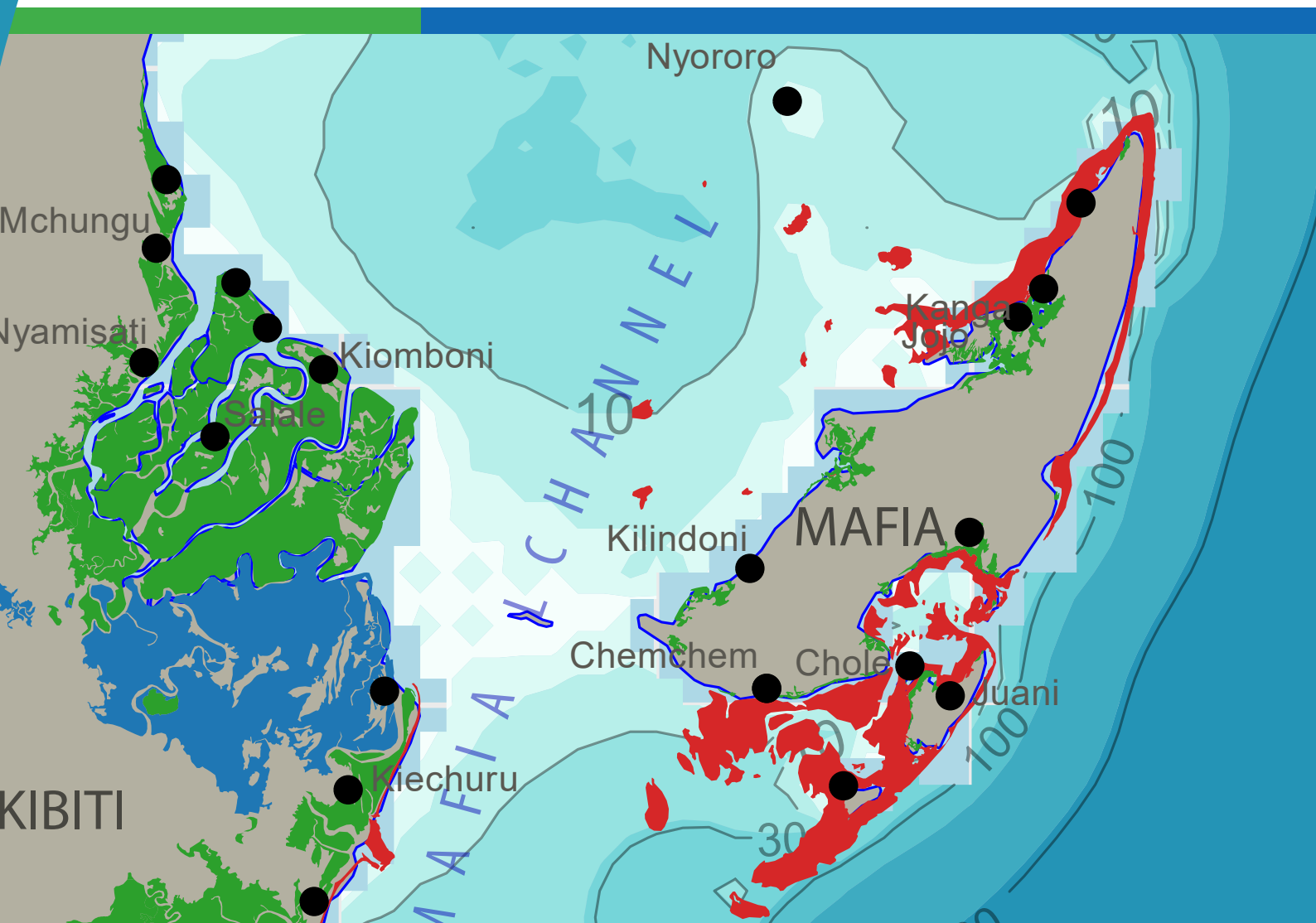
THE STATE OF THE ELECTRONIC CATCH ASSESSMENT (eCAS) SURVEY IN RUMAKI SEASCAPE

A case of Kibiti, Mafia, and Kilwa Districts



ISSN: xx–ISSN: xxxx–xxxx

Citation: URT 2023. The state of the Electronic Catch Assessment (eCAS) in the RUMAKI Seascape: A case of Kibiti, Mafia, and Kilwa Districts. No. 1. Pp xvi + 31 e-ISSN:xxxx–xxxx. Dar es Salaam.

Graphics:	Masumbuko Semba
Typeset and layout:	Masumbuko Semba
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The state of the Electronic Catch Assessment Survey (eCAS) in the RUMAKI Seascape

A case of Kibiti, Mafia, and Kilwa Districts

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June 2023

ACKNOWLEDGEMENT

The completion of this assignment would not have been possible without the invaluable support and contributions from various organizations and individuals, to whom we are profoundly grateful. Our deepest appreciation goes to WWF Tanzania, particularly through the Blue Action Fund programme, for their remarkable support and generous funding. Their involvement served as a pivotal driving force behind the successful accomplishment of this assignment. We are truly indebted to them for their unwavering commitment to environmental conservation and sustainable practices.

We would also like to acknowledge the Ministry of Livestock and Fisheries for their collaborative efforts and assistance. Their support was instrumental in making this assignment a success. Additionally, we would like to express our gratitude towards the Tanzania Fisheries Research Institute for providing us with their expertise and data accessibility, which proved invaluable to our work.

Finally, we would like to thank the exceptional contributions of Dr. Modesta Medad, Mr. Haji Machano, Mr. Jason Reuben, and Mr. Julian Easton. Their insights and suggestions significantly improved the quality of this assignment. Their expertise and passion for the subject matter were evident in the innovative ideas and perspectives they brought to the table. We are truly grateful for their support and would like to extend our sincerest appreciation to all those who helped us in completing this task.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

BMU	Beach Management Unit
CAS	Catch Assessment Survey
CFMA	Collaborative Fisheries Management Area
eCAS	Electronic Catch Assessment Survey
MIMP	Mafia Island Marine Park
MLF	Ministry of Fisheries and Livestock
MPA	Marine Parks Areas
NEM	Northeast Monsoon Season
RUMAKI	Rufiji Mafia Kilwa
SEM	Southeast Monsoon Season
TAFIRI	Tanzania Fisheries Research Institute
URT	United Republic of Tanzania
WWF	World Wide Fund
TP	Total production

FISHERIES CATCH ASSESSMENT IN DIGITAL TECHNOLOGY

1.1. OVERVIEW

In Tanzania, the marine fishery sector plays a crucial role in providing significant social and economic benefits, such as employment opportunities, food security, and income for fishing communities. This fishery operates in shallow coastal areas with water depths below 60 meters. These coastal waters have highly productive ecosystems that are interconnected across the three main channels of Pemba, Zanzibar, and Mafia, as noted by Sekadende et al. (2020).

The ocean dynamics in these coastal waters provide an ideal environment for a variety of marine priority fisheries, including prawn, octopus, small, medium and large pelagic species, Tuna and tuna-like, demersal, and coral reef fishes. The small-scale fisheries sector is the largest in the country, accounting for more than 90% of the total catch in marine waters (Jiddawi and Öhman 2002; Sekadende et al. 2020). Most of the artisanal fishery operates within the Rufiji-Mafia-Kilwa seascape. Despite the significant benefits that these ecosystems provide to local communities in terms of food and income, they face significant anthropogenic-human induced pressure.

The degradation of coastal habitats has significantly impacted fisheries activities, ultimately affecting the coastal communities that rely on these resources for income, food, and employment. However, data-driven information on the degradation of coastal ecosystems and fishery health is scarce, posing a challenge to the management of marine resources. To address this issue, the World Wildlife Fund (WWF) has initiated several programs aimed at understanding the state of coastal ecosystems and the health of fishery resources in the Kibiti, Mafia, and Kilwa seascape.

The program began with the establishment of Beach Management Units (BMUs) and Collaborative Fisheries Management Areas (CFMAs) in these districts, focusing on assisting in the recording of fish catch landings through catch assessment surveys (CAS). In 2018, the Tanzania Fisheries Research Institute (TAFIRI), in collaboration with WWF, scaled up the program by integrating electronic catch assessment systems (e-CAS) for data recording. This integration will enhance the accuracy of data collection and analysis, providing valuable insights into the status of the coastal ecosystem and fishery resources in the region. The WWF programs' data-driven approach will help inform effective management strategies for sustainable use and conservation of these vital marine resources.

Today, eCAS has provided a substantial number of fisheries catch and effort data for coastal waters (Sailale and Mpuruti 2021). Although the eCAS has archived a substantial number of fish catch and effort information, only the catch records for Kilwa, Mafia and Kibiti Districts were used. Therefore, this report has analyzed the quality of eCAS data collected

between 2017 and 2020. The report also summarizes the findings of five priority fisheries – Octopus, small pelagics and reef fisheries in the Mafia Island Marine Protected Area (MIMP). It also presents the quality of the data and fishery health in the CFMAs within Kilwa, Kibiti and Mafia seascape.

The trends of total landings from the priority fisheries (from both CAS and eCAS data) is also provided for Kilwa Kibiti and Mafia Districts. Furthermore, the report present the strengths and weaknesses of the platform and identify gaps that need to be addressed. The information in this report will assist fisheries managers, scientists, and development partners to plan and allocate resources for strategic interventions that are based on scientific findings. The results presented in this report assessed the quality of the data in the eCAS for RUMAKI seascape and whether the data can be used to describe the state of small-scale fishery in the coastal waters of Tanzania.

1.2. OBJECTIVES

The key objective of the assignment was to analyze available catch and effort data of artisanal fisheries in coastal waters of Kilwa, Mafia and Kibiti Districts. The specific objectives were:

1. To analyze the quantity and quality of the available eCAS data for priority fisheries and other fisheries from ten CFMAs in Kibiti, Mafia and Kilwa Districts.
2. To assess the spatial distribution (catch rates) of priority fisheries in Kibiti; Mafia and Kilwa Districts.
3. To analyze eCAS data (2017 - 2020) from Kibiti, Mafia and Kilwa Districts and present CPUE and annual fish production trends by priority fishery, for indicative CFMAs where data is sufficient, or otherwise by district.
4. To analyse MIMP CAS (catch data) from 2010 - 2020 and present CPUE and annual fish production trends, by priority fishery, in Mafia Island Marine Park. Include a preliminary interpretation of CPUE trends for each priority fishery, with reference to trends in relevant gear-effort (from 2009, 2016 and 2018 frame surveys).
5. To define one or more simple and replicable indicators and baselines (e.g., CPUE, total production, income per fisher), that are useful in tracking and assessing the sustainability of priority fisheries (small pelagics, prawn and octopus) focusing on the CFMAs in the districts of Mafia, Kibiti and Kilwa based on available data

DATA ACCESS, PROCESSING AND ANALYSIS

2.1. STUDY SITE

The study was conducted in the coastal water of Kibiti, Mafia and Kilwa Districts located between latitude 9.4°S and 7.5°S and longitude 38.9°E and 40.5°E (Figure 2.1). The catchment of this study consists of the shallow water over a wide continental shelf of about 40km long that cover about 25 percent of the Tanzanian mainland near shore waters and supports all mosaics of coastal marine habitats, composed of coral reefs, mangroves, sea grasses, and muddy flats. About 26 percent of national coral reef habitat is found in this seascape alongside the largest mangrove area, the Rufiji mangroves, spanning over 53,255 hectares in the Rufiji River delta. The habitat is complex and the discharge of Rufiji River makes

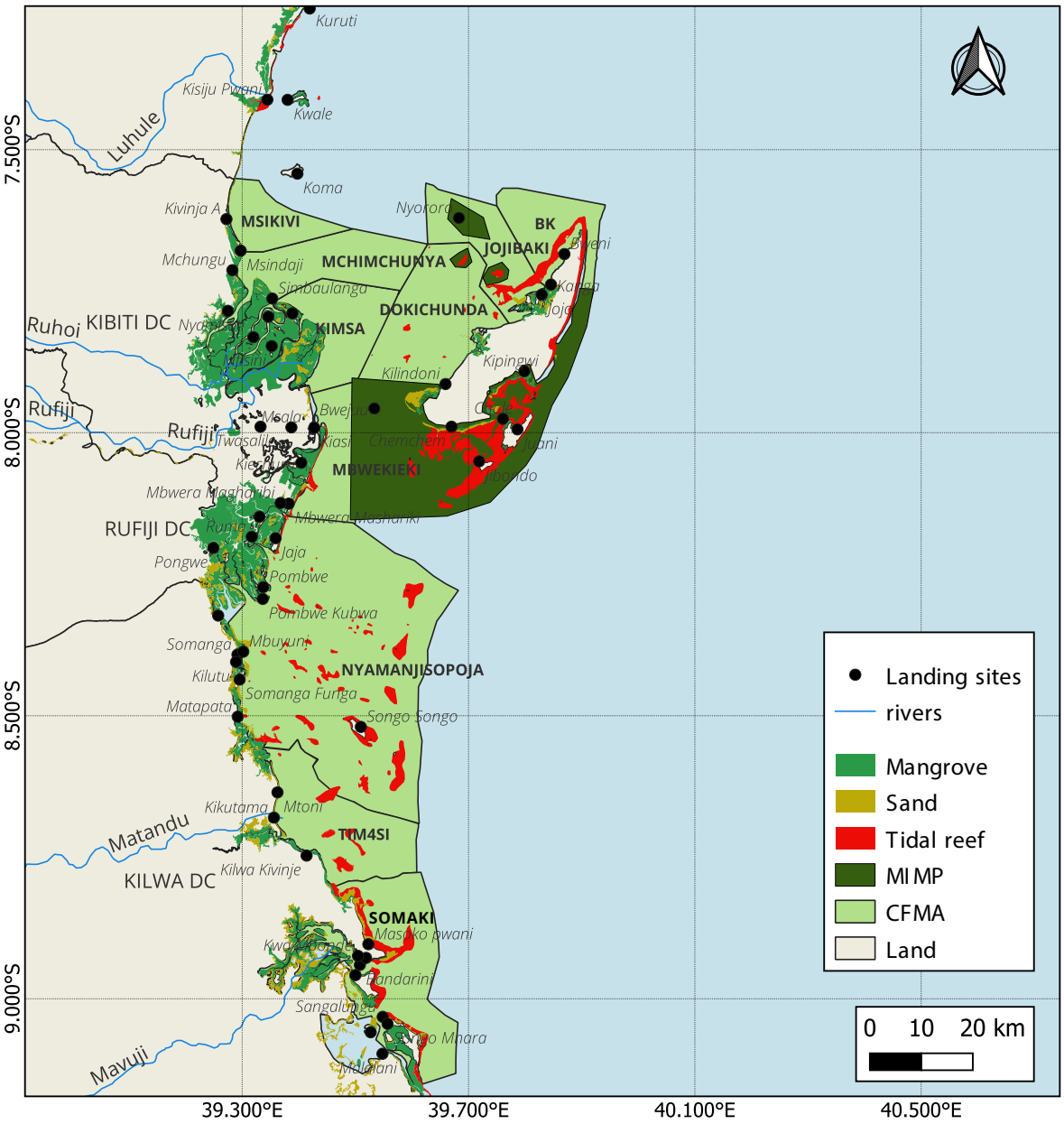


Figure 2.1: Map of the RUMAKI seascape showing the coastal habitats and landing sites in the Kibiti, Mafia and Kilwa Districts

the Kibiti, Mafia and Kilwa seascape one of the most biologically productive and diverse marine areas in Tanzania (UNEP, 2001). In addition to supporting high biodiversity, the ecological functioning of this seascape supports small-scale fisheries that provide food and income to local communities. The area also supports a growing tourism industry (Tumbo et al. 2015). The weather and climate of coastal waters of Tanzania is generally similar and is influenced by prevailing trade winds.

The reversal tendency of these trade winds creates two alternating monsoon seasons (Semba et al. (2019); Richmond (1995)). The first season is called northeast monsoon (NEM), which often occurs from November through April (Figure 2.2). This season is characterized with warm weather conditions and weak wind speed that blows from the northeast (Figure 2.2). The mirror of the northeast is the southeast monsoon (SEM), which occurs from May through October (Figure 2.2). The SEM has cooler weather and strong wind speed that blows from the southeast. Like other areas in the Western Indian Ocean region, the trade winds speed and direction has influence on the oceanographic dynamics in Kibiti, Mafia and Kilwa seascape, which affects fisheries patterns. Furthermore, the presence of river delta and estuaries that freshen the salt water with discharged from mainland resulting to high production in coastal ecosystem and the fisheries (Figure 2.1).

2.2. DATA

2.2.1. Landing sites

According to the CAS sampling scheme for the Marine Waters of Tanzania (Fisheries Development Division 2017), the sampling unit is made up of gear-craft combination, and that each data collecting landing site is assigned a minimum of 32 records of a given gear craft combination. These data are then collated at district level as a stratum, where by a district can be served by up to five villages landing sites. The requirement of this study has two factors that were not entirely considered by the sampling protocol, which are: (i) stratification by CFMA, and (ii) pooling the species data into priority species groups. The two actions have cancelling effects but the resulting sets need to be verified of their validity to the analysis required (Table 2.1).

Table 2.1: Landing sites designated for CAS as per Sampling Protocol

District	Villages/ BMUs
Mafia	Kilindoni, Dongo, Chunguruma, Banja, Bweni
Kibiti	Nyamisati, Mchungu, Kivinja, Pombwe
Kilwa	Mbuyuni-Somanga, Songosongo, Magengeni, Jimbiza, Masoko Pwan

Based on the 2018 frame survey, Tanzania mainland has more than 250 landing sites that are spread along 784 km of coastline. Among these sites, 106 landing sites record and upload fish catch and effort into the electronic catch assessment survey (eCAS) system (Sailale and Mpuruti 2021). Interestingly, there are 58 landing sites in the Kibiti, Kilwa and Mafia Districts that report catch and effort in the eCAS (Table 2.2). This suggests that the 3 target districts out of 16 coastal districts, but they represent 50 percent of all landing sites. About 30% of these landing sites are located in 22 villages of Kibiti, 10% of the sites are from 11 villages of Kilwa, and remaining 17% in 13 villages of Mafia. In the context of the collaborative fisheries Management areas, most of these landing sites are located at NYAMANJISOPOJA CFMA (Table 2.2). It is encouraging to see that most of the landing sites that contribute catch and effort data in the national eCAS database are within the RUMAKI seascape.

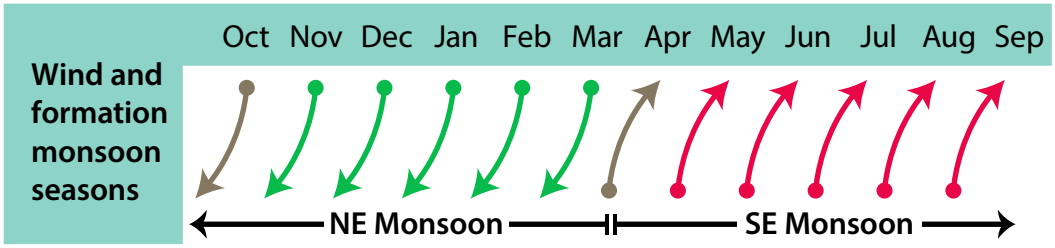


Figure 2.2: Direction of trade winds during the northeast (NE) and southeast (SE) monsoon

Table 2.2: Number and corresponding names of landing sites in each CFMA that contribute catch data in eCAS system

CFMA	Number	Names
BK	3	Bweni Bandarini, Bweni Mafia, Msikitini
DOKICHUNDA	6	Kilindoni Bandarini, Tumbuju, Kilindoni, Mfuruni, Kichevi, Kilwa Road
JOJIBAKI	5	Sinzarau, Jaani, Lwale,Mlundo,Banja
KIMSA	5	Basalona, Kifanju Mtetema, Kibanju, Dima-Lasini, Kiomboni Bandarini
MBWEKIEKI	4	Maimbwa, Kiechuru Kati, Uwandani, Nyaitoti
MCHIMCHUNYA	5	Nyamisati Pwani, Mchungu, Nyamisati, Kitintali, Mchinga
MSIKIVI	7	Nyamsungi, Mtakwani, Kariakoo, Mtakawane, Kaariakoo, Kimbembe, Dugiza
NYAMANJISOPOJA	15	Pembeni, Mbuyuni, Fungu La Nyani, Kempo, Kirambani, Mnguru, Suni, Funguni, Mwembe Ndizi, Pombwe Kubwa, Simaya, Nyuni, Mbwera Madukani, Mjimwema Fungu, Pombwe, Kuu
SOMAKI	2	Jimbiza, Masoko Pwani
TIM4SI	4	Magengeni, Mayungiyungi, Bonde, Kivinje

2.3. CATCH AND EFFORT DATA

This assignment used catch and effort fisheries data from the Ministry of Livestock and Fisheries (MLF) and the Mafia Island Marine Park (MIMP). The data is contained in the following data sets, all of which were collected by, or with significant contribution, from the communities. The first set is the eCAS data, which is the current platform that uses smartphones to collect data (Sailale and Mpuruti (2021). The eCAS platform was introduced in 2017, replacing the paper-based collection system (CAS) in which data was collected in stand-alone computers. A sub-set of this data was analyzed in this study for the dates between June 2017 to June 2021, and covers the entire RUMAKI area, excluding the MIMP.

The second set of data is from the historical data collected using pen and paper and stored in the stand-alone computers located in the RUMAKI districts. The data used in this study runs from 2010 to 2015, for the RUMAKI districts and excluding the MIMP. The third data set is generated by the communities within the MIMP and spans March 2009 to November 2018. This data was stored in the Mafia Island Marine Park's computer, and was collected using a pen and paper method. The final dataset included in this analysis is the Frame survey data which are collected at least once every two years, with the aim to obtain a snapshot of the fishing industry that can then derive the extrapolation factor for calculating the total production. Data used in this report were generated in 2018 and three earlier surveys, implemented in 2009, 2011, and 2016.

2.3.1. Record of data

A total of 55,764 data records were analyzed and linked with 40,721 catches. The distribution of these records is shown in Table 2.3. Mafia produced 81% of the data, collected between MIMP (59%) and RUMAKI (22%). Kilwa contributed 15% of the records, while Kibiti provided 3.6% of the data. Contribution based on the source of data, indicates that MIMP had 59% of data, with 14% of data recovered from old CAS data and 26% from the more recent eCAS data.

Table 2.3: Catch records of eCAS, CAS and MIMP collated from RUMAKI and MIMP area

	RUMAKI			
District	eCAS	CAS	MIMP	All
Kibiti	13.49	0.00	0.00	3.60
Kilwa	57.44	0.00	0.00	15.32
Mafia	29.07	100.00	100.00	81.08
All	14,360	9,132	32,272	55,764

2.4. DATA PROCESSING

2.4.1. Marine Management Areas

Tanzania has five distinct categories of marine management areas. Firstly, collaborative fisheries management areas (CFMAs) are specific regions within territorial waters that are overseen by communities through agreements made with the Director of Fisheries. Secondly, marine parks are areas managed by the Marine Parks and Reserves Unit. Thirdly, marine reserves are designated regions also managed by the Marine Parks and Reserves Unit. Fourthly, national parks consist of areas managed by the Tanzania National Parks Authority, which include marine components.

Lastly, there are areas that currently lack any of the aforementioned management categories and are consequently governed by general fisheries legislation. These areas are predominantly found in coastal districts undergoing CFMA development, such as Mkuranga and southern Kilwa, or in urban coastal locations where the establishment of CFMAs presents more challenges. At present, the coastal waters of mainland Tanzania has 29 CFMAs, three marine parks, and six bodies of water within districts that do not fall under CFMA or marine park-based management.

Within the RUMAKI seascape, there are ten CFMAs across three districts of Kibiti, Mafia and Kilwa (Figure 2). Mafia district has three, fully established CFMAs at Mafia, which include BK, JOJIBAKI, DOKICHUNDA, and the Mafia Island Marine Park. At Kibiti, there are four CFMAs, including MCHIMCHUMYA, KIMSA MBWEKIEKI and NYAMANJISOPOJA.

In Kilwa district there are three fully established CFMAs, including NYAMANJISOPOJA, which is shared with Kibiti; while others are TIM4SI, and SOMAKI. There is also a body of water which is yet to be divided into CFMAs. This body of water, however, is not generally considered as RUMAKI, and there is no data collected in this area. Within the RUMAKI area, each CFMA has at least BMU (with one or more landing sites) selected to platform fish catch and effort for the eCAS system (Table 2.4).

Table 2.4: Number of landing sites in each CFMA that contribute catch data in eCAS

CFMA	Villages	Landing Site	Landing site names
BK	1	3	Bweni Bandarini, Bweni Mafia, Msikitini
DOKICHUNDA	3	6	Kilindoni Bandarini, Tumbuju, Kilindoni, Mfuruni, Kichevi, Kilwa Road
JOJIBAKI	1	5	Sinzarau, Jaani, Lwale,Mlundo,Banja
KIMSA	2	4	Basalona, Kifanju Mtetema, Kibanju, Kiomboni Bandarini
MBWEKIEKI	2	4	Maimbwa, Kiechuru Kati, Uwandani, Nyaitoti, Dima Rasini
MCHIMCHUNYA	2	5	Nyamisati Pwani, Mchungu, Nyamisati, Kitintali, Mchinga

CFMA	Villages	Landing Site	Landing site names
MSIKIVI	1	7	Nyamsungi, Mtakwani, Kariakoo, Mtakawane, Kaariakoo, Kimbembe, Dugiza
NYAMANJISOPOJA	4	15	Pembeni, Mbuyuni, Fungu La Nyani, Kempo, Kirambani, Mnguru, Suni, Funguni, Mwembe Ndizi, Pombwe Kubwa, Simaya, Nyuni, Mbwera Madukani, Mjimwema Fungu, Pombwe, Kuu
SOMAKI	1	2	Jimbiza, Masoko Pwani
TIM4SI	2	4	Magengeni, Mayungiyungi, Bonde, Kivinje

2.4.2. Priority Fisheries

The analysis of data was based on the priority fisheries, the data were aggregated to the species shown in Table 2.5 and the gear-type A list that categories the species to its priority fisheries was prepared by considering the species and their environment.

Table 2.5: Priority fisheries in marine waters

Priority Fisheries	Description of the characteristic species
Elasmobranch	All species of sharks and rays
Octopus	All species of Octopus
Others	Other demersal species that does not belong to any of the other priority groups
Prawn	All penaeidea species
Reef Fish	All reef based and reef associated species, including schooling reef species
Small Pelagic	Anchovies, sardines, mackerels and small carangids
Tuna	All tuna and tuna like species

2.5. DATA PROCESSING AND TOOLS

Figure 3 is a conceptual diagram that shows the data gathering to communication with several intermediate steps. The analysis of the data was run using the R software, a language and environment for statistical computing, plotting, and reporting (R Core Team, 2022). The data obtained were in in various formats and initially cleaned, organized and structured into a tidy format that was easy to manipulate, analyze and plot in the R programme. The processed data were compiled and stored in comma separated delimited (.csv). The effective fishing time was computed using a lubridate package (Grolemund and Wickham, 2011), and was then used to calculate catch rates using the dplyr package (Wickham et al., 2022).

Catch rates were computed by dividing the total weight (kgs) obtained in each fishing trip by the number of fishers in a vessel. To ensure the quality of the catch rate data, a range of data records between the 5th and 95th percentile was used to remove extreme outliers. This statistical measure ensured that the catch rate data is more representative of the overall distribution and reduced the impact of any extreme values that could skew the results used in the analysis. Therefore, since the interquartile range accounts for natural variability in the data set, ensured the quality of the catch rate data used in this assignment.

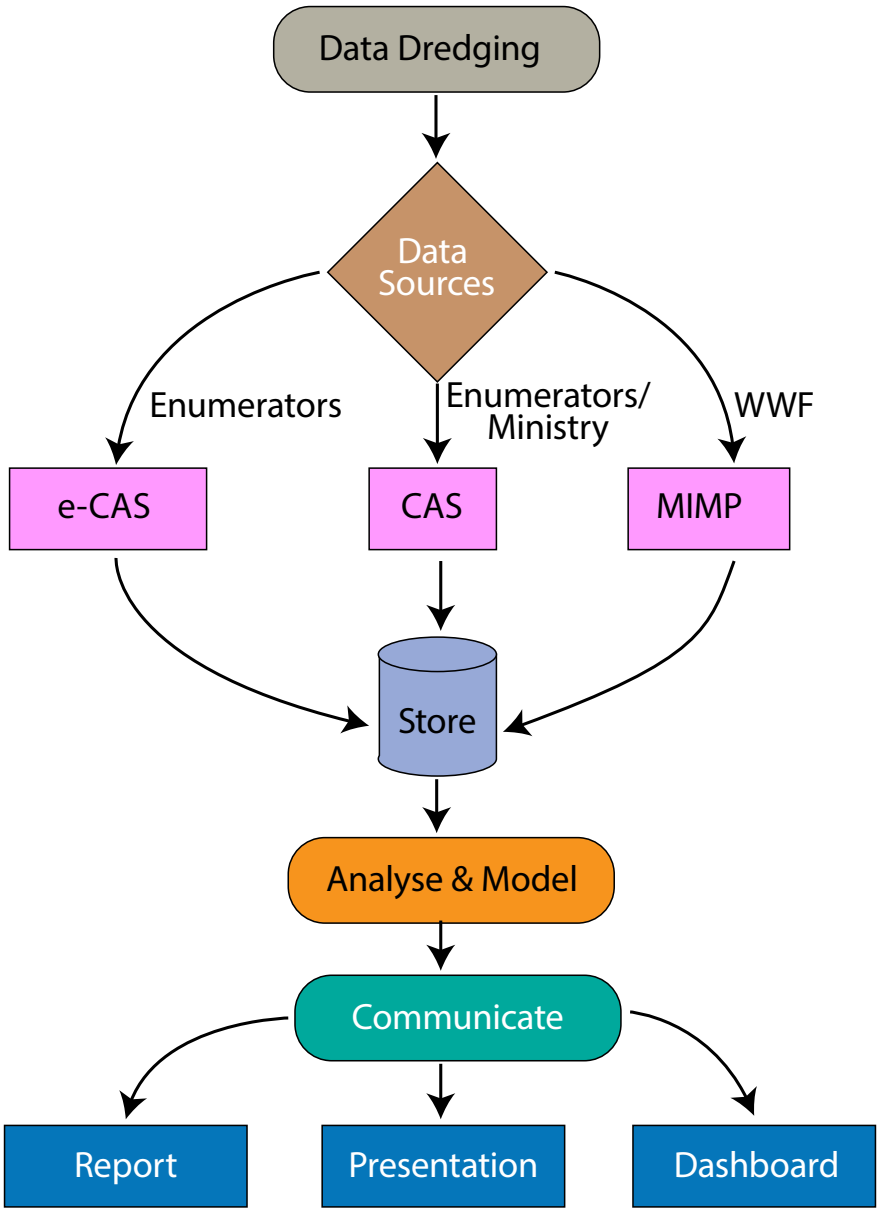


Figure 2.3: Conceptual drawing of analytical workflow reporting of fisheries data in Kibiti, Mafia and Kilwa Districts

RESULTS AND DISCUSSION OF CATCH ASSESSMENTS

3.1. eCAS CATCH RECORDS BY DISTRICT AND PRIORITY FISHERY

The total number of catch records that was collected in the RUMAKI seascape from 2017 to 2020 reached 14,360 (Table 3.1), where a 'catch record' equates to one fishing trip. The data were distributed as follows: Kibiti district provided 2,036 fish records, Mafia district produced 4,031 records and Kilwa district provided 8,293 records. It is worth noting that Kibiti district landing sites do not support octopus and tuna fisheries as these are located within the mangrove environments with no such fisheries in their proximity. Similarly, Mafia landings do not support prawn fisheries, because they do not have brackish waters. Kilwa district on the other hand has some prawn fishing but it is happening in the landing sites of Marendego and Namatungutungu, which are not part of the CAS system, and therefore records are not captured.

Table 3.1: The number of catch data records of priority fisheries in the eCAS by district

District	Elasmobranch	Octopus	Others	Prawn	Reef Fish	Small Pelagic	Tuna	Total
Kibiti	124	2	257	168	1,103	381	1	2,036
Mafia	94	563	194	-	2,441	558	181	4,031
Kilwa	235	378	171	-	6,359	932	218	8,293
Total	453	943	622	168	9,903	1,871	400	14,360

The number of catch records (data sets) between CFMAs show significant variation in the eCAS (Table 7). For instance, JOJIBAKI has 12 fish records, while MBWEKIEKI has 25 for the entire period of 4 years. KIMSA, MSIKIVI, and SOMAKI have less than 1,000 records for all the fishery types. The CFMAs that have more than 1,000 data records are: MCHIMCHUNYA (1,186 fish records), TIM4SI (1,194 fish records), BK (1,995 fish records), DOKICHUNDA (2,020 fish records), and NYAMANJISOPOJA (6,987 fish records), refer to (Table 7). Overall, there are no Collaborative fisheries management areas (CFMAs) that have sufficient data for all the priority fisheries.

The variation in catch records can be attributed to several factors, for example: The location of the management area and the type of fish that are abundant in those waters. Additionally, the fishing techniques used by the local fishermen can also impact the catch records. Finally the performance of BMUs and individuals involved and motivated in data collection is a key variable. For instance, the low number of prawns records in the NYAMANJISOPOJA CFMA is likely due to the poor performance of data collection within the Pombwe BMU. It is crucial to analyze these factors to ensure that sampling protocols are followed effectively to ensure consistency and for improved management decision-making.

Table 3.2: The fish records of priority fisheries in the eCAS by collaborative fisheries management areas in the Kibiti, Mafia and Kilwa Districts . The grey cell represent sample size above 30 samples

Management Area	Elasmo	Octopus	Others	Prawn	Reef Fish	Small Pelagic	Tuna	Total
MIMP				1			1	
JOJIBAKI			7		4	1		12
MBWEKIEKI				1	23	1		25
KIMSA	3		3	4	33	3		46
MSIKIVI				13	54	40		107
SOMAKI	14	178	3		496	34	59	784
MCHIMCHUNYA	20		62	143	664	296	1	1,186
TIM4SI	44	22	14		639	390	85	1,194
BK	55	532	22		1,330	23	33	1,995
DOKICHUNDA	39	30	165		1,104	534	148	2,020
NYAMANJISOPOJA	278	180	346	7	5,553	549	74	6,987
Total	453	943	622	168	9,903	1,871	400	14,360

The number of data records for priority fisheries within the nine collaborative management areas varied significantly in the eCAS system (Table 3.2, Figure 3.1. For instance, Elasmobranch has 453 records, while Octopus has 943. Additionally, there are 622 records of other fisheries, 168 for Prawn, 9,903 for Reef Fish, 1,871 for Small Pelagic, and 400 for Tuna. This variation in the number of records for each type of fishery highlights the need for a thorough check-up of sampling variability and power analysis in the light of priority fisheries.

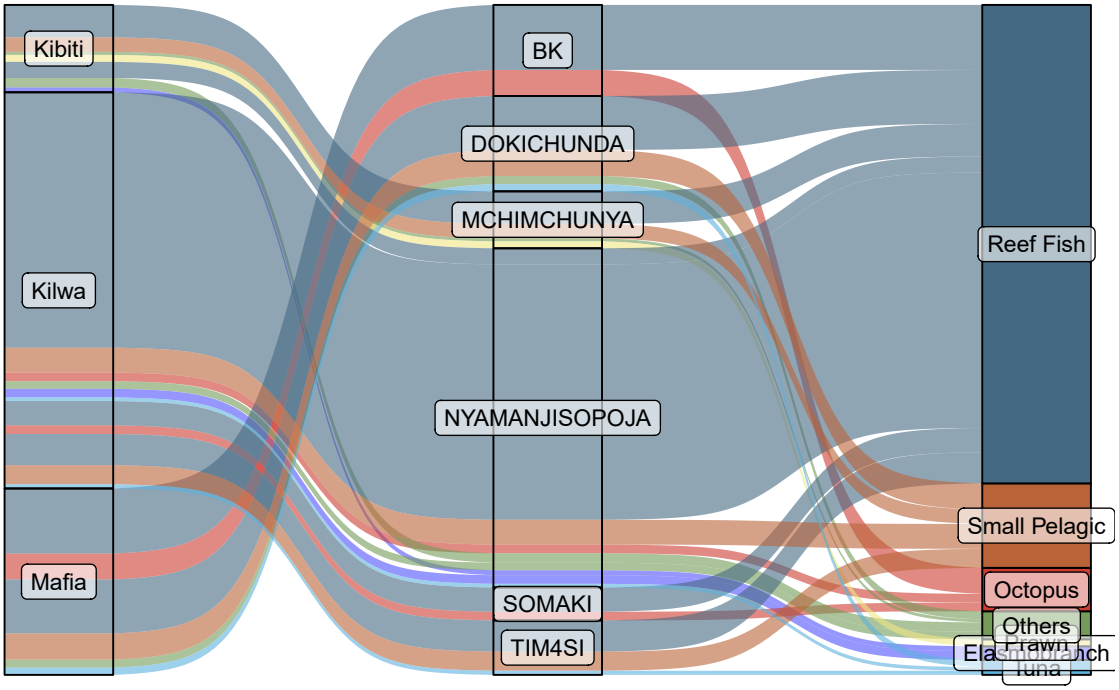


Figure 3.1: The catch records distributions of five priority fisheries in six selected CFMA across three districts of Kibiti, Kilwa and Mafia. The flow of data is shown using ribbons, and the width of the ribbons represents the frequency of data in each category. The fill color of the ribbons represents the priority fisheries.

3.2. eCAS CATCH RECORDS BY GEAR TYPE

Effective fisheries management requires a comprehensive understanding of fishing activity and the gear used to catch different species. In order to maintain sustainable fish populations, it is important to carefully manage the amount of fishing effort, and this includes identifying and regulating the use of specific gear types in managed areas. Table 3.3 provides valuable insights into the gear composition across the Community-Based Fisheries Management Areas (CFMAs) of RUMAKI.

The dominant gear type in RUMAKI CFMAs was the ring net, accounting for 32.2% of the total gear composition. This gear was primarily used at TIM4SI (90.41%) and DOKICHUNDA (53.21%) and targets small pelagic (97.12%), tuna (92.74%), reef (32.5%), and elasmobranch (14.23%) priority fisheries. The Dema trap was the second most commonly used gear type, comprising 25.8% of the total gear composition and found mainly at NYAMANJISOPOJA (37.6%), DOKICHUNDA (27.6%), and BK (18.8%). This gear is primarily used to catch reef (20.8%) priority fisheries.

Table 3.3: Percentage of eCAS catch records by fishing gears in 8 CFMAs in RUMAKI

Gear	BK	DOKI CHUNDA	KIMSA	MCHIM CHUNYA	MSIKIVI	NYAMANJIS OPOJA	SOMAKI	TIM4SI	Grand Total
Beach seine	-	-	-	-	-	-	-	0.13	0.03
Cast net	0.03	-	-	-	-	-	-	-	-
Dema Trap	18.76	27.59	-	-	-	37.6	1.14	4.59	25.82
Gill net 2.5	10.48	1.73	25.51	4.66	21.69	3.13	3.2	0.66	3.09
Handline	23.99	11.16	51.62	0	4.46	7.99	78.27	2.77	9.66
Long line	0.76	3.47	10.12	92.36	48.29	0.02	-	1.25	3.7
Ring net	-	53.23	-	1.24	-	8.92	8.03	90.41	32.18
Shark net	6.89	0.71	12.75	1.54	13.82	10.6	1.09	0.15	6.08
Spear	0.53	0.03	-	-	0.89	0.28	0	0.04	0.2
Unidentified	38.57	2.07	-	0.2	-	31.46	8.26	-	19.23
Wando trap	-	-	-	-	10.85	0.01	-	-	0.02

Hand line was the third most frequently used gear type, accounting for 9.7% of the total gear composition and found at SOMAKI, KIMSA, DOKICHUNDA, and BK at compositions of 78.27%, 51.62%, 11.16%, and 23.99%, respectively. This gear targets reef (16.66%) priority fisheries. Shark net had an overall composition of 6.08% across CFMAs in RUMAKI and was found at KIMSA and MSIKIVI at compositions of 13.82% and 12.75%, respectively. This gear targets elasmobranch (66.05%) priority fisheries.

Finally, the gill net was the least–recorded gear type, accounting for 3.09% of the total gear composition across all CFMAs in RUMAKI and found at KIMSA and MSIKIVI at compositions of 25.51% and 21.69%, respectively. This gear targets elasmobranch (14.14%) and prawn (77.81%) priority fisheries.

The information provided in Table 3.3 and Table 3.4 can be used to inform fisheries management policies and regulations, helping to ensure sustainable fishing practices and the conservation of fish populations for the future in CFMAs of RUMAKI seascape.

Table 3.4: Percentage of catch records in eCAS by fishing gear and priority fishery

Gear	Elasmo branch	Octopus	Others	Prawn	Reef Fish	Small Pelagic	Tuna	#N/A	Grand Total
Beach seine	0.10	0.46	0.00	0.00	0.64	0.00	0.00	0.00	0.24
Cast net	0.00	0.00	1.55	0.00	0.39	0.00	0.00	0.08	0.15
Dema Trap	0.78	0.18	1.21	0.00	20.79	0.01	0.00	2.61	7.14
Drift nets	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Gill net 2.0	0.43	0.00	0.73	0.00	1.42	0.00	0.00	0.00	0.50
Gill net 2.5	14.14	0.22	5.92	77.81	10.30	0.86	0.09	1.18	4.72
Handheld	0.02	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.06
Handline	1.44	0.21	7.50	0.00	16.66	0.17	3.40	1.99	6.13
Long line	1.27	0.11	0.40	0.00	4.05	0.14	0.14	0.01	1.47
Ring net	14.23	0.01	74.46	0.67	32.51	97.12	92.74	7.41	57.89
Shark net	66.05	0.18	4.85	0.00	4.14	0.02	3.22	0.30	4.66
Spear	1.49	98.44	3.38	0.00	0.73	0.02	0.03	0.00	5.79
Unidentified	0.00	0.02	0.00	21.12	7.99	1.66	0.37	86.42	11.18
Wando trap	0.04	0.01	0.00	0.40	0.21	0.00	0.00	0.00	0.07

3.3. CATCH RATES OF PRIORITY FISHERIES ACROSS CFMAS.

This analysis aimed to evaluate catch rates for six priority fisheries within six different CFMA management areas (Table 3.5). Although there are ten CFMAs with catch records in the RUMAKI seascape, only six were selected for analysis, based on those having a more sufficient number of fish catches records contained in the eCAS database. The six CFMAs include, SOMAKI, MCHIMCHUNYA, TIM4SI, BK, DOKICHUNDA and NYAMANJISOPOJA. Catch rate in the six CFMAs have significantly variation for some priority fisheries (Table 3.5), which might have implications for fisher livelihoods in the respective communities.

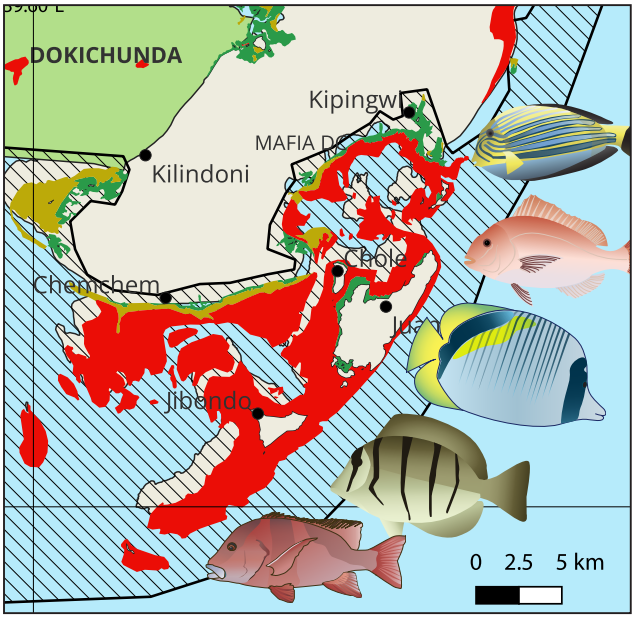
Table 3.5: The catch rates (Mean± and standard deviation) kg/ fisher/ trip, of priority fisheries by collaborative fisheries management areas

Priority Fishery	BK	DOKI CHUNDA	MCHIM CHUNYA	NYAMANJI SOPOJA	SOMAKI	TIM4SI
Elasmobranch	7.1±4.2	14.5±10.8	-	14.8±10.3	15.6±11.2	14.3±10.4
Octopus	3.2±1.8	5.9±2.3	-	4.7±2.4	5.8±2.1	4.6±2.3
Others	7.8±5.9	7.6±5.3	4.2±2.3	8.3±5.2	22.2±	13.8±7
Prawn	-	-	8.3±4.2	-	-	-
Reef Fish	7.9±5.3	6.9±5.1	7.8±4.3	6.6±4.6	5.6±3.9	5.5±4.4
Small Pelagic	13.6±16	19.5±19.3	9.5±7.5	13.5±16.8	13.3±11.3	18.3±18.8
Tuna	6.7±5.1	6.5±6.5	10±	4.4±3.5	9.5±5.1	8.5±6.8

3.3.1. Reef fish

The eCAS data in the six representative CFMAs in the RUMAKI seascape revealed that the mean catch rates of reef fish varied significantly among the CFMAs (Figure 3.2). The fishers at SOMAKI had the lowest catch rate of reef fish, with an average of 4.82kg/fisher/trip, while fishers at MCHIMCHUNYA had the highest catch rate, which was almost double at 8.01kg/fisher/trip.

BK had an average of 7.91kg/fisher/per trip, DOKICHUNDA had 6.91kg/fisher/trip, NYAMANJISOPOJA had 6.68kg/fisher, and TIM4SI had 5.53kg/fisher/trip. Table 10 shows that the catch rates at BK, DOKICHUNDA, MCHIMCHUNYA, and NYAMANJISOPOJA were significantly higher than SOMAKI ($p < 0.05$). However, the difference in catch rate between TIM4SI and SOMAKI was insignificant ($p > 0.05$). The differences in catch rates among the CFMAs can be attributed to a variety of factors, including differences in fishing practices, gear types, and environmental conditions. For example, MCHIMCHUNYA may have higher catch rates due to its location in an area with more abundant fish populations or due to the use of more effective fishing gear, i.e. the long line (Table 3.1).



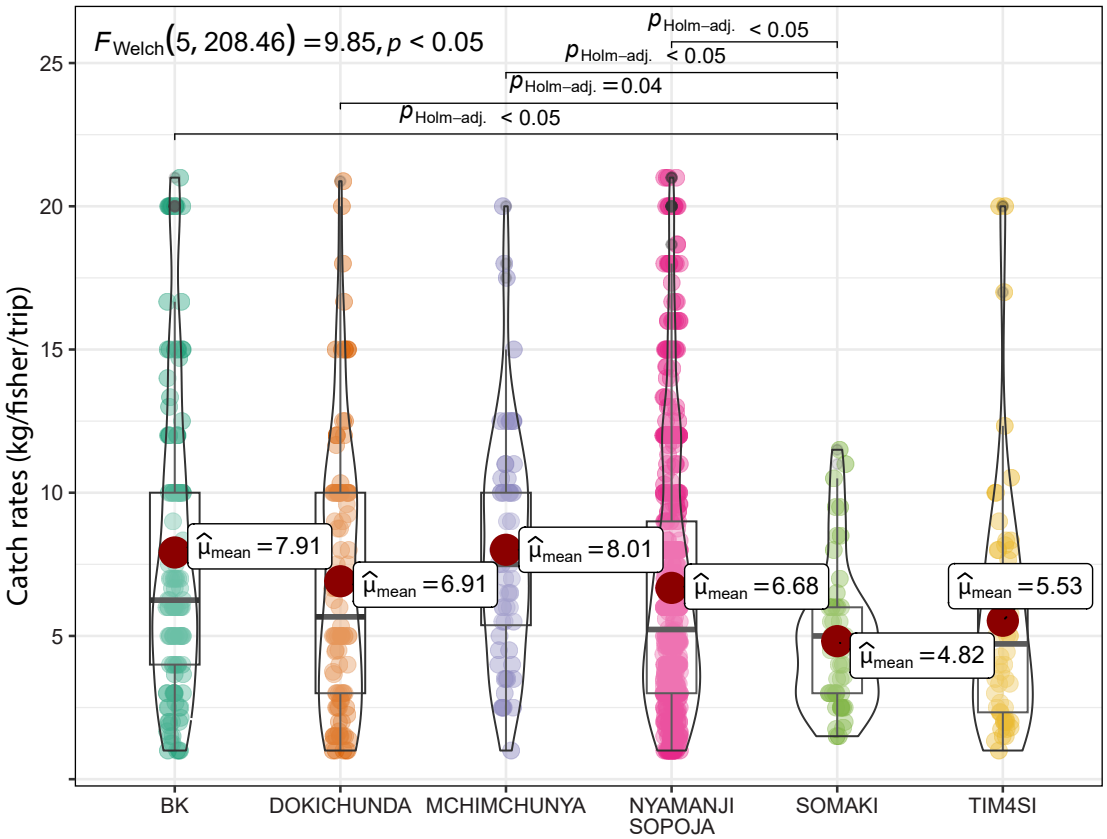


Figure 3.2: The mean catch rates (kg/fisher/trip) of reef fish by collaborative fisheries management areas

3.3.2. Small pelagic

The results shown in Figure 6 indicate that catch rates for small pelagic species varied significantly among the six CFMAs. Of these, MCHIMCHUNYA had the lowest catch rate, with fishers averaging 9.64kg/fisher/trip, while TIM4SI had the highest catch rate, almost double at 20.37kg/fisher/trip, followed closely by DOKICHUNDA with an average catch rate of 19.82kg/fisher/trip. Meanwhile, catch rates at BK, NYAMANJISOPOJA, and SOMAKI were around 13kg/fisher/trip.

Figure 3.3 indicates that catch rates at TIM4SI and DOKICHUNDA were significantly higher compared to those at MCHIMCHUNYA. Although catch rates at BK and SOMAKI were lower, by 7kg/fisher/trip, compared to TIM4SI and DOKICHUNDA, the difference was not statistically significant (Figure 3.3) due to the presence of outliers. These differences in catch rates are likely due to variations in access to more effective/expensive fishing gears. For instance, fishers in MCHIMCHUNYA use gill nets to target small pelagic fishes, mainly clupeidae (*Hilsa kelee*) *mbarata*. In contrast, fishers from Mafia and Kilwa use ring nets/purse seines to target anchovy *dagaa nyama*.

The findings have important implications for small pelagic fisheries management in the RUMAKI seascape. Catch rates for small pelagic species are significantly higher than those of other priority fisheries (Figure 3.3), except for elasmobranchs. Catch records in TIM4SI (90%) and DOKICHUNDA (53%) in particular are dominated by ringnets (Table 8). As such, there is potentially a need for management of ringnet use targeting small pelagics (Table 3.4), subject to undertaking stock assessment to determine the status of relevant small pelagic stocks.

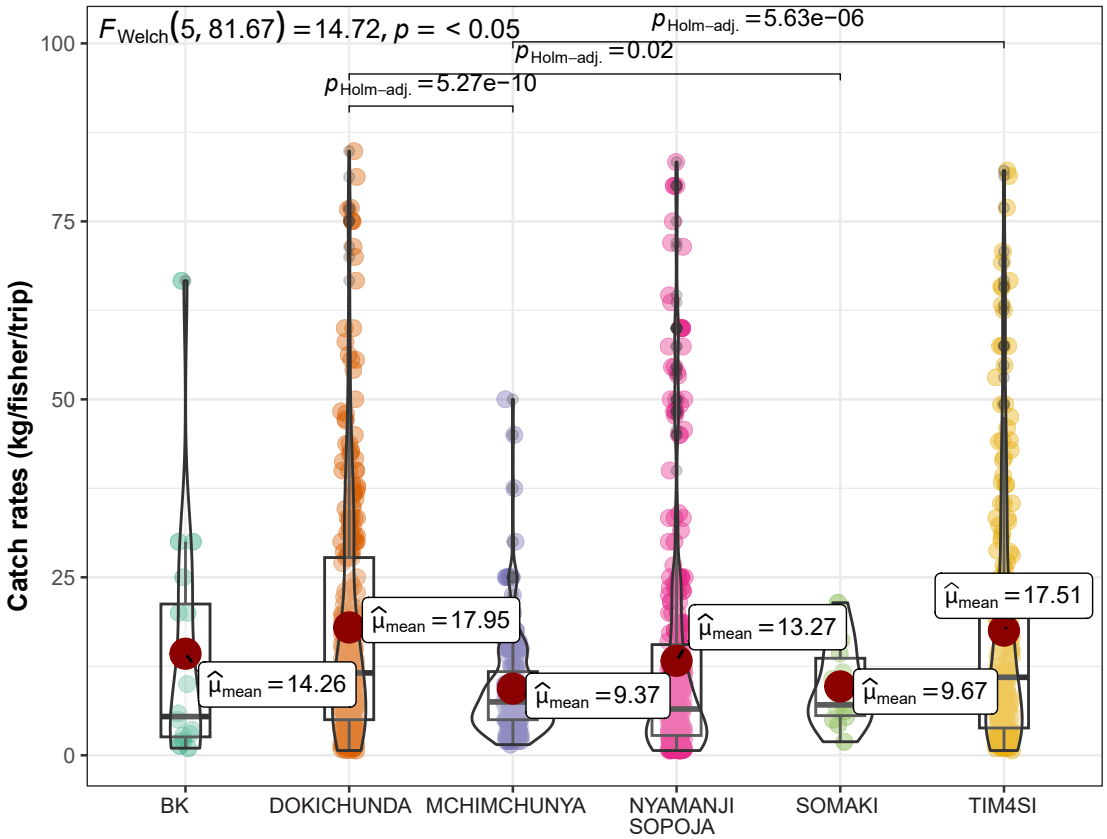
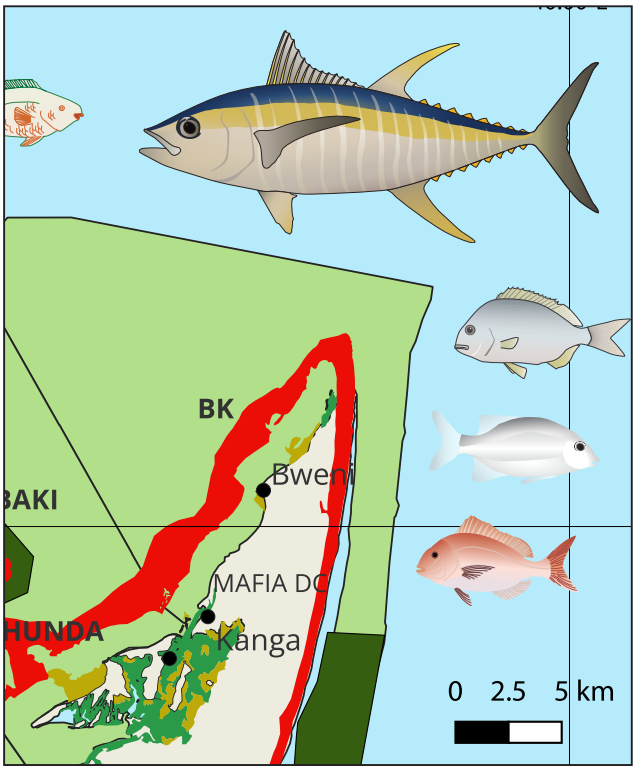


Figure 3.3: The mean catch rates of small pelagic fish by collaborative fisheries management areas

3.3.3. Tuna

The mean catch rates of tuna, as illustrated in Figure 7, show significant variation across CFMAs. Among the CFMAs analyzed, NYAMANJISOPOJA had the lowest catch rate of 4.43 kg/fisher/trip, whereas SOMAKI had the highest catch rate (almost double) of 9.49 kg/fisher/trip, followed by TIM4SI with an average catch rate of 8.48 kg/fisher/trip (Figure 3.4). The catch rates at BK and DOKICHUNDA were approximately 6.5 kg/fisher/trip.

Notably, the high catch rates of tuna at SOMAKI and TIM4SI were significantly higher than those at NYAMANJISOPOJA, but not significantly different from those at BK and DOKICHUNDA (Figure 3.4). It is important to note that the CFMA at MCHIMCHUNYA had limited tuna records, which rendered it unsuitable for analysis with other CFMAs in the area. Overall, these findings suggest that catch rates of tuna vary considerably across different CFMAs, and it may be beneficial to explore the underlying factors contributing to these differences.



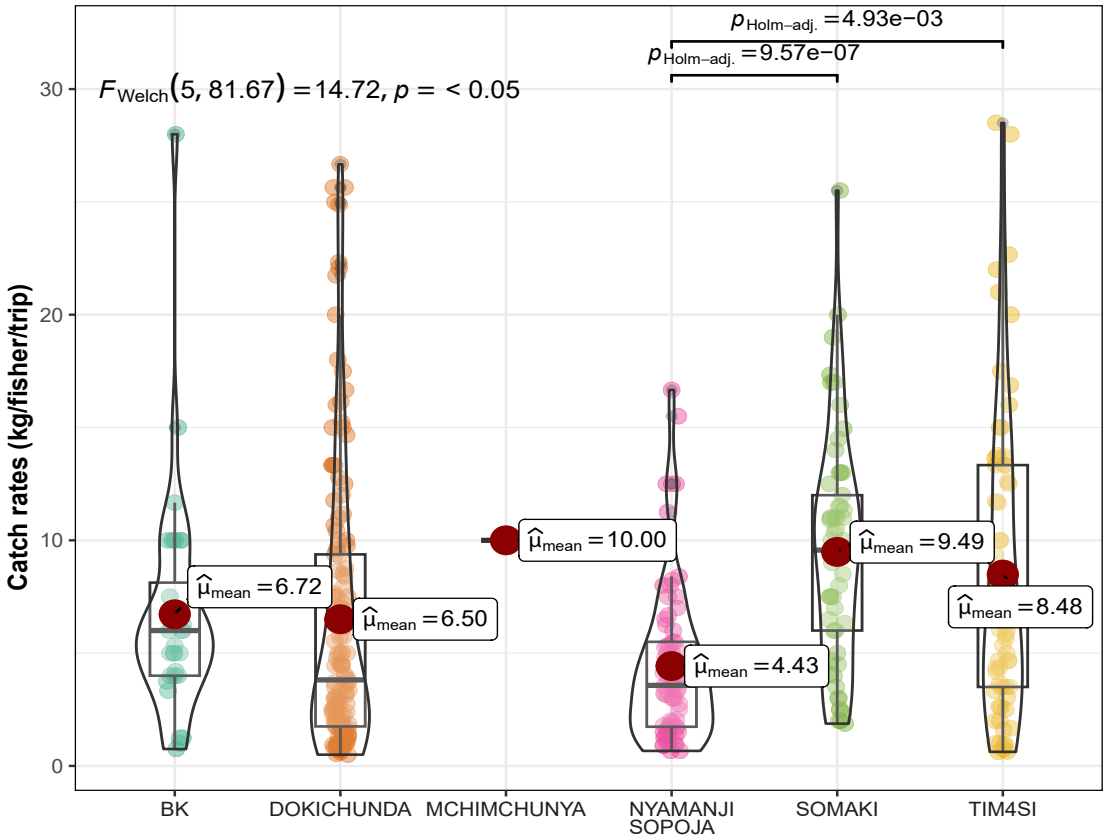
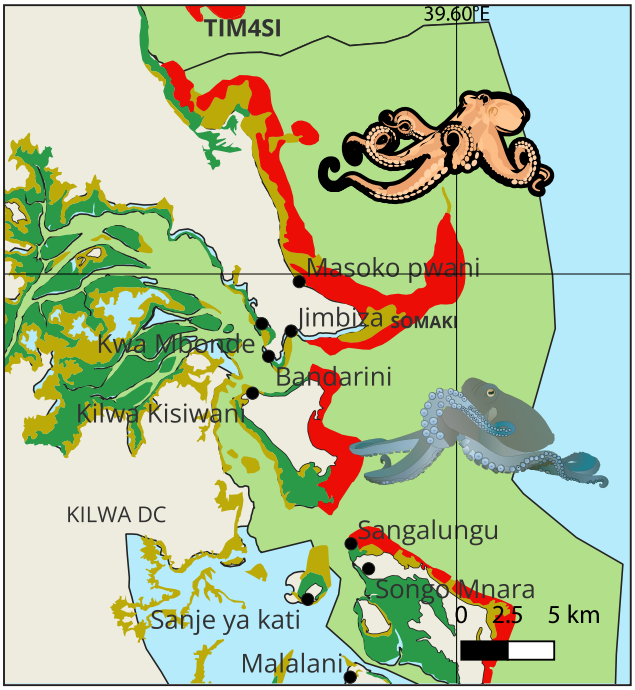


Figure 3.4: The mean catch rates of tuna fish by collaborative fisheries management areas

3.3.4. Octopus

The mean catches rates of octopus across different CFMAs reveal significant variations. The highest mean catch rate of 5.91kg/fisher/trip was found at DOKICHUNDA, followed by SOMAKI with 5.78kg/fisher/trip, NYAMANJISOPOJA with 4.46kg/fisher/trip, and TIM4SI with 4.60kg/fisher/trip (Figure 3.5). The lowest mean catch rate of 3.23kg/fisher/trip was found at BK. The mean catches rates of DOKICHUNDA, SOMAKI, and NYAMANJISOPOJA were significantly higher than BK, but insignificant with TIM4SI (Figure 3.5). It is worth noting that the CFMA at MCHIMCHUNYA had no octopus records and was excluded from the analysis with other CFMAs in the area (Figure 3.5). Despite its importance fishery in the RUMAKI seascape, fishers involved in octopus fishery get the lowest catch rates as compared to other priority fisheries.



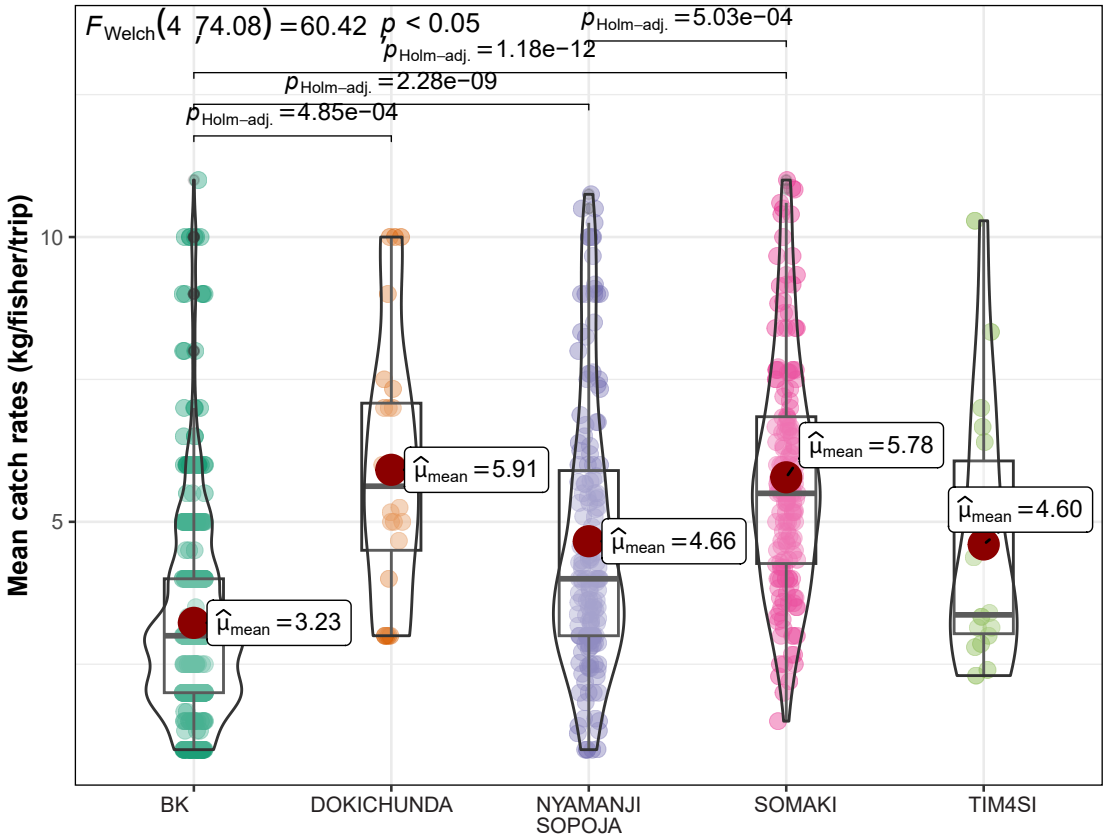
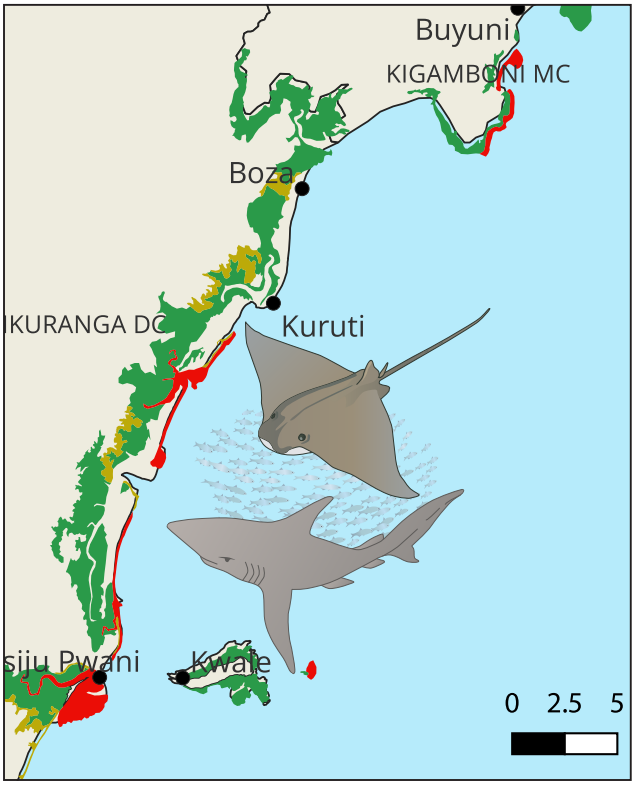


Figure 3.5: The mean catch rates of octopus by collaborative fisheries management areas

3.3.5. Elasmobranchs

Significant variations in the mean catch rates of elasmobranchs across different CFMAs have been identified (Figure 3.6). SOMAKI recorded the highest mean catch rate of 15.64 kg/fisher/trip, followed by NYAMANJISOPOJA with 14.83kg/fisher/trip, DOKICHUNDA with 14.50kg/fisher/trip, and TIM4SI with 14.260kg/fisher/trip (Figure 3.6). On the other hand, BK and MCHIMCHUNYA had the low mean catch rates of 7.11 and 6.11kg/fisher/trip, respectively. Interestingly, the catch rates at BK were significantly lower than other CFMAS (Figure 3.6). It is important to note that MCHIMCHUNYA had few elasmobranch records, with some deviating higher than others.



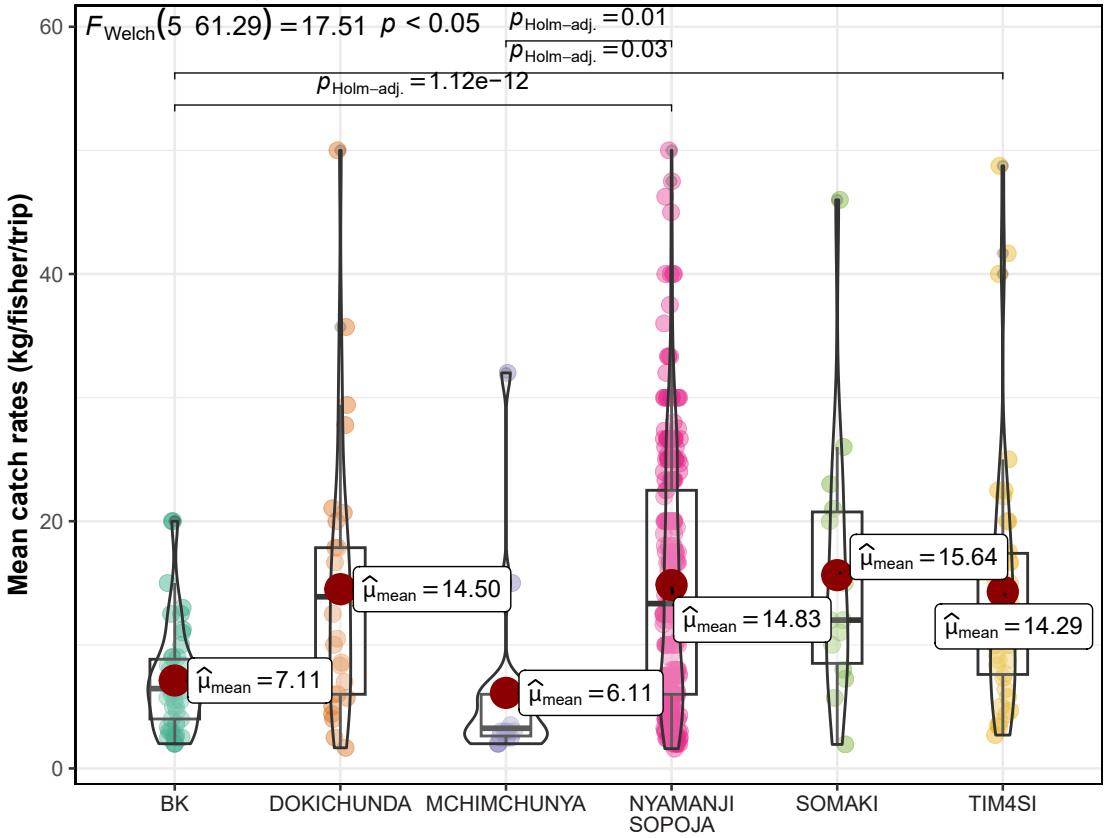
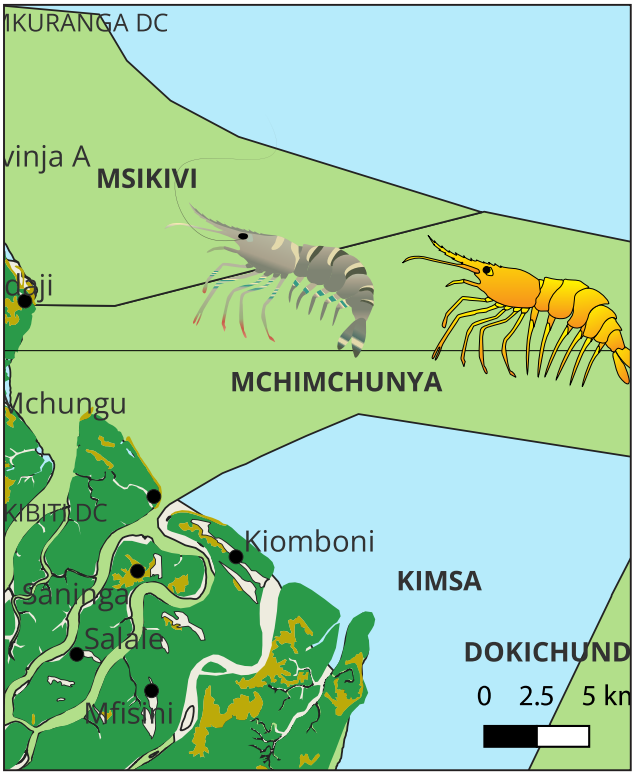


Figure 3.6: The mean catch rates of elasmobranch by collaborative fisheries management areas

3.3.6. Prawns

The prawn fishery in the Mafia channel holds significant importance in the seascape. This fishery occurs in all 5 CFMAs of Kibiti, namely KIMSA, MCHIMCHUNYA, KIMSA, MBWEKIEKI and NYAMANJISOPOJA. Out of the six representative CFMAs used in this report, prawn records in eCAS were only found in two CFMAs of MCHIMCHUNYA and NYAMANJISOPOJA (Figure 3.7), with 134 and 7 records respectively. Three other CFMAs were dropped from analyses earlier as they have fewer records of this fishery.

The study has identified significant variations in the mean catch rates of prawn between these two CFMAs, with MCHIMCHUMYA having the highest catch rate of 8.28kg/fisher/trip, which is significantly higher than the catch rates of 2.27kg/fisher/trip found at NYAMANJISOPOJA (Figure 10). It is important to note that although NYAMANJISOPOJA was used in the analysis but the CFMA had few records (Figure 3.7).



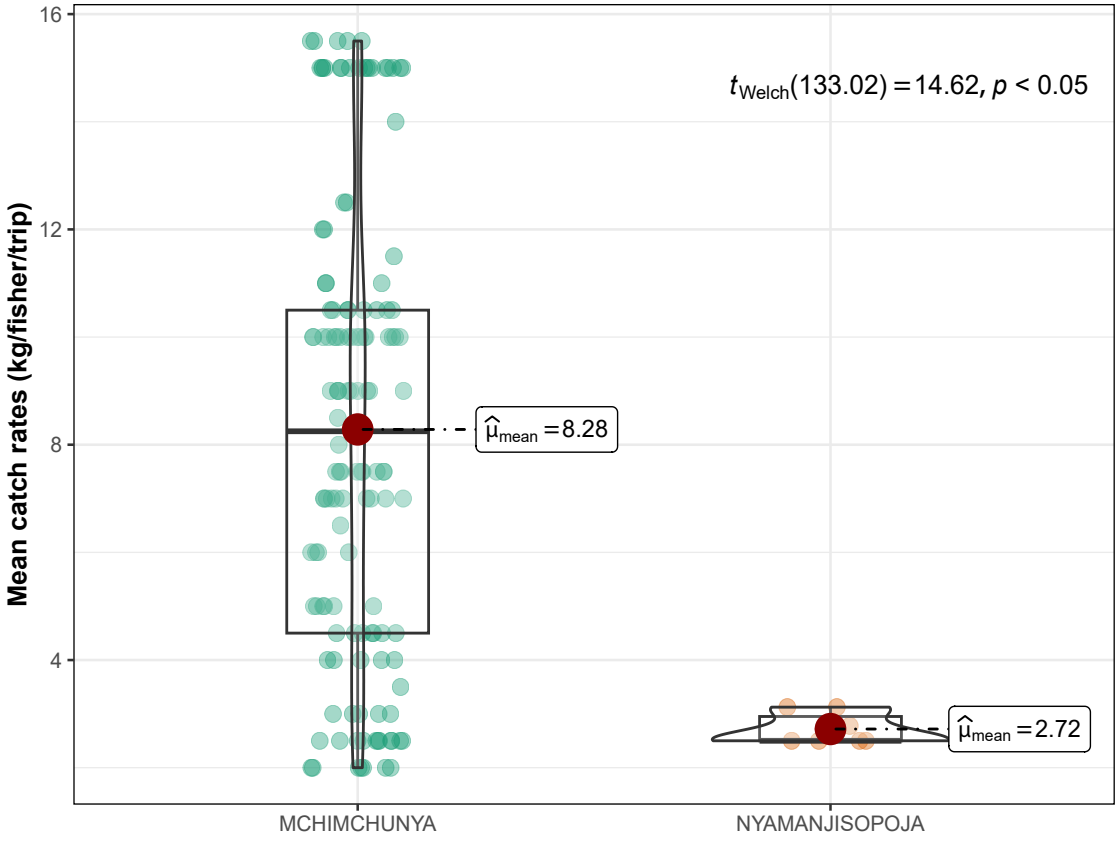
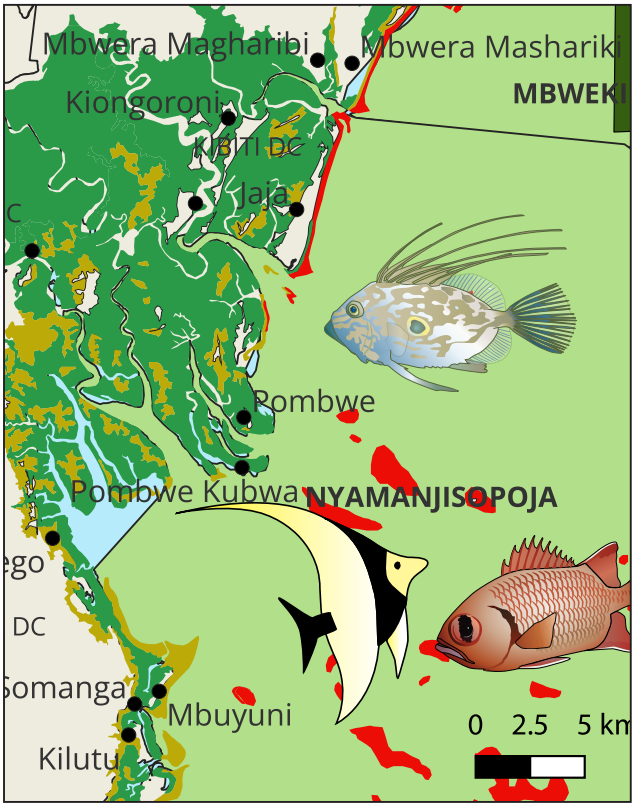


Figure 3.7: The mean catch rates of prawns by collaborative fisheries management areas

3.3.7. Other fisheries

This study analyzed the catch rates of other fish species in addition to the six priority fisheries. Species included in this group were those that could not be grouped into any other groups because of inability to identify the grouping of the species. The mean catches rates vary from 13.76kg/fisher/trip at TIM4SI and 4.20kg/fisher/trip at MCHIMCHUNYA. The mean catches rates at BK, DOKICHUNDA and NYAMANJISOPOJA were 7.75, 7.64 and 8.35kg/fisher/trip respectively (Figure 3.8). Despite the variation of catch rates of other fishery among the CFMAs, However, the differences in catch rates among the CFMAs were found to be insignificant (Figure 3.8). These findings suggest that while the six priority fisheries are crucial, other fish species are also being caught at varying rates.



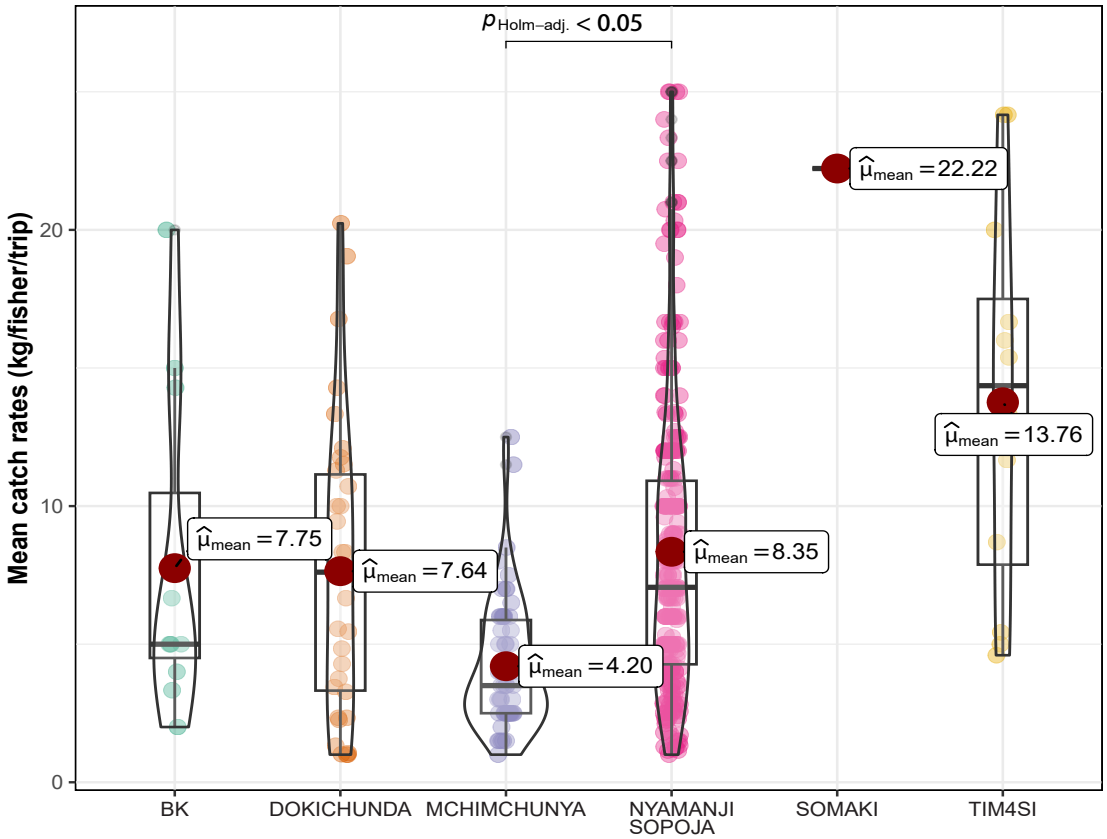


Figure 3.8: The mean catch rates of other fishes by collaborative fisheries management areas

3.4. ANNUAL CATCH RATE AND PRODUCTION TRENDS

Catch rates and fish production trends over 4 years (2017-20) were used to assess the performance of priority fisheries in six indicative CFMAs of the RUMAKI seascape. The priority fisheries include prawn, reef, small pelagics, elasmobranch and other fisheries. The catch rate trends of priority fisheries in Kibiti, Kilwa and Mafia districts are shown in (Figure 3.9).

In Kibiti District, the catch rate trends revealed that prawn increased from 5.0 Kg/fisher/trip in 2018 to 7.5 Kg/fisher/trip in 2019, and declined to 2.5 Kg/fisher/trip in 2020 but there was no data for prawn in 2017. The catch rate of reef priority fisheries of 7.5 Kg/fisher/trip was almost flat between 2017 and 2019, then dropped to 3 Kg/fisher/trip in 2020. The elasmobranch priority fisheries catch rate trend declined from 22 Kg/fisher/trip in 2017 to 14 Kg/fisher/trip in 2018, but showed a slight increase to 18 Kg/fisher/trip in 2019. On the other hand, the catch rate trend for small pelagics remained relatively flat at 10 Kg/fisher/trip between 2018 and 2020. Overall, elasmobranch is the fishery with the highest catch rate trends at Kibiti which could be contributed by conducive brackish water environment. Despite prawn being major priority fishery in Kibiti, it has the lowest catch rate trends. Notably, the catch rate trends for octopus and tuna priority fisheries are absent at Kibiti due to lack of catch data in the eCAS.

In Kilwa District, prawn fisheries are absent (Figure 3.9). Octopus has the lowest catch rates over the years at Kilwa, which increased from 3 Kg/fisher/trip in 2017 to 5 kg/fisher/trip in 2018, remaining flat in 2019 and 2020. The catch rate trend of reef fishery was almost flat at 7.5 Kg/fisher/trip between 2017 and 2018, and decreased to 6 Kg/fisher/trip in 2019 increased to 7.5 Kg/fisher/trip in 2020. Similarly, the catch rate for tuna decreased from 9 Kg/fisher/trip in 2017 to 5 Kg/fisher/trip in 2018, but then picked up to 7.5 Kg/fisher/trip in 2019 and further increased to 8 Kg/fisher/trip in 2020. Catch rate trend of elasmobranch increased from 9kg/fisher/trip in 2017 to 13kg/fisher/trip in 2018, and slightly

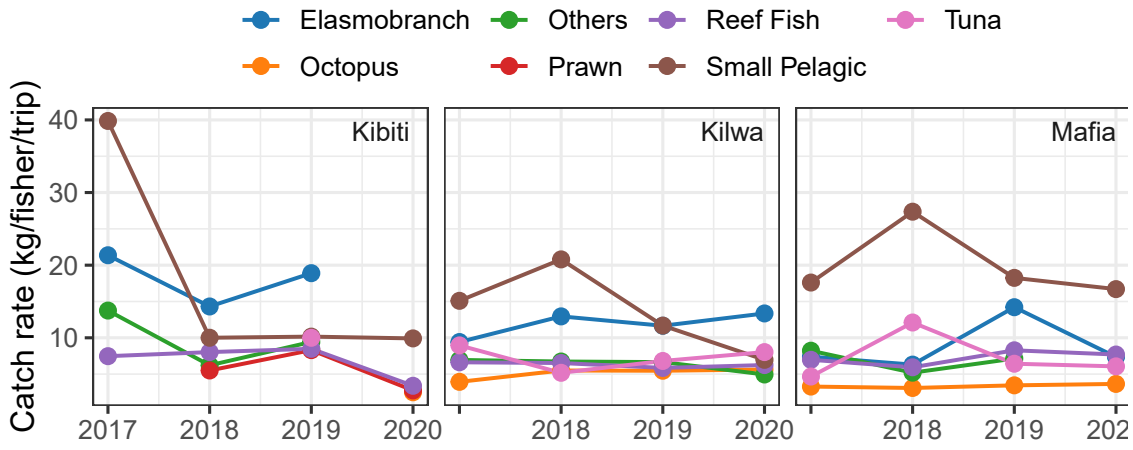


Figure 3.9: Annual mean catch rates trends (kg/fisher/trip) of priority fisheries by Districts

decreased to 11kg/fisher/trip in 2019 and increased to 13.5kg/fisher/trip in 2020. The catch rate of small pelagic in Kilwa increased from 15 Kg/fisher/trip in 2017 to 22 Kg/fisher/trip in 2018, but then decreased to 12.5 Kg/fisher/trip in 2019 and to 8 Kg/fisher/trip in 2020. Overall, the catch rate trends of priority fisheries in Kilwa show varying patterns. However, the decreasing trend of small pelagic fishery in Kilwa is higher compared to others priority fisheries. Contrary, the catch rate of elasmobranch and octopus in Kilwa shows an increasing trend.

In Mafia District, similar to Kilwa, five priority fisheries except prawn are found (Figure 3.9). The catch rate trend of octopus in Mafia was lowest at about 3 Kg/fisher/trip between 2017 and 2020. Reef fisheries catch rates trend decreased from 7 Kg/fisher/trip in 2017 to 5 Kg/fisher/trip in 2018 and slightly increase up to 7.5 Kg/fisher/trip in 2020. Elasmobranch catch rates trend decreased from 7 Kg/fisher/trip in 2017 to 5 Kg/fisher/trip in 2018, increased to 14 Kg/fisher/trip in 2019 before decreasing to 8 Kg/fisher/trip in 2020. Tuna catches rates trend increased from 7 Kg/fisher/trip in 2017 to 12.5 Kg/fisher/trip in 2018 and decreased to 5 Kg/fisher/trip 2019 and 4 Kg/fisher/trip in 2020. Similar to tuna, catch rates trend of small pelagic increased from 17 Kg/fisher/trip in 2017 to 26 Kg/fisher/trip in 2018 and decreased 18 Kg/fisher/trip 2019 and16 Kg/fisher/trip in 2020. Catch rates trend of octopus was the lowest yet stable compared to other priority fisheries in the RUMAKI seascape.

In summary, catch rates trend of small pelagic was the highest but it is decreasing at worrisome rates. Despite Kilwa being among the coastal district that fish prawn but only prawn data for Kibiti was found in the eCAS. The findings of the eCAS data the catch trend indicated that there has been a decline in the catch rates over the years, and this decline is more pronounced for small pelagic fish species. This suggests that the fish populations of small pelagic and other priority fisheries in the RUMAKI seascape is under pressure and that measures need to be taken to ensure their sustainable management.

Furthermore, the annual mean catch rate trends of priority fisheries were used to assess fisheries performance in six indicative collaborative fisheries management areas (CFMAs) in the RUMAKI seascape.

Small pelagic catch rates trend at BK was almost flat of 8 kg/fisher/trip between 2017 and 2019, and increased to 20 kg/fisher/trip in 2020 (Figure 3.10). The annual mean catch rate for octopus fishery remained flat at approximately 4 kg/fisher/trip. Reef and elasmobranch show similar catch rate trends pattern. Both reef and elasmobranch had catch rates trend of 7.5 kg/fisher/trip in 2017 and decreased to 6 and 5 kg/fisher/trip, respectively, in 2020. The catch rate trend of octopus and small pelagic are increasing while reef, elasmobranch and tuna are decreasing. Therefore, at BK octopus, and small pelagic fisheries are performing better.

In the DOKICHUNDA CFMA, small pelagic fishery had the highest annual mean catch rate compared to all other priority fishery, with approximately 17.5kg/fisher/trip in 2017 which increased to 27 kg/fisher/trip in 2018, then decreased to about 18 kg/fisher/trip in 2020. Tuna fishery had similar pattern to small pelagic but with relative lower catch rates. Catch rates of tuna was 4kg/fisher/trip in 2017 and increased to a maximum of 12.5 kg/fisher/trip in 2018 and dropped to about 3 kg/fisher/trip in 2020 (Figure 13). Catch rates of octopus was 5kg/fisher/trip in 2017, and slightly increased to 7.5kg/fisher/trip in 2018 and, then gradually decreased 3 kg/fisher/trip in 2020. Reef fishery gradually increased from 4 kg/fisher/trip in 2017 to 7.5 kg/fisher/trip in 2020. Unlike other CFMAs, MCHIMCHUNYA catch rate trends were unclear because of few data for trend analysis of priority fisheries with exception of reef fishery. Catch rate of reef was 7.5kg/fisher/trip in 2018 and slightly increased in 2019 to 8.0kg/fisher/trip and decreased to 4kg/fisher/trip in 2020.

In NYAMANJISOPOJA, all the six priority fisheries were found. The catch rate of elasmobranch was 12kg/fisher/trip in 2017 and increased to a maximum of 20kg/fisher/trip in 2019 and the decreased to 12.5kg/fisher/trip in 2020. Small pelagic had the catch rates 9kg/fisher/trip in 2017 and then increased to a maximum of 20kg/fisher/trip in 2018 and gradually decreased to 8kg/fisher/trip in 2020. The catch rates for tuna was 7.5kg/fisher/trip in 2017, and decreased to 4kg/fisher/trip in 2018, and remain flat up to 2020. Catch rates trend of reef fishery was 7.5kg/fisher/trip in 2017, and remain flat in 2018 then gradually decreased to 7.0kg/fisher/trip in 2020. The octopus catch rate was 4kg/fisher/trip in 2017 and increased slightly to about 5kg/fisher/trip in 2018

and then decreased gradually 3kg/fisher/trip in 2020 (Figure 13). Prawn data started in 2019 in eCAS that had catch rates of 2.5kg/fisher/trip and remain flat up to 2020.

In SOMAKI CFMA (Figure 3.10), catch rates trend for tuna fishery was 2kg/fisher/trip in 2017 and increased gradually to a maximum of 10kg/fisher/trip in 2019 and remain flat toward 2020. For reef fishery, the catch rate was about 6kg/fisher/trip in 2018, which slightly decreased in 2020 to about 4kg/fisher/trip. Trends of other priority fisheries were unclear due to insufficient data for trend analysis.

In TIM4SI, the catch rate of reef fishery was 6kg/fisher/trip in 2017 and remained relatively flat to 2020. Catch rate of small pelagic was 22kg/fisher/trip and remained flat until 2019 and then declined to 5kg/fisher/trip in 2020. Similar to small pelagic, elasmobranch had the catch rates of about 22kg/fisher/trip in 2017, which decreased to 14kg/fisher/trip in 2019, then increased to 18kg/fisher/trip in 2020. Small pelagic had high catch rates compared to other priority fisheries that varies across years.

Prawn fishery was only observed at MCHICHUNYA and NYAMANJISOPOJA, while octopus was observed in all CFMAs except MCHICHUNYA. The possible reason for dominance of certain priority fishery at CFMA level could be sampling protocol, where the minor strata is the district and not CFMA. But in this assessment, there are more than one landing site per CFMA because of WWFs on-going support in the RUMAKI seascape. Hence, there is a need to revise the data collection protocol, whereby the minor strata should be at the CFMA level.

In summary, the annual mean catches rate trends for priority fisheries in the different CFMAs showed varying patterns, with some fisheries performing better than others. It's important to continue to conserve and collected considering minor CFMA data.

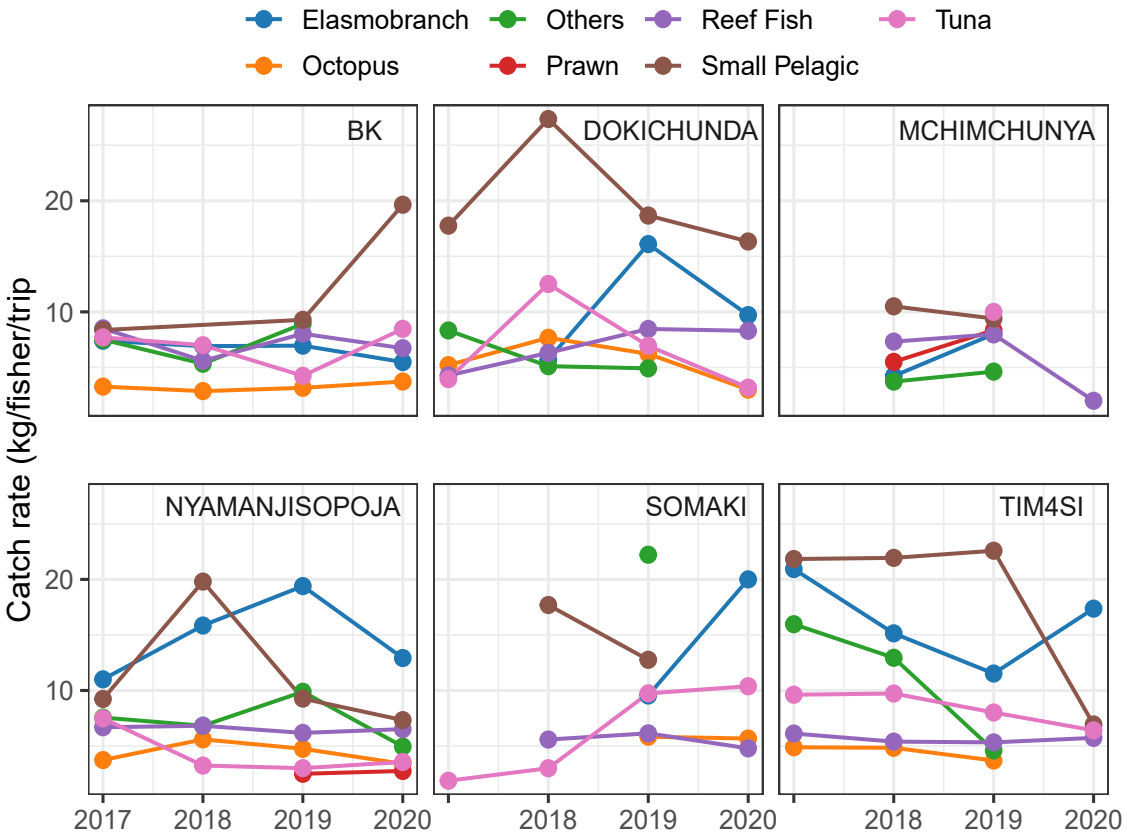


Figure 3.10: Annual mean catch rates trends (kg/fisher/trip) of priority fisheries by collaborative fisheries management areas in RUMAKI seascape

3.4.1. Annual total production

Total production trend (TPT) is a measure of the total amount of fish caught in a fishery over specified time. TPT is used as an indicator of fisheries performance. TPT is used to assess the overall productivity of a fishery, as well as the potential for sustainable harvests. Fish production was calculated based on the weight of fish caught using a catch per vessel per trip approach, and the total number of boat and gear combinations are considered to raise the total catch. The annual total production trends of priority fisheries in Kibiti, Kilwa and Mafia District are shown in Figure 3.11.

In Kibiti district, the annual total production trend of reef fisheries was 350 tons in 2017, which increased gradually to 600 tons in 2019, but declined to 450 tons in 2020. For small pelagic fishery, the catch was 350 tons in 2017 and decreased to 300 tons in 2018 but sharp declined to 50 tons in 2020. Elasmobranch fishery showed a gradual increasing trend in Kibiti, from 100 tons in 2017 to almost 290 tons in 2019. The total production trend of prawn fishery was only found at Kibiti district with the catch of 100 tons in 2017 and remain relative flat until 2018 and increased to 200 tons in 2019 and then declined to 50 tons in 2020 (Figure 3.11). In general, only elasmobranch fishery showed an increasing TPT, while TPT of other priority fisheries dwindled.

In Kilwa district, annual total production for four priority fisheries showed an increasing trend (Figure 3.11). The reef fishery had the total catch of 1,200 tons in 2017 and then slightly increased to 1,250 tons in 2018 which increased to maximum of 2,000 tons in 2019 before declined to 1,280 tons in 2020. The small pelagic fishery catches increased from 300 tons in 2017 to 520 tons in 2018 and remained flat up to 2020. Catch for tuna fishery in Kilwa was about 350 tons in 2017, and remain relative flat until 2018, then slightly increased to 450 tons in 2019, but declined to 370 tons in 2020. TPT of elasmobranch fishery was the lowest compared to other priory fisheries in Kilwa, with a catch of 130 tons in 2017 which increased to 230 tons in 2018 and sharp increase to

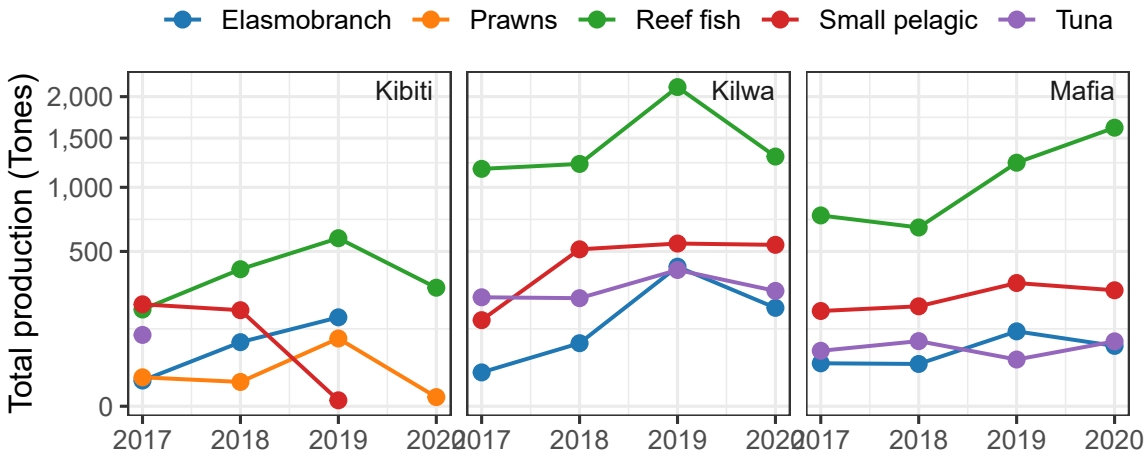


Figure 3.11: Annual total production trends (tonnes) of priority fisheries in Kibiti, Kilwa and Mafia Districts

the maximum of 300 tons in 2018, 400 tons in 2019, and slightly declined to 350 tons in 2020 (Figure 14).

In Mafia district, TPT of reef was 750 tons and slightly decreased to 720 tons in 2018 and then increased to a maximum of 1,700 tons in 2020. TPT of small pelagic was 300 tons in 2017 and increased to an estimated of 320 tons in 2018 and then slightly increased to 350 tons in 2019 and decreased to 340 tons in 2020. Like small pelagic, a TPT of elasmobranch was 140 tons in 2017 and increased to an estimated of 240 tons in 2018 and then slightly increased to 250 tons in 2019 and decreased to 220 tons in 2020. The TPT of tuna was 100 tons in 2017 which remained flat to 2018 and slightly increased to 250 tons in 2019 and decreased to 220 tons in 2020 (Figure 3.11). Overall, reef fisheries are the largest contributor to the annual total production among the priority fisheries in the RUMAKI seascape, followed by small pelagic fishery. The prawn fishery is only found in Kibiti district due to brackish waters that is ideal for their growth.

Figure 3.12 shows mean annual total production in Kibiti, Kilwa and Mafia districts for data collected during CAS and eCAS systems. The mean total annual production in Kibiti District was 183 tons for CAS, which was slighter lower than eCAS of 615 tons. Similarly, the mean annual total production at Kilwa of 1035 tons of CAS was lower than 2194 tons of eCAS at Kilwa district. Mafia district the mean total production of CAS was 1261 tons, which is also lower than 1380 tons of eCAS. In summary, the total production derived from eCAS was relatively higher compared to that of CAS system.

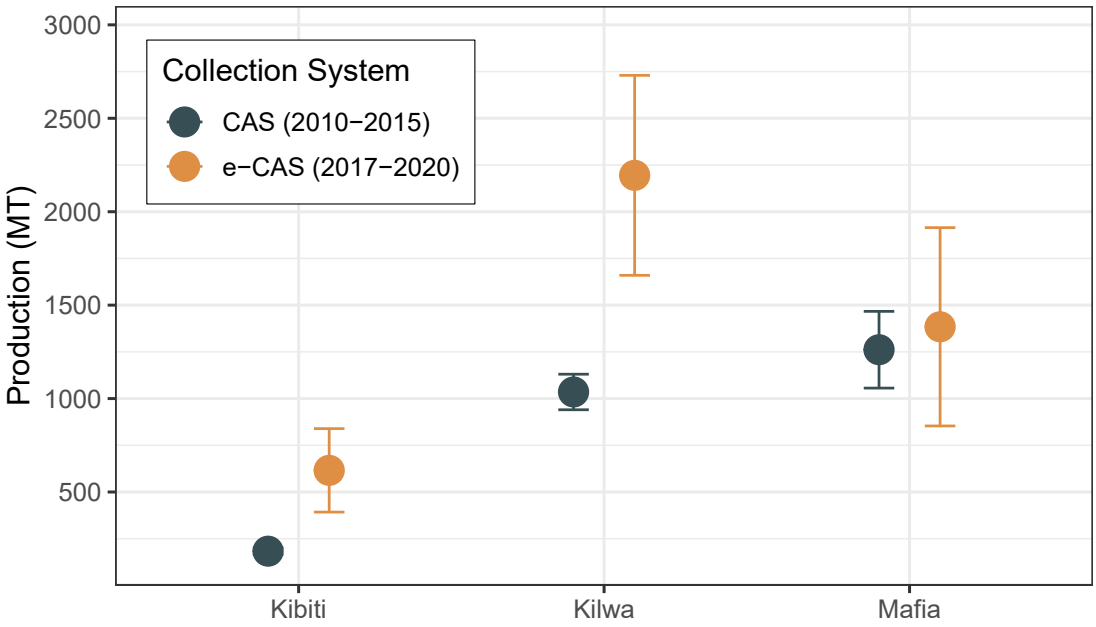


Figure 3.12: Mean total annual production (tonnes) between catch assessment (CAS) and electronic catchment assessment (eCAS) at Kibiti, Kilwa, and Mafia Districts.

3.5. CATCH RATE AND FISH PRODUCTION IN MAFIA ISLAND MARINE PARK

. The annual catch rate trends of the main priority fisheries in Mafia Island Marine Park (MIMP) have remained relatively stable over time (Figure 3.13). Small pelagic fishery has the highest catch rate trend compared to other priority fishery, which increased gradually from 8kg/fisher/trip in 2009 to 12.5kg/fisher/trip in 2018. Like small pelagic, the catch rate trend of elasmobranchs has increased over time from 7.9kg/fisher/trip in 2009 to 12.5kg/fisher/trip in 2020, but with a sharp drop in 2014. The catch rate of reef fish, octopus, and tuna show very similar trend patterns ranging between 4 and 8kg/fisher/trip that are stable over time but tuna had relatively high catch rates, followed by octopus and reef fish (Figure 3.13). 'Other' fishery in MIMP had the lowest catch rate trend with gaps of data for some years. In summary, the increasing catch rate trends of priority fisheries in MIMP suggest that the fisheries performance in the MIMP and conservation efforts and initiatives that are implemented in the area.

Figure 3.14 shows median catch rates between the pre-eCAS and eCAS periods for priority fisheries in the Mafia Island Marine Park (MIMP). The median catch rate of elasmobranch from CAS was 8kg/fisher/trip, which was relatively lower than 15kg/fisher/trip in the eCAS. Small pelagic median catch rate in the CAS was 5kg/fisher/trip, which was also lower compared to 13kg/fisher/trip in the eCAS. Reef fish catch rates from eCAS of 7kg/fisher/trip was relatively higher than 6kg/fisher/trip in the CAS. Similarly, the median catch rates of 7.8kg/fisher/trip of octopus in the eCAS was relatively higher than 7.2kg/fisher/trip found in the CAS. Unlike other priority fishery in the MIMP, which indicated eCAS with relatively higher median catch rates than CAS, tuna is the only priority fishery with median catch rates of 5kg/fisher/trip in the eCAS, which is lower than 7.3kg/fisher/trip in the CAS (Figure 3.14).

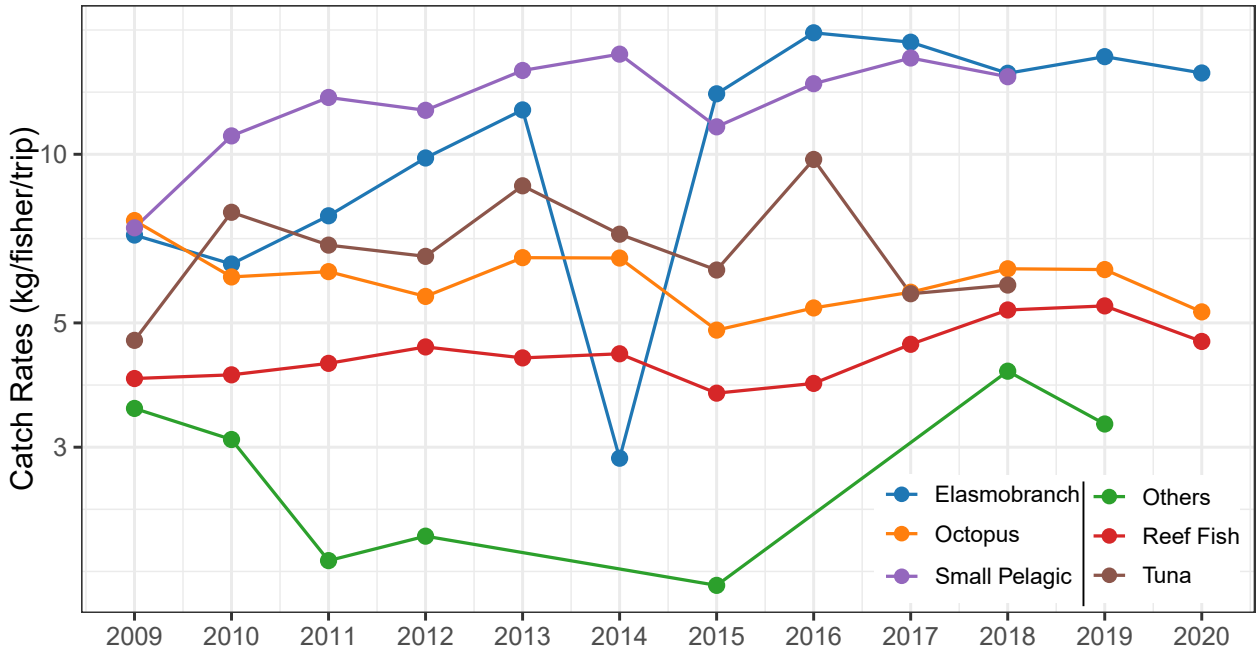


Figure 3.13: Annual catch rate trends (kg/fisher/trip) of priority fisheries in Mafia Island Marine Park

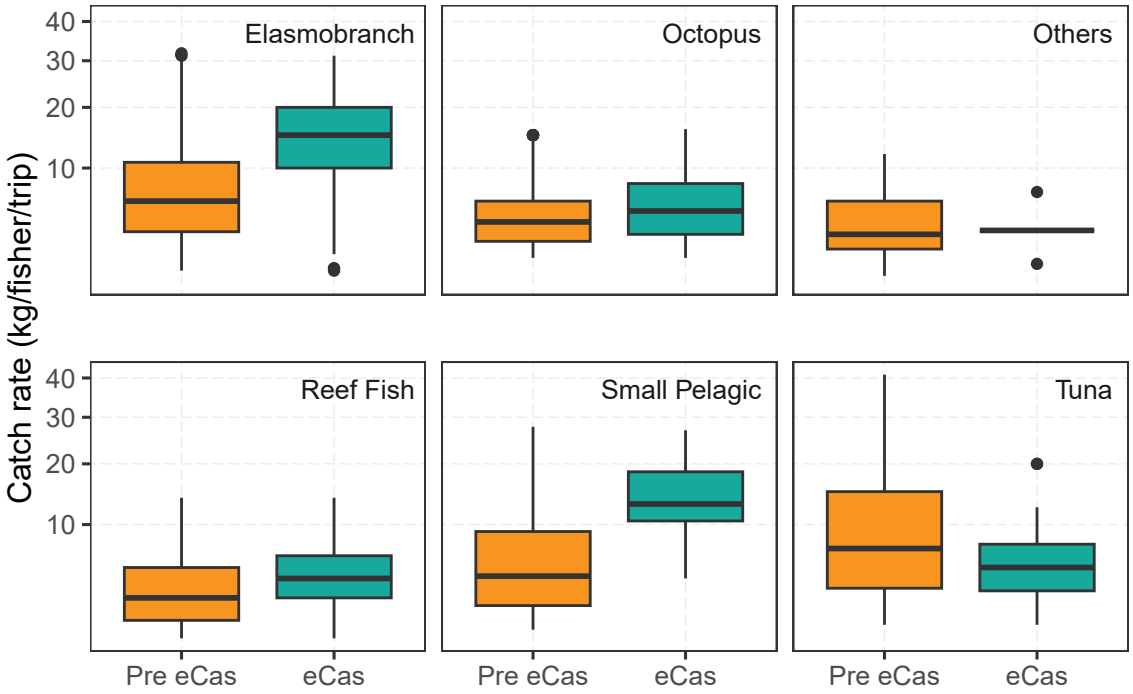


Figure 3.14: Median catch rates (kg/fisher/trip) in pre-eCAS (2010-2015) and eCAS (2017-2019) period by priority fisheries in the Mafia Island Marine Park (MIMP)

3.6. BASELINE INDICATOR FOR FISHERIES PERFORMANCE IN RUMAKI

Defining one or more simple and replicable indicators and baselines (e.g. CPUE, total production, income per fisher), that are useful in tracking and assessing the sustainability of priority fisheries (small pelagics, prawn and octopus) focusing on the CFMAs in the districts of Mafia, Kibiti and Kilwa based on available data.

To evaluate the performance of six priority fisheries in Kibiti, Kilwa, and Mafia districts, annual trends were analyzed using catch rates data from 2017 to 2020 in the six collaborative fisheries management areas (CFMAs). The priority fisheries include Elasmobranch, Octopus, Reef Fish, Small Pelagic, Tuna, and Prawn. This approach allows for a comprehensive assessment of fisheries management in the seascape, highlighting areas that require improvement and identifying successful management strategies.

Table 3.6 shows the catch rate trends of priority fisheries in six indicative CFMA over a period of four years. A negative trend indicates a decreasing catch rate, while a positive trend indicates an increasing catch rate and zero or close to zero trend indicate no change in catch rates.

At SOMAKI CFMA, only the elasmobranch fishery is doing well with an increasing trend of 1.74kg/fisher/year. The other priority fisheries are on the decline. Similar to the SOMAKI CFMA, the MCHIMCHUNYA fishery has shown positive catch rates for elasmobranch and prawn, with a recorded weight of 1.88kg and 1.42kg per fisher per year, respectively. However, the catch rates for other priority fisheries have shown a negative trend, indicating a decline in the amount caught.

At TIM4SI CFMA, all priority fisheries have experienced a negative trend, which suggests a decrease in the catch rates. There has been a notable increase in the catch rate of small pelagic and octopus at BK CFMA. Specifically, small pelagic has experienced a positive trend of approximately 2.11kg per fisher per year, while octopus has seen an increase of 0.22kg per fisher per year. However, it is important to note that other priority fishery has unfortunately experienced a negative trend.

The elasmobranch fishery has seen an increasing trend in catch rate of approximately 1.67 kilograms per fisher per year at DOKICHUNDA. In contrast, other priority fisheries have experienced a decreasing trend. At NYAMANJISOPOJA CFMA with the highest percentage of landing sites reporting to the eCAS system, indicate the catch rate of elasmobranchs with an increase of approximately 2.09kg per fisher per year. Similarly, the catch rate of prawns has also seen an increase of 0.042kg per fisher per year. Unfortunately, other priority fisheries at NYAMANJISOPOJA have experienced a decrease in catch rates.

Table 3.6: Annual catch rate trend of six priority fisheries in six collaborative fisheries management areas in the RUMAKI seascape 2017 to 2020. Green represent increasing trend and red represent a decreasing trend

CFMA	Elasmo branch	Octopus	Others	Reef Fish	Small Pelagic	Tuna	Prawn
SOMAKI	1.74	-0.027		-0.13	-2.05	3.263	-
MCHIMCHUNYA	1.88	-	0.448	-2.66	-0.549	-	1.42
TIM4SI	-2.40	-0.485	-3.98	-0.099	-2.42	-1.34	-
BK	-0.56	0.22	0.59	-0.42	2.11	-0.22	-
DOKICHUNDA	1.67	-1.09	-0.66	1.69	-1.41	-2.01	-
NYAMANJISOPOJA	2.09	-0.48	-0.802	-0.103	-1.288	-0.77	0.042

CONCLUSION AND RECOMMENDATION

The e-CAS system is an important tool for managing fisheries resources in Tanzania by providing data on the type and quantity of fish caught in each management area. Three districts in the RUMAKI seascape, Kibiti, Mafia, and Kilwa, have reported the highest fish records in the e-CAS, contributing to a total of 14,360 fish records. However, despite this accomplishment the overall performance of the BMUs in collecting these data was low (See Appendix 4.1 and Appendix 4.2w), impacting the timeline analyses, and even the catch rates of some gears and priority species. This calls for a dedicated effort to supervise BMUs in data collection on regular basis, in line with the directives of the data collection strategy.

Collaborative fisheries management areas (CFMAs) have been established to conserve and manage aquatic resources, including fisheries, in coastal waters of Kibiti, Mafia, and Kilwa Districts. However, the catch records in these areas show significant variation, which can be attributed to the location of the management area, the type of fish, and the fishing techniques used by local fishermen. The records of priority fisheries within the six collaborative management areas out of ten showed significantly in the e-CAS system, highlighting the need for a more rigorous sampling to offset the inherently high variability of the fisheries data. There is thus a need to revisit the sampling strategy and to derive the data requirement for the priority fisheries analyses, in line with the current approach to fisheries management in Tanzania.

The prioritization of certain fisheries over others can lead to the neglect of important species and disrupt the balance of marine ecosystems. To address this issue, it is recommended to improve data collection by ensuring that data collected are reflective of collaborative management areas (CFMAs). In addition, to avoid bias in data collection, all boats and gears should be sampled to represent the entire CFMA, instead of solely relying on certain boats and gears. This will provide a more accurate representation of the marine ecosystem and ensure the sustainability of fisheries in the long term.

Again, the assignment evaluated the spatial distribution of catch rates for six priority fisheries in the Rufiji/Kibiti; Mafia and Kilwa regions of Tanzania to identify any spatial variations in catch rates that may exist within management areas. The findings indicate that there are significant variations in catch rates of priority fisheries among the six-representative community-based fisheries management areas (CFMAs) in the RUMAKI seascape. The differences in catch rates among the CFMAs can be attributed to factors such as fishing practices, gear types, and environmental conditions. For instance, MCHIMCHUNYA CFMA may have higher catch rates due to its location in an area with more abundant fish populations or due to the use of more effective fishing gear. The analysis provides valuable insights into the effectiveness of current management strategies and informs future decision-making processes. Based on these findings, it is recommended that management efforts be tailored to the specific needs of each CFMA, taking into account the unique environmental conditions and fishing practices in each area.

This assignment continued to elaborate the use of catch rate trends to understand fish populations and fishing practices for sustainable fishing. The catch rate trends of priority fisheries in Kibiti, Kilwa, and Mafia districts of the RUMAKI seascape are analyzed using the electronic catch assessment system (eCAS) data collected from 2017 to 2020. The catch rate trends for prawn, reef, small pelagic, elasmobranch, and other fisheries are presented for each district. The results showed that the catch rate trends for different fisheries in each district vary, and some fisheries have shown an increasing trend while others have declined. For example, the catch rate of prawn in Kibiti increased in 2019 and then declined in 2020. Similarly, the catch rate of reef fish in Kilwa increased in 2018 and then decreased in 2019 and 2020. Overall, the result showed that the catch rate trends can inform management decisions for sustainable fishing practices.

Furthermore, the assignment examined the fishing practices in collaborative fisheries management areas (CFMAs) in the RUMAKI seascape by analyzing the annual mean catch rate trends of priority fisheries in each CFMA. The assignment found that the performance of each CFMA varied with some fisheries performing better than others. The annual mean catch rate trends for priority fisheries in each CFMA showed varying patterns, with some fisheries remaining stable, while others were gradually decreasing. The team recommends revising the data collection protocol to include the CFMA level as the minor strata to obtain more accurate data. Overall,

the team highlights the importance of conservation efforts and data collection in CFMAs to ensure sustainable fishing practices.

The annual catch rate trends of the priority fisheries in Mafia Island Marine Park (MIMP) vary over time. Small pelagic fishery has the highest catch rate, followed by elasmobranch fishery, tuna, octopus, and reef fishery. The catch rates of all priority fisheries have generally been increasing over time, likely due to the resources being within the protected area of MIMP. This increase in catch rates is a testament to MIMP's successful conservation efforts, which have led to the rich marine biodiversity in the area. Furthermore, the comparison of median catch rates between the pre-eCAS and e-CAS periods for priority fisheries in MIMP shows a significant improvement in fisheries management, conservation, and data collection during the e-CAS period. This improvement is reflected in the higher median catch rates for all priority fisheries, except for tuna, during the e-CAS period. These findings highlight the importance of effective conservation measures in maintaining healthy marine ecosystems and sustaining fisheries.

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APPENDIX

Appendix 4.1: Sampling Performance in the eCAS fir Kbiti District

Fishing unit	2018	2019	2020	2017
DC-HL	903	990	-	-
DC-GN	126	234	-	-
DC-SP	45	-	-	-
DC-RN	-	-	1	-
DC-LL	162	31	-	-
BT-SP	28	-	-	-
BT-SK	-	-	-	1

Appendix 4.2: Annual Sampling Performance in the eCAS for KilwaDistrict

Fishing unit	2017	2018	2019	2020
DC-HL	20	343	87	735
DC-GN	3	3	6	-
DC-SP	-	28	14	-
NG-SP	6	28	85	3
NG-GN	-	1	3	-
PC-SP	10	33	3	-
BT-HL	-	27	3	-
PC-GN	1	8	6	-
PC-HL	27	26	12	-
MS-HL	-	-	-	1
PC-RN	-	27	26	351
DC-RN	-	10	3	1
BT-SP	-	5	1	-
BT-GN	-	1	1	-
BT-LL	-	1	-	-
NG-HL	-	15	10	-
BT-RN	36	360	121	26
OC-HL	6	30	5	6
MS-LL	1	1	-	-
MS-SK	21	15	6	-
OC-GN	0	1	-	-
NG-RN	171	144	351	-
BT-SK	-	1	-	-
PC-SK	3	3	1	558

Appendix 4.3: Annual Sampling Performance in the eCAS for MafiaDistrict

Fishing_unit	2017	2018	2019	2020
DC-GN	7	-	-	-
DC-HL	1171	-	-	-
DC-LL	1	-	-	-
DC-SP	164	-	-	-
BT-HL	-	1	-	-
BT-LL	-	10	-	-
BT-RN	-	1499	-	-
DC-SK	-	2	-	-
OC-GN	-	16	-	-
OC-HL	-	16	-	-
BT-GN	-	-	1	-
OC-SK	-	-	35	-
PC-HL	-	-	3	-
MS-SK	-	-	-	68
NG-GN	-	-	-	1
NG-HL	-	-	-	37
NG-LL	-	-	-	3
NG-SK	-	-	-	21
PC-GN	-	-	-	8

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