The perspective from the FAO capture database. *Ocean and coastal management, 43*(8-9), 615-655.

Campbell. S. J., & Pardede, S. J. (2016). Reef fish structure and cascading effects in response to artisanal fishing pressure. *Fisheries research, 79,* (2006), 75-83.

Chande, M, Kimirei. I. A., Igulu, M. M., Kuguru, B., Kayanda, R., Mwakosya. C., Kangwe, S. J., & Sululu, J., Ulotu, E. (2019). Assessment of the impacts of artisanal fishing gears on nearshore fish stocks along coastal waters off the Kilwa–Mafia seascape in Tanzania. *Regional studies in marine science. 27*(2019),100531. https://doi.org/10.1016/j.rsma.2019.100531.

Clausen, R., & York, R. (2008). Economic Growth and Marine Biodiversity: Influence of Human Social Structure on Declining of Marine Trophic Levels. *Conservation biology, 22*(2), 458-466.

Dolder, P. J., Thorson, J. T., & Minto, C. (2018). Spatial separation of catches in highly mixed fisheries. *Journal of Scientific reports.* 8 (1), 1-11. https://doi.org/ 10.1038/s41598-018-31881-w

Eyo. J. E., & Akpati C. I. (1995). Fishing gears and methods, *Ezenwaji, HMG Inyang NM, Orji EC (Eds),*2012(03/04) 143-159. Proceedings of the UNDP-Sponsored Training Workshop on Artisanal Fisheries Development. Held at University of Nigeria, Nsukka, October 29 – November 12, 1995.

Freire, K. M. F., & Pauly, D. (2010), Fishing down Brazilian marine food webs with emphasis on the east Brazil large marine ecosystem. *Fisheries research,* 105(2010), 57-62. https://doi.org/ 10.1016/j.fishres.2010.02.008

Gomez, (2021). Artisanal fishery analysis within the Mpunguti marine reserve (Southern Kenya): gear based management towards sustainable strategies. (Master thesis, Algarve University). Faro, Portugal.

Guest, G., Bunce, A., & Johnson, L., ( 2006). "How Many Interviews are Enough? an Experiment with Data Saturation and Variability." *Field Methods*, 18 (1): 59–82. doi:10.1177/1525822X05279903.

Hicks, C. C., & McClanahan, T. R. (2012), Assessing gear modifications needed to optimize yields in a heavily exploited, multi-species, seagrass and coral reef fisher. *Fisheries management and ecology, 7*(5), 1-12. https://doi.org/ 10.1371/journal.pone.0036022

Jiddawi. N. S., & Ohman, M. C. (2002). Marine fisheries in Tanzania, *AMBIO a journal of the human environment, 31*(7-8), 518-527. https://doi.org/ 10.1579/0044-7447-31.7.518

Jiddawi, N., & Thyresson, M., Crona, B. (2012). Tracing value chains to understand effects of trede on coral reef fish in Zanzibar, Tanzania. *Marine policy*, https://doi.org/ 1016/j.marpol.2012.05.041

Kelly, B. J. G., Robbert, B., Kyle, S. M., Scott. L., James, D. C., Ronald, G. B., Fredrick, D. L., & Li, H. (2015). Power and sample size estimation for microbiome studies using pair wise distances and PERMANOVA. *Bioinformatics 31*(15),2461-2468.https://doi.org/ 10.1093/bioinformatics/btv183

Laurans. M., Gascuel, D., Chassot, E., & Thiam. D. (2004). Changes in the trophic structure of fish demersal communities in West Africa in the three last decade. *Aquatic living resoueces,17*(2004),163-173. https://doi.org/ 10.1051/alr:2004023

Lafferty, K. D., & Suchanek, T. H. (2016). Revisiting Paine's 1966 sea star removal experiment, the most-cited empirical article in the American naturalist. *American naturalist, 188*(4), 365-378. https://doi.org/ 10.1086/688045

Liang. C., & Pauly. D. (2017). Fisheries impact on China’s coastal ecosystems: Unmasking a pervasive ‘fishing down’ effect. *Plos ONE, 12*(3),1-15.

Linderman. R. (1942). The Trophic-Dynamic Aspect of Ecology. *Ecology* 23(4),399-417. https://doi.org/ 10.2307/1930126

Munga. C. N., Mwangi, S., Ong, H., Ruwa, R., Manyala, J., Groeneveld, J. C., & Kimai, E., Vanreusel, A. (2014). Fish Catch Composition of Artisanal and Bottom Trawl Fisheries in Malindi-Ungwana Bay, Kenya: A Cause for Conflict?. *Westen Indian Ocean Journal of Marine Science*, *13*(2), 177-188.

McClanahan. T. R., & Mangi. S. C. (2004), Gear-based management of a tropical artisanal fishery based on species selectivity and capture size. *Fisheries Management and Ecology,* 11(1)51-60.

Mwandya, A. W. (2010). Estuarine, Coastal and Shelf Science Spatial and seasonal variations of fish assemblages in mangrove creek systems in Zanzibar (Tanzania). *Estuarine, Coastal and Shelf Science, 89(4),* 277-286.

Paine. R. T. (1966). Food web complexity and species diversity or latitudinal gradients in species diversity tend to Though longitudinal be well described in a zoogeographic sense , they also are poorly under- lies in the of major ecological interest . Their importance stood. *The American naturalist, 100*(910), 65-75.

Pauly, D., & Watson, R. (2005). Background and interpretation of the ' Marine Trophic Index ' as a measure of biodiversity. *Phylosophical transactions of the royal society,* B360:415-423. https://doi.org/ doi:10.1098/rstb.2004.1597,28

Pauly, D., Palomares.M. l., Froese, R., Sa-a. P., Vakily. M., Preikshot, D., & Wallace, S. (2001). Fishing down Canadian aquatic food webs. *Canadian journal of fisheries and aquatic science, 58*(1), 51-62. https://doi.org/ 10.1139/f00-193

Pavluk, T., De Vaate, & Abrahambij, E. (2018). Trophic Index and Efficiency. *Enclopidia of ecology,* (2000), 495-502.

Pellowe, K. E., & Leslie, H. M. (2017). Seasonal variability shapes resilience of small-scale fisheries in Baja California Sur, Mexico. *PloS ONE 12*(8), 1-15.

Purcell, S. W., Fraser, N. J., Tagica, S., Lalavanua, W., Ceccerelli, D. M. (2018). Discriminating catch composition and fishing modes in an artisanal multispecies fisher. *Frontiers in marine science, 5*(243), 1-10.

Rocklin, D., Santoni, M. C., Culioli, J. M., Tomasini, J. A., Pelletier, D., Mouillot, D. (2009). Changes in the catch composition of artisanal fisheries attributable to dolphin depredation in a Mediterranean marine reserve. *ICES journal of marine science, 66* (4), 699-707. https://doi.org/ 10.1093/icesjms/fsp036

Robertson, M. D., Midway, S. R., West, L., & Tillya, H. (2018). Fishery Characteristics in two districts of coastal Tanzania. *Ocean and coastal management,163* (2018) 254-268.

Sala. E., Aburto-Oropeza, O., Reza, M., Paredes, G., López-Lemus, & Luis, G. (2004). Fishing Down Coastal Food Webs in the Gulf of California. *Fisheries, 29*(3), 19-25. https://doi.org/ 10.1577/1548-8446(2004)29[19:fdcfwi]2.0.co;2

Sekandende, B.S., Scot.L., Anderson. J., Aswani.S., Francis.J., Jacob.Z., Jebri.F., (2020). The small pelagic fishery of the Pemba Channel , Tanzania : What we know and what we need to know for management under climate change. *Ocean and Coastal Management, 197(2020),105322.*

Taylor, P., Jacquet, J., Fox, H., Motta, H., Ngusaru, A., Zeller, D. (2010). Few data but many fish: marine small-scale fisheries catches of Mozambique and Tanzania. *Africa Journal of Marine Science, 32* (2),37-41.

Temple, A. J., Wambiji, N., Poonian, C. N. S., Jiddawi, N., Stead, S. M., Kiszaka, J. J., & Berggren, P. (2019). Marine megafauna catch in south-western India Ocean small scale fisheries from landing data. *Biological conservation, 230*(2019), 113-121.https://doi.org/ 10.1016/j.biocon.2018.12.024

Terborgh, J. W. (2015). Toward a trophic theory of species diversity. *112*(37),11415-11422.doi/10.1073/pnas.1501070112

Tokeshi, A. M., Arakaki, S., & Daudi, J. R. P. (2013). Consuming Diversity: Analysis of Seasonal Catch Patterns in Multispecies Artisanal Reef Fisheries in North Sulawesi, Eastern Indonesia, Consuming Diversity: Analysis of seasonal Catch Patterns. *BioOne, 67*(1), 1-13. https://doi.org/ 10.2984/67.1.1

Trevor, A. W., Reg, F., Elizabeth, A. J., Simon, M., Carey, R. P., Grace, T. R., Daniel, T., & Sean, R. (2010). The trophic fingerprint of marine fisheries. *Nature, 468* (7322), 431-435. https://doi.org/ 10.1038/nature09528

Tuda, P. M., Wolf, M., & Breckwoldt, A. (2016). Ocean & Coastal Management Size structure and gear selectivity of target species in the multispecies multigear fishery of the Kenyan South Coast.*Nature, 130*(2016), 95-106. https://doi.org/ 10.1038/nature09528

Virginia, B., & Victoria, C. (2019). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales, *Qualitative Research in Sport, Exercise and Health. 3,(2),* 54-67.

William, V., & College, H. C. (2005). Lindeman’s trophic-dynamics aspect of Ecology: Will you still need me when I am 64? Limnology and oceanography *bulletin*, 14(3), 53-57.

Winston, B. R., Phiri, T. B., & Singini, W. (2018). Assessment of catch composition and economic analysis of monofilament and multifilament under meshed-gears (Ngongongo) at Likoma Island, Lake Malawi. *Journal of fisheries research,03* (1)7-17. https://doi.org/ 10.35841/fisheries-research.3.1.7-17.

# APPENDICES

## DESCRIPTIVE STATISTICS FROM RESPONDENTS

**Appendix I. Respondent's social economic characteristics (n=22)**

| Variable | Category | Frequency | Percentage |
|---|---|---|---|
| Sex | Male | 18 | 81.8% |
| | Female | 6 | 27.2% |
| Age | 18-29 | 3 | 13.6% |
| | 30-39 | 11 | 50% |
| | 40-49 | 5 | 22.7% |
| | 50-Above | 4 | 18.1% |
| Region | Moslems | 14 | 63.6% |
| | Christians | 8 | 36.3% |
| Education | Primary Education | 10 | 45.5% |
| | Secondary Education | 7 | 31.8% |
| | Certificate and Diploma | 3 | 13.6% |
| | Bachelor Degree | 2 | 9% |
| Experience in Fishing Industry | 1-5 Years | 8 | 36.3% |
| | 6-10 Years | 5 | 22.7% |
| | 10-15 Years | 6 | 27.2% |
| | 15-Above | 1 | 4.5% |

**Appendix II. Qualitative information obtained from respondents**

| | |
|---|---|
| Five main species landed | Siganus argenteus |
| | Panulirus penisillatus |
| | Octopus cyanea |
| | Naso branchycentron |
| | Ablennes hians |
| Major fishing vessels used | Boat |
| | Dugout cannoe |
| | Mashua |
| | Open canoe |
| | Ngalawa |
| Main fishing gears used | Handline |
| | Longline |
| | Sharknets/Gill nets |
| | Hook |
| | Spear/stick |

**Appendix III: Qualitative information obtained from respondents**

Five highly priced species in Kigamboni Fish markets

Panulirus ornatus

Siganus argenteus

Gymnasarda unicolor

rhinoptera javanica

caranx tille

Five species whose landings are observed to be declining with a range of five years (2016-2020)

Amblygaster sirm

Panulirus penisillatus

Siganus argenteus

Amphioctopus aegina

Atule mate

Five species whose landings are observed to be increasing within a range of five years (2016-2020)

Amblygaster sirm

Netuma thalsssina

Panulirus penisillatus

Naso branchycentron

Negaprion acutidens

Features that signify seasonality at the coast of Kigamboni Municipal

Monsoon winds

Rains

Moon

Summer

Available fish habitats t Kigamboni Municipal

Coral reefs

**Appendix IV: Local names, (Order, family, species = obtained from fishbase) of species mentioned in the study**

| | Local name | Order | Family | specie |
|---|---|---|---|---|
| 1 | Pweza | Octopoda | Octopodidae | amphioctopus aegina/ octopus cyanea |
| 2 | Changu Chole | Eupercaria/misc | Lethrinidae | lethrinus borbonicus |
| 3 | Njana | Eupercaria/misc | Lethrinidae | lethrinus lentjan |
| 4 | Kamba Kaki | Decapoda | Palinuridae | panulirus penisillatus |
| 5 | Hongwe | Siluriformes | Ariidae | netuma thalassina |
| 6 | Gongora | Beloniformes | Belonidae | ablennes hians |
| 7 | Kamba Mwanzi | Decapoda | Palinuridae | panulirus ornatus |
| 8 | Kamba Koche Wengine | Decapoda | Palinuridae | panulirus homarus |
| 9 | Kolekole | Carangiformes | Carangidae | caranx tille |
| 10 | Tasi | Acanthuriformes | Siganidae | Siganus argenteus |
| 11 | Changu Doa | Eupercaria/misc | Lethrinidae | lethrinus harak |
| 12 | Ngisi | Myopsida | Loliginidae | uroteuthis duvaucelli |
| 13 | Papa | Carcharhiniformes | Carcharhinidae | negaprion acutidens |
| 14 | Taa | Myliobatiformes | Rhinopteridae | rhinoptera javanica |
| 15 | Kapungu | Myliobatiformes | Aetobatidae | aetobatus ocellatus |
| 16 | Kumbasi | Acanthuriformes | Lobotidae | lobotes surinamensis |
| 17 | Komba | Eupercaria/misc | Haemulidae | Diagramma pictum |
| 18 | Dome | sepiida | sepiidae | sepia mirabilis |
| 19 | Sehewa Miraba | katsuwonus pelamis | Scombriformes | Scombridae |
| 20 | Jodari Meno | Scombriformes | Scombridae | gymnasarda unicolor |
| 21 | Nguru Mkondo | Scombriformes | Scombridae | acanthocybium solandiri |
| 22 | Songoro | Carangiformes | Rachycentridae | rachycentron canadum |
| 23 | Nyenga(Bocho) | Myliobatiformes | Dasyatidae | maculabatis ambigua (BOCHO) |
| 24 | Nduwaro | Carangiformes | Istiophoridae | istiophorus platypterus |
| 25 | Dagaa Damu | Clupeiformes | Clupeidae | Amblygaster sirm |
| 26 | Puju | Acanthuriformes | Acanthuridae | Naso brachycentron |
| 27 | Vibua | Carangiformes | Carangidae | Atule mate |

## Appendix IV: Research Clearance Letter

**THE OPEN UNIVERSITY OF TANZANIA**

***DIRECTORATE OF RESEARCH, PUBLICATIONS, AND POSTGRADUATE STUDIES***

P.O. Box 23409 Fax: 255-22-2668759
Dar es Salaam, Tanzania,
http://www.out.ac.tz

Tel: 255-22-2666752/2668445 ext.2101
Fax: 255-22-2668759,
E-mail: drpc@out.ac.tz

**Ref: PG201705573** **3rd July 2019**

TO WHOM IT MAY CONCERN

**RE: RESEARCH CLEARANCE**

The Open University of Tanzania was established by an act of Parliament no. 17 of 1992. The act became operational on the 1st March 1993 by public notes No. 55 in the official Gazette. Act number 7 of 1992 has now been replaced by the Open University of Tanzania charter, which is in line the university act of 2005. The charter became operational on 1st January 2007. One of the mission objectives of the university is to generate and apply knowledge through research. For this reason staff and students undertake research activities from time to time.

To facilitate the research function, the vice chancellor of the Open University of Tanzania was empowered to issue a research clearance to both staff and students of the university on behalf of the government of Tanzania and the Tanzania Commission of Science and Technology. The purpose of this letter is to introduce to you **Mr. Evodius Alfred Buberwa, Reg. No. PG201705573** who is pursuing **Master Degree of Project Management**. We hereby grant this clearance to conduct a research titled: **"The Influence of Gear –Vessel Combination on Artisanal Fishery Catch Composition: A Case Study of Kigamboni Municipal Coastal Area",** He will collect his data in Dar es Salaam Region between 24th August 2019. The research will be conducted in Dar es Salaam Region.

In case you need any further information, please contact:
The Deputy Vice Chancellor (Academic); The Open University of Tanzania; P.O. Box 23409; Dar es Salaam. Tel: 022-2-2668820

We thank you in advance for your cooperation and facilitation of this research activity.
Yours sincerely,

**Prof Hossea Rwegoshora**
**For: VICE CHANCELLOR**
**THE OPEN UNIVERSITY OF TANZANIA**