Fisheries Improvement Projects (FIPs) *Octopus Fishery Project*

Progress report



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**1. Background and Introduction**

Tanzania has a well-developed octopus fishery along the coastal regions. The fishery is exclusively artisanal and *Octopus cyanea* is a dominant species (Roper *et al*., 1984; Guard and Mgaya, 2003; TAFIRI, 2016). This species could be identified by the presence of two ocelli (eyespots) located a few centimetres below the eye, elliptical white spots found on the dorsal side of the tentacles and zebra stripes or bands on the ventral arm face (Guard and Mgaya, 2003).

Of the past few years, fishery for octopus has become more important due to the increase in its demand for the external market (Jiddawi and Othman, 2002; Bryceson *et al*., 2006) as well as local markets. The volumes of exported octopus are well known and well quantified. For example, the exported octopus into different external markets has been decreasing from 5,195 Mt in 2007 to 440 Mt 2016 (MALF, 2016). However, information on the status of the stock, ecology and life cycles, level of fishing intensity and traceability of the resource in the local market in Tanzania Mainland is limited. The results from a recent study on stock assessment of octopus in Tanzania Mainland (TAFIRI, 2016) and assessment by using the Benchmarking and Tracking revealed some gaps which need to be addressed for qualification of status of octopus fishery versus the MSC principles. It is expected that findings from this project will contribute the information towards raising qualifications for MSC certification.

It is worthy to note that the process of *Octopus cyanea* certification by Marine Stewardship Council (MSC) in Tanzania Mainland began in 2005 by the World Wildlife Fund (WWF) in collaboration with fisheries Department. Under this initiative, a lot of activities were conducted as a way forward towards certification. Such activities not limited to were; pre-analysis and pre-assessment in conjunction with development of Octopus Fishery Management Plan (OFMP). This study therefore was planned to add from the previous information (TAFIRI, 2016) on the status of the stock of *O. cyanea* in marine waters of Mainland Tanzania which include their abundance, distribution and their biometric information. The study further gathered information required for MSC assessment which includes harvesting strategy for the exploitation of the Tanzanian octopus, Endangered, Threatened, and Protected Species (ETP) and by-catch species.

**2. Objectives of this study**

The specific objectives of the project:

1. To map the octopus reefs in Mafia and Kilwa
2. To assess environmental parameters on the sampling sites
3. To estimate fecundity of the species
4. To undertake spatial and size evaluation of Octopus catches in Tanzania
5. ***Assessment of leakeges, propose solutions and mechanisms to obtain total mortality and improve traceability of octopus catches in the sampling sites and traceability aspects of the octopus‘‘***
6. To characterize octopus fishery and how fishing is operated and catch handled.
7. To assess and quantify primary and secondary by-catch associated with octopus fishery
8. To find out if octopus fishers collect lobsters as a primary by-catch and document the extent
9. To assess the impact of octopus fisheries on lobster.
10. To assess stock status of lobster in selected sites in Mafia and Kilwa. To assess and document the type of gears used in octopus fishing and how they impact the fishery and habitat
11. To assess the impact of octopus fishery to the reef system.
12. To assess the impact of octopus fishery to the ecosystem. Study the trophic impact of removal of octopus and lobster on the coral reef.
13. To assess the impacts of octopus fishery on Endangered, Threatened, and Protected Species (ETP)
14. To assess the likelihood that sea cucumbers are illegally targeted by octopus fishers.
15. To assess the effectiveness of sea cucumber fishing ban on the population recovery. Find out which species of sea cucumber is under CITES list of species.
16. To gather information on sea cucumber stock status. Check existing biological and ecological information related to sea cucumbers. Document effectiveness of data collection for sea cucumbers.
17. To synthesize information on the current reef status.
18. To check if Ecosystem Approach to Fisheries is applied to Octopus Fishery Management Plan and implemented.
19. To develop a Structured Research Programme on Tanzanian Octopus
20. To develop capacity building packages in artisanal fisheries data collection and statistics in both English and Swahili versions

**NOTE:**

1. As we have indicated and agreed on the Inception Report, an Objective iv; **‘‘Assessment of leakeges, propose solutions and mechanisms to obtain total mortality and improve traceability of octopus catches in the sampling sites and traceability aspects of the octopus‘‘** *w*as conducted.
2. The activities highlighted with red colour are not yet done due to time limit and funds issue. They were planned to be done after receiving the second instalment

**3. APPROACH AND METHODOLOGY**

**3.1 Study Site**

This study was conducted in two sites along the coast of Tanzania Mainland includes Somanga and Songosongo Island (Kilwa region); Bwejuu and Jibondo (Mafia Island)



**2**

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Figure 1: A map of Tanzania showing the proposed study sites namely; 1 = Mafia, 2 = Kilwa

**3.2 Data Collection**

Catch-effort data of *O. cyanea* were collected from the landing sites each month during spring tide for three months in collaboration with enumerators (trained fishers/BMU) while the District Fisheries Officers (DFOs) in a respective site acted as the supervisors. Catch-effort data that were collected include the following:

1. Time of departure from village
2. Time of arrival at the fishing site
3. Name of fishing site
4. Time of start fishing
5. Time of end fishing
6. Time of return
7. Length of time actively spent in fishing
8. Number of fishers
9. Total catch of the octo pus in weight (kg) and number
10. By-catch species in weight (kg) and number

The above data were collected using a structured interviews (standardised interviews) with the buyers/agents and fishers at the fish landing sites immediately after they return from fishing. Catch-effort data were used to calculate Catch per Unit Effort (CPUE). Information on exploited octopus and number of fishermen by gender with specifications on level of engagement of these fishermen in octopus fisheries was recorded.

Catch-effort data collection employed a mobile based technology that records, reports, processes, stores and send fisheries data from specific site in real time and then send through special gateway to cloud storage for sharing.

Total weight (kg) and number of *O. cyanea* collected per day per boat were recorded at the landing site immediately after the fishers return from fishing. All catch from octopus fisher was quantitatively recorded and sub-sample of *O. cyanea* was taken for biological measurements which include sex identification and morphometric data (individual total length, weight, dorsal mantle length and by-catch). Both dorsal mantle length and total length of individuals were measured to the nearest 1 mm using a 100 cm measuring board and total weight of individuals were measured using a 50 kg weighing scale to the nearest 0.1 kg. A maximum of 50 specimens of *O. cyanea* was sampled per site per spring tide for further analysis which includes identification of maturity stages, estimation of gonadosomatic index, fecundity and gut content analysis. For fecundity estimates ovary and proximal oviducts of each female was removed from the visceral cavity and weighed (±0.01 g), then egg samples were taken and be fixed in Gilson’s fluid for further analysis. The eggs were kept in the solution and regularly shaking for three months.

**3.3 Data analysis**

All catch-effort, gut content and gonad data were entered into excel database and analysed using excel, R, MINITAB and OriginPro statistical software. Results of these analysis included catch yields, average weight by month, weight and length frequencies, catch per unit effort (CPUE), sex ratio, gut content analysis, gonadosomatic index, size at first maturity.

**3.3.1 Length-weight relationships**

Length-weight relationships of *Octopus cyanea* for both sexes was analysed at each zone/region (the pooled two sites) using the power curve equation:

W = qLb (Guard and Mgaya, 2003)

Where W is the total wet weight (g), L is the dorsal mantle length (mm), b is the slope of the regression line and q is the intercept on the Y-axis.

The significance of a regression was tested using student t-test (Zar, 1996).

**3.3.2 Sex and sex ratio determination**

Sex of mature octopus was differentiated by the presence of ligula at the third right arm (hectocotylized arm) present in males. Sex for immature individuals was determined by assessing the development of the gonads after dissection of the animal (Guard and Mgaya, 2003). Sex ratio was analysed and tested for the significant difference from the expected 1:1 ratio for the three sampling period. Deviation from the expected 1:1 ratio was tested using the Chi-square test.

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# RESULTS AND DISCUSSION

* 1. **Review on the identified gaps on the octopus stock assessment report (2017)**
     1. ***Monthly mean CPUE, in kg/fisher/day***

Catch rates articulated in terms of catch per unit effort (CPUE) was used as an index for abundance. The mean catch rates (kg/fisher/day) observed during the study differed considerably among the sampling sites, (F (4, 1) = 23.262, p < 0.05). Bwejuu and Songosongo had higher catch rates of 6.44 Kg/fisher/day(N = 47) and 6.04 Kg/fisher/day(N = 68) compared to Jibondo and Somanga which had lower catch rates of 3.27 Kg/fisher/day(N = 251) and 3.29 Kg/fisher/day(N = 96) respectively. Tukey test also showed sites with higher catches being different from the ones with lower catches. Additionally, catch rates observed in Songosongo varied significantly with months (F (4, 1) = 4.9309, p < 0.05). Tukey test showed February and March having significant higher catches than December and January while the rest of the sites had no differences for the sampling months. The difference observed may partly be explained by closure management strategy since data collection in March synchronised with opening event of the octopus fishery of some closed reefs in Songosongo. Closures support octopus fishery by fuelling other coral reefs due to spillover effect if recovery is substantial. In addition, closure reduces overfishing and other ecological stressors allowing most of the octopus growing to maturation (Prado *et al*. 2008). This explains higher mean total landings observed in Songosongo in February but much evident in March on the opening event (Fig. 2).



Figure. 2. Mean catch rates (Kg/fisher/day) of the octopus fish landings in Tanzania per site per month (December 2017 to March 2018). Error bars show the variation among the phases of the lunar cycle.

* + 1. ***Monthly mean total landings***

Monthly mean total landings for the studied sites differed considerably (F (4, 1) = 42.9, p < 0.05). Songosongo, Bwejuu and Somanga had fairly higher catch rates of 47.77 (N = 68), 36.19 (47) and 32.95 Kg (N = 96) respectively compared to Jibondo which had lower total mean catches of 8.5 Kg (N = 251). On a One-way ANOVA and Tukey test showed monthly mean total catch of February and March being higher than December and January for Songosongo (F (4, 1) = 4.9309, p < 0.05).



Figure 3. Mean total catch of the octopus fish landings in Tanzania per site per per month (December 2017 to March 2018). Error bars show the variation among the phases of the lunar cycle.

***4.1.3 Length–weight relationships***

Length and weight of 4388 individual *Octopus cyanea* were taken for three months from all sites, out of this, 2722 individuals were measured in Kilwa and 1666 individuals were measured in Mafia. Results of the length-weight analyses for each site indicated that all octopi exhibited negative allometric growth (b<3), the phenomenon whereby parts of the same organism grow at different rates (Mosby, 2008). This agrees with results obtained by other authors for *O. cyanea* (Guard and Mgaya, 2003; Chande, 2010; TAFIRI, 2016) and *O. vulgaris* (Sanchez and Obarti, 1993). In addition to this, the animal with the higher slope value (b) is increasing in weight per unit increase in length at a faster rate than the animal with the lower slope value (Guard and Mgaya, 2002). Results of this study showed that Octopi in Mafia grow at a faster rate than the octopi of Kilwa and this concurred with observation by TAFIRI (2017). If octopus fishery is well managed, they increase in weight as much as 200 g in only ten days (IUCN, 2004). Difference in growth rate may be influenced by factors such as physical and environmental conditions and food abundance.

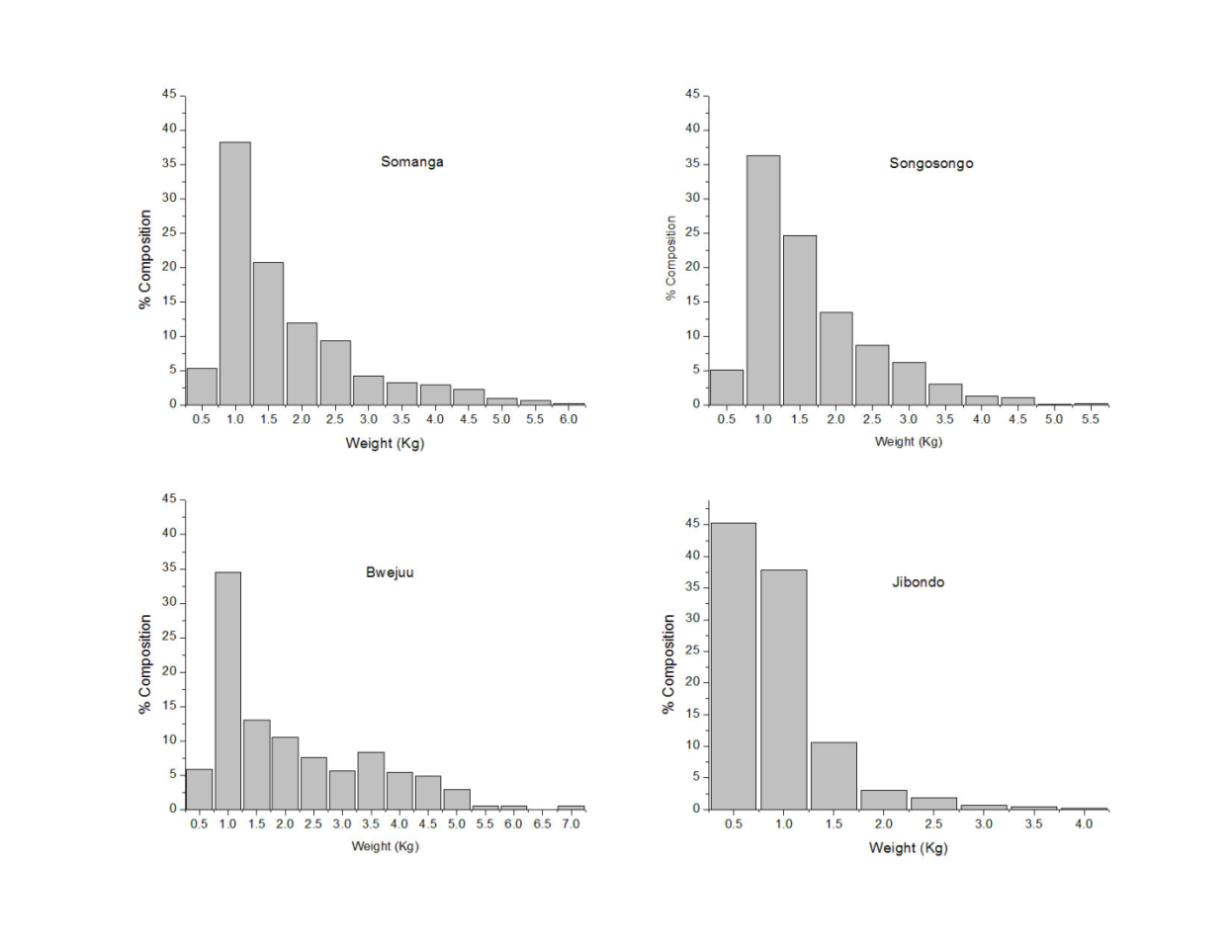
**C:\Users\Muhaji\Desktop\Graph3.TIF**

**Figure 4.** Length-weight relationship of *O. cyanea* sampled from Mafia and Kilwa districts during the study.

***4.1.4 Size (weight) frequency distribution***

The wide range of the modal size classes of *O. cyanea* and big sized octopus was found at Bwejuu (0. 1 to 7.0 kg) followed by Somanga (0.2-6.0 kg) and Songongongo (0.1 - 6.0 kg) and lowest was in Jibondo (0.2 to 4.0 kg) (Fig. 5).

The highest percentage of smaller sized (< 0.5 Kg) individuals of *O. cyanea* were recorded at Jibondo where they accounted for 36% (n = 4380). Contrary, Somanga, Songosongo and Bwejuu landing sites recorded only 2%, 3% and 5% respectively of individuals weighing less than 0.5 Kg. The highest number of smaller individuals of *O. cyanea* in catches at Jibondo compared to other landing sites suggests that there has been high fishing pressure over long period which resulted into reduction of large individuals in the respective fishing grounds. Besides, the higher number of larger sized individuals found in catches at Somanga and Songosongo probably could be attributed to the fact that sampling at these sites was conducted after the closure. In addition, the calm sea condition during sampling period favoured fishing activities as it was a beginning of the transition period “Matlai” from NEM to SEM. This is a good result of the closure activity practicing in these areas since 2016 as one of the management strategies. There was also a small percentage of small sized octopus of less than 0.5 Kg at Bwejuu in which a low fishing pressure in this area for a long period has assisted in maintaining large sized individuals. It is worthy also to note that, Bwejuu area is closer to Mafia Marine Park and this could be attributed to the observed larger sized octopus. Octopus from the park could move to a nearby octopus fishing reefs in which fishers used to fish. Therefore, differences in the level of fishing effort, with a combination of management strategies as well as fishing regimes could be the main factors for the observed differences in the octopus size at various sites. Therefore reduction of fishing effort in sub-tidal zones that are fished by Jibondo artisanal fishers could help in minimizing the off take of small individuals at the same time maintain high number of large sized individuals.

Guard and Mgaya (2002) proposed the size limits of approximately 0.3 Kg and 0.6 Kg as the minimum weights at which male and female *O. cyanea* mature respectively. Though there is high intra-species variation (Domain *et al.,* 2000; Guard and Mgaya, 2002; Semmens *et al.,* 2004), it is most likely that any individual caught at a smaller size than the stated above (Guard, 2003) is unlikely to have been reproduced. Protecting reef flat areas may also be useful as it is thought that they are used by immature female octopus to feed and grow before shifting to deeper waters to spawn (Oosthuizen and Smale, 2003). For that reason, leaving reef flats unfished for some months before peak spawning could enrich spawning and potentially recruitment. This is a practices that are been done at Somanga and Songosongo. 

**Figure 5:** Size (weight) frequency distribution of *O. cyanea* at Bwejuu and Jibondo landing sites in Mafia and; Somanga and Songosongo landing sites in Kilwa

## 4.1.4 Reproduction

### Sex ratio

A total number of 2722 and 1666 individuals were dissected for sexes identification at Kilwa and Mafia respectively of which 2306 were females and 2082 were males. The Chi-square test indicated that the sex ratio of *O. cyanea* was significantly biased towards females for both areas (1. 11F:1M, n=2722, p = 0.006 for Kilwa; 1.1F:1M, n=1666, p = 0.045 for Mafia). Contrary, a study by TAFIRI (2017) indicated the skewedness towards males that means the sex ratio was not significantly different from 1:1 ratio which implies that there was no segregation of sexes during the sampling period. However, it should be noted that with exception of Mafia, the present study did not replicate the previously study sites (TAFIRI, 2016). The presence of more females could on the present study suggest that the sampling period (December 2017, to February 2018) was the period before spawning. It should be noted that octopus fishers in Tanzania do conducted their fishing activities at inshore waters and during spawning period there always low number of female’s individuals in shallow waters compared to spawning periods. During spawning, the spawning females go to deeper area and therefore become inaccessible to fishing.

Since the sampling period of the present study was short, we cannot ascertain whether this is a comprehensive reason of high number of females than males. Nevertheless, it is has been documented that *O. cyanea* does not exhibit seasonal reproduction a series of environmental factors influences the process of sexual maturity (Herwig *et al*., 2012; Raberinary, 2012). The most influential factors being photoperiod and temperature (Mangold, 1983) which affect not only the growth rate but also determine the onset of maturity for this species .Other studies of populations of *Octopus* spp reported a higher number of males than females (Mangold-Wirz, 1963; Cortez, 1995; Hernández-López, 2000) and variations in the sex ratio with respect to size (or weight) and sexual maturity. It has been reported that during the periods of **maximal reproduction**, the number of female *O. vulgaris* apparently increases in shallow areas as a consequence of vertical migrations from deeper areas. This has been observed in natural populations of *O. vulgaris* from the Mediterranean Sea (Mangold-Wirz, 1963; Guerra, 1977) and the west coast of Africa (Guerra, 1977, 1979; Hatanaka, 1979b; Smale and Buchan, 1981), and it is probably a consequence of the search for better feeding areas before reproduction (Cortez, 1995). Likewise, females also go to deeper waters during spawning.

**4.1.5 Recruitment**

Recruitment patterns required data (month year and weight (average weight) showed Songosongo and Somanga followed by Bweju had relatively higher recruitment than Jibondo (Figs 6 A, B, C). However the observed recruitment pattern in the present study is not different from what has been reported from previous studies (Guard 2009; TAFIRI 2016). The general result indicates that recruitment is occurring throughout the year for all study sites. Mafia study sites (Jibondo and Bwejuu) indicated highest recruitment pulses in month of May while Mtambwe (Tanga) indicated in January (TAFIRI, 207). It was reported that in Tanzania brooding of octopus is most likely to occur year round but with brooding peaks indicated during January and October and November and the recruitment pulse follows a few months after (Guard, 2003). In this case data of maturity status of individuals collected in the present study could be used as well to confirm the recruitment pulses.

A *O.cyanea* recruiment pattern for pooled data

B Recruitment of *O. cyanea* among study sites and sampling period

C Recruitment of *O. cyanea* among study sites and sampling period (Dec 2017-Jan.2018

**Figure 6** Recruitment of *O. cyanea* in Kilwa and Mafia between Dec 2017 and January 2018

sites

sites

**4.2 Characterize octopus fishery and the potential of the fishery on the reef. Document how does octopus fishers operate/catch octopus; depth at which octopus are caught; method of catching and tide regime. Document the behaviour of fishermen on the reef during octopus fishing. Document how catch is handled after harvest**

Octopods possess eight circum-orally arms, and lack tentacles which are present in squid and Cuttlefishes (Gillespie *et al*., 1998). The mantle is reduced, and attached dorsally with the head. The suckers are attached straight to the arms, not mounted on stalks, and lack pedicels or chitinous rings. The distinctive mollusc shell is reduced or absent. Fins are absent, or set low on the sides of the mantle when present. The central tooth of the radula has one large prognostication and two or more small lateral points, and the first and second lateral teeth are multicuspid. The buccal membrane is absent, and the olfactory organ is a ciliated pit(Gillespie et al., 1998).The Octopod are divided into two suborders groups, cirrata and the Incirrata. Cirrate octopuses possess muscular cirri along the arms and have paddle shaped fins. They are mainly deep-sea pelagic and epibenthic forms. Incirrate octopuses possess neither cirri nor fins, and are moderately deep to shallow water benthic or epipelagic forms. Cirrate octopuses have not traditionally supported fisheries. Only one of eight extant families of incirrate octopuses, the Octopodidae, is of commercial importance and lives mostly near shores in rocky substratum, example in coral reefs areas of the coastal waters of Tanzania. Therefore, further discussions will base on octopodidae which are mainly caught by small-scale fishers in coastal east Africa.

The eastern coast of Africa especially Tanzania is endowed with fringing reefs which shelters over 1,424 kilometres coastline guaranteeing potentiality of the fishery (Muhando et al., 2001, Francis and Bryceson, 2000) The Tanzania Octopus Fishery primarily targets the *octopus cyanea* with lesser targeted catches of the *octopus vulgaris* and lobster as primarily by-catch. The main fishing method is iron stick, wooden stick and rarely spear gun, same was reported by Guard (2003) and TAFIRI (2017). The majority of the octopus harvest is done in the intertidal reef area whereby women and children, glean for octopus, sea cucumbers and shells and most of men do dive in deeper waters of reef flats or hunt for octopus at high tide using a mask and snorkel and iron stick/ harpoon. In gleaning for octopus, the fishers use a single pointed, un-barbed spear, to extract octopus hiding in niches on the reef flat. Shore diving is perhaps the most common form of octopus fishing in Tanzania. Usually shore divers hunt at depths of 5–25 metres depending on location where coral reefs are situated (Gillespie *et al*., 1998, Francis and Bryceson, 2000). In some locations, divers can experience drop-offs from 5 to 40 metres close to the shore line (Gillespie *et al*., 1998, Francis and Bryceson, 2000). In tropical areas like Tanzania, dangerous sea organisms including sharks may be less common, but other challenges facing octopus fishery is on how to manage the entry and exit during the period of south east monsoon (SE) when the ocean is very rough. Foot fishing is preferred in area with close proximity to coral reefs; nevertheless timing is important to avoid the diver not get pushed onto rocks by waves.

The octopus fishermen in Tanzania do fishing subsequently following lunar pattern, which is divided into new moon that is day 1-4 representing full moon spring tide between day 4-9 neap tide, day 10-18 spring tides and day 19-24 from the new moon which represented neap tides (Jiddawi *et al.,* 2002*)*. Octopus fishing covers the entire tidal and lunar cycles which are known to affect fishery landings in the region. However, most of octopus fishing are concentrated on the two spring tides of a month. Tidal circulation administrates fishing time to about 6 hours daily since navigating across habitats are tidal dependent (TAFIRI, 2016; de la Torre-Castro *et al*., 2014).

The octopus traders often commission fishers with fishing equipment, including boat and fuel for the fishing trip (pers. observ.). They also pay premium prices to the octopus fishermen for the octopus catch as a motivation to maintain them. This phenomenon is most common in Kilwa, where livelihood depend mostly on fisheries and household consumption is at a smaller amount of the o fish sold including octopus. Most of the octopus that are bought by traders ends in local fish processing companies such as TANPESCA that process and export octopus products overseas.

For the skin divers, after catching the octopus in the wild, each individual fisher in a boat aggregate his octopus catches and tie them together with a rope. Once fishers are back ashore they weigh the total catch of the octopus individually and sell to the traders. Fishermen who caught big-sized octopus gets more return than with fewer or small-sized octopus. However, most fishers are restricted to sell their catch to traders who facilitate their fishing trip giving them less options to accessing other available markets.

**4.3 Primary and secondary by-catch associated with octopus fishery**

By catch is one of the most significant issues affecting fisheries management today because virtually all capture fisheries are capable of producing by-catch. There are two main categories of by-catch namely; **primary** and **secondary** by-catch. Primary by-catch are only in-scope species that are managed according to either target or limit reference point while secondary by-catch are out-scope species and unmanaged that contains a large variety of species such as birds, amphibians, reptiles and mammals. Fishermen gleaning for octopus in both intertidal and sub-tidal areas are opportunistic and they always target other species such as reef fish, squid, crabs, sea shells, sea cucumber and lobster as primary by-catch. No secondary by-catch was observed on the octopus fishery. During the survey, by-catch species were recorded, photographed and quantified in-terms of number.

By-catch species composition (by percentage) in Tanzania coastal waters and per sampling site is presented in Figs 7 and 8 respectively. It has shown that siganidae (48%) is the main by-catch of the octopus fishery followed by Loliginidae (28%) and Panuliridae (11%) (Fig. 7). However, it was found that by-catch species percentage contribution differ from one sampling site to another (Fig. 8). In Mafia, panuliridae (lobster) was found to dominate the by-catch species (70%) in Bwejuu followed by fish; Serranidae (27%) and scaridae (3%). Contrary, octopus by-catch in Jibondo; the site in Mafia, was found to be dominated by fish; Siganidae (94%) supplemented by Scaridae, Serranidae, Loniginidae and others by equal or less than 3%.

In Kilwa, Lolinigidae was a dominant by-catch at Songosongo sampling site (100%) and Somanga (48%). Other octopus by-catch at Somanga was crabs, fish and shells. Lobster is one of the main octopus by-catch and it is a highly valuable marine product of high value but they tend to reside deeper than most sub-tidal snorkel fishermen can swim to. Although only a small proportion of lobster stock can be impacted by octopus snorkel fishers, there are also octopus skin divers who are a potential threat to lobster stock and therefore this resource is highly vulnerable to octopus fishery. Based on the results, lobster in Bwejuu (Mafia) seems to be in high risk than in other areas. In addition to other by-catch species, octopus fishers in Somanga were collect and sell sea shells to the octopus agents who have become respectable shell dealers. Foot fishers are very much attracted to the collection of sea shells as they move along the interdial reefs. Reef fishes and squids are a popular by-catch and therefore they are highly vulnerable to octopus fishery.

**Figure 7.** By-catch percentage composition of the octopus composition in Kilwa na Mafia (Dec. 2017; and January and February 2018

**Figure 8.** By-catch percentage composition of the octopus composition: (a) Bwejuu (b) Jibondo (c) Somanga

(d) Songosongo (Dec. 2017 and; January and February 2018)

**4.4 Assess stock status of lobster in selected sites in Mafia and Kilwa**

By catch is one of the most significant issues affecting fisheries management today because virtually all capture fisheries are capable of producing by-catch.

TAFIRI (2016) reported Fishermen gleaning for octopus in both intertidal and sub-tidal areas are opportunistic and will target other species including lobster. The following by catch were photographed and recorded during previous study (TAFIRI 2016) but were not quantified.

Lobster, a highly valuable marine product tends to reside deeper than most sub-tidal snorkel fishermen can swim to. Although only a small proportion of this lobster stock can be impacted by octopus snorkel fishers, there are also scuba divers who are a potential threat to lobster stock (Guard, 2009). In artisanal lobster fishery, Bwathondi (1973) identified *Panulirus ornatus*, *P. longipes*, *P. versicolor*, *P. homarus* and *P. penicillatus* as occurring in Tanzanian waters. The first two are the most abundant, contributing more than 80 percent to the landings in 1080s (Bwathondi, 1980). The most common fishing method involves divers with a hand-held net and an octopus; the latter is used to flush the lobster so that they can be scooped up by the net. Dealing with the period 1966 through 1975, Bwathondi and Mwaya (1984) refer to annual catches reaching 80 tonnes. More recent data are not available as the catches of lobster are not identified separately within the official statistics. No assessments of the lobster biomass or potential yields have been undertaken.



**4.5 Assess the impact of octopus fisheries on lobster**

By catch is one of the most significant issues affecting fisheries management today because virtually all capture fisheries are capable of producing by-catch. Lobster, a highly valuable marine product tends to reside deeper than most sub-tidal snorkel fishermen can swim to. Although only a small proportion of this lobster stock can be impacted by octopus snorkel fishers, there are also SKIN divers who are a potential threat to lobster stock. TAFIRI (2016) reported that fishermen that are gleaning for octopus both in the intertidal and sub-tidal areas are opportunistic and normally target other species including lobster. During the current study, lobster was among the major octopus by-catch although the quantity caught differ from one sampling site to another.

**4.6 Type of gears used in octopus fishing and their impact to the fishery and habitat**

Traditionally, octopus fishery has been practiced by women and children by walking on the intertidal reef flat with the use of wooden slender stick as the fishing gear (Guard and Mgaya, 2002). Recently, men has been engaged in this fishery due to the increase in its demand for export and local market, and instead of fishing only on the intertidal reef flat, the fishery is now extended to the subtidal inner reef by snorkeling and skin diving with the use of iron stick. According to octopus fishers from the visited/study sites, iron stick is more efficient in catching octopus as compared to wooden stick simply because it can easily bend following the path of the hole where octopus is hidden. Nevertheless, fishers can negatively use the iron stick to break part of the coral where octopus is hidden to facilitate it’s easily removal. The use of iron stick to break corals while searching for octopus is not practiced very often by the octopus fishers, so it does not has a significant impact to the coral destruction but in a long run its impact could be significant. Dpear guns were also found to be in use for catching octopus but in mimimu level. The change of fishing gears is believed to be associated with an increase in total catch landings but on the other side it has significantly affected size of octopus taken from the fishery (Guard, 2003).

**4.7 Impact of octopus fishery to the reef habitat and ecosystem**

Octopus fishery may have impact on the reef cover, substrate and ecosystem in general, but information on the impact of octopus fishery to the habitat and ecosystem was not covered during the first three months of data collection. We are expecting to gather this information during the second phase of this study after reimbursement of the remaining fund. Risk Based Framework (RBF) methodologies particularly Consequence Spatial Analysis (CSA) and Scale Intensity Consequence Analysis (SICA) will be used to assess octopus fishery and its impact to the habitat (reef system) and ecosystem.

**4.8 Trophic impact of removal of octopus on the coral reef**

This study revealed that, *Octopus cyanea* is an opportunistic predator which feed on crab, fish, lobster, gastropod and prawn, it also experiences cannibalism by feeding on their own youngs. Crab is the dominant prey which comprises of 70% of the total number of octopus prey examined. This concurred with the result revealed by TAFIRI (2016). The continuous removal of octopus from the reef ecosystem therefore, it could results into increase abundance of crabs in that particular ecosystem. However, this information can be quantified by monitoring octopus abundance and prey (crab) densities at different locations for at least 3 to 5 years (Ambrose, 1986). From this perceptive, if predators is a significant source of mortality for their prey, the respective abundances will be negatively correlated. This approach can also be applied on the study of the trophic impact of the removal of lobster from the coral reef.

**4.9 Information on the current reef status**

Recent status of reefs was provided by Guard, 2003, who studied three reefs including Nyama reef (Kwale, Tanga), Kitutia reef (Jibondo, Mafia) and Msangamkuu reef (Msangamkuu, Mtwara). In his study, he revealed the evidence of the effects of the coral bleaching event in 1998 (e.g algae covered dead coral) in all sites and within all tidal zones. Also Msangamkuu had the highest live coral cover and appeared in a healthier state compared to the other two reefs surveyed in his study. In the second phase of this study, we are expecting to visit the same reefs that were surveyed by Guard, 2003 to assess their current status.

**4,10 Impacts of octopus fishery on Endangered, Threatened, and Protected Species (ETP)**

Endangered, threatened or protected (ETP) species are defined as species that are recognized by national ETP legislation; or species listed in under Appendix 1[[1]](#footnote-1) of the Convention on International Trade in Endangered Species (CITES). Interviews with octopus fishers during the study period in both areas revealed that there was no interaction between the octopus fishery and sea turtles, marine mammals and seabirds. The nature of the fishery and the specific gear used make interactions with these protected species unlikely. Moreover, fishing activities is not conducted at night hence ETP such as seabirds cannot be found during day hours. Therefore, it would be benign to say that risks from octopus fishing to protected species are more or less negligible.

**4.11 Impact of octopus fishery on Sea cucumber**

Due to insufficient funds and time constraints, it was not possible to ascertain comprehensively the effectiveness of the sea cucumber ban on the population recovery. In a short period that was allocated we wanted to compare the field observed size of the individual with those from the literature from the time before the prohibition. However, there was no citing of sea cucumber during the study period, the reasons could be there was no recovery or hesitations or fears from the fishers to declare any catches of sea cucumbers. Similarly, this observation should be treated with caution as fishers might be continuing harvesting and selling sea cucumber illegally considering that the market is still available (the sanction is imposed in mainland Tanzania and not Zanzibar). It is worth to note that international trade is a threat to the conservation of sea cucumber species, as it has been given to the possible role of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as a complementary measure for regulating the sustainable use of sea cucumber fisheries. Only one species is currently listed in a CITES (*Isostichopus fuscusin* Appendix III by Ecuador). Apparently, in Tanzania, a major constraint for CITES list is lack of monitoring and enforcement at the local fishery level as illustrated in Eriksson et al. 2010.

**4.12 Information on sea cucumber stock status**

A comprehensive literature review of publications on sea cucumbers in the WIO can be found in Muthiga and Conand (2014) and Conand (2007). In Tanzania mainland, there is no new data on exploitation, ecology and biology of sea cucumber. Information available is dated back to 2007 and below. These studies have been done along the coastal villages in Tanzania, however they are generally scattered and localized to specific areas with no national approach for establishment of fishery regulation of the resources rather than a cessation on export of sea cucumber due to overfishing (Mgaya and Mmbaga, 2007). These studies depicted that there has been a rapid expansion of sea cucumber exploitation at some sites of Tanzania (Mgaya *et al*. 1999; Mmbaga and Mgaya, 2004; Mgaya and Mmbaga 2007). They portrayed a decrease in number of high valued species namely; *H. scabra* and *H. nobilis*, and high representation of low valued commercialized species that are being exploited. The biology of some commercial species *Holothuria scabra* (sand fish) has been studied by Mmbaga and Ndaro (2002), however, the biology of most other species has received no attention. In addition, Mmbaga and Mgaya, (2004), Mmbaga (2017) provided a synthesis of *H. scraba* and *H. nobilis* fishery and their socio-economic aspects in Tanzania mainland. It is generally known that information on the ecology of the main commercial species is important for fisheries management, yet very little has been carried out. This has pose a challenge to efforts on assessing the impact of sea cucumber fishery, for example the importance of different ecosystems such as coral reefs, sea grasses, mud flats etc for different stages during the life history of commercial species and how changes in these ecosystems affect sea cucumber populations is not clear. Information on the habitats of juveniles that is necessary for understanding recruitment is also lacking. Factors that control population densities including predation and causes of sea cucumber mortality are difficult issues which have also received little attention. As of today, there are no population studies to establish target or limit reference points for managing sea cucumber of both commercial and non-commercial value species. For effective assessment of sea cucumber resources, catch data collection modalities should be established and implemented. Dependent fishery monitoring specific to sea cucumbers in terms of size of harvest will give a well-defined picture of size of species and the value distribution in fishers catch. Also, visual census of coverage and density along their habitat will be of importance in order to establish the status quo of the sea cucumber populations.

**4.13 Check if Ecosystem Approach to Fisheries is applied to Octopus Fishery Management Plan and implemented**

At the moment EAF is applied to all studies which tries to answer the key fisheries management question of the stock status and the population dynamics of resources aiming at maintaining a balanced harvesting of the stock while also considering to maintain the environment

**4.14 Develop capacity building packages in artisanal fisheries data collection and statistics in both English and Swahili versions**

Training has been offered to some Beach Management Unit (BMU) members and District Fisheries Officers (DFOs) on the collection octopus data in all study sites. Training were based on collecting of data including catch-effort data and morphometric data both manually and using the mobile smart phones. In addition, training has been offered to fishers collection CAS for octopus in all study sites. Either the training manual will be prepared or updating the mobile data collection manual which have been prepared previously in 2016. This activity will be done at the end of the project

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1. https://cites.org/eng/app/appendices.php [↑](#footnote-ref-1)