KENYA MARINE FISHERIES SOCIOECONOMIC PROJECT

COMPONENT 1

ENHANCED GOVERNANCE OF MARINE FISHERIES AND BLUE ECONOMY

Research Strategy

Deepwater Snapper Fishery Stock Assessment

NOVEMBER 2021

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1. THE STATUS OF DEEPWATER SNAPPER FISHERY

1.1. BACKGROUND

Kenya marine fisheries production is dominated by small scale fisheries operating in shallow water using traditional fishing vessels and fishing gear in nearshore environments within territorial waters. The main fishing grounds are seagrass beds, estuaries, lagoons protected by the narrow coral reef, which runs parallel to the coastline a few kilometres offshore. Annual catches reported in fisheries bulletin have been about 9000mt, less than 10% of the national fish production. Reconstruction of catch data following the FAO guidelines indicate an annual production of between 15000mt and 23000mt (La Manach et al., 2015). Recent reconstruction of catch data to account for data leakage through landing fish at non-designated landing sites, underreporting and auto-consumption (fish directly consumed by fishers and their close families) estimate the total marine catch of 54,000mt (Owiti,). The fish stocks in the nearshore environments are optimally exploited or overexploited (McClanahan and Obura, 1995; Obura, 2001; Samoiles et al., 2017). This is attributed to increasing fishing pressure driven by high demand for fish from the growing population, use of destructive fishing gears, and climate change. The development of industrial fishing and the expansion of fishing grounds into deeper water and offshore demersal and pelagic fisheries resources are often seen as options to maintain or increase catches and the associated benefits from marine fisheries (Ruwa, 2007; Government of Kenya, 2007).

The Kenyan coastline is characterised by a narrow continental shelf, fringing coral reefs, mangrove and seagrass ecosystems, and river estuaries discharge into the Indian Ocean at Vanga, Mombasa, Mtwapa, Mida Creek, the Sabaki River mouth, the Tana River, and the extensive Lamu archipelagos. The continental shelf is less than 4 km wide. However, sediment discharges from the Tana River resulted in mass sediments deposits that formed the North Kenya Bank (NKB). The NKB straddle at latitude 2°50” - 3°00” S; Longitude 40°45” - 40°57” E, and extends to approximately 30 nm from the nearest coastline. The wider part of the continental shelf is referred to as the North Kenya Banks (Morgans, 1959), and since its initial identification has long been viewed as a potentially important fishing ground. The ecosystem complex and the upwelling of the colder Somali current in the NKB have resulted in the most significant productive fishing grounds in Kenya’s coastal waters and supported many fishers’ livelihoods (Ruwa et al., 2003; Samoilys et al., 2011).

The NKB is an expansive continental shelf area of approximately 4 325 km^2 lying between 2-4°S. The upper-ocean circulation of the tropical western Indian Ocean is influenced by the seasonal monsoon winds, which drive the South Equatorial Current (SEC), the East African Coastal Current (EACC), the Somali Current (SC) and the South Equatorial Counter Current (SECC). Southern and central Kenyan coastal waters are strongly influenced by the EACC, which flows northwards year-round, extending into northern Kenyan and Somalian waters during the SEM months. The EACC is nutrient-poor, and its waters exhibit low productivity rates (Painter, 2020). Northern Kenya is also seasonally impacted by the SC, which flows southwards during the NEM months (November to March), reversing during the SEM in response to changes in large-scale atmospheric pressure gradients over the WIO (Duing and Szekielda 1977). The south-flowing SC meets the northward-flowing EACC at the north Kenya Coat and south Somali Coast during the NEM season, forming the east-flowing SECC. The meeting of the two currents drives an upwelling of cold nutrient-rich deep water supporting high marine productivity (Smith SL, 1992).

The NKB artisanal deep-sea demersal hand line fishery is multi-species and operates in the region between 2°5'– 3°00'S, 40°45' – 40° 57'E. Hand line fishing is carried out primarily in the 100-400m depth range. Artisanal fishing occurs mainly during the dry, calm NEM season (October-March) characterised by weaker winds, allowing fishers to safely go to sea (R/V Dr Fridtjof Nansen report, 1980). The target pelagic species are large pelagic species include, *Thunnus albacares*, and *Thunnus obesus*, *Xaphius Gladys,* while key demersal species include *Argyrops spinifer, Epinephelus flavocaeruleus, Epinephelus poecilonotus, Lutjanus sanguineus, Etelis coruscans, Pristipomoides filamentosus, and Pristipomoides sieboldii* which are highly valued in the market (R/V Dr Fridtjof Nansen report, 1980). A data gap analysis study for the SWIOFC project identified the key priority deepwater demersal species in the WIO (Table 1).

Table 1. Deep water demersal species identified during SWIOFP

FAO	**Species**	**Family**	**Main depth stratum**	**Importance**
Priority 1 List				
PFM	*Pristipomoides filamentosus*	Lutjanidae	Intermediate	Widespread
ETC	*Etelis coruscans*	Lutjanidae	Deep	Widespread
ETA	*Etelis carbunculus*	Lutjanidae	Deep	Widespread
EFH	*Epinephelus chlorostigma*	Serranidae	Shallow/intermediate	Widespread
LHN	*Lethrinus nebulosus*	Lethrinidae	Shallow/intermediate	Widespread

PLY1	*Polysteganus baisacci*	Sparidae	Intermediate/deep	Mauritius
SBU	*Polysteganus coeruleopunctatus*	Sparidae	Shallow/intermediate	Mozambique

During the KCDP, field experiments were conducted to evaluate the possibility of developing a drop line fishery at the NKB. The snapper identified during the trials were *Etelis coruscans, Lutjanus sanguineus, Pristipomoides filamentosus,* and *Pristipomoides sieboldiito*, while the grouper species were *Epinephelus flavocaeruleus, Epinephelus poecilonotus*, *Hyporthodus octofasciatus*, while one Sparidae*, Argyrops spinifer,* one species of Triakidae *Mustelus palumbes* and one species of Carangidae *Elagatis bipinnulata* were identified. From the results, the promotion for the adoption of the demersal dropline fishing gear by the fishers, boat owners and other involved stakeholders was recommended. (Omutoko et al., 2015). Given that this is a relatively unexplored fishery, there is inadequate scientific data to inform the management of the fishery and regulate fishing activities in the NKB. Moreover, the fishery has not been subjected to any formal stock assessment, and hence no reference points nor indicators exist for the target species.

Therefore, there is an urgent need to compile the existing information from the previous projects (KCDP, SWIOFP) to initiate a stock assessment for target species to determine the stock status using broad-brush stock assessments (catch & effort data) to guide the development of a precautionary management strategy for the fishery. Based on the KEMSFED baseline report (Fulanda, 2018), the following areas of intervention have been proposed for the NBK fishery:

- Initiate extensive stock assessments to determine the stock status and sustainability of the stocks,
- Establish a management strategy setting reference points for monitoring and evaluation of the fishery, including stock rebuilding strategies where applicable for precautionary
- Conduct a comprehensive RBF analysis for the fishery in order to set clear reference points for target species stock assessments

1.2. AIM AND OBJECTIVES

The aim of the study is to evaluate the contribution of deepwater snappers to the NKB fishery and determine the status of the stock of the key deepwater snapper species. The specific objectives include to:

1. Determine the present contribution and level of exploitation of deepwater snapper species in the NBK deepwater fishery

   Activities

i) Conduct a data mapping exercise to characterise the deepwater snapper fisheries in NBK to establish baselines, identify trends and information gaps for the fishery
ii) Analyse and present a preliminary summary and analysis of all the data collected in the experimental dropline fishery trials
iii) Determine the Spatio-temporal variations of the catches

2. Develop an effective fisheries management plan for the NBK fishery to guide in the sustainable exploitation of the deepwater snappers

Activities

i) Collection of catch and effort data from the fishery
ii) Collection of length-frequency samples of the main species from the fishery to estimate growth parameters
iii) Sample maturity information of deepwater snapper species in the NKB fishery
iv) Collect selectivity data of the existing fishing gears (hooks and line) and assess their viability
v) Develop size-based indicators to monitor and provide a proxy for stock status and monitor fishery performance.

1.3. Expected Outputs

The following outputs are expected:

i) Hard copies of the data sheets
ii) Soft copies of the data
iii) Trip reports
iv) Annual progress reports on the stock status of the key species

1.4. Expected Outcomes

The expected outcomes from this study are:

i) Information on the status of the targeted species.
ii) Develop a management plan/regulation of the deepwater snapper fishery with control measures.
iii) Advanced capacity for long term fisheries stock assessment e.g. M.Sc., stock assessment training etc.

1.5. Expected Impacts

The expected impacts from this study include:

i) Sustainable management of the deepwater snapper fishery
ii) Improved long term benefits and support of livelihoods to the fisher communities.

1.6. Materials and Methods

1.3.1 Study Area

The study will be done in the NKB (Figure 1) where the deepwater snapper's are landed. The main selected landing sites are: Watamu, Malindi and Ngomeni and Kipini located in Kilifi County. These sites have been selected due to their locality with higher deep water snapper landings. The main fishing gear for this study will be the hand line and the drop line.

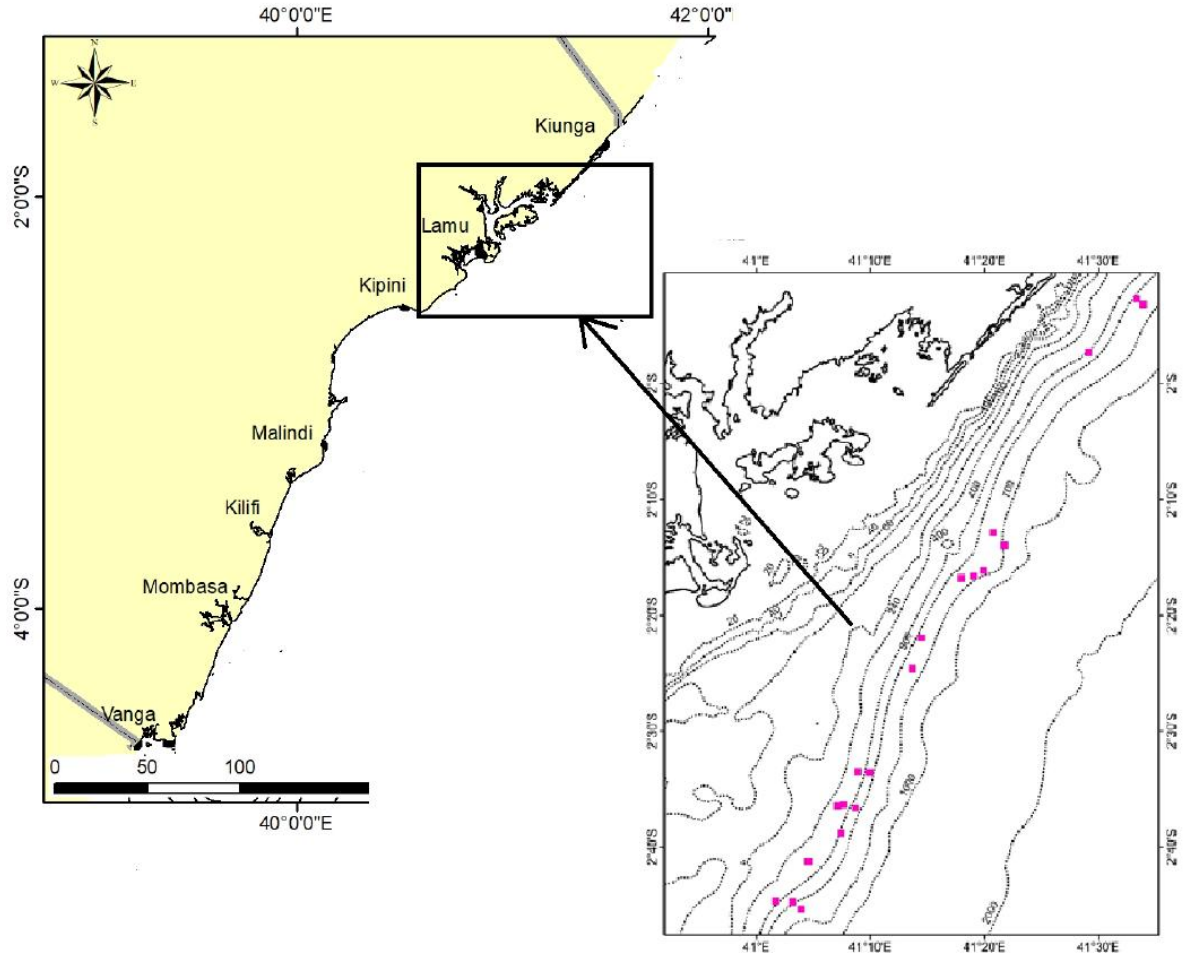

Figure 1. North Kenya Banks showing depth contours

1.3.2 Study Species

Based on the previous studies the target species for this study are *Etelis coruscans, Lutjanus sanguineus, Pristipomoides filamentosus,* and *Pristipomoides sieboldiito*.

1.3.3 Sampling Methods

Identification of deep water fishers, vessels and gear: At the beginning of the study BMU officials will be interviewed to identify the fishers and vessels that target deepwater snappers. The particulars of the fishing gear used will be recorded for each.

Mapping of fishing grounds: the fishing grounds for deep water snappers will be identified and mapped using two approaches:

1) Participatory mapping through interviews with fishers to name the fishing grounds and point them out on a map printout of the NKB
2) Down load/note fishing locations from fishers who use GPS
3) Hand held GPS will be provided to deep water snapper fishers to mark the locations of fishing during the project

Land based catch assessment: Deep water snappers catches will be monitored monthly for seven days at each landing site, over a period of 12 months.

Fishing crew information: Name of vessel owner, name of captain, number of crew, time (start time and end time)
Vessel and gear data: vessel name, vessel type, size,
Fishing gear data: gear type (drop line/hand line), hook size type (round/J hook) and size will be described following Annex 1
Catch data: Total catch (Kg), Species weight and numbers
Biological data: For each individual total length (TL), fork length (FL) body weight (g), gonad weight, maturity stage, and otoliths collected.

The total length will be measured using measuring board (to the nearest 0.1cm) while the body weight will be recorded using an electronic weighing scale (to the nearest 0.01kgs). Other data to be detailed are the number of fish, number of species, hours fished, date into the fishing and date out from the fishing, number of hours and days fished. Gonads will be removed from the key species to determine sex, gonad weight and maturity status using a macroscopic key adapted from the scheme of Saber et al., (2019) presented in Table 1.

Table 1. Macroscopic maturity stages of ovaries (Source: Saber et al., 2019)

Reproductive stage	Females	Males
1. Immature (virgin)	Ovaries are small; more or less translucent-pinkish.	Testes are small, thin flattened and ribbon-like; more or less translucent - lightly pink.
2. Developing (early developing) and regenerating (recovering)	Ovaries are increasing in size; pink-orange colour. External blood vessels start to develop around the gonads (vascularisation).	Testes are increasing in size and triangular in cross section; whitish - pinkish colour. Sperm does not flow with pressure
3. Spawning capable (late developing)	Ovaries are well developed and firm; yellow - orange colour. Opaque oocytes are visible. Testes are well developed; whitish - pinkish colour.	Accumulation of sperm in the spermatic ducts, sperm flows with low pressure

4. Spawning	Ovaries are greatly enlarged; orange - reddish colour, with conspicuous superficial blood vessels.	Opaque oocytes are visible and large translucent hydrated oocytes may be visible. Testes are greatly enlarged with conspicuous superficial blood vessels; pinkish colour. Large amount of sperm flows freely under very lightly pressure.
5. Regressing	Ovaries are bloody and flaccid, show a wrinkled wall; reddish colour.	Testes are flaccid and bloodshot; pinkish colour. Sperm may still flow (only small quantity)

1.4 Data analysis

Mapping of fishing grounds

The data collected using participatory mapping, GPS downloads from fishers and mapping that will be carried out during the survey will be collated to determine the extent of the deep water snapper fishing grounds. The data will be projection using GIS to produce maps of deep water snapper fishing grounds.

Spatial and seasonal variation of catches

To assess spatial and seasonal variations in the catch composition, size structure, sex ratios, maturity and relative condition factor of the key species, parametric analysis and non-parametric approaches will be used as appropriate.

The stock status

Length based data analysis will be used to determine population indices for the key species, including Mortality (F/Z), Exploitation rate, YPR, MSY, etc).

Hook size selectivity analysis will be undertaken to determine impact of hook type and hook size on the population and recommend the most appropriate option for the key deep water snapper species

1.5 Reporting

Data and information will be recorded in datasheets prepared for this study. All surveys will involve briefing before each survey trip. A trip report will be prepared at the end of each sampling survey and made available to all teams. A final workshop will be held to analyse the data recorded from all the surveys and prepare a final report with recommendations for management.

1.5.1

1.5.4. References

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1.5.5 Annexes

Particular	Determination
Hook size	Record manufacturer code for 'size', narrowest width, and degree of offset for each hook type used.
For hook shape	Determine if the hook is a circle, J, tuna or teracima hook shape, or refer to the manufacturer code for shape
Hook width	Refer to the manufacturer model number or otherwise use calipers to measure narrowest width to the nearest mm
Hook offset	Record yes or no, or record the manufacturer degree of offset
Bait species	For each set determine each species and type of artificial bait If part of a large species record (small fish species, squid species, piece of large fish species, piece of marine

	mammal, piece of sea turtle, other)

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2.0 WORKPLAN AND BUDGET ESTIMATE

Table 1: Work plan and summary budget

The preparation of research strategy, data sheets and other documents will be undertaken in the first one month of the project. A stock assessment training for all the team will be done during the second month. Meeting with BMUs in the four field sites will be undertaken to inform and sensitise the members about the intended research project, and identify vessels, vessel owners and fishers who undertake deep water snapper fishing. This will be followed by field work for an initial 12 months. There will be progress reporting during the middle and end of field work to provide feedback to the fisher communities.

Deep water snapper stock assessment work plan															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Preparation of strategy and work plan															
Training															
BMU sensitisation meeting and fisher interviews															
Field work															
Progress and Final Reporting															
Dissemination															

Table 2: Detailed Budget

The month budget is based on 4 sites each to be sampled by two scientist, 4 technical staff/intern, four BMU member and four KeFS officer. The scientist, technician/inter will be paid overnight accommodation allowances while the KeFS officer and BMU member will be paid a daily lunch allowance. The team will be supported by one vehicle and one driver during field work. A budget for field equipment, air time and fuel for the vehicle is included.

Item	Number	Months	Days	Unit Cost	Total Cost		
Accomodation-Domestic travel- Scientists (KMFRI/UNIVERSITIES)	2	6	7	10,500	882,000	**882,000.00**	**8,820.00**
Accomodation-Domestic travel for technicians	4	6	7	8,400	1,411,200	**1,411,200.00**	**14,112.00**
Accomodation-Domestic travel for interns					-	**-**	**-**
Accomodation-Domestic travel for drivers	1	6	7	8,400	352,800	**352,800.00**	**3,528.00**
Meal allowances County fisheries officers	4	6	14	1,000	336,000	**336,000.00**	**3,360.00**
Meal allowances BMU data collectors	4	6	14	500	168,000	**168,000.00**	**1,680.00**
Fuel & lubricants					-	**-**	**-**
Boat hire/ boat fuel and lubricants	1	4	4	15,000	240,000	**240,000.00**	**2,400.00**
Communication	1	6	7	2,000	84,000	**84,000.00**	**840.00**
Office supplies	1	1	1	10,000	10,000	**10,000.00**	**100.00**
Fish handling tools	4	1	1	10,000		**40,000.00**	**400.00**

					40,000		
Laboratory chemicals	5	1	1	10,000	50,000	**50,000.00**	**500.00**
ICT	1	1	1	100,000	100,000	**100,000.00**	**1,000.00**
Printing and publishing	1	1	1	100,000	100,000	**100,000.00**	**1,000.00**
PPEs & related accessories	1	1	1	5,000	5,000	**5,000.00**	**50.00**
					3,779,000	**3,779,000**	**37,790.00**

Table 3: The Fishery Team / Personnel

Participant Name	Responsibility:	Affiliation:
Dr Edward Kimani	**Team Leader**	KMFRI
Almubarak Athman Abubakar	Research Scientist (Assistant team leader	KMFRI
Hafidh Ishamed	Technical Assistant	KMFRI
Nimrod Ismael	Technical Assistant	KMFRI
Geofrey Odhiambo	Technical Assistant	KMFRI
Jibril Olunga	Technical Assistant	KMFRI