

**KENYA MARINE AND FISHERIES RESEARCH INSTITUTE  
MOMBASA**

**RV MTAFITI RESEARCH CRUISES**

**SUMMARY**



Course Participants - RV Mtafiti Regional Training (18-27 April 2016)

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## **Introduction**

The acquisition of RV Mtafiti has enabled Kenya Marine and Fisheries Research Institute (KMFRI) and by extension Kenya to venture into deep sea surveys. Kenya aims to collect data and information on the marine environment and the resources therein to support exploitation and management planning. To achieve this goal, and other regional and international obligations KMFRI has planned extensive surveys using RV Mtafiti during the next few years. To effectively cover the EEZ, four survey blocks were identified as follows:

- 1) Territorial waters from Vanga in the South to Lamu in the North.
- 2) Block 1 off Lamu county
- 3) Block 2 off Kilifi county
- 4) Block 3 off Kwale county

The plan envisages surveying the above identified blocks during both the Northeast Monsoon (NEM) and Southeast Monsoon (SEM) seasons during the year. This is because the monsoon climate variability controls the currents and subsequently the marine productivity and fish abundance.

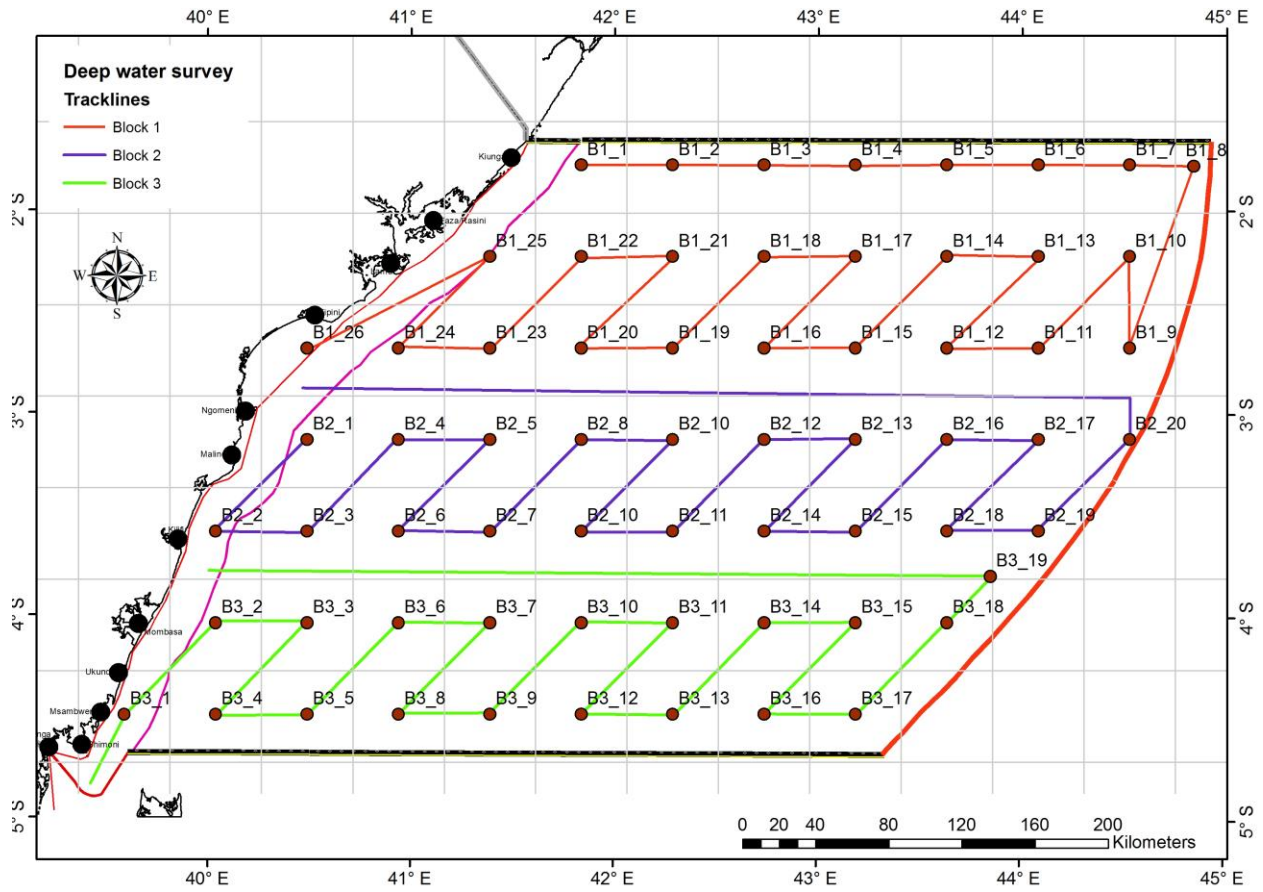


Figure. EEZ Sampling stations

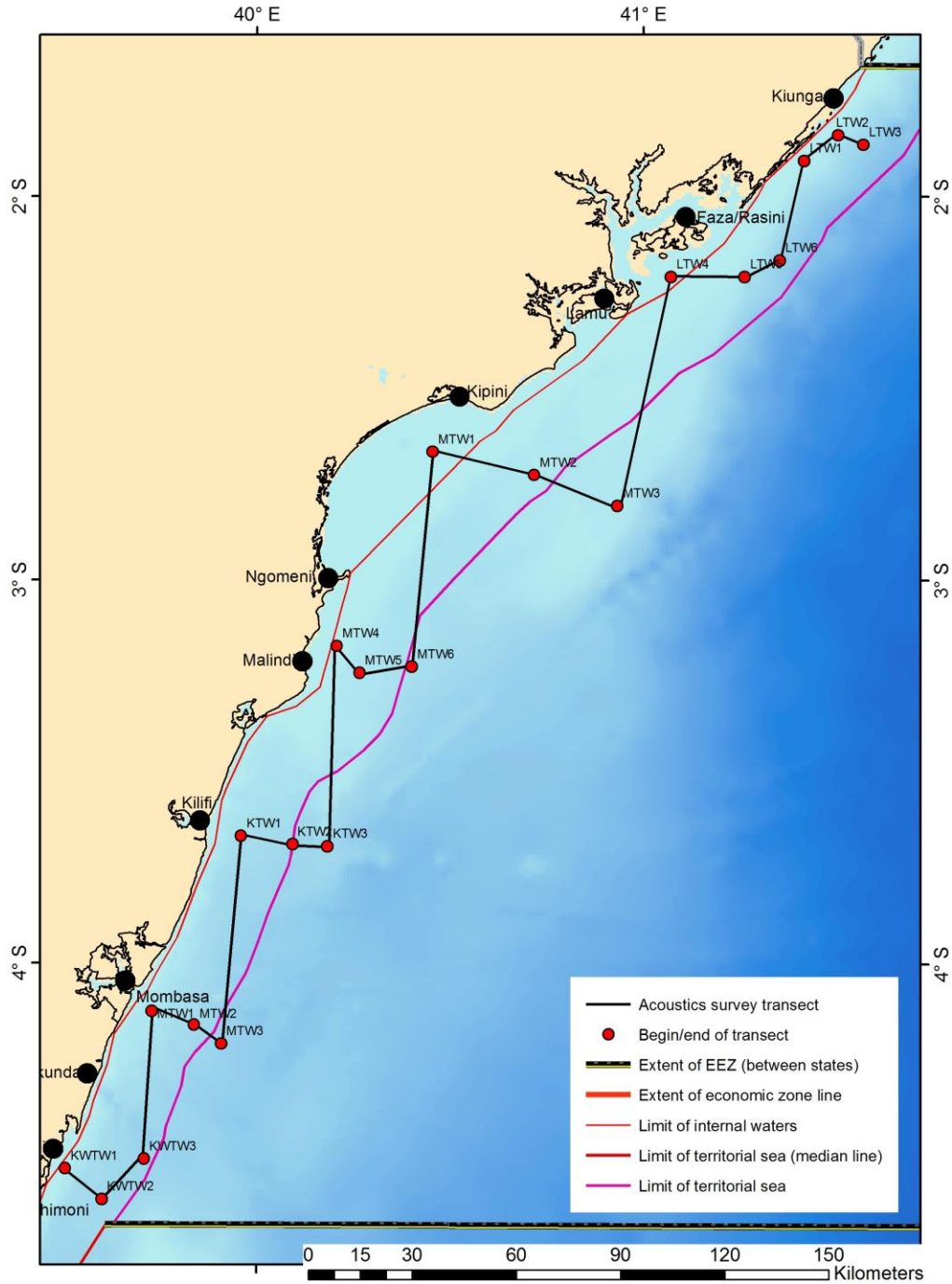


Figure. Territorial sea sampling stations

## **SURVEYS UNDERTAKEN**

### **Cruise 1: Date: 12 -23 April 2016**

#### **Name: RV Mtafiti KCDP MCS and Research Cruise Plan**

This survey was undertaken within the territorial waster as well as the EEZ to assess the performance of the vessel and equipment at sea. A total of 13 stations were visited to make observations, collect samples as well as data during 7 days. The cruise was conducted jointly by the State Department of Fisheries (SDF) and the Kenya Marine and Fisheries Research Institute (KMFRI) with funding from the Kenya Government through Kenya marine and Fisheries Research Institute. The aim of the cruise was to assess the performance of the new vessel RV Mtafiti at sea by undertaking Monitoring Control and Surveillance (MCS) as well as fisheries, and environment survey. The MCS was done to verify that the industry's practices and behaviour are consistent with the regulations established to implement policy objectives. The patrol, its objectives and results reflected Kenya's MCS strategy. This patrol was therefore complementary to the envisioned strategic objective and also the Kenya National Oceans and Fisheries Policy (2008) objectives.

#### **Specific Objectives of the MCS**

- i. To asses the RV Mtafiti, the equipment, personnel capacity for MCS
- ii. Identification of vessels in zones of high longliner activities
- iii. Verify absence/presence of illegal fishing
- iv. Investigate potential areas of illegal fishing in the authorized fishing zones. Report on the fishing gear of the long line fishing vessels, as well as the transshipment, during the fishing operations, Species targeted as well as shark fins
- v. Investigate areas frequented by IUU vessels, the IUU vessels which fish in the zone regularly at night and the day in Kenyan and international waters.

#### **Important information to note during the MCS Patrol Mission:**

- i. Authorization to fish in EEZ

- ii. Authorization of fishing license from flag state
- iii. Verification of permission to fish in the Indian Ocean waters.
- iv. Verification of fish caught corresponds with fishing log; and also, if the information tallies with the entry and exit reports sent to the country of EEZ.
- v. Monitor transshipment: verify if amount of fish transshipped corresponds to the logs and with copies of transshipment documents/documents from carrier vessel.
- vi. Radio interrogation about cargo on board, port of departure, transshipment.
- vii. Verify conformation to resolution 01/02 IOTC.
- viii. Functioning of VMS.

## **Cruise 2: 18-27 April 2016, KMFRI Mombasa (2 days on Board RV Mtafiti)**

**Name:** Training on scientific cruise planning, oceanographic sampling, fisheries and data management

Co-funded by: VLIZ-Belgium, IOC-UNESCO, KMFRI)

**Aim:** Help jump start the deployment of RV Mtafiti and thereby the advancement of marine science in the region

### **OBJECTIVES:**

1. Create a critical pool of staff to act scientific campaign leaders
2. To ensure cost effective use of ship time
3. Guarantee quality of collected samples and data
4. Create awareness of the availability of RV Mtafiti

**Resource persons:** Harrison Ong'anda, Dr. Nina Wambiji, Andre CATTRIJSSE, Klaas DENEUDT, Francisco HERNANDEZ

### **Participants:**

- |                     |            |
|---------------------|------------|
| 1. Christopher AURA | KENYA      |
| 2. Rahamata BOINA   | COMOROS    |
| 3. Noca DA SILVA    | MOZAMBIQUE |
| 4. Calvin GERRY     | SEYCHELLES |
| 5. Amon KIMELI      | KENYA      |
| 6. Esther MAGONDU   | KENYA      |
| 7. Agnes MUTHUMBI   | KENYA      |

8. Rui MUTOMBENE	MOZAMBIQUE
9. Victor MWAKA	KENYA
10. Samuel NDIRANGU	KENYA
11. Mathew NGULI	KENYA
12. Gladys OKEMWA	KENYA
13. Johnstone OMUHAYA	KENYA
14. Florette RASOARILALAO	MADAGASCAR
15. Sabyasachi SAUTYA	INDIA

### **Outcome**

The participants were trained on how to plan for a scientific cruise, operating a research vessel, use of sampling equipment, budgeting, calculating daily rates or rate per cruise, general overview of fisheries techniques and application, data management plan – storage and processing of collected data, data analysis and visualization.

### **Cruise 3: 12 – 17 September 2016,**

**Name:** Testing and Training on Simrad Ek60 Echosounder Acoustics

The primary purpose of this cruise was to test and commission the installed EK60 multibeam acoustic echo sounder and train KMFRI staff on the operation of the instrument.

The survey covered an area of approximately 5,700 km<sup>2</sup> of the Kenyan territorial and EEZ waters; in the south coast. The maximum recorded depth was 1500 m offshore (Figure 1). It was evident that with sufficient sampling, acoustic equipment onboard RV Mtafiti can be used to map the sea floor in detail, a critical support tool for informing the blue economy.

KMFRI acquired a SIMRAD EK60 echosounder, subsequently installed in the RV Mtafiti. The purpose of the device/system is to collect biomass and numbers of fish at real-time measurement through the process of fish hydro-acoustics survey. Fish acoustic surveys is a dependable source of fish stock data to guide management decisions. They have reliably been use in stock monitoring activities in many fisheries as a source of fisheries independent information. A test survey took place on 12-17 September 2016 to test the system and train KMFRI scientists on its workings. Survey track lines were limited to the time which was allocated for this survey. The data analysis showed that fish densities were low (0-4 tons km<sup>2</sup>) in inshore waters adjacent to Shimoni . The densities increased further offshore Shimoni with some transects recording more



than 100 tons km<sup>2</sup> of fish. Higher densities were observed in waters close to Ukunda and Mombasa areas. The estimates show that there was a total of 122,442 metric tonnes of fish in 5,700 km<sup>2</sup> area surveyed which is about 0.6 of the production of Lake Victoria. It was evident that with sufficient sampling, acoustic equipment on-board RV Mtafiti can be used to map the sea floor. All these products will play key role in informing the blue economy. The way forward is for KMFRI to organise for a full scale survey as well as develop a critical number of manpower for data collection and analysis.

#### **Cruise 4: - November 25 and December 4 2016**

**Name:** Territorial Waters fish biomass survey

Acoustic estimates show varied spatial fish densities and biomass distribution in different regions of the Kenyan territorial waters. In total there was 243,941 tons of fish within the territorial waters (Table 1). Monetary-wise the resource is worth about KES 60 billion. The annually exploitable stock is estimated to be worth KES 15 billion assuming a 25% exploitation. Lamu region registered both the highest densities and biomass. North Kenyan banks registered the second highest densities though the biomass in this region was lower than Kilifi because of its relatively smaller spatial extent. Evident, was a steady increase of fish biomass densities from the south to the north in the territorial waters,

The echograms shown further revealed interesting geomorphological features including deep canyons of up to 600m deep and seamounts extending up to 250m high. The features were notably located in the vicinity of mouths of rivers or creeks e.g the mouth of River Tana (see Image 1 and 6 off Kipini). Images 2-6 (off Lamu) and image 7 off Kilifi Creek.

The northern region around Lamu and Kiwayu showed high surface POC levels, probably due to the surrounding mangroves in the region

Silicate levels were found to be located in deeper waters in the mid EEZ and end EEZ. There was a dilution gradient towards the surface these are distinct process occurring in these regions. The difference between available silicate [Si(OH)<sub>4</sub>] and nitrate [NO<sup>-3</sup> ], has been used as a tracer of

the return path of deep waters upwelled in the Southern Ocean into the thermoclines of ocean systems (Sarmiento et al.,2004).

Nitrate levels were high in the deeper waters of the near shore and mid EEZ regions, the surface waters had depleted levels. The midwater DO levels in these two regions were higher than the outer EEZ region, a probable indicator of downward circulation of the upper waters rich in DO. The outer EEZ region had depleted DO in the region around 100m and 250m suggesting upward movement of deeper oxygen depleted waters.

The distribution of ammonia showed some interesting trend that seemed to agree with the indication that there was some upwelling in the outer EEZ region this region has indications of upward Si movement gradient. The nitrate levels were however quite low and depleted within the productivity zone. However ammonia levels were highest in these region and more so at the depth with depleted DO levels.

The Hydro-acoustic fish densities distribution along the EEZ revealed high relationship between chlorophyll, nitrate and Si\*. Underpinning the importance of these parameters to the fishery distribution within the marine waters. The high Si\* signature points at upwelling as a driver of productivity in the region between longitude 42 degrees E and 43 degrees E and at the end of the EEZ boarder.

Dominant phytoplankton species during the December 2016 cruise was the Diatom *Chaetoceros* sp, *Rhizosolenia* sp, and *Guinardia* sp (Fig 4). These species were the most dominant at all sites sampled. Other common species at all sites were *Bacteriastrum hyalinum* sp. *Protoperidinium* sp., *Coscinodiscus* sp, *Alexandrium* sp, *Oscillatoria* sp and *Ostreopsis* sp.

Calanoid copepods dominated the zooplankton catch at all sites. Dominant calanoids were *Calanoides carinatus* and *Neocalanus* sp while dominant cyclopiids were *Oithona* sp, *Oncaea* sp and *Corycaeus* sp. These species were predominant at all stations.

Fish larvae of priority pelagic species (Family Scombridae) were present. These were *Thunnus maccoyi*, *T. albacares*, *Euthynnus affinis*, and *Katsuwonus pelamis*. Other offshore larvae found were Billfish larvae *Tetrapturus* sp (Isitiophoridae) *Oxyphorhamphus* sp (Hemiramphidae),

Carangidae and Holocentridae.

## **Cruise 5: 4-19 December 2016**

**Name:** Hydro-Acoustics Survey, North Kenya Exclusive Economic Zone – Block 1

The aim of the survey was to collect data on fish biomass and limited station profiles for water samples up to depths of 460m. fish biomass summary, lists the types of data and number of data sheets filled, types of samples collected and their fate and describes the scientific strategy of the survey. The survey off the Kenyan coast covered one geographical area of the Northern portion of Kenya's EEZ. Acoustic data was collected during the survey to estimate biomass of pelagic fish stocks. Environmental data collected at sea included; Sea Temperature Profile, Dissolved Oxygen (DO),.

Acoustics data was collected as per the operating procedure of conducting the equipment calibration on the three transmitting frequencies for detection of different sizes and biomass of fish and plankton biomass and vessel speed of 9 knots.. Plankton sampling was conducted using a plankton net tow at 1.2 knots. Water samples were collected using the Niskin bottle and sub samples taken for BOD, Oxygen and Salinity.

The estimates of fish biomass within the EEZ block 1 has about 321,264.94 tons of fish. With the current market value, the resource is worth at least KES 80 billion with an exploitable stock valued at KES 20 billion. Most fish were concentrated in the upper layer (0-100 m) of the water column. The upper layer of the water <100m contained 90% of the total fish biomass which makes it accessible by existing fishing technologies. The rest 10 % of the fish biomass was found between 100-350m deep. The catches from a commercial long-line fishery, indicate likely composition of the exploitable pelagic stock to consist of four major families (Xiphiidae, Scombridae, Carcharinidae and Istiophoridae) representing 97% of the total catches. The preliminary results provide a very promising indicator of the fish available in the Kenya EEZ that may be exploited to support the coastal economy and support food security for Kenya.

Subsequent surveys should also incorporate mid-water trawling to obtain fish samples for species identification to improve the resolution and interpretation of the data by the allocation of the fish biomass to taxonomic groups. Thus, the completion of this exploratory survey will provide the first clear estimate of fish biomass in Kenya's EEZ and territorial waters.. The results will further guide more targeted fishing surveys and future investments in the offshore fishing ventures.

### **Cruise 6: 6–21 February 2017**

**Name:** Fish Biomass and the Environment of Kenya's Exclusive Economic Zone (EEZ) Off Kilifi County (Block 2)

The outputs from the survey provide an indicator of productivity and estimates of fish biomass, sea bottom morphology and biodiversity hotspots in the EEZ. Understanding the seasonal variations in occurrence will be important to obtain a more comprehensive picture.

The fish biomass estimates of the surveyed block was 745,590 tons. Overall the fish biomass was highest in shallow water less than 100m deep with low biomass in deep waters greater than 350m.

The extrapolated bathymetry surface generated is highly indicative due to the wide spacing of data points and cruise tracks. The surveyed water depths (bathymetry) ranged between as low as 90 m to 4400 m deep. A few unique bathymetric features were observed among them seamounts (some as high as 250 m) and deep-sea canyons/trenches (some as deep as 500 m). There is therefore a need to further survey these features especially with full sea floor coverage techniques e.g. multibeam echo sounder (MBES) to ascertain their orientation and lateral extents. This information subsequently assists in determining the processes and geological evolution of the Kenyan Ocean basin.

Microplastic abundance ranged from 0.03 to 0.30 particles/120 mL.

Dominant phytoplankton species during the Block 2 cruise was the Diatom *Chaetoceros* sp, *Rhizosolenia* sp, and *Pseudo-nitzschia* sp sp (Fig 4). These species were the most dominant at all sites sampled. Other common species at all sites were *Thalassionema nitzschoides*, *Coscinodiscus* sp. and *Protoperidinium* sp.

Copepods dominated the zooplankton catch at all sites and contributed over 90% of contribution of zooplankton. Dominant zooplankton was Chaetognatha followed by *Oncaea* sp (Cyclopoid copepod), *Paracalanus* sp (Calanoid copepod) and *Eucalanus* sp (Calanoid copepod). Other dominant species were *Oikopleura* (Appendicularia), *Centropages* sp. (Calanoid copepod) and *Tortanus* sp.

Weather conditions were excellent during the survey, with clear skies and light winds. Five species of seabirds were recorded, of which gulls and terns (*Laridae* species) were the most numerous. Species documented included Sooty terns, Common terns *Sterna hirundo*, Gullbilled terns *Gelochelidon nilotica*, Lesser crested terns *Sterna bengalensis*, Brown noddies *Anous stolidus* and a shearwater

### **Cruise 7: 5–21 May, 2017**

**Name:** Fish Biomass and the Environment of Kenya's Exclusive Economic Zone (EEZ) Off Kwale County (Block 3)

This summary provides the results of the surveys conducted in Block 3 in May, 2017 (SEM season). The biomass estimates for Block 3 was 919,345 Mt. Overall the fish biomass was highest in pelagic section (0-100 m) with more than 40 tons/km<sup>2</sup> in some areas.

Different species of animals were sighted during this cruise including dolphins, birds, fish, turtles, and a butterfly. The weather conditions were very rough during the survey, with cloudy skies, heavy rain, strong winds and strong waves. Four species of seabirds were recorded, of which gulls and terns (*Laridae* species) were the most dominant. Species documented included Black cormorant, Brown noddies (*Anous stolidus*) and several unidentified seabirds.

During this cruise both zooplankton and phytoplankton samples were successfully collected. A total of 19 zooplankton samples were successfully collected and 19 replicate phytoplankton samples were collected

Bathymetric data was also collected.

It was during this cruise that the ship propeller entangled a net, necessitating towing of the vessel to the Kenya Navy base at Manda.

### **Cruise 8: 7 – 11 November 2017**

**Name:** The RV Mtafiti Equipment Testing Cruise

The was carried out off Kwale and Mombasa areas with an aim of testing, commissioning and training on the use of ADCP descript, sediment grab, new phytoplankton (bongo) nets, piston corer. The cruise was carried out as a procurement requirement of supply, delivery, installation, testing, commissioning and training as defined in equipment purchase contracts. This specific activity was therefore geared towards provision of information to facilitate inspection and acceptance of the ADCP descript, sediment grab, new phytoplankton (bongo) nets, piston corer before payment can be made to the suppliers.

Samples collected is undergoing analysis.