MOZAMBIQUE SPEED PROJECT

Sustainable Fisheries Assessment in Mozambique: Nampula and Zambezia

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Sustainable Fisheries Assessment in Mozambique: Nampula and Zambezia

Supporting the Policy Enabling Environment for Development (SPEED)

Report Authors:

Atanasio Brito, Ph.D. – Senior Director, Fish Forever Mozambique (Project Lead)

Courtney Cox, Ph.D. – Senior Director, Applied Marine Science

Cremildo Armando, M.A. – Program Implementation Manager (Field Team Lead, Nampula)

Edson Jose, M.Sc. – Senior Program Implementation Manager (Field Team Lead, Zambezia)

Paula Santana Afonso, M.Sc. – Consultant

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COR: Nelson Guilaze

COP: Luis Sitoe

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ACRONYMS

ADNAP	Administração Nacional das Pescas (National Fisheries Administration)
CCP	Conselho Comunitário de Pesca (Community Fisheries Council)
DPAP	Direção provincial de Agricultura e Pesca (Provincial Directorates of Agriculture and Fisheries)
HHS	household survey
IIP	Instituto Nacional de Investigação Pesqueira (National Fisheries Research Institute)
IDEPA	Instituto Nacional de Pesca e Aquacultura (National Institute for Fisheries and Aquaculture Development)
IDPPE	Instituto de Desenvolvimento de Pesca de Pequena Escala (Institute for Development of Small Scale Fisheries)
INE	Instituto Nacional de Estatística (National Statistics Institute)
INIP	Instituto Nacional de Inspeção de Pescado (National Institute of Fish Inspection)
FAO	Fundo Mundial da Alimentação (Food and Agriculture Organization)
MIMAIP	Ministério do Mar, Águas Interiores e Pescas (Ministry of the Sea, Inland Waters and Fisheries)
SDAE	Servicos distritais de Actividades Economicas (District Service of Economic Activities)
VCA	value chain analysis

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EXECUTIVE SUMMARY

Artisanal fisheries are vital to coastal villages in Mozambique, producing over 90 percent of the 400,000 tons of annual fish landings, yet poor management and overfishing threaten both people and nature. This report provides an in-depth analysis of artisanal fisheries in the provinces of Nampula and Zambezia. A combination of desk research, fisheries stock assessment and modeling, and field trip missions to both provinces for data collection and validation was used to understand the various fisheries in the region, including fisheries status, harvesting practices, threats, management status and options, supply chains, and the different ways these fisheries support livelihoods, food security, and culture for men and women in the communities. Data sources included fishery catch data, group interviews, key informant interviews, and household surveys in all districts with intensive or full coverage or limited coverage depending on historical data availability and assumed priority.

The government estimates ***100,949 fishers*** are involved in maritime fishing activities in Nampula and Zambezia ***using 22,796 artisanal fishing gears***. There are ***20,981 boats and crafts registered*** in the two provinces, with only 3 percent (701 boats) motorized, while the majority uses simple means of propulsion, such as paddling or sailing.

The ***most common fishing gear in the two provinces are gillnet (31 percent), hook and line (28 percent), and beach seine (23.1 percent).*** These three types of fishing gear represent 82 percent of all gears in the study area. The main species recorded in available catch data include anchovies, sardines, scads or horse mackerels, croakers, emperors, snappers, jacks, mackerels, sable fish, and catfish.

Stock Assessment and Fisheries Recovery Modeling

The stock assessment results indicate that 16 fisheries or 50 percent of the 32 surveyed units (districts and fishing gears) ***are overexploited. Overfishing was caused mainly by beach seines, most likely due to the use of very small meshes in the nets*** (represented by species caught before or at the size at first maturity of 50 percent of the individuals [L50]). Beach seine is responsible for most of the overfishing and sustainability challenges in the region. These stock assessments were conducted for multi-species and multi-gear artisanal fisheries caught using the three main gears. Schaefer surplus production modeling was combined with trend analysis of the annual government scientific monitoring indicators, fishing effort, catch landings, and catch rates (catch per unit of effort) to improve the accuracy of the assessment.

For each district, simulations were used to predict fisheries recovery after implementation of marine protected areas (MPAs) that achieve one of the following three management objectives: (1) maximize total fish biomass across the district, (2) maximize total catch in fished locations, and (3) maximize both total biomass and catch. Fish biomass (relative to unfished levels) and catch (relative to catch prior to MPA establishment) under equilibrium conditions (100 years) were predicted for each simulation.

Fisheries recovery simulations maximizing both total biomass and catch show that improvements are possible within ten years by protecting 20 percent of critical habitat in optimally placed no-take MPAs and reducing fishing effort.

In all cases, management measures that reduce fishing pressure outside of MPAs, such as gear restrictions, are critical. Simulations showed that catch recovery potential varied across species and districts. In some cases, catch may not improve by establishing MPAs that protect 20 percent of key habitats alone (*i.e.*, Nacala Velha).

Total biomass (biomass inside MPA, outside MPA, and catch) can increase by as much as 2.9 times by reducing fishing effort outside MPAs, reaching up to 40 percent of unfished biomass. This was evidenced through a simulation included in the report that assumes fishing pressure is not concentrated outside MPAs as a response to MPA implementation and that further management efforts were put into place, reducing overall fishing effort by 50 percent.

Summary table on status of stocks by fishing gears and covered districts

Area	Districts	Beach Seine	Gillnet	Line and Hook	Species <L50
1	Memba	Optimal	Optimal	**Overexploited**	
	Nacala-a-velha	**Overexploited**	*NA*	**Overexploited**	
	Nacala Porto	**Overexploited**	Optimal	Optimal	
	Ilha de Moc	**Overexploited**	Optimal	Optimal	
	Mossoril	Optimal	Optimal	Optimal	
	Mongicual	Optimal	Optimal	*NA*	
2	Angoche	**Overexploited**	**Overexploited**	Optimal	*Upeneus vittatus* *Hilsa kelee*
	Moma	Optimal	**Overexploited**	Optimal	*Pelona ditchela*
3	Pebane	Optimal	Optimal	**Overexploited**	*Hilsa kelee*
	Maganja da Costa	**Overexploited**	**Overexploited**		*Pelona ditchela*
	Namacurra	**Overexploited**	**Overexploited**		
4	Quelimane	**Overexploited**	**Overexploited**	**Overexploited**	*Hilsa kelee* *Pelona ditchela* *Sardinella albella*

(<L50 indicates species that are caught before reaching maturity.)

Value Chain Assessment

Information on the small-scale fishing sector value chain was obtained through interviews with 113 fish traders or buyers (18 of whom are women) and 86 fishers (5 of whom are women). Interviews with fishers suggested that in most districts, the price is set by the buyer and is perceived as fair. The relationship between fishers and buyers is perceived as non-abusive, with linkages emerging from friendships, family ties, and community relations.

Both fishers and buyers agreed that pricing is the main challenge in their business relations, as no centralized mechanism exists for accessing market information, such as pricing, permits, or best practices. Prices are negotiated upon landing with the upper hand given to buyers. Additionally, while the relationship is perceived as non-abusive by both parties, fishers would suffer more serious consequences if these relationships were to end. The cost of their fishing trip is partially covered by buyers through the provision of ice and gas, and fishers normally sell to the same buyer, whereas buyers purchase from an average of 11 different fishers.

These results suggest ***improvements in the competitiveness of the entire value chain are in order.*** These should prioritize the improvement of fisher income and facilitate opportunities for them to obtain higher value for their products without compromising the sustainable management of fishing resources.

Also, both fishers and buyers indicated ***infrastructure in the form of roads, power for cold storage, and ice production supporting the value chain should be improved***.

Socioeconomic Assessment

Household surveys were conducted to understand livelihoods, fishing, and related activities, including access and ownership of resources, food security and income, power and decision-making, and norms and beliefs. ***Approximately 89 percent of households interviewed were involved in fishing activities.*** An alarmingly high number of respondents ***(>50 percent) across four of nine districts reported they do not have sufficient income.*** Monthly incomes varied across study areas, but ***Memba had a notably low average income below the national minimum wage, suggesting that people immigrating from Cabo Delgado to Memba without means of support could be influencing the average income.***

Most of the respondents, who reported they are ***confident they will be able to buy enough food for their families for the next 12 months, depend primarily on fish catch for household income, complemented by farming.*** Districts with agriculture as their primary or secondary source of income reported low confidence in providing food for the next 12 months.

More than half of the members in most districts felt ***confident that they will continue to benefit from community management of their fisheries, that fishing regulations are effective at ensuring catches remain stable, and that it is important for fishing areas to be managed and protected.***

Conversely, there is a ***widespread perception that fish catch has declined within the past two years and will continue to do so in the next five years.*** The stock assessment confirms ***overfishing is indeed occurring due to the use of mosquito nets and other unregulated and unreported gears.*** Overall, the common perception that community-based management is effective contradicts this perception of declining catches and reveals a lack of community awareness of marine resources as a common good, and as such, must be managed by everyone.

Gender Assessment

The value chain and socioeconomic assessment interviews suggest that ***men are primarily involved in fishing and women in processing and trading.*** Notably, ***while men still dominate fishing in the district of Nampula, the average women per household involved in fishing is higher than other districts,*** which may be a result of the ecological conditions in the region being more conducive to women's fishing behaviors (*i.e.*, gear, species).

Aside from processing and trading, the woman's main activity is taking care of children and housework, which may not leave much space for income-generating activities. These roles may explain why most respondents across all districts reported financial decisions in the household are at times made by the couple but more frequently by the man.

Women made up 16 percent of the fish buyer value chain interviews compared to 6 percent in the fisher value chain interviews. The relationship between fisher and trader is an asymmetric one, where the buyer has a more powerful position often determining the price and possessing the liquidity and business to trade fish up the value chain. ***Women would benefit from access to financial services as it could facilitate the ability to save, invest, and expand.***

Number of Fishers Supported

The number of fishers across the districts reported in government census data was approximately 89,700 in 2019. Based on stock assessment findings and average fisher per gear, approximately 100,000 fishers meet a target fishing effort or number of gears per year of 75 percent of Fmsy. However, managing for maximum sustainable yield does not necessarily ensure wellbeing or sufficient income for fisher households as seen through household surveys which revealed that **only 25% of fisher households across the two provinces reported sufficient income to cover their family's**

needs. Based on the annual income reported as sufficient and the value per metric ton, we estimate that each household would require 3.2 metric tons (mt) per year to cover the family's needs. Catch is not distributed equally amongst fishers for beach sienes and gill nets. Approximately 15 fishers split catch from a beach siene with the main fisher taking 50%, the next in charge taking 25% and the remaining 13 fishers splitting 25%. For gill nets the same is true for an average of 8 fishers per net. Main beach siene and gill net fishers and second beach siene fishers exceeded this amount in 2019. Hook and line fishers split catch equally. The remaining beach siene and gill net fishers along with hook and line fishers did not meet this threshold in 2019.

Assuming fishing pressure is managed through marine reserves and other fishing restrictions catch increases 1.2 times over the course of 10 years, **approximately 26,500 fishers could be supported at a catch per unit effort of 3.2 mt/year**. When considering a 3.2 mt/year for main and second fishers and a 2-fold increase in catch per year for all other fishers, **the fishery could support 54,800 fishers and up to 115,000 fishers if catch value increases**. Increasing both catch volume and catch value are critical for supporting fisher livelihoods particularly for fishers that do not lead the efforts. Access to financial services, opportunities to develop small businesses, and financial management skills are needed to secure fisher livelihoods and financial resilience.

Violent Extremism and Fisher Migration Assessment

The value chain and socioeconomic assessment surveys revealed that ***more than 50 percent of the households in Nacala Porto, Pebane, Mocubela, Maganja da Costa, and Namacurra reported concerns on violent extremism*** in the north affecting their communities. This includes responses from the child of the head of household, the spouse of the head of household, and the head of household. When disaggregating responses between the female head of household (FHH) and male head of household (MHH), *less than* 50 percent of the FHH in all districts except Pebane are concerned about violent extremism, while *more than* 50 percent of the MHH in all districts except Angoche are concerned.

In the value chain surveys, more than half of the fishers and buyers in most districts reported they are also concerned about violent extremism. Most notably, buyers in Memba—the district closest to violent extremism in the north—are especially concerned, with ***58 percent reporting that it is negatively affecting their income, and 83 percent reporting that they think it will affect their income in the future.*** All districts show an increase in concern when comparing how violent extremism is affecting their food and income now versus how it will affect these dimensions in the future.

Ultimately, when asked about why fishers were migrating to new areas, majority of the respondents reported that ***fishers were seeking areas with higher catch.*** None reported a connection to violent extremism events. This finding agrees with past studies, which state that movement of fishers and fishing boats up and down along the Mozambican coast is within the context of history, culture, fisheries resource availability, climate, and ecology. This survey was able to confirm that this is still occurring but was unable to establish any link between these movements and participation in violent extremism. More specialized research is required to link these movements to vulnerability to the lure of extremism, especially among the youth in Mozambique.

Main Recommendations

- Invest in comprehensive and regular artisanal fishing monitoring.
- Conduct a specialized study to assess value retention focusing on high-value species.
- Promote adoption of sustainable fishing behaviors and participatory enforcement.
- Assess the financial and social sustainability of development projects.
- Involve youth in the next set of development projects and prioritize livelihood projects.
- Mitigate the social impact of the legal ban on beach seines anticipated in 2024.

- Limit the number of fishing gears allowed in each district.
- Promote empowerment of women to support increased access to strategic resources and a voice in decision-making processes through participation in savings clubs, financial literacy trainings, small enterprise development, and fisheries management.
- Use participatory processes, promote adoption of sustainable fishing behaviors, and secure sustainable financing for management activities.
- Design optimal networks of no-fishing zones (MPAs).
- Continue predictive modeling efforts to better understand the impact of both spatial closures and fishing restrictions on recovery of important fisheries species, including small pelagic fishes.

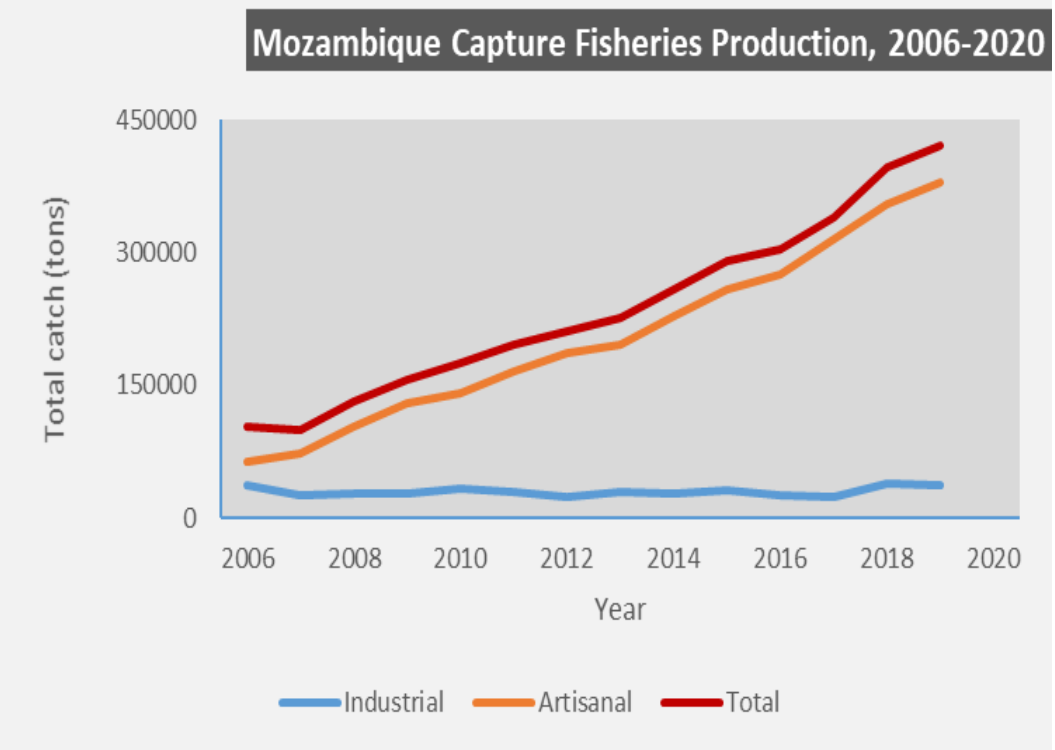
1. INTRODUCTION

The Supporting the Policy Enabling Environment for Development (SPEED) project is a five-year program (from March 22, 2021 to March 20, 2026) with a financial package of approximately $39.9 million. The project was created to promote a business environment in Mozambique and increase the role of the private sector in agriculture, trade, energy, biodiversity, conservation, and health. The project also envisages strengthening economic governance and public management while strengthening the role of civil society to improve the country's ability to plan, manage, and finance its own development.

Artisanal fishing was selected to be part of the possible activities under the SPEED project as it guarantees food security and is one of the main sources of livelihood in coastal communities in Mozambique. In this context, a consultancy work was requested from Rare, Inc. (rare.org) for a period of three months to carry out an assessment of artisanal fishing in the provinces of Nampula and Zambezia.

The contribution of the fishing sector to the national economy is estimated at 2 percent of gross domestic product (GDP) (Ministério do Mar, Águas Interiores e Pescas, 2019), with annual production estimated at 400,000 tons of different products of marine and freshwater origin (MIMAIP, 2020 a). The value of fishery export products in Mozambique represents 1.1 percent of national exports, ranking as the 13th product (Instituto Nacional de Estatística, 2015). In the 1980s, fishery products contributed around 30 percent of national exports, being then the key sector in the national economy. This changed when new products entered the national economy, such as aluminum, gas, coal, energy, ores (*e.g.,* titanium), precious stones, sugar, and wood (INE, 2015). In agricultural and livestock exports, fishery products are the third most exported after wood and sugar (INE, 2015).

On a global scale, fish production has been decreasing, showing a clear saturation in the exploitation of wild fish resources, while aquaculture production has increased substantially over the years (FAO, 2020). However, in Mozambique, statistical data for the last 20 years show an increase in national fish production (Figure 1 right). This increase in production is due to the contribution of artisanal fishing, which represents around 90 percent of the national catch in 2019 (MIMAIP, 2020 a). The increase in catches from artisanal fisheries is linked to the improvement in statistical information over time and to the efforts of the Government of Mozambique to modernize fisheries, allowing access to less exploited fishing grounds and offshore areas. Despite this apparently promising scenario of increased fishing production for the artisanal sector, recent studies indicate that at least eight commercial species in the country are overexploited or in a state of optimal exploitation, with no room for increasing fishing capacity for these resources, in any sub-sector of activity (IIP, 2014). Of those eight species, only two are not caught by marine artisanal fishing.



(Source: Adapted, MIMAIP, 2020)

Figure 1. *Mozambique Capture Fisheries Production 2005-2020*

Artisanal fishing contributed around 380,330 tons per year in 2019. It is the sector with the highest valuation of catches (25,208 million meticais in 2019 [MIMAIP, 2020 a]) and supports more than 400,000 stakeholders in the entire chain of production (IDPPE, 2013). Combining the poverty of fishing communities, the overexploitation of some fishery resources, and the use of destructive fishing gear or practices all over the country, the Government of Mozambique recently introduced management measures to mitigate negative impacts of fishing. These include the massification of small-scale freshwater aquaculture (*e.g.*, tilapia), the introduction of closed seasons for artisanal shrimp fishing (in Sofala Bank) and mud crab fishing across the country, and the recent approval of a revised legislative package (REPMAR, 2020) that provides for the creation of community management areas (community managed access with no-take reserves) and strengthens the artisanal fisheries co-management system.

One of the gaps in artisanal fishing is the lack of systematic and consistent assessments of the state of exploitation of the target resources of this fishery—a fact that is not observed in the industrial and semi-industrial sector, where annual research cruises and stock assessments have been carried out to update harvest control rules. Annual or bi-annual resource assessments have been carried out for shallow-water and deep-water shrimps and other target species of industrial and semi-industrial fisheries. The absence of effective monitoring mechanisms for artisanal fisheries is associated with its diffuse, informal, undocumented, and open access regime, which in turn results in weak management for this most important sub-sector.

This report presents an assessment of artisanal fishing in the provinces of Nampula and Zambezia, located in the central-northern region of Mozambique. These two provinces represent around 54 percent of the global production of marine artisanal fisheries in the country and support 100,949 fishers (MIMAIP, 2020 b). Located in Nampula and Zambezia is Sofala Bank, one of the main fishing grounds in Mozambique and known for its commercial shallow-water shrimp fishery. In addition to Sofala Bank, this region has the largest marine conservation area in the country (Area for the Environmental Protection of Ilhas Primeiras and Segundas or APAIPS in its Portuguese acronym).

The aim of this report is to assess the fisheries' ecological, economic, social, and management status and identify evidence-based opportunities for improved management, which will also serve as baseline data to help demonstrate the results and impact of future projects in Mozambique.

1.1 OBJECTIVES

1. Characterize the main fisheries of coastal Nampula and Zambezia and their status.
    a. Describe the main fisheries.
    b. Identify the main fishing areas for significant fisheries, as well as chief species sought, and the typical harvesting techniques and methods and vessel types, as appropriate.
    c. Summarize the current status of stocks for these fisheries and evaluate the quality of the data underpinning this assessment.
    d. Identify the key factors behind trends in the main fisheries, specifically, threats to fish stocks. If appropriate, also identify successes from management arrangements.
    e. Identify ways current harvesting practices are degrading biodiversity, including key habitats (*e.g.*, coral reefs) or protected species.

2. Describe the socioeconomic dimensions of these fisheries.
    a. Describe the relationship between the main fisheries in these provinces and key stakeholder groups.
    b. Describe socioeconomic benefits to different groups in terms of food security, livelihoods, income, identity, and others.
    c. Evaluate the importance of these fisheries to coastal communities.
    d. Describe how different stakeholder groups perceive the status of the main fisheries.
3. Summarize ongoing and past fisheries management programs and key lessons learned from these efforts.
    a. Describe management measures, if any, currently applied to coastal fisheries in these provinces.
    b. List fisheries projects implemented in these geographic areas in the past.

4. Estimate the ecological and socioeconomic impacts of potential management arrangements on the following:
    a. Fishery management measures
    b. Socioeconomic benefits (*i.e.*, food security and income)

2. STUDY AREA

Nampula and Zambezia provinces are located in the central-northern region of Mozambique (Figure 2). These are bordered to the south by Marromeu district of Sofala province and to the north by Mecufi district in Cabo Delgado province.

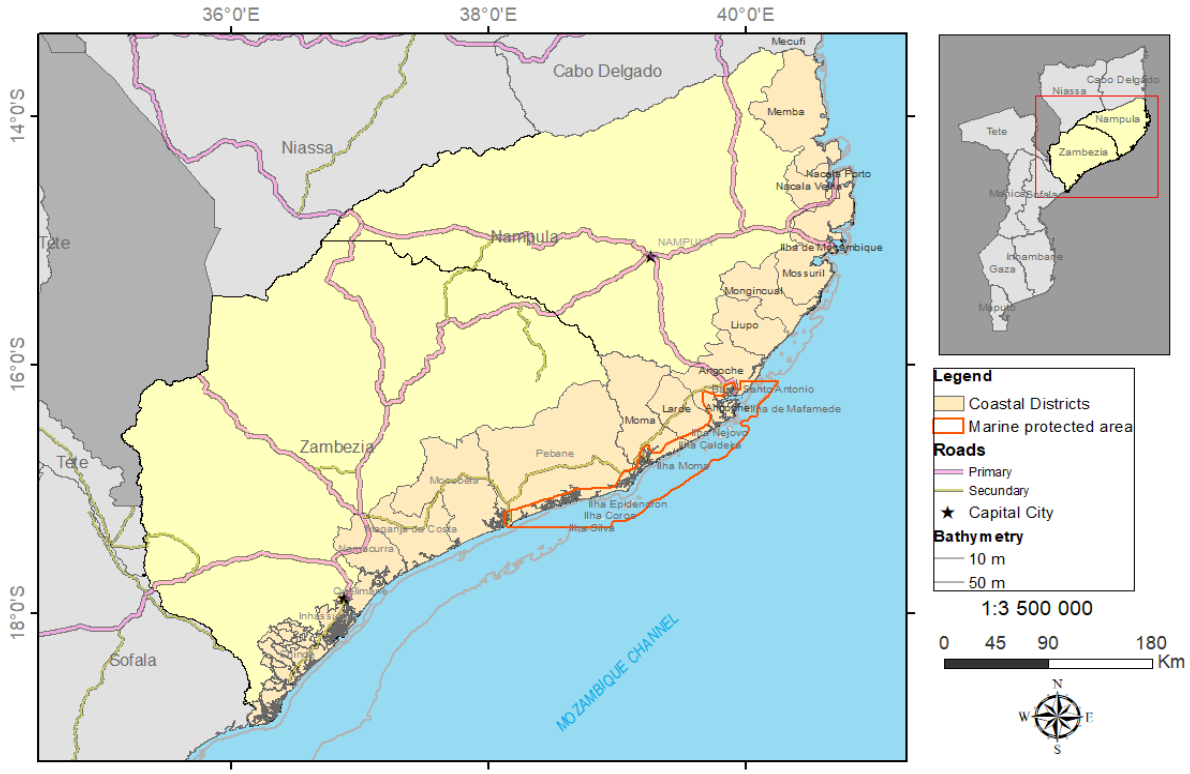


Figure 2. *Nampula and Zambezia provinces in Mozambique*

The coastal zone of the two provinces is divided administratively into 18 districts (Table 1). The population is estimated at 3,301,142 inhabitants, with population density ranging from 21 inhabitants per square kilometer (in Pebane in northern Zambezia) to 713 inhabitants per square kilometer (in Nacala Porto city in Nampula). The official language is Portuguese, and in the coastal area of the study, four local languages dominate: (1) Makhuwa in Nampula, (2) Elomwe in Pebane, (3) Chwabo between Maganja da Costa and Inhassunge, and (4) Sena in Chinde. These linguistic differences are associated with distinct cultures characterized in two ways: Arab influence in the northern zone from Memba to Pebane, where most of the communities practice Islam; and Catholic tradition in the rest of the region, among peoples of the so-called lower Zambezia, influenced by the Zambezi valley.

Table 1. *Districts in Nampula and Zambezia provinces, population (national government census data of 2017), main local language, area (km²), and population density (inhabitants per km²)*

Province	District	Population	Local Language	Area (km2)	Population Density by km2
Nampula	Memba	328,460	Makhuwa	5250	41.5
	Nacala Velha	121,726	Makhuwa	1151	92.6
	Nacala Porto	287,536	Makhuwa	324	713
	Mussoril	174,641	Makhuwa	3433	38.3
	Ilha de Mozambique	64,577	Makhuwa	184	287.7
	Mongicual	98,177	Makhuwa	2283	43
	Liupo	89,259	Makhuwa	2121	42.8
	Angoche	347,176	Makhuwa	3056	82.5
	Larde	98,385	Makhuwa	2458	53
	Moma	324,442	Makhuwa	3911	82
Zambezia	Pebane	212,364	Elomwe	10095	21
	Mocubela	124,734	Chwabo	4759	26
	Maganja da Costa	149,672	Chwabo	2872	52
	Namacurra	146,700	Chwabo	2021	22
	Nicoadala	192,820	Chwabo	2765	73
	Quelimane	359,194	Chwabo	6176	61
	Inhassunge	92,808	Chwabo	754	123
	Chinde	88,761	Sena	3120	28
	Total	***3,301,432***			

(Source: INE, 2018, www.citypopulation.de/en)

Several marine habitats and species exist in the region. With fewer rivers, the northern zone (from Memba to Mossuril) is characterized by the presence of coral reefs and clean and transparent waters. In this region, tourism is more developed, with national and foreign capital. The central area of Sofala Bank (between Angoche and Chinde) has several rivers and estuaries with turbid waters and is surrounded by large forests of mangroves, which serve as shelter and protection for various marine species of commercial interest. There is also an emerging mining exploration industry (*e.g.*, heavy sands) with foreign capital in Larde, Angoche, and Inhassunge.

Located in the coastal areas of Angoche and Pebane districts is the main marine conservation area in Mozambique (Environmental Protection Area of the First and Second Islands). Established in 2012, the conservation area aims to protect important species and habitats in the region, especially sea turtles, corals, and mangroves. With main islands concentrated in this sub-region, the area is a unique habitat where mangroves, corals, and seagrass interconnect, making it a reference pole for biodiversity. This gives the coastal and marine areas of Nampula and Zambezia great socioeconomic importance for local communities that practice artisanal fishing throughout the region, as well as large public and private companies that use the potential of the sea in different sectors. Table 2 and Figure 3 summarize the coastal and marine economic activities in the two provinces.

Table 2. Main coastal and marine economic activities in Nampula and Zambezia

Activities	Districts	Sector	National Income
Industrial Fishing (shallow-water shrimp)	From Angoche (at north) to Chinde	**Industrial sector.** Vessels over 12 meters long could directly impact fish stock in the region.	High
Mineral Resources	Angoche, Larde, Inhassunge, Chinde	**Coastal heavy sands.** Operations of private companies with foreign capital could cause pollution and habitat degradation.	High
Tourism	Memba, Nacala, Ilha de Mozambique (more prominent)	**Sea and coastal areas.** Less impact on live marine resources; some overlapping of activities with artisanal fisheries (social impact).	Moderate
Ports	• Commercial port: Nacala Porto and Quelimane • Fishing port: Angoche • Private ports (mineral resources): Angoche (from mineral resources in Angoche) and Nacala Velha (from coal in Tete)	**Marine and coastal areas.** Potential impact from pollution (private ports) and dredging (only in Quelimane)	High
Aquaculture	Chinde (shrimp and fish)	**Coastal areas.** Local impact that directly affects ecosystems and artisanal fisheries.	Moderate
Mangrove Uses	All areas but more prominent in Quelimane and Inhassunge	**Coastal areas.** Using mangroves for coal and construction directly affects ecosystems.	Less

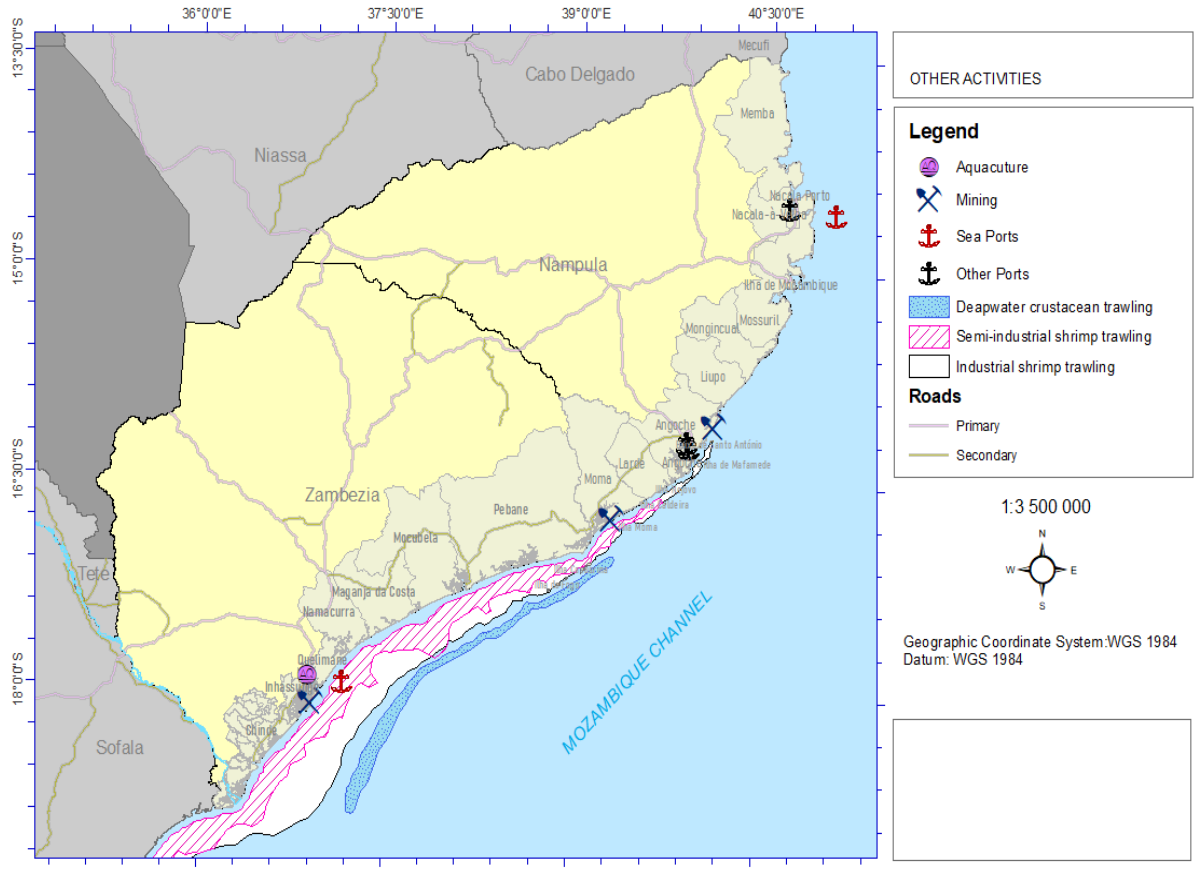


Figure 3. Main coastal and marine economic activities in Nampula and Zambezia

3. METHODOLOGY

A combination of methods for sourcing data and information was used: a desk review and on-site data collection.

3.1 DESK REVIEW

The desk review used different sources of bibliographic information, including government reports and data series to characterize the artisanal fishing subsector. Two data sources were explored and analyzed: (1) the update of the 2019 artisanal fishing census in Sofala Bank carried out by MIMAIP, and (2) the SNAPA (National Artisanal Fishing Sampling System) fishing statistical data series from 2010 to 2020.

In addition to the bibliographic information consulted and used in this report, on-site data collection carried out in August 2021 involved structured surveys with key informants, focus groups, and households in Nampula and Zambezia for socioeconomic characterization. In total, 1,014 interviews were carried out in both provinces.

3.2 SOCIOECONOMIC SURVEY

Socioeconomic indicators were assessed across each district where the number of households interviewed ranged from 5 to 202. For each district, surveys were distributed proportionally among targeted districts based on estimated population numbers and further distributed based on proportion of number of fishers in each community (Table 3). Most of the people interviewed were the heads of household. Over 60 percent of the heads of household across all districts were men, with 100 percent of those interviewed in Nacala Porto, Mogincual, Angoche, Maganja da Costa, and Mocubela as male heads of household. Others interviewed included the child, spouse, sibling, or parent of the head of household.

Table 3. *Number of households interviewed during socioeconomic surveys*

Districts	House holds Surveyed	Women Interviewed (%)	Men Interviewed (%)	Head of Households Interviewed (%)	Households with Income from Small-scale Fishing (%)	FHH with Income from Small-scale Fishing (%)	MHH with Income from Small-scale Fishing (%)
Memba	203	35	65	73	37	8	41
Nacala Porto	56	0	100	100	91	0	91
Ilha de Moçambique	311	36	64	70	40	14	48
Mogincual	45	0	100	100	89	0	89
Angoche	202	37	63	100	99	70	99
Pebane	155	2	98	86	67	0	69
Maganja da Costa	23	0	100	100	87	0	87
Mocubela	5	0	100	100	40	0	40
Namacurra	14	14	86	93	50	0	33
Total	***1,014***				***600***		

The household survey has 54 core questions covering several topics, including basic information, livelihood, fishing and related activities, household assets, financial resilience, social capital, fishery management, enforcement and compliance, food security, attitudes, expenditures and income, and perceptions on violent extremism. Not all questions are responded to by all interviewees because

several are specifically tailored to fisher households while others are tailored to communities with managed access areas, fishery management regulations, or management bodies. As such, the total number of questions answered by interviewees varied across communities.

3.3 VALUE CHAIN ANALYSIS

During the on-site data collection, additional semi-structured interviews using a standardized questionnaire were conducted with 113 fish traders and 86 fishers in selected Nampula and Zambezia districts to collect information regarding the value chain of fish. These interviews included main actors in fisheries, fish processing, fish trade, and transport, as well as price relationships and other value-adding activities for two to three pre-selected species of fish with greatest socioeconomic importance.

Figure 4. *Field teams in Nampula and Zambezia during household interviews (left) and on focus groups (right). Photo credits: Rare and E. Jose*

3.4 OTHER OBSERVATIONS

Observations were taken on the environmental and social aspects to support interpretation and validate historical data and information.

In parallel, interviews or contacts with governmental and non-governmental institutions were systematically established throughout the process of preparing this report to identify key contextual factors and collect past reports, grey literature, and other relevant information. Lists of contacted persons are presented in Annex A.

3.5 STOCK ASSESSMENT MODELING

Data analysis for the assessment of artisanal fisheries resources was carried out using a combination of methods: trend analysis of the main historical monitoring indicators in the data series (catch, fishing effort, and catch per unit of effort or CPUE) and the Schaefer Surplus production model by fishing gear and district. The districts of Liupo, Larde, and Mocubela—administratively established in 2013—were only reflected in national fisheries statistics in 2016 and, therefore, were not considered as administrative units in these analyses. Given that those units result from administrative splits from large districts, new fisheries statistics from Liupo were coupled with the "parent" district of Mogincual, while those from Larde were merged with the district of Moma and from Mocubela with the district of Maganja da Costa, the latter being the only district from Zambezia.

Using "surplus production models" can determine the optimal level of fishing effort, such as the effort that leads to the maximum yield that can be sustained without affecting the long-term productivity of the fishing stock, the so-called Maximum Sustainable Yield (MSY) (Sparre and Venema, 1997). In this report, the Schaefer model was used to estimate the maximum sustainable effort and its maximum sustainable catch, which is also equivalent to the exploitable potential or stock accessible to five of the main fishing gears: beach seine, surface gill net, and handline (line and hook).

3.6 FISHERIES RECOVERY MODELING

Marine protected area placement optimization is based on connectivity-informed fishery simulations. We simulated fish population dynamics in nine nominated districts of Mozambique according to agreed resource management objectives for four taxa of coral reef fishes to optimize MPA placement. Optimizations were conducted using two different planning grids: (1) a large-scale planning grid developed by co-investigator Eric Treml to simulate larval dispersal by ocean currents across a wider region surrounding Mozambique, and (2) a small-scale planning grid to calculate connectivity via both larval dispersal and adult movements according to the distribution of coral reef habitat and estimated scales of fish movements during these two different life history periods. All estimates of connectivity were based on the same reef habitat data, which represented a global layer of coral reef habitat (https://data.unep-wcmc.org/datasets/1) partially corrected by Treml based on more reliable local data on reef distribution.

The large-scale planning grid was generated in one-kilometer resolution. However, individual grid cells were merged into clusters assumed to represent the geomorphology of distinct reef patches, thereby resulting in an asymmetric distribution of both grid cell area and reef area within grid cells. Details on procedures to develop the large-scale planning grid and on associated simulations of larval dispersal among distinct reef patches have been documented by Treml. For the purpose of fishery modeling and MPA placement optimization described here, we used the provided large-scale planning grid, simulated local larval output, and estimated probabilities of larval dispersal between distinct reef patches.

In addition, nine small-scale planning grids were developed based on the provided layers of coral reef habitat to represent district waters in Mozambique. For each district, a buffer of 25 kilometers was applied to generate district planning grids in one-kilometer resolution, which matched the initial (un-clustered) format of the large-scale planning grid. The 25-kilometer buffer was chosen to prevent strong edge effects in subsequent fishery simulations expected to result from adult home range movements beyond district boundaries (the maximum estimated home range was 3.4 kilometer ± 2.1 kilometer [mean ± SD] for emperors). District planning grids were then clipped by reef area to identify and select only those grid cells which contained reef habitat, and to calculate the centroid of reef area within each of the reef-containing grid cells. In the next step, we calculated the over-water distance between every pair of reef-containing grid cells by using the "gDistance" package in R. This was done by firstly using a high-resolution global layer of the Earth's coastline (Wessel and Smith, 1996) in combination with the layer of reef habitat to generate a resistance layer in raster format (50-meter resolution) that specified which areas of our planning grid were accessible to fishes (reef or water) and which were not (land). In contrast to simpler calculations of Euclidean distances, this resistance layer or transition matrix was necessary to calculate the seascape distances that take into account that fishes need to move around rather than through islands or complex shapes of coastline, thereby providing a much more realistic representation of potential population connectivity. To quantify potential population connectivity in the next step, we accessed existing databases and scientific literature to determine plausible values of the mean scale and associated standard deviation of adult home range movements and larval dispersal for each of the four taxa of coral reef fishes (Table 4). We then used a negative binomial probability density function to represent these means and associated standard deviations and calculated the probability of adult movements and larval dispersal from and to every reef containing grid cells according to the estimated seascape distance between them. The two resulting probability matrices (adult home range movements and larval dispersal) were used for subsequent fishery modeling and MPA placement optimization.

In consultation with local communities and in line with biophysical simulations of larval dispersal, fishery simulations aimed at representing key target species in Mozambique (Table 4). Fishery simulations were based on a Deriso-Schnute delay-difference model, which mimics age-structured population dynamics under data-poor conditions (for details, see Hilborn and Waters, 1992). Simulations were based on an annual time step, capturing changes in fish biomass and catch according to natural adult mortality or survival, growth, adult movements, larval dispersal, density-dependent recruitment, and

fishing pressure in each area of the planning grid. All simulations started with a spawning event based upon which eggs were released from all areas and in proportion to the local biomass of mature fish in those areas at a given time. Eggs were assumed to develop into larvae and distributed across space to calculate settlement as predicted according to the above-described larval dispersal probability matrices. Settled juveniles were then subjected to density-dependent mortality before entering the adult population by calculating recruitment according to a Beverton-Holt stock-recruitment relationship (Walters et al., 2007). Further detail on principal equations and procedures used for fishery simulations are given in multiple previous studies (Krueck et al., 2017; Krueck et al., 2019).

Table 4. *Key modeling parameters used to represent a variety of fishery target species and life history characteristics*

	Grouper	Fusilier	Emperor	Parrotfish	Comments
Species used to derive parameters values	Epinephelus merra and E. malabor	Caesio cuning and closely related spp.	Lethrinus nebulosus and closely related spp.	Idealized across various target species	
Survival (s)	0.6	0.5	0.85	0.5	
Growth (p)	0.5	0.5	0.2	0.7	
Steepness (h)	0.7	0.7	0.5	0.7	
Scale of adult home range (mean ± SD)	0.4 km ± 0.4 km	2 km ± 2 km	3.4 km ± 2.1 km	0.1 km ± 0.1 km	Home range not used in large-scale simulations
Scale of larval dispersal (mean ± SD)	50 km ± 50 km	100 km ± 100 km	100 km ± 100 km	50 km ± 50 km	Defined by biophysical simulations in large-scale simulations

To parameterize the fishery model for the purpose of this project, empirical estimates of natural annual mortality or survival (s) and growth (p) of target species groups or families were sourced from FishBase (www.fishbase.se/search.php). Estimates of the steepness of the Beverton-Holt recruitment relationship (h) were narrowed down based on plausible parameter ranges available from seminal meta-analyses (Myers et al., 1999) and finally determined in alignment with other life history characteristics (mortality and growth). The scale of adult home range movements was estimated from the scientific literature for these particular or closely related species (Green et al., 2015). Scales of larval dispersal were estimated coarsely based on several detailed studies available now for groupers and some other coral reef fishes (Bode et al., 2016; Williamson et al, 2016; Almany et al., 2017). Given a lack of quantitative information on habitat quality or fish population sizes in Mozambique, unfished biomass in each area of the planning grid was estimated to be proportional to the area of coral reef habitat. We did not include georeferenced quantitative information on fishing effort in these simulations but assumed the distribution of fishing pressure to be uniform. We will continue to develop the model by incorporating fishing effort collected through this project. Based on these assumptions, the key purpose of fishery simulations was to support decisions on protected area placement according to spatial heterogeneity in the distribution of coral reef habitat and the likely dispersal of the early life stages of key target species by ocean currents (large-scale planning grid), and the distribution of coral reef habitat and empirically estimated scales of movements of both early life stages and adults (small-scale planning grid).

Response variables considered for MPA placement optimization included predicted fish biomass (relative to unfished levels) and catch (relative to catch prior to MPA establishment) under equilibrium conditions (100 years). In all simulation scenarios, meta-populations were assumed to be depleted to 10 percent of unfished levels before alternative MPA networks were introduced to assess associated impacts on both fish population biomass and catch. This assumption is intentionally pessimistic, but

realistic for families of key target species in overfished systems (Krueck et al., 2019), helping to identify MPA systems that are most likely to help to prevent further declines under fishing pressure that may intensify in the future. In addition, we ran simulations that assumed fishing effort was concentrated outside of MPAs as a response to MPA implementation, as well as simulations that assumed fishing effort was not concentrated outside of MPAs.

For each district, fishery simulations were used to select near-optimal sets of locations to achieve three management objectives: (1) maximize total fish biomass across the district, (2) maximize total catch in fished locations, and (3) maximize both total biomass and catch. Optimizations were started by using a simple greedy approach that selected best protected area locations in a stepwise manner according to their relative performance in achieving stated management objectives. For balanced scenarios, such as objective 3, fish biomass and catch were normalized by their respective maxima across locations, and a new total performance score calculated based on the sum of these two normalized metrics multiplied by a previously specified weight of their assumed importance. For this study, we used equal weights of one for both total fish biomass and catch, aiming to achieve a harmonic balance. In other cases, either total biomass or catch might be perceived as less important than the other, in which case this imbalance could be reflected in variable optimization importance weights. All optimization runs were completed once the total habitat coverage of the MPA system reached the stated goal (20 percent). Following the first (fully) greedy optimization run, we initiated up to 100 optimization runs seeded based on a random selection of protected area locations that covered between one and ten percent of all locations. These random seeds were aimed at ensuring that fixed starting points as in the first optimization run did not trap MPA system optimization outcomes in suboptimal space (local maxima). Following the random seeds, up to 100 additional optimization runs were initiated based on an increasing proportion of protected area locations that had always been selected for protection in preceding optimization runs. These "informed" optimization runs were stopped regardless of the specified number of seeds as soon as the best MPA system had stopped changing over the last five runs. Finally, once the three principal steps of the optimization procedure were completed (fully greedy, random, and informed), we tested for possible iterative improvements—that is, whether simple changes in status from "protected" to "fished" or vice versa—of any area in the planning region would result in an improvement of the best identified MPA systems.

Key outcomes from the optimization routine included the frequency of protected area selections and best overall MPA system identified across all optimization runs. We further calculated various combinations of cumulative MPA selection frequencies to capture outcomes across management objectives by species, outcomes across management objectives and species by planning grid (small-scale versus large-scale connectivity), and across all optimization scenarios. To combine MPA selection frequencies for the two different planning grids (small-scale and large-scale), areas in the small-scale planning grid were matched to their nearest neighbor in the large-scale planning grid.

4. RESULTS

4.1 OVERVIEW OF FISHERIES SECTOR IN MOZAMBIQUE

The 2,740-kilometer Mozambique coastline is characterized by the following three main areas:

1. The coral coast in the north—from the mouth of Rovuma River to the north of Angoche district—is characterized by deep bays. In this region, fisheries resources are predominantly demersal with coral species or those associated with coral reefs.

2. The central area between the south of Angoche and River Save is known as a delta region of several rivers, particularly Zambezi and Save. This region is home to Sofala Bank and has the largest mangrove forest in the country, as well as a concentration of surface shrimp fisheries exploited by

fleets. Other fisheries resources in this region are associated with shrimp and estuarine environments.

3. The southern region, extending from River Save delta to the border with South Africa, has parabolic dunes and estuarine lakes. In this region, fisheries resources are hybrid, with the occurrence of large fisheries for demersal fish and some deep-water and surface crustaceans.

The fisheries sector in Mozambique is characterized by the following three subsectors (REPMAR, 2020):

1. **Industrial fishing** uses robust vessels with more than 24 meters in length and has an on-board freezing system. This subsector uses the most developed fishing technology in the country. Main industrial fisheries are shallow-water and deep-water shrimp, demersal fish (caught by line and hook), and tuna, with the latter having a combined operation with national vessels, as well as other vessels licensed in Mozambique but have home ports outside the country.

2. **Semi-industrial fishing** uses boats with sizes between 13 and 24 meters long, and uses ice for storing fish on board. Semi-industrial fisheries in Mozambique include line demersal resources, shallow-water shrimp in Sofala Bank and Maputo Bay (including the mouth of Limpopo River), kapenta (in the Cabora Bassa reservoir in Tete province), and a recent fish fleet operating pelagic fish trawl but is not yet fully established.

3. **Artisanal fishing**, the most popular fisheries in the country, is distributed along the entire coastline and in freshwater courses and lakes. When artisanal fishing is practiced using a vessel, it should not exceed 13 meters in length and should use simple and rudimentary methods. Artisanal fishers need a license to operate and should have an associated commercial component.

The national fishery production improved from 290,913 metric tons in 2015 to 420,845 metric tons in 2019, where artisanal fishing contributed around 90 percent of the total production per year (MIMAIP, 2020 a). The sector contributes 2 percent to the national GDP (MIMAIP, 2019 a) and exported products generating $59,891 million to the state coffers in 2019 (INE, 2015). Fishing plays an important role in a food insecure country, where it benefits 29 percent of households in Mozambique (INE, 2020). Despite recent data estimating that per capita consumption of fish has decreased from 13.6 kilograms in 2014 to 11.6 kilograms in 2019 (INE, 2020), fish remains as the main source of protein in the country.

Fishing activities are under the tutelage of Ministério do Mar, Águas Interiores e Pescas (MIMAIP) or the Ministry of the Sea, Inland Waters, and Fisheries, which has specialized institutions with a specific mandate for each activity. The main sub-sectors are summarized in Table 5.

Table 5. *Public fisheries sector institutions in Mozambique*

Area	Institution	Scope	
Management	National Fisheries Administration (ADNAP, IP)	Fisheries management, licensing, and ordinance (including participatory forms of management, co-management, and good practices)	Institution under the supervision of MIMAIP with provincial representations in all provinces
Policies	National Directorate of Fisheries Policy (DIPOL)	Sectorial policies	Central level Ministry directorate
Fisheries Research (Living Resources and Environment)	National Institute of Fisheries Research (IIP)	Mainly applied research for management of living resources and environment (including oceanography and ecology)	Nationwide, with representations in all provinces Institution subordinated to MIMAIP

Development	National Institute for the Development of Fisheries and Aquaculture (IDEPA). IDEPA was created five years ago by merging two former institutions: Small-scale Fisheries Development Institute (IDDPE) and Institute for Aquaculture Development (INAQUA)	Promotion of artisanal fishing and aquaculture (including technology, advocacy, socioeconomic studies, and fish processing)	Nationwide, with representations in all provinces Institution subordinated to MIMAIP.
Surveillance	Directorate of Operations	Monitoring of fishing activities	National scope Direction of the Ministry
Planning	National Directorate for Studies, Planning, and Infrastructure	Planning, monitoring of sector activities, compiling fisheries performance indicators, and socioeconomic studies	National scope Direction of the Ministry
Sanitary and Biosafety Inspection	National Institute of Fish Inspection	Control and quality of fisheries resources Institution certified to issue certificates for export	Nationwide, with representations in all provinces Institution subordinated to MIMAIP
Funding	PROAZUL	Promotion and guidance of private projects for implementation based on blue economy principles	Guarded by MIMAIP With financial and patrimonial autonomy National scope

At the provincial level, activities in the fisheries sector are ensured by the Provincial Directorates of Agriculture and Fisheries (DPAP), which report to the provincial consultative council, and the Provincial Services for Economic Activities (SPAE) under the guidance of the State Representation at the provincial level. These bodies work in close collaboration with the provincial delegations of ADNAP, IIP, INIP, and IDEPA. At the district level, the activities of the fisheries sector are coordinated by the District Services for Economic Activities (SDAE), which articulate their activities with the SPAE and the district government.

The legal framework of the fisheries sector in Mozambique is governed by a set of laws, regulations, and decrees that guide and establish the operating mechanisms of the activity. Table 6 illustrates the main legal instruments to regulate and guide fisheries in the country.

Table 6. *Main legal instruments for fisheries in Mozambique*

Legal Instrument	Reference	Scope
Fisheries policy	Resolution No. 11/96	Frames the policy of fishing activity in the main development objectives of the country
Fisheries law (act)	Law No. 22/2013 of 22 November	Lays down the general principles and provides the basis for regulating access to and exercise of fishing, as well as for the adoption of measures for the exploitation, conservation, and sustainable preservation of fishing resources, including the framework of sanctions to be applied in the event of an infringement of its provisions
Maritime fishing regulation (REPMAR)	Decree No. 89/2020 of 8 October	Regulates the provisions of Law No. 22/2013 of 22 November in sea fishing
Sports and recreation fishing regulation	Decree No. 50/99 of 31 August	Regulates the provisions of Law No. 22/2013 of 22 November in sport and recreational fishing
Policy for monitoring, surveillance, and control and its implementation strategy	Resolution No. 28/2008 of 15 July	Reduction and prevention of illegal, unreported, and unregulated fishing Guides different ministries involved in the fisheries monitoring, control, and surveillance activity system

4.2 ARTISANAL FISHERIES IN NAMPULA AND ZAMBEZIA PROVINCES

4.2.1 GENERAL DESCRIPTION

In 2019, approximately100,949 fishers were involved in maritime fishing activities in Nampula and Zambezia alone, using 22,796 artisanal fishing gears (MIMAIP, 2020 b). Fishers represent approximately 1 to 7 percent of the population across the two provinces (Figure 5). Angoche, Ilha de Mozambique, Mussoril, and Pebane have the highest proportions of fishers relative to the total population. There are about 20,981 boats and crafts registered in the two provinces, with only 3 percent (701 boats) motorized, while the majority uses simple means of propulsion, such as paddling or sailing (Table 7).

Table 7. *Number of fishing vessels, fishing gears, and fishers in Nampula and Zambezia*

	Vessels			Gears	Fishers
	Total	*With motor*	*No motor*		
Nampula	14,903	568	14,335	15,329	72,436
Zambezia	6,078	133	5,945	7,467	28,513
Total	***20,981***	***701***	***20,280***	***22,796***	***100,949***

(Source: MIMAIP, 2020 b)

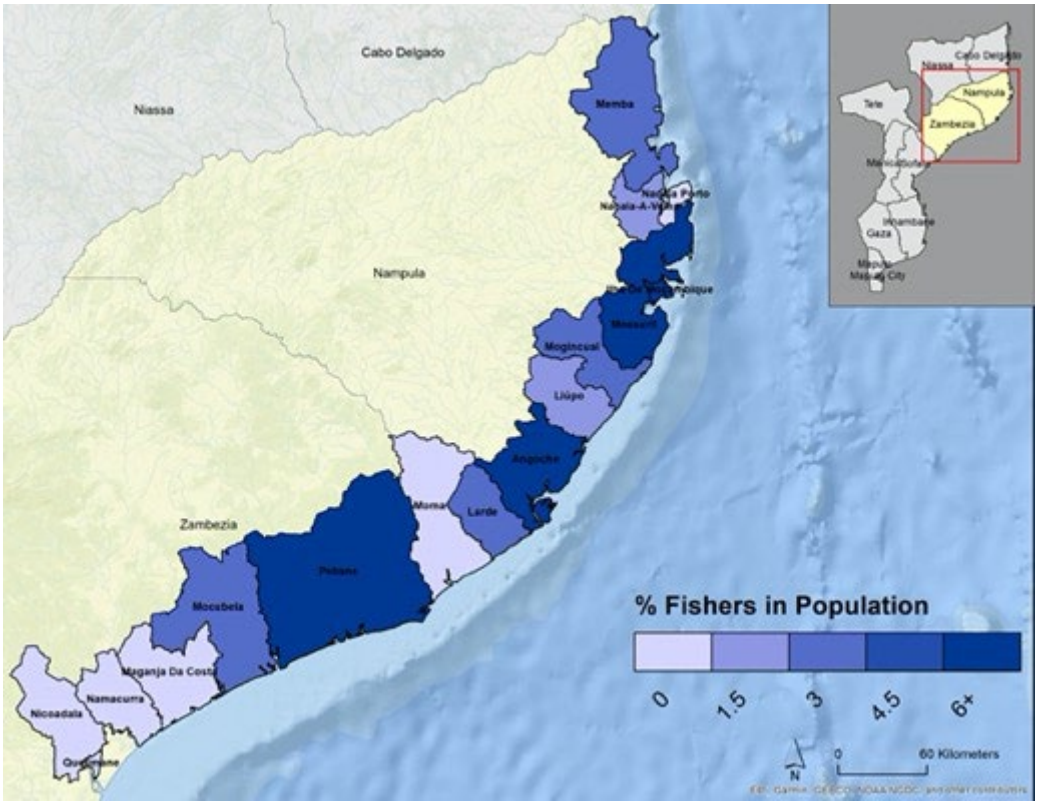
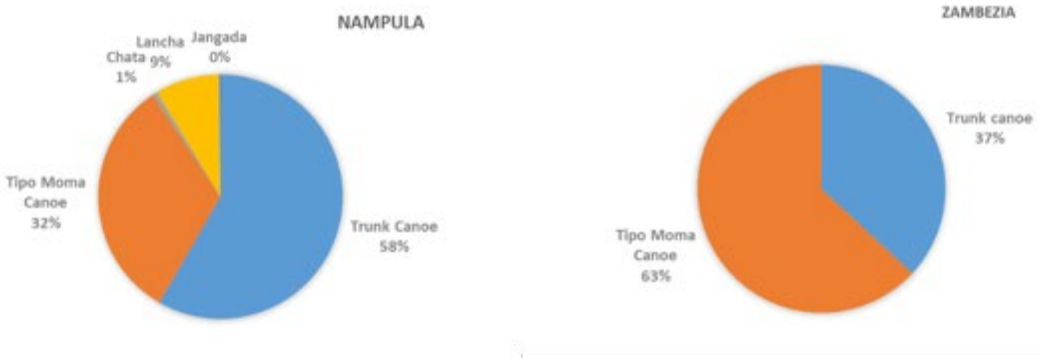


Figure 5. *Proportion of fishers by district in Nampula and Zambezia*

Figure 6. *Types of vessels used in Nampula and Zambezia: trunk canoe (left) and chata (right). Photo credit: P.S. Alfonso*

In Nampula, the most common vessels are the excavated tree trunk canoe with 8,692 units (58 percent). There are also Moma-type canoes with 4,822 units (32 percent) and other boats called *lanchas* with 1,271 units (9 percent). There are also registered *Jangadas* and *Chatas* but in smaller number. In Zambezia, only two types of boats are recorded: Moma-type canoes with 3,834 units (63 percent) and excavated tree trunk canoes with 2,224 units (37 percent) (Figure 7). There are no available information of the number of vessels by fishing gear.



(Source: Adapted MIMAIP, 2020 b)

Figure 7. *Types of fishing boats in Nampula and Zambezia*

The most common fishing gear in the two provinces are gillnet (31 percent), hook and line (28 percent), and beach seine (23.1 percent). These three types of fishing gear represent 82 percent of all gears in the study area. The contribution of different fishing gears by province is shown in Table 8.

Table 8. *Number of fishing gears in Nampula and Zambezia*

Gears	Nampula	Zambezia	Nampula and Zambezia	Contribution (%)
Seine	3,215	2,053	5,268	**23.1**
Hook and line	5,832	649	6,481	**28.4**
Gillnet	3,599	3,510	7,109	**31.2**
Chicocota	84	487	571	**2.5**
Longline	122	663	785	**3.4**
Harpoon and Dive	1,580	0	1,580	**6.9**
Purse Seine	263	11	274	**1.2**
Trap	193	31	224	**1.0**
Others	441	63	504	**2.2**
Total	***15,329***	***7,467***	***22,796***	***100%***

(Source: Adapted from MIMAIP, 2020 b)

Nampula has twice the number of fishing gears than Zambezia (Table 8). The districts of Memba, Mossuril, and Angoche in Nampula and Pebane in Zambezia are the districts with the highest number of fishing gears (Figure 8).

(Source: Adapted from MIMAIP, 2020 b)

Figure 8. *Number of fishing gears (all types combined) by district. Dark blue bars are districts in Nampula and light blue bars are districts in Zambezia, arranged from north to south.*

The main characterization of fishing gear and fishing patterns are summarized in Table 9. Women normally only use 'quinias" and collect invertebrates in the intertidal zone. The most abundant and formal gears are used by men.

Table 9. *General gear characteristics in Nampula and Zambezia*

Gear Type	Characteristics	Vessels	Mesh Size	Fishers by Gear	Women	Environment and Target Species
Beach seine	A beach seine is used from the shore or coastal areas. The gear is composed of a bunt (bag or loose netting) and long wings, which are often lengthened with long ropes for towing the seine toward the beach.	Beach seines are usually set from a boat (in general, a small boat and, in many cases, without engine). Vessels used include *Chatas* and Moma-type canoes.	Bag: 38 mm but often mosquito nets Wings: 38 mm but also mosquito nets Net: 500 m up to 2 km long	9 to 22	No women involved	Target species: Demersal and pelagic species (gear not selective) Habitats: Seagrass and sand banks Possible impact on habitats: Beach seines can disturb breeding activities and can frequently capture juveniles.
Hook and Line	Handlines used without a pole or rod. This gear type includes jigging lines operated by hand and used on small boats. Baits used are usually squid, scad, and worms.	This gear can use boats for commercial proposes. For subsistence use, the gear is set from the beach	Hook number 5 to 9	1 in Nacala Porto and Nacala Velha	No women involved	Target species: Big demersal rock or sand fish and pelagic species. Habitats: Coral reef or rocky areas, seagrass and sandy

		Vessels used include excavated trunk canoes, *Chatas*, and Moma-type canoes.		Up to 8 in other areas		bottoms, pelagic environment (large pelagic fishes, such as tuna and tuna-like species) Possible impact on habitats: Minimal or unknown
Gillnet	A gillnet is a wall of netting that hangs in the water column. It consists of netting, typically made of monofilament nylon, attached between a head-rope and a foot-rope. The net is kept open vertically by the differences in buoyancy between the two ropes. The mesh size can vary and used according to the target species. The mesh is designed to entangle fish by the head and not all of the body.	*Chatas* and Moma-type canoes are more commonly used in the region.	Surface gillnet: minimum 1.5 to 2 in Bottom gillnet: maximum 5 to 8 in	5 to 8	No women involved	Target species: Small pelagic fish (depends on mesh size used) and demersal fish (when bottom gillnet is used) Habitat: Pelagic environment for surface gillnet Possible impact on habitat: Around the world, gillnets are responsible for deaths of sea turtles and sea mammals. The impact of gillnets on habitats and species in Nampula and Zambezia is unknown.
Purse seine	A purse seine is made of a long wall of netting framed with floatline and leadline (usually of equal or longer length than the former). It has purse rings hanging from the lower edge of the gear, through which runs a purse line made of rope that allows the pursing of the net.	When using more than one boat during fishing, *Chatas* and Moma-type canoes are more commonly used. This fishing involves one or more divers for pursing the net.		15 to 20	No women involved	Target species: Large and small pelagic species that are shoaling. Habitats: Marine pelagic habitats Possible impact on habitats: Minimal, because purse seines do not have contact with bottom subtract
Harpoon	Harpoon is an underwater piercing gear used for catching large fish. A barbed missile resembling a spear is attached to a long rope and thrown by hand or fired from a gun. Fishers dive with harpoon and mask to catch their target.	Harpoon fishing uses all type of vessels in the region, except for excavated trunk canoes.	-.	3 to 8	No women involved	Target species: Octopus, lobster, demersal fish, and large pelagic fish Habitat: Coral or rocky areas Possible impact on habitat: Harpoon fishing can cause overfishing of coral fish species and damage to coral reefs.

Figure 9. *Some gears used during fishing activities in Nampula and Zambezia: (a) beach seine during its hauling, (b) hook and line, and (c) gillnet. Photo credit: E. Jose*

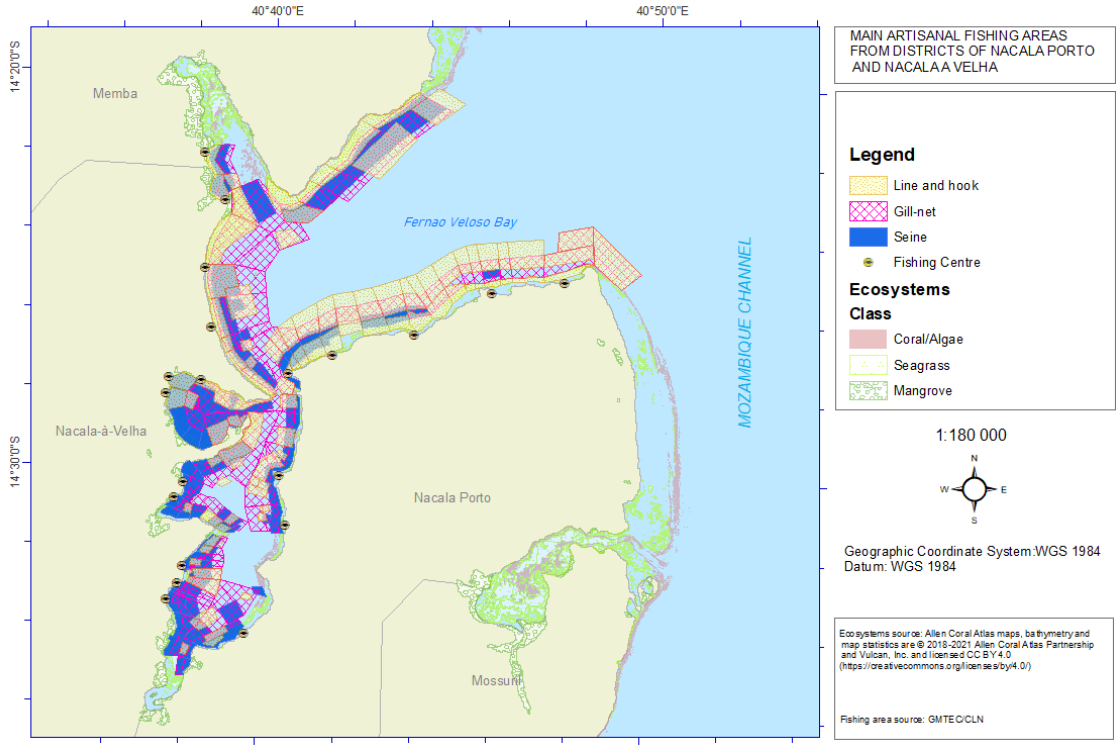
Figure 10. *Fishing captures in Nampula and Zambezia: (a) Engraulididae (anchovies), (b) Nacala, and (c) Hilsa kelee*

4.2.2 FISHING GROUNDS

Data from fishing areas were adapted and compiled from the recent past work carried out by government and private institutions. Geo-referenced data from shapefiles were sourced and reworked to combine maps of interest based on the relevant geographical units and the main fishing gears (beach seine, gillnet, and hook and line). Only fishing areas to the north of Memba district, from Mussoril to Mogincual and Pebane, were not readily available for this assessment. Women mostly fish in the interdidal from Memba down to Mogincual. The following are the fishing areas represented in this study.

Nacala Bay. Fishers operating in Nacala Bay are from the districts of Nacala Velha, Nacala Porto, and southern Memba. The three districts use the same fishing areas with a clear overlap in the use of fishing gears. The seine is used closer to the shore, while the gillnet and the line and hook are used in a wider area (Figure 11). In the middle of Fernão Veloso Bay, there is no fishing activity due to high

depths and security restrictions in the area brought by the commercial port of Nacala Porto. There are few motorized boats operating in the bay.



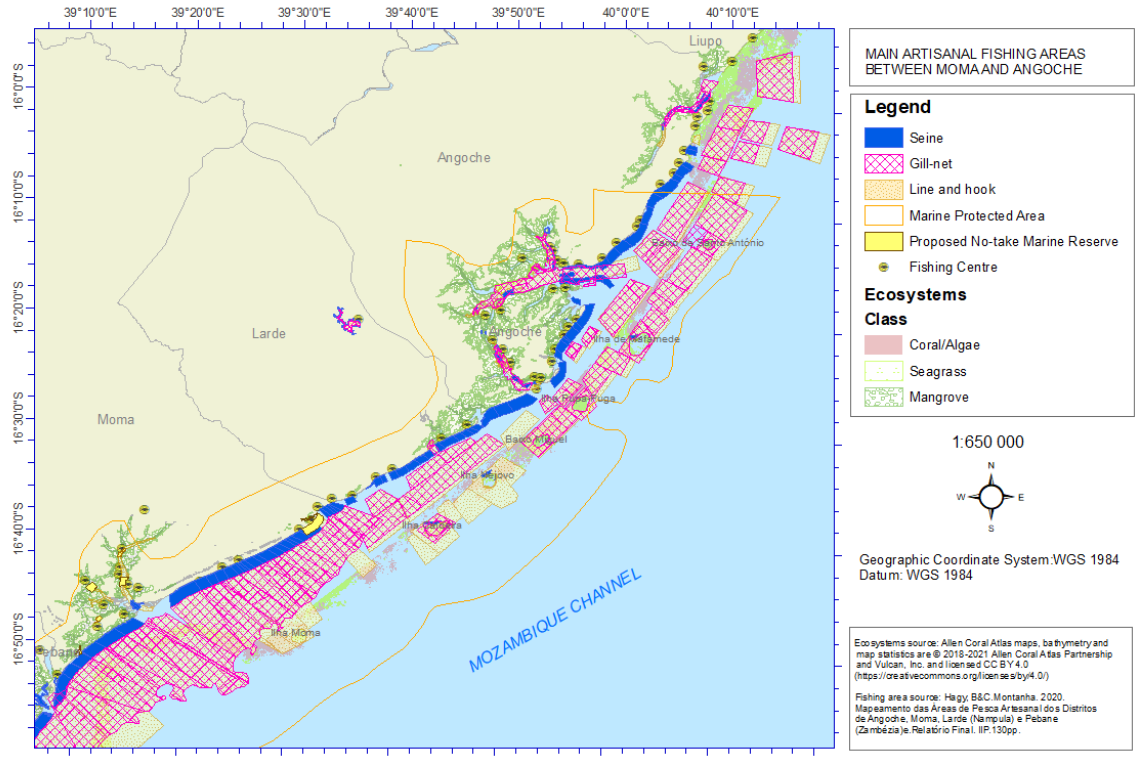
(Source: Adapted from GMTEC, 2021 in prep)

Figure 11. *Fishing ground in Nacala Bay*

Moma to Angoche. In this region, line and hook has a larger area of use compared to other areas. There is a visible overlap between areas where gillnet and line and hook are used, while seine is exclusively used toward the coast (Figure 12). The fishing pattern also shows some activities in estuaries or sheltered areas, mainly using gillnet. Areas in the region with no fishing activity are due to lack of attractive substrates. The most attractive fishing area substrate in the region is characterized by the presence of coral, rubble, and seagrass.

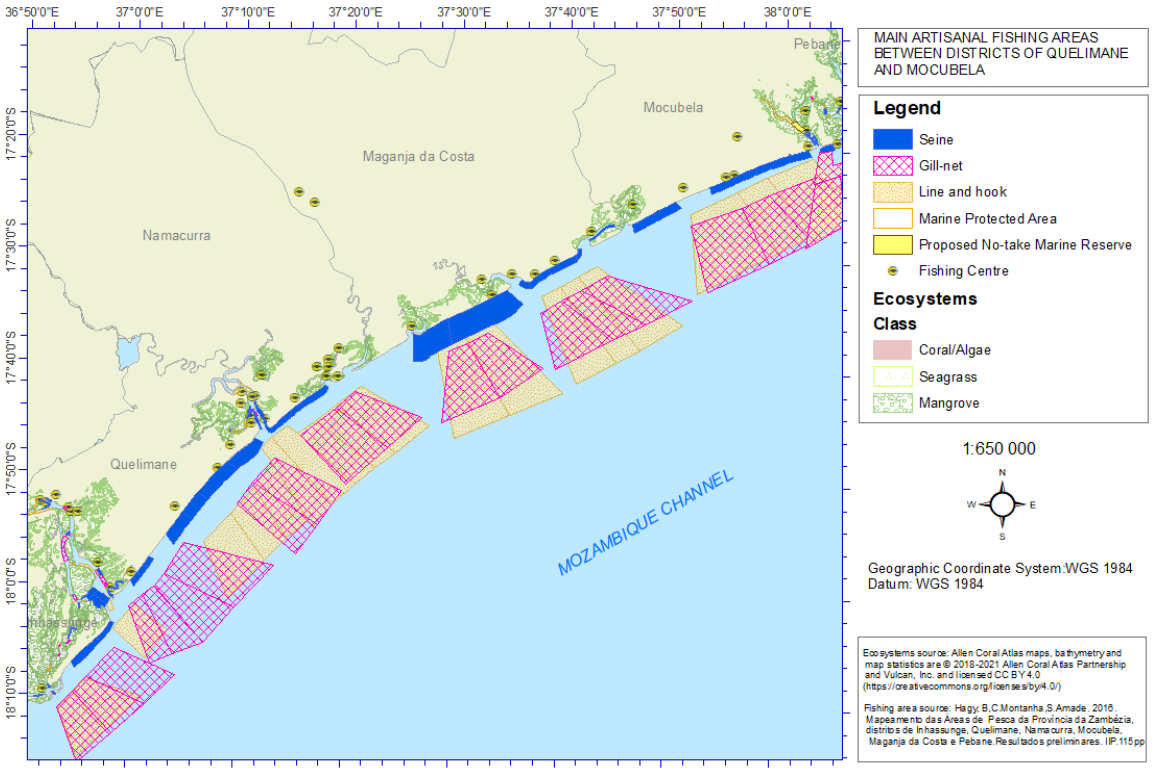
Quelimane to Mocubela. In this region, there are large concentrations of beach seines along the coast. This area is also characterized by many rivers and estuaries, which makes accessibility to remote areas along the coastline a challenge for fishers. In some cases, they prefer exploring the estuaries rather than going offshore. This can be noted as majority of the fishing centers are in estuaries. Fishers who use gillnet and line and hook offshore explore the same areas and have the same landing sites on the coast. The fishing area pattern shows overlap between these two fishing gears (Figure 13).

Chinde to Inhassunge. This region shows the role of rivers and estuaries as alternative fishing grounds. The lowest artisanal fishing operation offshore of all mapped areas was observed in this region. The use of gillnet in Chinde is quite localized, with small fishing grounds identified along the coast and at the mouth of rivers. Beach seine is mostly concentrated near river mouths in both districts. Chinde seems to be a fishing area explored exclusively using line and hook without any overlap of other fishing gears. In Inhassunge, there is a larger fishing area reported for artisanal fishing, probably due to its proximity to the Zambezia capital city of Quelimane (Figure 14).



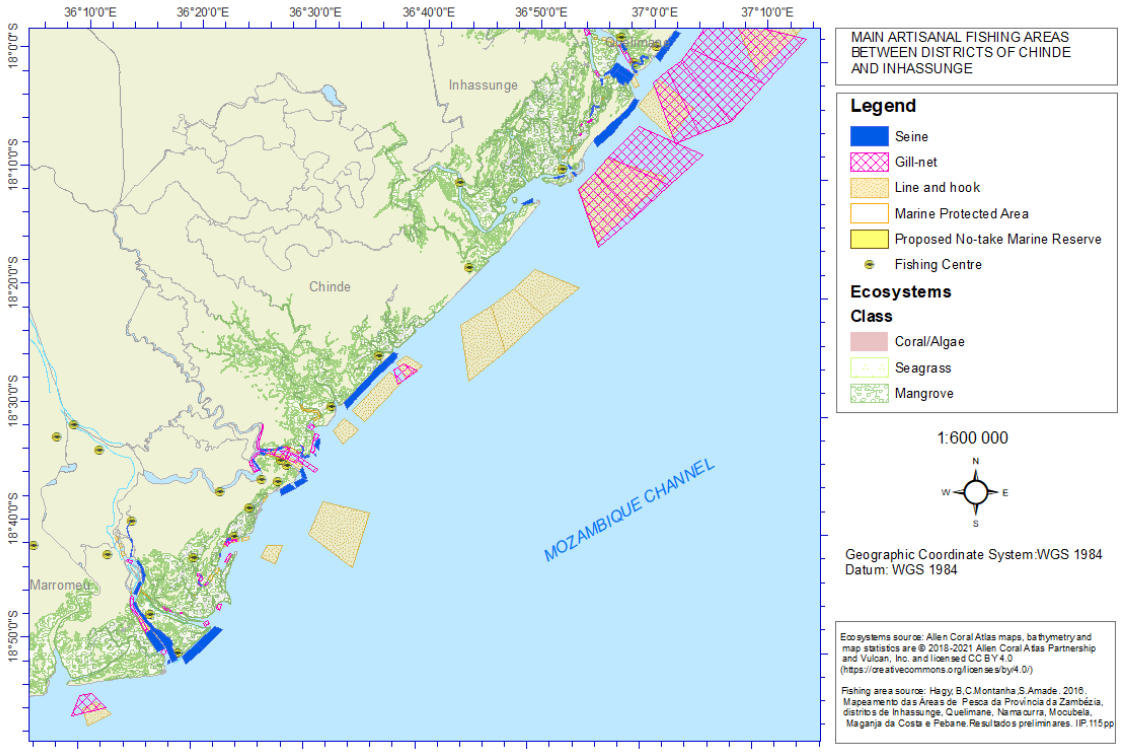
(Source: Adapted from Hagy and Montanha, 2020)

Figure 12. *Fishing ground from Moma to Angoche*



(Source: Adapted from Hagy et. al, 2020)

Figure 13. *Fishing ground from Quelimane to Mocubela*



(Source: Adapted from Hagy et. al., 2020)

Figure 14. *Fishing ground from Chinde to Inhassunge*

4.2.3 STOCK ASSESSMENT

Trend Analyses

The monitoring indicators available in fishing statistics are annual catches, fishing effort, and catch per unit of effort. The combined catches of Nampula and Zambezia in 2019 were 140,619 metric tons, which represented 54 percent of the national marine fishing catch for that year. Beach seine, surface gillnet, and purse seine had the greatest contribution to the global catches of the two districts (Table 10). The fishing effort was higher for handline (hook and line) followed by gillnet and beach seine (Table 11).

Table 10*. Contribution of catches of artisanal fishing in Nampula and Zambezia by fishing gear in year 2019.*

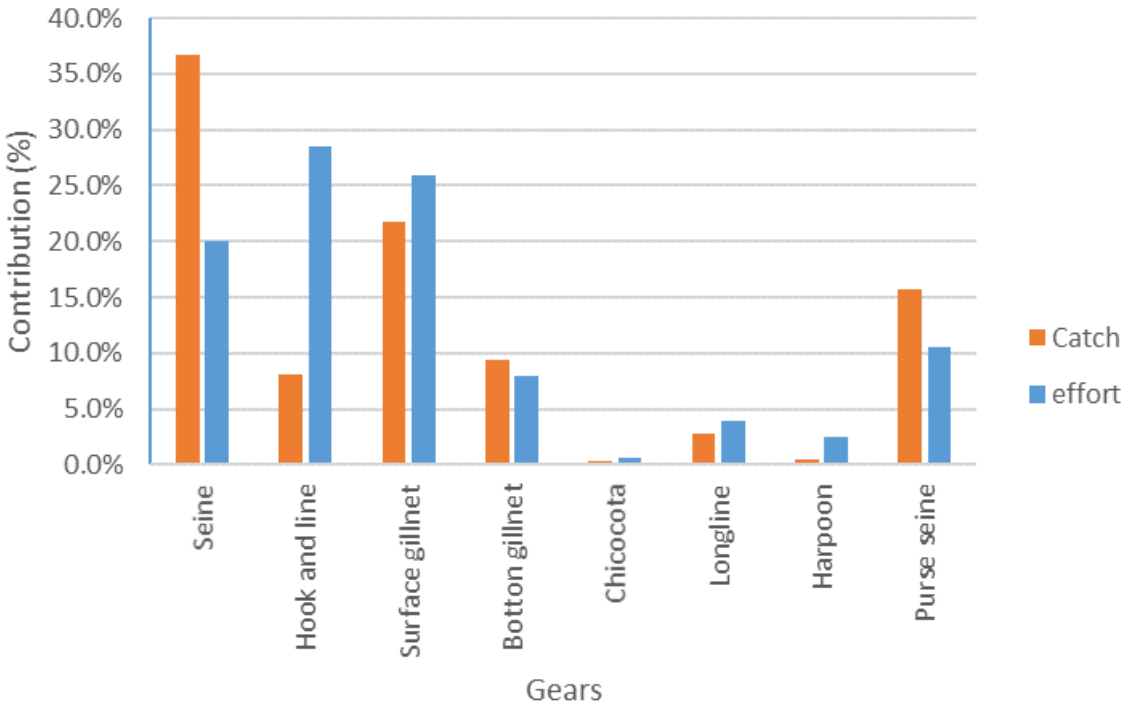
Gears	Nampula Catch (MT)	Zambezia Catch (MT)	Nampula and Zambezia Combined Catch (MT)	% in Marine National Catch
Seine	27.250	24.391	51.641	20.0
Hook and line	7.775	3.604	11.378	4.4
Surface gillnet	12.905	17.697	30.602	11.9
Bottom gillnet	793	12.334	13.126	5.1
Chicocota	0	467	467	0.2
Longline	0	4.019	4.019	1.6
Harpoon	594	0	594	0.2
Purse seine	22.038	0	22.038	8.5
Trap	136	0	136	0.1
By-catch*	1.290	5.327	6.617	2.6
Total	***72.780***	***67.838***	***140.619***	***54.00***

(Source: Adapted from SNAPA, 2019)

***Table 11**. Contribution of artisanal fishing effort in Nampula and Zambezia, by fishing gear in year 2019*

Gears	Nampula	Zambezia	Nampula and Zambezia Combined	Contribution (%) in Both Provinces
Seine	140.619	279.439	420.058	20.1%
Hook and line	478.364	117.222	595.587	28.4%
Surface gillnet	255.183	286.368	541.551	25.9%
Bottom gillnet	47.954	117.645	165.599	7.9%
Chicocota	-	13.464	13.464	0.6%
Longline	-	83.890	83.890	4.0%
Harpoon	53.663	-	53.663	2.6%
Purse seine	219.836	-	219.836	10.5%
Trap	-	-		0.0%

(Source: Adapted from SNAPA, 2019)



(Source: Adapted from SNAPA, 2019)

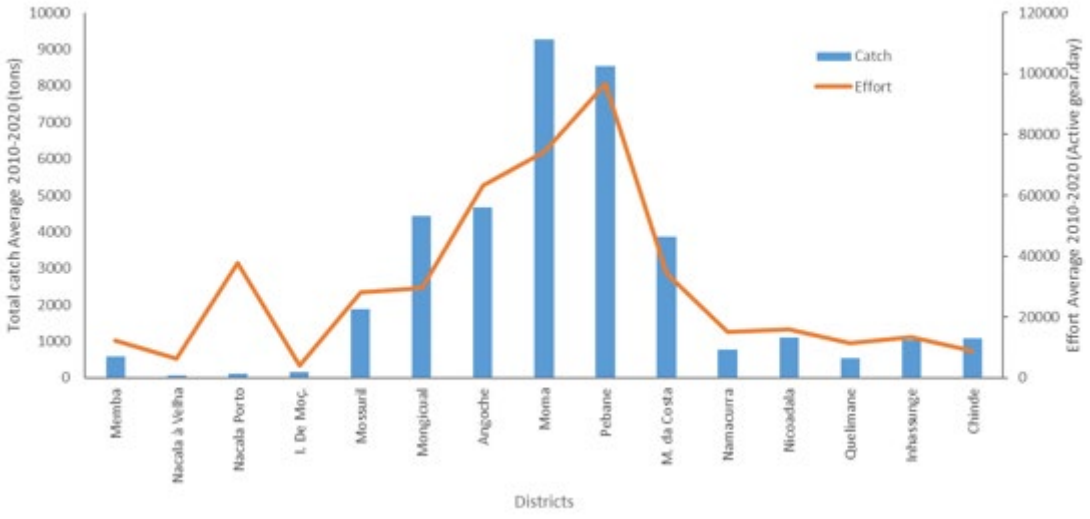
***Figure 15.** Contribution of fishing catch and effort (%) by fishing gear in Nampula and Zambezia in 2019*

Beach seine, surface gillnet, hook and line, bottom gillnet, and purse seine were selected for analysis of trends and general assessment of fisheries based the criteria that they represent 5 percent or more in overall catches and effort reported in 2019 (SNAPA, 2019; MIMAIP, 2020 b).

Beach seine

Beach seining is an active fishing gear and works according to the tidal ranges. Usually, the operation starts in low tides. The net size, mesh size, and cable used vary widely between and within regions. Over 5.268 fishing gears are involved in this activity in the two provinces (MIMAIP, 2020 b).

Average catch (metric tons per year) and fishing effort (active gears per year) indicate that Moma (in Nampula) and Pebane (in Zambezia) were the districts with more activity and fishing production (Figure 16).

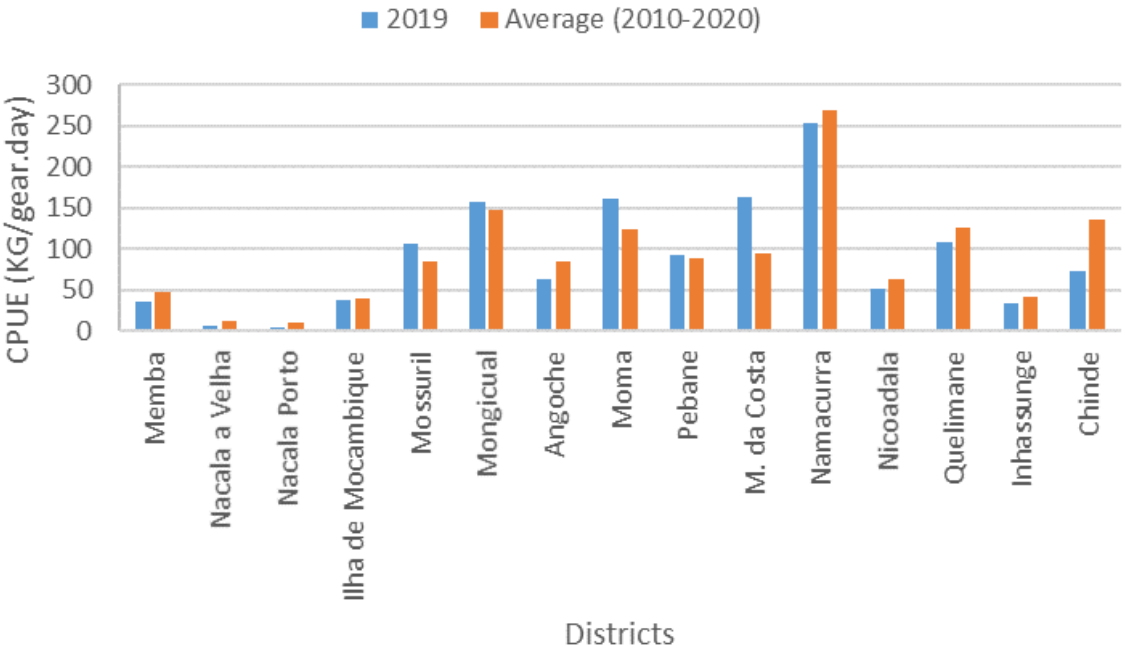


(Source: Adapted from SNAPA, 2010-2020)

Figure 16. *Average beach seine catch (2010-2020) in metric tons and average fishing effort (2010-2020) from active gear.day in the coastal districts of Nampula and Zambezia. Note: Districts arranged from north to south.*

Average beach seine CPUE ranged from 11 kilograms per gear.day in Nacala Velha to 269 kilograms per gear.day in Namacurra. The districts lying in Sofala Bank (from Mogincual to Chinde) observed the highest CPUEs with values above 50 kilograms per gear.day (Figure 17).

In catch rates (CPUE), the year 2019 was used as a reference and a comparison was made with the average for the period 2010 to 2020. The data indicate that in the districts of Memba, Nacala Velha, Nacala Porto, Angoche, Nicoadala, and Inhassunge, CPUE was lower in 2019 compared to the average for the ten-year period. These results could suggest overfishing in those districts (Figure 17).



(Source: Adapted from SNAPA, 2010-2020)

Figure 17. *Beach seine CPUE between the reference year (2019) and the average of the period (2010-2020)*

Beach seine catches and fishing effort data from the available series (2010-2020) were also graphed by district (Figure 18). The data shows positive trends in catches in Mossuril, Angoche, Moma, Pebane, Maganja da costa, Namacurra, Nicoadala, Quelimane, Inhassunge, and Chinde. Beach seine catches decreased over time in Nacala Velha and Ilha de Mozambique. In Memba, despite a significant increase in 2020, the trends of the last six years were stable, and above the 2011-2012 lowest values. In Nacala Porto, after an increase in catches between 2015 and 2018, they fell in 2020 back to similar levels observed from 2010 to 2013. For this district, catch has decreased due to fishery performance in the last two years.

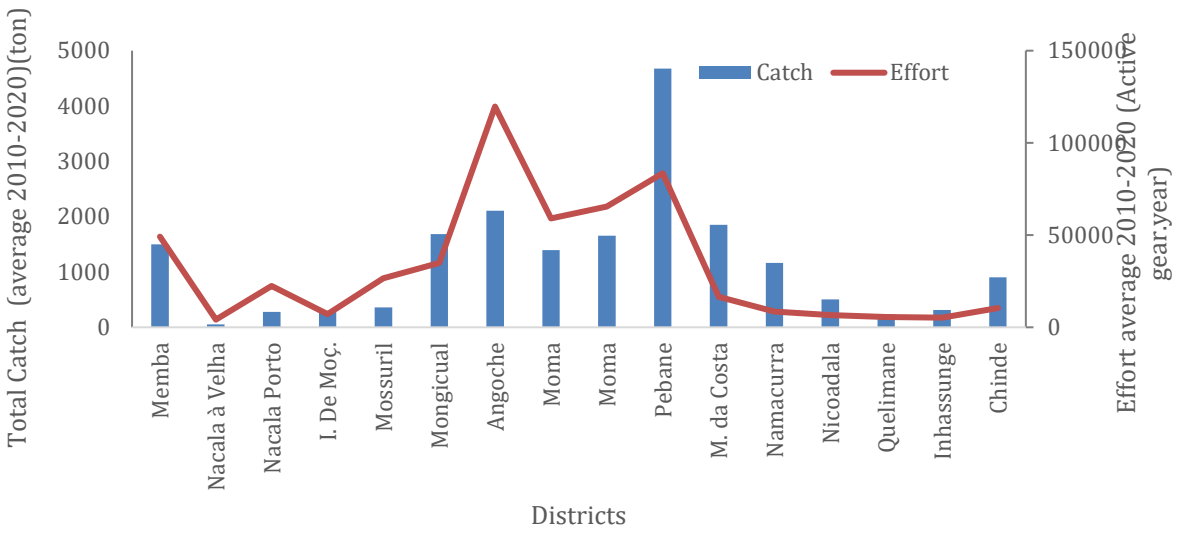
The beach seine fishing effort increased over time in Memba, Nacala Velha, Namacurra, Nicoadala, and Chinde. While in the districts of Nacala Porto, Ilha de Mozambique, Mossuril, Angoche, and Maganja da Costa, the fishing effort was reduced over time. Mogincual had fluctuations but with a general tendency of increased effort. For Pebane and Inhassunge, there were not many fluctuations in the effort, considering that this is stable. In Moma, the fishing effort has fluctuated around 70,000 to 80,000 active gears per year (Figure 18).

(Source: Adapted from SNAPA, 2010-2020)

Figure 18. *Trends in beach seine annual catches and fishing effort in the coastal districts of Nampula and Zambezia between 2010 and 2020*

Surface Gillnet

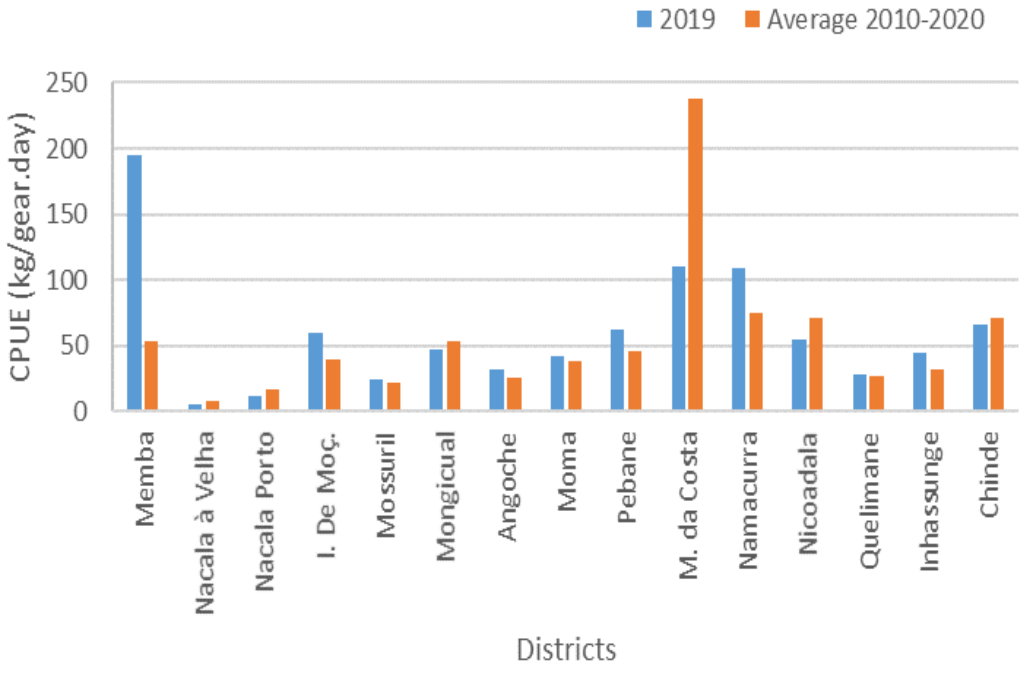
Surface gillnet was recorded in all districts of the two provinces. The highest activity was observed in the central region of the study area between the districts of Mogincual in Nampula and Pebane in Zambezia. The catches show a similar trend to the effort, with the lowest levels to the south of Maganja da Costa. The district of Angoche was the one with the greatest surface gillnet fishing effort, and the district of Pebane the highest average catch (Figure 19).



(Source: Adapted from SNAPA, 2010-2020)

Figure 19. *Average catch (2010-2020) in metric tons and average effort (2010-2020) from active surface gillnet (gears per day) in the coastal districts of Nampula and Zambezia of surface gillnet fishing*

The average surface gillnet CPUE highly fluctuated from 8 to 250 kilograms per day. Nacala Bay (Nacala Porto and Nacala Velha) had the lowest rates and Maganja da Costa an extremely high value, compared to the other districts. Note that the southern region of the study area, between Maganja da Costa and Chinde, recorded higher catch rates (Figure 20).



(Source: Adapted from SNAPA, 2010-2020)

Figure 20. *Average CPUE of reference year (2019) and average for the period (2010-2020) for surface gillnets*

The surface gillnet CPUE in the reference year (2019) was higher than the average CPUE for the time series period 2010-2020, in the districts of Memba, Ilha de Mozambique, Pebane, Namacurra, and Inhassunge. This is an indication of a positive trend.

Surface gillnet trend analysis for the entire time series is shown in Figure 21 by district. Catches increased over time in 10 of the 15 districts in the two provinces, progressively with a clear geographical indication in the districts of Sofala Bank region (Moma to Chinde). The other districts outside Sofala Bank with increased catches were Memba and Nacala Porto, the districts to the north of the study area. Nacala Velha showed a downward trend. In the districts of Ilha de Mozambique, Mossuril, and Angoche, there were fluctuations over time.

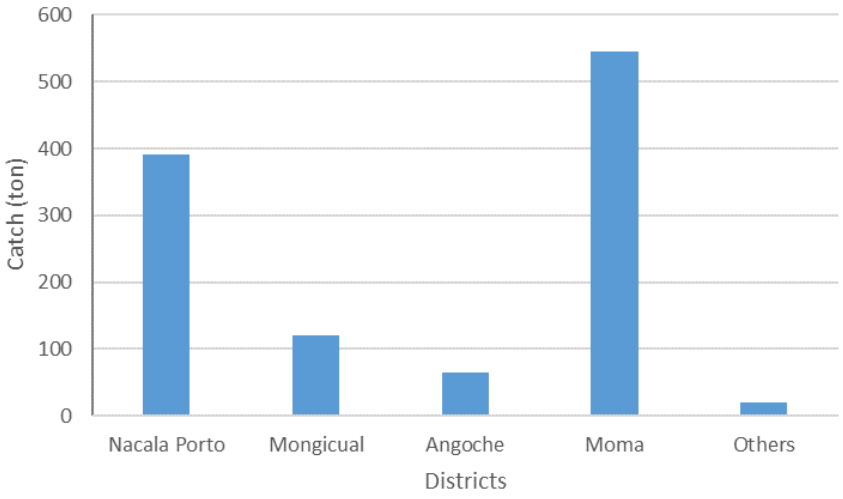
Fishing effort showed a sharp or slight upward trend in all districts, except for Nicoadala, which showed no pattern, and Nacala Velha where effort decreased (Figure 21).

(Source: Adapted from SNAPA, 2010-2020)

Figure 21. *Trends in surface gill net annual catches and fishing effort in the coastal districts of Nampula and Zambezia between 2010 and 2020*

Bottom Gillnet

The bottom gillnet was only recorded in Nampula fisheries statistics. Data is scarce and it is not possible to analyze trends over time. Moma district contributes the most catch of all coastal districts in Nampula. Catch rates ranged from 5 kilograms per gear.day in Nacala Velha to 121 kilograms per gear.day in Angoche (Figure 22).



(Source: Adapted from SNAPA, 2010-2020)

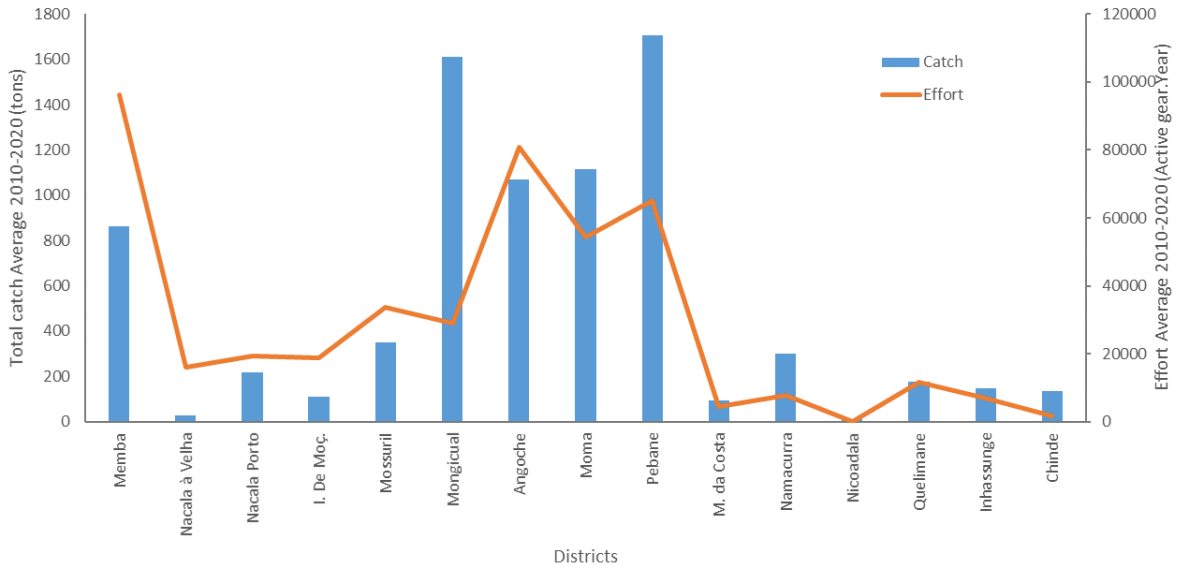
***Figure 22**. Average annual bottom gillnet catches (tons) in Nampula districts*

Line and Hook (Handline)

The handline is made up of a monofilament thread, containing at its end one or more hooks of varying size according to the specialization of fishing. The most used bait in the region is horse mackerel (*Decapterus sp*). There is also reference to the use of squid as bait, nematodes, and other fish. For catching pelagic species (tuna and tuna-like species), fishers prefer fresh bait such as horse mackerel. The operating time of handlines varies but generally fishers stay at sea for a period of eight to ten hours, preferring night fishing in Nacala, but there are references to fishing operations that last more than two days (*e.g.,* Angoche).

The difference for capturing the target species depends on the type of bait used, the lead but mainly on the length of the line and the distance between hooked lines. The type of tide is not decisive for these fisheries, according to opinions of the fishermen, the weather (winds) being a condition for the operation of this gear (line of hand and longline).

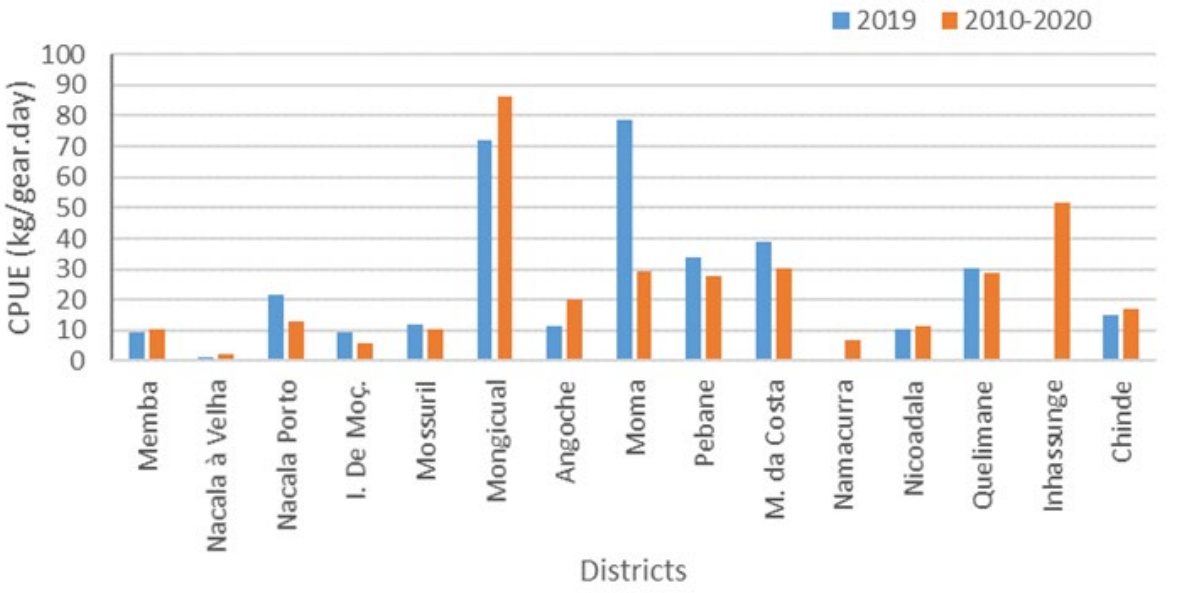
Overall data from the districts show that the highest catches are observed in the central region of the study area (between Mogincual and Pebane), but there is also a significant catch of line fish resources in Memba (Figure 23). The occurrence of coral reefs in the North of Nampula and in the Primeiras e Segundas archipelago can justify this observation.



(Source: Adapted from SNAPA, 2010-2020)

Figure 23. *Average line and hook catches (metric tons) and average fishing effort (active gears per day) for the period (2010-2020) and coastal districts of Nampula and Zambezia*

The line and hook CPUE ranged from 80 kilograms per gear.day in Mogincual to a minimum of two kilograms per gear.day in Nacala Velha. These variations may be related to the type of vessel used (canoe in Nacala with only one fisher, while in Mogincual, fishing is done using boats with more fishers). CPUE data confirm that the central region from Mogincual to Namacurra has the best average yields per vessel (Figure 24).



(Source: Adapted from SNAPA, 2010-2020)

Figure 24*. Average CPUE of reference year (2019) and average for the period (2010-2020) for line and hook*

In general, the reference year 2019 was not very productive for angling, in comparison to the average of the time series. Eight of the 15 districts presented values below the district average for 2019, with higher productivity in the center and south of the studied region. The districts with warning signs (using trend analysis) in 2019 were Nacala Velha, Mogincual, and Chinde. In Namacurra and Inhassunge, the government did not record data for line and hook in 2019, which does not mean, however, that this activity did not occur (Figure 24).

Trends in annual catches and fishing effort by district is shown in Figure 25. There is an increase in fishing effort over the time series in the districts of Memba, Angoche, and Moma, apparently related to the development and promotion of programs for open sea fisheries by the government. Catches also increased over time in Ilha de Mozambique, Angoche, Moma, Maganja da Costa, Quelimane, and Chinde. For this fishery, the analysis of trends (especially effort) is difficult to interpret and may be associated with the weakness of government data collection to quantify this indicator as mentioned by previous observations in other regions of the country (Santana Afonso and Mafuca, 2001).

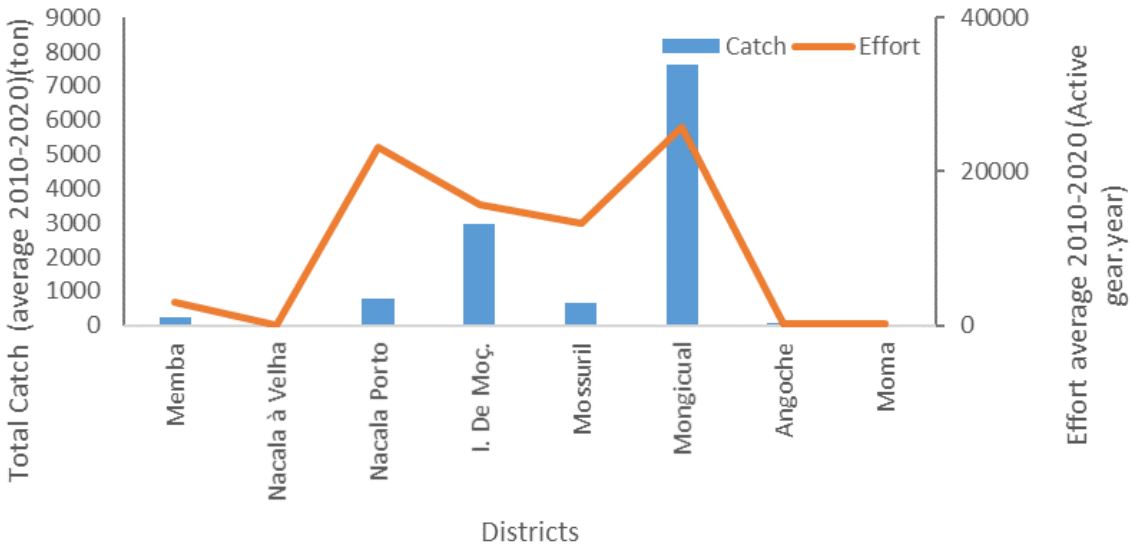
(Source: Adapted from SNAPA, 2010-2020)

Figure 25. *Trends in hook and line annual catches and fishing effort in the coastal districts of Nampula and Zambezia between 2010 and 2020*

Purse seine

Purse seines are only observed in Nampula. These can be confused on the ground with the trawl net if the fishing operation is not observed. Generally, the activity is carried out off the coast in clean waters, with variations depending on the physical conditions of the region.

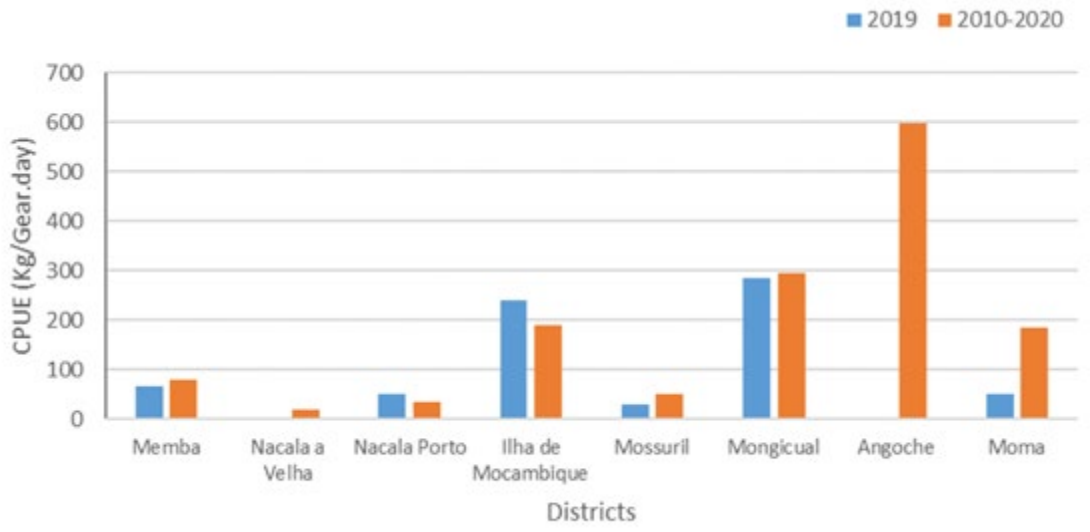
The registration of fishing gear in Nampula represents a coverage of only 1.2 percent corresponding to 274 units throughout the province (Table 8). The quality and quantity of fisheries statistics are insufficient to analyze trends over time. With the available information, it was observed the districts with the greatest activity were Nacala Porto, Mossuril, Ilha de Mozambique, and Mogincual. The largest catches were observed in Mogincual and Ilha de Mozambique, with values above 2,000 metric tons per year. These places are outside Sofala Bank have more transparent and lipid waters and are more suitable for the operation of the purse seine. In Angoche and Moma, although there is purse seine activity, their contribution to capture was negligible, with annual values between 50 metric tons per year (in Moma) and 177 metric tons per year (in Angoche) (Figure 26).



(Source: Adapted from SNAPA, 2010-2020)

Figure 26. *Average annual catch and fishing effort for the period (2010-2020) for purse-seines in Nampula districts*

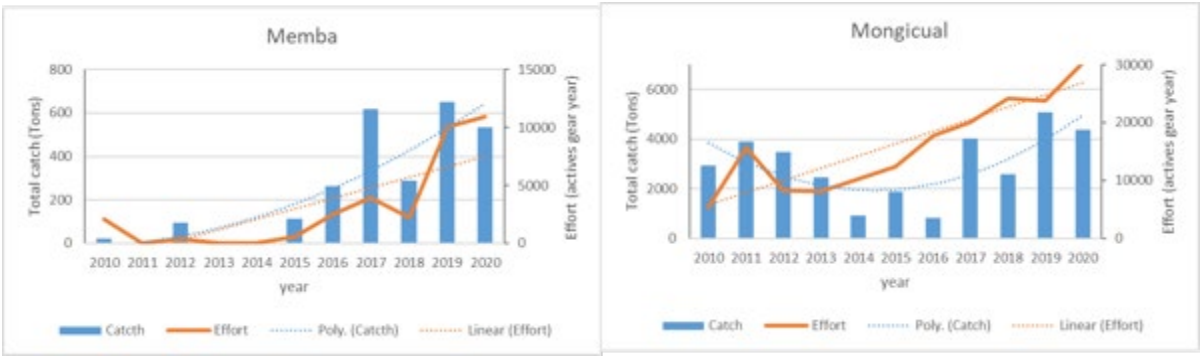
Historical purse seine CPUE ranged from 17 kilograms per gear.day (Nacala Velha) to 600 kilograms per gear.day in Angoche (Figure 27). The highest catch rates are between the Ilha de Mozambique and Angoche, with Mogincual being the main fishery for the purse seine.



(Source: Adapted from SNAPA, 2010-2020)

***Figure 27**. Average CPUE of reference year (2019) and average for the period (2010-2020) for purse seine*

There are no complete data sets for all districts and therefore it is not possible to assess the trend for the purse seine fishery in the study area. For the districts where it was possible (Memba and Mogincual) there is an increase for fishing effort in both districts catches have also increased over time in Memba, and in the last 4 years in Mogincual (Figure 28). The purse seine requires efficient and quick operation. One of the factors that can influence the performance of this fishery is the lack of engines on the boats, not allowing them to reach areas with great opportunities for fishing resources.



(Source: Adapted from SNAPA, 2010-2020)

***Figure 28.** Trends in purse-seine annual catches and fishing effort in the coastal districts of Nampula between 2010 and 2020*

Other Gears and Fishing Methods

Unreported, illegal, and undocumented gears and methods

There are fishing gears in the region that are not being reported because they are not licensed and authorized in Mozambique. Despite the lack of numbers available, during the field work, it was possible to verify a significant number of them, popular due to their associated low cost of operation. Many of these fishing gears operate overnight and have been subject to surveillance and seizure by the fishing authorities and CCPs.

Chicocota. *Chicocota* is a passive gear (stow net) that emerged in the province of Sofala and expanded to other regions. This gear functions as a fixed physical barrier to the resource and usually placed in canals or in areas with large tidal current for a long time at the same place in rows. These nets are fixed by means of anchors or stakes, placed according to the direction and strength of the current. In the beginning (around 2004), the practitioners of this gear used remnants of nets of industrial shrimp fishing, but currently use the same net used in beach seines. The product of this gear serves for self-sustenance and marketing. The main species captured in *Chicocotas* include juvenile fishes including the *Engraulididae* (anchovies), shrimp, and sable fish or cutlassfish (Rare, 2021).

This "gear" is operated exclusively by men in all districts of Zambezia. In Nampula, there is some involvement of women in this activity. Together with quinias, chicocotas are easier and cheaper to operate than other gears and are used on shallow banks/beach and river mouths. *Chicocota* may or may not use small, rudimentary fishing vessels.

Quinias and the use of insecticide-treated bed nets. *Quinias* is a fishing gear with the same characteristic as a drag net but without the bag and with very reduced mesh dimensions. In some places they use cloth or even mosquito nets to arm the net. All over Mozambique, this "gear" is used by women and children, usually during the low tide. Usually, the net is operated by two people and the main species caught are the juvenile shrimps, crab, squid, and fish of very small size. The product of this activity is for self-sustaining and is associated with extreme levels of poverty and food security in the region. In Zambezia, this is used by men, while in Nampula, it is basically an activity involving women and children. In some places in Zambezia, it was possible to observe in some *quinias*, mosquito nets for hospital use, which are most commonly distributed to households through mass campaigns approximately every three years. Interviewees during the field work reported that there is a black market for these nets, that are traded at an equivalent price of $1.5 a unit that are used mostly in *quinias*. Many of these nets are insecticide-treated bed nets. Insecticide-treated bed nets (ITNs) are a form of personal protection that has been shown to reduce malaria illness, severe disease, and death due to malaria in endemic regions such as Zambezia and Nampula. In community-wide trials in several African settings, ITNs were shown to reduce the death of children under 5 years from all causes by about 20% (www.CDC.gov/malaria). CDC further states that only two insecticides classes are approved for use on ITNs (pyrroles and pyrethroids). While these insecticides have been shown to pose very low health risks to humans and other mammals, they are toxic to insects, aquatic life in particular crustaceans and fish (Werner and Moran, 2008). Haya (1989) in his extensive review on the toxicity of pyrethroids, has confirmed that they are extremely toxic to fish, with acute lethality suggesting its effects on the nervous system, respiratory surfaces, and renal ion with more sensitivity on early juvenile fish and newly hatched larvae. Exposures of fish to sublethal concentrations of pyrethroids have also resulted in decreased growth and impaired swimming performance. The effects on bioenergetics and energy metabolism are variable. Further research is needed to clarify the possible risks associated with long-term environmental exposure to pyrethroids (Saillenfait et al 2015).

*Figure 29. **A** - Quinias and the use of insecticide-treated bed nets; **B** - Typical catch: juvenile fish and small shrimps*

***Rede boleia* net.** This is a miniature beach seine used to catch the fish that escapes in the beach seine in operation. This gear has no bag, and has small mesh size, being able to use mosquito nets. It is an opportunistic activity, carried out by young people and children, who are waiting for the trawl hauls (to the beach) to approach it while on shallow water to place their gear after the beach seine while small fish escapes from the meshes. Catches of this gear depend directly on the catches of the beach seine and the "product" is used primarily for family self-sustenance.

*Figure 30. **A** - Typical multi-species catch from beach seines; **B** - Typical catch of surface gillnets composed of small pelagic fish*

Collection of invertebrates. A secular activity in the country and in the region, usually practiced by women and children, collection of invertebrates occurs normally during low tides in banks of seagrass to collect various invertebrates. The number of women and children involved in this activity is unknown. In Ilha de Mozambique, it was observed during the low tide, with about 20 people collecting invertebrates in small stretches. In Mocubela (Zambezia), women use hoes or other objects to collect organisms that are buried in the substrate. Several species have been observed with the most common being bivalve mollusks (the clam *Meretrix meretrix*), sea urchins (*Tripneustes gratilla*) (were reported in Nacala Porto, by Fernando, 2011, who also reported similar species in Ilha de Mozambique and Mossuril. Swimming crab (*Portunus pelagicus*) and the mangrove horn (*Terebralia sp*) are also common. The latter species was associated with a crab fishing and crab fattening system.

Octopus fishing. Identified in two variants for octopus fishing in the region. In the first and second islands, the depth for activity varies from five to ten meters in places quite distant from the coast. The

"octopus catch" is made exclusively by men, who dive on coral reefs or rocky areas, with blunt objects to capture the resource. The other variant, observed in Memba, involves only women, who move to shallow water areas and with the aid of a harpoon or iron, to collect the octopus without the need to dive.

Crab fishing. Mangrove crab fishing *(Scylla serrata)* in recent years has come under great pressure with the emergence of Asian companies dedicated to buying and exporting this crustacean. The estimated number of people who catch crab in the two provinces is 7,963, all men. The districts with the largest people involved in the capture according to a study by Filipe *et. al.*, (2020) are Chinde, (in Zambezia), Moma, and Angoche (in Nampula) contributing with 50 percent of fishers of the study area. Fishing is made during low tide, with the use of a line or directly by harvesting by hand in areas of mangrove or near these ecosystems. The annual catch of mangrove crab was estimated at about 14,600 metric ton per year.

Foreign capital companies, which are engaged in the purchase of crabs, have set up collection and buying stations in some districts, thus exerting great pressure on the harvest of local communities. The product is transported alive, mostly to China, but in the process of shipping, the "crustacean" is fed to maintain its physiological conditions. Verbal reports indicated enormous pressure from (mangrove horn *Terebralia*), traditionally captured by local communities in Zambezia and used for food, and now became crab food during export.

Due to the pressure exerted by *the Scyla serrata* trade, a seasonal closure for this resource during the period of three summer months was enacted by the national government in 2019.

Main Species in Artisanal Fisheries

The species data were compiled by geographical region, according to coastal type (Table 12).

Table 12. *Species composition (main species and others more important) by region for beach seine, hook and line, and surface gillnet in Nampula and Zambezia*

	Beach Siene		**Hook and line**		**Surface gillnet**	
Area	***Species***	***Others minor Species***	***Species***	***Others minor Species***	***Species***	***Other minor Species***
1. Coraline coast: Memba-Mongincual	*Decapterus sp (25%)* *Sardinella sp (10%)* *Megalaspis cordyla (8%)* *Alepes djedaba (6%)*	*Gazza minuta* *Upeneus vittatus* *Sphyraena barracuda* *Scomberoides lysan* *Sillago sihama* *Loligo forbesi (squid, 4%)* *Rastrelinger kanagurta*	*Canrax sp. (41%)* *Lethrinus sp. (22%)* *Lutjanus sp. (9%)*	*Somberomorus commerson* *Loligo forbesi* *Siganus sutor* *Gerres oyena* Sillago sihama *Epinephelus ongus*	*Chirocentrus sp (49%)* *Decapterus kurroides (12 %)* *Hemiramfhus far (10%)*	*Scomberoides sp* *Scomberomorus sp* *Rastrelliger kanagurta* *Megalaspis cordyla* *Sphyraena jello* *Polynemus plebeius*

2. Estuarine coast Sofala Bank-North: Angoche-Moma	*Trichiurus lepturus Penaeus indicus** Acetes erythraeus** Pellona ditch ela*	*Sardinella albella Megalaspis cordyla Pomadasys sp Somberomorus commerson Sillago sihama Upeneus vittatus*	*Somberomorus commerson Sillago sihama*	*Pomadasys sp*	*Sardinella albella Hilsa kelee Trichiurus lepturus*	*Otolithes ruber* Sillago sihama *Pellona ditchela Upeneus vittatus*
3. Estuarine coast Sofala Bank-central area: Pebane-Nicoadala	Engraulididae (28%) *Acetes erythraeus** (25%) Penaeus indicus* (12%)*	*Otolithes ruber Johnius dussumieri Pellona ditchela Pleisonika martia** Hilsa kelee Polynemus sextarius Hemiramfhus far (9%)*	*Pomadasys kaakan (38%) Arius dussumieri (35%) Otolithes ruber (15%) Umbrina canariensis (15%)*	*Muraenesox bagio*	*Pelona ditchela (21%) Thyrssa vitrirostris (15%) Trichiurus lepturus (13%) Polynemus sextarius (11%)*	*Otolithes ruber Hilsa kelee Sardinella albella Upeneus vittatus Johnius dussumieri*
4. Estuarine Coast Sofala Bank South: Quelimane-Chinde	*Johnius dussumieri (26%) Engraulididae (20%) Arius dussumieri (16%) Hilsa kelee (14%)*	*Otolithes ruber Pomadasys kaakan Trichiurus lepturus Acetes erythraeus** (5%) Sardinella albella Pellona ditchela Penaeus indicus** (2%) Lobster Himantura gerrardi*	*Pomadasys kaakan (38%) Arius dussumieri (35%) Johnius dussumieri (40%)*	*Otolithes ruber Himantura gerrardi*	*Hilsa kelee (62%) Arius dussumieri (15%) Trichiurus lepturus (11%)*	*Pomadasys kaakan Himatura gerrardi Johnius dussumieri*

(Source: Adapted from IIP, 2017, IIP, 2019)

**shrimp

Beach seine. Trawling is the least selective gear in the region and the one that captures the most species in total. The main group caught are the small pelagic fishes, including anchovies (Engraulididae), sardines (*Sardinella sp, Pellona ditchela*) and scad or horse mackerel (*Decapterus sp*) in all regions. In Sofala Bank (areas 2, 3, and 4), in addition to small pelagics fishes, there are significant contributions from shrimp and species associated with estuaries such as croakers (*Otolithes ruber, Johnius dussumieri*).

Hook and line. The species caught in the hook and line were mostly from rocky bottoms (*Lethrinidae* and *Lutjanus sp*) and large pelagic (*Caranx sp.*) in area 1 (Memba-Mogincual). In the other regions, the species captured are demersal fish associated with estuarine environments (croakers and catfish).

Surface gillnet. The surface gill caught mainly small pelagic fish species such as horse mackerel (*Decapterus sp*), sardines (*Hilsa kelee, Pelona ditchela*), largehead hairtail, also known as sable fish or cutlassfish (*Trichiurus lepturus*), in all areas. Between Pebane and Quelimane (area 2, 3, and 4), shrimp and species associated with shallow water shrimp such as croakers (*Johnius dussumieri, Otolithes ruber*) and catfish (*Arius dussimieri*) are caught.

STOCK STATUS FOR ARTISANAL FISHERIES

Stock assessment for this multi-species and multi-gear artisanal fisheries was done for three of the main fishing gears, namely beach seine, surface gillnets and line and hook. Surplus production modeling was combined with trend analysis of the annual monitoring indicators, fishing effort, catch and CPUE.

Beach Seine

The results of the surplus production model to assess stock status shows that beach seine is in a state of overfishing in the districts of Memba, Nacala Velha, Nacala Porto, Angoche, Maganja da Costa, Namacurra, and Quelimane, where the current fishing effort is above the fishing effort that produces sustainable catch (fMSY) (Table 13). While monitoring indicators do not always corroborate, the CPUE generally supports the model findings. Where catches show a positive trend, can be a result of increases in fishing gears, but not as an indication of availability of the stocks.

Table 13. *Stock assessment results for resources accessible to beach seines*

Districts	Trends 2010-2020			Surplus Model (Schaefer)					Overall Status
	Effort	Catch	CPUE	MSY	Ycurr	fMSY	fcurr	fcurr/fMSY (<0.75)	
Memba	+	-	-	575	506	16950	13878	0.8	Over-exploited
Nacala -a- velha	-	-	-	88	68	9889	11320	1.1	Over-exploited
Nacala porto	+	-	-	361	275	42500	73722	1.7	Over-exploited
Ilha de Moc	-	-	=	301	143	12275	3797	0.3	Optimal
Mussoril	-	+	+	3557	2503	71286	23682	0.3	Optimal
Mogincual	+	+	+	3091	1777	19656	9375	0.5	Optimal
Angoche	-	+	-	5515	5953	78278	92435	1.2	Over-exploited
Moma	=	+	+	10363	10414	101800	57761	0.6	Optimal
Pebane	=	+	+	11564	11149	196333	119377	0.6	Optimal
Maganja da Costa	-	+	+	1944	3093	18000	18967	1.1	Over-exploited
Namacurra	+	+	-	607	1516	17425	14943	0.9	Over-exploited
Quelimane	+	+	-	570	573	11938	13963	1.2	Over-exploited
Inhassunge	-	+	-	na	na	na	na	na	na
Chinde	+	+	-	na	na	na	na	na	na

(+ Increase; - Decrease; Red Pressure signal; Green Healthy fisheries; na=data deficient; MSY=Maximum sustainable yield; Ycurr=current catch in 2019; fcurr=current fishing effort in 2019; fMSY=fishing effort that produces MSY)

Surface Gillnet

Angoche, Moma, Maganja da Costa, Namacurra, and Quelimane showed signs of overfishing in surface gillnet based on the surplus production model (Table 14). The trend of increasing fishing effort over time in almost all districts may indicate a certain pressure in the medium-long term for the target resources of this fishery if additional measures are not taken to manage the fisheries.

Table 14. Stock assessment results for resources accessible to surface gillnets

Districts	Trends 2010-2020			Surplus Model (Schaefer)					Overall Status
	Effort	Catch	CPUE	MSY	Ycurr	fMSY	fcurr	fcurr/fMSY (<0.75)	
Memba	+	-	+	842	5263	45875	27040	0.6	Optimal
Nacala -a- velha	-	+	-	na	na	na	na	na	na
Nacala porto	+	+	-	439	340	33125	26262	0.8	Optimal
Ilha de Moc	+	+	+	301	390	12275	6488	0.5	Optimal
Mussoril	+	+	-	1022	763	71500	30656	0.4	Optimal
Mogincual	+	+	-	2792	1777	23630	9375	0.4	Optimal
Angoche	+	na	-	5515	2889	78278	88841	1.1	Over-exploited
Moma	+	+	+	9716	10414	69700	57761	0.8	Over-exploited
Pebane	+	+	+	10225	7419	357500	118639	0.3	Optimal
Maganja da costa	+	+	-	1429	3093	18900	18967	1.0	Over-exploited
Namacurra	+	+	+	222	2178	7450	11166	1.5	Over-exploited
Quelimane	+	+	-	220	219	8567	7820	0.9	Over-exploited
Inhassunge	+	+	+	na	na	na	na	na	na
Chinde	+	+	-	na	na	na	na	na	na

(+ Increase; - Decrease; Red Pressure signal; Green Healthy fisheries; na=data deficient; MSY=Maximum sustainable yield; Ycurr=current catch in 2019; fcurr=current fishing effort in 2019; fMSY=fishing effort that produces MSY)

Hook and Line

Hook and line shows signs of overexploitation in Memba, Nacala Velha, Pebane, and Quelimane based on the surplus production model (Table 15). Data coverage was poor in a number of districts which did not allow an assessment.

Table 15. Stock assessment results for resources accessible to hook and line

	Trends 2010-2020			Surplus Model (Schaefer)					Overall Status
Districts	Effort	Catch	CPUE	MSY	Ycurr	fMSY	fcurr	fcurr/fMSY (<0.75)	
Memba	+	+	+	1053	1263	132500	130592	1.0	Over-exploited
Nacala -a- velha	na	na	-	56	43	43333	38352	0.9	Over-exploited
Nacala porto	na	na	+	317	558	32500	17692	0.5	Optimal
Ilha de Moc	na	+	+	352	201	108333	21191	0.2	Optimal
Mussoril	na	na	+	1160	600	196667	50053	0.3	Optimal
Mogincual	na	na	-	na	na	na	na	na	na
Angoche	+	+	+	3393	2078	291250	185349	0.6	Optimal
Moma	+	+	+	14568	10414	120700	57761	0.5	Optimal
Pebane	na	+	+	2066	2483	71875	73405	1.0	Over-exploited
Maganja da costa	na	+	+	na	na	na	na	na	na
Namacurra	na	na	+	na	na	na	na	na	na
Quelimane	na	+	+	2066	2483	71875	73405	1.0	Over-exploited
Inhassunge	na	+	+	na	na	na	na	na	
Chinde	na	+	-	na	na	na	na	na	na

(+ Increase; - Decrease; Red Pressure signal; Green Healthy fisheries; na=data deficient or no trend; MSY=Maximum sustainable yield; Ycurr=current catch in 2019; fcurr=current fishing effort in 2019; fMSY=fishing effort that produces MSY)

STATUS BY SPECIES (STOCKS)

Results on stock status done by the government fisheries science institution, (IIP, 2017) covering main species caught in Nampula and Zambezia provinces is shown in Table 17. Overall, target species were caught before or close to the size at first maturity of 50% of the individuals (L50) (Table 16). This recruitment overfishing seen particularly for the kelee shad *Hilsa kellee* and the orange mouth anchovy or glassnose *Thryssa vitrirostris* in the regions from Angoche to Chinde district, which was caused mainly by beach seines, probably due to the use of very small meshes in the nets. The Indian pellona (shad) *Pelona ditchela* was being overexploited in Zambezia. The stock assessment using Schaefer surplus production modeling indicated that localized overfishing was occurring in Quelimane-Chinde region for the pelagic fishes *Thryssa vitrirostris*, *Sardinella albela* and *Pellona ditchela (*Table 16*)*.

Table 16*. Stock status for selected species assessed in 2017 (source: IIP, 2017)*

Species	Area	Gear	L50	Current Catch (MT)/MSY	Status
Hilsa kelee	Quelimane-Chinde	Seine/Gillnet	Species under L50 only for Seine	1017/1056	Optimal
	Pebane-Nicoadala	Seine/Gillnet	Species under L50	297/350	Optimal
	Angoche-Moma	Seine/Gillnet	Species under L50	na	na
Thyrssa vitrirostris	Quelimane-Chinde	Seine	Species under L50	1017.2/1056	Overexploited
	Pebane-Nicoadala	Seine	Species under L50 only for seine	1607/1056	Optimal
	Angoche-Moma	Seine	Close L50	na	Na
Sardinella albella	Memba-Mogincual	Seine/Gillnet	Above L50	na	Na
	Quelimane-Chinde	Seine	Under L50	85.6/82.5	Overexploited
	Pebane-Nicoadala	Seine/Gillnet	Above	304/326	optimal
	Angoche-Moma	Seine	Above	na	Na
Decapterus kurroides	Memba-Mogincual	Seine/gillnet/purse seine	Above	na	Na
Decapterus Russelli	Memba-Mogincual	Seine	Above	na	Na
Pelona ditchela	Quelimane-Chinde	Seine/Gillnet	Under L50	70.4/44.9	Overexploited
	Pebane-Nicoadala	Seine/Gillnet	Under L50	75.8/50	Overexploited
Sillago sihama	Angoche-Moma	Seine/Gillnet	Close L50	na	na
Upeneus vittatus	Angoche-Moma	Seine/Gillnet	Under L50	na	na
Thryssa setirostris	Quelimane-Chinde	Seine	Above	na	na
	Pebane-Nicoadala	Seine	Above	na	na

4.2.4 FISHERIES RECOVERY AND ECOLOGICAL CARRYING CAPACITY

Fisheries simulations show that improvements in total biomass and catch are possible within ten years by protecting 20 percent of critical habitat in optimally placed no-take MPAs and reducing fishing effort. The simulations assumed populations are depleted to 10% of unfished levels before MPA networks were introduced and fishing pressure is concentrated outside of MPA areas as a response to MPA implementation. This assumption is intentionally pessimistic but is realistic in some areas and demonstrates the potential of management under even the most extreme conductions.

Figure 31 shows the results of the protected area optimizations across Ilha de Mozambique as a selection frequency map. The red polygons represent areas that were selected to be included in protected areas most frequently across all simulations. Figure 24 presents relative catch trends over time under the simulations with the objective to maximize both catch and biomass outside of protected areas.

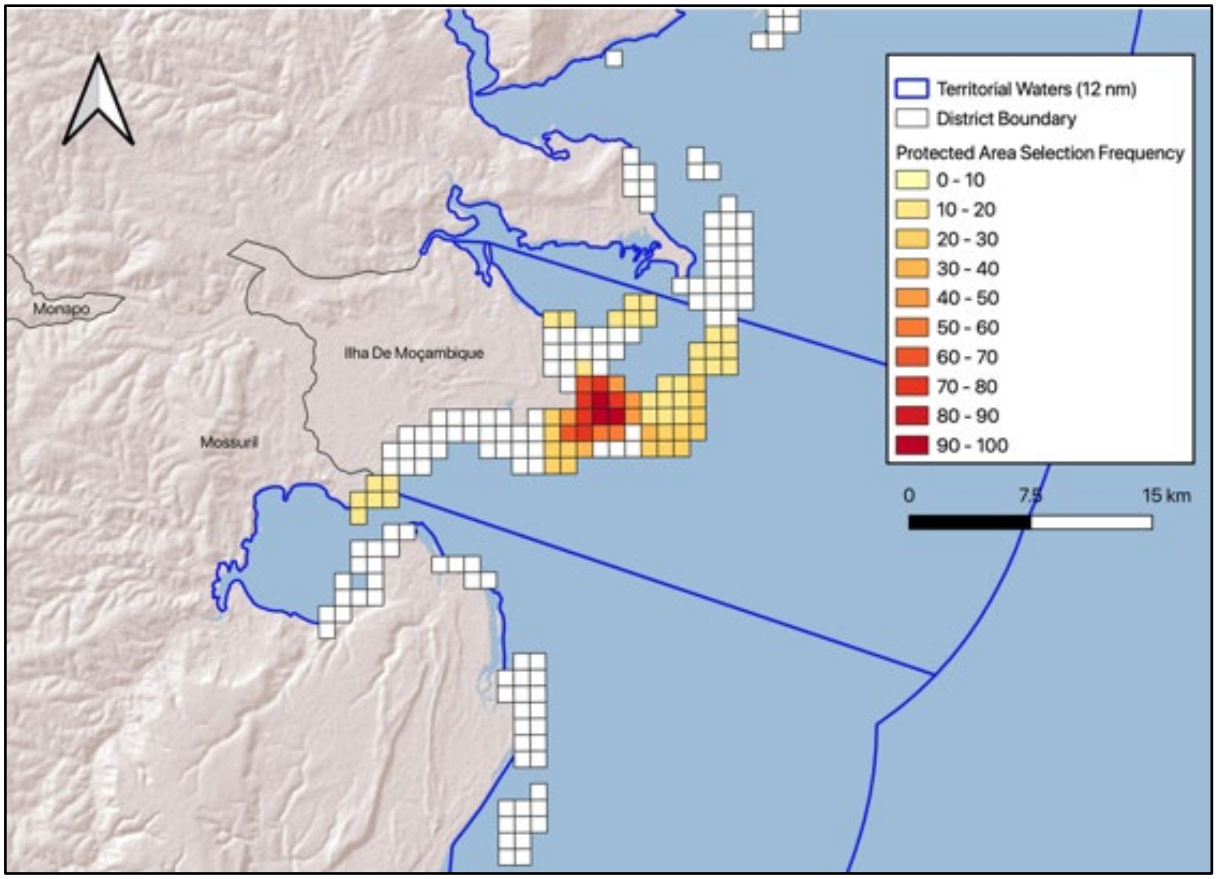


Figure 31. *Combined frequencies of selections across best protected area designs and across species groups for Ilha de Mozambique*

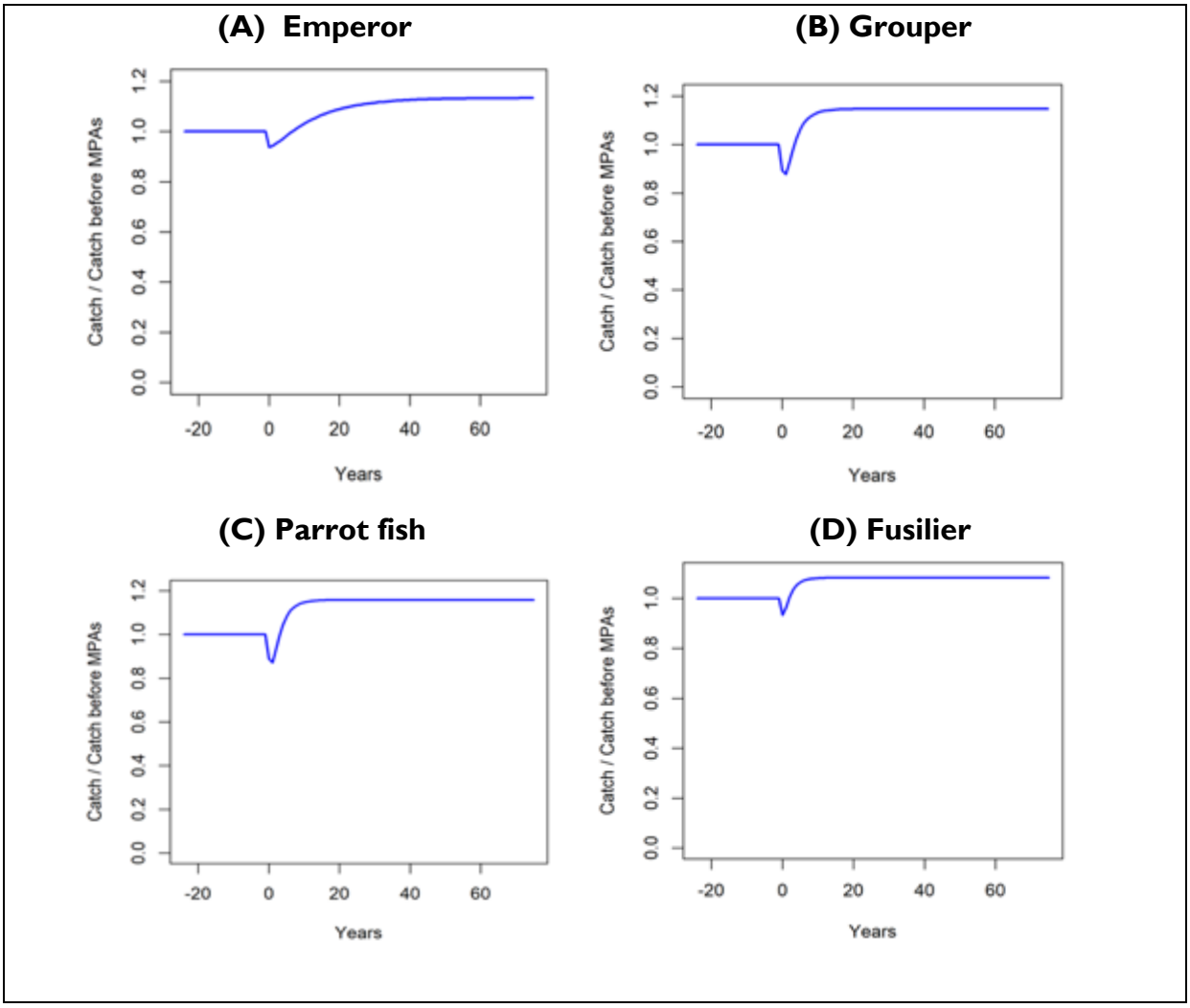


Figure 32. *Relative catch trend for (A) Emperor, (B) Grouper, (C) Parrotfish, and (D) Fusilier associated with fishery simulations used to select near-optimal sets of MPA locations to maximize both total biomass and catch in Ilha de Mozambique assuming fishing pressure is concentrated outside of MPAs. This represents a worst-case scenario.*

Catch recovery potential varied across species and districts. See Annex B for results associated with simulations across eight additional districts. In some cases, catch may not improve by establishing MPAs that protect 20 percent of key habitats alone (*i.e.*, Nacala Velha). In all cases, management measures that reduce fishing pressure outside of MPAs such as gear restrictions are critical. We included a simulation that assumes fishing pressure is not concentrated outside of MPAs as a response to MPA implementation (Figure 33). Under this scenario, both the magnitude and speed of catch recovery increase. ***We also predicted fish biomass under the assumption that further management efforts were put into place reducing overall fishing effort by 50 percent. Under this scenario, the magnitude of total biomass (biomass inside MPA, outside MPA, and catch) can increase by as much as 2.9 times by reducing fishing effort outside of MPAs reaching up to 40 percent of unfished biomass*** (Table 17).

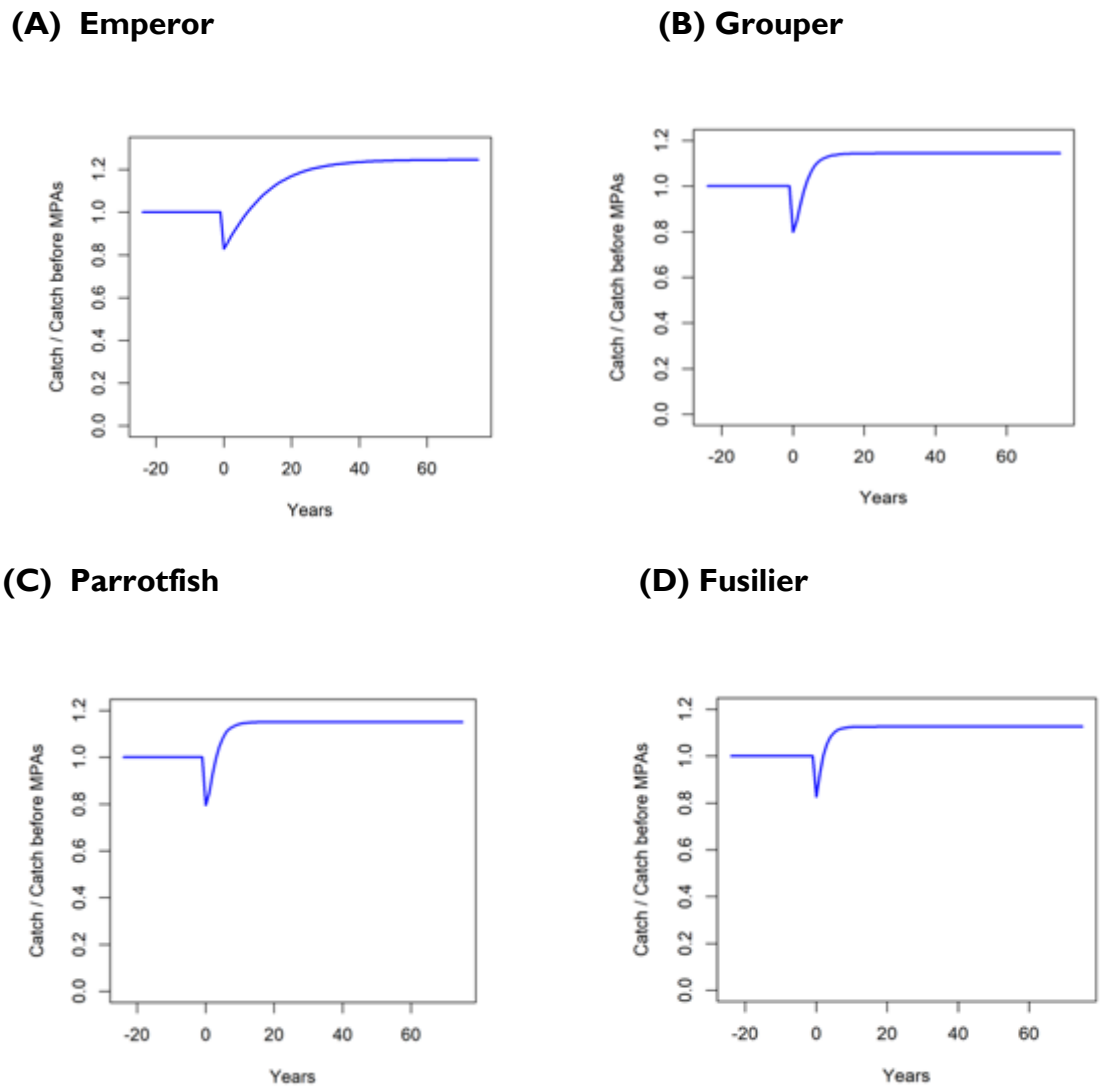


Figure 33. *Relative catch trend for (A) Emperor, (B) Grouper, (C) Parrotfish, and (D) Fusilier associated with fishery simulations used to select near-optimal sets of MPA locations to maximize both total biomass and catch in Ilha de Mocambique assuming fishing pressure is not concentrated outside of MPAs.*

Table 17. *Effects of MPA implementation and reduced fishing effort on total biomass in Ilha de Mozambique. B is predicted fish biomass and B0 is unfished biomass.*

Total Biomass (B/B0)

	MPA + fishing concentrated outside	MPA + no fishing concentrated outside	MPA + no fishing concentrated outside + fishing effort reduced outside
Emperor	0.12	0.15	0.3
Grouper	0.21	0.24	0.4
Parrotfish	0.22	0.25	0.4
Fusilier	0.14	0.18	0.4

Considering the movement of both larval and adult fish is essential for spatial planning and effective fisheries management. It is well established that fish move beyond protected area boundaries, but further research is needed to better understand fine scale population dynamics and implications for fisheries. As we continue to study these systems by incorporating the fishing pressure data collected for this project, it is imperative that MPAs fully protected from fishing are established in areas that maximize management objectives and fishing regulations are in place that provide adequate protection outside of no-fishing areas.

STOCK ASSESSMENT REMARKS

The stock assessment was made, based on the Schaefer surplus production model (calculated in this work), the length-at-maturity of some key species made by IIP, 2017 and trend analysis of fisheries monitoring indicators. Overall, 16 (50 percent) fisheries are overexploited out of 32 surveyed units. Of these assessed fisheries, seven are for beach seine, fife for surface gillnets and four for line and hook. In terms of gear, beach seine is the gear causing most overfishing and sustainability problems in the region.

Beach seine mainly catches small pelagic fishes and some shrimps. The white shrimp resources (*Penaeus indicus*), fished also by the industrial and semi-industrial fleet using bottom trawling, is in a state of overexploitation according to the work carried out by the National Institute of Fisheries Research (IIP, 2020- EERP).

Small pelagic fish (sardines, anchovies, and horse mackerel) are also fished in artisanal surface gill net fishing in the region. IIP (2017) indicated the overfishing of three small pelagic fish species (*Thryssa vitrirostris; Sardinella albella, Pelona ditchela*) in these two gears in Zambezia province. These combined results, together with the growing trend in surface gillnet fishing effort, can compromise the sustainability of fishing in the region in the long term.

By region, the summarized information indicates that in the district of Angoche the two most important fisheries (beach seine and surface gill net) are in a state of overexploitation. This is a similar case for the district of Quelimane for beach seine, gillnet, and line fishing. In Nacala Bay (Nacala Velha and Nacala Porto), beach-seining is also in a state of overexploitation. In this location, fishing is carried out throughout the bay and many nets are operated with a very small mesh size (Cremildo Armando, Rare-personal observation). Data from the National Population Census in Mozambique show that Angoche, Quelimane, Nacala Porto (and by inference Nacala-a-Velha) are the most populated districts in the region (INE.gov.mz) and overexploitation of fisheries may be a direct indication of human pressure in these places.

Maganja da Costa and Namacurra, districts with similar ecosystems, and possibly connectivity of species and habitats, showed over-fishing for beach seine and gillnet respectively and the target species are small pelagic fishes. (IIP, 2017) indicated in evaluation studies for singular species and for the region, the overexploitation of Pellona *ditchela* caught by these two gears.

The district of Pebane shows a different trend. It presents an excessive exploitation of line fishing, where the main species in this place are the demersal fishes. For Quelimane, the linefish resources also showed an overexploitation. In this region and due to the absence of muddy substrates, the main resource caught are larger estuarine species (catfish, javelin grunter, croaker). The overexploitation of hook and line stocks in Quelimane, and the fishing effort above the sustainable levels, can be an indicator of social pressure and the need to supply the market (city of Quelimane) with larger fish species.

The summary of the combined stock assessment results is shown in Table 18.

Table 18. Summary status of stocks by fishing gears and covered districts

Area	Districts	Seine	Gillnet	Line and Hook	Species <L50
	Memba	Optimal	Optimal	Over-exploited	
	Nacala -a- velha	Over-exploited	na	Over-exploited	
	Nacala porto	Over-exploited	Optimal	Optimal	
	Ilha de Moc	Over-exploited	Optimal	Optimal	
	Mussoril	Optimal	Optimal	Optimal	
1	Mongicual	Optimal	Optimal	na	
	Angoche	Over-exploited	Over-exploited	Optimal	Upeneus Vitatus (seine) Hilsa kelee (seine & gillnet), Pelona ditchela (seine)
2	Moma	Optimal	Over-exploited	Optimal	
	Pebane	Optimal	Optimal	Over-exploited	
	Maganja da costa	Over-exploited	Over-exploited		Pellona ditchella, Hilsa kelee (seine & gillnet)
3	Namacurra	Over-exploited	Over-exploited		
4	Quelimane	Over-exploited	Over-exploited	Over-exploited	Pellona ditchella, Hilsa kelee, (seine & gillnet) sardinella albella, Pelona ditchela (seine)

4.3 SOCIOECONOMICS AND VALUE CHAIN OF FISHERIES

4.3.1 VALUE CHAIN OF FISHERIES

This value chain analysis (VCA) focuses on the first link of the chain, the relationship between fisher and primary local buyer. This relationship entails not only the extraction and selling of the fish, but the services received by the fisher and buyer to carry on their economic activities.

A perspective of the small-scale fishing sector value chain can reveal response strategies that increase the sustainability and competitiveness of the entire value chain and the economic agents that comprise it. The analysis of the value chain allows the understanding of the critical activities of the actors, the governance system, trust and links between actors, the distribution of benefits and the analysis of challenging links for the efficiency of the value chain.

Ultimately, the VCA aims to improve the income of fishers, processors, and buyers, by analyzing opportunities for them to obtain higher or additional value for their products without compromising the sustainable management of fishing resources.

The following analysis aims to describe and understand the initial link of the value chain in the selected districts of Nampula and Zambezia provinces. Relationships and linkages between fishers and buyers are of friendship and family and constitute an important part of the fishing communities; their mutual well-being along with sustainable fishing practices are key for the health of the fishing ecosystem.

A total of 199 interviews were conducted during the month of August 2021 (Table 19).

Table 19. Summary of the fishers and buyers interviewed by gender

District	Fishers surveyed	Women Fishers interviewed (%)	Men Fishers interviewed (%)	Buyers surveyed	Women Buyers interviewed (%)	Men Buyers interviewed (%)
Angoche	13	15	85	11	54.5	45.5
Ilha de Moc	0	0	0	14	14.3	85.7
Maganja da Costa	3	0	100	6	0.0	100.0
Memba	0	0	0	12	25.0	75.0
Mocubela	2	0	100	2	0.0	100.0
Moma	8	13	88	8	0.0	100.0
Mongicual	13	0	100	11	0.0	100.0
Nacala Porto	10	20	80	14	28.6	71.4
Namacurra	8	0	100	8	0.0	100.0
Pebane	13	0	100	11	9.1	90.9
Quelimane	16	0	100	16	12.5	87.5
Total	**86**	**6%**	**94%**	**113**	**16%**	**84%**

Interviews with fishers

Almost all the interviewees (95 percent) reported that fishing is the main source of their livelihood, with complementary activities such as transport of people and goods by boat. Over 70 percent are experienced fishers with more than ten years of doing the activity. The fishing activity (extraction) is a male dominant activity, with zero reports of women in fishing crews. Of all fishers interviewed, women made up 6 percent, and are present in the fishing activity by extracting mollusks on the shore or fishing for sardines [interviewed] (Table 19). Picking mollusks is a subsistence activity with minimal equipment requirements. Women fishers reported they used beach drags owned by them or borrowed bottom gill nets to fish for sardines, in both high and low season.

Fishing crews depend on the size and type of boat; only 14 fishers (16 percent) reported fishing alone in trunk canoes. Fishing crews average 8.5 members in boats that are locally called *tipo moma*, the largest crew reported was of 31 members.

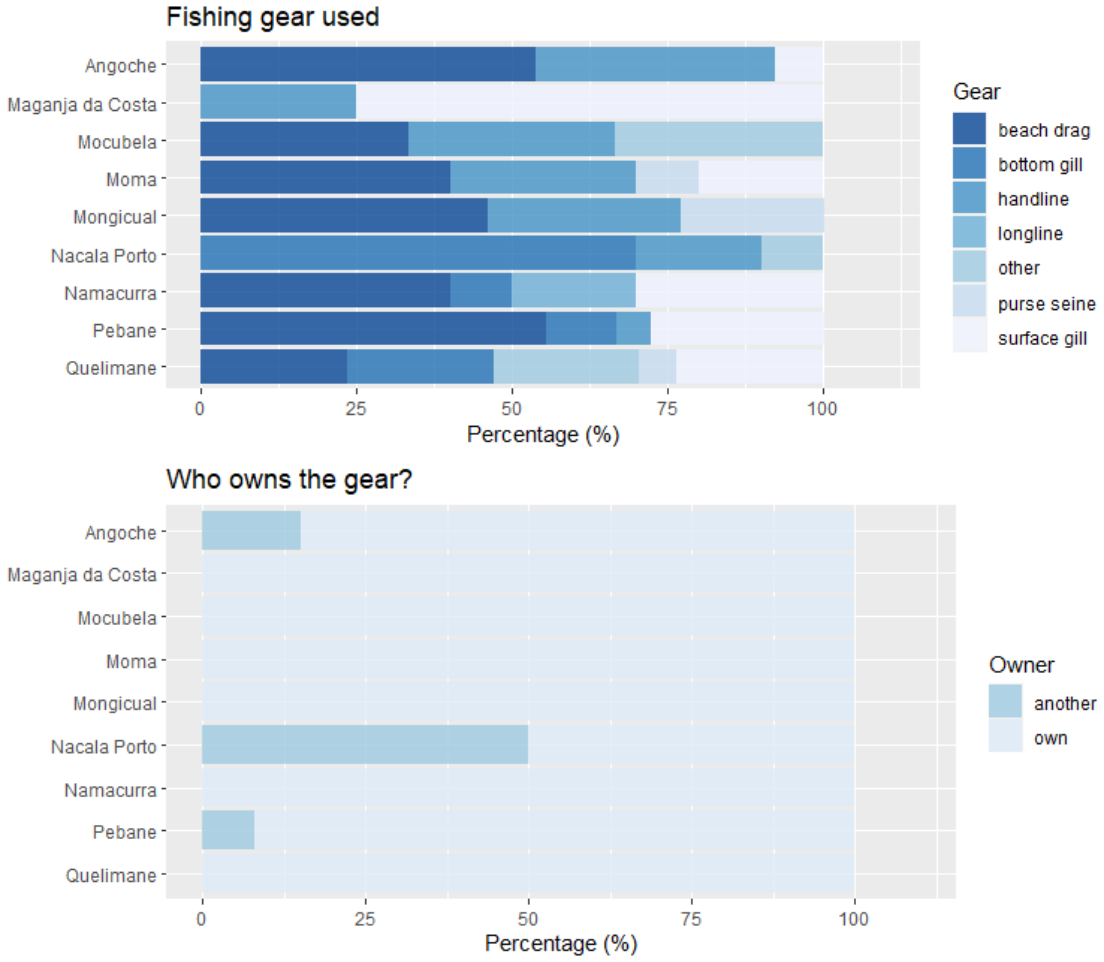


Figure 34. *Type and ownership of boats and fishing gear used by interviews*

Fishers (83 percent) own their productive assets boat and gears, being *tipo moma* and speedboats (boats with engines) the most common type of owned boats; and gillnets the most common type of gear, although this varies slightly by district (Figure 35). Owning productive assets provides fishers with the ability to be more profitable in their activities, however it also implies that the cost of maintaining and repairing their assets is higher. Of the five women fishers interviewed, three reported owning their own gear, consisting of either a handline or beach drag. Those who do not own the productive assets have to either rent (from other fishers or local buyers) or borrow them (with agreed compensation to be paid in fish, cash, or favor retribution). Of the five women fishers, two reported that they borrow bottom gillnets.

All fishers reported fishing for business but also for household consumption, it is estimated that between one to five percent is kept for household consumption. High value species such as grouper, tuna, mangrove crabs, and white bass, among others, are for sale in an effort to maximize their profit while low value species such as anchovy are kept for consumption.

In Zambezia, fishers could not distinguish the main species captured in high or low fishing season. The species remain the same all year round. The interviewees reported that the fishing campaign in a month lasts for 15 days. In peak season, more than 65 percent of fishers reported an average catch of more than 60 kilograms per fishing trip with an average price for their catch basket of 2,922 meticais per kilogram for a total average income per fishing trip of 175,320 meticais (approximately $2,700). During the lean season, total catch is reduced by half (Figure 35).

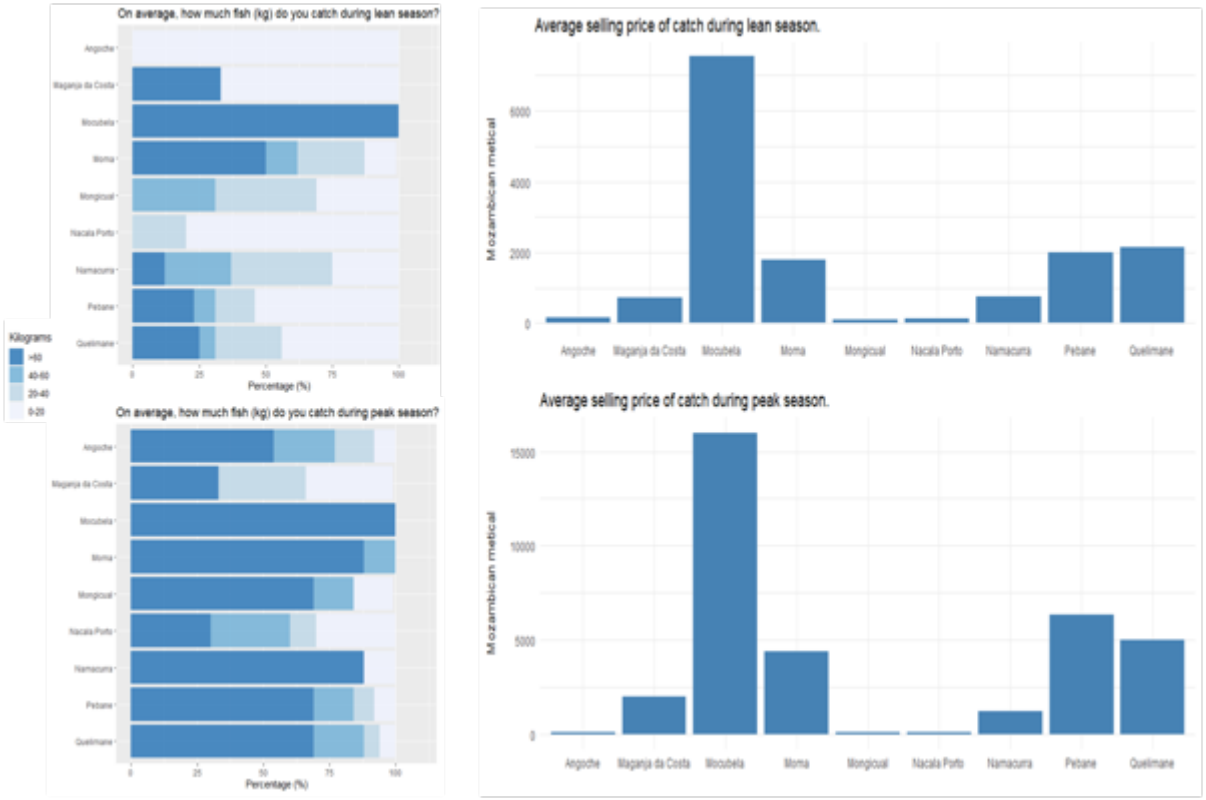


Figure 35. *Average selling price of catch (meticais) in lean and peak season*

Most of the fishers (80 percent, including women fishers) reported that the price they received for their catch is fair and is set by the buyer, with payments for the catch received in cash (Figure 36). Fishers do not have a mechanism to find buyers that would pay better prices for their catch, and it is rather done by estimating the cost of the fishing trip, the expected profit from the catch and the arrangement with buyers. In areas where ice is available, particularly homemade ice, it is sold at prices ranging between 25 and 50 meticais per gallon. However, this alternative source of ice supply is not enough to satisfy the demand that is growing every day due to the attractive fresh fish market in the region.

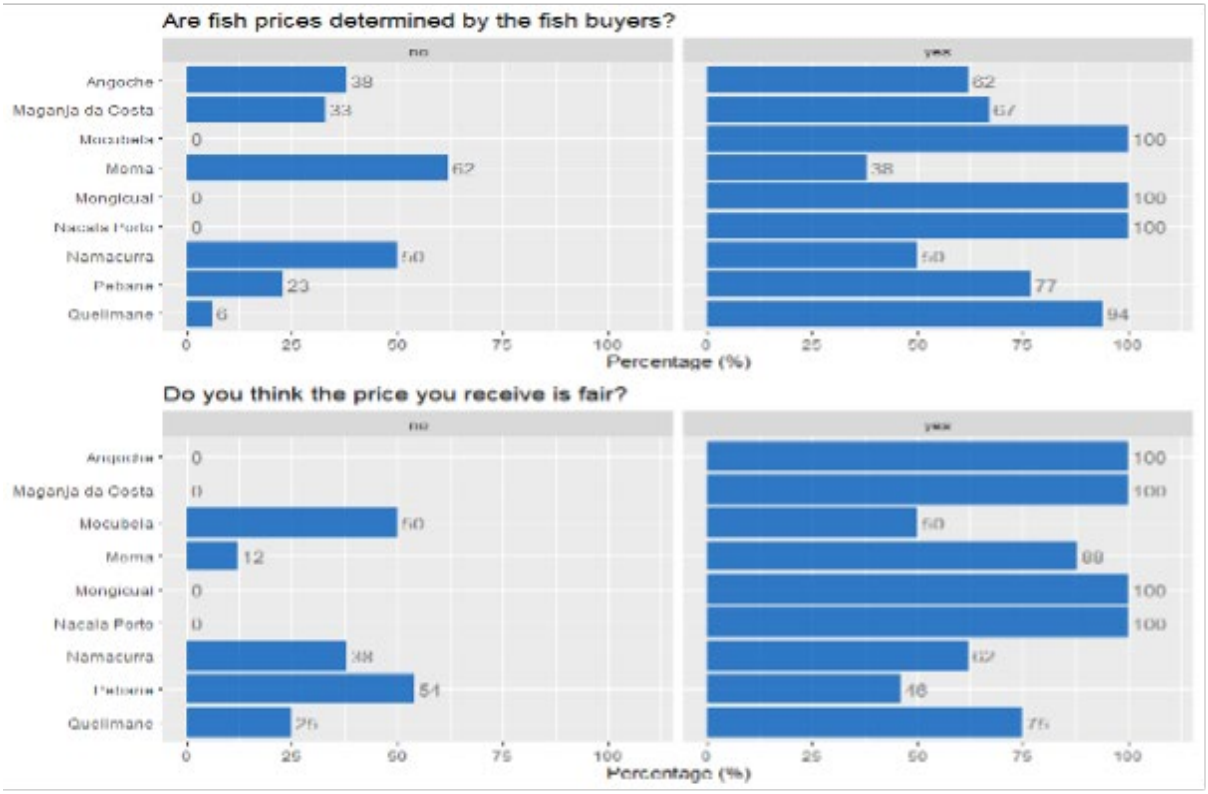


Figure 36. *Local perception related with fish price*

Linkages are clear when fishers are reported to have a solid, long-standing relationship with their main buyers. Trust in the buyers (all reported informal agreements) and the linkages created between them are the main reasons why fishers preferred to sell their catch to the buyers they regularly deal with; 26 percent of the fishers reported that the relationship started out of a friendship, 26 percent reported that the relationship started because they know other fishers dealing with the same buyer.

With the changing of seasons (low and high) more than 50 percent of fishers reported that the relationship doesn't change; however, when asked why the relationship changes if at all, fishers reported that it adapts to lower number of fish traded and in needed times, buyers (who normally have more liquidity than fishers) provide fishers with loans and other mitigating mechanism to account for the reduction of income due to lower catch.

When both men and women fishers were asked about the challenges in the fisher- buyer relationship the answers were split evenly between not having issues and pricing of the catch. Disaggregating women fisher responses revealed that four of the five women fishers believe there are no issues, and one believes there to be a pricing issue. This again is a signal that pricing of the catch is not done under market circumstances, rather is done in a negotiation upon landing. Fishers expressed that their main challenges when it comes to sell fish to buyers are due to lack of a market to sell fish, few or only one buyer, lack of equipment (Figure 37) maintenance which makes fishing trip more costly, and finally the lack of liquidity of buyers which limits the number of fish to be sold in the first link of the value chain. Under "other" in Figure 29, just over 10 percent of fishers reported that there is more effort by fishermen than there are fish in the sea, and a few reported the lack of infrastructure to store and transport fish.

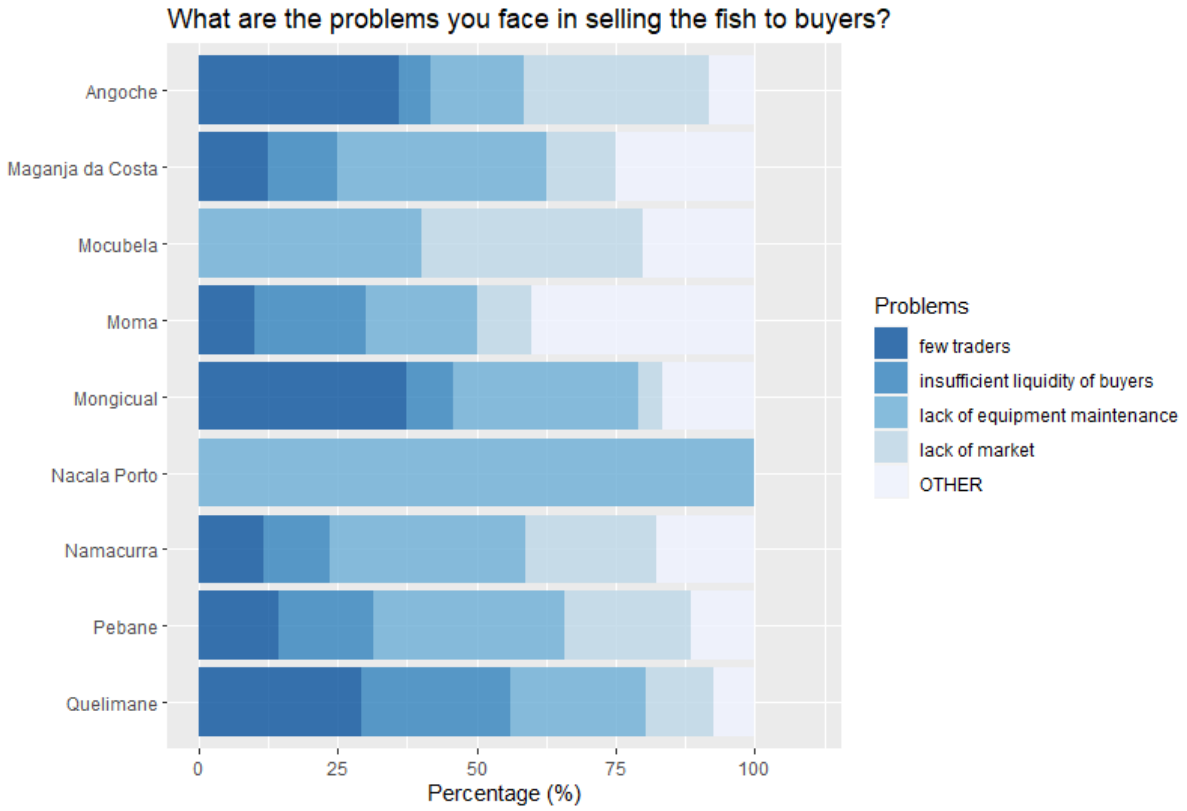


Figure 37. *Problems reported with fish selling*

When it comes to opportunities for addressing problems or constraints in the fisher-buyer relationship, fishers expressed that government support is needed in the form of infrastructure and access to working capital for maintenance and improvement of their assets, additionally fishers would like to access competitive markets instead of a monopsony (one buyer for many sellers with the capacity to set prices).

Interviews with buyers

All buyers listed trading fish as their main source of livelihoods with 12 years average of experience in the business. Over two-thirds (66 percent) of the interviewees stated that they work alone while seven percent claimed that they work with a family member from their household, and an additional 10 percent claimed to have a business partner. This is consistent for both men and women buyers. Around 16 percent (18) of the interviewees were women (Table 19).

Buyers confirmed that in high season the amount of catch per fisher is more than 60 kilograms, while in low season the catch weight is reduced to almost half of it (30 kilograms), and the amount bought per week by the buyers is reflective of this trend (Figure 38). When disaggregated by gender, women buyers showed a similar trend in high season, buying more than 60 kilos on average. In low season, however, 60 percent of women reported buying as low as zero to 20 kilos, compared to only 23 percent of men reducing their purchase to zero to 20 kilos. All buyers confirmed that they keep some of the fish for household consumption. This is consistent for both men and women. About half of the buyers source their fish directly from buyers, while all of them purchase both from fishers and other buyers. The purchase decision is influenced by the buyer's client preferences.

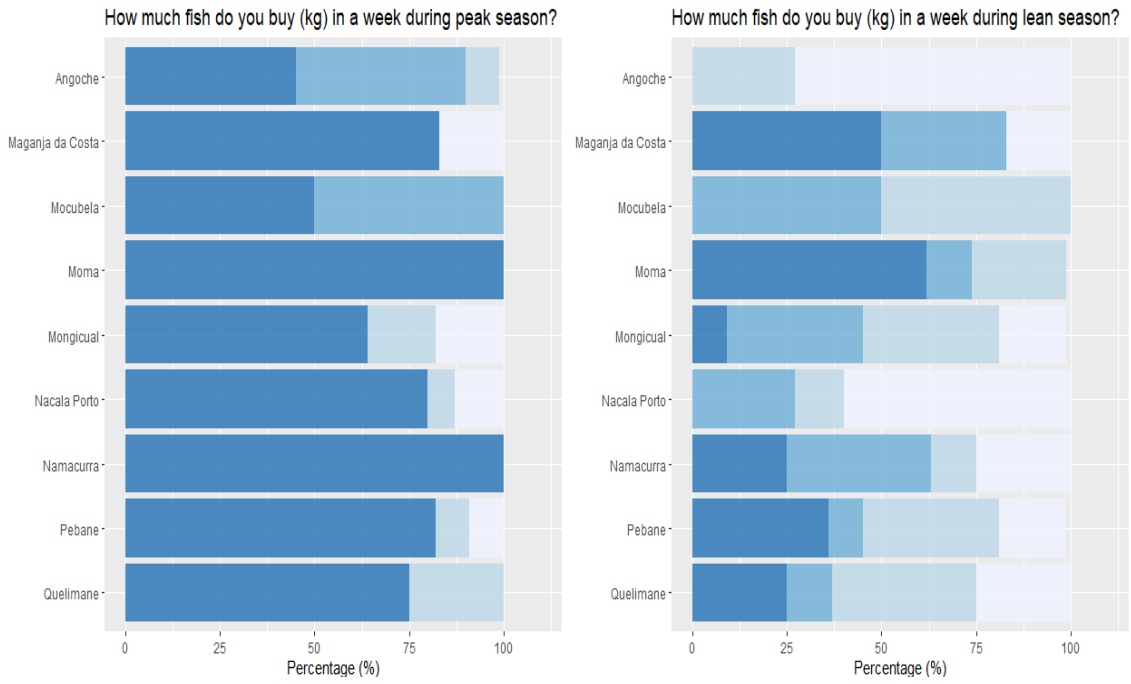


Figure 38. *Fish bought by buyers per week in high and low season*

On average, buyers work with ten different fishers or crews who maintain long standing relationships (more than five years) of mutual benefit. Buyers provide fishers with additional services such as advancing cash, ice, and gear for the fishing trips and fishers provide buyers with first options to buy the catch. The cost of those services is included in the price that buyers paid for the catch and the estimated value of those are from market prices. This is true for both men and women interviewed.

Even though the relationships between fishers and buyers are informal and there is no legal obligation to stay in it, about a third of the buyers claimed that even if they want to, they won't be able to stop the relationship without affecting their trade (supply of fish) (Figure 39). More than half of the fishers also claimed that the relationship doesn't change with high and low seasons but adapted to different volumes and prices; they also confirmed that in low season buyers supported fishers with cash and or staples such as food.

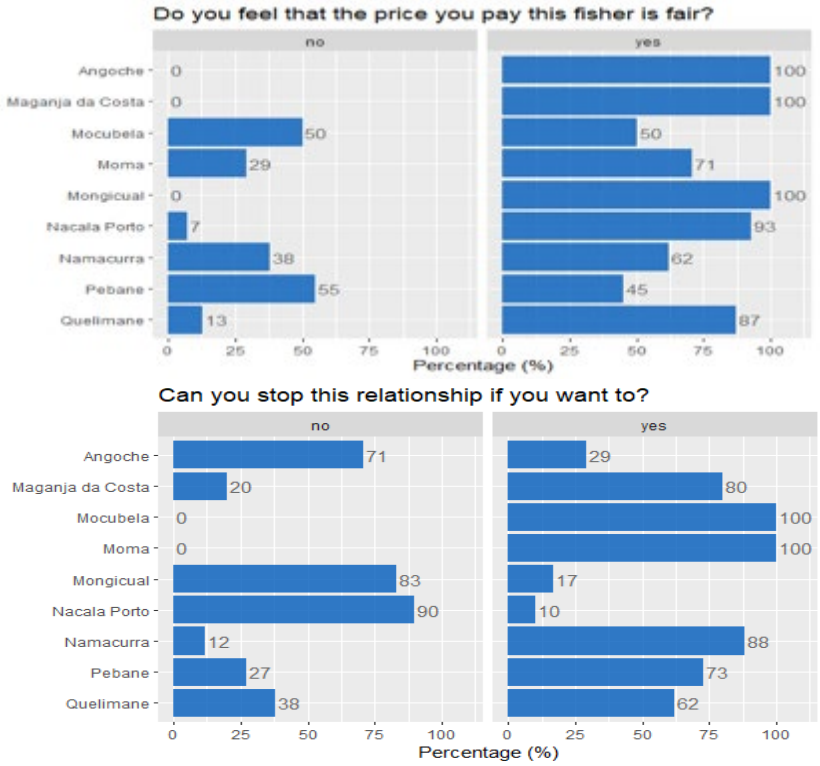


Figure 39. *Relationship between fishers and buyers*

Linkages and trust between fishers and buyers start with the origins of their relationships, half of the buyers stated that the relationship with fishers is due to friendship and the other half because they are relatives. When disaggregated by gender, most women buyers reported the relationship is due to friendship.

The price that buyers paid for the catch is considered fair by the buyers and the main reasons are that the price is agreed by both parties, the price often includes the cost of the services provided to fishers; at the agreed price, there is profit for both parties (Figure 40). All the buyers agreed that the price they paid is also influenced by their own selling price to their customers who are other buyers (secondary buyers) market sellers and occasionally the final consumer.

Different from the fisher-buyer relationships that is dominated by one buyer purchasing from many fishers who are regulars, buyers responded (80 percent) that they don't have regular customers but sell fish to the next link in the chain depending on the conditions of the trade, *i.e.*, taking fish to different markets if they have the means to transport it, or the price difference according to who is buying (another buyer, final consumer, etc.)

Majority of buyers (76 percent) reported that they don't receive any services from their clients (as opposed to fishers) and all the agreements are informal with over 70 percent stating that the business relationship has been going for more than five years and in the event of stopping that relationship the continuity of their business is in peril.

Prices to the next link of the chain are obtained via telephone or from other market agents such as fish traders, business, and personal contacts in the markets. Information about permits, quality of fish and best practices for handling the catch are obtained from their respective CCP's (fishing community council) and government officials in the community. Buyers don't seek financial assistance either for business or personal in the next link of the chain, they rely on personal savings, liquidity, and personal connections.

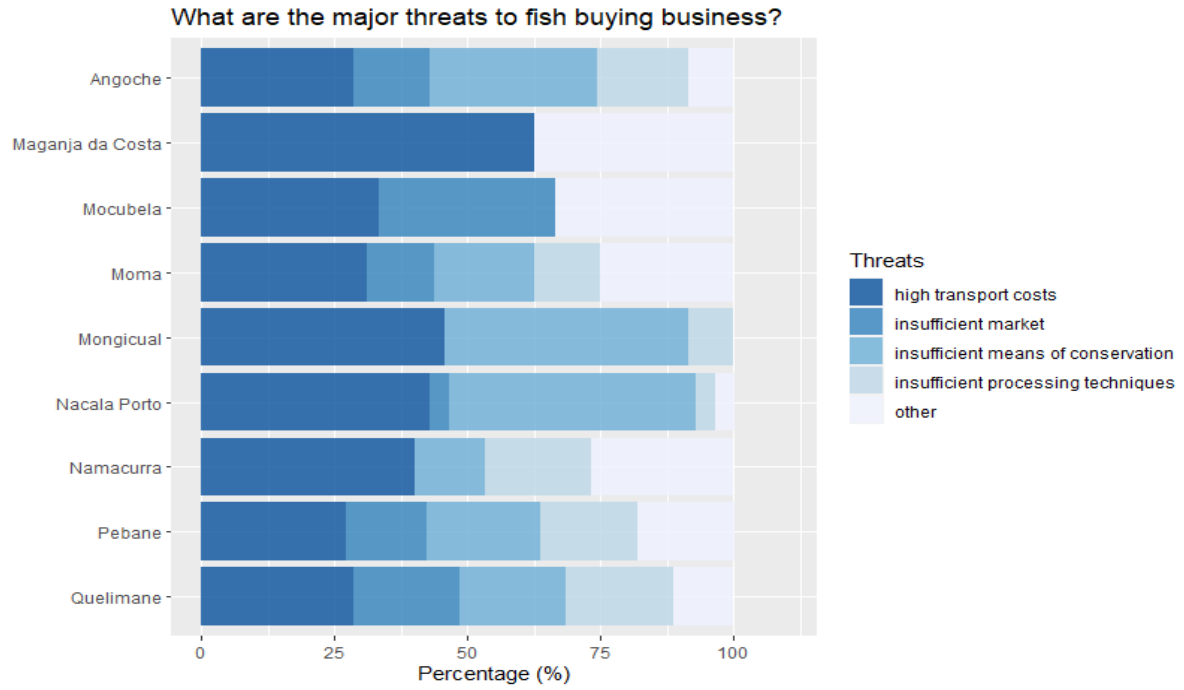


Figure 40. *Majority threats on trade business*

When asked about challenges in the relationship with the fishers, buyers answered that pricing of the catch is the main source of the challenges followed by fishers not following through in their commitments of selling fish to the buyer; however more than half of the buyers stated that they don't perceive any major issues. When it comes to the challenges to improve fish trading, the majority of buyers from each district stated that high cost of transportation and the lack of a reliable cold chain are the major threats to fish trading. Insufficient means of conservation was reported as a concern in the majority of the districts surveyed (Figure 41).

Gender Dimensions in the Value Chain Analysis

Women participation in the VCA is limited to five fishers and 18 buyers, 6 percent and 16 percent of the total interviewees. A preliminary analysis was made taking into consideration the following dimensions of gender:

- **Access and ownership of resources:** Fishing extraction is a male dominated activity with some exception of seining and near shore fishing; however, 16 percent of the first buyers were women. Business assets such as boats and gears are owned by male fishers. Three of the five women fishers owned their gear (handline and beach drag). The number of fishers that women and men buy from was similar in Nacala Porto (M=14, W=13), but in Pebane women on average buy from more fishers than men (M=8, W=15). In districts Angoche and Quelimane, women bought from less fishers than men on average (Figure 41). This may be because 100 percent of the women in Angoche reported they keep some of the fish they buy, compared to 60 percent of men. In Quelimane, 100 percent of the women reported they keep some of the fish they buy, compared to 64 percent of men.

  Fish buyers possess the liquidity and business to trade fresh fish up the value chain. In this context, women buyers should be able to access financial services for their business needs. Most often women are not head of household and assets are not in their name limiting their opportunities to access bank account or loans. For women buyers in fishing communities in

Mozambique, access to financial resources could impact their business positively as they will be able to save, invest, and expand for the benefit of their business. Activities such as savings clubs, financial inclusion, and small enterprise development support increased access of women to strategic resources.

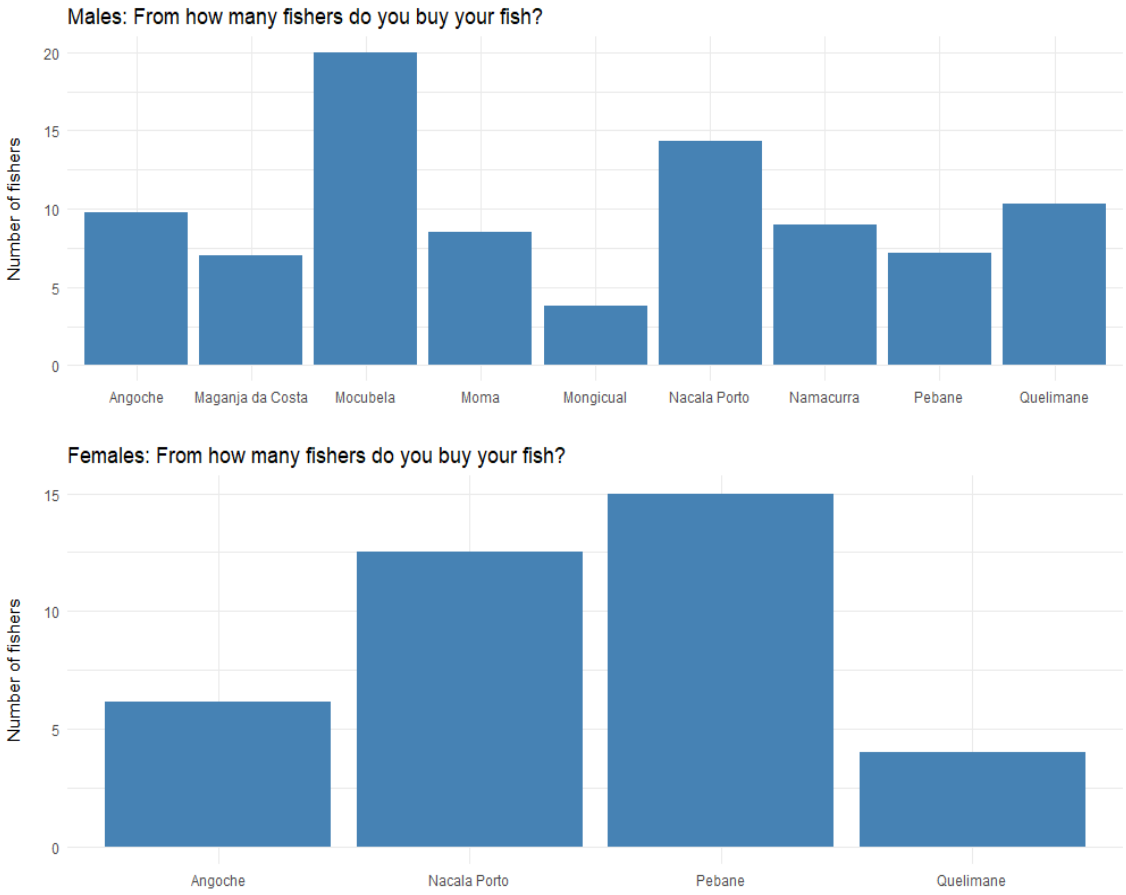


Figure 41. Access and ownership of the resource

- **Power and decision making:** The relationship between fisher and primary buyer is an asymmetric relation where the buyer has a more powerful position, in most cases due to the absence of a market where supply, demand and a larger number of participants will help determine the price of fish. In this relationship, gender also plays a determining role. All women and the majority of men in each district reported the price for fish was set by them and not the fisher. However, in the district Pebane, the one woman interviewed reported the price was not fair, even though it was reported they set the price rather than fishers. When asked about the bad things associated with selling, the woman buyer reported that fishers take a long time to pay, which may explain in some capacity why the price is perceived as being not fair. An opportunity exists to promote empowerment of women through their greater participation in the decision-making bodies of the fishery and the activities that are carried in the communities (Figure 42).

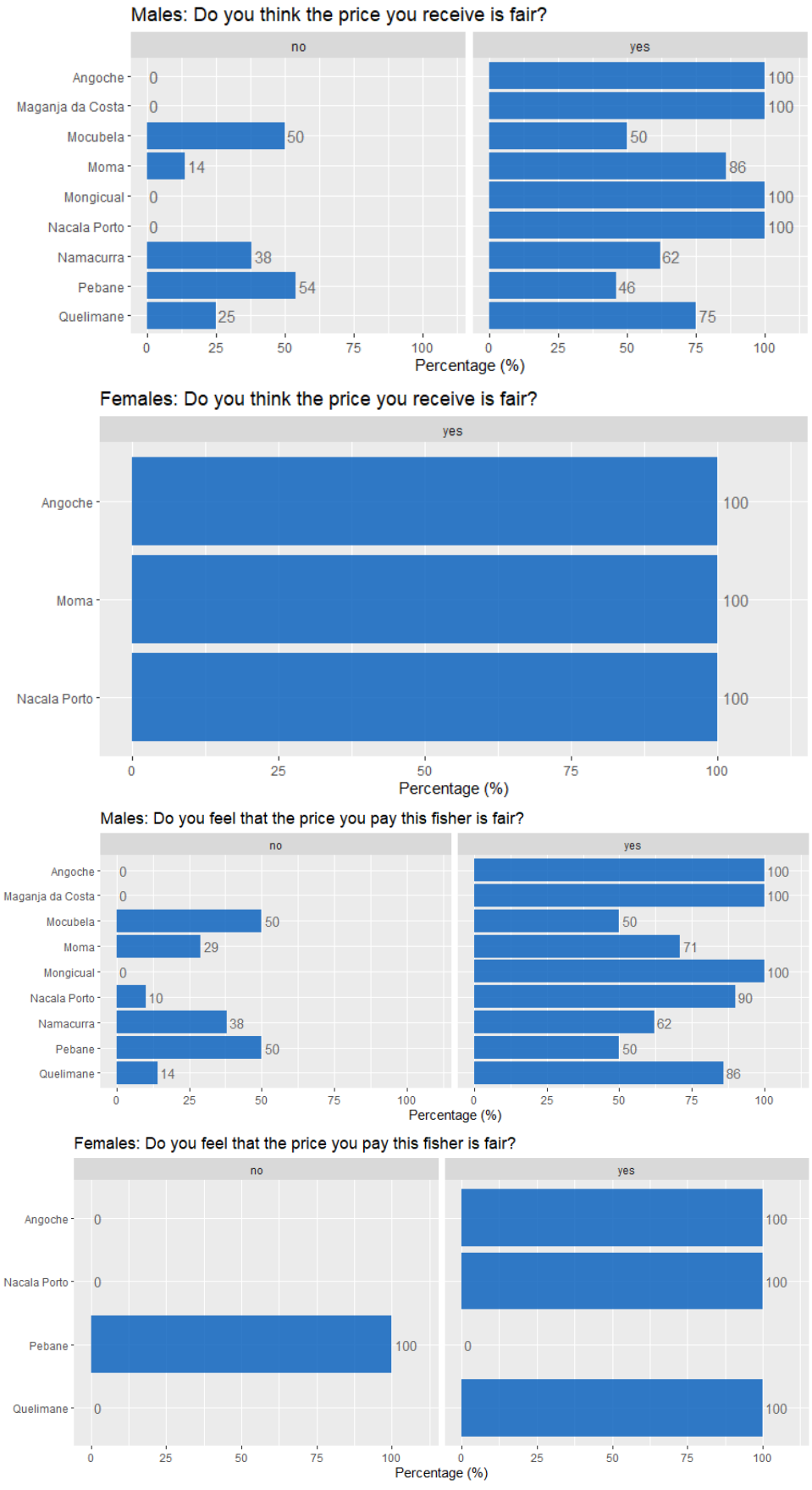


Figure 42. *Power and decision making*

- **Roles and responsibilities**

Value Chain Analysis Remarks

- The first link of the value chain is the relationship between fisher and primary buyer. This relation is characterized by fishers who own their productive assets such as boats and gear, and the buyer with the liquidity to purchase fish in cash.
- Most fishers don't perceive the relationship as abusive and think the price received for their catch is fair.
- More women than men on average reported keeping some of the fish they buy and sell for themselves.
- Most men own their own boat and gear. The three women that owned their gear used a handline and beach drag. Women borrowed bottom gillnets.
- Buyers provide fishers with cash and other support services in low fishing season and often include the cost of providing this service in the price they pay for the catch.
- The linkages between fishers and buyers are solid and emerge from friendship, family ties and community relations, which is true for both men and women.
- Breaking these relationships or linkages have more serious consequences for fishers because they normally sell to the same buyer; however, buyers purchase from an average of 11 different fishers.
- The cost of a fishing trip is partly covered by buyers who provide fishers with ice and gas.
- Buyers do not finance their operation from the next link of the chain (next buyer) they use their own funds to cover for deficits or take loans from friends.
- Both fishers and buyers agreed that a way to upgrade that relationship and the business in general is to improve infrastructure such as roads, power for cold storage and ice production.
- Buyers agreed that high cost of gas is an impediment for longer distance trading.
- Fishers and buyers don't have a mechanism to access market information such as prices.
- Fishers and buyers must negotiate the price upon landing.
- Permits, best practices and market access are vital for the business but there is no centralized place to obtain this information.
- Both fishers and buyers agreed that pricing is the main challenge when it comes to their business relationship.
- Women's access to resources start with the design of MA+R, for the benefit of all community members that depend on the fishery. When designing MA+R, women should be included in the design to account for activities such as mollusk picking.

4.3.2 SOCIOECONOMICS

Roles and responsibilities in the household

Exactly 1,014 people were interviewed, with 900 involved in fishing activities. The number of women interviewed involved in fishing was 124 (14 percent).

The average number of people involved in fishing indicates that men have a more direct role in the activity with an average of at least 0.9 to 1.5 men in each household dedicated to fishing. The presence of women in fishing is reduced when compared to men (Figure 43 left). Women in the north of Nampula (between Memba and Ilha de Mozambique), being more involved in fishing is probably related to the ecological conditions of the region characterized by shallow water rocky and seagrass habitats,

allowing a greater intervention of women in the fishing activity. This is because these conditions are conducive to the gear and species sought after by women (beach drag or seine, sardines, mollusks).

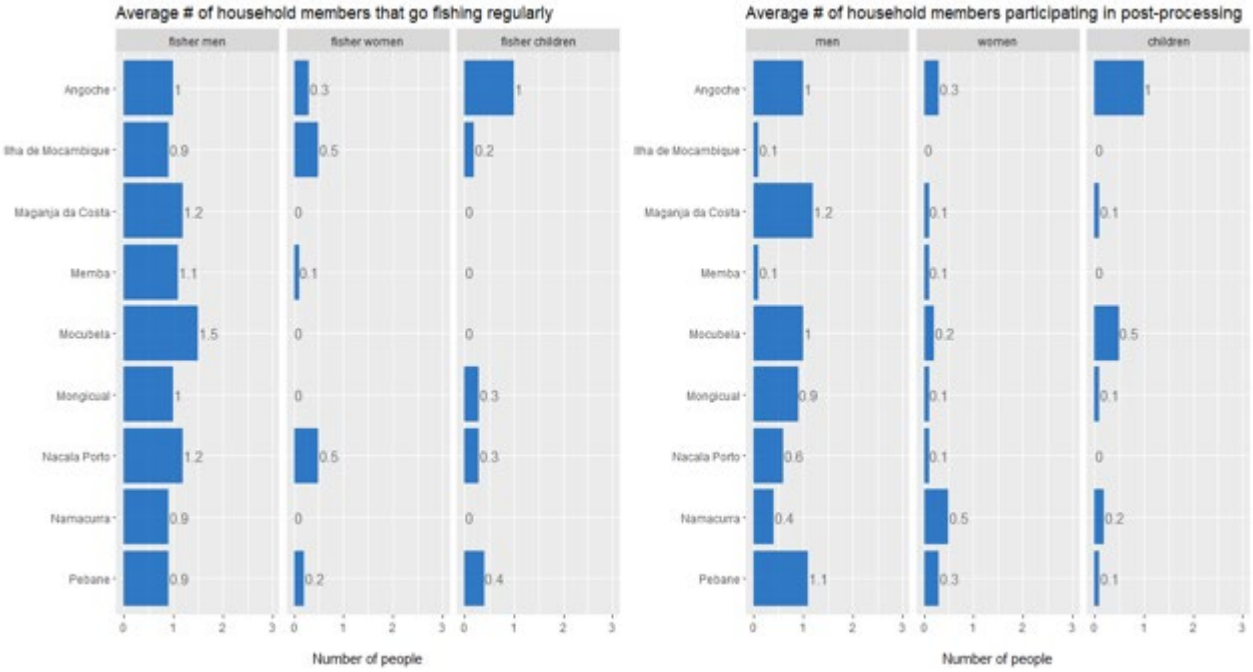


Figure 43. *Average of house member that go fishing (left)) and members participating in post processing activities (right)*

Women and children are more involved in post-processing activities when compared to direct participation in fishing (Figure 44, right). However, in the interviews obtained, men continue to dominate this activity. This effect may be related to the role of women, where more than 60 percent of the women interviewees are involved in domestic activities, such as taking care of the children and the house, with not much space left for other income-generating activities (Figure 45).

Figure 44. A *- Women and children involved in fish processing at Malanha;* ***B -*** *Children involved in post-processing of fish in Nacala Velha*

The role of children, both in fishing and post-processing is associated with women activities, where children are naturally involved in activities where women are involved.

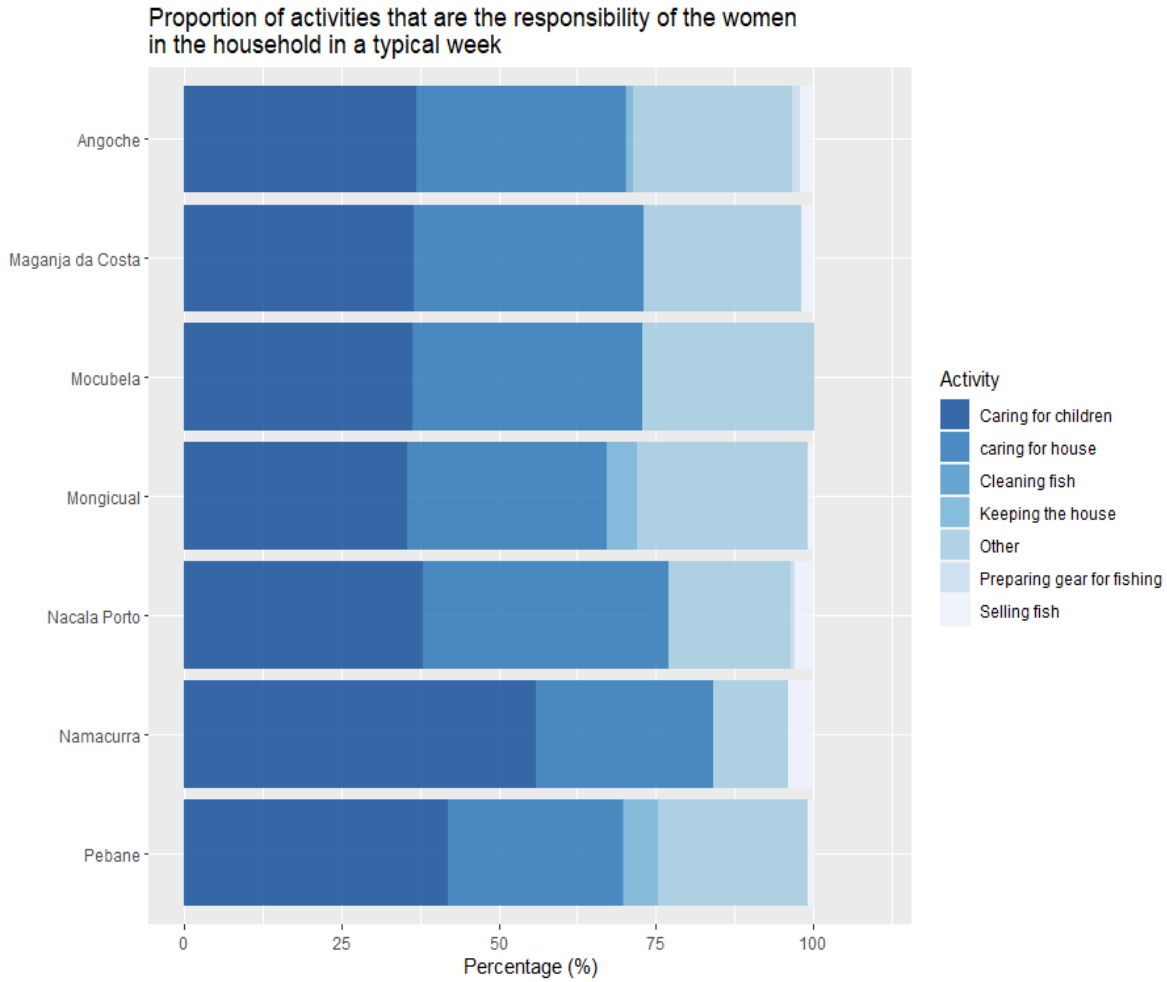


Figure 45. *Activities of women responsibility in the household*

Access and ownership of resource

At least half of all interviewees across districts, have a feeling that the fisheries provide equal benefits to all members of the communities. In Memba, only 48 percent of responses show some feeling of injustice for not having equal benefits in fishing (Figure 46). While this needs to be better explained, this district is near Cabo Delgado and has seen an unusual immigration of people who flee from the violent extremism and probably feel that they are not able to benefit from fisheries.

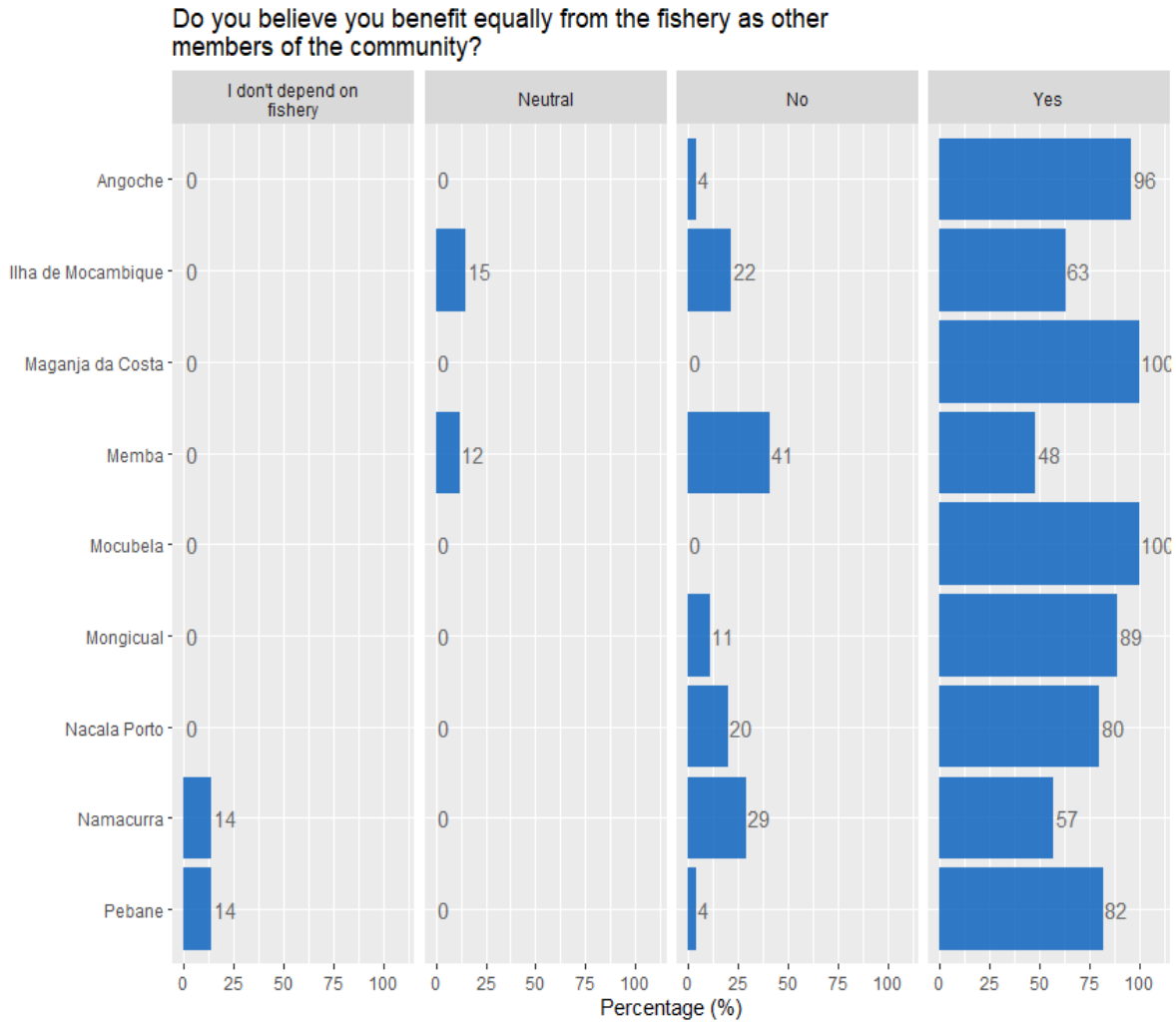


Figure 46. *Perceptions in fisheries benefits*

Additionally, there is a widespread feeling that fishing rights are not evenly distributed. Maganja da Costa (70 percent) and Angoche (59 percent) were the places with the highest responses of displeasure in relation to fishing rights (Figure, 47). Angoche is in a conservation area, with some access restrictions to the resource, while Maganja da Costa has not been privileged in fisheries development projects.

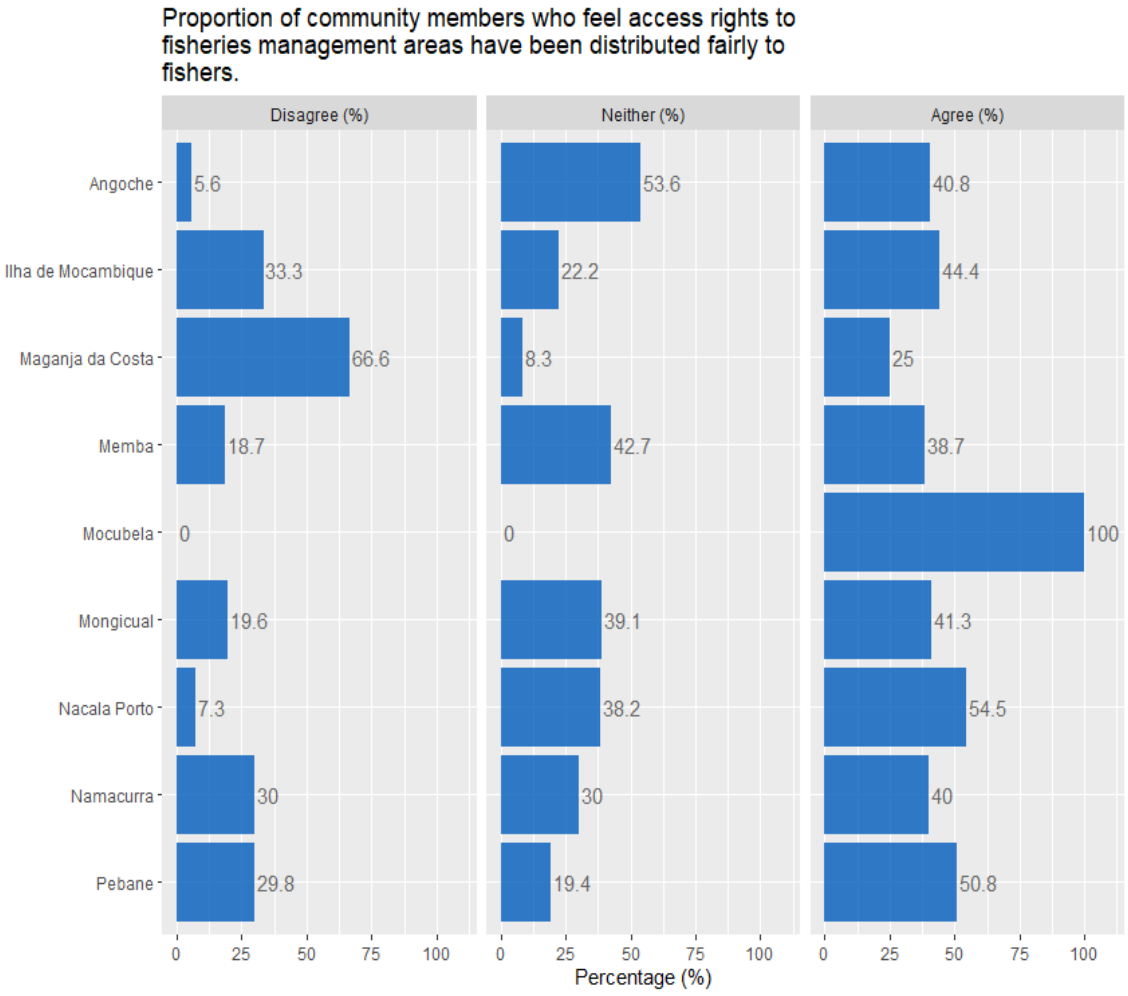


***Figure 47**. Perception to the access rights to the fisheries*

The proportion of fishers who perceived that their catch remained stable or increased over the past two or five years was relatively low (Figure 48). This result suggests that although there is free access to capture resources, there does not seem to be a sense of ownership for a common good.

Only fishers from Memba and Maganja da Costa, perceived that their catch did not change or decreased over the past two or five years. The growing demand for demersal fish at open sea, may have influenced this perception in Memba province.

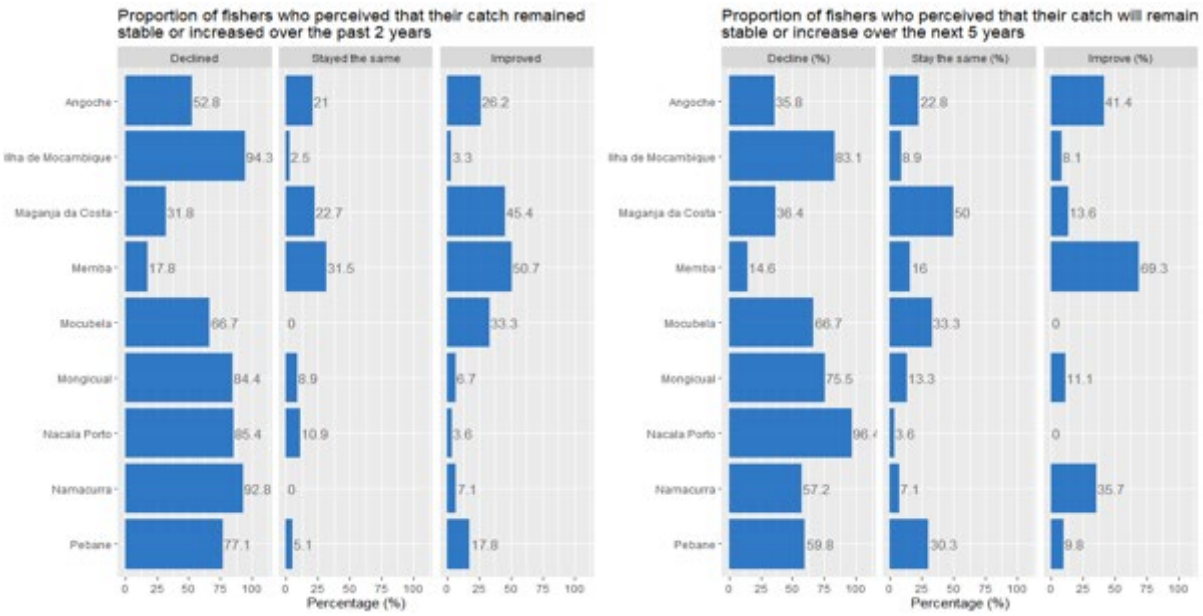


Figure 48. *Summary of household survey questions assessing whether community members are confident that their fisheries will improve or stabilize over the past two years (left) and over the past five years (right)*

In general, over 50 percent of members in each district surveyed felt confident that they will continue to benefit from community management of the fishery (Figure 49 top). However, only 31 percent of fishers from Namacurra showed confidence in future community management. This is likely associated with their higher perception of catch declines in the past. All interviewed feel confident that area is important to be managed and protected (Figure 49 bottom) except members interviewed in Maganja da Costa, where 62 percent of responses were neutral. There is consistency to Maganja da Costa's responses, where there is no perception of declining catches, and thus, the respondents do not see a need for improved fisheries management. These local perceptions contradict the surplus production model results, which indicated an overfishing for beach seining. The absence of community awareness about the importance of fisheries management and regular sharing of catch data due to absence of development projects in the area may have influenced this result.

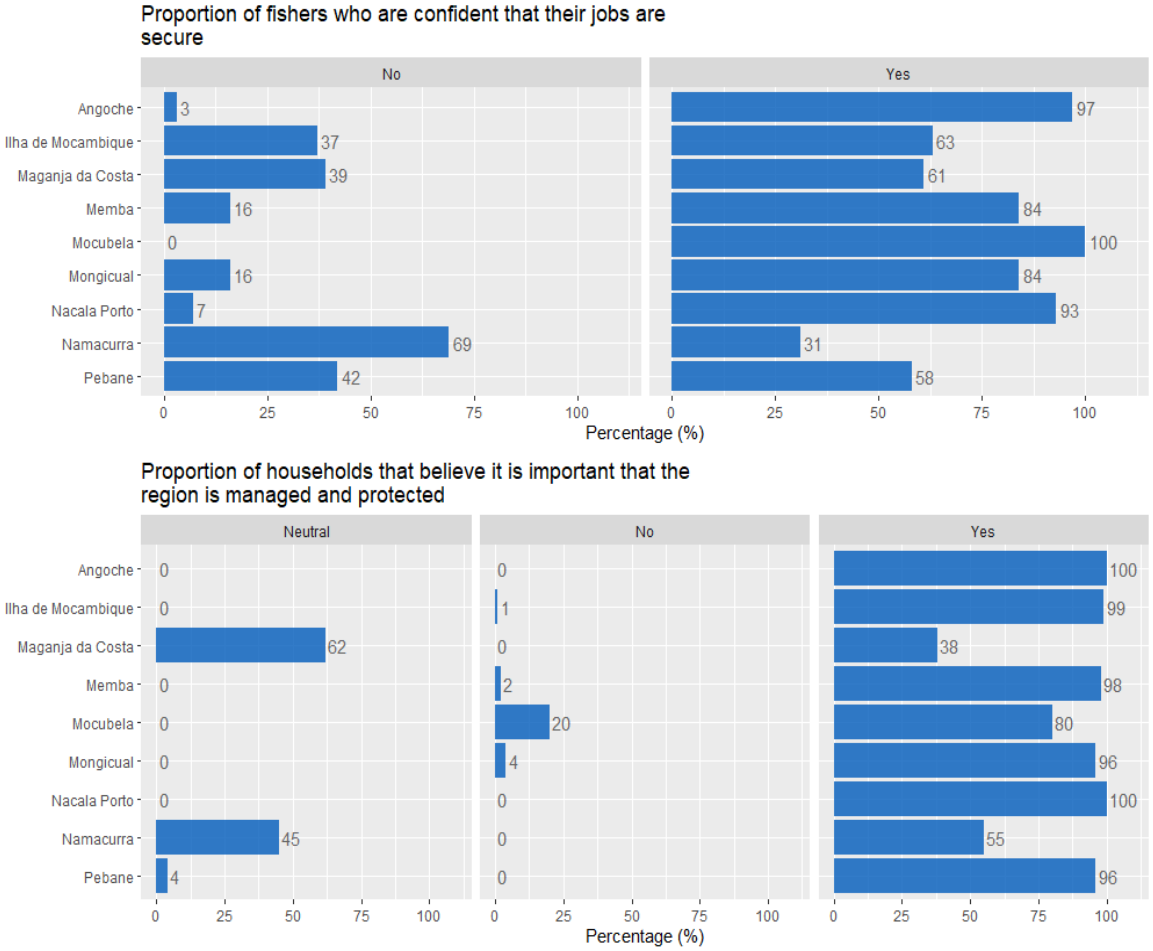


***Figure 49**. Proportion of fishers who are confident with their jobs and believe that is important that the region is managed and protect.*

At least half of respondents (more than 50 percent) feel that current fishing regulations are effective at managing the fishery and at ensuring catches remain stable, with the exception of Ilha de Mozambique, (only 33 percent agree) (Figure 50). Again, in Ilha de Mozambique nearly half the respondents disagreed with the statement that current fishing regulations were effective at managing the fishery and this is also related to other results associated with perceived declines in catches (Figure 50 right) and the low income in their families (Figure 55). When disaggregated based on gender, perceptions were similar for both men and women in Ilha de Mozambique.

The general perception that community management is effective contradicts the perception of declining catches by the same interviewed group. This latter confirms stock assessment, with overfishing (including the catch of juveniles) due to the use of mosquito nets and other unregulated and unreported gears. Once again, this vision shows a weakness in the appropriation of the marine resource as a common good, which must be managed by everyone.

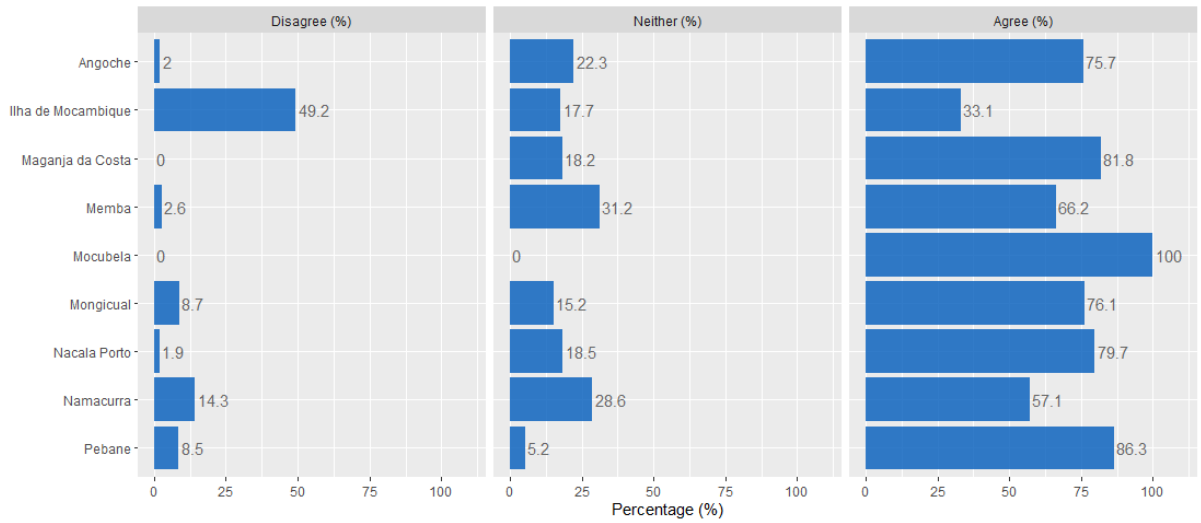


Figure 50. *Proposition of community members who feel that current fishing regulations are effective*

Figure 51. *Couple of fish buyers in Nacala Porto (credits: P. S. Afonso)*

Power and decision making

The decision in the family, based on gender responses, is taken by both men and women. However, analyzing individual responses, there is a tendency that financial decisions are more frequently done by men than women (Figure 43). Ilha de Mozambique, Namacurra, Nacala Porto and Memba, over 70 percent of men interviewed confirmed this fact.

This evidence may be associated with the low contribution of women to family income, which makes them more vulnerable and dependent on men. In Zambezia, where fishing activity normally involves physical disputes, it is a natural limitation for women's involvement in direct fishing activities.

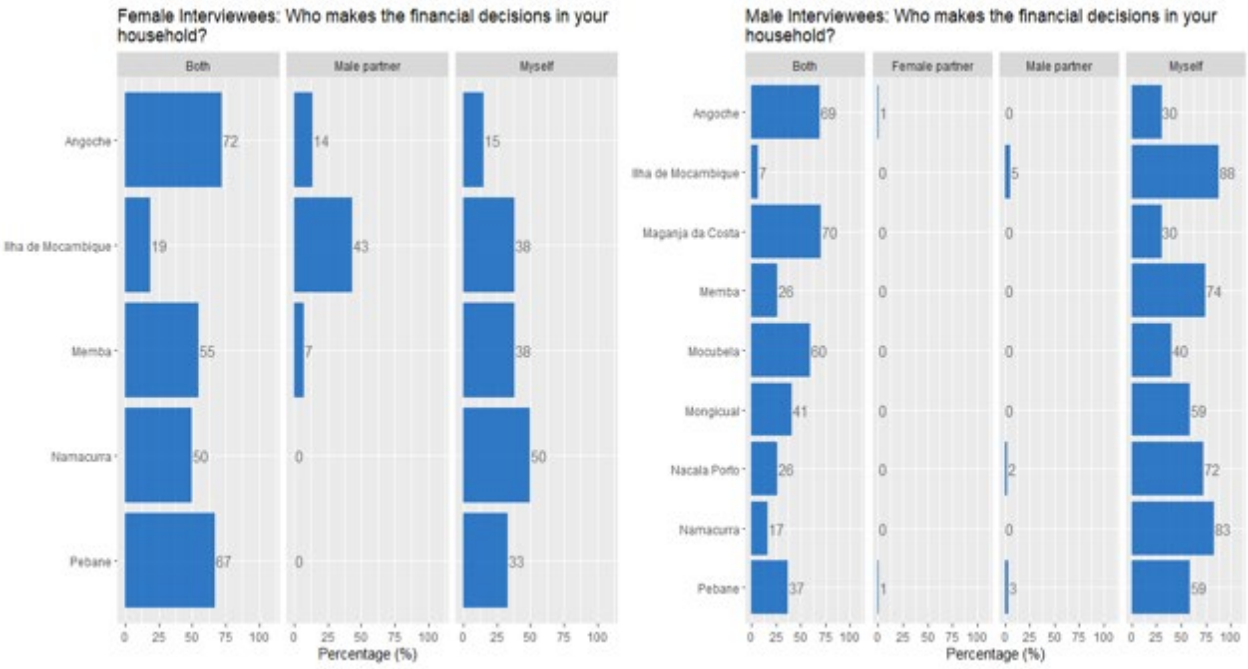


Figure 52. *Financial decisions - interviews by gender*

Food security and income

Most of the members of these communities depend heavily on fish catch for household income, complemented by farming (Figures 53). In Ilha de Mozambique, tourism has some relative importance, while in Memba and Pebane, aquaculture seems to have an emerging relevance as a source of income (Figure 54).

Food security is related to the ability of community members to continuously have enough food to feed their families. We found between 11 to 48 percent of fisher households that are confident that they will be able to procure enough food for them and their family for the next 12 months (Figure 54). Mocubela, Pebane, Namacurra, and Mogincual were especially alarming where over 40 percent of households reported not having confidence to have enough food for their families in the next 12 months. These districts have agriculture as their secondary income-generating activity with values between 25 to 50 percent of the answers. Mocubela, in particular, represented the largest proportion of agriculture as an income activity (more than 50 percent). In summary, food insecurity is not only associated with fishing, but mainly with agriculture, which is the second income-generating activity.

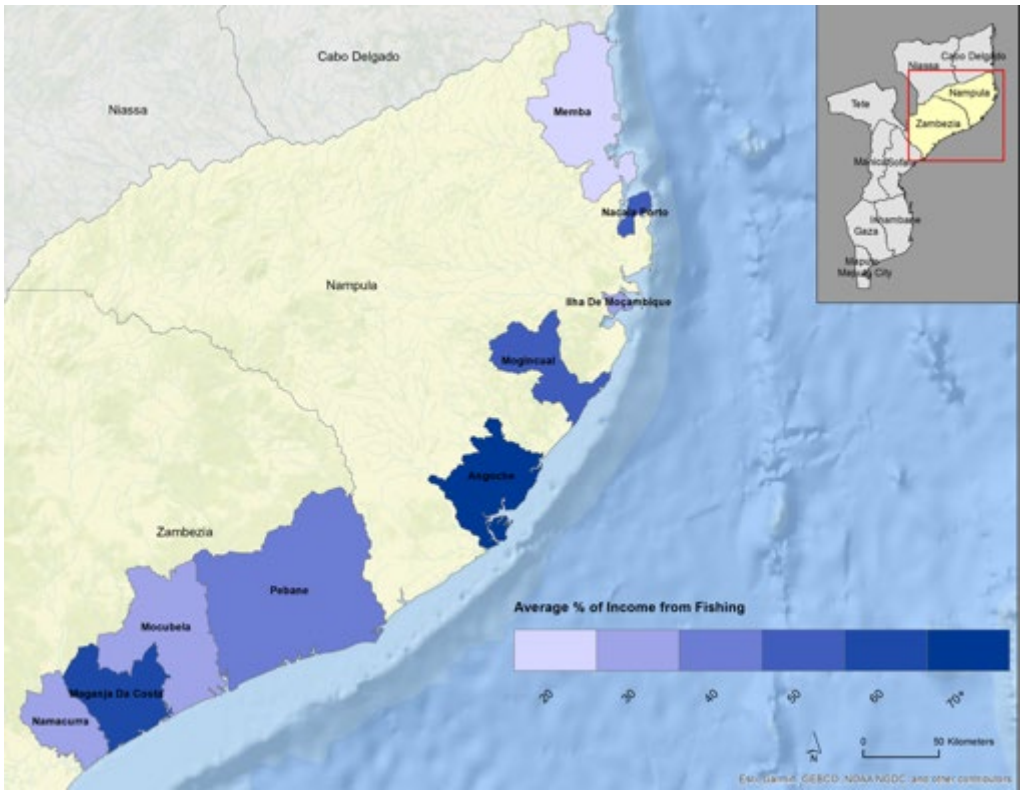


Figure 53. *Household income from fishing*

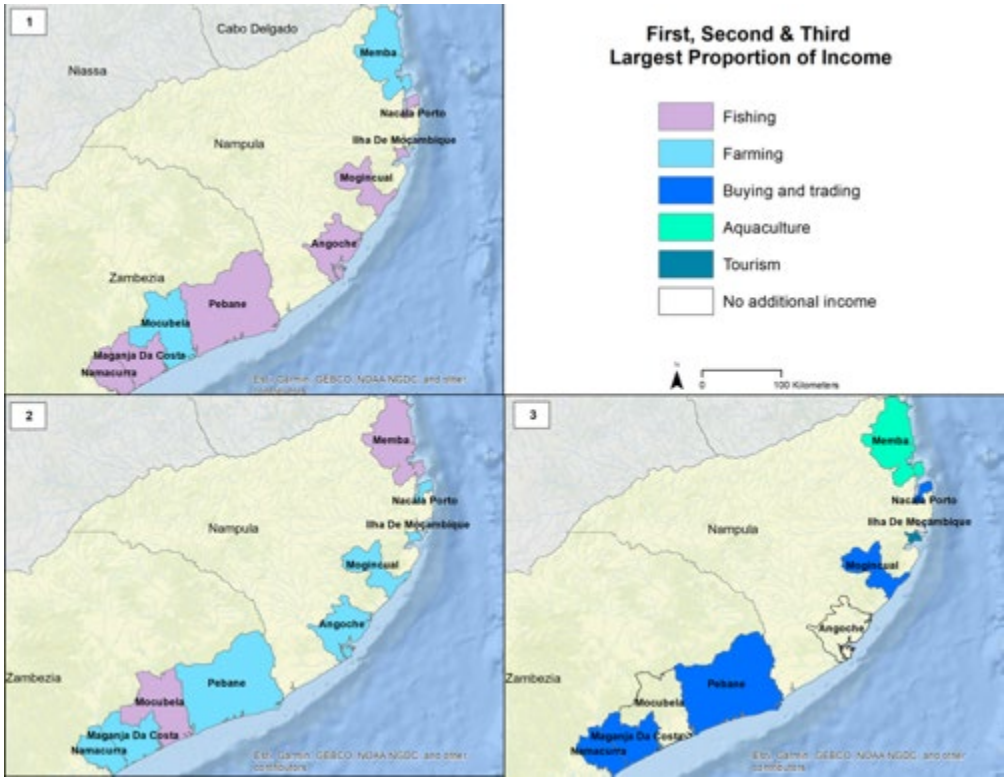


Figure 54. *Primary sources of income*

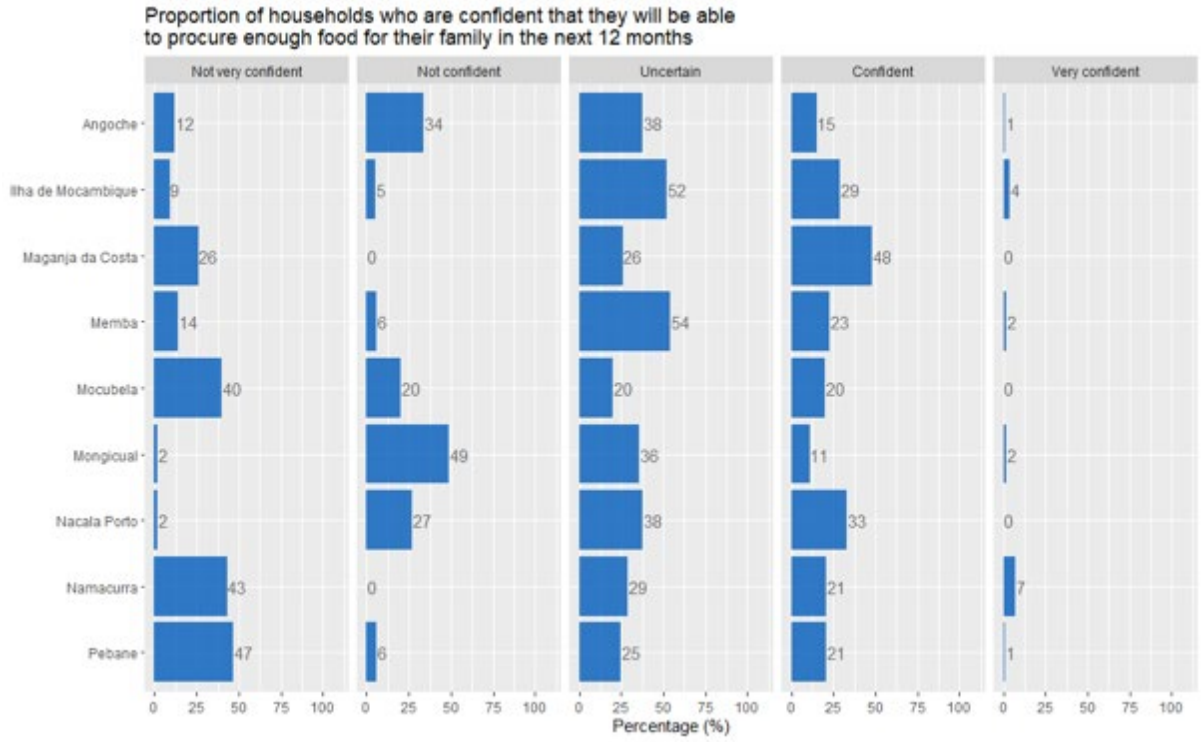


Figure 55. *Proportion of household's confidence in food security*

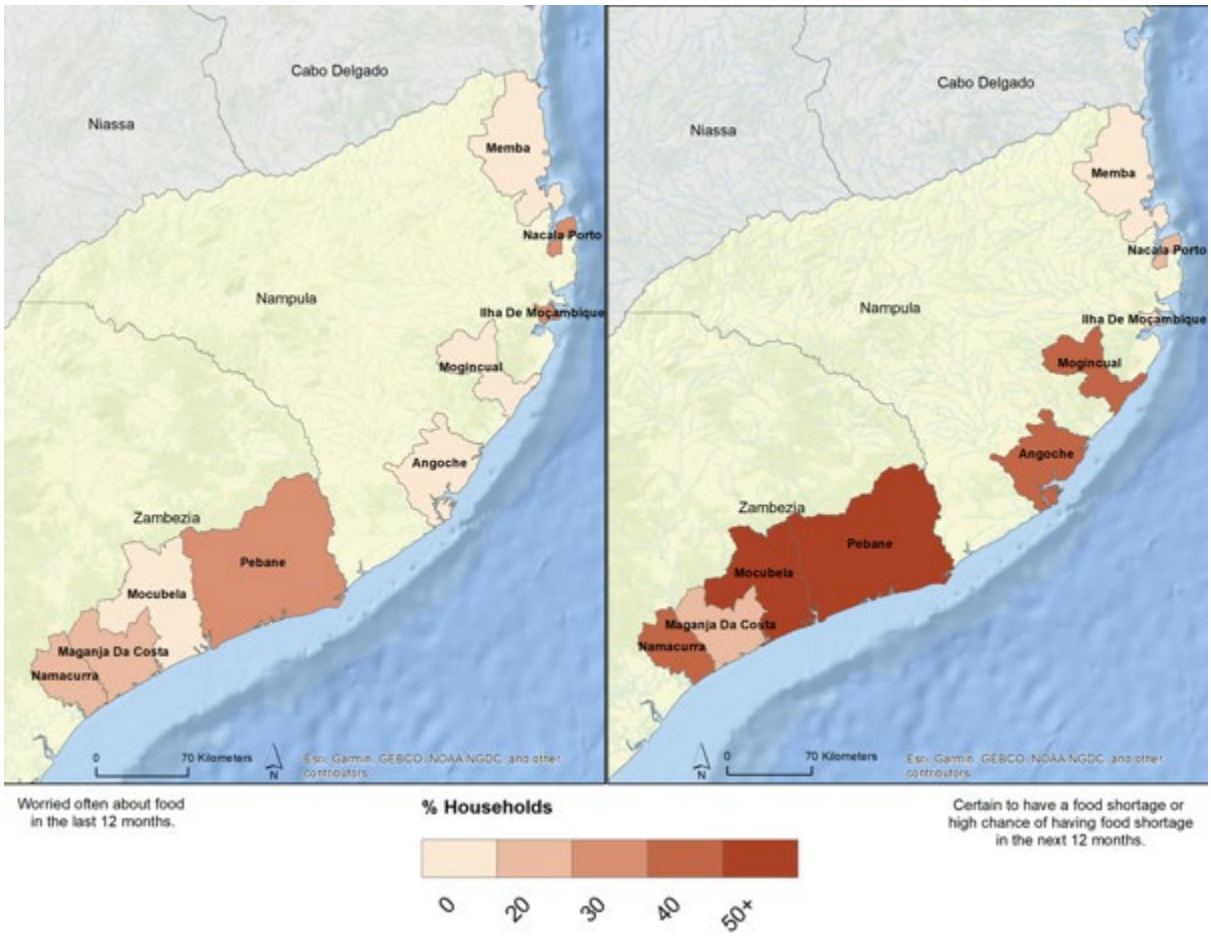


Figure 56. *Spatial representation of household perception of food security by district.*

Most of the respondents in four of the nine districts reported that they do not have sufficient income (men and women response combined) (Figure 57). Most of the female respondents in two of the five districts reported their household does not have sufficient income (Figure 58).

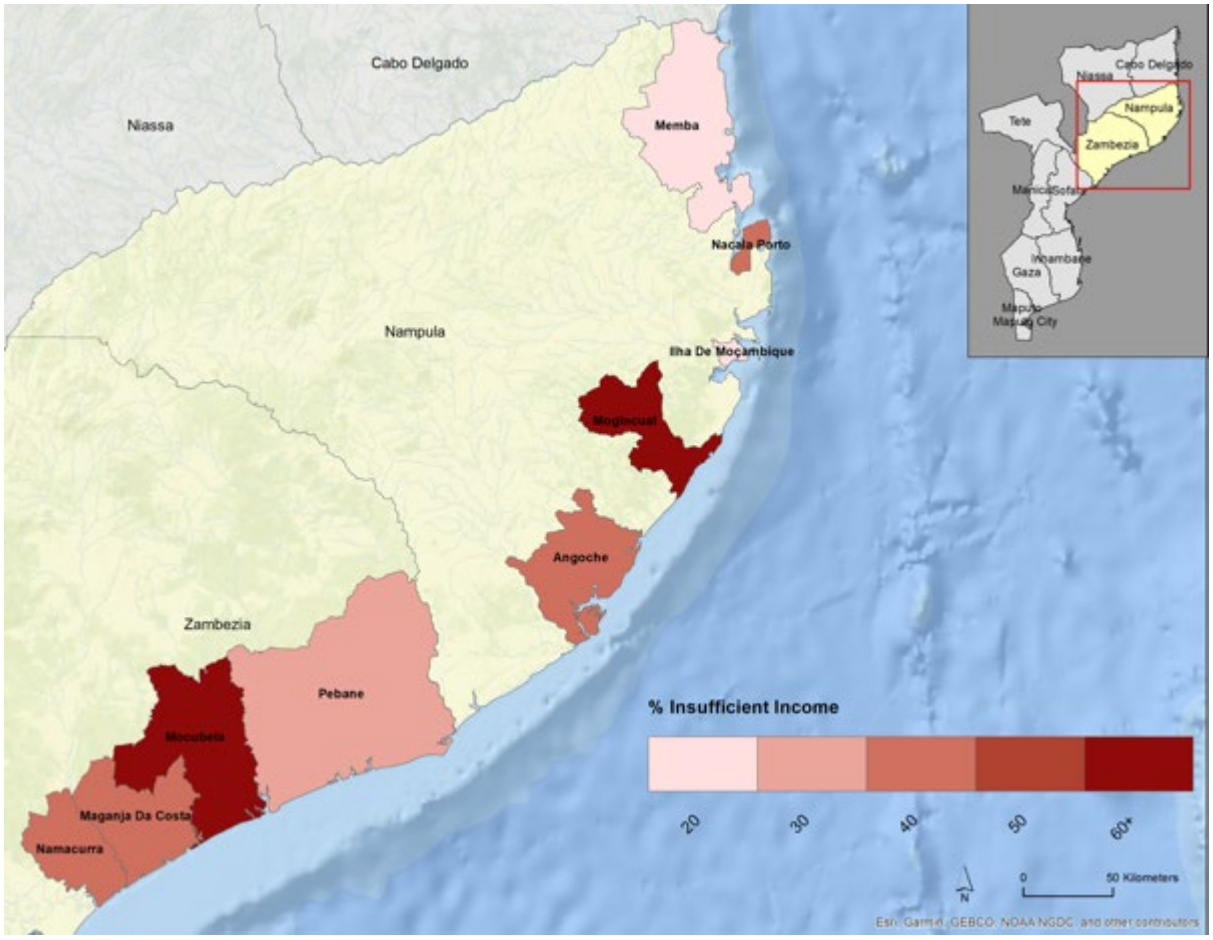


Figure 57. *Proportion of households that believe they have insufficient income to cover their family's needs.*

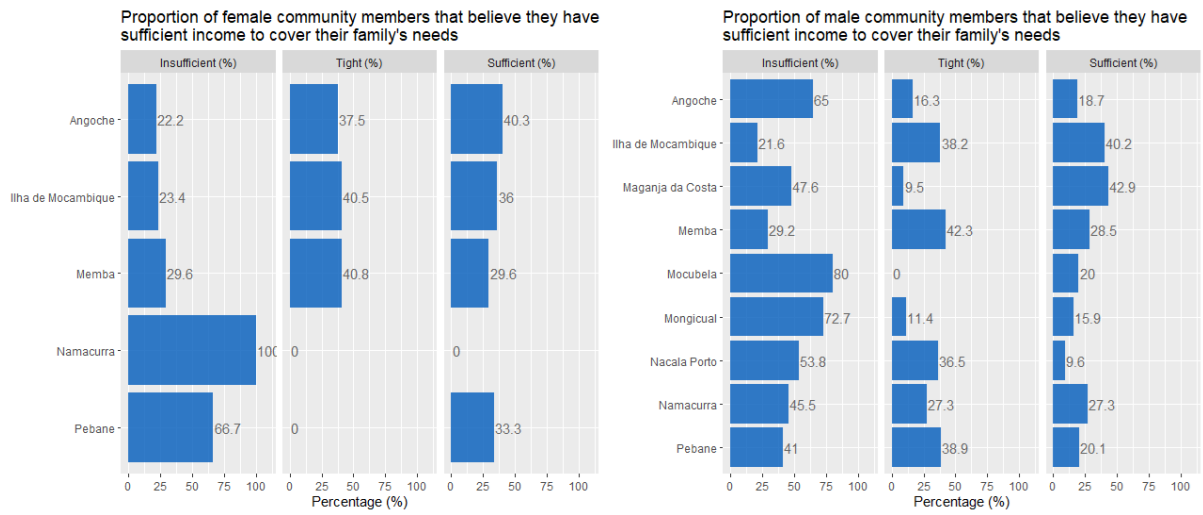


Figure 58. *Ability to cover family's needs disaggregated by gender.*

Average monthly incomes from all household livelihoods varied across the study area (Figure 59). Maganja de Costa and Mocubela are the places with the highest monthly income (above 30,000 meticais, equivalent to $500). Memba was the lowest average income with monthly values below the national minimum wage (<5,000 meticais per month, equivalent to $100), which also may be related to people immigrating to Memba from Cabo Delgado, without any support means.

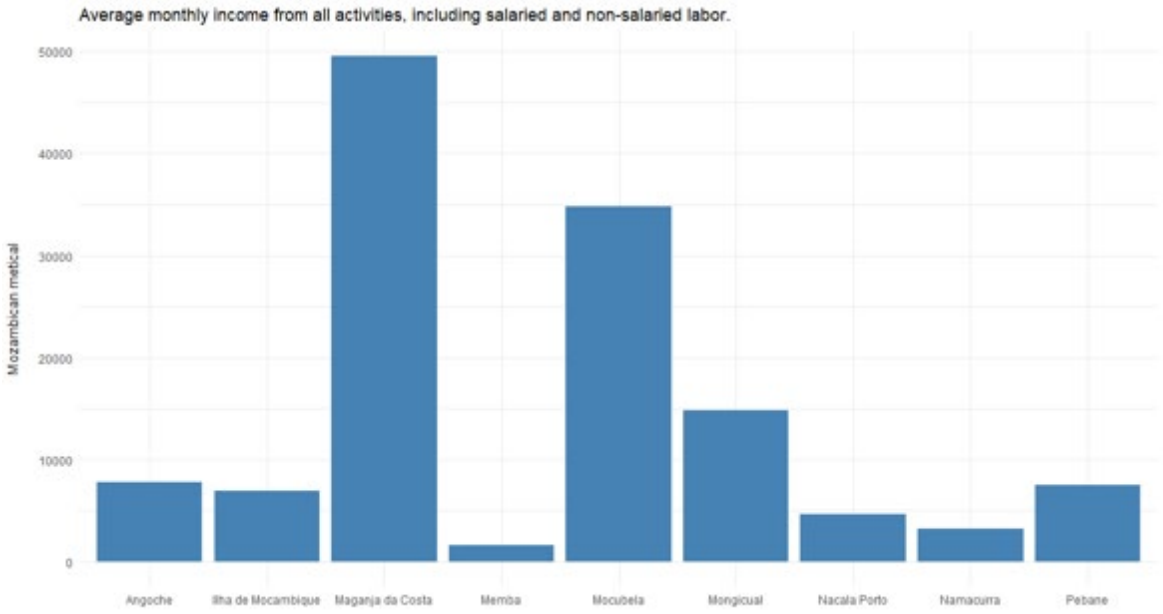


Figure 59. *Average monthly income from activities salaried and no-salaried labor*

The assets purchased in the last 12 months in Maganja de Costa, Mocubela, and Mogincual show high values (≥ 3%), which correlates with the highest average incomes (Figure 60).

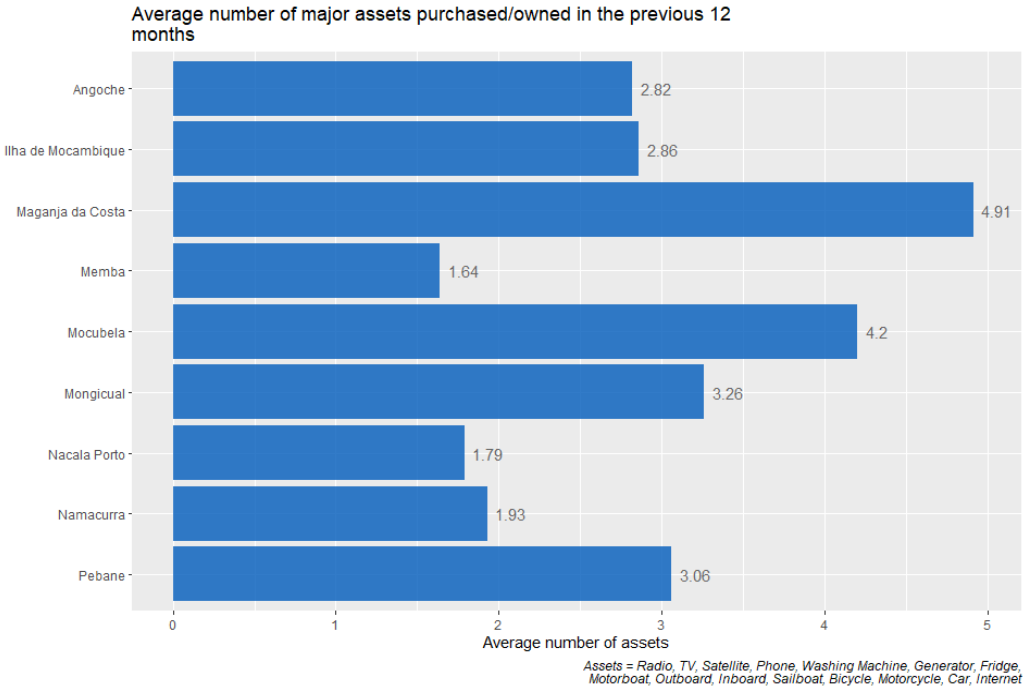


Figure 60. *Average number of assets purchased in the previous months by area*

Norms and Beliefs

- **Religion and fisheries.** The coastal communities in the Nampula province and Pebane (in Zambezia) are mostly Islamic where, for example, on Fridays after 11:30 A.M., there is no fishing activity because the communities are involved in the religious cult called Jumu'ah (Fridays are considered a celebration in their own right, and Muslims take special care in wearing clean clothes and preparing special meals on this day).
- **Beliefs**. There are reports of a belief associated with the sea, called **olomba**, characterized by offering flour, sugar, and coconut to the ancestors. This offering is left under a mangrove tree. The purpose of this ritual, only practiced by men, is a request for good catches in fishing.
- Most of the interviewees (54 to 80 percent) believes that they can manage their fisheries effectively. They believe in artisanal fisheries as an activity that generates incomes (Figure 61).

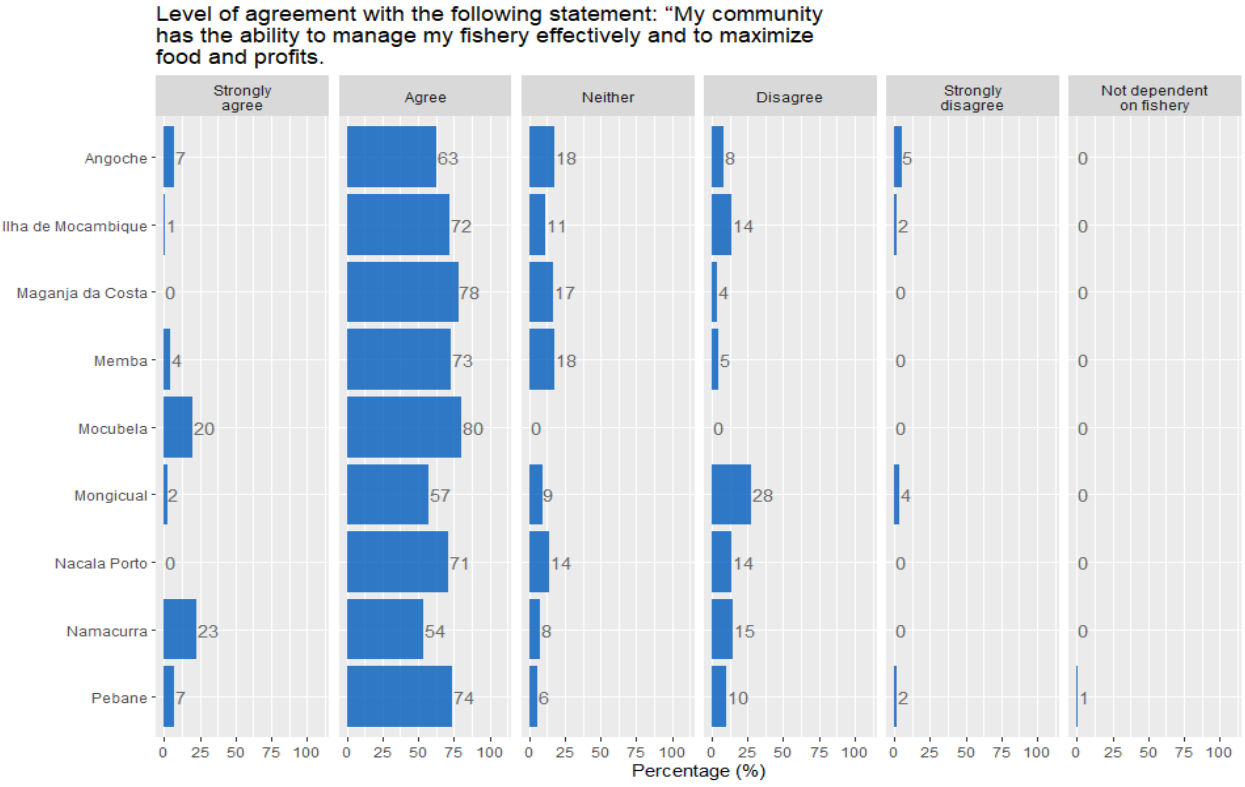


Figure 61. *Perception on community ability to manage fishery*

Socioeconomic Remarks

• There are important challenges of women participation in fisheries management bodies in charge of decision-making often associated with traditional and cultural barriers.

• Men have a more active role in artisanal fishing than women. Women and children are more involved in post-processing activities.

• Financial decisions in the household are made by the couple but more frequently by the man.

• The woman's main activity is taking care of the children and taking care of the housework, there is not much space for other family income activities. Because of this role of women, when they go to fishing centers, they go with their children, introducing them naturally to the fishing activity.

4.3.3 NUMBER OF FISHERS SUPPORTED

Based on findings from the stock assessment, fishery recovery model, and socioeconomic surveys, we estimated the number of fishers that could be supported by the fisheries across Nampula and Zambezia provinces under effective management strategies that reduce fishing effort. The number of fishers across the districts included in this analysis was approximately 89,700 in 2019 as reported in government census data. Household surveys revealed that only 25% of fisher households across the two provinces felt that their income was sufficient to cover their family's needs. On average, an average monthly income of approximately MZN 6,000 was reported by households that felt their income was sufficient and 49% of household income was earned from fishing. This suggests that MZN 35,280 per year from fishing is sufficient to cover household needs. We estimated catch value to be MZN 11,000 per metric tons (mt) based on household survey responses and government data. We also assumed that income from the fishery is earned by one fisher per household. Based on the annual income reported as sufficient and the value per metric ton, we estimate that each household would require 3.2 mt per year. Catch is not distributed equally amongst fishers using beach sienes and gill nets. Approximately 15 fishers split catch from one beach siene with the lead fisher taking 50%, the second in charge taking 25% and the remaining 13 fishers splitting 25% of the total catch. For gill nets the same is true for an average of 8 fishers per net. Hook and line fishers split catch equally among 3 fishers per boat. Lead fishers using beach sienes and gill nets and second beach siene fishers exceeded 3.2 mt per year in 2019. The remaining beach siene and gill net fishers along with all hook and line fishers did not meet this threshold in 2019 (Table 20).

We estimated a 1.2-fold increase in catch over 10 years resulting from a reduction in fishing pressure through gear restrictions and no-fishing zones based on findings from the fisheries recovery model. This represents an average increase across all species and districts and assumes a worst-case scenario where fish are depleted to 10% of unfished biomass. Using this assumption provides a conservative estimate of total fishers supported. Further analysis is recommended to determine precise predictions of the optimal number of fishers in each district.

Based on stock assessment findings and average fisher per gear, approximately 100,000 fishers meet a target fishing effort or number of gears per year of 75 percent of Fmsy. Fishing pressure is reduced in districts where overfishing occurring and can be potentially increased in areas where fish populations are stable. Managing the number of fishers based on maximum sustainable yield theoretically ensures the long-term sustainability of fish populations but does not necessarily ensure wellbeing or sufficient income for fisher households (Giron-Nava, 2019). Assuming a 1.2-fold increase in catch over the course of 10 years, only 26,500 fishers could be supported at a catch per unit effort of 3.2 mt/year. Given the current catch allocation structure for beach sienes and gill nets, it is unlikely that each fisher would receive equal catch in the future. When considering a 3.2 mt/year for lead and second fishers and a 2-fold increase in catch per year for all other fishers, the fishery could support 54,800 fishers (Table 20).

Table 20. *Number of fishers supported under the assumption that Fisher 1 and 2 (beach siene and gill nets) catch 3.2mt/year and all other fishers double their catch per year. Hook and line fishers are all assumed to catch 3.2 mt/yr.*

	2019				Year 10			
Gear	Catch (mt)	Fisher 1 (mt/year)	Fisher 2 (mt/year)	Other Fishers (mt/year)	Catch (mt)	Fisher 1 (number)	Fisher 2 (number)	Other Fishers (number)
Beach Siene	46,320	7.50	3.75	0.29	55,584	8,700	4,300	23,000
Gill net	14,738	4.39	2.19	0.17	17,685	2,800	1,400	11,000
Hook and Line	9,124	1.13	1.13	1.13	10,948	1,200	1,200	1,200

To maximize the number of fishers supported, effective fisheries management that increases catch should be coupled with efforts to reduce the catch volume needed to earn sufficient income. For instance, if the mean value of catch doubles, the volume needed to cover the family's needs decreases to 1.6 mt/year and the number of fishers supported increases to 75,300 under the assumption that the lead and second fishers catch 3.2mt/yr and all other fishers double their catch per year. Approximately 105,000 fishers could be supported if the catch needed to sufficiently support the household decreased to 0.8 mt/yr. This could be accomplished by increasing the catch value that is retained by fisher households, diversifying income sources, securing access to loans, and/or building fisher household savings. Access to financial services, opportunities to develop small businesses, and financial management skills are critical for securing fisher livelihoods and financial resilience particularly for fishers that do not lead fishing efforts.

5. VIOLENT EXTREMISM AND MIGRATION

The socioeconomic dynamics related to migration movements recorded along the coastal zone of the country, particularly in Nampula, Zambezia, and Sofala, was recently reported (IDEPA, 2017). According to this study, massive movements of artisanal fishermen have been recorded in the coastal region of the provinces of Nampula, Zambezia and Sofala, also reaching the province of Cabo Delgado in the north and with trends for the Southern region, especially the province of Inhambane and Maputo. This phenomenon is evidenced by the number of fishermen involved and the fact that they carry gear, vessels including crew. Nampula is distinguished mainly as a place of departure of migrant fishermen. The cause of the country is the reduction in the stock of fishing resources in certain regions of the country, especially Nampula from which migrant fishermen depart, mainly for beach trawler fishing. Although the above study characterized this movement as being from the north (Nampula) to the south (Zambezia and Sofala), during the fieldwork of the present study, oral sources reported a situation of migrate in the south-north direction (Zambezia, mainly since Namacurra) in some cases in dubious circumstances. Testimonials refer to young fishermen in the district of Namacurra, administrative post of Macuse that in an attempt to travel north, without a guide passed by the Community Council of Fisheries were paraded by the police at a road checkpoint having not been able to document or justify to the police on the reason of travel of a large group of young people. Mobilization and recruitment are organized by the owners of fishing units (also known as bosses) who act directly as main actors in mobilization and recruitment.

Employers sometimes rely on the involvement of reference people in the communities that establish contacts and identify interested fishermen. Between the owners of the fishing units and the fishermen recruited, they establish verbal agreements, in which the working conditions are defined, which boils down to the agreement of the period of their duration and how to share the income generated during the marketing year. On the other hand, the agreement is confirmed when the boss makes an advance of a certain value to the fisherman (ranging from 1,000 to 2,000 MT) which, the fisherman leaves with his family at the time of his departure. This amount is estimated by the employer, the later, when the division and distribution of the income acquired during the campaign is made. IDEPA, 2017 points out that migrations occur conditioned by a varied set of factors of a political, economic, social, cultural, and environmental nature associated with moments of instability or crises, but also with the existence or emergence of opportunities in other places with a stay that varies from six months to five or more years, and the longest ones remained those made outside the province.

Asked whether the violent extremism observed in the north of the country, affects the well-being of local households in Nampula and Zambezia, more than 50 percent of the responses in Nacala Porto, Pebane, Mocubela, Maganja da Costa and Namacurra, agreed that terrorism affects the community (Tables 21 and 22). Relatedly, in the value chain interviews, more than half of the fishers and buyers in most districts are concerned about the violent extremism in the north affecting their communities. Buyers in Memba are especially concerned about the violent extremism, with 58 percent reporting that it is negatively affecting their income now and 83 percent reporting they think it will affect their income in the future. All districts show an increase in concern when comparing how violent extremism is affecting their food and income now versus how it will affect those dimensions in the future.

While most fishers and buyers are aware of fisher migrations out of the community, they are not particularly concerned about it. When asked why the fishers were leaving the communities, the majority of buyers and fishers reported that fishers were seeking areas with higher catch and none reported there was a connection to violent extremism events (refer to Annex C).

Table 21. *Proportion of households who disagree or agree with the following statement: "I am concerned about the violent extremism in the North affecting may community."*

Districts	Strongly agree (%)	Agree (%)	Neither (%)	Disagree (%)	Strongly disagree (%)
Nacala porto	11	63	0	5	20
Mogincual	35	7	0	2	57
Angoche	23	8	36	11	21
Pebane	21	32	21	24	1
Mocubela	20	40	0	40	0
Maganja da costa	26	65	9	0	0
Namacurra	7	50	14	21	7

Table 22. *Proportion of households who think violent extremism in the north is affecting income and food availability*

District	Negatively affecting income (%)	Negatively affecting food availability (%)
Nacala porto	57	30
Mogincual	89	71
Angoche	46	45
Pebane	11	0
Mocubela	0	0
Maganja da costa	0	0
Namacurra	29	7

It is important to understand the movement of fishers and fishing boats up and down along the Mozambican coast within the context of history, culture, fisheries resource availability, climate, and ecology. Historically, the fisher communities of the northern Mozambican coast fall into the Swahili group of languages, and, in fact, from Quelimane all the way to Cabo Delgado, seven kingdoms (sultanates) were established by seven brothers who came from Shiraz in Iran roughly around the 1400s. These were Muslim sultanates, which interbred with the local Makua tribes on the coast and the interior, creating modern Mozambican Swahili culture as we know it today, from the Koti in Angoche to the Muani and Makwe in northern Cabo Delgado. Thus, there are historical, linguistic, and cultural commonalities all along the coast.

Movement along the coast was and is enabled by the fact that winds in the dryer winter months generally blow from the south to north (April through September), while winds in the wetter, summer months (October through March), blow from north to south. This is true all along the coast from Sofala northwards and was one of the prime reasons that first millennium Arab seafarers were able to reach Sofala. To this day the season change in wind direction facilitates commerce as well as fishing, with boats moving north when the south winds are blowing north.

The reason for this change has to do with the movements of the intertropical convergence zone (ITCZ), from north to south and back again on an annual basis. The ITCZ brings rain southwards to southern Africa during the wetter summer months (Ziegler *et al*., 2013).

The availability of fish is also another important factor. Areas that have been highly populated by humans for many years, such as Ilha de Mozambique and the Nacala region are overfished (as their correspondingly low catch per unit effort as documented in this report shows) and fishermen from these areas move both North and South in search of fisheries resources. For example, during the early years of the establishment of the Quirimbas National Park, it was found that for every local fishers camped in the islands, 20 fishers had come north from Nampula, in search of better fish capture.

During surveys for the creation of the Vamizi Island Tourist resort, a similar phenomenon presented itself, with fisherman camping for years in the same locations, forming semi-permanent villages.

The ongoing conflict in northern Cabo Delgado has displaced some of these semi-permanent fishers from their preferred fishing waters back to their home waters. Anecdotal information from the Institute of Disaster Management (INGD) in September of 2021 suggested that there were significant numbers of internally displaced people from conflict areas that did not in fact go to refugee camps, but instead returned to their permanent homes along the Nampula coastline. Thus, these internally displaced people suffer economic displacement, not actual physical residential displacement. However, effects on their livelihoods and the livelihoods of their host communities are significant and contribute to overfishing in these areas. It is likely this impact that most respondents are referring to when they indicate concerns that violent extremism will have on their livelihoods; no evidence of active violent extremism has yet been reported in Nampula.

Movement up and down the coast from Angoche south to Quelimane is also a historical phenomenon, as fishers here also follow the seasons and the winds in search of better fishing resources. This area represents the swamp coast of Mozambique, a coastline characterized by mangrove swamps, sand beaches, and turbid waters as a result of the discharge of multiple rivers and estuaries. This is in contrast to Nacala northwards, which is known as the coral coast, and has coral, sand and rock substrates, with deep underwater cliffs and canyons. Fishermen move freely up and down the coast searching for concentrations of fish, which also move up and down the coastline. The MIMAIP has established Community Fishing Councils to manage each CCP's home waters, however, current fisheries legislation does not allow CCPs to deny entry to outside fisherman, so access is open for all, creating risk of the tragedy of the commons.

Thus, movement of fishers and fishing boats is a long-standing phenomenon. This survey was able to confirm that this is still occurring but was unable to establish any link between these movements and participation in violent extremism.

However, this does not mean that there does not exist a vulnerability to the lure of extremism within the youth of Mozambique. Our survey documented the fact that young men without prospects would sign on with fishing boat captains for anywhere from 6 months to five years. Prior research has indicated that the young men of the crew share in half of the catch, while the boat captain takes the other half. If 8 to 10 people are needed to pull a beach seine (for example), and a day's worth of effort yields less than 12 kilos of fish (as per our results in Nacala), then each young man will receive less than a kilo of fish in return for a day of backbreaking effort pulling beach seines by hand. It is a real question whether the caloric value of fish received is higher than the caloric value expended while pulling the nets. The simple fact that young men agree to such long contracts for such small returns indicates a degree of desperation that makes them vulnerable targets for any sort of violent extremism, whether political (as in the centre of Mozambique) or religious (as in the north).

6. OVERVIEW OF FISHERIES DEVELOPMENT PROJECTS

Several fisheries and aquaculture sectoral development projects have been implemented and are being implemented in the coastal region of Nampula and Zambezia to benefit fisher communities. Historical records date back to 1994 when the first major artisanal fishing project for the districts of Angoche, Moma, Mogincual and Pebane, was launched, marking the beginning of integrated development projects. These projects were funded by external partners but implemented by the government. They included in addition to improving fishing activity, access to other basic infrastructure such as access to water, health, access routes and education. After 2001, new projects expanded their geography to encompass the entire region of Sofala Bank, focusing on the diversification of the fisheries value chain and the consolidation of fisheries extension services and the capacity of fisheries research in coastal districts.

From 2011 to 2019, and in an attempt to leverage success from the two previous projects, two new projects were implemented by the government in the entire coastline of Mozambique with partial funding from international funding. The new project coincided with changes in the government administrative system of the country, resulting in the extinction of the former Ministry of Fisheries and its replacement by a new ministry with a wider mandate, the Ministry of the Sea, Inland Waters, and Fisheries. Along with this new ministry some line institutions also were extinguished or repurposed. The former IDPPE, an institution that was responsible for the development of artisanal fisheries in Mozambique, was replaced by IDEPA, an institution with a higher mandate, that in addition to artisanal fishing, it must also be responsible for the development and promotion of small-scale aquaculture (ii) the extinction of the provincial delegations of the IDPPE, passing the responsibility to the provincial fisheries directorates (iii) the transfer of responsibility for the collection of statistical information of artisanal fisheries from the IIP to MIMAIP, and the entry into force a new system for data collection named (ARTFISH), still in the experimental phase, which substantially decreases the quality of information available. On the positive side, there is a greater consolidation of artisanal fishing research, with the beginning of the mapping of fishing grounds, the assessment of resources by regions and the preparation of surveys of marine species never before monitored such as mangrove crab, octopus, and other invertebrates. Over this period (2011-2019) the government, with support of development projects promoted new activities, including nutrition and food security, still in a very incipient way and promoted artisanal fishing in more offshore areas by financing, better motorized boats, creating more opportunity for fishermen and with the intention of reducing the fishing pressure along the coast. Those projects also integrated infrastructure components: building or rehabilitating access roads to the main fishing centers and building first-sale fish markets with freezing capacity.

Only after 2015, development projects emerged based on an approach that incorporates climate change resilience actions and limited studies of ecosystems and biodiversity. Projects at this stage are being funded to local and international NGOs and less to government services, probably as a result of changes in funding strategies by international development partners. Table 23 presents a summary of the main development projects implemented in the artisanal fisheries sector in Mozambique.

Table 23. *Main fisheries development projects in Nampul and Zambezia*

Project name	Project scope	Source of funding	Project duration	Project geography	Outcomes and lessons	Comments
Ppan- artisanal fisheries project for nampula /projecto de pesca artesanal de nampula	Integrated project for improving small scale fisheries livelihoods	FIDA	1994-2001	Angoche, Moma, Mogincual (Nampula) and Pebane (Zambezia)	(i)First integrated development project for small scale fisheries (ii)Community Fisheries councils engagement (iii)Fisheries extension work-start of fisheries extensionist (iv)women empowerment	Managed by IDPPE; Closed
Artisanal fisheries project for sofala bank/projecto de pesca artesanal do banco de sofala (ppabas).	Improvement of socio-economic conditions of fisheries communities	FIDA	2002-2011	All districts in Sofala Bank (Angoche, Moma in Nampula, all coastal districts of Zambezia and Sofala)	(i)Fish value chain diversification (ii) credit for fish value chain, (iii) social infrastructure and services (primary health, education, water) (iv) strengthening of institutional capacity of government;(v) Strengthening of fisheries extension network	Managed by IDPPE; Closed
Prodirpa -project for strengthening of acess rigths to fishing resources by artisanal fishers/ projecto de reforço dos direitos de acesso aos recursos pelos pescadores artesanais	*Community empowerment for natural resource management:*	Belgium Fund for Food Security; IFAD; Mozambique government	3 years (2014-2016)	All coastal districts of Nampula, Zambezia and Sofala.	(i) Advocacy and knowledge transfer on access rights to natural resources, (ii) territorial mapping and land use planning and first approach on climate change in artisanal fishing	Managed by IDPPE/IDEPA; Closed
Propesca-project for promotion of artisanal fishing/ projecto de promoção da pesca artesanal –	Integrated project for improving livelihoods. Increasing the volume of higher value fish on a sustainable basis, and increasing the yields	FIDA, OPEP, EU, Mozambique government	7 years (2011-2019)	Entire coast of Mozambique with focus in 30 "development poles"	(i) Improve fish value chain (ii)Fish support infrastructure (first sale markets and access roads)	Managed by IDPPE/IDEPA; Closed; Maintenance of project infrastructure by

	obtained from marketed fish.				(iii)consolidation of associativism (iv)trainings on nutrition and food security	government has been challenging
Ppamc/fishcc- project for artisanal fisheries and climate change adaptation/projecto de pesca artesanal de adaptação às mudanças climáticas	Small scale fisheries co-management, access rights, livelihoods and climate change resilience; piloting community managed-access and reserve	Nordic Development Fund (managed by World Bank)	4 years (2015-2019)	Memba (in Nampula)	(i)Piloting community management areas, no-take reserves & control measures (ii) Preparing fisheries co-management plans (iii) Introducing the fisheries co-management governance framework into Mozambique legislation (iv). Effectiveness of social marketing approaches (v) Role of livelihood initiatives in fisheries co-management	Managed by IDPPE/IDEPA but implementation outsourced to international NGO Rare; Closed
Crcc- coastal resilience for climate change project; projecto de reforço da resiliência em comunidades vulneráveis na zona costeira em moçambique	Capacity building in natural resource management; livelihoods, climate change; community managed-access and reserve	Embassy of Sweden	4 years (2018-2021)	Nampula – Memba	(i)-Fisheries and natural resources management plans (ongoing) (ii) community management areas, no-take reserves & control measures; climate change and socio economic resilience (ongoing)	Co-managed and co-implemented by government: MIMAIP, NGOs: IUCN and Rare Ongoing (closing in 2021)
Swiofish1 mz -project for fisheries governance and shared growth /projecto de governação e crescimento partilhado das pescarias –	Improve social, economic and environmental benefits from maritime fishing; fisheries co-management; community managed-access and reserve	World Bank	3 years (2019-2021	Nampula province (Angoche, Moma*, Mogincual, Larde and Liupo); Zambezia (Pebane*, Mocubela, Maganja da Costa, Namacurra, Quelimane); Sofala (Dondo*) *Focus districts	()-Fisheries and natural resources management plans (ongoing only Pebane and Moma) (ii) community management areas, no-take reserves & control measures only in Pebane and Moma	Managed by MIMAIP; implementation outsourced to NGO WWF Ongoing (closing in 2021
Project for development of small scale aquaculture/projecto de	Small scale aquaculture development	$49 M , of which IFAD $43 M, Mozambique	5 years (2021-2026)	Nampula: Mossuril, and Larde..	N/A	Ongoing

desenvolvimento de aquacultura de pequena escala		government $3.1 M; beneficiaries $2.9 M		
Mais peixe	Improve fish value chain through credit		Improve the income level of traditional fishermen, in a sustainable way, with growing connections with new or existing markets; • Promote micro, small and medium enterprises (MSMEs) • Raise awareness among economic actors about the need to align the development of economic activities with the sustainability of marine resources.	Ongoing

In addition to development projects, promoted by the public sector and external financing, there are other initiatives led by civil society in the region. Table 24 indicates some of these initiatives. Only civil society projects, are more focused on biodiversity conservation and formal conservation areas with some activity in fisheries, but in this case, based on the empowerment of community fisheries councils and advocates.

Table 24. *Some projects managed and implemented entirely by NGOs in Nampula and Zambezia province*

Location	Institution	Project scope	Comments
Angoche as moma	Wwf-care	Fishing management Co-management Rehabilitation of habitats	2008-2018
Angoche-moma-larde-pebane	Wwf	Support for the establishment of apaips with a focus on the accoes of the marine ecosystem	Active • Mangrove restoration • Support for CCPs in local management
Angoche as moma-larde-pebane	Wwf	Shrimp accompanying fauna	Early forecast 2022
Old nacala	Cln	Livelihoods of the communities affected by the installation of the coal transshipment harbour	Active • Fishing in the open sea • Support for CCPs in local management
Mossuril and ilha de mocambique	Oikos	Environmental and social resilience of coastal communities	Active
Ilha de mocambique	rare	Establishment of community management areas and no take reserves; behavior adoption	Active
Memba	rare	Establishment of community management areas and no take reserves; behavior adoption	Active
Memba and mossuril	Wcs	Establishment of marine conservation areas tailored to the commission on biodiversity objectives	Late 2021 forecast

Geographically and over time the region with more presence of development projects, is between Angoche and Pebane. The higher fishing activity in this region and the marine conservation area in the region are the factors that seem to dictate this preference.

In the northern section of the study area, there is a growing involvement of projects in Memba district, motivated by the occurrence of demersal fish of commercial value, coral and mangrove ecosystems that are being targeted for better management and conservation. In this area, and according to verbal reports, the region of Cabo Delgado, which has become a risky area due to security concerns, has been losing investments.

The Ilha de Mozambique district, despite having a large population density, is a world heritage site; few fisheries and marine conservation projects have also been assigned. Similarly, in Zambezia, particularly in the region between Maganja da Costa and Chinde, there is little presence of integrated projects and social and economic support to artisanal fishermen. While there is an

important mangrove ecosystem and diverse fisheries. Poor access routes in and to Chinde and Inhassunge can be a limiting factor.

7. EXISTING MANAGEMENT MEASURES: LESSONS LEARNED AND PERSPECTIVES

In Mozambique, artisanal fishing is generally an activity that operates on an open access regime. This means that there are no limits on the number of entries and there are no catch limits (bag limits). The main management measures are concentrated towards high-value, export oriented resources including shrimps, that entail closed seasons affecting beach seines that are known to target these, as well as closed seasons for mud crab, resources that have a growing fishing pressure. In the artisanal fisheries, general management measures include mainly requirements for licensing, mesh size and indication of gears that are allowed to fish, and area zoning. Artisanal fisheries have an exclusive access zone within 3 nautical miles of the coast, where other fishing sectors, mainly the industrial, cannot operate.

The maritime fisheries regulation (REPMAR) is the legal framework that establishes regulatory measures for fishing in Mozambique. This regulation was recently revised (Decree 89/2020 of 8 October) with a number of novel legal provisions for fisheries participatory management adopted. REPMAR introduces the following new provisions:

- Participatory fisheries management principle adopted as preferential model (article 21).
- Provision on access rights for fishing communities to protect and promote their wellbeing (article 21).
- Concept of community-managed fishing area (article 23), which enables some form of managed-access or limits the open access regime.
- Co-shared responsibilities (Government and Fisheries Community Councils) to implement, in the community-managed fishing area, the management measures contained in the artisanal fisheries management plans (article 23).
- Trawling in coral areas with any type of fishing vessel is prohibited (article 54).
- Ban of beach seining to become effective in 2024 (article 52).
- Introduces fisheries resource recovery/conservation zones managed by communities (equivalent to no-take reserves) (articles 149, 151, 152).

In summary the new REPMAR, strengthens fisheries participatory management and access rights to artisanal fisheries by recognizing and empowering the Community Fisheries Councils, as the community-based organization in charge of representing the local fisher community when it comes to fisheries management and in the co-management fora at all administrative levels, subnational and national . While the CCPs were trialed in the 1990's they were first legalized recognized in 2004, having their roles and responsibilities now better articulated under the 2020 REPMAR.

There are 57 CCPs established in the two provinces. Table 24 summarizes their numbers by location, leadership and other statistics. The government and its development partners have been working to support both technically and logistically the CCPs, including their electoral process, to make it better gender balanced, now with women in CCP decision-making averaging around 24% (range 0-56%). Districts to the South of the study area (Maganja da Costa-Chinde), have had lesser gender balance, and lower performance scores, coinciding with areas that have less benefited from development projects.

Table 25. CCP statistical information in Zambezia and Nampula provinces

		Leadership membership			Performance score by ADNAP in 2020		
District	Nr of CCPs	Men	Women	%women	deficient	fair	good
Memba	4	45	17	37,8	1	3	
Nacala Velha	2	22	7	31,8		1	1
Nacala Porto	2	29	11	37,9		2	1
Mussoril	3	32	14	43,8		2	1
Ilha de Mocambique	3	38	20	52,6		1	2
Mogincual	2	29	9	31,0		1	1
Liupo	2	21	8	38,1		1	1
Angoche	6	84	19	22,6		2	4
Moma	10	132	29	22,0	2	4	4
Pebane	9	199	26	13,1	1		8
Mocubela	3	34	13	38,2	1		2
Maganja da Costa	1	19	1	5,3	1		0
Namacurra	1	29	1	3,4			1
Quelimane	4	56	11	19,6	2		2
Inhassunge	1	12	0	0,0			1
Chinde	4	75	12	16,0	1		3
Total	**57**	**781**	**186**	**23,8**	**8**	**17**	**29**

(Source: Adapted from ADNAP).

The implementation of the banning of beach seines, as part of the new provisions of REPMAR, is being analyzed by the government. During this study, ADNAP representative (Mr. Joaquim Tembe) indicated that the government is preparing a strategy and action plan to address the banning of this gear, including estimating potential socio-economic impacts. This is because, as shown in this report, beach seines are estimated at 5,268 units in Nampula and Zambezia alone, employing over 47,000 fishers and contributing with 53% of catches (51,641 metric tons per year). This banning is obviously justified by the known environmental impacts of beach seines including degradation of critical habitats, low selective standards for species and size. Even for other gears, recent studies by the Institute of Fisheries Research (IIP, 2020), indicate that in some places the characteristics of fishing gear are outside the limits established by law, including the use of mosquito nets, part of which are distributed in the communities by the health services to fight malaria (see section above).

There are ongoing engagements between ADNAP, partner NGOs Rare and WWF and local CCPs for the development of the first ever artisanal fisheries management plans in 9 districts of Mozambique, including 4 in the provinces of Nampula and Zambezia Memba and Ilha de Mozambique (both by Rare), Moma and Pebane (by WWF). These management plans identified community managed access areas and no-take reserves within 3 nautical miles of the coastlines of each district (Table 25). This new legal feature is expected to be rolled out across the coastal districts of Mozambique with support of development partners, which is expected to improve fisheries management while balancing exploration with protection.

Other protection initiatives in the region of the Primeiras and Segundas arquipelagos include the creation of marine sanctuaries or areas of total protection, under the management plan of the APAIPs. In the area of Nacala Porto, on the initiative of a tourist enterprise, an artificial reef was created, with a fishing closure that directly benefits tourism.

Table 26. *Management measures by fishing activity*

Fishery	Main management measures	Legal framework
Artisanal shrimp fishing	• Established mesh size (38mm for beach seine) *.	Repmar-article 170
	• Zoning: -trawling on board - exerted beyond 0.5 miles from the coast; - beach-seining - exercised 1/4 of the mile from the coast*.	Repmar, 2020
	• 5-month closed season (sofala bank)	Annual ministerial decree, according to recommendations from research
Mangrove crab (scylla serrata)	• 3-month closed season	Annual ministerial decree according to recommendations from research
artisanal fisheries in general	Management plans for artisanal fisheries are foreseen. [there is currently no approved management plan. In the study area are in preparation the management plan for pebane, moma, memba and mozambique island.	Initiative with a framework in the repmar, but still without implementation on the ground
	Community management areas there are local initiatives in areas of community management of total exclusion of fishing activity. Legally no area has been declared.	Initiative with legal framework but still without effective implementation on the ground
	Sanctuaries in the first and second islands, promoted by civil society and with the effective involvement of community fisheries councils. Legally this initiative is part of the management plan of apaips	Initiative with local participation and involvement of local governments. With framing within conservation legislation.
	Artificial reefs: nacala porto. An area that took 10 years to be populated by marine species and closed to fishing. It was initially created to benefit tourism (diving), but currently the system has evolved and involves the supervision and patrol of the area by the local community, and it has the right to fish in defined periods for this purpose.	Initiative that had no legal framework in the past and was done by private initiative. There is currently legal framework in repmar.
	Coral reefs: prohibited trawling on coral reefs	
	Mangroves: prohibited mangrove cutting	

A general assessment of the management framework is that although there are formal and informal measures established, their implementation has been deficient, resulting in high exploitation levels of fishing resources due to undergoing localized pressure. This pressure is caused by following:

1. Use of small meshes for inappropriate trawling, even using mosquito nets
2. Use of unregulated gears such as *quinias* and *chicocotas*. Because they are illegal activity, their record and magnitude of the problem is not known.
3. Degradation of the mangrove ecosystem, mainly around large human clusters, that may be compromising nursery grounds for important fish and crustaceans.
4. Failure to comply with the maximum length limits of the gill nets and beach seines (even within areas where there are community management measures under implementation).

In some places there are formal campaigns carried out by government authorities, and NGOs and in other areas, becoming common, the involvement of CCPs in the surveillance and enforcement activities. Since the surveillance and enforcement campaigns depend on the financial resources involved, it is not a continuous activity. Several violations are possible to see, during the course of fishing activity (corroborated by the socioeconomic surveys).

With the exception of mangroves, which has recently received high visibility for its conservation, other habitats remain without any special protection measures, especially outside the MPAs. The lack of surveillance in remote areas (*e.g.*, coral reefs) does not make it possible to assess the impact of fishing on these habitats.

8. FINAL REMARKS AND RECOMMENDATION FOR MANAGEMENT

Fisheries statistics. There has been a decrease in the availability of reliable information for artisanal fishing in the last 5 years. The migration of the current data collection system to a digital system would improve monitoring of artisanal fishing activity in the region and streamline data usage for management purposes. The beach seine seems to be the best represented in the fisheries statistics, and the other gears are often neglected. Therefore, the fishing pressure on species associated with these other gears is not well understood.

> ***><> Recommendation 1****: Invest in comprehensive and regular artisanal fishing monitoring through digital data collection with opportunities for fishers and fish buyers to participate in the process.*

Captured species. Small pelagic and demersal fishes are the most common in current catch data. These species contribute to the food security of local communities and supply the rural market of inland areas. Shrimp and crab are being intensively exploited due to export pressure.

> ***><> Recommendation 2:*** *Conduct a specialized study to assess value retention focusing on the high-value species, i.e., shrimp and mangrove crab which can better identify the challenges associated in this value chain dominated by Asian market.*

Fishing areas. The beach seine operates along the coast, while the other gears are more nearshore or offshore. There is an overlap of line and hook fishing and gillnets in almost all regions. While there is no space use conflict, there is a growing conflict resulting from illegal, unreported, and unregulated gears that use mosquito nets. These gears are competing directly with the legally recognized gears and driving the latter into joining these illegal practices.

> ***><>Recommendation 3:*** *Promote adoption of sustainable fishing behaviors and participatory enforcement.*

Development projects. The sustainability of development projects is threatened by lack of capacity and investment. The southern region of Zambezia province (between Maganja da Costa and Chinde), is the region with least support from environmental and conservation partners and projects. Currently climate resilience and habitat conservation are being prioritized. This may be referring to fishing activity to a secondary position.

> ***><>Recommendation 4.1.*** *Assess the financial and social sustainability of development projects. Include capacity building initiatives for local government and communities such as on-the job training and co-implementation of initiatives.*
>
> ***><>Recommendation 4.2.*** *Involve youth in the next set of development projects and prioritize livelihood projects for Memba, Nacala, and Ilha de Mozambique districts due to incoming populations fleeing the conflict of Cabo Delgado or high population densities, and for the Districts of Angoche, Moma, Pebane, Maganja da Costa which have historically been the source of immigration of fishers traveling to South or North as cheap labor and probably being recruited into violent extremism.*

Resource assessment. The assessment of the resource by districts indicates some localized overexploitation for some fishing gear. The beach seines have the most sustainability problems in the region. Data from previous studies indicate that some species are being caught below the first maturation, which may compromise sustainability of the fishery. Excessive effort is localized and often

rampant in Nacala, Angoche, Moma in Nampula province and in Pebane, Maganja da Costa, Namacurra and Quelimane specially for beach seines and gillnets.

><>***Recommendation 5.1.*** *Mitigate the social impact of legal ban on beach seines anticipated in 2024. Over 5,268 Beach seines employ at least 50% of the 100,900 fishermen in this region alone.*

><>***Recommendation 5.2.*** *Limit the number of gears allowed in each district at estimated fMSY (number of active gears/year), or as a proxy, this number should be divided by 180 or equivalent number of active days in each year (assuming a 75 percent conservative monthly effective fishing days of 20 days is 15). Set a target for gears allowed at 75% fMSY.*

	Beach-seine		Surface-gill net		Line and hook	
Districts	fMSY	Recommended number of units	fMSY	Recommended number of units	fMSY	Recommended number of units
Memba	16,950	94	45,875	255	132,500	736
Nacala -a- Velha	9,889	55	na	na	43,333	241
Nacala Porto	42,500	236	33,125	184	32,500	181
Ilha de Moc	12,275	68	12,275	68	108,333	602
Mussoril	71,286	396	71,500	397	196,667	1,093
Mogincual	19,656	109	23,630	131	na	na
Angoche	78,278	435	78,278	435	291,250	1,618
Moma	101,800	566	69,700	387	120,700	671
Pebane	196,333	1,091	357,500	1,986	71,875	399
Maganja da Costa	18,000	100	18,900	105	na	na
Namacurra	17,425	97	7,450	41	na	na
Quelimane	11,938	66	8,567	48	71,875	399
Inhassunge	na	na	na	na	na	na
Chinde	na	na	na	na	na	na

><> ***Recommendation 5.3.*** *There is also a need to understand the illegal trade and motivation for use of mosquito bed-nets in fishing, especially in the districts mentioned in recommendation 5.2. This should also assess the level of and impact of insecticides in marine life.*

Management measures: Although there are formal and informal management measures in the region, the current compliance is unsatisfactory. There are serious violations in fishing gear, mainly by the use of unsuitable mesh size.

><>***Recommendation 6.*** *Use participatory processes for developing fisheries management regulations and spatial closures, promote adoption of sustainable fishing behaviors, and secure sustainable financing for management activities.*

Stock recovery modeling: No-fishing zones in combination with reduced fishing effort outside these zones through fisheries appropriate fishing regulations are needed to recover overfished populations and sustain healthy fisheries. Using only reef-associated fishes, Parrotfish, Emperors, Fusiliers and Groupers, was a limitation given that other species are commonly caught in many areas. Further work is needed to model recovery of pelagic and estuarine species as well as incorporate current fishing effort into predictive models.

> ***><>Recommendation 7.*** *Design optimal networks of no-fishing zones (MPAs) based on fish movement and available habitat to complement and support fishing regulations across all waters. Continue predictive modeling efforts to better understand the impact of both spatial closures and fishing restrictions on recovery of important fisheries species.*

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ANNEXES

ANNEX A : PEOPLE CONSULTED

PEOPLE CONTACTED AT GOVERNMENT LEVEL

NATIONAL LEVEL

1. HE. Augusta Maita- Minister of the sea, inland waters and fisheries (MIMAIP)
2. Picardo Bastos- deputy director, Institute for Development of Aquaculture and Fisheries
3. Selso Cuaira-Service Director, Institute for Development of Aquaculture and Fisheries
4. Jorge Mafuca-Director of Fisheries Research Institute
5. Eugenio Amarante-Director, of National Directorate of Studies, Planining and Infrastructures
6. Cassamo Hassane Junior, Deputy director, National Fisheries Administration
7. Joaquim Tembe-head of department, National Fisheries Administration
8. Miguel Langa, CEO ProAzul, Development Fund for Blue Economy, MIMAIP
9. Felismina Antia-Director of Policy, MIMAIP

PROVINCIAL LEVEL: ZAMBEZIA

10. Jabula Zibia -provincial director of fisheries and agriculture of Zambezia
11. Fernando R. Namucua -director, Provincial Service of Economic Activities, Zambezia
12. Agnelo Bissane – head of department of the Sea, Inland Waters and Fisheries, at SPAE-Zambézia
13. João Mucaima – Technician, department of fisheries development at DPAP-Zambézia
14. Adélio Salimo – Extensionist, district of Mocubela
15. Ângelo Alfaica – Extensionist, district of Namacurra
16. Argentino Artur – Extensionist, district of Quelimane
17. Raimundo Manuel – Extensionist, district of Pebane
18. Omeca Sande – Extensionist, district of Pebane-
19. Carlos Pitanha – Extensionist, district of Pebane

PROVINCIAL LEVEL: NAMPULA

20. Jaime Chissico- director, Provincial Service of Economic Activities, Nampula
21. Zacarias Taiar-Representative of Fisheries Administration, Nampula
22. Mahando Sunati, SPAE Nampula
23. Muireque Variano - Extensionist, district of Memba
24. Mamudo Chale - Extensionist, district of Nacala
25. Nazario Cancala - Extensionist, district of Ilha de Moçambique
26. Atumane Age - Extensionist, district of Mongicual
27. Paulo Sebastiao - Extensionist, district of Angoche
28. Mussa Braimo – Extensionist, district of Moma
29. Óscar Assane – Extensionist, district of Moma

COMMUNITY-BASED ORGANIZATIONS MET ZAMBEZIA

30. Abacar Sunde - CCP of Chuabo Dembe
31. Oliveira Mutacala - CCP of Icidua
32. Alimo- CCP of Gazelas
33. Ussene Momade - CCP of Malanha
34. -- CCP of Muceliua

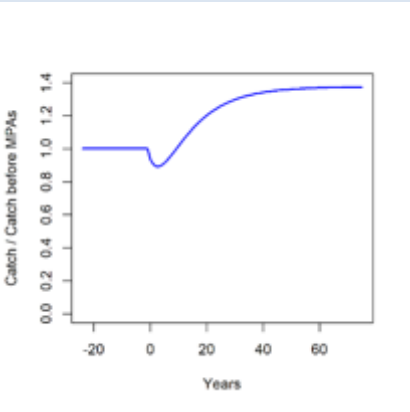
35. António Romão- CCP of Muli
36. Jaime Saide - CCP of Tomeia
37. - CCP of Nacalela
38. Husseine Sualei- CCP of Fuzi
39. Cassimo Niguera - CCP of Maverane
40. Manuel Momade- CCP of Malua
41. Costa Mutumpa- CCP of Gurai
42. Alilo Selemane- CCP of Joaque
43. Hassane Camala- CCP of Barada
44. Sufuane Nur- CCP of Muoloa
45. Hilário Fulano- CCP of Cabuir

COMMUNITY-BASED ORGANIZATIONS MET NAMPULA

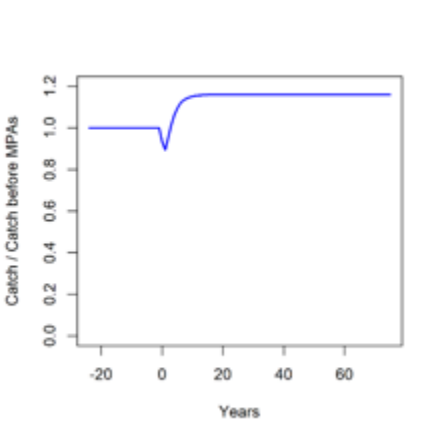
46. Muana Rissique - CCP of Memba sede
47. Jamal Omar -CCP of Baixo Pinda
48. Essimela Mussa-CCP of Quissimajulo
49. Silamo Mussuali-CCP of Mahelene
50. Manuel Ussene -CCP of Naherengue
51. Atumane Mussa -CCP of Sanculo
52. Naima Ali -CCP of Quissanga
53. Jose Issa - CCP of Ilha Insular
54. Ibramugi Ali - CCP of Namige-sede
55. Arlindo Nahota - CCP of Meculuvelane
56. Sabino Assane - CCP of Angoche sede
57. Edizal Selemane - CCP of Sangagy
58. Januário Amade - CCP of Mucoroje
59. Alide Atumene-CCP of Moma-sede

ANNEX B: STOCK RECOVERY MODELING

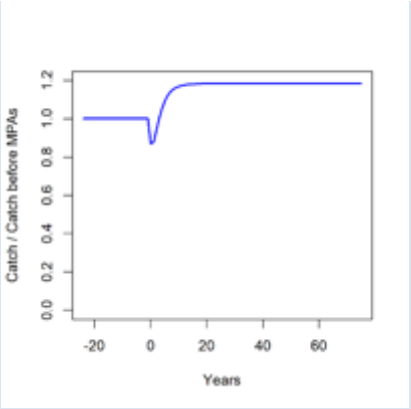
Memba MPA prioritization



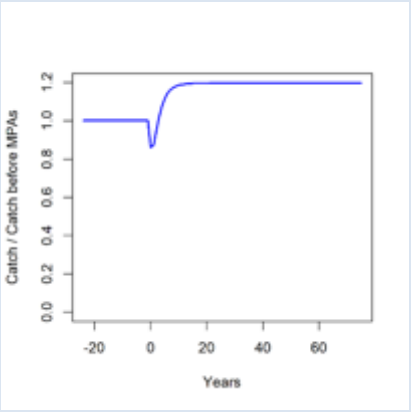
Memba Emperor Recovery



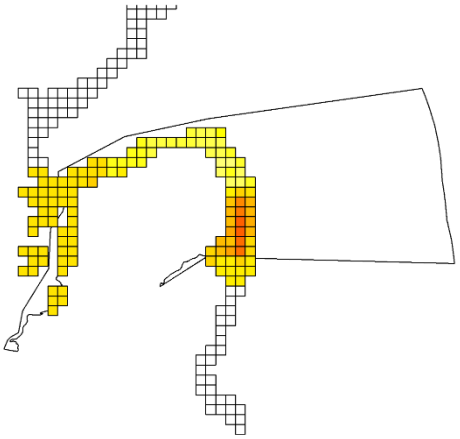
Memba Fusilier Recovery



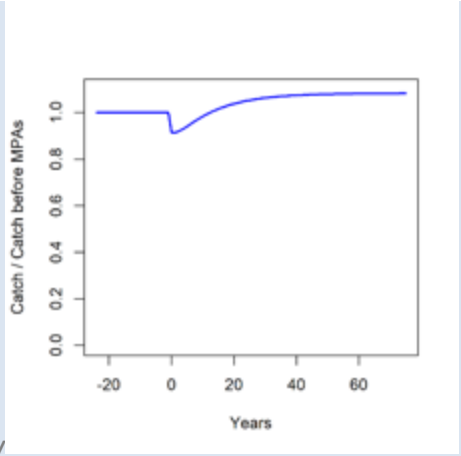
Memba Grouper Recovery



Memba Parrotfish Recovery



Nacala MPA prioritization



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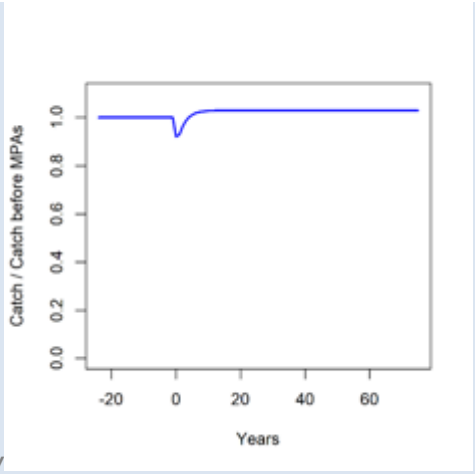
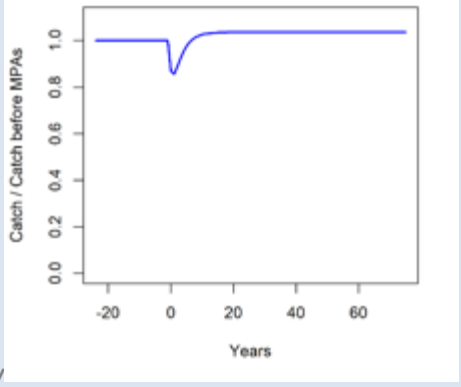
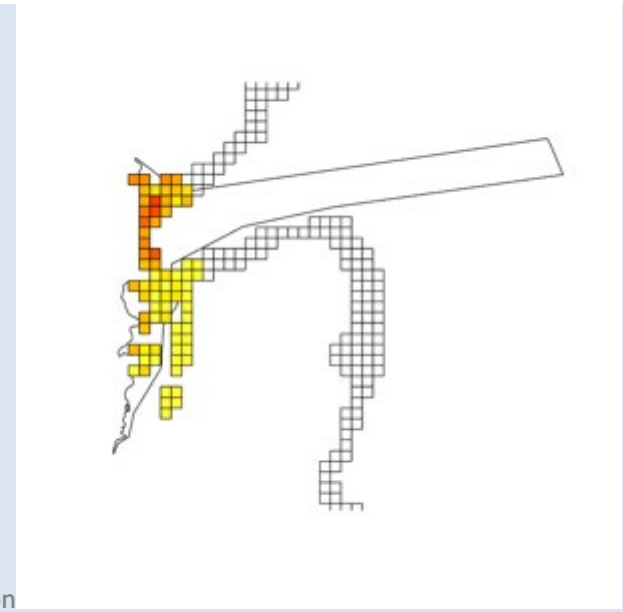


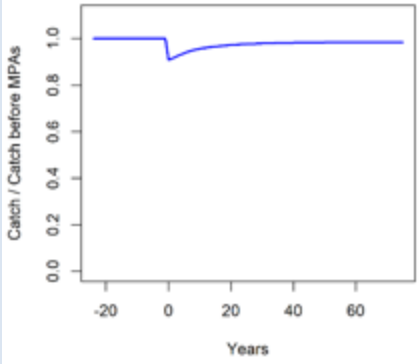
Nacala Fusilier Recovery



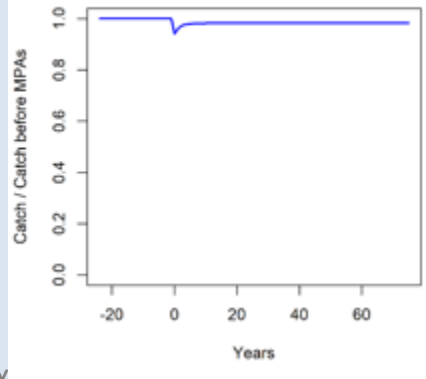
Nacala Grouper Recovery



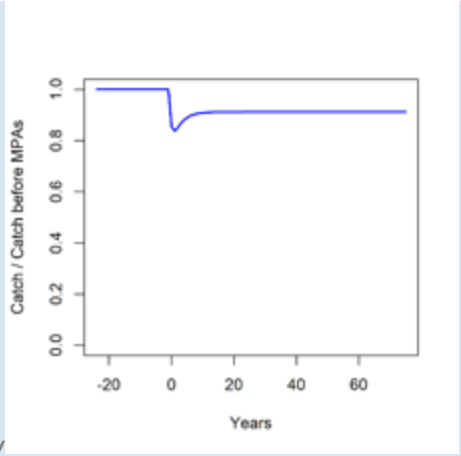
Nacala Velha MPA prioritization



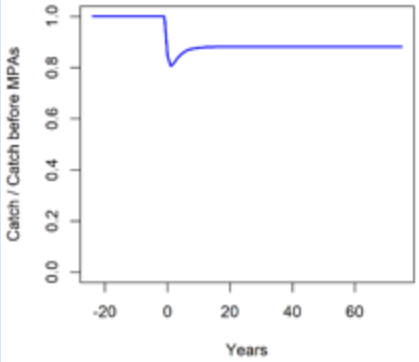
Nacala Velha Emperor Recovery



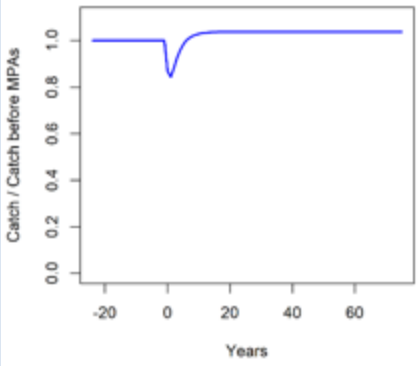
Nacala Velha Fusilier Recovery



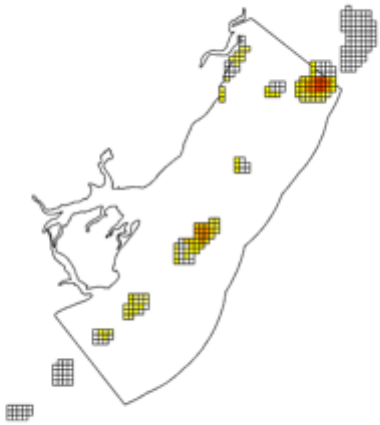
Nacala Velha Grouper Recovery



Nacala Velha Parrotfish Recovery

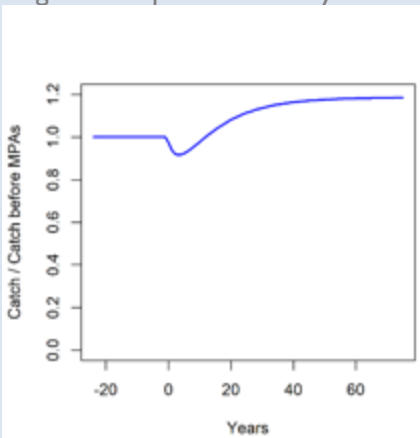


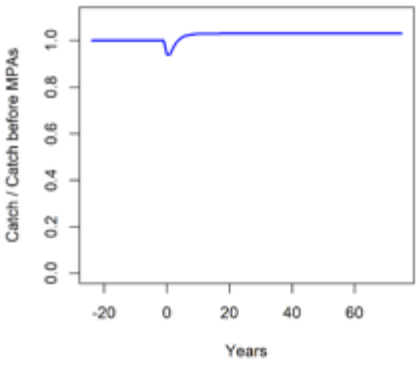
Nacala Parrotfish Recovery



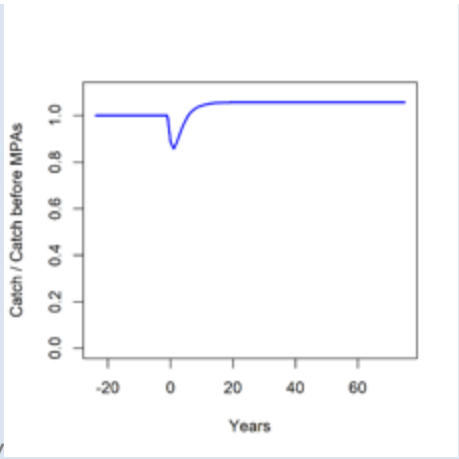
Angoche MPA prioritization

Angoche Emperor recovery



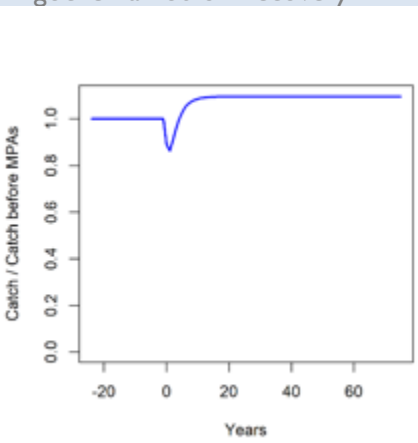


Angoche Fusilier Recovery



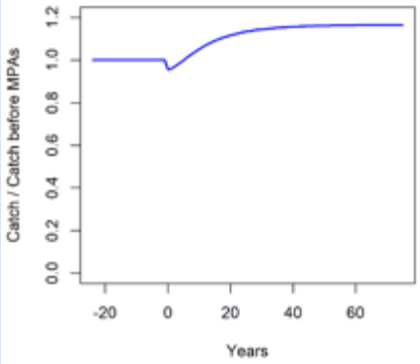
Angoche Grouper Recovery

Angoche Parrotfish Recovery

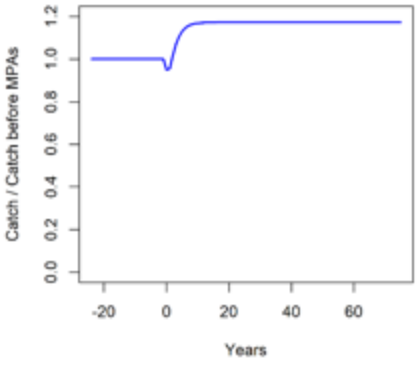


Pebane MPA prioritization

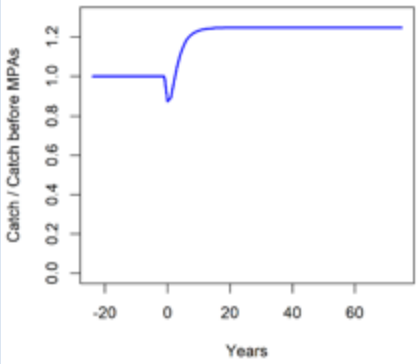
Pebane Emperor Recovery



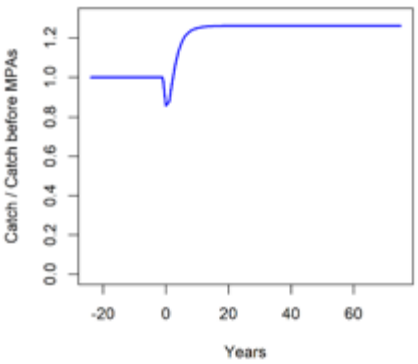
Pebane Fusilier Recovery



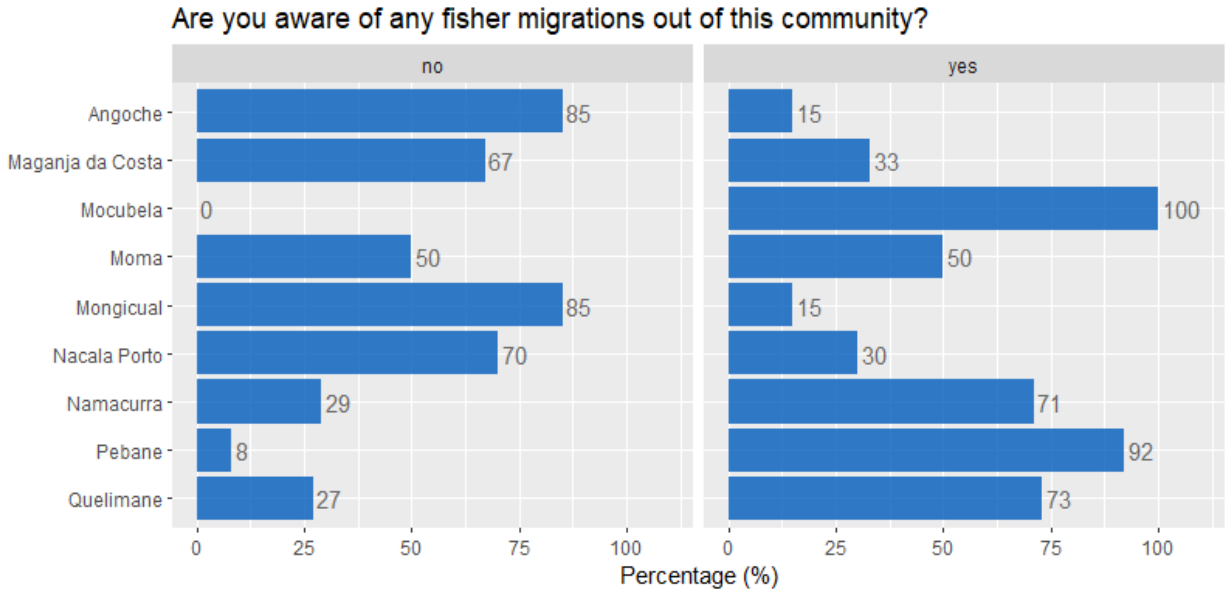
Pebane Grouper Recovery

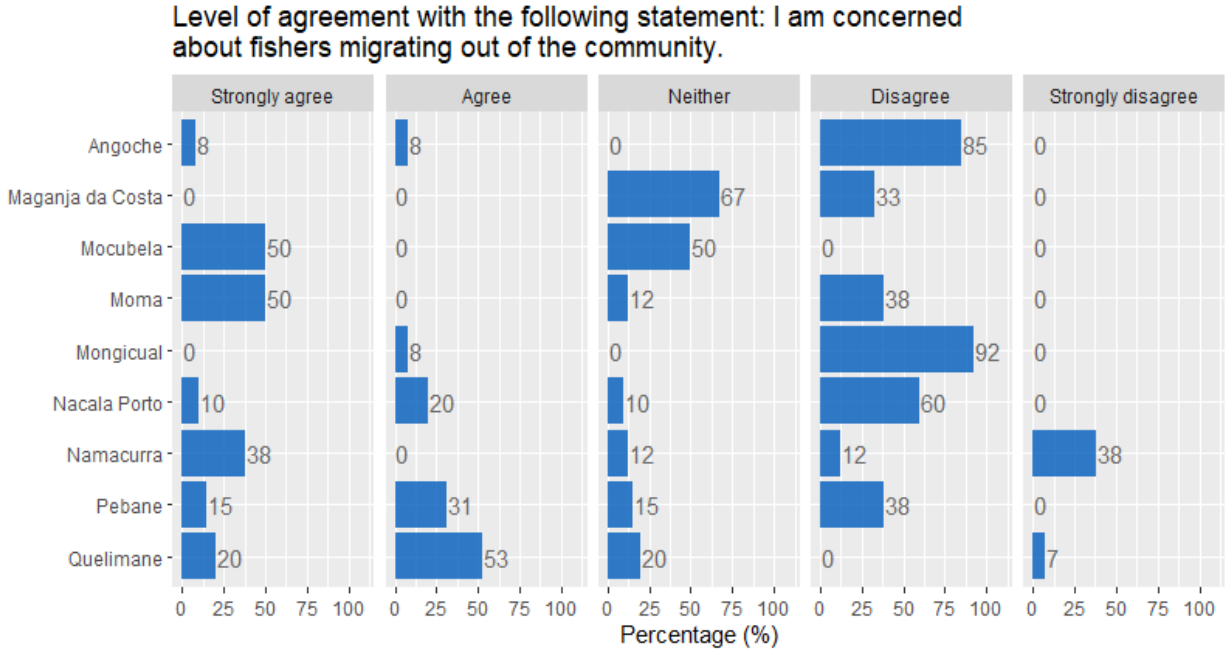


Pebane Parrotfish Recovery



VCA Fishers:


Are you aware of any fisher migrations out of this community?
no
yes
Angoche
Maganja da Costa
Mocubela
Moma
Mongicual
Nacala Porto
Namacurra
Pebane
Quelimane
85
67
0
50
85
70
29
8
27
15
33
100
50
15
30
71
92
73
0
25
50
75
100
Percentage (%)


Level of agreement with the following statement: I am concerned about fishers migrating out of the community.
Strongly agree
Agree
Neither
Disagree
Strongly disagree
Angoche
Maganja da Costa
Mocubela
Moma
Mongicual
Nacala Porto
Namacurra
Pebane
Quelimane
8
0
50
50
0
10
38
15
20
8
0
0
0
8
20
0
31
53
0
67
50
12
0
10
12
15
20
85
33
0
38
92
60
12
38
0
0
0
0
0
0
0
38
0
7
0
25
50
75
100
Percentage (%)

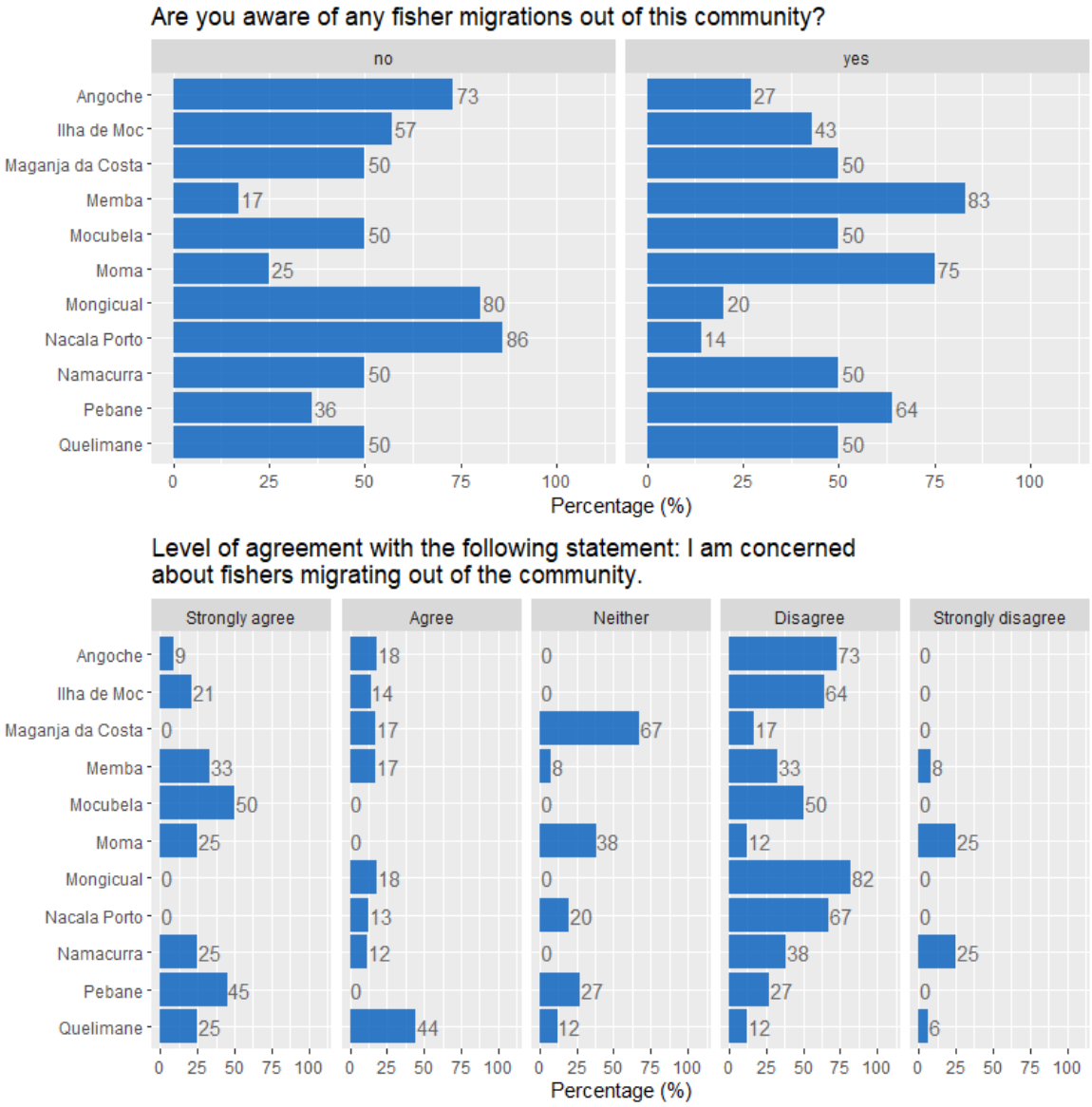
Q39: Proportion of fishers who disagree or agree with the following statement. "I am concerned about the violent extremism in the north affecting my community."

	Strongly agree (%)	Agree (%)	Neither (%)	Disagree (%)	Strongly disagree (%)
Angoche	69	23	0	8	0
Maganja da Costa	67	0	33	0	0
Mocubela	100	0	0	0	0
Moma	38	50	0	13	0
Mongicual	36	14	7	29	7
Nacala Porto	45	18	0	36	0
Namacurra	13	38	13	25	13
Pebane	15	31	31	23	0
Quelimane	12	59	18	0	0

Q40-43: Proportion of households who think violent extremism in the north is affecting income and food availability, and will in the future.

	Negatively affecting income (%)	Negatively affecting food availability (%)	Negatively affecting income in future (%)	Negatively affecting food availability in future (%)
Angoche	8	0	54	54
Maganja da Costa	0	0	0	0
Mocubela	50	50	50	50
Moma	12.5	0	62.5	50
Mongicual	0	0	36	29
Nacala Porto	18	9	64	64
Namacurra	13	13	38	50
Pebane	15	0	54	54
Quelimane	18	24	38	31

VCA Buyers


Are you aware of any fisher migrations out of this community?
no
yes
Angoche
Ilha de Moc
Maganja da Costa
Memba
Mocubela
Moma
Mongicual
Nacala Porto
Namacurra
Pebane
Quelimane
73
57
50
17
50
25
80
86
50
36
50
27
43
50
83
50
75
20
14
50
64
50
0
25
50
75
100
Percentage (%)
Level of agreement with the following statement: I am concerned about fishers migrating out of the community.
Strongly agree
Agree
Neither
Disagree
Strongly disagree
9
21
0
33
50
25
0
0
25
0
18
13
12
0
45
25
18
14
17
17
0
0
18
13
12
0
44
0
67
8
0
38
0
20
0
27
12
73
64
17
33
50
12
82
67
38
27
12
0
0
0
8
0
25
0
0
25
0
6
Percentage (%)

Q42: Proportion of fishers who disagree or agree with the following statement. "I am concerned about the violent extremism in the north affecting my community."

	Strongly agree (%)	Agree (%)	Neither (%)	Disagree (%)	Strongly disagree (%)
Angoche	27	64	0	9	0
Ilha de Moc	67	0	13	13	0
Maganja da Costa	67	33	0	0	0
Memba	50	33	8	8	0
Mocubela	50	50	0	0	0
Moma	0	38	25	38	0
Mongicual	18	55	9	9	0
Nacala Porto	20	53	13	13	0
Nacala Velha	0	0	0	0	100
Namacurra	13	25	25	13	25
Pebane	18	45	18	18	0
Quelimane	0	63	25	6	6

Q43-46: Proportion of households who think violent extremism in the north is affecting income and food availability, and will in the future

	Negatively affecting income (%)	Negatively affecting food availability (%)	Negatively affecting income in future (%)	Negatively affecting food availability in future (%)
Angoche	0	0	64	55
Ilha de Moc	33	0	40	13
Maganja da Costa	0	0	17	17
Memba	58	67	83	92
Mocubela	0	0	50	50
Moma	0	0	50	25
Mongicual	27	0	36	0
Nacala Porto	33	13	60	53
Nacala Velha	100	0	0	0
Namacurra	25	13	63	50
Pebane	9	9	55	55
Quelimane	13	13	50	44