Socio-economic Factors Associated with Slow Recovery Of Prawn Stock: Evidence from Prawn Fishing Communities in Tanzania Mainland

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Abstract

Over three decades, Tanzania Mainland has been experiencing a decrease in prawn stock. One of the governments' responses in redressing this situation was to impose management restrictions for industrial and artisanal fisheries. Recent evidence from various biological studies shows a sign of recovery, but at a slow and unexpected pace. As a result, there has been a dilemma based on the lack of understanding as to why, despite all the efforts to control and manage prawn fishery, the stock has not been increasing at the expected level. This has led to the need for undertaking a socio-economic analysis to comprehend the factors—beyond the biological aspects—that might be determining the prawn stock situation in Tanzania Mainland. Findings from regressional analysis suggest that age, daily income from prawn fishing, and ownership of vessels determine fishing effort. Other factors, including increase in demand for prawn (local and international), increase in the number of collectors (petty traders and middlemen), the lack of market monitoring, non-adherence to closure system, and illegal fishing practices: these have been among the factors behind prawn stock development in Tanzania Mainland.

Keywords: *fishing effort, prawn stock, stock recovery, livelihoods, closure system*

Introduction

The contribution of fishery and related activities to the GDP and people's livelihood in Tanzania is significant in many ways. Prawn fishery has been one of the main contributors to the national economy in the marine fisheries sub-sector of Tanzania Mainland; and a source of income and protein to local coastal communities (Mwamoto, 1990). Prio to 1960, prawn fishery in Tanzania Mainland was solely an artisanal activity: it was in the 1960s that industrial fishery started to operate (ibid.). Industrial prawn fishery has operated in three main trawling zones: Zone 1 (Saadani and Bagamoyo trawling grounds); Zone 2 (Rufiji-Mafia channel, also referred to as Kisiju trawling ground); and Zone 3 (Jaja and Kilwa trawling grounds). Bwathondi et al. (2010) have suggested that the increase in fishing vessels has been causing an increase in fishing efforts. This scenario has led to a decline in the quantity and size of prawns in most fishing communities in Tanzania. As a response to the decline in prawn stock, in 2007 the government banned prawn industrial fishery (Mwakosya et. al., 2010). In the same context, the Fisheries Regulations of 2020 were amended. In the amended regulations, the northern prawn (Bagamoyo/Saadani) fishing zone

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is closed on 30th September and re-opened on the 1st March of each year; while the southern zone (Rufiji Delta and Jaja/Kilwa) is closed on 31st August and re-opened on 1st April of each year (MLF, 2020).

Evidence from other countries, such as the Philippines, shows that closure systems decrease fishing efforts while at the same time increasing stock and fish biomass (Marcus, et al., 2022). Similarly, experience from Kenya indicates that declines in catch and user conflicts resulted in similar government management measures (Munga, et al., 2013). However, Chimba and Masuka (2014) have questioned whether fishing season closures are effective methods of increasing reproductive output due to an increase in illegal fishing and ineffective enforcement of laws and regulations that support closures.

Prawn Fishery, Stock Sustainability and the Livelihood of Local Communities
Any sustainable fishing endeavour that do not consider artisanal fisher's livelihood and survival will not be effective (Adili & Antonia, 2017; Mkare & von der Heyden, 2013; Munga & Ndegwa, 2012). An exclusion of fishers' socio-economic needs will create conflicts between managers and local users who rely on the resources for their livelihood. The livelihood of some coastal communities—not only in Tanzania Mainland but also in East Africa in general—has become significantly dependent on prawn fishing and related activities, especially over the last 30 years since the advent of prawn export markets and the availability of ice (Munga & Ndegwa, 2012; Adili & Antonia, 2017). An example of such coastal communities in Tanzania live in Saadani inner Delta villages (Mbwera East and West) and around Pangani, Wami, Ruvu (Shalli & Sigalla, 2022; MALF, 2017). Similarly, Mosha et. al. (2013: 61) confirmed that "… the prawn fishery and other estuarine fishers dominate the local economies of Saadani village."

Although prawn fishing is a male-dominant activity, women have also been engaging in prawn fishing related activities such as selling food to artisanal fishers along the fishing grounds, selling fried prawn (especially *Macrobranchium rude*), locally known as *kitumbo* (Shalli & Sigalla, 2022; Macusi et al., 2022). Even if no empirical data are available to show the relationship between resource use and population dynamics in the study areas, it is evident that one of the plausible causes of the decrease of prawn stock is the interdependence between resource (prawn), population increase, and the scarcity of other means of livelihood. For example, limited alternative means of livelihood, on one hand, and an increase in the population, on the other, has increased prawn fishing activities. Although there are post-closure assessments in East Africa in general—and Tanzania in particular—these studies have mainly focused on the composition of species (Mosha et al., 2013; Munga et al., 2013); size structure (Mwakyosa et al., 2021; Mkare et al., (2013); catch rates, magnitude and distribution of fishing effort (Munga et al., 2012; Munga et al., 2014); facilities, determinants of income (Mwakyosa et al., 2021; Adili & Antonia, 2017); and services at landing sites (URT, 2018; TAFIRI, 2016). However, evidence-based information on the factors associated with slow recovery

of prawn is limited. Hypothetically, it is assumed that artisanal fishing has been contributing to the slow recovery. This articles discusses three major issues in the context of the slow recovery pace of prawn stock: first, the changing socio-economic status of artisanal fishers from major prawn fishing communities in Tanzania Mainland; secondly, how the current prawn fishing practices and patterns affect both prawn stock recovery and local people's livelihoods despite the closure system (moratorium) being in place; and thirdly, the contribution of some selected socio-economic factors to the slow recovery of prawn stock.

Methodology

Description of the Study Communities

The study was carried out in 9 major prawn fishing villages distributed in five district councils: Kiomboni, Mbwera East, Mbwera West and Msindaji (Kibiti), Nyamatungutungu (Kilwa), Kisiju Pwani and Boza (Mkuranga), Custom/Dunda (Bagamoyo) and Saadani (Chalinze). Based on the amended Fisheries Regulations of 2020, the selected villages cover two prawn fishing zones: the northern prawn fishing zone, which includes Bagamoyo and Saadani; and the southern prawn fishing zone, which covers villages around the Rufiji Delta and Kilwa. The inclusion criterion for the selection of the study villages was the presence of a substantial number of artisanal prawn fishers.
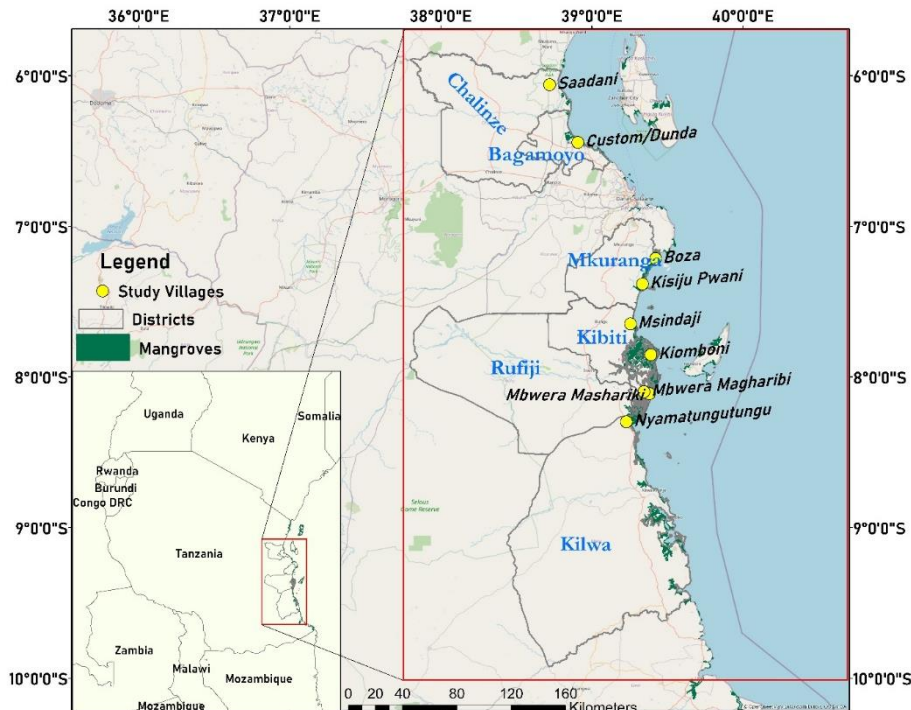

Figure 1: Map of the Tanzanian Coast Showing the Study Sites Distributed in Four Coastal District Councils

This is a cross-section design study that used mixed techniques of data collection. Primary and secondary data were used in the study. A sample size for a social survey of 291 prawn fishers was determined using the Cochran (1963) formula. Focus group discussions (FGDs) were applied to specific groups of people, such as collectors/petty traders and small shrimp collectors. One FGD of petty traders/collectors with 5 participants for each village, and one FGD for small shrimp collectors with a minimum of 2–and a maximum of 4–participants were conducted in Nyamatungutungu village (Kilwa District), Msindaji, Mbwera East and West villages (Kibiti District).

The sampling process adopted a multi-stage sampling procedure. First, a purposive sampling was used to select resident artisanal fishers with long fishing experiences in the community. Second, a simple random sampling procedure was applied in the selection of respondents from a list of identified artisanal resident fishers. Third, when a simple random sample was not practical (for some reasons), a convenience sampling technique was used to find respondents along the fishing grounds.

Semi-structured interviews were applied in the collection of data mainly from artisanal prawn fishers. Information from a semi-structured questionnaire was validated by qualitative information from in-depth interviews and focus group discussions. This technique was used to collect quantitative data from artisanal fishers from all nine (9) study villages. A simple random sampling was used in the selection of resident prawn fishers. A list of fishers was used to guide the selection of artisanal prawn fishers. Local village and BMU leaders facilitated the identification of eligible prawn fishers. Two eligibility criteria were used for selecting participants: first, a fisher must be a permanent resident in the village; and second, s/he must have a long fishing experience of not less than 10 years in the trade. Respondents were subjected to semi-structured interviews, containing both closed- and open-ended questions. The Mobile Data Collection (MDC) with OpenDataKit (ODK) tool was used as an instrument of data collection.

In-depth interviews were conducted with village leaders, village executive officers, BMU leaders, and experts from public institutions and private companies. These interviews provided information on prawn stocks, trends, markets and management policies and practices; as well as information on compliances and resistance to the implementation of management policies.

FGDs were used for gaining an understanding of fishers' perceptions on closed seasons, and management policies pertaining to prawn fisheries. The participants included prawn collectors/petty traders and small shrimp fishers. One FGD for collectors/petty traders was carried out in each village; with each of these discussions having a maximum of five (5) participants. Another FGD was carried out in selected villages with small shrimp fishers' activity. Women were the majority for small shrimp fishing; and each group had 3–5 participants. The FGDs focused on opinions and perceptions on management issues, markets, sustainability of prawn fishery and challenges experienced by artisanal prawn fishers.

Non-participant observation was applied to level out researcher biases in other data collection techniques, and reveal differences between what participants say and what they actually do. Observation and documentation of the socio-economic activities were important for understanding economic potentials and challenges existing in every community that we visited. The information on such things as fishing practices, pattens, gear seed, fishing grounds, and means of livelihood were gathered through this technique.

Documentary review was used to collect secondary data from published and unpublished official documents such as research reports from TAFIRI and the Ministry of Livestock and Fisheries (MFL), and purchase orders from hotels. Additional documents and materials relevant to the study were obtained from websites. The adoption of these research designs, methods and their respective techniques of data collection was grounded on some philosophical and theoretical considerations. The quantitative approach is grounded on the logic that it is important to quantify some information and learn their relationship to empirically describe a social phenomenon. Quantitative data allowed us to make a plausible relationship and association between variables such as prawn stock dynamics and other means of livelihood, prawn stock dynamics and population increase, and prawn stock and demand increase; whereas qualitative data help to explain the underlying forces (factors) causing the relationships between the variables. The qualitative data helped to understand how, for example, the absence of other livelihood alternatives and population increase affected compliance to fishing regulation, by-laws and the closure system.

Data Analysis
The quantitative data were analysed with the SPSS software, version 20.0, to generate descriptive and inferential statistics. For descriptive statistics, frequencies and percentage distribution were generated and presented in graphs and tables. For inferential statistics, a multiple regression analysis was used to assess the socio-demographic factors influencing prawn fishing pressure. The outcome variable (fishing effort) was regressed against selected explanatory socio-demographic variables: age, education, daily income from prawn fishing, household size, number of household alternative livelihoods, ownership of fishing vessels, and ownership of fishing gears. Content analysis was used to analyse the qualitative information.

Findings
Socio-economic factors have been playing an important role in the utilization of natural resources. The challenge of natural resource utilization has always been how to balance the trade-off between people's livelihoods and a sustainable utilization of the natural resource in question (Sigalla, 2013). Understanding the socio-demographic characteristics of people engaged in prawn fishery broadens the understanding of fishing patterns and practices. The socio-demographic analysis shows that more than 56 percent of prawn fishers are 41 years old and above;

whereas, less than half are aged between 18 and 40 years. About 28 percent of them are aged above 50 years; followed by the age-group of 31–40 years (25%) (Figure. 4). The data suggest that more than three-quarters (79%) of prawn fishers are married. About 9.9% and 8.6% confirmed to be single (never married) or live separately from their partners, respectively.

Furthermore, the level of education varied between districts. More than half (67%) had completed primary education, followed by 15.5% who had no formal education. Those who confirmed that they did not complete primary education were 12.4%; whereas very few (4.1%) had completed ordinary-level secondary school education. Only two (2) (0.6%), and one (1) (0.3%) had completed vocational training and university, respectively. The average household size was 5.1, which is a bit higher than the national average household size of 4.8 for Tanzania Mainland (URT, 2013). The data suggest that fishing communities from Kibiti (Kiomboni, Mbwera East and West), and Mkuranga districts (Boza), had higher household sizes of between five (5) and eight (8) persons, compared to other communities. Other villages from Kilwa (Nyamatungutungu), Kibiti (Msindaji), Chalinze (Saadani), followed by Bagamoyo (Dunda), had communities with small household sizes of 1–4 persons.
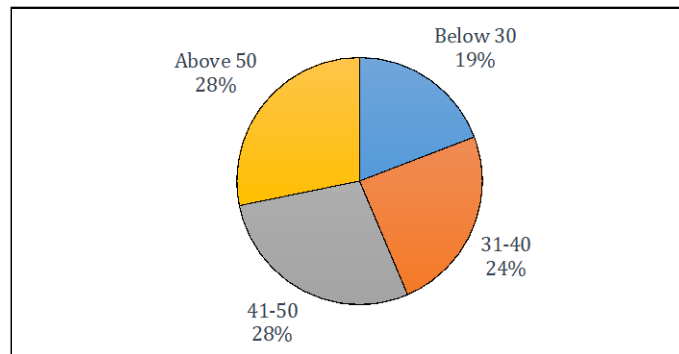

Figure 2: Percentage Distribution of Age of Respondents in the Study Area

Similarly, our analysis focused on socio-demographic information of prawn collectors/agents who are important actors in the prawn value-chain. Collectors influence fishing efforts in certain manners, thus understanding their socio-economic status is crucial to developing management policies with high compliance and success. For instance, a study by Marcusi and colleagues in the Philippines suggests that most artisanal fishers sell their fish catch to their financiers (Marcusi et al., 2022). What Marcusi et al. (ibid.) refers to as financiers is similar to collectors in our case. Using collectors' information enables us to determine the actual number of prawn fishers and fishing efforts. Table 1 presents the number of collectors, fishing vessels, and an estimated number of artisanal fishers from all nine (9) fishing communities.

Table 1: Number of Collectors, Fishing Vessel/Gear Owned and Respective Number of Fishers Under Collectors by Villages and Districts

Village	District	No. of Collectors	No. of Dugout Canoe or Cast Net	Total Number of Fishers
1. Kiomboni	Kibiti	15	99	198
2. Mbwera East		5	51	102
3. Mbwera West		5	99	198
4. Msindaji		14	30	60
5. Nyamatungutungu	Kilwa	9	31	62
6. Kisiju Pwani	Mkuranga	7	42	84
7. Boza		11	65	130
8. Sadaani	Chalinze	6	214	428
9. Custom/Dunda	Bagamoyo	4	85	470

Source: Field Findings, 2023

Frequently Harvested Prawn Species

The findings show that the most common prawn species harvested by artisanal fishers are *kitumbo (Macrobranchium rude)* (86%) and white *(Fenneropenaeus indicus)* (72%); followed by tiger *(Penaeus semisulcatus)* (34%), king/*kitumbo (Penaeus monodon)* (11%), and *chola (Metapenaeus monoceros)* (2.1%). Artisanal fishers confirmed that although *Macrobrachium rude* is the most frequently harvested prawn species, it has less economic importance to them because it is not for sale in big markets like Feri or in the international market: it is mainly sold within the local market in the communities for local consumption. The most demanded species in the national and international markets are *P. Monodon, P. Semisulcatus* and *Fenneropenaeus Indicus.*

Socio-economic Factors Influencing Fishing Effort

Various factors influence fishing efforts in different manners. Demographically, the natural increase in population in various prawn fishing communities has been influencing fishing efforts partly because there has been limited other means of livelihood apart from fishing. Population growth has increased the number of prawn fishers. One of the indicators of this increase is the increase of prawn landing sites, fishers using vessels, and foot fishers. Figure 3 illustrates this trend.
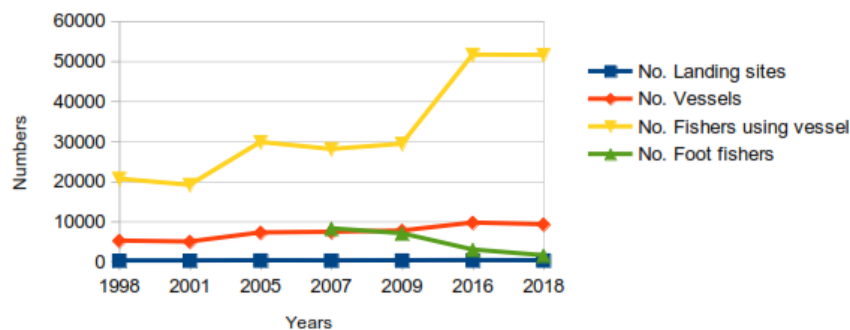

Figure 3: Trends of Landing Sites, Number of Vessels, Fishers Using Vessels and Foot Fishers from 1998 to 2018
Source: URT, Marine Fisheries Frame Survey 2018

The data presented in Figure 3 show that the number of fishing vessels has gradually been increasing since 2001. Similarly, the number of fishers using vessels has been increasing during the same period. The data on foot fishers—which are only available since 2007—shows that the number of foot fishers decreased gradually between 2007 and 2009, but decreased drastically from 2009. This information suggest an increase in fishing activities from artisanal prawn fishers. As we have argued in previous sections, the increase of collectors or middlemen is one of the clear indicators of fishing pressure because they own fishing vessels that intensify fishing activities.

Time Spent for Prawn Fishing in a Year
The number of fishing hours, days, and months at sea is a measure of fishing effort. To get this information, fishers were asked how many hours a day, days in a month, and months in a year, they spent fishing. The data suggest that fishers spent an average of 5.93 hours in a day, 17.63 days a month, and 5.73 months a year for prawn fishing. Moreover, the findings suggest that the time spent for fishing activities varies by village, for some reasons. For instance, the data show that in the four villages of Custom/Dunda, Kisiju Pwani, Kiomboni, and Nyamatungutungu, fishers spent an average of seven (7) hours from departure to returning time; while others spent an average of 4 to 6 hours. The minimum time is one hour; and the maximum is 20 hours.
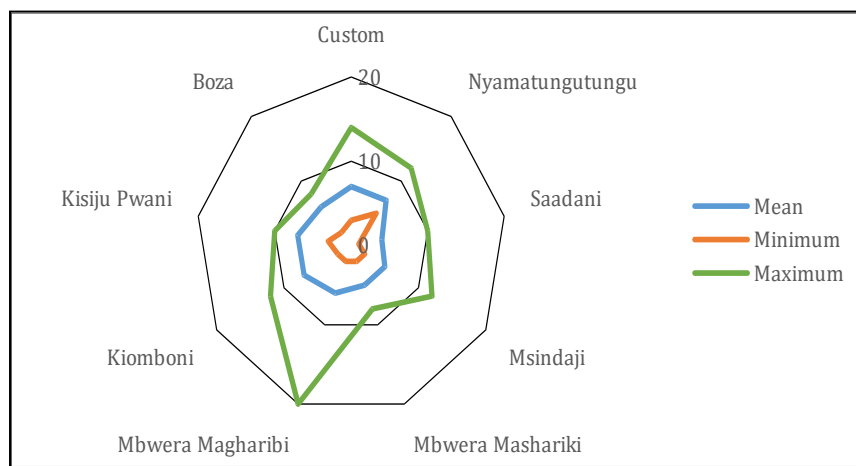

Figure 4: Fishing Hours in a Day
Source: Field Findings, 2022

Similarly, the study shows that prawn fishers in Custom/Dunda Village, in Bagamoyo, have the highest average number of fishing days (23 days) per month, followed by those in Kisiju Pwani (Mkuranga), and in Saadani (Chalinze) who spend an average of 20 days.
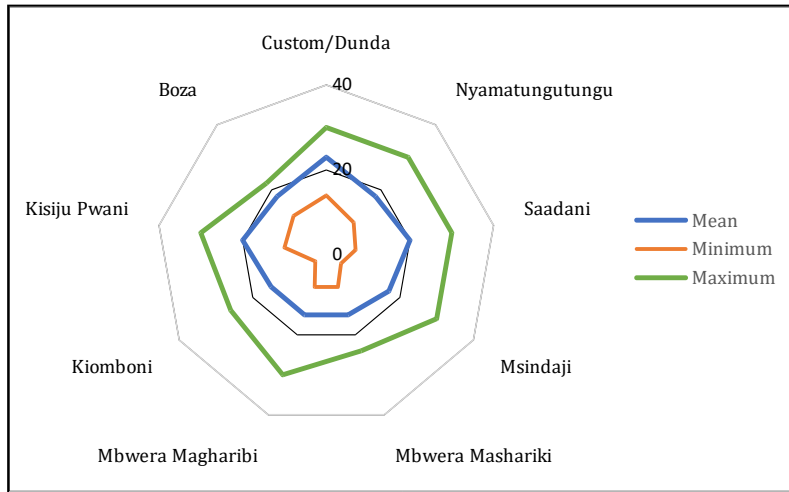
Figure 5: Number of fishing days in a month
Source: Field Findings, 2022

Socioeconomic Factors Influencing Fishing Pressure

Artisanal prawn fishers in Tanzania Mainland are exposed to different socio-economic factors that in many ways influence or determine their fishing habits and patterns. To understand factors influencing the slow pace of stock recovery for prawns in Tanzania generally, and particularly after the introduction of moratorium and closure, the socio-economic factors were thought to provide crucial information to broaden the understanding. The multiple regression analysis was used to show how age, number of alternative livelihood activities, daily income from prawn fishing, education, ownership of fishing gears, ownership of fishing vessels, and household size (as explanatory variables) influence fishing pressure. These explanatory variables were regressed against fishing effort (as an outcome variable), measured in the number of fishing days per month. These variables were chosen mainly because they cut across the social and economic domains, and were expected to provide a plausible and comprehensive insights into fishing pressure. Tables 2, 3 and 4 present varied socio-economic characteristics of the respondents.

Table 2 shows that the average fishers' daily gross income from prawn fishing was TZS29.911. The number of alternative livelihood activities for a household of a prawn fisher ranged from 0 to 5, with about 75 percent of households having 0 to 2 alternative livelihood options, mainly finfish fishing, and subsistence farming. The household size ranged between 1 and 14 people; with more than a half having household size of 5 persons and above. The respondents' ages ranged between 18 and 87 years, with more than a half having the age of 40 years and above. The average level of formal education was Standard VI, with more than a half having completed primary education.

Table 2: Description of Continuous Variables Used in Regression Analysis Against Fishing Effort

Variable	Mean	Std. Dev.	Min.	Max.
Fishing effort (*dependent variable*)	17.63	5.822	3	30
Age	43.455	13.731	18	87
No. of alternative livelihood options	1.962	1.048	0	5
Daily income of respondent from prawn fishing	29,911	44,679	2,000	500,000
Education	5.708	2.777	0	11
No HH members	5.110	2.493	1	14

Source: Field Findings, 2022

The descriptive statistics show that most prawn fishers do not own fishing gear and vessels (Table 3). The majority of those not owning such equipment are provided with such gear by collectors/agent/petty traders under some agreements. Others hire or share them in a group. Fishing efforts also varied widely, with some fishers hardly going out to the sea three days a month, others almost every day, others with the average of about 18 days per month; or just over four days a week.

Table 3: Description of Categorical Variables Used in Regression Analysis

Variable	Level	Description	Count (%)
Ownership of fishing gear	1	Owned by fisher	81(27.93)
	0	Otherwise	209 (72.07)
Ownership of fishing vessel	1	Owned by fisher	119 (41.18)
	0	Otherwise	172 (58.82)

Field Findings, 2022

Table 4: Regression Analysis of Socio-economic Variables Influencing Fishing Pressure

Average fishing days per month	Coef.	St. Err.	t-value	p-value	Sig
Age	-0.071	0.024	-2.91	0.004	***
No. of alternative livelihood options	-0.573	0.324	-1.77	0.078	*
Daily income from prawn fishing	+1.733	0.298	5.81	<0.01	***
Education level	-0.166	0.116	-1.43	0.154	
Ownership of fishing gear	+1.161	0.744	1.56	0.12	
Ownership of fishing vessel	+0.796	0.199	4.00	<0.01	***
Household size	-0.082	0.138	-0.60	0.55	
Constant	-4.749	4.522	-1.05	0.295	

Note: F-test =9.135 Prob >F= 0.000; *** p<0.01 ** p<0.05 * p<0.1

Field Findings, 2022

Figure 6 shows respondents' views related to factors that have been contributing to the poor compliance of laws, by-laws and regulations such as closure system. The lack of employment opportunities is the leading factor. As a result of this, young people—especially boys—opt to engage in fishing activities. As the number of fishers increases, it creates competition; and sometime poor compliance.
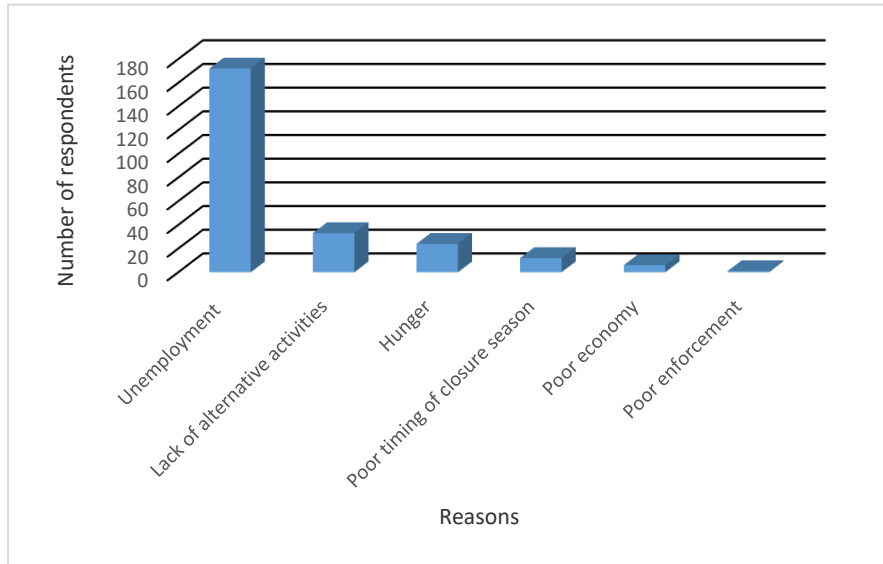
Figure 6: Reasons for Poor Compliance on Laws, by-Laws and Regulations

Similarly, the study focused on the respondents' knowledge on better fishing period. The world 'better' in our case refers to high catch. The idea was to understand artisanal fishers experience related to the closure system. The results of this enquiry are presented in Table 5.

Table 5: An Ideal Prawn Fishing Calendar for Each District

	Bagamoyo	Chalinze	Mkuranga	Kibiti/Rufiji	Kilwa
January			■	■	■
February			■	■	■
March	■	■	■	■	■
April	■	■	■	■	■
May	■	■	■		■
June	■	■	■		■
July			■		
August					
September		■			
October		■			
November	■	■	■	■	
December	■	■	■	■	■

Source: Field Findings, 2022

The information provided in Table 5 reveal ideal months for prawning based on the experiences of local artisanal fishers. March and April were mentioned as the ideal months for prawn fishing for all fishing zones, although March is within the closure period for the Southern zone. November was mentioned as the ideal

prawn fishing month for fishers from Bagamoyo, Chalinze (Sadaani) and Mkuranga (Boza and Kisiju Pwani), though November is within the closure period for Northern Zone and Mkuranga district (Zone 1 and 2) zones. Similarly, December was mentioned as the ideal prawn fishing month by artisanal fishers from all the five districts, even though this month also falls within the closure period. The word 'ideal' means prawn availability is good. Artisanal fishers were of the view that during these months they catch more prawn. This is an indicator that prawn fishing continues even during closure periods. It also shows that compliance to closure is poor.

Discussion
It is evident that the fishing closure system can be effective (Mosha et al., 2013; Munga et al., 2013). However, its effectiveness depends on various factors such as the enforcement of laws, by-laws and regulations; as well as compliance to all regulative laws and policies. Equally important is the absence of illegal fishing. In addition to these factors, our discussions emphasized the importance of the availability of alternative of means of livelihood to the artisanal fishers. For instance, some coastal communities—such as villages in inner Rufiji Delta and Saadan—have been generating their income mainly from prawn fishing. Their geographical position and climate do not allow other livelihood activities (Shalli & Sigalla, 2022). The data suggest that fishers from Mbwera West (Kibiti), Dunda/Custom (Bagamoyo), Kisiju Pwani (Mkuranga) and Saadani (Chalinze) have the highest number of days (20) spent at sea for fishing. The time spent on fishing is a reflection of not only the fishing effort but also the absence of other income generating activities. Mwakyosa et al. (2021) suggest that time spent on fishing can also influence catch composition. The importance of a means of livelihood of artisanal fishers is well argued by Adili and Antonia (2017), Mkare and von der Hyden (2013), Munga and Ndegwa (2012): all agree that alternative means of livelihood, apart from fishing, is an important aspect of a sustainable fishery.

In the same context, our findings confirm an increase in fishing pressure, which is caused by several factors in general, and particularly by overdependence on prawn fishing (as a source of income) due to the absence of other sources of income, and the increase in demand for prawns. For instance, villages like Mbwera East and West (Kibiti) mangroves were sources of income (alternative to prawn fishing), but government restrictions to access and use of mangroves for economic activities increased pressure on prawn fishing. Fishing pressure has also been facilitated by an increase in prawn demand within the country and outside (East Africa and Europe). Our discussions with more than 20 corporate, tourist hotels and restaurants in Dar es Salaam reveal that there is an increase in the number of local people who eat prawns, apart from tourists. This has increased the demand for prawns locally (URT, 2022). Similarly, within the East Africa region, Rwanda and Uganda have been increasing demand for prawns from Tanzania. Also, apart from the traditional market in Europe (Portugal and Spain), other European countries have been importing prawn from Tanzania.

The increase in fishing pressure is manifested by an increase in the number of petty traders/middlemen/agents who buy prawn from artisanal fishers directly (Mwambao Coastal Community Network Tanzania, 2021). Middlemen own fishing vessels which are given to artisanal fishers under the agreement that artisanal fishers will sell prawn to the respective middlemen who own vessels at fixed prices. During FGDs with artisanal fishers, they complained that collectors have the power to set low prices for prawns because they offer some inputs required by fishers. The study findings suggest that the number of fishing vessels increased rapidly specifically in the years between 2001 and 2009. This increase in the number of fishing vessels is a clear reflection of the demand for prawns. It is worth noting that the current stock assessment shows the tendency of overfishing in general; and particularly higher exploitation levels from artisanal fishers in Bagamoyo and Nyamisati (Mwakyosa et al., 2021).

Moreover, the regression analysis of data suggests that ownership of fishing vessels and gears are significant factors influencing fishing activities. Therefore, when the number of fishers (users) and demand increases on the one hand, meanwhile as the means of livelihood for these communities remain limited on the other, it is logical that fishing will continue even during closure periods. Fishers complained that the proposed closing period is against reality in the sense that the moratorium covers the most ideal fishing times with high catches. According to the local knowledge, the best fishing seasons are December to April, and January to March; thus, closures fall within the best seasons (Mwakyosa & Mwaka, 2021). These factors can partly explain the slow recovery of prawn stock even after the implementation of the closure system for artisanal fishers. Even if this study did not focus on illegal fishing, it is reasonable to argue that illegal fishing in this socio-economic environment is inevitable. It is worth noting that the slow recovery of prawn may have been contributed by fishing activities during the closure period. Equally, the closure system might not have been effective because some artisanal fishers have no other means of livelihood than opting to continue with illegal fishing. Within this context, Mosha et al. (2013) explain how fishery in general, and particularly prawn fishing, is an important means of livelihood and survival for people in Saadani:

> ...the lives and livelihood of the people in Saadan areas are linked to the environmental services which the estuary provides. This fishery is a vital and valuable economic resource to the local community. Small-scale artisanal fishery accounts for the majority of fish and prawns caught in Saadani area. The prawn fishery and other estuarine fishes dominate the local economies in Saadani village. Considering the low income of the Saada community, the study proposed closed season should go hand in hand with the provision of alternative livelihood to the community and the proposed prawns closed season should not hinder any artisanal fisher from fishing other types of fish during the closed period so long as they use environmental friendly fishing gears (ibid: 61).

Our discussions with artisanal fishers in Msindaji (Kibiti), Kiomboni (Kibiti-Rufiji), Mbwera East and West (Kibiti) reveals that the closure period falls within the time when catch is high; whereas the opening is during the low catch period. For instance, for Nyamatungutungu (Kilwa), prawns locally known as king

(*Penaeus monodon*) are more available between December and March, whereas prawns known as white (*Fenneropenaeus indicus*) are more available between October and November. Similarly, for villages such as Kiomboni, Mbwera East, and West (Kitibi district), high catch is between September and December: these months are within the government's closure period, which is from 31 August to 1 March each calendar year for the Southern zone.

The data from regression analysis show that the age of a prawn fisher, daily income from prawn fishing, and the ownership of fishing vessels are significant socioeconomic drivers that influence prawn fishing effort in the study areas. The age of a prawn fisher is negatively correlated with fishing effort. This implies that an increase in the age of a fisher reduces the chance of the number of days a fisher spends fishing. As fishers get older, they cannot spend many days working at sea since fishing is a tedious and laborious job. It is also possible that younger fishers are the ones more likely to have most family responsibilities than older ones, like caring for growing children and their wives, since prawn fishers are men. The daily income of a fisher from prawn fishing was found to positively correlate with fishing effort. An increase in daily income from prawn fishing increases the chance of fishing pressure. Prawn fishing is perceived as a lucrative business, consequently, people are attracted to fish for many days. Similarly, ownership of fishing vessels is a positive factor that influences fishing effort. This implies that as many people continue to own fishing vessels, the more likely they would increase fishing effort. Fishing vessels are expensive; thus, it is a capital intensive endeavour, investing in it would mean fishers would therefore continue to fish to compensate for the costs of the costs incurred. In the same context, vessel owners may rent their vessels to other fishers, eventually increasing fishing pressure.

Likewise, the data suggest that the number of alternative livelihood activities, level of education, ownership of gear, and size of the household had no significant influence on fishing effort. This suggests that fishers do not always increase or decrease fishing effort because of the number of alternative livelihood options. However, the findings suggest that the number of alternative livelihoods had a negative correlation with fishing efforts. Thus, this evidence suggests that an increase in the number of alternative livelihood options reduces the chance of days spent fishing, as sometimes a fisher may need to attend to other livelihood options. This means fishers would likely stop fishing prawns if there are other profitable businesses in the area. Similarly, the negative regression coefficient of education level implies that an increase in the education level of a prawn fisher would likely reduce fishing pressure. An increase in the level of education is expected to increase positive attitudes about environmental conservation, including complying with restrictions on the use of destructive fishing methods. Again, advancement in education increases the possibilities of alternative sources of income such as formal employment.

Surprisingly, our data show that household size had a negative correlation with fishing effort. This means an increase in a household size of a prawn fisher reduces

the chances of fishing effort. This is contrary to what was expected. Perhaps, this is because the majority of prawn fishers in the study area do not own fishing gears or vessels, making fishery not a generational inherited activity: it is for those who have access to fishing vessels or gears. Thus, large families opt to engage in other livelihood activities to cope with their life situations. The ownership of vessels and gears had a positive correlation with fishing effort, which suggest that when more people own fishing gear, it would likely increase the fishing pressure.

Conclusion

The study findings show several indicators of an increase in fishing effort, namely: an increase in the number of prawn fishers, an increase in the number of fishers using fishing vessels, an increase in the number of landing sites, and the number of collectors/middlemen. Socioeconomic factors influencing fishing efforts include limited alternatives to livelihood activities, low level of education, increase in the demand for prawns from Tanzania (nationally and internationally). Based on evidence obtained from the fishing communities, we argue that all these factors have been contributing to the slow recovery of prawn stock in Tanzania Mainland.

The study recommends the following. First, is the improvement of other means of livelihood in prawn fishing communities; and second, there is need to increase education opportunities, especially secondary education and vocational training focusing on craft activities. The latter will open new employment opportunities for young people, especially boys, on the one hand; and ease overdependence on fishing activities on the other hand. Third, it is important to monitor the supply and demand of prawns at the market level to make the closure system effective. For instance, monitoring of the supply chain during the closure period will reduce cases of illegal fishing. The market (corporate, tourists hotels and restaurants) should also be included as key stakeholders in monitoring the supply chain of prawns. The establishment of a primary cooperative among artisanal prawn fishers would reduce their dependence on collectors/petty traders, on the one hand; while providing them the possibilities of owning fishing vessels, on the other. In the long-run, this will give prawn fishers more bargaining power of price for their catch.

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