KENYA MARINE FISHERIES SOCIO-ECONOMIC PROJECT

COMPONENT 1

ENHANCED GOVERNANCE OF MARINE FISHERIES

AND BLUE ECONOMY

Research Strategy on
Stock Assesment of the Small Scale CoastalTuna Fishery

JUNE 2022

Table of Contents

1. RATIONALE

Tuna fisheries are an vital source of income and protein for countries of the western Indian ocean (WIO) region where tuna and tuna-like species are exploited commercially by both industrial and small-scale fisheries. In Kenya and most of the WIO, the small-scale sector is the main source of supply to the local markets. Small-scale tuna fisheries operate in coastal areas using a variety of fishing gear types. Based on the biannual marine frame survey, the majority of tuna fishers in Kenya use gillnets (150), trolling lines (106), handlines (75), long lines (45), monofilament nets (15) and other gears (23) (Ndegwa et al., 2020). The fishery operates within the general Fisheries Management and Development Act, 2016 (No. 35 of 2016); however, there are no species measures in place for the fishery, especially for species reported as overexploited by IOTC such as the yellowfin tuna (IOTC, 2021). Moreover, like other tropical small-scale fisheries, the small-scale tuna fishery in Kenya suffers from data paucity which limits stock assessments.

The sustainability of exploited tuna and tuna-like species stocks within the Indian Ocean has increasingly been questioned based on recent assessments by the Indian Ocean Tuna Commission (IOTC). Rebulding of the overfished stocks requires a multi-national effort that is informed by good scientific evidence. Consequently, there has been an increasing call for member states to provide species disaggregated catch information for the small-scale/artisanal sector by IOTC. Efforts to assess the small-scale tuna fishery along the Kenya coast within the framework of the KCDP (2013-2015) and WIOMSA-MASMA project (2019-2021). Biological information collected includes length and weight, and gonad maturity *T.albacares*, *T.obesus* and *K. pelamis* (Alubeidy 2017).

Given the global economic importance of tuna fisheries and their importance in regional and local economies, it is imperative that there is a continuous effort to collect data and information on fishery the performance to inform management and development initiatives. Obtaining quantitative information over time is fundamental for assessing the performance of the fishery and status of the stocks. This strategy describes the efforts to improve the quality of information available for the fishery with support of the Kenya Marine Fisheries and Socio-Economic Development (KEMFSED) project. The aim of this work is improve knowledge on the status and performance of the small scale tuna fishery in Kenya. The information generated will also inform revision of the existing development and management strategy which has expired.

2. SPECIFIC OBJECTIVES

1. Review and document the current information (biological and technical) on Kenya's coastal tuna fishery
2. Conduct risk-based assesssement for primary and secondary species caught by small-scale tuna fisheries
3. Assess spatial and seasonal variations in catch, effort (gear-vessel combinations), and catch rates (catch per unit effort) of primary and secondary species caught in the tuna fishery
4. Assess selectivity patterns of fishing gears that catch tuna and tuna-like species based on demographic variables: size structure, mean sizes and maturity
5. Using length-based approaches, determine the status of coastal tuna stocks and recommend options for local management
6. Map and characterise the spatial distribution of small scale tuna fishing effort to inform marine spatial planning needs

3. RESEARCH ACTIVITIES

The following research activities will be implemented to provide answers to the following research questions:

(1) What is the catch composition and catch variability of artisanal fishing gears targeting tuna and tuna-like species and how does it vary in time and space?
(2) What is the status and sustainability of priority species stocks?
(3) How do tuna fishers distribute their fishing effort and gear use and how does this affect their catches?

3.1 Data gap analysis

As a priority, the first activity shall consist of a gap analysis to assess data and information on tuna fishery in Kenya. This shall include compiling existing data and studies and integration to provide a baseline and identify information gaps, which require additional data collection for long-term planning of projects. Available data at KMFRI on small scale tuna fishery consists of catch composition and maturity data for some species (*T. albacares*, *T. obesus* and *K. pelamis*) from 2013-2015 KCDP and 2019-2021 MASMA project. As a priority, a data gap analysis will include review of published and gray literature on the tuna fishery to provide a comprehensive baseline.

3.2 Catch Sampling

Based on recommendations of the baseline report on priority fisheries (Fulanda 2018), research efforts should be directed towards developing a harvest strategy for the tuna fishery. To enable this catch sampling of small-scale fishing vessels targeting tuna and tuna-like species will be conducted to track

species-specific patterns in catches of tuna and tuna-like species at selected landing sites along the Kenya coast. Sampling will be stratified spatially into five study sites: Vanga (Kwale County), Kilifi, Watamu (Kilifi County), Amu and Kiwayu (Lamu county) shown in Figure 1. The selected landing sites are known to have high landings of tuna. Catch sampling will cover a full year cyle to capture monthly and seasonal variations. The scientific sampling will be augmented with catch assessment data collected by the counties by KEMSFED during the project period to enable production estimates at county-level.

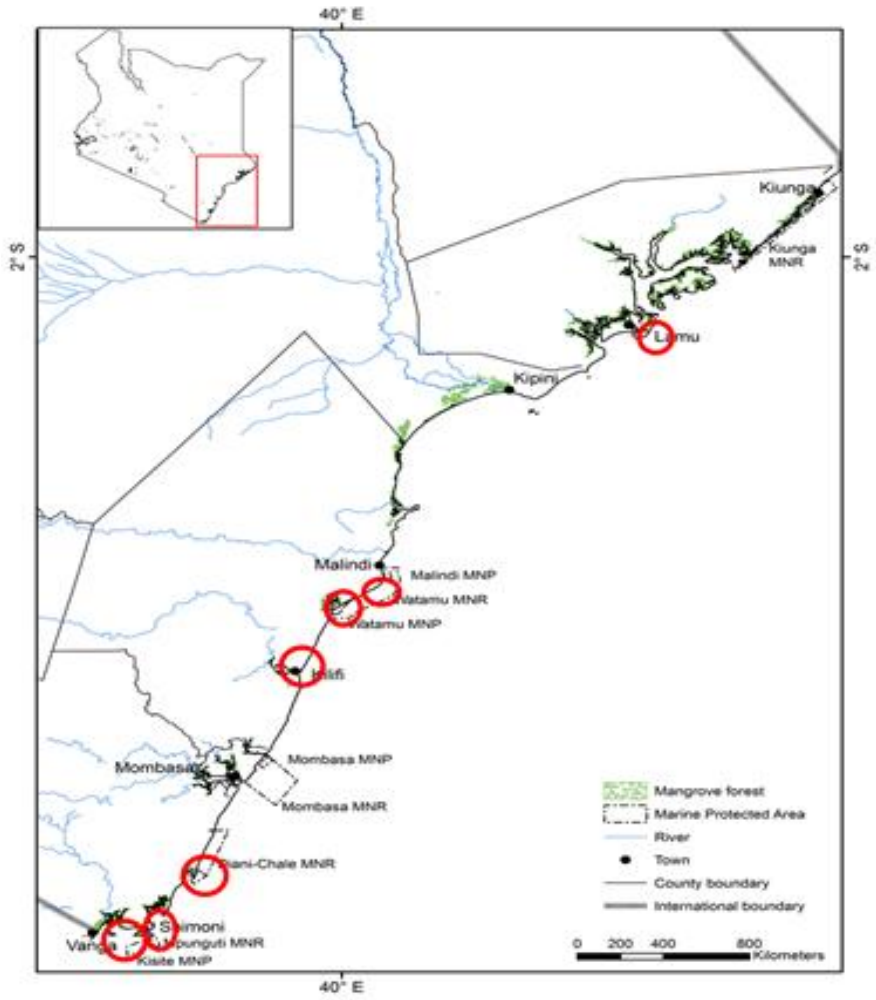

Figure 1. Map of the select study sites along the Kenyan coast

During sampling, details of the type of gears used (mesh-size, length and width, hook size) vessel length, crew size, and names of visited fishing grounds) will be noted in a standardized data form. Sampling of the fish catches will involve randomly selecting a representative sample of fishing vessels and interviewing the captain as guided by the data collection form on request after taking the total weight of the catch. The entire catch will be sampled for small catches, and individual length (TL, cm) and weight (Wt, g) measured. A sub-sample (20 - 30%) of the total catch will be set aside for large catches. This sample will be sorted by species using fish identification guides (Lieske and Myers, 1994;

Anam and Mosdarta, 2012). Each sampled fish will be measured for length to the nearest centimetre (cm) using a measuring board or tape measures and weighed using a digital spring balance to the nearest 0.01g.

3.3 Biological data collection

Although all tuna species landed along will be documented, three species have been prioritized for stock assessment under this project: Yellowfin tuna *Thunnus albacares*, Bigeye tuna *Thunnus obesus* and Kawakawa *Euthynnus affinis.* The three species have a high commercially value comprising about 73% of all the total tuna landings in Kenya (KMFRI unpublished data). Fork length and total length will be measured to the nearest cm using a measuring board, while whole fish weight will be measured to the nearest g using a digital weighing scale. Fish specimens will be obtained, cut open on the ventral side starting from the genital aperture up to 10 cm from the operculum. Gonads will be extracted to determine sex and for staging the maturity. The maturity stages will be quantified macroscopically basedon the external feature of the gonads and categorised into five maturity stages (Schaefer, 1987) as shown in Table 1. However, it is important to note that the most accurate approach requires histological examination under a microscope, and all efforts will be made to conduct histological examination during the stud period. In addition, sampling gonads may be difficult for high value species such as yellowfin which are most often landed gutted to maintain freshness. This caveat should be taken into consideration.

Table 1. Maturity stages for visual examination of tuna species

Stage	Criteria	
	Males	**Females**
I	Gonads small ribbon-like, not possible to determine sex by gross examination	Gonads small ribbon-like, not possible to determine sex by gross examination
1	**Immature**; testes extremely thin, flattened and ribbon-like, but sex determinable by gross examination	**Immature**; gonads elongated, slender, but sex determinable by gross examination
2	Enlarged testes, triangular in cross section, no milt in central canal	**Early maturing**; gonads enlarged but individual ova not visible to the naked eye
3	**Maturing**; milt flows freely if testes pinched or pressed	**Late maturing**; gonads enlarged, individual ova visible to the naked eye
4	**Ripe**; testes large, milt flows freely from testes	**Ripe**; ovary greatly enlarged, ova translucent, easily dislodged from follicles or loose in lumen of ovary
5	**Spent**; testes flabby, bloodshot, surface dull red, little or no milt in central canal	**Spawned**; includes recently spawned and post-spawning fish, mature ova remnants in various stages of resorption, and mature ova remnants about 1.0mm in diameter

3.4 Mapping small scale tuna fishing effort

Although some mapping of tuna fishing grounds has been conducted, there is need to expand this to more sites to provide a more comprehensive picture of the distribution of fishing grounds and fishing effort. This information will be useful for identifying key fishing grounds which can inform marine

spatial planning. At each of the selected landing sites, captains of boats that record high catches of tuna will be identified and trained on how to operate the tracking devices and then issued with the SPOT GEN 4 tracking device for use while at sea fishing. The device will be switched on immediately after they leave for fishing. Upon reaching the fishing ground before deploying their fishing gears, the boat captain will log in, and the coordinates of the fishing ground will be recorded on the find me SPOT website.

4. DATA ANALYSIS

4.1 Catch assessment and biological data

Sampled catch data for each species will be raised to estimate the total catch for each fishing trip sampled based on the gear-vessel combination. Spatial and temporal variations in catch composition, relative abundance (%) and catch rates of the targeted species will then be derived. The catch-per-unit-effort (CPUE) by vessel-gear category will also be calculated as kg/fisher/hr.

For the biological data, the sex ratio (proportion of females) in each Fork length (FL) class (i.e., classes of 5 cm intervals) will be calculated for each sampling area. A binomial test (Zar, 1984) will be used to examine whether the sex ratio in each FL class and sampling area deviated from an expected 1:1 per FL class or not (p=0.05). Size at maturity will be estimated by plotting a sigmoid logistic curve. The estimates of the logistic regression model parameters for the sample and the plot of the observed proportions and the fitted sigmoid curve will be calculated. A gonad index (GI) will be estimated monthly from the equation: GI=(GW/FL3)×104 where GW=Gonad weight and FL=Fork length . The timing and frequency of spawning will be established by plotting the proportion of fish by maturity stage and gonad indices against the sampling period.

4.2 Assessment of stock status

The study will apply length-based methods to determine whether the selected species are being fished sustainably. Length measurements for each species will be pooled over all gears into 2 to 4 cm length classes and to develop length fishery distributions (LFDs). The LFDs will then be used to construct length-con verted catch curves, for the purpose of estimating natural mortality rates (M) and instantaneous rate of total mortality (Z). Fishing mortality (F) will then be derived as F = Z – M while the rate of exploitation (E) will be calculated for harvested stocks as E = F / Z. This will include an analysis of Spawning Potential Ration (SPR) and various selectivity indicators (Table 2). SPR analysis will be conducted by entering input parameters onto the online application available on http://www.barefootecologist.com.au/. Hordyk et al. (2015). Due to the migratory nature of the

species, estimates of life history parameters (i.e L_{inf} . L_{max} , and K) which will be obtained from published estimates from the Indian Ocean region (e.g published on IOTC website) for use in application of the model. The results of SPR analysis will provide reference points on stock status of the key tuna species (i.e., under exploited (SPR<40%), moderate (20<SPR<40%) and over exploited (SPR<20%). Selectivity parameters that will be calculated from the length composition data, described in detail by Babcock et al., 2018) are shown in Table 2.

Table 2. Selectibity indicators that will be used

Selectivy indicators		
L_c	cm	Length fully recruited into fishery
L_λ	cm	Maximum fully recruited length in fishery
SL_{50}	cm	Length at 50% selection in logistic selectivity curve
SL_{95}	cm	Length at 95% selection in logistic selectivity curve

5. REPORTING

Reporting will be done on a quarterly basis and will include the following deliverables:

i) A cleaned database of data collected during the study period

ii) Back to office reports of the field work

ii) Progress reports

iii) A technical report on stock assessment of selected tuna species

ib) Maps oft tuna fishing grounds

iv) Manuscripts

6. Expected Outputs

i) A baseline report for the small scale tuna fishery with identified data gaps and recommendations

ii) Temporal trends in catch rates for key tuna species

iii) Biological information on maturity and length at maturity (L_{50}) for selected priority species south and north of Kenya coast

iv) Hotposts of fishing grounds and fishing effort for small scale tuna fishery will be identified and mapped

7. Expected Outcomes

i) Better managed small scale tuna fishery

ii) Updated management strategy for small scale tuna fishery informed by best available science

iii) Data sharing to IOTC to inform management of the studied tuna species

8. References

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9. WORKPLAN AND BUDGET ESTIMATE

Table 1: Work plan and summary budget

Activity	Quarter 1			Quarter 2			Quarter 3			Quarter 4			
	J	F	M	A	M	J	J	A	S	O	N	D	Budget/Yr (KES)
Shore-based catch assessments surveys and collection of biological data on priority species													
Mapping of small scale tuna fishing grounds in selected sites													
Quartely data analysis and report writing													
												TOTAL	

Table 2: The Fishery Team / Personnel

Participant Name	Responsibility:	Affiliation:
Dr Gladys Okemwa	**Team leader/Stock assessment**	KMFRI
Fatuma Mzingirwa	Stock assessment	KMFRI
Almubarak Athman	Stock assessment	KMFRI
Evans Nyanchoka	Data enumeration	KMFRI
Joshua Omweri	Data enumeration	KMFRI
Jibril Olunga	Data enumeration	KMFRI
2 Interns	Data enumeration	KMFRI