NORAD-FAO PROGRAMME
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CRUISE REPORTS *DR FRIDTJOF NANSEN*
EAF-Nansen/CR/2023/07

Fisheries resources and ecosystem surveys off southeast Africa: Marine ecosystem of the United Republic of Tanzania

28 June to 13 July 2023

Tanzania Fisheries Research Institute, Dar es Salaam, United Republic of Tanzania
Kenya Marine and Fisheries Research Institute, Mombasa, Kenya
Ministry of Fisheries and Marine Resources, Windhoek, Namibia
Institute of Marine Science, United Republic of Tanzania, Zanzibar
Institute of Marine Research, Bergen, Norway

THE EAF-NANSEN PROGRAMME

The EAF-Nansen Programme "Supporting the Application of the Ecosystem Approach to Fisheries Management considering Climate and Pollution Impacts" supports partner countries and regional organizations in Africa and the Bay of Bengal, improving their capacity for the sustainable management of their fisheries and other uses of marine and coastal resources through the implementation of the ecosystem approach to fisheries (EAF), taking into consideration the impacts of the climate and pollution.

The Programme is executed by the Food and Agriculture Organization of the United Nations (FAO) in close collaboration with the Institute of Marine Research (IMR) of Bergen, Norway, and funded by the Norwegian Agency for Development Cooperation (Norad). This Programme, which started in 2017, represents the current phase of the Nansen Programme which started in 1975.

The aim of the Programme is that sustainable fisheries improve food and nutrition security for people in partner countries. It builds on three pillars, science, fisheries management and capacity development, and supports partner countries to produce relevant and timely evidence-based advice for fisheries management, to manage fisheries according to the EAF principles and to further develop their human and organizational capacity to manage fisheries sustainably. In line with the EAF principles, the Programme adopts a broad scope, taking into consideration a wide range of impacts of human activities and natural processes on marine resources and ecosystems including fisheries, pollution, climate variability and change.

A new state of the art research ship, the R/V *Dr. Fridtjof Nansen*, is an integral part of the Programme. A comprehensive science plan, covering a broad selection of research areas, and directed at producing knowledge for informing policy and management decisions, guides the Programme's scientific work.

The Programme works in partnership with countries, regional organizations, other United Nations agencies as well as other partner projects and institutions.

LE PROGRAMME EAF-NANSEN

Le Programme EAF-Nansen «Soutenir l'application de l'approche écosystémique pour la gestion des pêches compte tenu des impacts du climat et de la pollution» appuie les pays partenaires et les organisations régionales en Afrique et dans le golfe du Bengale en vue d'améliorer la capacité de gestion durable de leurs pêcheries et autres utilisation des ressources marines et côtières, grâce à la mise en œuvre de l'Approche écosystémique des pêches (AEP), en tenant compte des impacts du climat et de la pollution.

Le Programme EAF-Nansen est exécuté par l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) en étroite collaboration avec l'Institut de recherche marine (IMR) de Bergen, en Norvège, et financé par l'Agence norvégienne de coopération au développement (Norad). Ce Programme, qui a débuté en 2017, représente la phase actuelle du programme Nansen qui a débuté en 1975.

L'objectif du Programme est que la pêche durable améliore la sécurité alimentaire et nutritionnelle des populations des pays partenaires. Il s'appuie sur trois piliers, la science, la gestion des pêches et le développement des capacités. Le Programme aide les pays partenaires à produire des avis pertinents et opportuns fondés sur des données factuelles pour la gestion des pêcheries conformément aux principes de l'AEP et à développer davantage leur capacité humaine et organisationnelle à gérer durablement les pêches. Conformément aux principes de l'AEP, le Programme adopte une large vision, prenant en compte un large éventail d'impacts des activités humaines et des processus naturels sur les ressources et les écosystèmes marins, y compris la pêche, la pollution, la variabilité et le changement climatique.

Un nouveau navire de recherche aux technologies avancées, le Dr. Fridtjof Nansen, fait partie intégrante du Programme. Un plan scientifique détaillé, couvrant un large éventail de domaines de recherche et visant à produire des connaissances pour éclairer les décisions de politique et de gestion, guide les travaux scientifiques du Programme.

Le Programme travaille en partenariat avec des pays partenaires, des organisations régionales, d'autres agences des Nations Unies ainsi que d'autres projets et institutions partenaires.

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CRUISE REPORTS *DR. FRIDTJOF NANSEN*

Fisheries resources and ecosystem surveys off southeast Africa: Marine ecosystem of the United Republic of Tanzania

28 June to 13 July 2023

by

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Institute of Marine Research

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ABBREVIATIONS

ADCP	acoustic Doppler current profiler
ATR FTIR	attenuated total reflectance – Fourier transform infrared spectroscopy
CTD	conductivity, temperature and depth profiler
CUFES	continuous underwater fish egg sampler
EACC	East African Coastal Current
EAF	ecosystem approach to fisheries
EEZ	exclusive economic zone
FAO	Food and Agriculture Organization of the United Nations
GEBCO	General Bathymetric Chart of the Oceans
HCl	hydrochloric acid
IEW	Indian Equatorial Water
IIP	National Institute of Fisheries Research (Mozambique)
IMR	Institute of Marine Research
IMS	Institute of Marine Sciences
IUW	Indonesian Upper Water
KMFRI	Kenya Marine and Fisheries Research Institute
LSSS	Large Scale Survey System
MLF	Ministry of Livestock and Fisheries
Multpelt	multipurpose pelagic ecosystem trawl
NASC	nautical area scattering coefficient
NatMIRC	National Marine Information and Research Centre (Namibia)
ORI	Oceanographic Research Institute (South Africa)
pCO_2	partial pressure of carbon dioxide
RSPGIW	Red Sea-Persian Gulf Intermediate Water
SAIAB	South African Institute for Aquatic Biodiversity
SICW	Southern Indian Central Water
SSH	sea surface height
SST	sea surface temperature
SUZA	State University Zanzibar
TAFIRI	Tanzania Fisheries Research Institute
TAMISEMI	Tawala za Miko ana Serikali za Mitaa (Regional administration and local government)
TSG	thermosalinograph
UDSM	University of Dar es Salaam
ZAFIRI	Zanzibar Fisheries Research Institute

EXECUTIVE SUMMARY

This survey of the marine ecosystem of the United Republic of Tanzania was the fifth to be conducted in the country's waters with the research vessel R/V *Dr. Fridtjof Nansen*. The first three surveys were carried out in 1982 and 1983 (with the first R/V *Dr. Fridtjof Nansen*) and another survey was conducted in 2018 with the newest vessel. The survey described in this report (Leg 4.2) started on 28 June and ended on 25 July 2023 with a port call in Dar es Salaam on 11 July. During the one-month survey the coast was covered from the south to the north.

The cruise – an acoustic survey combined with a swept area survey and environmental sampling stations – was executed as planned and 85 pelagic and demersal fishing stations were conducted. The information presented in this report summarizes the results of the data compiled during the survey. Samples and data have been transferred to the United Republic of Tanzania according to the Sailing Order.

The weather during the survey was mostly calm and often overcast, accompanied by a few rain showers. The sea surface temperature was generally between 26 °C and 27 °C. Strong northward directed currents were experienced over a large part of the survey area, especially offshore along the continental shelf. Current systems between the continent and the islands were in the same general direction but were more turbulent and varied in magnitude.

The abundance of pelagic resources observed during the survey was relatively low. The most abundant species in the pelagic species 1 (PEL1) acoustic group were from the Engraulidae (*Encrasicholina heteroloba*, *Stolephorus commersonnii* and *Stolephorus indicus*), the Clupeidae (*Sardinella gibbosa*) and the Dussumieridae (*Dussumieria acuta*) families. The pelagic species group 2 (PEL2) was diverse but was dominated by species belonging to the Carangidae family. The biomass estimates of the two species groups, Pel1 and Pel2, were 2 935 tonnes and 9 582 tonnes, respectively.

The United Republic of Tanzania has a rugged and steep underwater topography with coral reefs and sponge beds that limit the trawlable areas. Despite this, the trawl survey was conducted successfully, covering a depth range from 20 m to 1 083 m. Overall, the swept area biomass was estimated to be 46 000 tonnes. The largest part of this biomass was made up of species of low commercial importance, but a total biomass of 6 490 tonnes of valuable commercial species was estimated, in addition to 3 500 tonnes of sharks, 2 450 tonnes of pelagic species, 1 700 tonnes of cephalopods and 1 000 tonnes of shrimps. The highest biomass was recorded in the central part of the United Republic of Tanzania, especially in the Mafia Island stratum where about half of the overall biomass was observed. The lowest biomass was observed in the south of the surveyed area, specifically in the Mtwara district. However, it must be noted that this region presents very difficult trawling conditions.

A detailed comparison with previous surveys has not been undertaken but there are reasons to believe that the biomass of most fish species on the shelf has declined. A detailed retrospective investigation is recommended.

The survey area displayed very high biodiversity, with more than 540 species of fishes observed. Several of these were new records for the United Republic of Tanzania.

RÉSUMÉ

La campagne réalisée actuellement avec le N/R *Dr. Fridtjof Nansen* en République-Unie de Tanzanie est la cinquième de la série. Les deux premières campagnes ont été effectuées en 1982 et 1983 (avec le premier N/R *Dr. Fridtjof Nansen*), et une autre campagne a été réalisée en 2018 avec le nouveau navire. La campagne (segment 4.2) a démarré le 28 juin et s›est terminée le 25 juillet, avec une escale à Dar Es Salaam le 11 juillet. Au cours de cette campagne d'un mois, une étude des fonds marins a été réalisée du sud au nord.

Le plan de la campagne a été suivi comme prévu avec une étude acoustique combinée à une étude de la zone et un programme d'échantillonnage environnemental avec 85 stations de pêche pélagique et démersale effectuées. Les informations présentées dans ce rapport détaillent succinctement les données compilées au cours de la campagne. Les échantillons et les données ont été transférés en République-Unie de Tanzanie conformément aux plans établis dans l'ordre de navigation.

Durant la campagne, le temps était généralement calme, souvent couvert et accompagné de quelques averses de pluie. La température de la mer en surface était généralement comprise entre 26 et 27 °C. De forts courants orientés nord ont été observés sur une grande partie de la campagne, en particulier au large, le long du plateau continental. Les systèmes de courants entre la partie continentale et les îles enregistrés, de même direction générale, étaient plus turbulents et d›ampleur variable.

Les ressources pélagiques observées au cours de la campagne ont été relativement peu abondantes. Les espèces les plus abondantes du groupe acoustique Pel1 appartenaient aux familles Engraulidae, en particulier *Encrasicholina heteroloba*, *Stolephorus commersonnii* et *S. indicus*, Clupeidae, *Sardinella gibbosa* et Dussumieridae, *Dussumieria acuta*. Le groupe Pel2 était diversifié, les espèces appartenant à la famille des Carangidae dominant largement. Les estimations de la biomasse des deux groupes d'espèces, Pel1 et Pel2, étaient respectivement de 2 935 et 9 582 tonnes.

La topographie marine de la République-Unie de Tanzanie est accidentée et abrupte avec des récifs coralliens et des bancs d'éponges qui limitent les zones chalutables. Malgré cela, la campagne de chalutage a été menée avec succès à différents niveaux de profondeur entre 20 et 1 083 m. Globalement, la biomasse de la zone étudiée a été estimée à 46 000 tonnes. La majeure partie de cette biomasse était constituée d'espèces de faible importance commerciale, mais une biomasse totale de 6 490 tonnes d'espèces commerciales de valeur a été estimée, en plus de 3 500 tonnes de requins, 2 450 tonnes d'espèces pélagiques, 1 700 tonnes de céphalopodes et 1 000 tonnes de crevettes. La biomasse la plus élevée a été enregistrée dans la partie centrale de la République-Unie de Tanzanie, en particulier dans la strate Mafia où environ la moitié de la biomasse totale a été observée. La biomasse la plus faible a été observée dans le sud de la zone étudiée, et plus particulièrement dans le district de Mtwala. Cependant, cette région présente des conditions de chalutage très difficiles.

Une comparaison détaillée avec les campagnes précédentes n'a pas été réalisée, mais il y a des raisons de croire que la biomasse de la plupart des espèces de poissons sur le plateau a diminué. Une étude rétrospective détaillée est recommandée.

La zone étudiée présentait une très grande biodiversité avec plus de 540 espèces de poissons observées. Plusieurs d'entre elles n'avaient jamais été identifiées en République-Unie de Tanzanie.

1. INTRODUCTION

1.1 The EAF-Nansen Science Plan

The research activities under the EAF-Nansen Programme are guided by the EAF-Nansen Science Plan. The Science Plan is intended to ensure good scientific use of the wealth of data generated by the R/V *Dr. Fridtjof Nansen* and other related data, addressing key research questions in support of tactical and strategic fisheries management. The Science Plan covers 11 research themes and is presented in Figure 1.

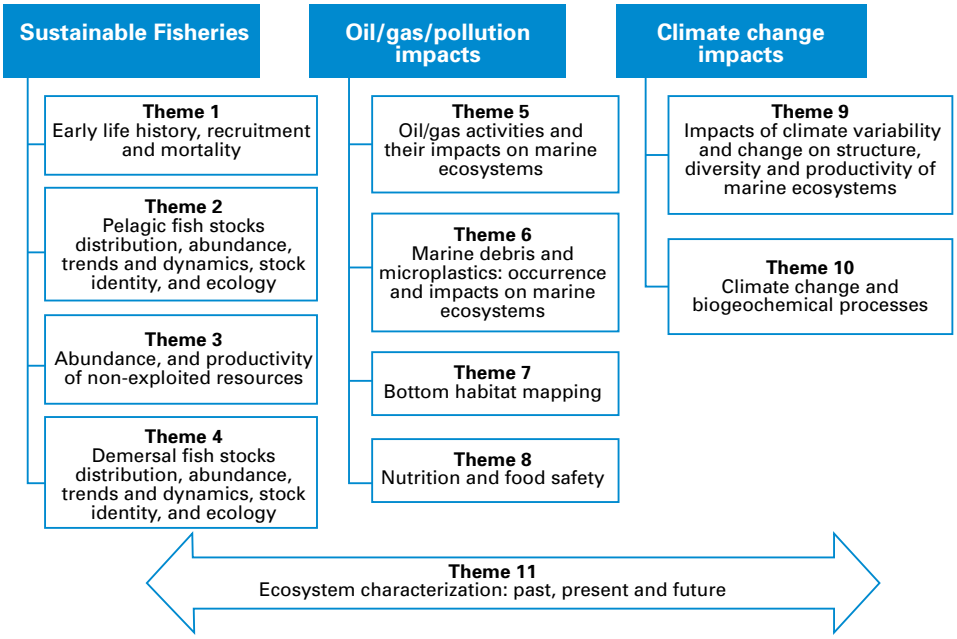

Figure 1. Research themes of the EAF-Nansen Science Plan

1.2 The survey area

The survey area was the territorial and exclusive economic zone (EEZ) of both the United Republic of Tanzania and the United Republic of Tanzania, Zanzibar, stretching between Mozambique and Kenya. The United Republic of Tanzania forms part of the northern reaches of the Agulhas-Somali Current Large Marine Ecosystem. The climate is influenced by monsoon wind systems: the northeast monsoon winds that blow from northern Somalia to southern Madagascar, and the southeast monsoon traversing the southern parts of Madagascar to the northern parts of Somalia (Semba *et al.,* 2019). The seasonal reversing wind patterns influence the climate and oceanographic conditions of the United Republic of Tanzania where the climate is tropical, with a wet season normally occurring between October and March and a dry season between April and September.

The continental shelf is narrow with a very steep slope in the south but widening northwards. There are several large islands on the shelf, most notably Mafia Island, Unguja Island and Pemba Island (Pemba Island and Unguja Island together forming the United Republic of Tanzania, Zanzibar). In the survey area two major perennial rivers, the Ruvuma and the Rufiji rivers, drain into the Indian Ocean. The region also has large mangrove areas fringing coral reefs around several of the islands and deep caverns cutting through the shelf. The northward East African Coastal Current (EACC) is the dominant oceanographic influence along the coastline of the United Republic of Tanzania and weaker side arms of this current penetrate on the shelf as well as between the islands and the mainland.

The marine waters of the United Republic of Tanzania display a diverse marine flora and fauna. The waters are typically oligotrophic but with increased productivity in the shallow waters between the

islands and the mainland, and generally display relatively high species diversity. However, there is limited information on the status of fish stocks, species diversity and distribution, largely because of research and financial capacity that has reduced over time.

To monitor the status of the different stocks and their distribution, the demersal and pelagic resources along the continental shelf between 20 m and 1 000 m bottom depth were investigated during Leg 4.2 of the R/V *Dr. Fridtjof Nansen* research survey in 2023 (Figure 2). The ecosystem survey combined a hydroacoustic survey and a swept area demersal resources survey.

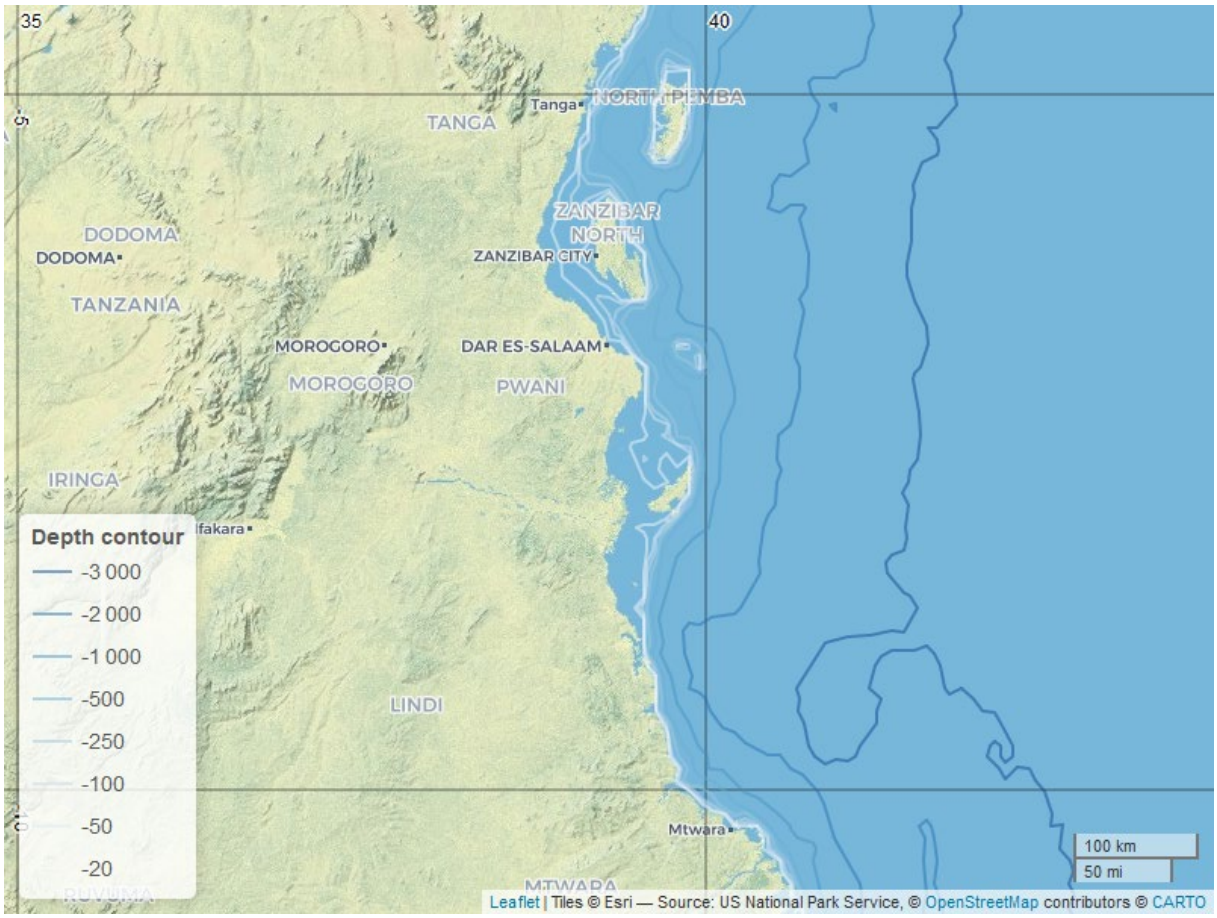

Figure 2. The area surveyed with the R/V *Dr. Fridtjof Nansen* during Leg 4.2 in the United Republic of Tanzania in 2023

1.3 Survey objectives

The survey aimed to cover the demersal and pelagic resources on the continental shelf and slope in the marine EEZ of the United Republic of Tanzania. While fishery resources represented a key priority, other aspects including habitats, environmental conditions and the presence of microplastics and marine debris were also addressed to improve knowledge on the composition, diversity and distribution of demersal and pelagic communities. Based on the above, the following objectives were agreed (in a prioritized order):

1. Obtain information on demersal and pelagic fish abundance, species and size composition and distribution.
2. Carry out standard biological sampling of priority species (including length, weight, sex and maturity).
3. Obtain measurements of environmental variables of the water column (salinity, temperature, dissolved oxygen, fluorescence, dissolved nutrients and chlorophyll *a*) through conductivity, temperature and depth (CTD) casts and water samples.

4. Obtain current measurements with an acoustic Doppler current profiler (ADCP).
5. Obtain information on the biomass, diversity and distribution of phytoplankton, mesozooplankton and ichthyoplankton.
6. Obtain information on the presence of microplastic particles in the surface waters, in the water column, in biota and on the presence of litter registered in trawl hauls.
7. Obtain information on food safety and nutrition of selected species.

The collected data were used to prepare this survey report; scientific reports and papers are expected to be produced in the future as part of the Science Plan. The data collected will be used for regional resource assessment work, e.g. the Southwest Indian Ocean Fisheries Commission.

1.4 Participation

A total of 28 researchers and technicians from Norway, Spain, Austria, Russian Federation, Namibia, Mozambique, Kenya and the United Republic of Tanzania participated in the survey. The full list of the participants and their affiliations is provided in Table 1.

Table 1. List of participants, roles and affiliations

No	Leg	Participant	Role	Email	Sex	Affiliation	Citizenship
1	Leg 4.2	Jens-Otto Krakstad	Cruise leader	jensotto@hi.no	M	IMR	Norway
2	Leg 4.2	Bernadine Irene Everett	Fish team	warriorbern@gmail.com	F	ORI	South Africa
3	Leg 4.2	Sarah Ann Bruck	Fish team leader	sarah.bruck@hi.no	F	IMR	Norway
4	Leg 4.2	Sara Zamora Terol	Plankton team leader	sara.zamora.terol@hi.no	F	IMR	Spain
5	Leg 4.2	Rupert Wienerroither	Fish team leader	ruper.wienerroither@hi.no	M	IMR	Austria
6	Leg 4.2	Jan Frode Wilhelmsen	Chief instruments engineer	jan.frode.wilhelmsen@hi.no	M	IMR	Norway
7	Leg 4.2	Sverre Waardal Heum	Instruments engineer	sverre.waardal.heum@hi.no	M	IMR	Norway
8	Leg 4.3	Benjamin Marum	Chief instruments engineer	benjamin.marum@hi.no	M	IMR	Norway
9	Leg 4.4	Ole Vigeland	Instruments engineer	ole.vigeland@hi.no	M	IMR	Norway
10	Leg 4.2	Saskia Sune Kisting	Oceanography team leader	saskiakisting@gmail.com	F	NatMIRC	Namibia
11	Leg 4.2	Mary Alphonce Kishe	Cruise co-leader	mariakishe@tafiri.go.tz	F	TAFIRI	United Republic of Tanzania
12	Leg 4.2	Prisca Mziray	Water chemistry	priscamziray@gmail.com	F	TAFIRI	United Republic of Tanzania
13	Leg 4.2	Talhiya Maulid Ali	Water chemistry	talhiyaali@yahoo.com	F	SUZA/ UDSM	United Republic of Tanzania, Zanzibar

No	Leg	Participant	Role	Email	Sex	Affiliation	Citizenship
14	Leg 4.2	Fidelis Msaya Kayanda	Water chemistry	Fideliskayanda1@gmail.com	M	TAFIRI	United Republic of Tanzania
15	Leg 4.2	Benedicto Boniphace Kashindye	Physical oceanography	benedictokashindye@tafiri.go.tz	M	TAFIRI	United Republic of Tanzania
16	Leg 4.2	Sihaba Ramadhan Mwaitega	Plankton biology	sihabamwaitega@tafiri.go.tz	F	TAFIRI	United Republic of Tanzania
17	Leg 4.2	Barnabas Tarimo	Plankton biology	tarimobarnabas@yahoo.com	M	IMS/UDSM	United Republic of Tanzania, Zanzibar
18	Leg 4.2	Mariam Kadama Maduhu	Fisheries biology/ taxonomy	mariamkmaduhu@gmail.com	F	MLF	United Republic of Tanzania, Zanzibar
19	Leg 4.2	Catherine Adam Mwakosya	Fisheries biology/ taxonomy	catherinemwakosya@tafiri.go.tz	F	TAFIRI	United Republic of Tanzania
20	Leg 4.2	Patroba Patrick Matiku	Fisheries biology/ taxonomy	putni2p@yahoo.com	M	TAFIRI	United Republic of Tanzania
21	Leg 4.2	Yussuf Salim	Fisheries biology/ taxonomy	bakaryussuf94@gmail.com	M	ZAFIRI/ UDSM	United Republic of Tanzania, Zanzibar
22	Leg 4.2	Rui Jorge Mutombene	Fisheries biology/ taxonomy	ruimutombene@gmail.com	M	IIP	Mozambique
23	Leg 4.2	Henriques Oreste Bustani	Water chemistry	henbustan@gmail.com	M	IIP	Mozambique
24	Leg 4.2	Aniceto Zulficar Alfredo	Plankton biology	anicetolfredo@gmail.com	M	IIP	Mozambique
25	Leg 4.2	Athman Salim Hussein	Physical oceanography	athmansalim@gmail.com	M	KMFRI	Kenya
26	Leg 4.2	James A Magoto	Fisheries biology/ taxonomy	jamesalfredmase@yahoo.com	M	TAMISEMI/ UDSM	United Republic of Tanzania
27	Leg 4.2	Atuganile Malambugi	Fisheries biology/ taxonomy	atumalambugi@gmail.com	F	TAFIRI/ UDSM	United Republic of Tanzania
28	Leg 4.2	Sergey Bogorodsky	Fisheries biology/ taxonomy	ic187196@yandex.ru	M	FAO	Russian Federation

Notes: IMR = Institute of Marine Research, Norway; TAFIRI = Tanzania Fisheries Research Institute; ZAFIRI = Zanzibar Fisheries Research Institute; KMFRI = Kenya Marine and Fisheries Research Institute; IIP = National Institute of Fisheries Research, Mozambique; ORI = Oceanographic Research Institute, South Africa; NatMIRC = National Marine Information and Research Centre, Namibia; IMS = Institute of Marine Sciences, United Republic of Tanzania, Zanzibar; SUZA = State University Zanzibar; MLF = Ministry of Livestock and Fisheries; TAMISEMI = Tawala za Miko ana Serikali za Mitaa (Regional Administration and Local Government); UDSM = University of Dar es Salaam.

1.5 Narrative

The survey started on 28 June 2023 from Dar es Salaam in the United Republic of Tanzania. All cruise participants arrived on board in the morning and the vessel left port for anchorage later the same day. Due to some administrative delays, the vessel departed Dar es Salaam the following afternoon. It transited southwards (roughly 240 NM) to the border between Mozambique and the United Republic of Tanzania (10°25' south) where the sampling programme commenced on 30 June at 18.00.

The transects were perpendicular to the depth isobath and the first transect was started from offshore at 1 500 m depth. A break in the survey took place between 10 and 13 July for a crew change in Dar es Salaam and a port call event. After the crew change the vessel continued the survey on 13 July northwards to the border with Kenya. On 22 July a short stop was made at the northwestern end of Unguja Island to calibrate the echo sounder. The vessel returned to Dar es Salaam on 25 July in the morning to end the survey, change the scientific crew and proceed with the cruise to Mozambique.

1.6 Survey design and effort

During Leg 4.2 sampling was conducted according to the R/V *Dr. Fridtjof Nansen* survey protocol, which is standardized to the extent possible, to allow comparability across larger geographic scales.

Historically, the Tanzanian coastal waters have been divided into four strata/zones: Pemba Island (north) from approximately 4°42' south (border with Kenya) to 5°57' south; the United Republic of Tanzania, Zanzibar from 5°57' south to 6°57' south; Mafia Island from 6°57' south to 9° south; and Mtwara (south) from 9° south to 10°28' south (border with Mozambique).

The survey design consisted of parallel transects perpendicular to the coast and spaced approximately 10 NM apart, covering the depth region between 20 m (when safety limits allowed) to 1 000 m bottom depth. The continental shelf was depth stratified for the bottom trawl stations as follows: 20 m to 50 m, 50 m to 100 m, 100 m to 200 m, 200 m to 500 m and 500 m to 1 000 m. Where bottom conditions allowed for it, trawling was conducted to a depth of ~ 1 000 m. Specific environmental transects with superstations were conducted at every 1° latitude, approximately every sixth transect, and extended to 1 500 m bottom depth. The survey area is presented in Figure 2.

The survey tracks and the sampling frequency followed the agreed survey design described in the Sailing Orders and was like the ecosystem survey completed in Mozambique during Leg 4.1. Swept area bottom trawls for demersal fish identification and swept area analyses and pelagic trawls for acoustic target identification (EK80, 38 kHz frequency) were conducted regularly during the survey. The acoustic transects regularly ended before 20 m bottom depth due to the very steep inner shelf. An overview of the trawl stations can be found in Figure 6.

The positioning of transects was based on the ultimate decision of the responsible navigating officers, resulting in slight deviations from the planned transects mainly to avoid smaller vessels and for the R/V *Dr. Fridtjof Nansen's* safety at shallow depths. In most cases the 20 m isobath was not reached and acoustic transects stopped before then (mainly deeper than the 30 m isobath).

Specific environmental transects with superstations were conducted according to a regular grid (every 1° latitude, i.e. 60 NM). Typically, these transects covered the depth region from 20 m to 1 500 m (CTD to 1 500 m, other instruments down to a maximum of 200 m).

A superstation was defined as a station containing a set of sampling devices deployed in close connection (time and space) to each other, including CTD (hydrographic parameters), phytoplankton net, WP2 net (zooplankton), Bongo net (ichthyoplankton) and a Manta trawl (microplastics and ichthyoplankton). An overview of equipment and sampling depths of the superstations conducted at the environmental transects is shown in Figure 3.

CTD deployments were conducted at the superstations along the environmental transects as well as at every trawl station, except at fishing stations that were close to CTD stations (< 5 NM) (Figure 4).

At the environmental transects, standard plankton and microplastic sampling were conducted using the above-mentioned sampling gear. Microplastic samples were also taken with a Manta trawl. An overview of all the plankton and microplastic sampling conducted during Leg 4.2 is shown in Figure 5. The survey effort along the survey area is summarized in Table 2.

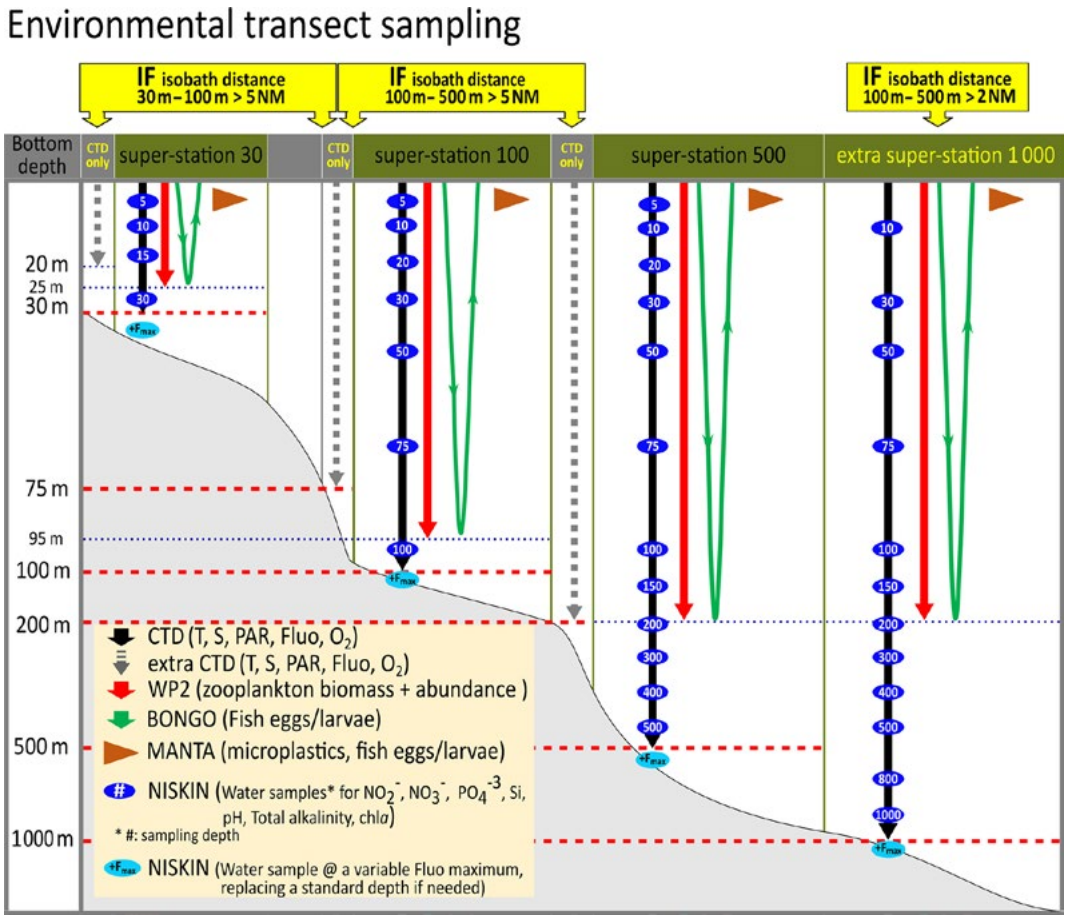

Figure 3. Sampling along environmental transects at predefined superstations

Table 2. Survey effort in number of sampling stations (total and by subarea)

Notes: Number of BT (demersal) and PT (pelagic) trawl hauls, CTD, phytoplankton net, WP2, Bongo and Manta net deployments, as well as the distance sailed (NM).

Region	Activity	Period	Bongo	BT	CTD	Manta	Phyto	PT	WP2	Distance	Days
	Steaming	25 June to 30 June 2023 24 July to 25 July 2023								296.8	6.5
United Republic of Tanzania	Entire survey	30 June to 24 July 2023								2 602.9	23.6
United Republic of Tanzania	Survey		30	72	111	26	23	12	29		
Total		25 June to 24 July 2023	30	72	111	26	23	12	29	2 899.7	30.1

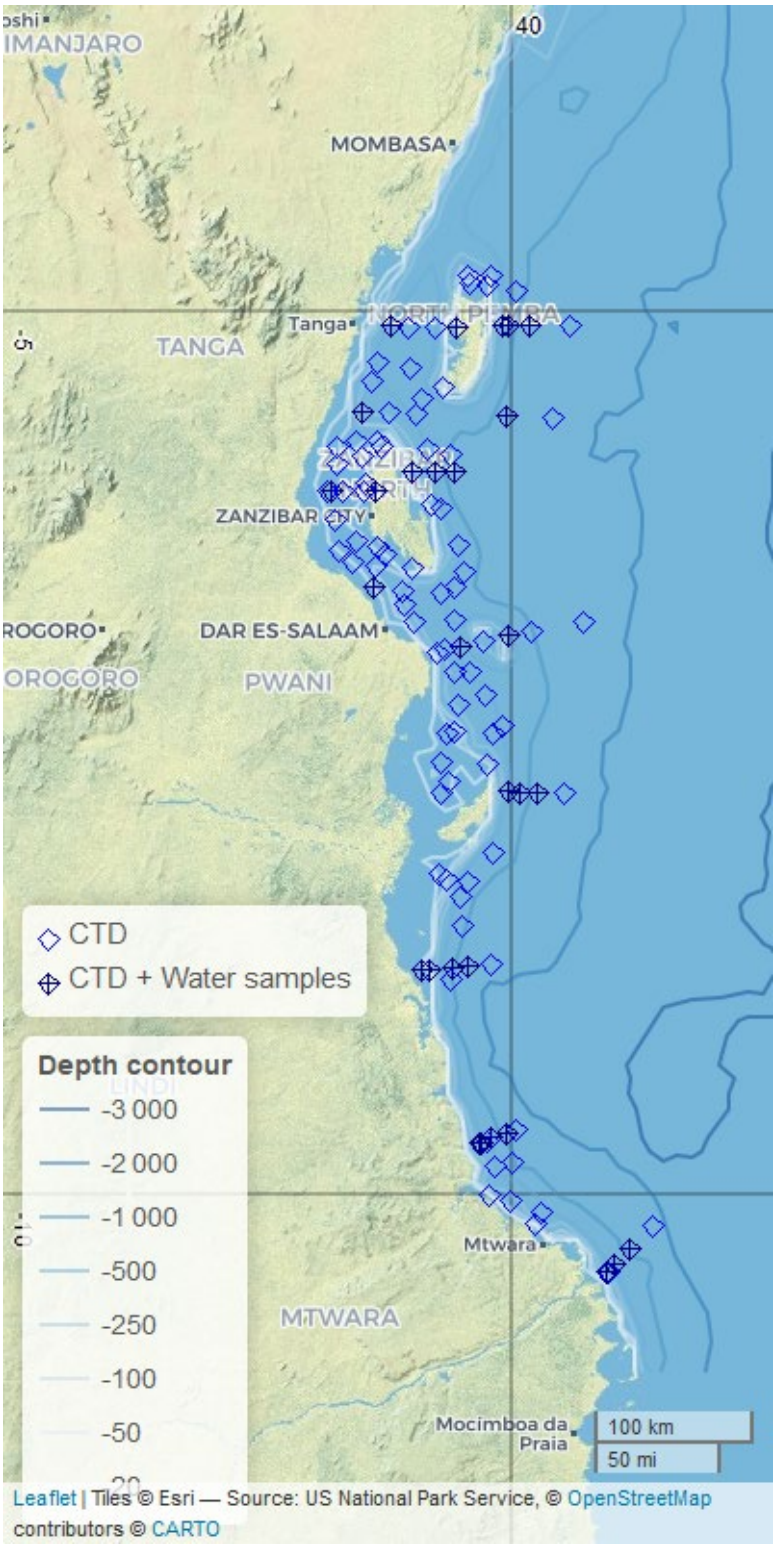

Figure 4. Location of fixed hydrographic sampling stations during Leg 4.2

Notes: Stations without water samples are shown as filled diamonds, whereas those with water samples are shown as empty diamonds.

Figure 5. Location of WP2 sampling stations during Leg 4.2

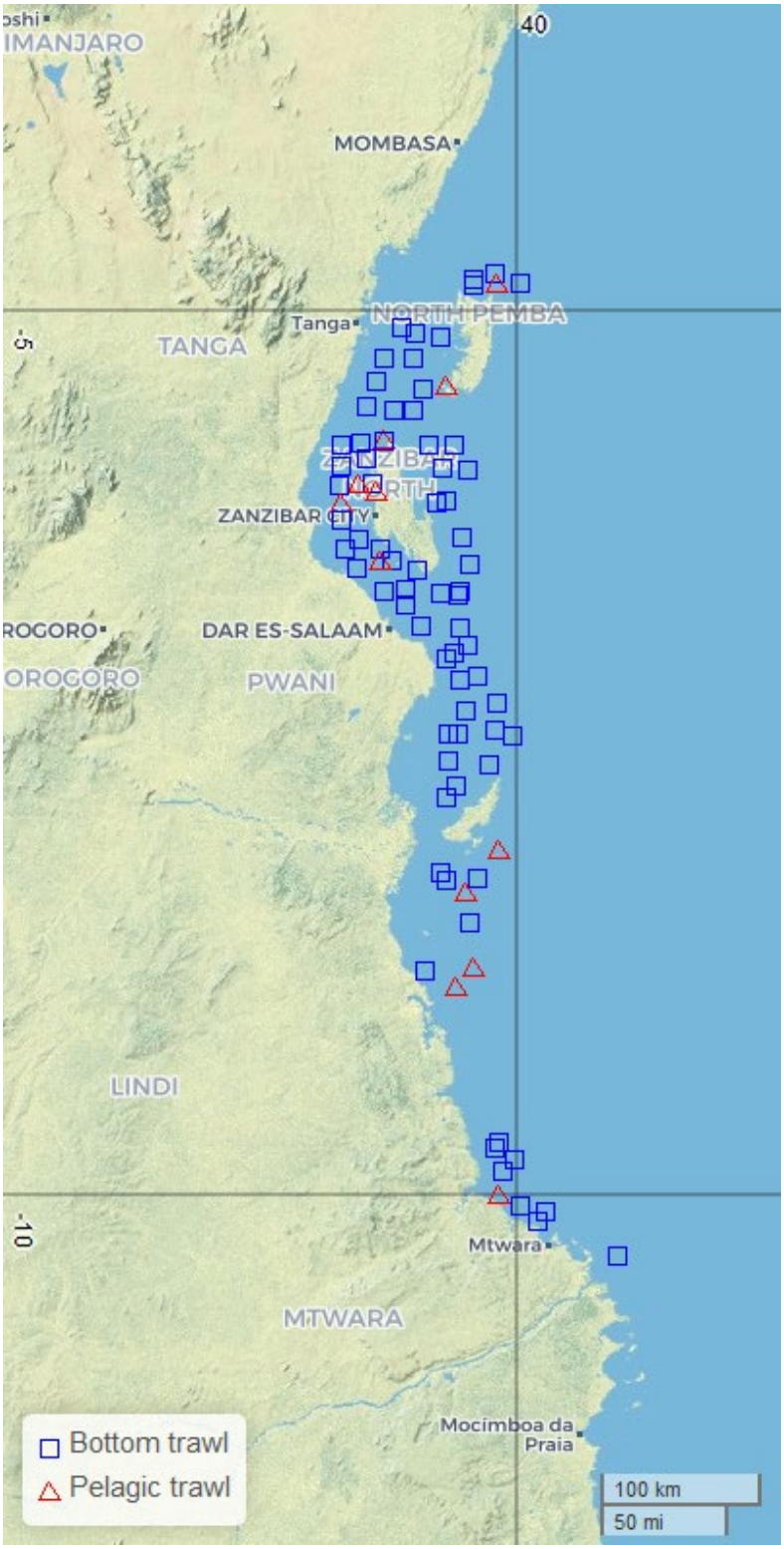

Figure 6. Location of trawl stations during Leg 4.2

2. METHODS

2.1 Meteorology

Meteorological data were logged continuously from the AANDERAA Smartguard meteorological station and included wind direction and speed, air pressure, relative humidity, air temperature and solar radiation. All data were stored on the vessel's Cruise Logger database and processed with IMR's N-Underway software.

2.2 Oceanography

2.2.1 Underway hydrographic sampling

2.2.1.1 Ocean currents

Ocean current data were collected with two vessel-mounted Teledyne RDI Ocean Surveyor ADCPs operating at 75 kHz (depth range of 650 m) and 150 kHz (depth range of 400 m). The ADCPs ran in narrow band mode and averaged data in 8 m vertical bins. Heading, pitch, roll and positional data were acquired by a Kongsberg Marine SEAPATH unit. Teledyne's VmDAS software was used to collect the raw current data and it was processed with IMR's N-CLIM software.

2.2.1.2 Sea surface temperature, salinity and fluorescence

One SBE 21 SeaCAT thermosalinograph (TSG) ran continuously during the survey, obtaining samples at 6 m depth to measure seawater salinity and temperature every 10 seconds. The 6 m TSG measured water from the intake located on the drop keel and it was also equipped with a Sea-Bird WETStar fluorometer for added subsurface fluorescence detection. The 4 m TSG that would have measured water from the intake of the engine cooling water was not operational during the survey.

2.2.1.3 Partial pressure of carbon dioxide

The CONTROS HydroC® CO_2 FT sensor which measures partial pressure of carbon dioxide (pCO_2) using water from the vessel's 4 m intake was not in use during the survey.

2.2.2 Fixed hydrographic sampling

2.2.2.1 Conductivity, temperature and depth sensors

A Sea-Bird 911plus CTD containing the sensors identified in Annex 1 were mounted to a 12-bottle rosette water sampler for use at every fixed hydrographic station and in association with every trawl. Sensor data logging and profiling were performed using Sea-Bird's Seasave software.

Water was collected from the entire water column at selected CTD stations throughout the fixed transects for conductivity and dissolved oxygen sensor validation and calibration. For this purpose, a Guildline Portasal salinometer 8410A was used to measure the samples collected for conductivity (salinity) and a Metrohm 916 Ti-Touch potentiometric titrator performing automated Winkler titrations (Grasshoff, Kremling and Ehrhardt, 1983; Langdon, 2010) was used to measure the samples collected for dissolved oxygen.

2.2.2.2 Water column ocean currents

The lowered ADCP was not used during the survey.

2.2.2.3 Ocean acidification parameters

Data on pH and total alkalinity were not collected during the survey.

2.2.2.4 Nutrient samples

Water samples for the analysis of nitrite, nitrate, silicate and phosphate were collected in 15 ml high-clarity polypropylene conical centrifuge tubes with polyethylene dome seal screw caps from the rosette water sampler at the superstation and frozen for preservation. The samples were analysed after the survey. During analysis, samples were thawed in a 50 ˚C water bath for 40 minutes and then allowed to cool to room temperature for 45 minutes (Becker *et al.*, 2019). The nutrient samples were measured on the vessel later in the year with a SEAL QuAAtro39 continuous segmented flow analyser (QuAAtro Methods: Q-070-05 Rev. 7; Q-068-05 Rev. 12; Q-064-05 Rev. 8; Q-038-04 Rev. 4 [multitest MT3B]).

2.2.2.5 Chlorophyll pigments

Water samples for the analysis of chlorophyll *a* were collected in 276 ml high-density polyethylene bottles from the rosette water sampler from depths ranging from 5 m to 200 m at every superstation. After collection, samples were filtered with 25 mm Munktell MG F filters with a 0.7 µm particle retention on a 200 mm Hg vacuum pumped filtration system. The filters were extracted with 10 ml of 90 percent acetone for 15 to 24 hours at 4 °C.

Samples were then centrifuged and transferred to cuvettes for analysis on a Turner Designs 10AU fluorometer (Welschmeyer, 1994; Jeffrey and Humphrey, 1975). Samples were first measured without acid for chlorophyll *a* determination and then a second time with two drops of 5 percent hydrochloric acid (HCl) for phaeopigment determination. The 10AU fluorometer is calibrated once a year with standard solutions created from chlorophyll *a* solid derived from spinach. In addition, blank measurements with 90 percent acetone and stability measurements with a 10AU Solid Secondary Standard are conducted before and after every sample set analysis.

2.3 Plankton

2.3.1 Phytoplankton

Water samples for phytoplankton community composition analysis were collected only at the superstations. Water was collected at predefined depths (5 m, 15 m, 25 m, 50 m and 75 m) with Niskin bottles on the CTD-rosette, with 75 m as the maximum depth of sample collection. Samples were fixed in a 2 percent formaldehyde solution.

Phytoplankton nets (35 cm in diameter and with a mesh size of 10 µm) were deployed at the superstations. The net was hauled vertically at a speed of 0.1 m/s from the depth of 30 m to the surface (from about 5 m above the bottom at the 30 m stations). The samples were preserved with a 2 ml of 4 percent borax buffered, 20 percent formaldehyde solution in 100 ml bottles (i.e. a final solution of about 0.4 percent formaldehyde). These samples were not quantitative but were used to establish the taxonomic composition of the phytoplankton community.

2.3.2 Zooplankton

Zooplankton samples were collected with a WP2 net of 180 µm at the superstations positioned along the environmental transects at the isobaths 30 m, 100 m and 500 m.

All samples were collected by vertical hauls at a speed of 0.5 m/s for the 180 µm net and 0.75 m/s for the 200 µm net. The nets were towed within 5 m above the bottom to the surface, or from a maximum of 200 m depth to the surface at deep stations. The plankton leader ensured that this procedure was followed accurately and noted the actual depth of the tow (displayed on the monitor) and took flowmeter counts before and after the tow.

The WP2 samples collected with the 180 µm net were processed as follows:

- The samples were halved with a Motoda splitter.
- One half was used for biomass estimation (size fractionation through 2 000 µm, 1 000 µm and 180 µm mesh sizes).

The second half was preserved in a 4 percent borax buffered formaldehyde solution and processed onboard through the FlowCam Macro. The exact procedure followed is described in detail in the Nansen Plankton Guidelines.[1]

The WP2 samples collected with the 200 µm were directly fixed in a 4 percent borax buffered formaldehyde solution for later taxonomic analysis.

2.3.3 Ichthyoplankton

Ichthyoplankton was collected at the same superstations as the zooplankton samples with double oblique tows of a Bongo net (60 cm diameter) equipped with 405 µm nets. The Bongo was towed obliquely within 5 m above the bottom or a maximum depth of 200 m to the surface at deep stations. Wire speed and the vessel speed strictly followed the Nansen Plankton Guidelines. Once the Bongo net was on board, the samples were transferred to the laboratory and processed as follows:

- The sample from the right net (H) was preserved directly in 95 percent ethanol.
- The sample from the left net (V) was preserved directly in a 4 percent borax buffered formaldehyde solution (especially made for ichthyoplankton). When time allowed these samples were examined under the microscope and all fish larvae (and eggs if possible) were sorted. When sorting was completed, the bulk sample was used for the estimation of the zooplankton displacement volume (details in the Nansen Plankton Guidelines). Finally, the sample was returned to its bottle using the same 4 percent formaldehyde solution. The sorted ichthyoplankton was photographed and preserved with a 4 percent formaldehyde solution (especially made for ichthyoplankton) in small, labelled scintillation vials indicating clearly which net was used for sorting, the preservative, station, etc. More details on the sample processing can be found in the Nansen Plankton Guidelines.

In addition, fish larvae collected by the Manta trawl were sorted, photographed and preserved in 96 percent ethanol in small scintillation vials for genetic analysis.

A custom continuous underwater fish egg sampler (CUFES) system was used to collect fish eggs at selected stations with an isobath of less than 200 m. The flow rate of the CUFES was 72 l/min.

2.3.4 Jellyfish

Jellyfish were recorded throughout the survey from all trawl hauls. Identification was conducted to the lowest taxonomic level and recorded in the customized data acquisition system Fish2Data and Biotic Editor.

2.4 Fishery resources

Depending on its size, either the whole catch or a subsample was sorted and measured. For all trawl hauls the catch was sorted per species, and number and weight measurements were taken for all fish species. For priority species, individual lengths and weights were recorded using an electronic fish meter connected to its data acquisition system Fish2Data, and later entered in the Biotic Editor software running on the vessel's server. Prior to the survey, training was provided to the cruise participants on the use of the electronic fish meter, Fish2Data and Biotic Editor software.

2.4.1 Pelagic resources

Target identification tows were conducted to support acoustic data interpretation and to collect biological

[1] See https://nansen-surveys.imr.no/doku.php?id=plankton_lab_information

data whenever acoustic recordings were observed on the echo sounder. These tows used either the Gisund Super bottom trawl on the bottom, or with floats in the surface in shallow areas, or a small pelagic Åkra trawl. Trawls were conducted at any time. When carrying out a trawl haul, the ship deviated from the survey grid. After the trawl was completed the ship returned to the point at which the acoustic transect was interrupted, with a small overlap between the interrupted and renewed transect. Before or after each trawl a CTD cast was conducted down to the bottom, without water sampling.

Species composition, length frequencies and biological sampling were conducted according to standard procedures for each trawl sample. The number of trawl samples depended on the density and distribution of acoustic targets observed and the need for species identification. The frequency of tows depended on the presence and degree of mixing of acoustic targets requiring identification. The emphasis was on catching relatively small quantities of fish in good condition for target identification and conducting biological analysis.

Detailed sampling protocols for what is considered as standard sampling on the R/V *Dr. Fridtjof Nansen* can be found in the Nansen Wiki (https://nansen-surveys.imr.no/doku.php). Other sampling protocols, area specific information and a detailed description of the sampling conducted are provided in this repot.

2.4.1.1 Trawling and biological sampling

A representative subsample of the target species in the catch was obtained from each trawl station and 100 individuals (when available) were measured for length and weight. In cases of apparent bi- and/or multimodal length distributions, more individuals were measured to ensure that representative length distributions were obtained.

For determination of sex and maturity, five fish per 1 cm length group were examined at each fishing station. The sampling protocol and configuration was entered in the Fish2Data software for recording length, weight, sex and maturity measurements. Trawl duration was determined by the amount of biological material registered by the SCANMAR trawl eye sensor during trawl deployments. A detailed description of instruments and fishing gears is given in Annex 1. Once the catch was on deck it was assessed and, if necessary, subsampling was conducted. Hauls with catches > 1 000 kg were pre-weighed with a scale attached to the crane at the stern (total weight of catch = "weight of catch + weight of gear" – "weight of empty gear"). At all trawl hauls the catch was sorted and length and weight measurements were taken for all fish species using the electronic fish meter.

The identification of taxa found in the United Republic of Tanzania was based on digital and online taxonomy guides, printed books and FAO identification guides. Additionally, the survey had a dedicated taxonomist on board to assist with the identification of species. The Sailing Order provided guidelines on the detailed sampling that was conducted during the survey.

2.4.1.2 Acoustic abundance estimation

The acoustic backscatter data were recorded continuously using Simrad EK80 scientific split-beam echo sounders equipped with keel-mounted transducers at nominal operating frequencies of 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz and 333 kHz (continuous wave pulse). The Sailing Order provided details of the echo sounder settings used during the survey.

Acoustic backscatter data verification trawl hauls were taken whenever significant acoustic backscatter was recorded and/or the backscatter source identity was uncertain.

Acoustic data were scrutinized on board using the Large Scale Survey System (LSSS) post-processing software version 2.14.0 (Korneliussen *et al.,* 2016). The acoustic backscatter was assigned to predefined acoustic categories (Table 3) in the LSSS. The acoustic backscatter was split based on the acoustic backscatter properties (e.g. acoustic frequency response), the trawl catch composition and fish behaviour as evident in acoustic recordings. Other useful information was also employed whenever applicable (e.g. time of the year, location). The nautical area scattering coefficient (NASC or s_A, m^2 NM^{-2}) split by acoustic category was then exported from the LSSS software for subsequent use in the StoX software.

An adaptive volume backscattering threshold was applied in the acoustic backscatter scrutinization process

in LSSS, generally, between −50 dB and −60 dB. Thresholding to remove the plankton backscattering was conducted at levels between −53 dB and −60 dB. Deep and characteristic mesopelagic layer (mostly below 100 m to 150 m depth) backscatter allocation was generally done with a threshold of −65 dB. A −60 dB to −55 dB threshold was used for shallow observations (< 100 m) of mesopelagic layers that were mixed with prominent subsurface plankton layers. The remainder of the backscatter was allocated to the "plankton" acoustic category at −82 dB threshold.

StoX software (version 3.6.2) was used to calculate the relative biomass and abundance indices. StoX software used the split-by-acoustic-category backscatter data, the biotic trawl catch data, the stratum polygon and the fish acoustic target strength-to-fish-length relationship. For details see Johnsen *et al.,* 2019.

The following acoustic target strength (TS, dB) to fish length (L, cm) relationship was used for all fish species of interest: $TS = 20*logL−72\ dB$

The relative biomass and abundance indices were estimated for the two pelagic fish species categories: pelagic species group 1 (PEL1) and pelagic species group 2 (PEL2).

Table 3. Allocation of acoustic densities to species groups

Notes: The mean integrator value in each sampling unit (NASC values) was divided between the listed standard categories/groups of fish. Note that for the groups PEL1 and PEL2 only examples are listed.

Acoustic category	Group	Taxon	Species
PEL1	Pelagic group 1	Clupeidae	*Sardinella gibbosa*
		Dussumieriidae	*Dussumieria acuta*
		Engraulidae	*Encrasicholina heteroloba*
			Stolephorus commersonnii
			Stolephorus indicus
PEL2	Pelagic group 2	Carangidae	*Alectis ciliaris*
			Carangoides chrysophrys
			Carangoides coeruleopinnatus
			Carangoides malabaricus
		Scombridae	*Scomberomorus commerson*
		Sphyraenidae	*Sphyraena obtusata*
		Trichiuridae	*Trichiurus lepturus*
BOTT	Demersal species	Ariidae	
		Centrophoridae	
		Dalatiidae	
		Leiognathidae	
		Mullidae	
		Ostracoberycidae	
		Plesiobatidae	
		Serranidae	
MESO	Mesopelagic fish	*Lampanyctodes hectoris*	
	Lightfish	*Maurolicus* spp.	
	Mesopelagic fish	(e.g. Myctophidae)	
PLANK	Plankton	Plankton, Euphausiids	

The collected biological and acoustic data for the target species were processed into abundance estimates as described in Table 3. The abundance calculation was conducted using StoX version 3.6.2 (www:hi.no/en/hi/forskning/projects/stox) (Johnsen *et al.,* 2019). StoX is an open-source software developed at IMR in Norway to analyse survey data and calculate survey estimates from acoustic and swept area surveys. All biomass and abundance estimates for the target species were prepared based on predefined strata.

2.4.2 Demersal resources

2.4.2.1 Trawling and biological sampling

Demersal trawl stations were conducted on the shelf and slope between about 30 m to 1 000 m depths.

Trawl duration was standardized to 30 minutes, but all hauls with a duration greater than 15 minutes (and covering a distance of > 0.5 NM) were included in the estimates. Trawl duration was determined on a station-by-station basis by the cruise leader and navigators based on trawl sensor (SCANMAR) recordings of fish quantities entering the trawl.

At stations where large quantities of fish entered the trawl, the duration was kept below 30 minutes. In areas with poor bottom conditions the trawl duration was also shortened to avoid damage to the trawl gear. Hence, some stations did not reach the minimum 15-minute trawl time and were coded as invalid in the database. A detailed description of instruments and fishing gear is presented in Annex 1.

Once the catch was on deck it was assessed, and if necessary, a subsample was taken and processed. At all trawl hauls the catch (or a subsample of the catch) was sorted and length and weight measurements were taken for all fish species using the electronic fish meter and its customized data-acquisition software (Fish2Data). Registrations were then transferred and stored to the Biotic Editor software. In addition, further biological sampling was conducted for pre-agreed priority species. The Sailing Order provided guidelines on the detailed sampling protocols that were used during the survey.

2.4.2.2 Swept-area abundance estimation

Swept-area abundance estimates were calculated from the average catch per NM^2 multiplied with the stratum size. The abundance estimates were calculated using StoX software (version 3.6.2) for the main demersal species caught during the survey. A coefficient of variance was obtained from bootstrapping with 1 000 iterations. Estimates were calculated for each of the six bathymetric strata (20 m to 50 m, 50 m to 100 m, 100 m to 200 m and 200 m to 500 m).[2]

2.4.2.3 Other trawl-related sampling

The protocol that was followed for cartilaginous taxa was the same as for demersal and pelagic resources. Specimens for taxonomic courses were collected following the protocol described in the Sailing Order. Taxa that could not be identified were preserved in formalin or frozen and sent to the South African Institute for Aquatic Biodiversity (SAIAB) for inclusion in the EAF-Nansen species collection and identification by taxonomic experts.

2.5 Benthos and benthic habitats

2.5.1 Epibenthos sampling from demersal trawl catches

Not relevant for this survey.

2.5.2 Sampling with Van Veen grab

Not relevant for this survey.

[2] For more information see StoX documentation at ftp://ftp.imr.no/StoX/Documentation

2.6 Microplastics

Microplastics were collected with a Manta trawl deployed after or during the Bongo net operation. The Manta trawl (19 cm [height] × 61 cm [width], 335 µm mesh size) was towed outside the wake of the vessel at 2 knots to 3 knots (around 1.5 m/s) for 15 minutes. Procedures of sampling and sample processing are described in the Nansen Plankton Guidelines (see Nansen Wiki). Samples were collected and microplastics were sorted under a stereomicroscope and photographed, washed in fresh water and stored in labelled Eppendorf tubes with station information. Polymer identification will be done by the attenuated total reflectance method for Fourier transform infrared spectroscopy (ATR FTIR) in Bergen.

After sorting, the bulk of neuston samples were preserved in 96 percent ethanol. In the case of a lack of time for analysis or bad weather, samples were preserved in the same way and processed later.

2.7 Marine debris

Marine debris were registered and classified at each station according to the standard sampling protocol for marine debris.[3] All pieces of litter were weighed and counted and when possible, photographs were taken of the individual pieces for a future reference catalogue. The data and the reference photographs were recorded using Fish2Data. Plastic material was only found at one station during the survey.

2.8 Bottom habitat mapping

2.8.1 Bathymetry

Bottom depth read was obtained continuously from the EK80 echo sounder (down to 500 m depth, 38 kHz) The information was also registered in the survey logger (Toktlogger) system, through the appropriate National Marine Electronics Association message. If sampling station bottom depth exceeded 500 m, a temporary manual adjustment to EK80 settings was made to obtain local bottom depth read (this implies adjustment to the EK80 bottom detector and a slower ping rate than the standard 1 Hz), so that the information was registered in the survey logger).

2.8.2 Multibeam mapping of bottom habitats

The EM710, or alternatively the EM302 multibeam bottom mapping echo sounders, were used to record and store bottom depth information in the Olex system on board. Data were recorded and stored and will be made available for any future analysis.

Both the EM302 and the EM710 multibeam echo sounders are high-resolution seabed mapping systems. Across track coverage (swath width) is up to 5.5 times the water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. Ping rate is set according to depth. Sound profiles are set manually in the system according to the area of operation.

The EM302 is hull mounted and has a maximum range of 10-7 000 m and an operating frequency of 30 kHz. The system has sub-bottom profiling capacity in integration with SBP 300.

The EM710 is mounted on the drop keel and the operational depth of the EM710 is from 3 m to 2 000 m. The operating frequencies are between 70 kHz and 100 kHz. The along-track beam width is 1 degree. The receiving beam width is 2 degrees.

Data from the EM302 were logged to the onboard Olex plotting system in standard resolution mode.

2.8.3 Sediment composition

Not relevant for this survey.

[3] https://nansen-surveys.imr.no/lib/exe/fetch.php?media=nansen-surveys:fishlab_marine_litter_categories.docx

2.8.3.1 Granulometry

Not relevant for this survey.

2.8.3.2 Chemical composition

Not relevant for this survey.

2.8.3.3 Contaminants

Not relevant for this survey.

2.9 Vulnerable marine ecosystems

Not relevant for this survey.

2.10 Top predators

Not relevant for this survey.

2.11 Food safety

Specimens were collected for the analysis of nutrient profiles, contaminants and microplastics. The whole fish was stored in plastic bags marked with species, station and date, according to the Sailing Order. Samples were collected at different geographical coordinates. The frozen samples were analysed at IMR in Bergen, Norway.

2.12 Additional sampling

Not relevant for this survey.

3. RESULTS

3.1 Meteorology

3.1.1 Wind

Wind speed and direction are key for upwelling and downwelling processes and these processes drive ocean productivity. In the United Republic of Tanzania the wind patterns off the coast have been investigated by, among others, Mahongo, Francis and Osima (2011). The northeast monsoons typically last from November to March, while the southeast monsoon is from April to October. Stronger winds are typically experienced in the south (Mtwara) while a relaxation of the winds can be observed off Dar es Salaam.

During the survey the wind was generally from the southeast and the wind speed typically varied between 5 m/s to 13 m/s (Figure 7). Generally, the strongest winds were experienced offshore northeast of Mafia Island and east of the Republic of Tanzania, Zanzibar and Pemba Island. Typically, weaker winds were found closer to the coast on the western sides of the islands.

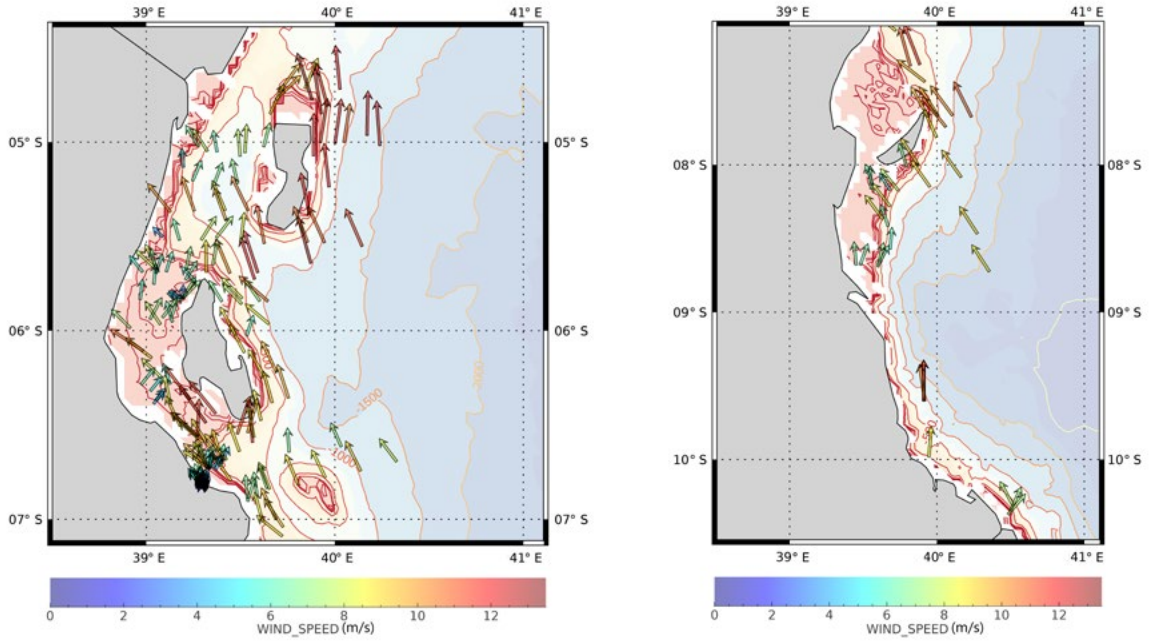

Figure 7. Wind speed and direction observations along the coast of the United Republic of Tanzania

3.2 Oceanography

Oceanographic results are presented for ocean currents, sea surface measurements and CTD deployments along the coast of the United Republic of Tanzania. Hydrographic conditions were monitored during the southeast monsoon season which spans the period May to September. The southeast monsoon influences the climate and has a marked effect on air and seawater temperature, wind and rainfall. The EACC is the dominant oceanographic influence along the Tanzanian coastline during the southeast monsoon.

3.2.1 Underway hydrographic sampling

3.2.1.1 Ocean currents

Ocean currents play an integral part in ocean circulation as well as distributing nutrients and heat to different parts of the ocean and creating retention zones which are favourable habitats for marine life. Currents that encounter coastal and island continental shelves also cause perturbation and hence create localized upwelling which makes an area productive. One of the most prominent features in

the coastal ecosystem off the United Republic of Tanzania is the strong northward-directed surface current, the EACC extending to a depth of 120 m to 150 m (Figure 8). The plot shows current speed and direction recorded from the 75 kHz ADCP. In the south (Mtwara region) a weak current was observed inside of the EACC deflecting towards the coast (0 cm/s to 20 cm/s). Further north a possible gyre was created inside of Mafia Island while water masses passed each side of the United Republic of Tanzania, Zanzibar. South of Pemba Island, the EACC split in two on each side of the island. Immediately off Pemba Island, the current speed was very high, possibly as much as 230 cm/s as measured from the vessel's ADCP log (surface). However, the maximum current speed recorded by the ADCP was 120 cm/s (24 m to 40 m depth) outside Mafia Island and Pemba Island.

Low-speed currents between 20 cm/s and 40 cm/s were mainly found along the coast of the United Republic of Tanzania and within the Mafia and Zanzibar channels. The low-speed currents within these channels were caused by disturbances created when high-speed currents interact with the continental shelves of the islands. The low-speed currents within the Mafia and Zanzibar channels showed signs of localized upwelling, which increases productivity in these areas.

The surface current velocities at 24 m to 40 m depths were overlaid with the sea surface height (SSH) to check whether there were eddies within the territorial waters (Figure 8).

The current's speed decreased with increasing depths due to friction as it approached the sea floor. This is observed in figures 9, 10 and 11. The current was otherwise quite consistent northward in all depth layers observed, but with a tendency to reverse direction in a southward direction in the deeper layers of the channel west of Pemba Island (Figure 11), creating a circular water current in deeper layers in this deep channel.

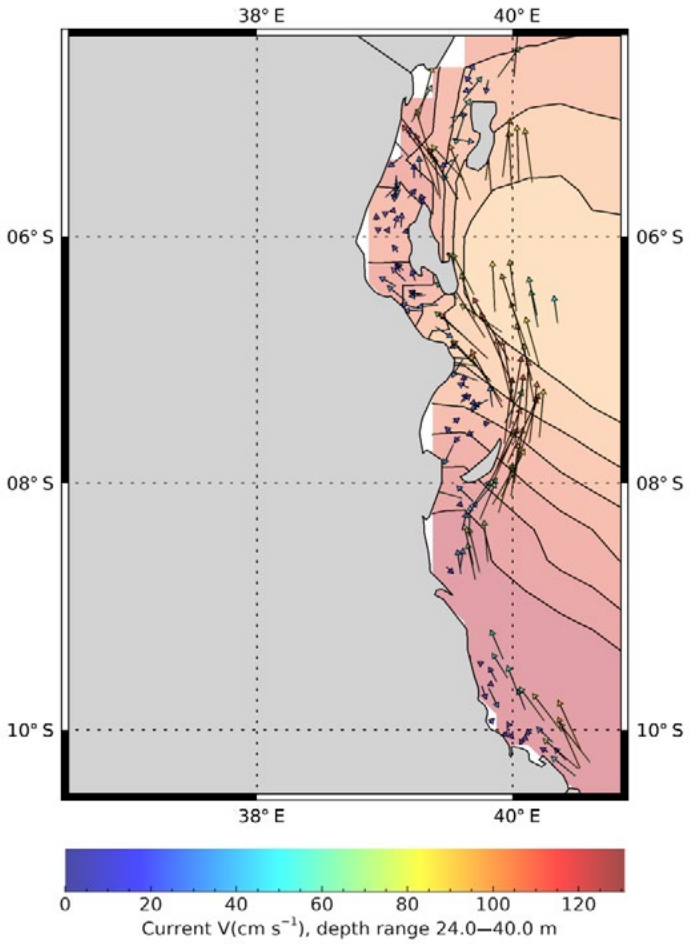

Figure 8. Horizontal ocean currents between 26 m and 40 m in the Tanzanian territorial waters

Notes: Recorded with the 75 kHz ADCP and overlaid with SSH.

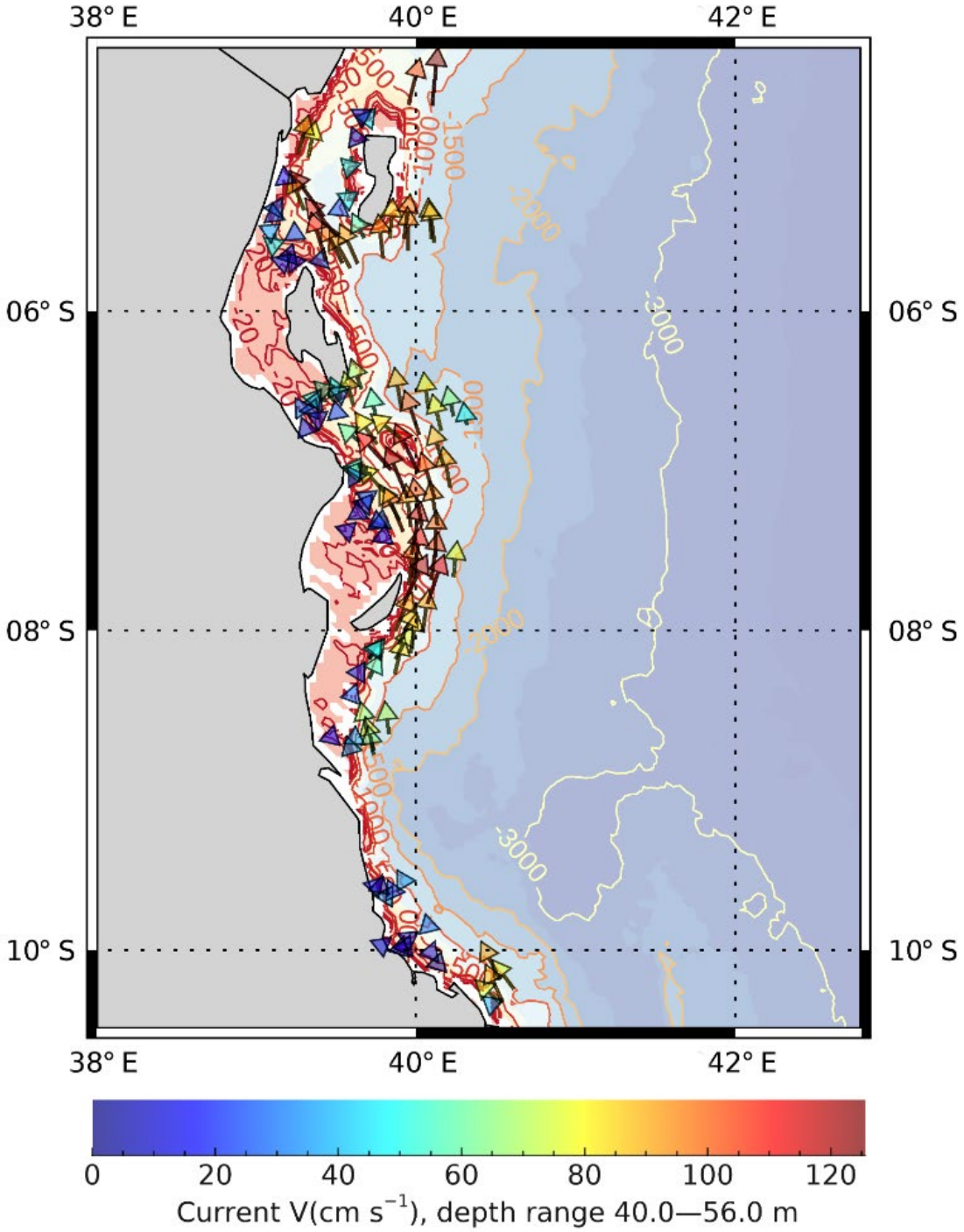

Figure 9. Horizontal ocean currents between 40 m and 56 m in the Tanzanian territorial waters

Notes: Recorded with the 75 kHz ADCP.

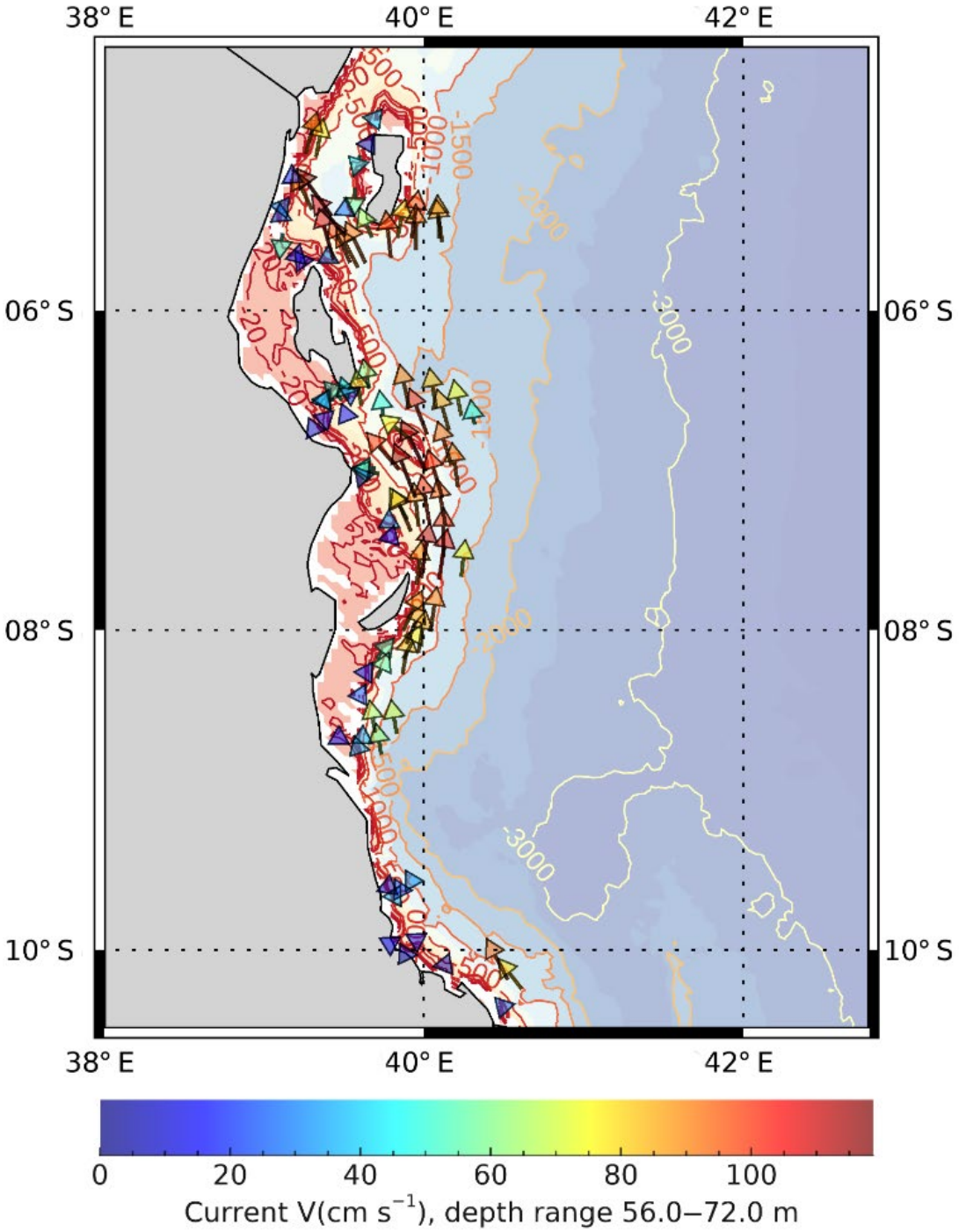

Figure 10. Horizontal ocean currents between 56 m and 72 m in the Tanzanian territorial waters

Notes: Recorded with the 75 kHz ADCP.

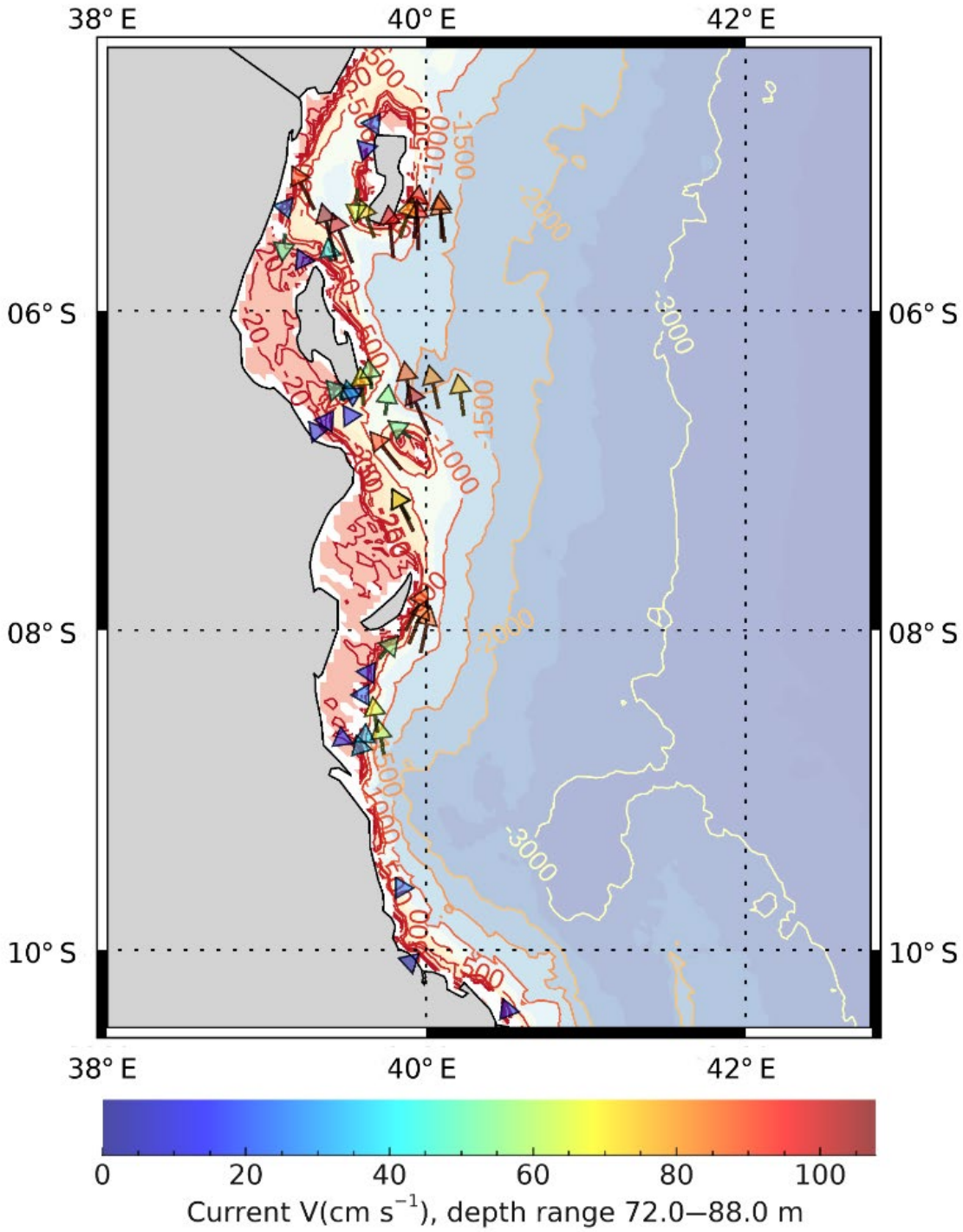

Figure 11. Horizontal ocean currents between 73 m and 88 m in the Tanzanian territorial waters

Notes: Recorded with the 75 kHz ADCP.

3.2.1.2 Sea surface temperature, salinity and fluorescence

The near surface waters of 6 m depth within Tanzanian waters indicated different levels of temperature, salinity and fluorescence (Figure 12) recorded by the TSG from the southern part of the United Republic of Tanzania to north of Pemba Island. In the southern part of the United Republic of Tanzania, the region from 10°5' south to 10° south showed a gradient of increasing temperature and salinity from the coast towards the deep-sea, while low salinities were observed off the southern coast near the mouth of the Ruvuma River. The low salinities in this area may have been influenced by the freshwater discharge from the river.

Well mixed waters were observed between 8° south and 5°5˙ south inside and outside the Mafia Channel all the way to the southern part of the Pemba Channel. Within the Pemba Channel there was a mix of waters, but low temperatures and salinities dominated in the northwestern side of Pemba Island, probably caused by localized upwelling, which is key for ocean productivity. Relatively high fluorescence values were observed south of the Zanzibar Channel between 7° south and 6°5' south, while medium fluorescence values were observed between 8°5' south and 7° south, which covered the southern and northern parts of the Mafia Channel. The areas with relatively high fluorescence values are considered potential fishing zones.

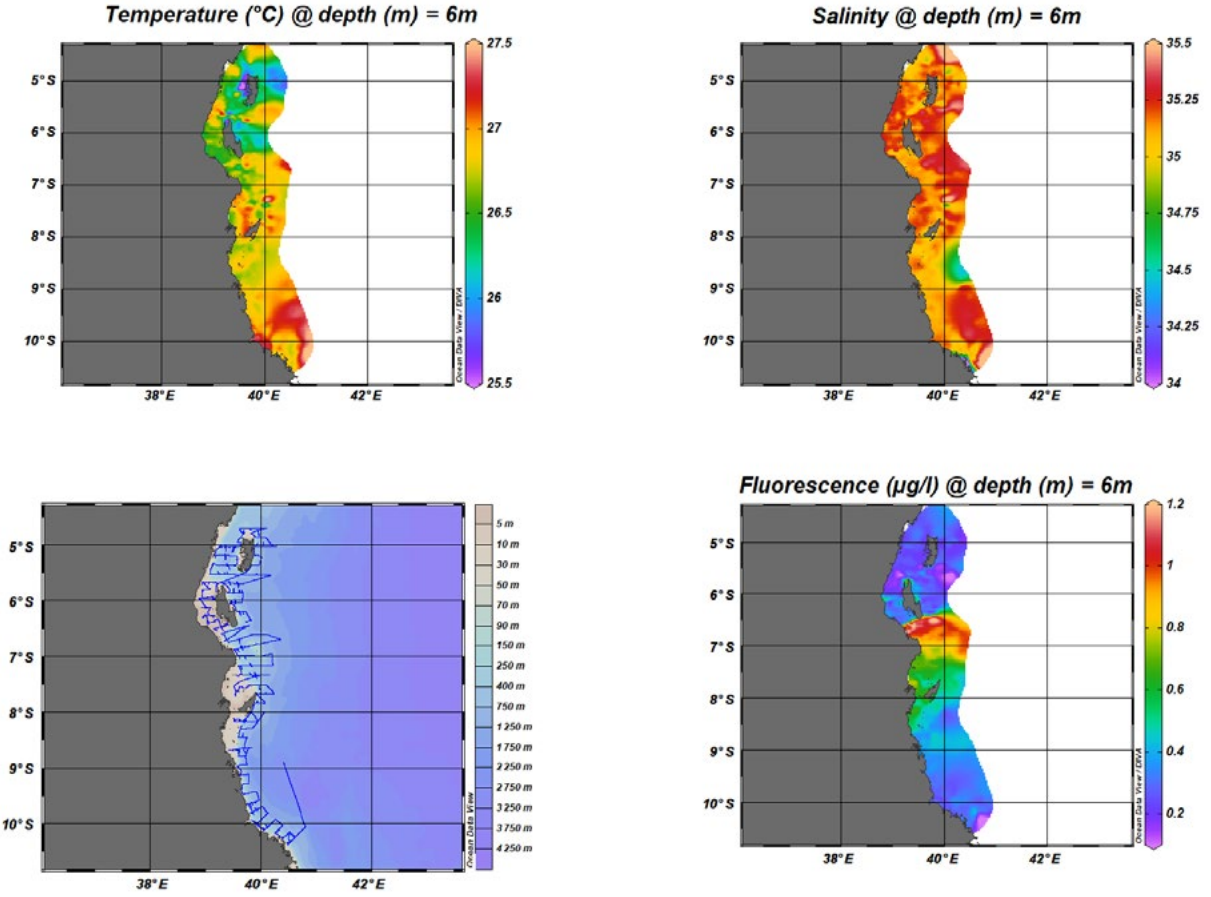

Figure 12. Temperature, salinity and fluorescence observations from the 6 m intake thermosalinograph along the Tanzanian coast

3.2.1.3 Partial pressure of carbon dioxide

pCO_2 measurements were not conducted during this survey.

3.2.2 Fixed hydrographic sampling

A total of 111 CTD deployments were performed during the environmental transects and on each trawl station during the ecosystem survey of the United Republic of Tanzania (Figure 4). The characterization of the water masses is presented in Figure 13. During this study four major water masses were identified along the Tanzanian coast:

- Southern Indian Central Water (SICW) – temperature 8 ˚C to 25 ˚C, salinity 34.6 PSU to 35.8 PSU);
- Tropical surface water – temperature 22 ˚C to 30 ˚C, salinity 34 PSU to 35.4 PSU);
- Red Sea–Persian Gulf Intermediate Water (RSPGIW) – temperature 5 ˚C to 14 ˚C, salinity 34.8 PSU to 35.4 PSU; and
- Antarctic Intermediate Water – temperature 2 ˚C to 10 ˚C, salinity 33.8 PSU to 34.8 PSU.

The indicative temperatures and salinities for each water mass are based on summaries by Emery (2001). Two other water masses (not shown) were possibly observed:

- the Indonesian Upper Water (IUW) – temperature 8 °C to 23 °C, salinity 34.4 PSU to 35 PSU; and
- the Indian Equatorial Water (IEW) – temperature 8 °C to 23 °C, salinity 34.6 PSU to 35 PSU.

Here too the indicative temperatures and salinities for each water mass are based on summaries by Emery (2001). Figure 13 also provides typical oxygen ranges for the observed water masses. Previous publications have not reported corresponding summaries of the typical oxygen for these same water masses, specifically for the EACC ecoregion (Painter, 2020). Water properties from the IIW and the RSPGIW masses are characterized by cool and oxygen-poor water.

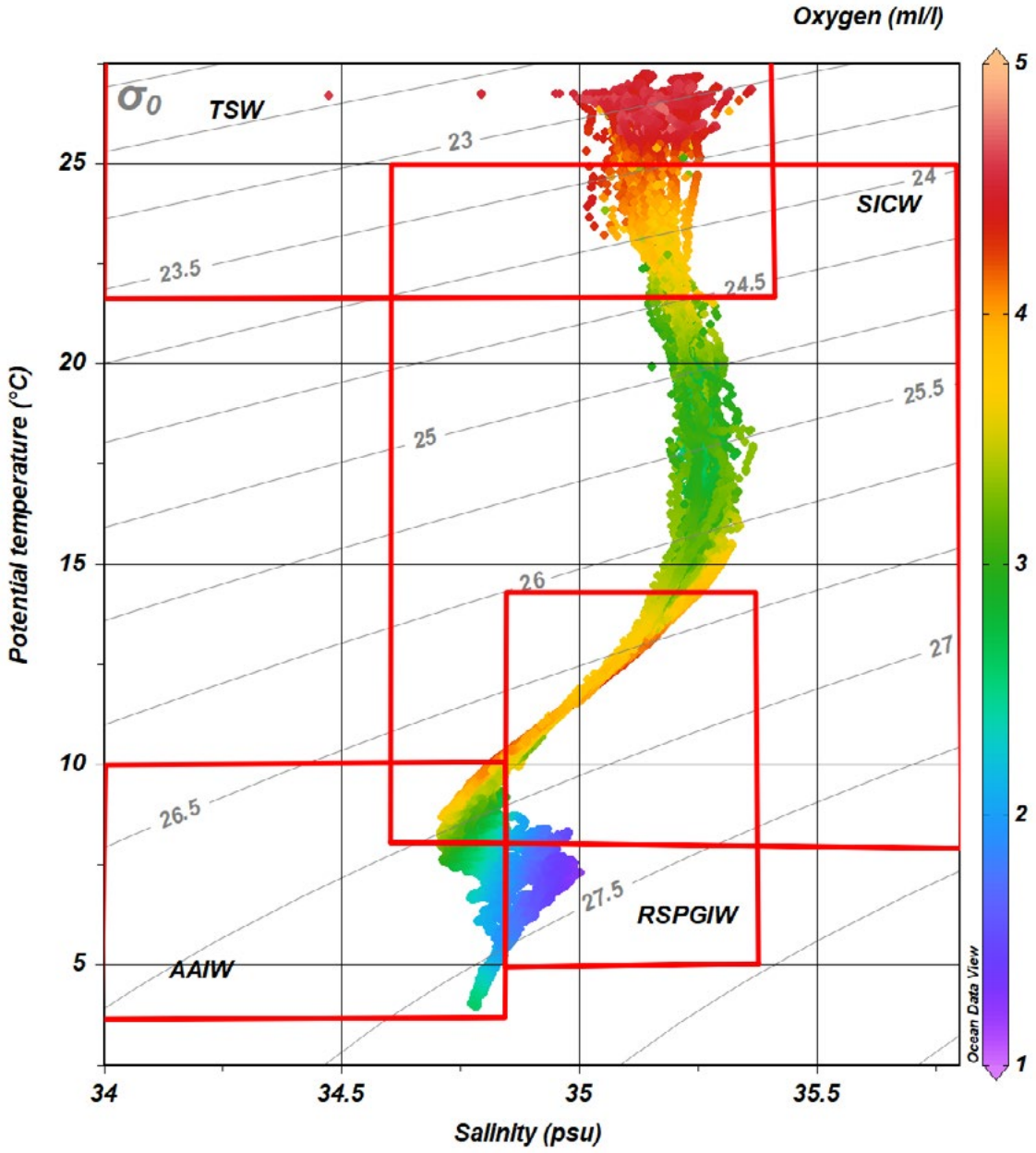

Figure 13. Temperature–salinity plot from CTD data from the hydrographic stations

Notes: Conventional limits of core water masses are indicated by the red boxes and represent the SICW, IUW, RSPGIW, IEW and IIW.

Table 4. Overview of conductivity, temperature and depth deployments and samples collected for chemical oceanography along the Tanzanian coast

CTD	CTD water	pH	Total alkalinity	Nutrients	Chlorophyll *a*	Dissolved oxygen	Salinity
111	31	0	0	496	347	496	465

3.2.2.1 Conductivity, temperature and depth sensors

Oceanographic results, including temperature, salinity, dissolved oxygen and fluorescence measured from the CTD sensor data, are presented here. Figures 14 to 24 show the vertical distribution of temperature, salinity, oxygen and fluorescence as recorded from the two southern hydrographic transects 1 and 2, respectively.

The temperature section shows a warm upper layer (0 m to 100 m) with sea surface temperature (SST) exceeding 25 ˚C extending from the coast to offshore waters across transects 1 and 2. This warm surface layer declined with increasing depth, indicating a thermocline at approximately 300 m depth at both transects. Cold waters with temperatures less than 10 ˚C were found between 500 m and 1 000 m depth. The upper water column at the southernmost Transect 1 at ~ 10°5' south (Figure 14) and Transect 2 at ~ 9°8'5" south (Figure 15) was well oxygenated, with dissolved oxygen concentrations ranging from 3.5 ml/l to 4.5 ml/l.

In the intermediate water (100 m to 300 m), dissolved oxygen concentrations were generally lower, between 3 ml/l and 3.5 ml/l. The lowest levels of dissolved oxygen concentrations, ranging from 1.5 ml/l to 2.5 ml/l, were observed in deeper waters between 800 m and 1 000 m. The vertical distribution of fluorescence data indicates that there were relatively low concentrations of fluorescence in the upper water column (0 m to 100 m). The highest fluorescence of 0.8 µg/l was measured at the southernmost transect.

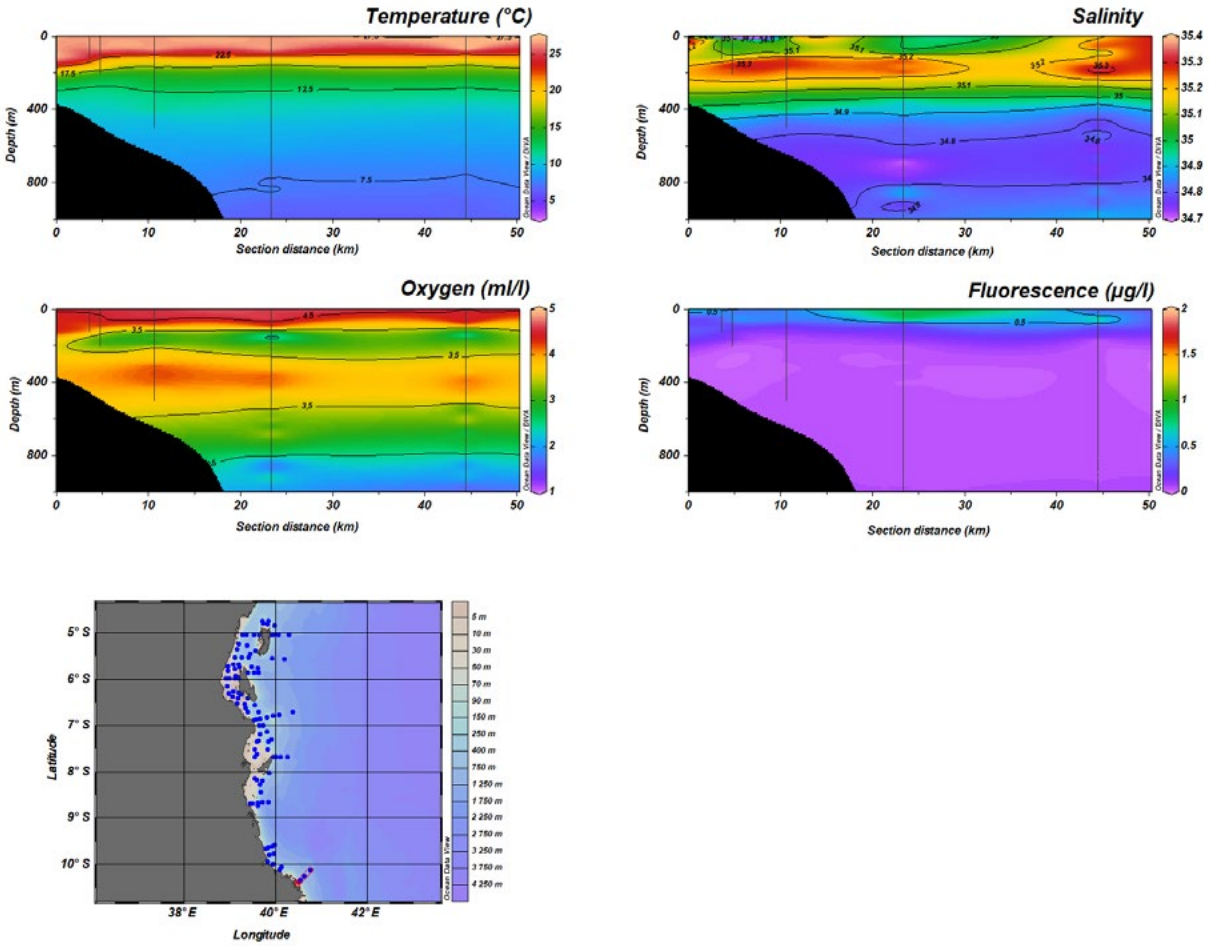

Figure 14. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 1 (southern region, 10°5' south)

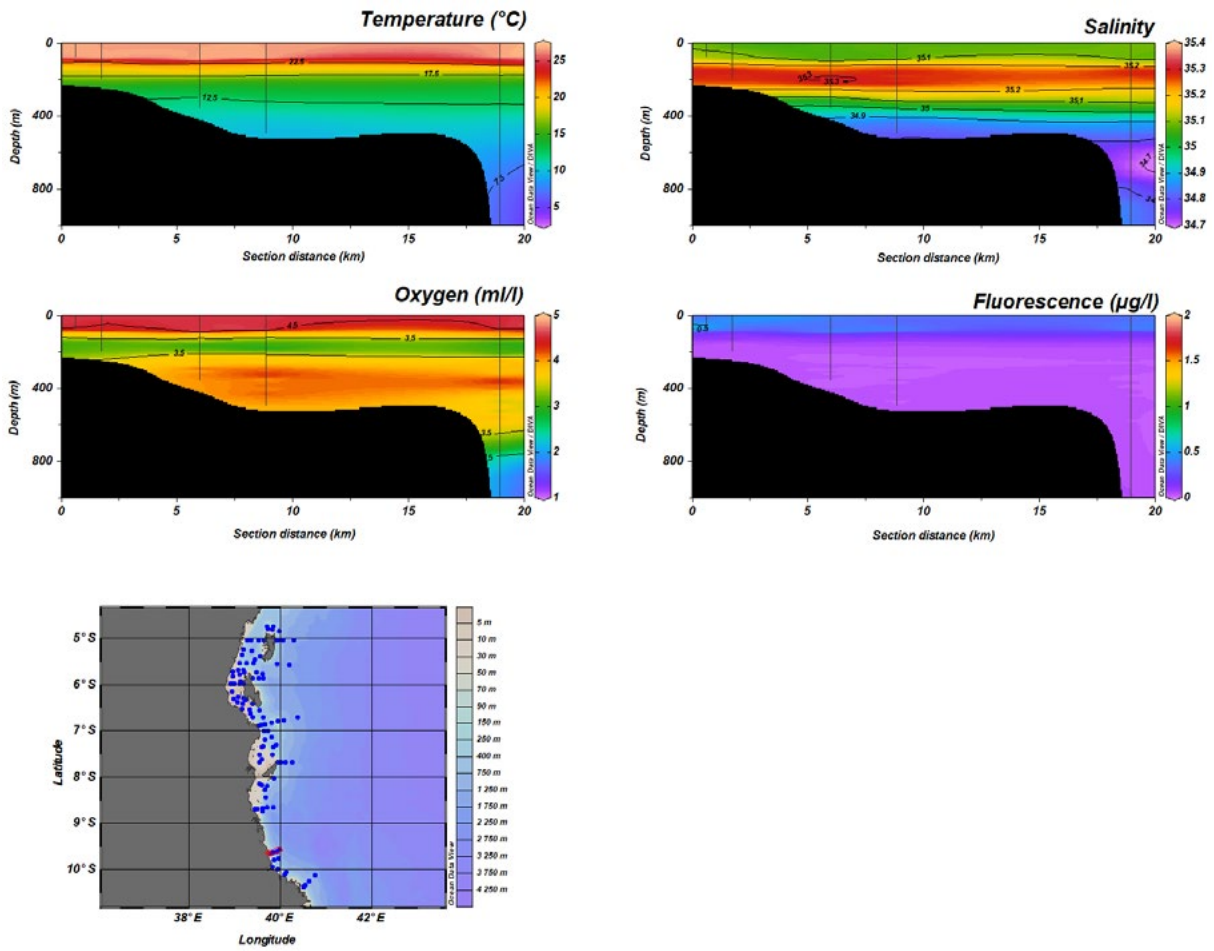

Figure 15. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 2 (9°8' south)

SST along Transect 3 (Figure 16) followed the same trend as the southern transects with temperatures exceeding 25 °C, extending to almost 200 m depth at the coast. Salinity of 35.1 PSU covered the upper layer (0 m to 100 m) from the coast to offshore waters, with a patch of higher salinity (35.3 PSU) within the 200 m zone. Dissolved oxygen concentrations ranged from 3.5 ml/l to 4.5 ml/l throughout the water column to a depth of 800 m. The innermost stations had the highest dissolved oxygen concentration at 4.5 ml/l within the upper 200 m layer. This dissolved oxygen layer decreased slightly offshore. The maximum fluorescence recorded was 0.6 µg/l at the stations closest to the coast. This fluorescence layer extended down the water column to above 200 m.

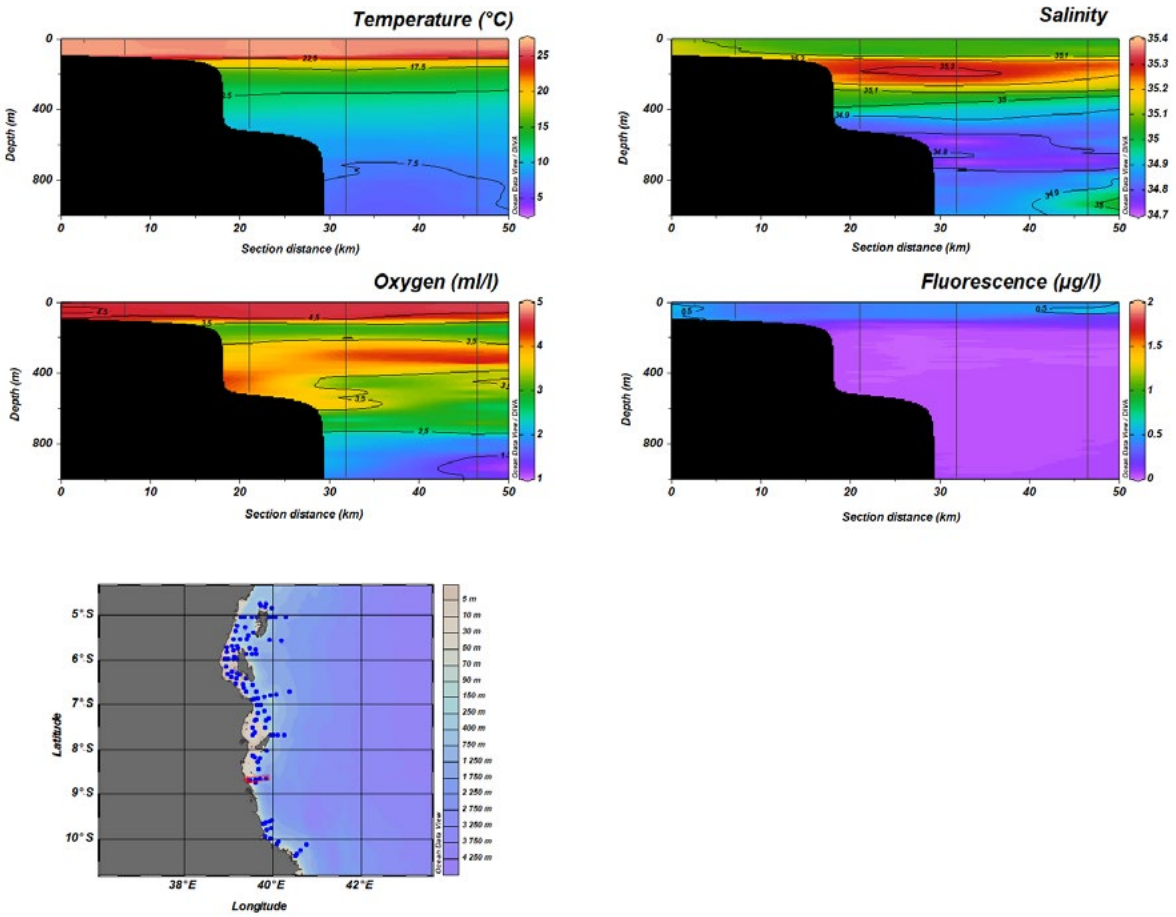

Figure 16. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 3 (8°8' south)

Transect 4, situated on the northern edge of Mafia Island (~ 7°8' south) showed a SST of > 25 °C decreasing down the water column and displaying once again a deep thermocline at about 300 m (Figure 17). The highest salinity values of between 35.2 PSU and 35.3 PSU were recorded offshore (0 m to 300 m). At the coast close to Mafia Island, slightly lower salinity (35.2 PSU) was recorded. The salinity values were lowest (34.7 PSU to 34.9 PSU) between 500 m and 800 m. In the upper mixed layer (0 m to 100 m) the dissolved oxygen concentration was between 3.5 ml/l and 4.5 ml/l with lower oxygen concentrations only seen well below 600 m. The vertical distribution of fluorescence data indicates low concentrations of fluorescence between 0.4 µg/l and 0.5 µg/l in the surface waters (0 m to 100 m).

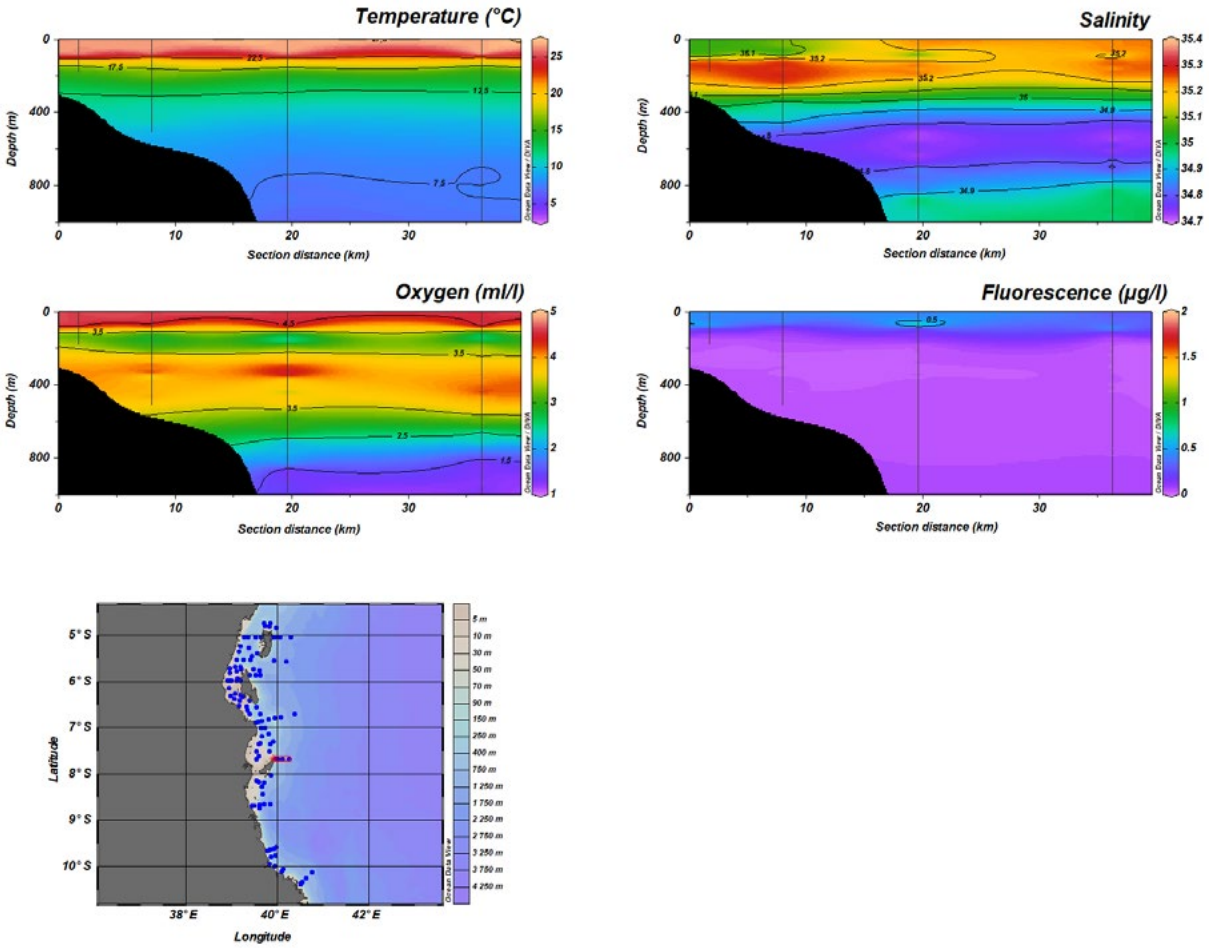

Figure 17. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 4 (7°8' south).

Figure 18 shows hydrographic profiles as recorded at Transect 5 (between 7° south and 8° south) within the Mafia Channel, which is situated near the mouth of the Rufiji River. In this area the continental shelf is substantially wider than the typically narrow Tanzanian coast. Transect 5 exhibits a SST of > 25 °C down to around 100 m from the coast to the offshore waters. Salinity levels of 35.2 PSU were recorded in the surface layer, with a pocket of slightly higher salinity of 35.3 PSU between 100 m and 200 m. A gradual decrease of salinity is observed down the water column.

The variation in salinity can be attributed to the mixing of the four main water masses that are present in Tanzanian waters, described in Figure 13. A high gradient of dissolved oxygen was observed at this transect as dissolved oxygen concentrations decreased from 4.5 ml/l in the upper 100 m layer to 4 ml/l down the rest of the water column.

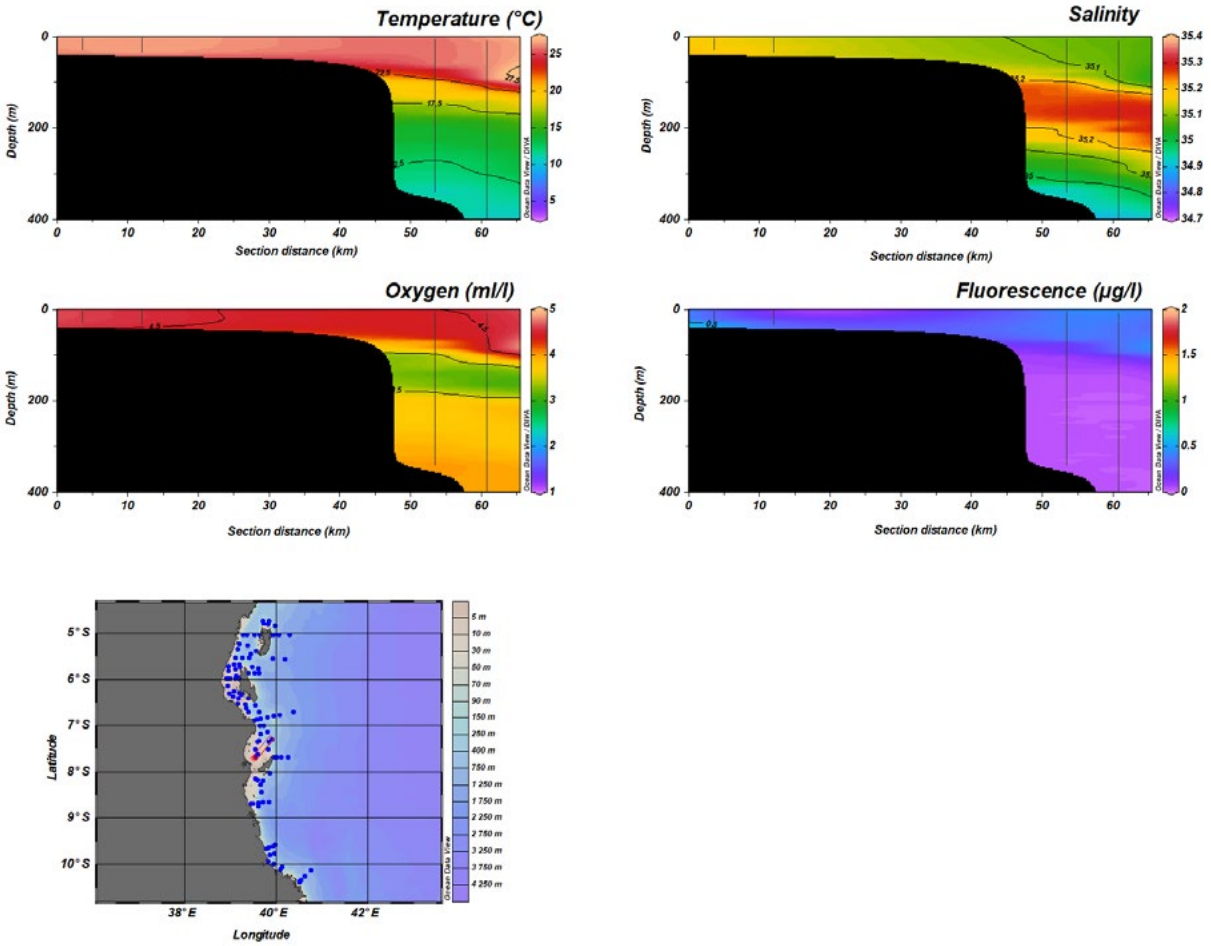

Figure 18. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 5 (Mafia Channel, 7°8' south)

Figure 19 presents the vertical cross-sections south of the Zanzibar Channel (Transect 6). Surface temperature surpassed 25 °C from the coast to offshore waters. A deeper thermocline was evident close to 400 m. Salinity varied from 35.2 PSU to 35.3 PSU in the upper 200 m layer, showing mixing of the surface and subsurface layer. Dissolved oxygen reached a maximum of 4.5 ml/l in the 0 m to 100 m layer and decreased down the water column with a minimum of 1.5 ml/l at approximately 1 000 m. As in the previous transects, fluorescence remained low with a maximum of 0.6 µg/l recorded in the upper 100 m layer at the coast and decreasing to 0.4 µg/l at stations further offshore.

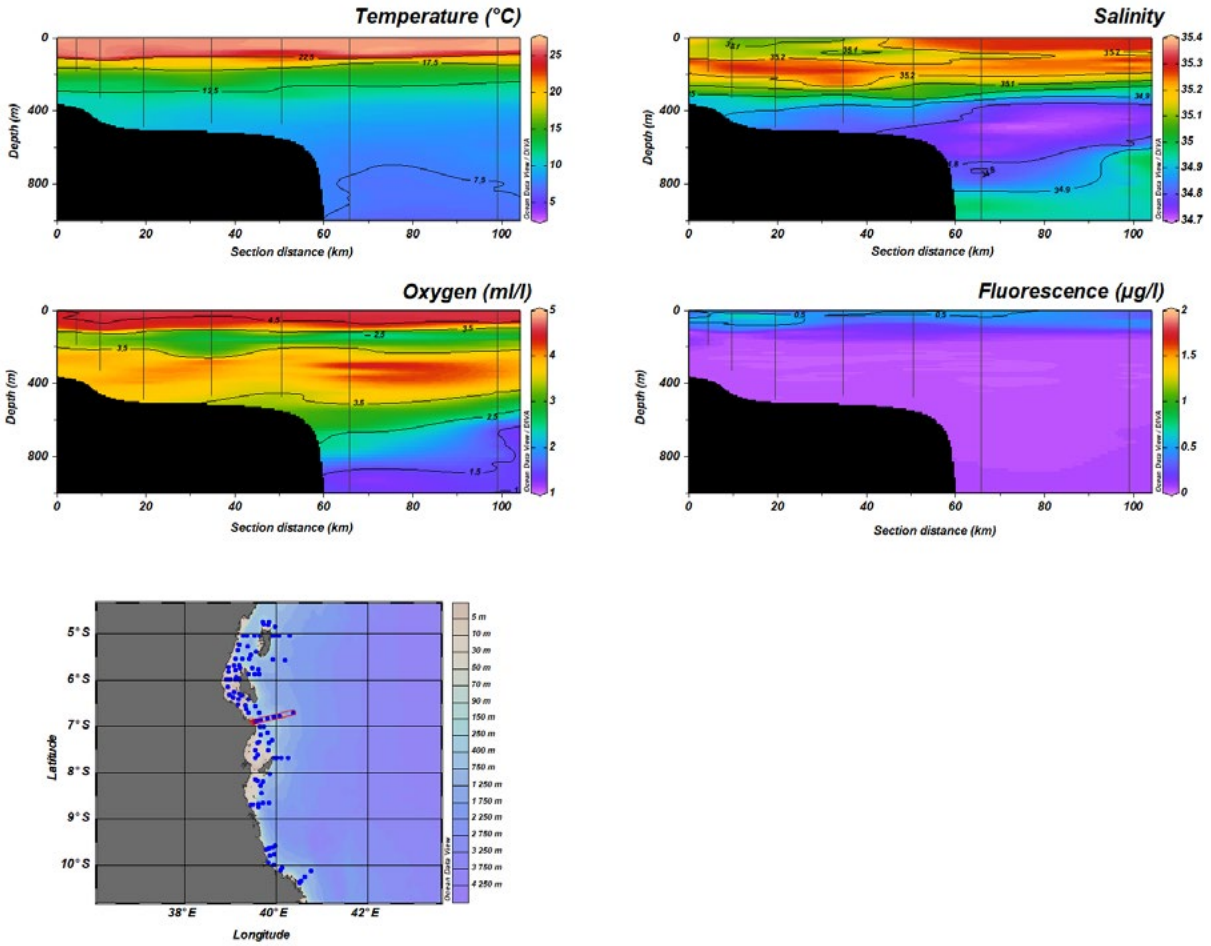

Figure 19. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 6 (south of Zanzibar Channel, 6°8' south).

The shallow waters of the Zanzibar Channel presented uniform temperatures exceeding 25 °C from the Tanzanian coast to the coast of The United Republic of Tanzania, Zanzibar (Figure 20). The 50 m layer of the water column was well mixed, with salinity reaching 35.2 PSU and a maximum dissolved oxygen of 4.5 ml/l. A patch of maximum fluorescence at 0.8 µg/l was recorded near a depth of 50 m.

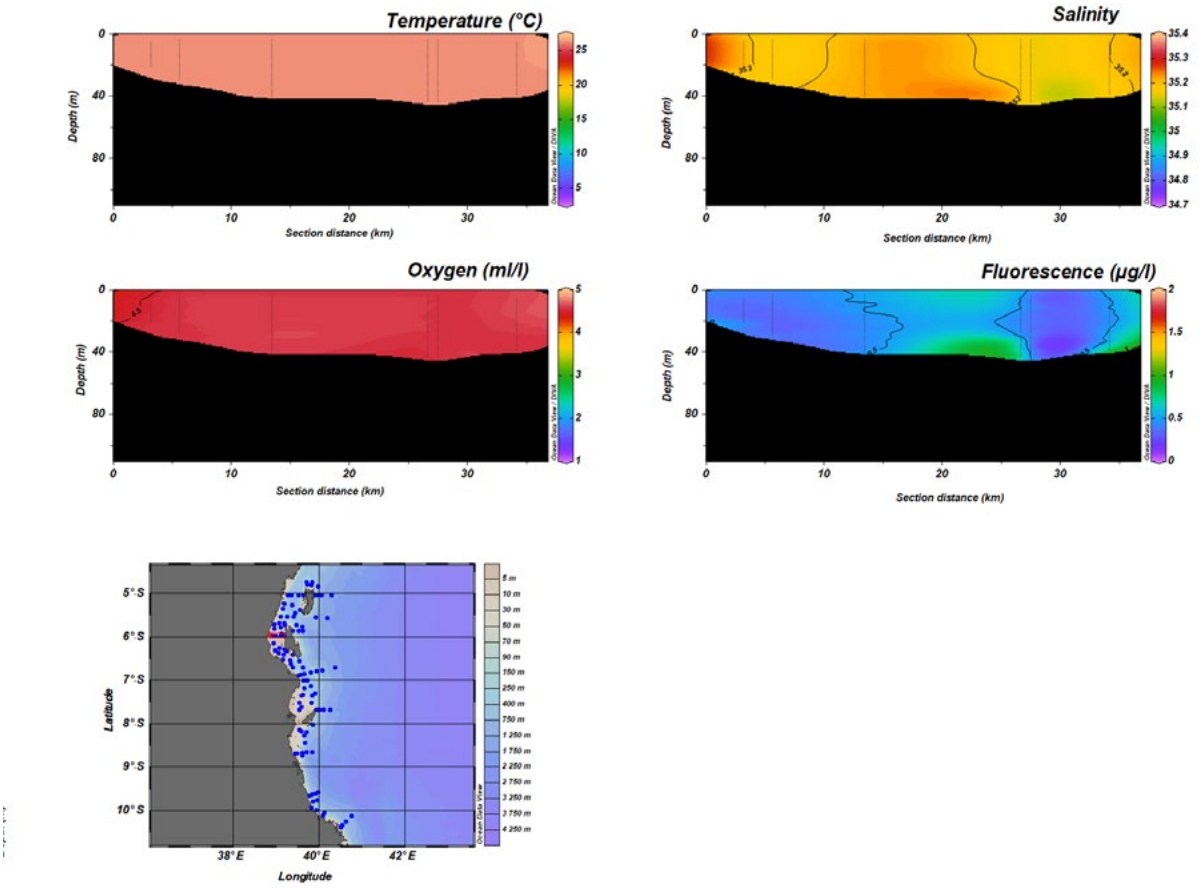

Figure 20. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 7 (Zanzibar Channel, 6° south)

Figure 21 shows a mixed layer between 0 m and 200 m at Transect 8 with temperature ranging from 22.5 °C to 25.5 °C. Water mixing is further evident in the salinity which ranged from 35.2 PSU to 35.3 PSU between 0 m and 300 m. The highest salinity was recorded at the offshore stations of the transect, with the intrusion of lower salinity water below 400 m. Dissolved oxygen varied between 3.5 ml/l and 4.5 ml/l in the upper 200 m layer from the coastal stations to the offshore stations. Minimum dissolved oxygen levels between 1.5 ml/l and 2 ml/l were recorded below 600 m.

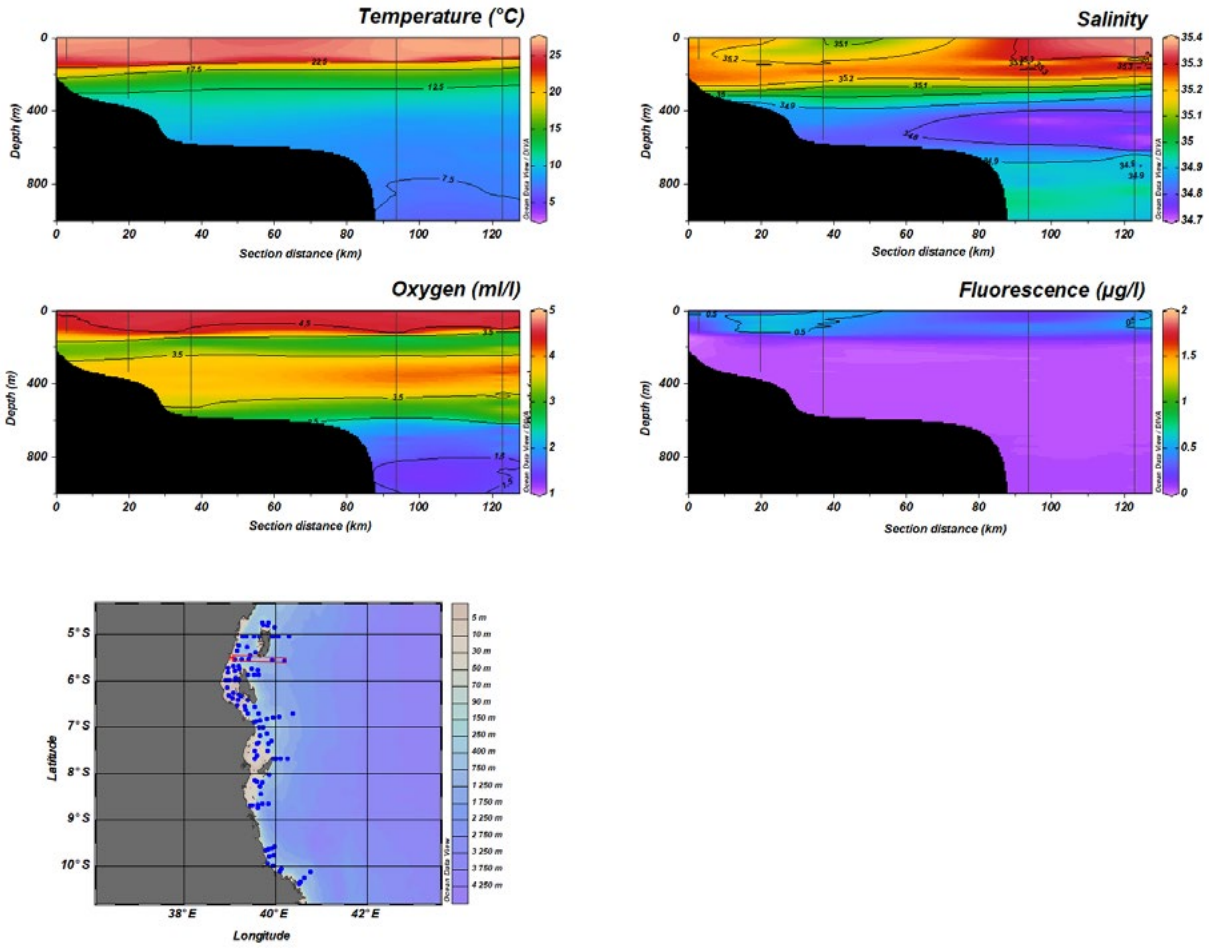

Figure 21. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by CTD deployments at Transect 8 (south of Pemba Island, 5°5' south)

Figure 22 shows a mixed layer from 0 m to 200 m at Transect 9 with temperatures ranging from 22.5 °C to 25.5 °C. The thermocline was found at ~ 200 m depth. The highest salinity values of about 35.2 PSU to 35.3 PSU were found between 150 m and 200 m depth. The surface layers (0 m to 150 m) and intermediate depths (200 m to 300 m) exhibited salinity levels of between 35.1 PSU and 35.2 PSU, an indication of localized upwelling. Dissolved oxygen varied between 4 ml/l and 5.0 ml/l in the upper 200 m layer from the coastal stations, with declining trends towards Pemba Island. Minimum dissolved oxygen levels of 2.5 ml/l to 1 ml/l were recorded below 650 m. The highest fluorescence values were found in the upper 200 m, with the highest concentration observed from the Tanzanian coast, declining towards Pemba Island.

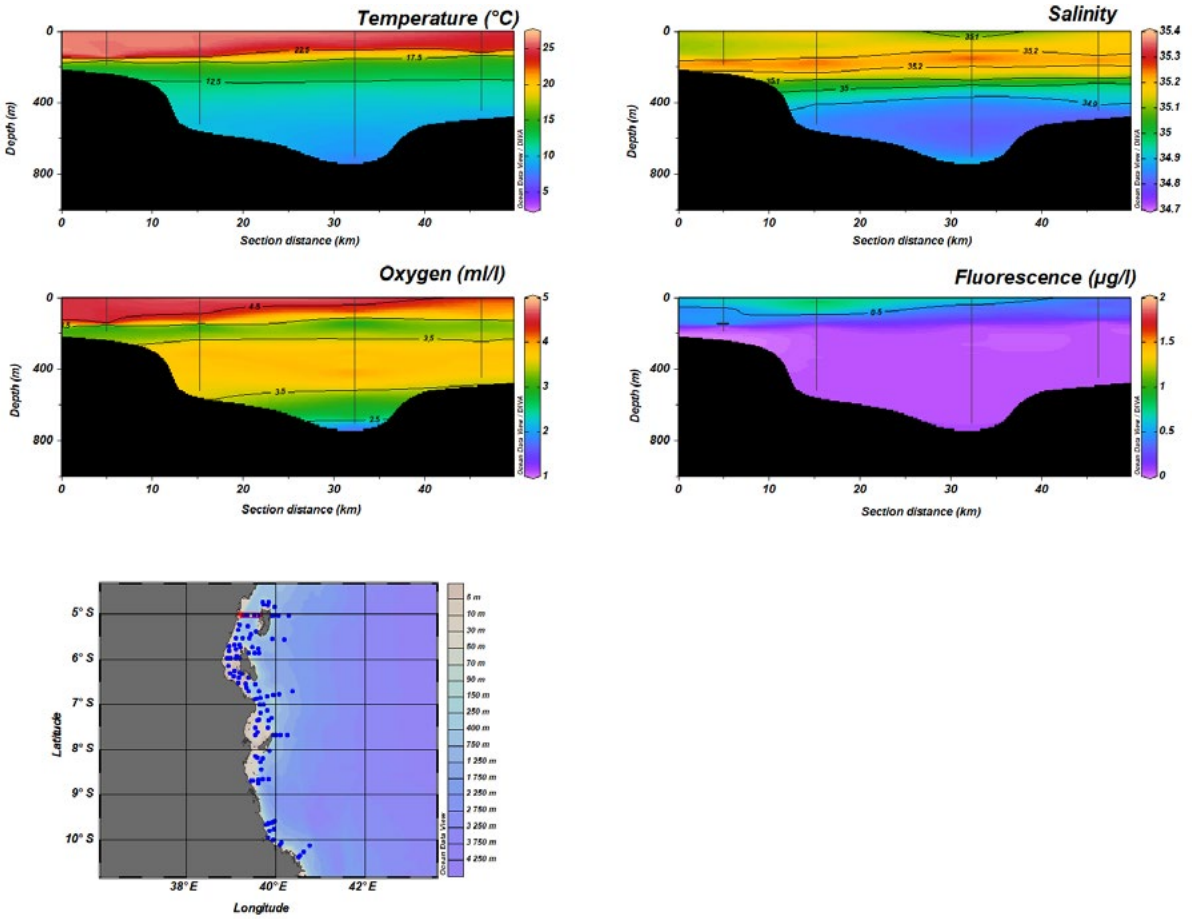

Figure 22. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 9 (south of Pemba Island, 5° south).

Figure 23 shows a mixed layer from 0 m to 100 m at Transect 10 with temperatures ranging from 22.5 °C to 25.5 °C. The thermocline was lifted somewhat compared with the previous section and was found at ~ 100 m depth. Water mixing was evident in the salinity which ranged from 35.2 PSU to 35.4 PSU between 0 m and 200 m. The highest salinity values, ranging from 35.3 PSU to 35.4 PSU, were found between 100 m and 200 m depth. Dissolved oxygen varied between 4 ml/l and 5 ml/l in the upper 100 m. Minimum dissolved oxygen levels of 2 ml/l to 1 ml/l were recorded below 800 m. The highest fluorescence values were found in the upper 100 m.

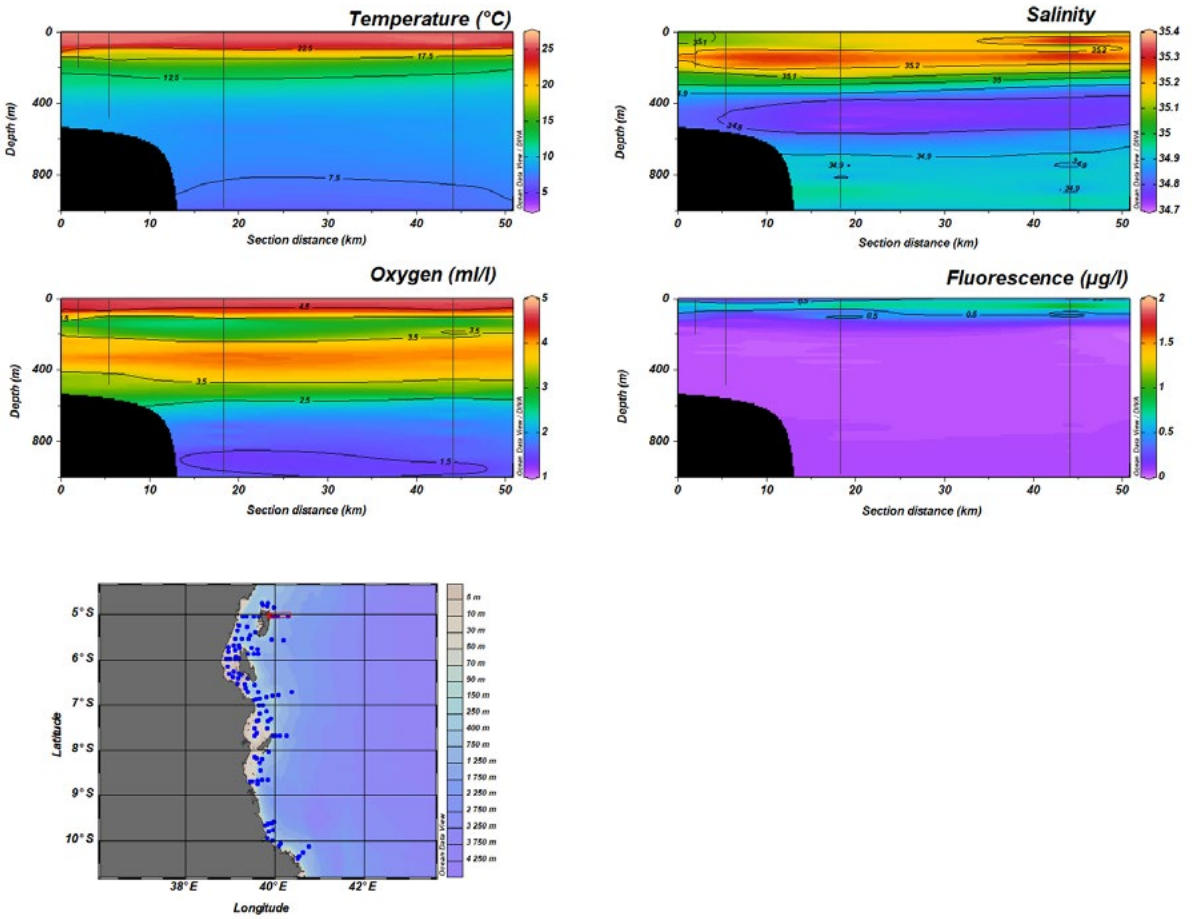

Figure 23. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 10 (north of Pemba Island, 5° south)

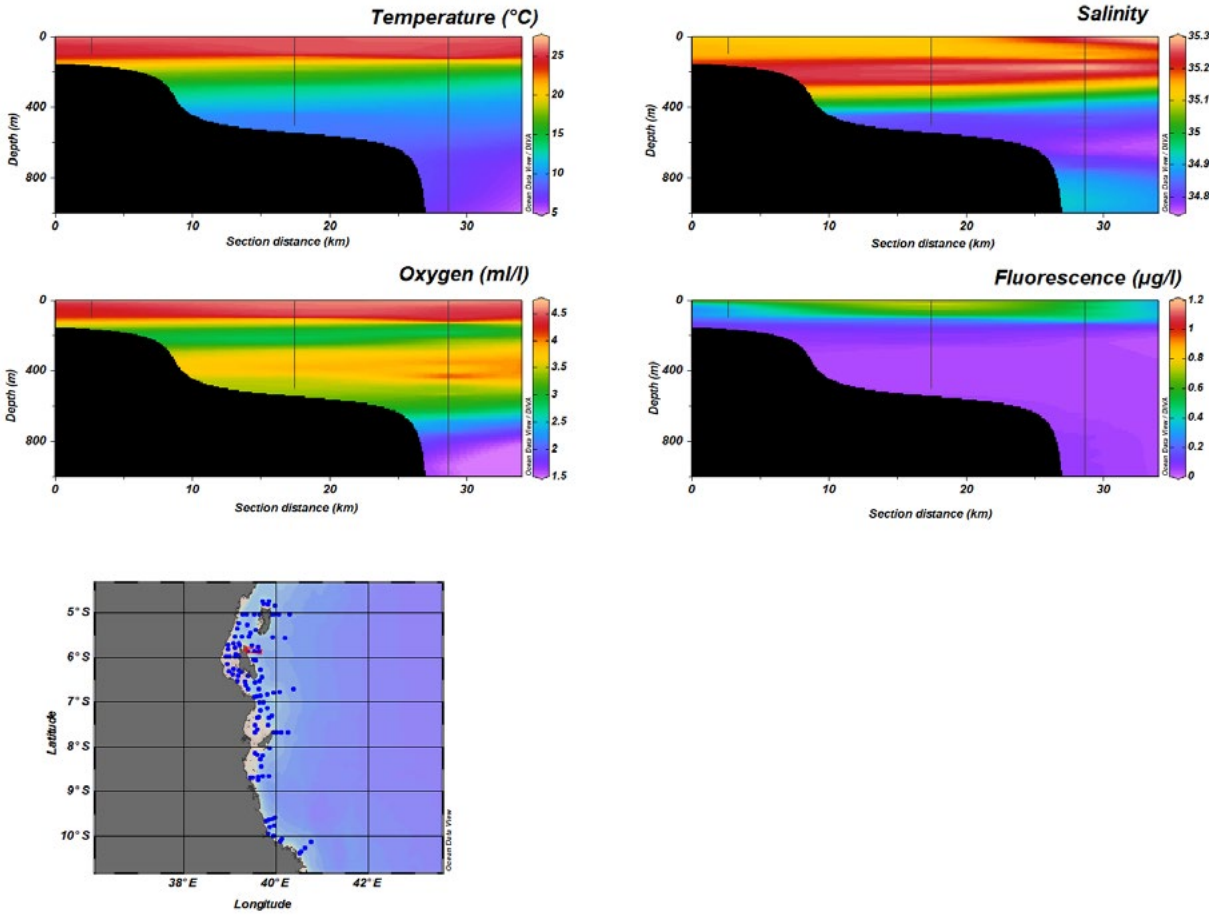

Figure 24. A vertical cross-section of temperature, salinity, dissolved oxygen and fluorescence recorded by conductivity, temperature and depth sensors at Transect 11 (north of Unguja Island, 6° south).

3.2.2.2 Ocean acidification

Samples for pH and total alkalinity were not collected during this survey.

3.3 Plankton

A total of 118 plankton sampling activities were conducted during the survey, together with the collection of water samples from the Niskin bottles at selected stations. A summary of the type of activities, number of samples collected and analysed during the survey is presented in Table 5.

Table 5. Number of samples, sorted taxa and microplastics collected with different plankton gears (phytoplankton net, WP2, Bongo, Manta and Niskin)

	Phytoplankton net	Niskin phytoplankton	WP2	Bongo	Manta	Total
Nets deployed	24	-	29	29	26	108
Total samples collected	24	62	29	58	26	199
Total samples sorted	-	-	-	29	26	55
Aluminum trays dry Biomass	-	-	75	-	-	75
Fish larvae sorted	-	-	-	4 664	316	4 980
Eggs sorted	-	-	-	not sorted	not sorted	0
Microplastics sorted	-	-	-	-	10	10
FlowCam samples analysed	-	-	27	-	-	27

3.3.1 Phytoplankton

A total of 86 samples for phytoplankton analysis were collected at all stations of the environmental transects. From these samples, 34 were collected with a phytoplankton net to analyse the composition of the plankton community from the upper 30 m. In stations 537, 538, 539, 557, 600, 607 and 609 it was not possible to deploy the net because of strong currents.

The remainder of the samples were collected with Niskin bottles, 31 of them from the maximum fluorescence depth and another 31 from the depth strata 0 m to 100 m to allow for integration over the entire water column. In stations where the bottom depth was less than 100 m, the number and depth locations of the samples was modified accordingly. Samples collected with Niskin bottles were used to estimate the abundance of phytoplankton. All the samples were transferred to TAFIRI where they were analysed.

3.3.2 Zooplankton

A total of 29 WP2 nets were deployed during the survey. On four occasions (at stations 537, 538, 539 and 557) the net was not deployed because of strong sea currents. The WP2 samples were transferred to ZAFIRI for further taxonomic analysis.

From these samples, a total of 75 biomass trays were produced (half the sample) to estimate zooplankton dry weight. These samples will be analysed at IMR in Bergen, Norway.

3.3.3 Ichthyoplankton

A total of 29 Bongo nets and 26 Manta trawls were deployed during the survey. From the Bongo V samples collected, a total of 4 664 fish larvae were isolated and identified, where possible. From the Manta trawl, a total of 316 fish larvae were isolated. The bulk samples and sorted samples were transferred to ZAFIRI for further taxonomic analysis of fish larvae. The Bongo H samples collected for genetic analysis were also sent to ZAFIRI.

The fish larvae were not equally distributed in the survey area. Figure 25 shows some preliminary results of larvae density per station (numbers/m^3). The highest concentrations were found west of Unguja Island and they were generally higher inshore and in the northern part of the survey area. There was also a general increase in diversity of larvae and an increase in anchovy eggs and larvae in the same area.

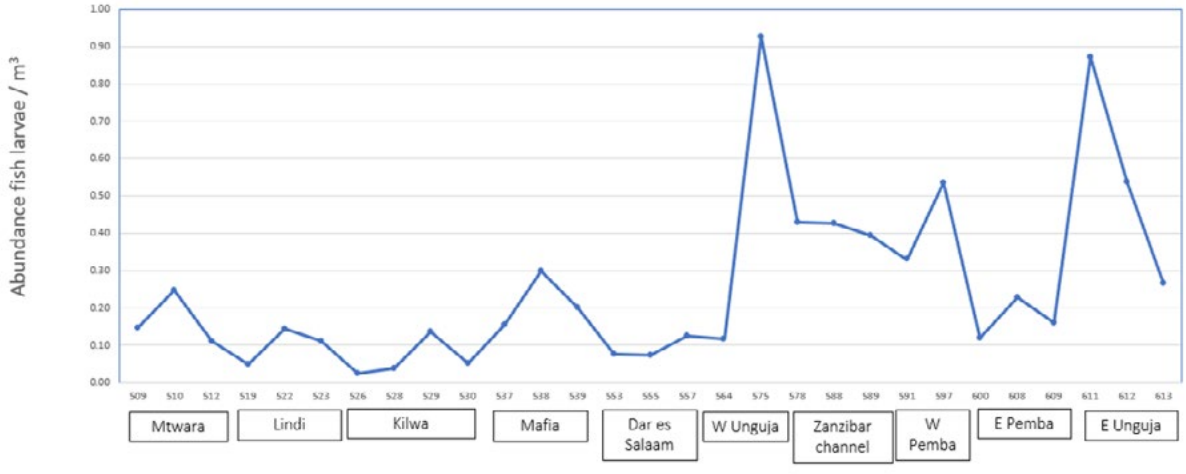

Figure 25. Density of larvae per sampling station (numbers/m^3) in the Bongo net samples

3.3.4 Jellyfish

Jellyfish were registered regularly in trawl catches and in plankton samples and recorded routinely. No major concentrations were observed.

3.4 Fishery resources

The coast of the United Republic of Tanzania is generally challenging to access with trawl gear because of strong northward flowing currents (Figure 8), steep and rugged underwater terrain and, in shallow waters, coral or sponge gardens. In addition, nautical maps are inaccurate in shallow waters causing navigational difficulties, especially around Mafia Island. Many areas were not accessible for bottom trawling at all because of the rugged bottom conditions. These were the shelf between Kilwa, Kisiwani and Lindi, the eastern outer part of Mafia Island, and large parts of the east side of Pemba Island and the United Republic of Tanzania, Zanzibar.

The northern part of the Zanzibar Channel and the north and northwestern side of Pemba Island had large sponge gardens and coral reef structures. Demersal trawling in those areas can cause great ecological damage and loss of fishing gear. Demersal trawling is therefore strongly discouraged.

Both the pelagic and demersal fish resources were prioritized in this survey. The pelagic resources were investigated using a combination of targeted trawling and acoustic recordings. The results are presented in Section 3.4.2. *D*emersal resources were assessed according to the swept area catch rates from stratified random trawl stations (Section 3.4.3). A total of 85 trawl stations were conducted and of these 83 valid stations were carried out, divided into 71 bottom and 12 pelagic trawls (Table 2).

The depth distribution of the trawl stations is described in Figure 26. The largest number of trawl hauls was conducted in relatively shallow waters. Minimum bottom depth during the fishing operations was 24 m. As can be observed in Figure 26, considerably fewer trawl hauls were conducted between 100 m and 300 m because of challenging bottom conditions in this depth zone.

Overall, within the 83 trawl stations, 846 marine species were identified, including fish and epibenthos (crustaceans, molluscs, echinoderms, etc.) The most encountered species are shown in Figure 27 in which species found at more than 15 stations are displayed. In total, 6 091 individuals from 131 species were measured for length and weight. Of these, sex was recorded for 1 618 individuals and maturity data for 412 individuals.

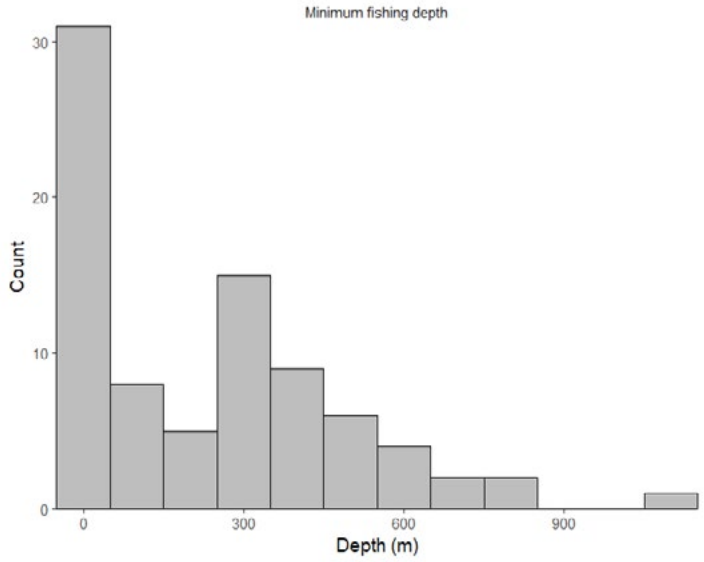

Figure 26. Distribution of the trawl stations according to bottom depth

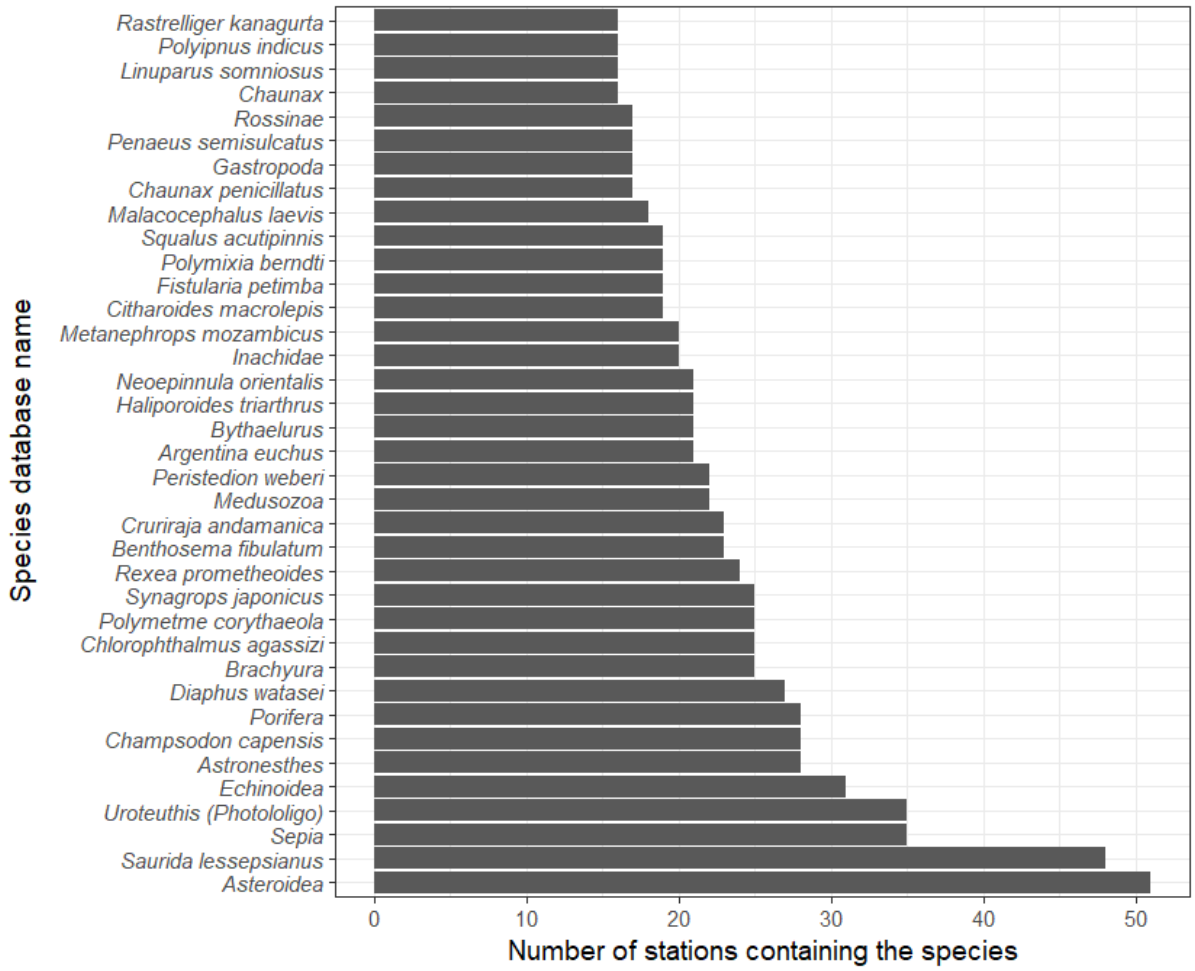

Figure 27. Occurrence of the species most commonly found in the trawl during the survey

Notes: Only species found at more than 15 stations are listed.

3.4.1 Catch rates

Total catches ranged between 0 kg and 3 252 kg. The highest catches were registered close to the coast (Figure 28).

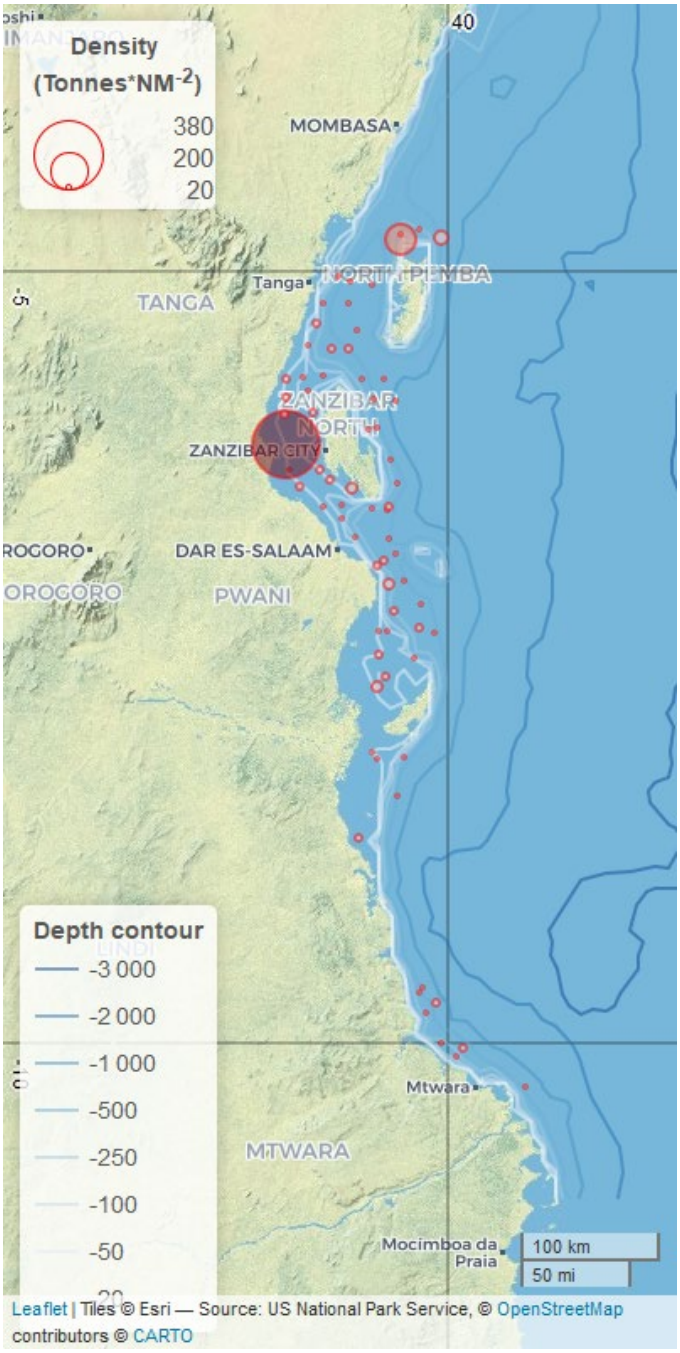

Figure 28. Distribution of demersal trawl catches (tonnes/NM^2) in the survey area

3.4.2 Pelagic resources

A priority objective of the survey was to map the distribution of the pelagic resources and provide maps of acoustic backscatter and biomass indices for the PEL1 and PEL2 species groups.

3.4.2.1 Distribution

According to the Sailing Order, the acoustic survey was to cover the shelf from ~ 20 m to 500 m bottom depth. The vessel was rarely able to go closer to the coast than 30 m bottom depth and often had to end the transect at 100 m bottom depth because of the steep shelf. The strata used are described in

the methodology section of this report. Pelagic fish resources were generally found in shallow waters < 100 m bottom depth, especially in areas where the current was relaxing. Typically, this was on the shallow bank south of Pemba Island and on the inside west and especially the northwest side of all the major islands in the archipelago. Typical for these areas is that they are retention areas caused by the strong current regimes surrounding them.

Pelagic species group 1

The most common pelagic species in the group PEL1 belonged to the Engraulidae, especially *Encrasicholina heteroloba, Stolephorus commersonnii* and *Stolephorus indicus*, the Clupeidae, *Sardinella gibbosa* and the Dussumieridae, *Dussumieria acuta*, families.

PEL1 species were found in very few areas (Figure 29). No PEL1 species were found in the southern stratum. In the stratum "Mafia Island", two catches with clupeoid fish were made in the shallow bank between Kilwa Kivinje and south of Pemba Island. This bank was mostly inaccessible for the vessel. Most fish were found further north on the shallow bank northwest of Pemba Island. Further north in the United Republic of Tanzania, Zanzibar transect, PEL1 species, especially anchovy, were found in the shallow zone between the United Republic of Tanzania, Zanzibar and the mainland.

In the "Pemba" stratum, PEL1 species were found in two areas. The first was in the shallow zone between Mangata Bay and Tanga City. In this area a fringing reef and small islands made it impossible to access the shallow waters. The second area was the shallow zone off the northern tip of Pemba Island. In this area, typical upwelling conditions were observed during the survey period.

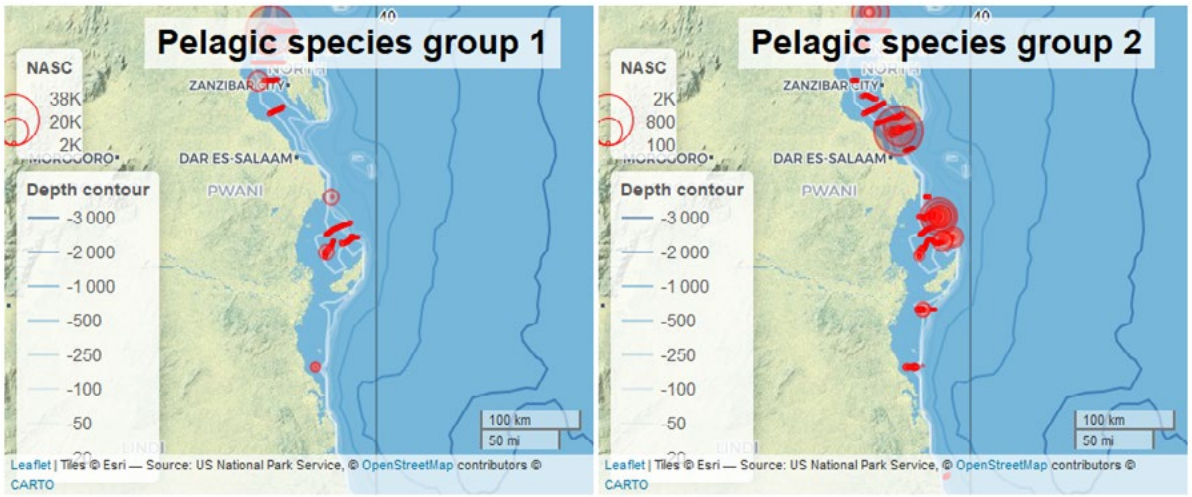

Figure 29. Distribution of PEL1 and PEL2 species in the survey area

Pelagic species group 2

The PEL2 species typically showed a wider distribution compared to the PEL1 species, but the two species groups were otherwise found in the same areas in shallow waters, mostly on the inside of the large islands protected from the strong northwards directed current in deeper waters (Figure 29).

The PEL2 group was diverse with several common species, mostly with low to medium density. The most common PEL2 species belonged to the Carangidae family, among them *Alectis ciliaris*, *Carangoides chrysophrys*, *Carangoides coeruleopinnatus* and *Carangoides malabaricus*. Two Scombridae species were also common, namely *Rastrelliger kanagurta* and *Scomberomorus commerson*. Among the Sphyraenidae (barracudas) it was *Sphyraena obtusata* that dominated the catches, while in deeper waters the almost omnipresent *Trichiurus lepturus* (Trichiuridae) was recorded, especially in the southern part of the survey area.

In the southern region, PEL2 species were found very close to the coast and often in shallow and narrow inlets and bays where acoustic registrations started appearing on the echo sounder just when the vessel had finished the acoustic transect (interstransect transit). Only a few such registrations were included in the acoustic estimates. In the Pemba Island zone the species were found in the same areas as the

PEL1 species, in the shallow bank between Kilwa Kivinje and south of Pemba Island, and on the inside western and northern side of the island. Most of this shallow zone was inaccessible.

In the Zanzibar Channel the PEL2 species had a wider distribution on the shelf and were found further to the south and to the north than the PEL1 species which had higher registrations in the central and northern part of the channel. Some PEL2 species were also caught in trawl hauls outside the United Republic of Tanzania, Zanzibar although no acoustic registrations were visible on the echo sounder. In the northernmost stratum "Pemba", PEL2 species were observed in shallow waters on each side of the channel and on the northern small shelf off Pemba Island.

3.4.2.2 Biological characteristics

The length–frequency distributions of the main pelagic species are shown in Figure 30. Only species with a minimum of 50 measured fish are shown. The species selected were the PEL1 species, *Sardinella gibbosa*, *Encrasicholina pseudoheteroloba*, *Encrasicholina intermedia* and *Stolephorus commersonnii*; and the PEL2 species *Decapterus russelli*, *Rastrelliger kanagurta* and *Trichiurus lepturus*.

Most of the PEL1 specimen samples collected consisted of juvenile fish. The *Sardinella gibbosa* showed a size range from 8 cm to 16 cm with a modal peak at 13 cm. The *Encrasicholina pseudoheteroloba* and *Encrasicholina intermedia* specimens collected were presumably only 0 group and had identical size ranges and modal peaks, ranging between 5 cm and 10 cm and with a modal peak at 8 cm, while the *Stolephorus commersonnii* ranged between 8 cm and 10 cm with a peak at 10 cm.

The PEL2 species typically showed a wider size range. The *Decapterus russelli* ranged between 6 cm and 27 cm and showed modal peaks at 7 cm and 12 cm. The *Rastrelliger kanagurta* ranged between 5 cm and 24 cm with modal peaks at 7 cm, 10 cm and 18 cm. The *Trichiurus lepturus* is long and slender, ranging between 18 cm and 104 cm in length. It was difficult to identify clear modal peaks for this species, although there was an indication of a peak at 80 cm.

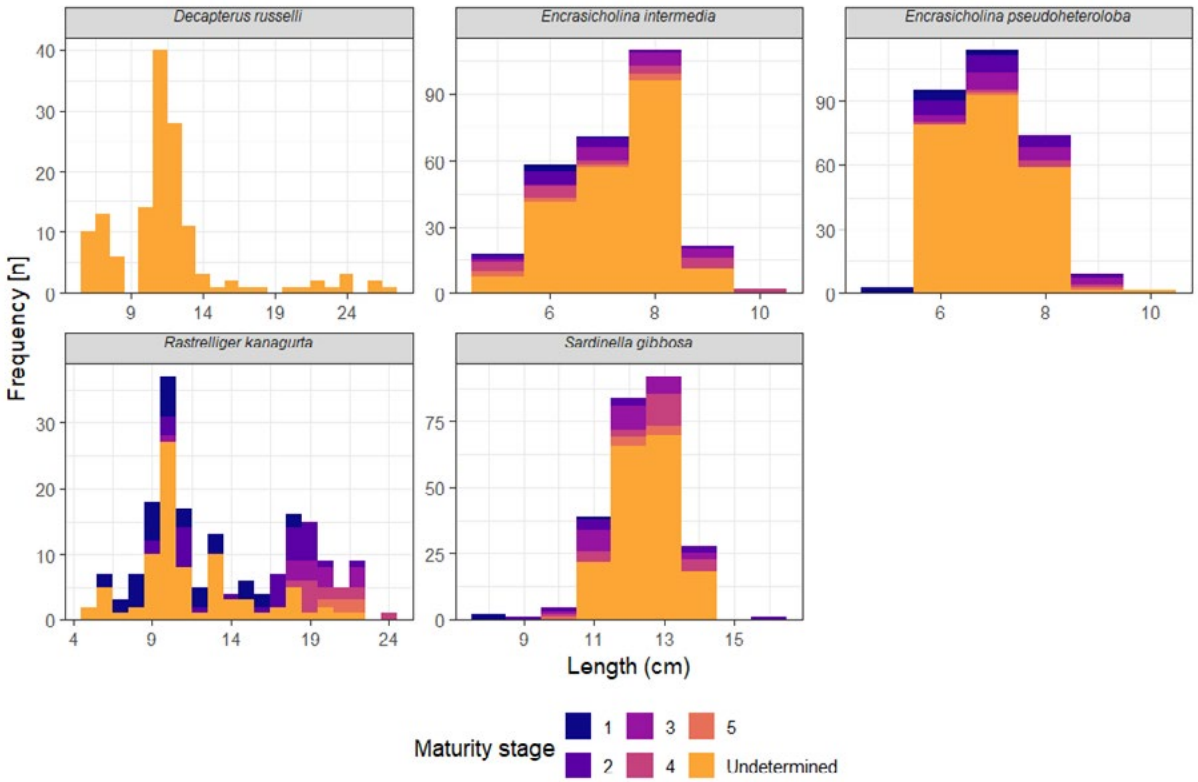

Figure 30. Length distribution of the main pelagic species during Leg 4.2

The length–weight relationship for the same species as for the length–frequency distributions are shown in Figure 31. The length–weight relationships were used in the biomass calculations to convert number of fish to biomass.

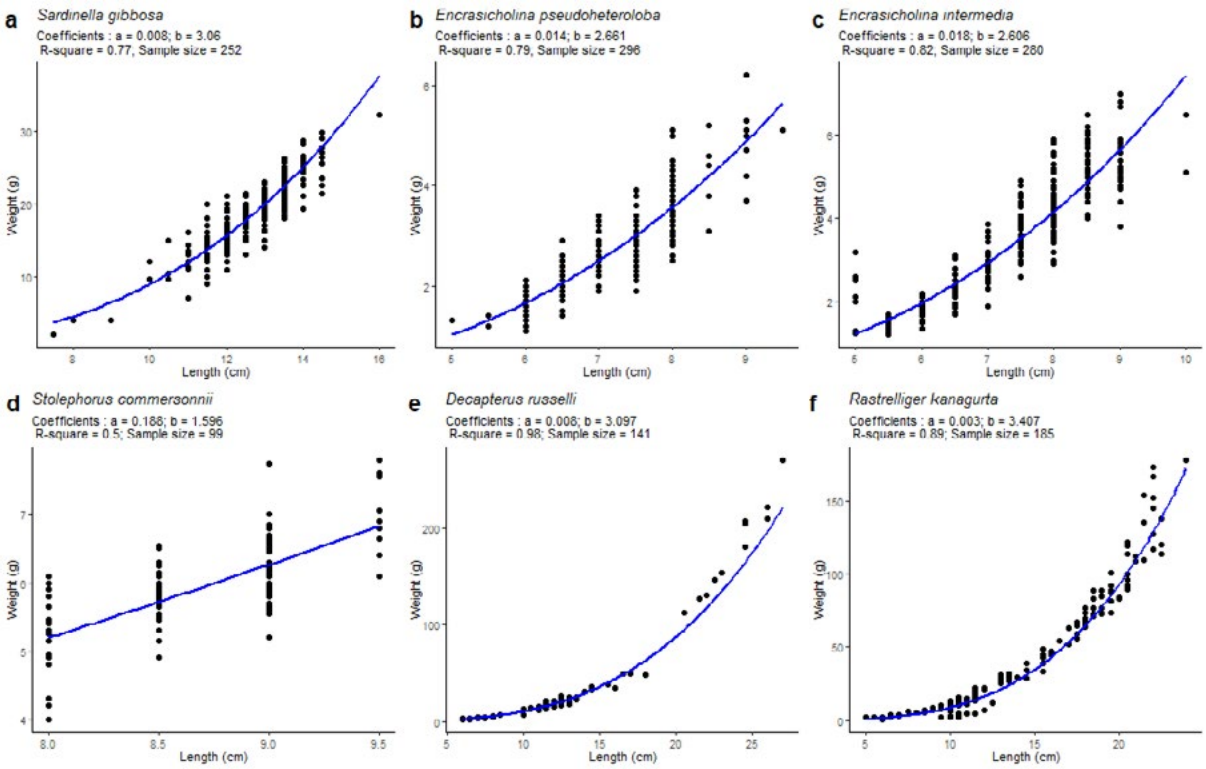

Figure 31. Length–weight relationship of the main pelagic species during Leg 4.2

3.4.2.3 Biomass and abundance indices

The acoustic biomass and abundance indexes were estimated for the two groups PEL1 and PEL2. Table 6 shows the biomass per stratum, while Figure 32 shows the number of individuals per strata in the depth area between 20 m and 500 m. The StoX software was used for fish abundance index calculation purposes (Johnsen *et al*., 2019). The biomass was calculated for each stratum separately. The area for each stratum was based on depth data provided from the General Bathymetric Chart of the Oceans (GEBCO) 2023 gridded bathymetric dataset (GEBCO, 2023) combined with soundings from the 2018 survey. The size of the areas was calculated in StoX and was as follows:

- Mtwara (United Republic of Tanzania, south): 20 m to 500 m depth = 545 NM^2;
- Mafia Island: 20 m to 500 m depth = 1 965 NM^2;
- United Republic of Tanzania, Zanzibar: 20 m to 500 m depth = 1 467 NM^2; and
- Pemba Island: 20 m to 500 m depth = 883 NM^2.

The areas calculated are not directly comparable with the area estimations conducted in 1982 and 1983 and used in the 2018 report. Historic biomass estimates are therefore not directly comparable and need to be updated to these newer area calculations.

The StoX biomass estimates of PEL1 and PEL2 species were based on a combined length frequency consisting of all the specimens from all species measured in the group. This approach has limitations but makes it possible to produce an overall index for the group that would otherwise not be possible. Based on this, an overall biomass of 3 214 tonnes of PEL1 species and 8 598 tonnes of PEL2 species was estimated in the survey area.

Mtwara (south)

Very few PEL1 species were found in the southern strata and no biomass calculation was carried out. The PEL2 species in the area had very low abundance and a total biomass of 33 tonnes was calculated.

Mafia Island (central south)

No pelagic fish resources were observed on the outer part of Mafia Island. South of Mafia Island and towards the mainland, medium densities were observed for both PEL1 and PEL2 species. The biomass of PEL1 species in the area was the largest within the survey area with an estimate of 2 778 tonnes. PEL2 species were relatively abundant on the shelf between Mafia Island and the mainland. The biomass of PEL2 species was 6 006 tonnes in the area covered by the survey.

United Republic of Tanzania, Zanzibar (central north)

Pelagic fish were found in the Zanzibar Channel and especially on the northwestern side of the island. The PEL1 species were found mostly on the northern side of the Zanzibar Channel. The biomass was low at 433 tonnes.

PEL2 species were more widely distributed on the side of the island facing the mainland. A biomass of 2 254 tonnes was estimated.

Pemba Island (north)

Pemba Island has many bays and inlets that could not be covered by the survey and the coverage was therefore only partial. Due to the nature of the shelf, with a shallow area along the coast and another shallow zone around Pemba Island separated by a deep channel, the region had to be divided into two substrata. In the area surveyed, very few pelagic fish were found. Some very small pelagic fish were recorded in one trawl on the northern side of the island. Roughly 2 tonnes were estimated in this area. The distribution was found in a smaller upwelling area caused by the local current systems.

PEL2 species were recorded in relatively small concentrations, mainly along the Tanzanian coast and at the northern tip of Mafia Island. A total of 304 tonnes was estimated.

Table 6. The biomass estimates per stratum including 5 percent and 95 percent confidence intervals and coefficients of variance for PEL1 and PEL2 acoustic species categories

Stratum	Species	Biomass	CI5	CI95	CV
United Republic of Tanzania, central north, 20 m to 500 m	PEL1	433	200	729	0.38
United Republic of Tanzania, central south, 20 m to 500 m_I	PEL1	2 778	872	6 016	0.55
United Republic of Tanzania, north, 20 m to 500 m_I	PEL1	0	0	0	
United Republic of Tanzania, north, 20 m to 500 m_II	PEL1	2	0	5	0.92
United Republic of Tanzania, south, 20 m to 500m	PEL1	0	0	0	
Total	**PEL1**	**3 214**	**1 301**	**6 321**	**0.48**
United Republic of Tanzania, central north, 20 m to 500m	PEL2	2 254	786	3 909	0.44
United Republic of Tanzania, central south, 20 m to 500 m_I	PEL2	6 006	1 632	12 901	0.62
United Republic of Tanzania, north, 20 m to 500 m_I	PEL2	293	0	620	0.86
United Republic of Tanzania, north, 20 m to 500 m_II	PEL2	11	0	35	1.03
United Republic of Tanzania, south, 20 m to 500m	PEL2	33	8	68	0.54
Total	**PEL2**	**8 598**	**3 789**	**15 601**	**0.45**

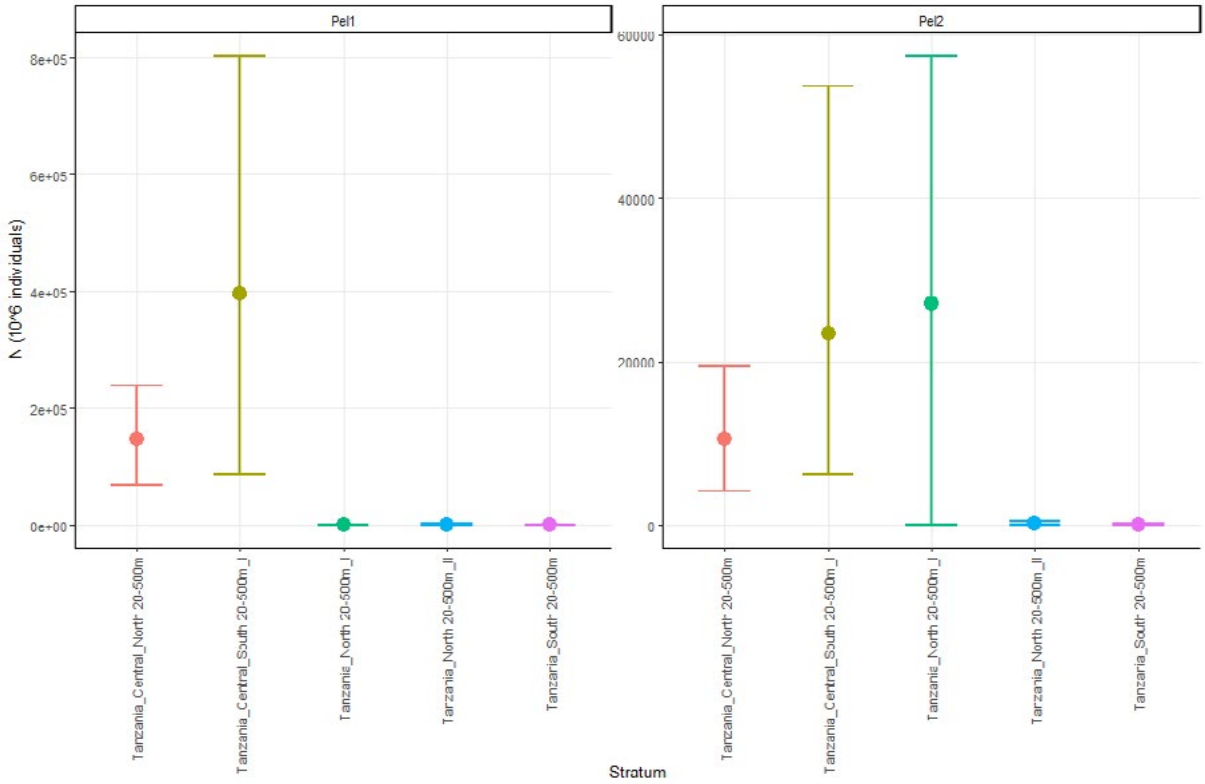

Figure 32. Number of individuals per stratum between 20 m and 500 m for PEL1 (left) and PEL2 (right)

3.4.3 Demersal resources

For the demersal trawl hauls, catch rates in tonnes per NM^2 were calculated for the main resource groups (Table 7) and for the commercially important demersal resources (Table 8) respectively. The information is presented per main stratum for the United Republic of Tanzania.

Overall catch rates in tonnes per NM^2 for the main groups in the survey were medium to low density. The "other" group was the most abundant with 0.44 tonnes/NM^2, followed by sharks (0.46 tonnes/NM^2), pelagic species (0.25 tonnes/NM^2), demersal species (0.23 tonnes/NM^2), rays (0.20 tonnes/NM^2), shrimps (0.17 tonnes/NM^2) and cephalopods (0.14 tonnes/NM^2). For all non-demersal resources, the catch rates should be considered non-representative because the demersal trawl was not used for quantifying non-demersal resources.

The stratum around the United Republic of Tanzania, Zanzibar had the highest catch rates while the lowest catches were found in the southern region of Mtwara. The "other" group had catches ranging between 0.15 tonnes/NM^2 to 0.88 tonnes/NM^2 while sharks had catch rates ranging between 0.23 tonnes/NM^2 and 0.75 tonnes/NM^2. Pelagic species ranged between 1.18 tonnes/NM^2 and 0.12 tonnes/NM^2 while demersal species had a range of catch rates between 0.13 tonnes/NM^2 (Mtwara) to 0.33 tonnes/NM^2 (Mafia Island). Cephalopods, shrimps and rays were also important.

For the selected demersal groups, catches were generally highest around the United Republic of Tanzania, Zanzibar. Overall, groupers had the highest catch rates with 0.33 tonnes/NM^2 followed by snappers (0.25 tonnes/NM^2), croakers and grunts (0.23 tonnes/NM^2).

Table 7. Catch rates in tonnes per NM^2 for the main resources groups in the survey area

Leg	Demersal	Pelagic	Cephalopods	Shrimps	Sharks	Rays	Other
Average whole area	0.23	0.25	0.14	0.17	0.46	0.20	0.44
Mafia Island	0.33	0.24	0.15	0.21	0.75	0.19	0.33
Mtwara (south)	0.13	1.18	0.30	0.03	0.23	0.15	0.15
Pemba Island (north)	0.23	0.12	0.12	0.23	0.31	0.28	0.16
United Republic of Tanzania, Zanzibar	0.16	0.24	0.05	0.12	0.25	0.08	0.88

Table 8. Catch rates in tonnes per NM^2 for important demersal resources in the survey area

Leg	Croakers	Groupers	Grunts	Seabreams	Snappers	Other
Average whole area	0.23	0.33	0.23	0.19	0.25	0.40
Mafia Island	0.24	0.63	0.32	0.12	0.34	0.32
Mtwara (south)	0.26	–	–	0.09	–	0.17
Pemba Island (north)	0.18	0.92		0.46	0.12	0.17
United Republic of Tanzania, Zanzibar	0.17	0.06	0.12	0.11	0.26	0.74

3.4.3.1 Distribution

The distribution of selected demersal species is shown in Figure 33. The selection was based on the list of predefined "priority demersal taxa" but included some other abundant species observed during the survey. The species shown are *Saurida lessepsianus*, *Upeneus suahelicus*, *Upeneus sulphureus*, *Centrophorus moluccensis*, *Pomadasys stridens* and *Linuparus somniosus*.

The Saurida genus is mostly of low commercial value and is not targeted by any fishery. However, the genus and especially *Saurida lessepsianus* was almost omnipresent in the survey area but with lower density south of Mafia Island and around Pemba Island.

The goatfishes, *Upeneus* spp. are common along the Tanzanian coast and during the survey eight different species were caught. The species are targeted by the artisanal fishery. *Upeneus suahelicus* and *Upeneus sulphureus* were most frequently caught. *Upeneus suahelicus* was caught at 11 stations in the inshore part of the survey area, mostly inside Mafia Island and the United Republic of Tanzania, Zanzibar. The *Upeneus sulphureus* was found at nine stations in the shallow region and had a similar distribution to *Upeneus suahelicus*.

The smallfin gulper shark, *Centrophorus moluccensis,* is typically found on the outer continental shelves and upper slopes, on or near the bottom. The species was common in the catches and therefore included in the description of the demersal species. Most of the catches were made in the southern part of the survey area and between Mafia Island and the United Republic of Tanzania, Zanzibar in the slope and deep-water trawl stations.

The grunt *Pomadasys stridens* is popular in the artisanal fishery in the United Republic of Tanzania, and was found inshore at eight stations, mostly inside Mafia Island and the United Republic of Tanzania, Zanzibar.

The crustacean *Linuparus somniosus* is a spiny lobster (langust) and is not caught commercially in the United Republic of Tanzania. The species was found in relatively high abundance at 16 stations on the slope and with similarly high abundance between Mafia Island and the United Republic of Tanzania, Zanzibar.

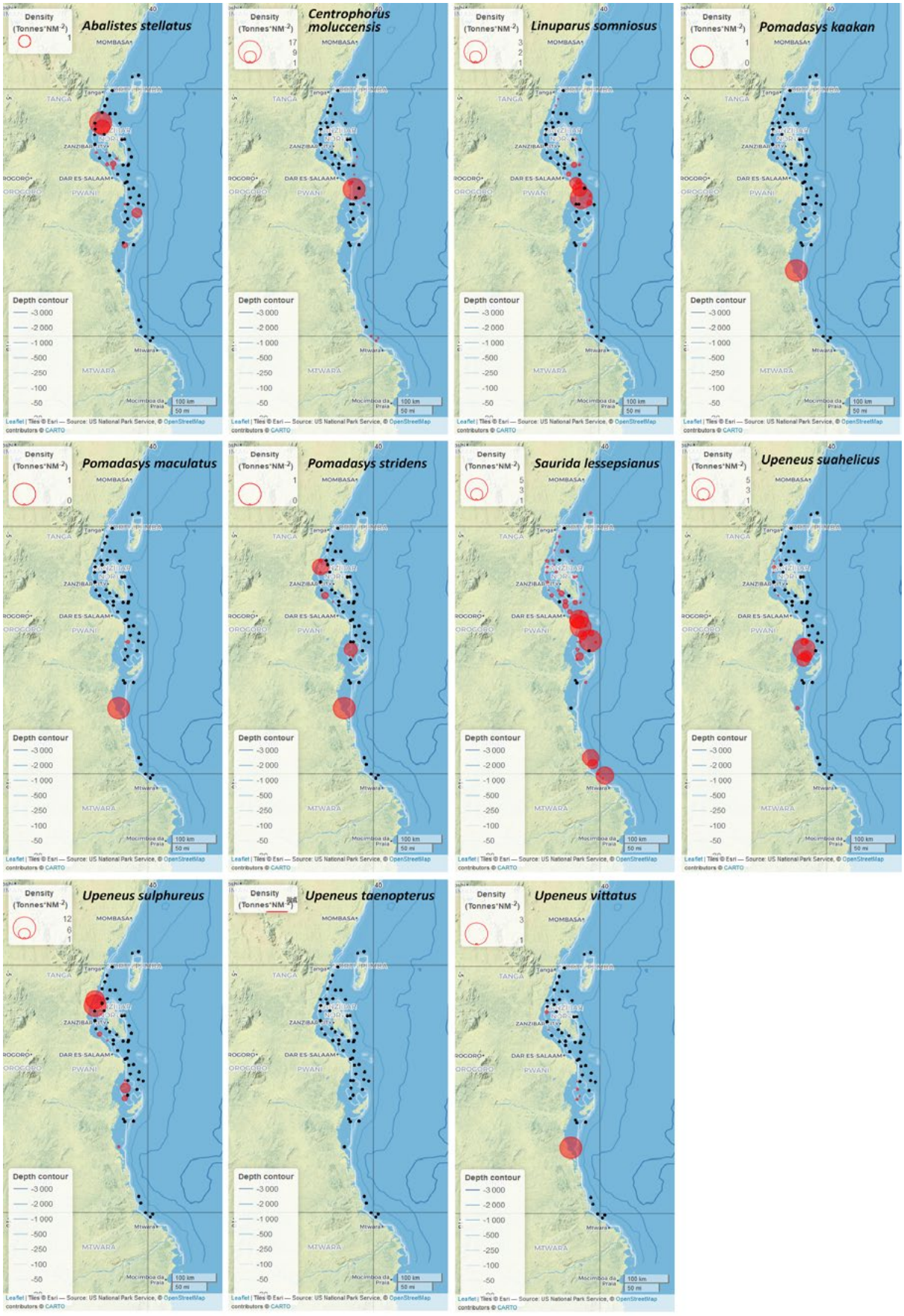

Figure 33. Distribution of selected abundant demersal species in the survey area (*Upeneus suahelicus, Upeneus sulphureus, Saurida lessepsianus, Centrophorus moluccensis, Pomadasys stridens, Linuparus somniosus*)

3.4.3.2 Biological characteristics

The length–frequency distributions of some selected demersal species, as derived from the measured individuals in the samples, are shown in Figure 34. Of the species shown, length data were only recorded for four species: *Saurida lessepsianus*, *Upeneus suahelicus*, *Upeneus sulphureus* and *Centrophorus moluccensis*.

Saurida lessepsianus ranged in size from 7 cm to 43 cm total length. It showed modal peaks at 18 cm, 26 cm and 33 cm. *Upeneus suahelicus* is reported to have a maximum length of 13.5 cm according to Fishbase. However, during the survey the specimens ranged in size from 9 cm to 16 cm total length, with a modal peak at 10 cm. *Upeneus sulphureus* has a maximum size of 23 cm total length according to Fishbase. The individuals found during the survey ranged in size from 8 cm to 14 cm total length with a modal peak at 11 cm. *Centrophorus moluccensis* ranged in size from 28 cm to 100 cm total length.

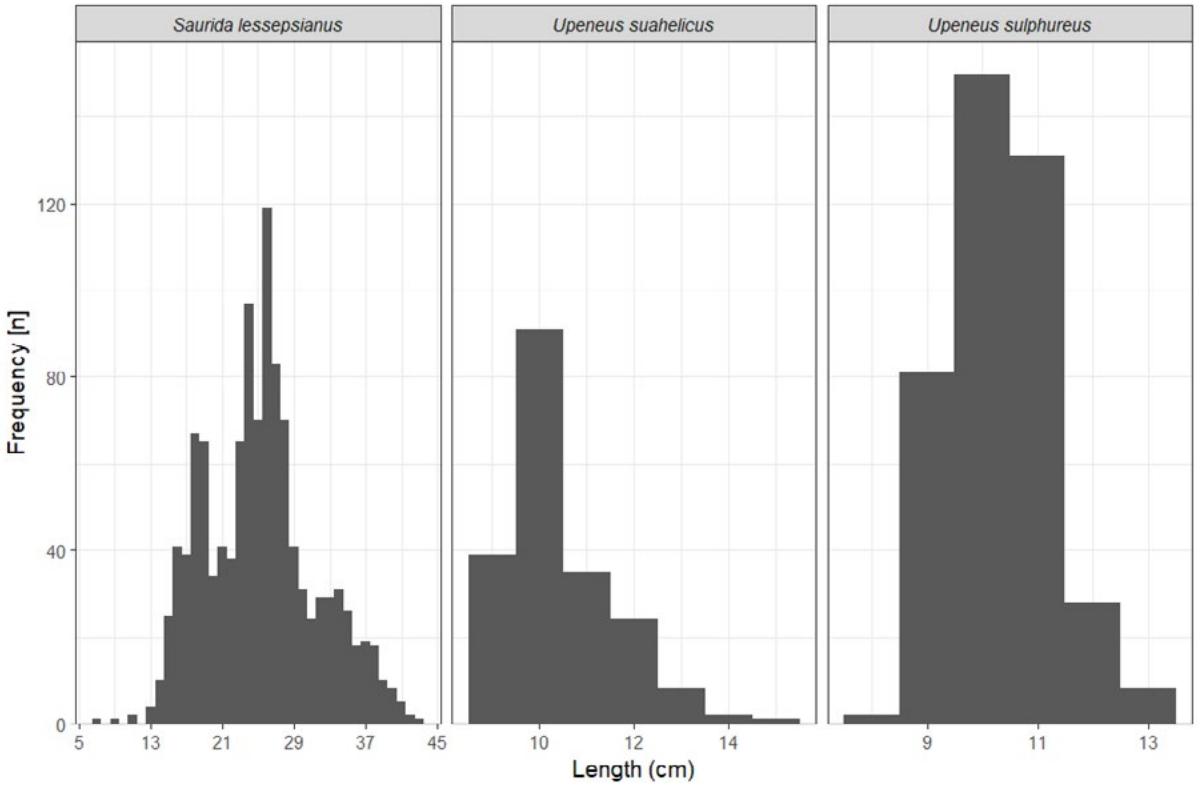

Figure 34. Length distribution of main demersal species during Leg 4.2

3.4.3.3 Biomass and abundance indices

Four major strata and depth strata were used to assess the demersal resources. The area for each stratum was based on depth data provided from the GEBCO 2023 gridded bathymetric dataset (GEBCO, 2023) combined with soundings from the 2018 survey. The size of the areas was calculated in StoX and is shown in Table 9. The areas calculated are not directly comparable with area estimations conducted in 1982 and 1983 and referred to in the 2018 report. Historic biomass estimates are therefore not directly comparable and need to be updated to these newer area calculations.

Table 9. The stratum areas in NM^2 calculated in StoX for the swept area biomass calculations

Strata	20–50 m	50–200 m	200–500 m	Total
United Republic of Tanzania, south	44	123	378	545
Mafia Island	472	308	1 154	1 934
United Republic of Tanzania, Zanzibar	765	356	377	1 498
Pemba Island	93	148	641	882
Total	**1 374**	**935**	**2 550**	**4 859**

The biomass estimates are given for the main groups: cephalopods, shrimps, pelagic species, rays, sharks, commercially important demersal species and "other". In addition, biomass estimates are provided for selected important demersal families such as croakers, groupers, grunts, seabreams and snappers, and some selected abundant species. The biomass per stratum for these groups can be found in tables 10 and 11 while a summary can be found in Table 13 in the "Concluding remarks".

Mtwara (south)

Generally, this region had the lowest biomass of fish and other species in the demersal trawl catches with an estimated 2 676 tonnes. With strong currents along a narrow, steep and rugged shelf few trawls were conducted and no trawls were made inside of 200 m bottom depth, contributing to the result. Cephalopods were the most abundant group with a biomass of 289 tonnes, followed by sharks with an estimated biomass of 247 tonnes and pelagic species with a biomass of 247 tonnes. Among the demersal species (6 tonnes) the most important were the seabreams with a biomass of 5 tonnes.

The "other" category had a biomass of 1 787 tonnes. *Saurida lessepsianus* is a non-commercial species in the "other" category and was common across the survey area. The biomass in Mtwara was estimated at 656 tonnes. The smallfin gulper shark, *Centrophorus moluccensis* was mostly found in deep waters in trawl stations between 200 m and 500 m. The biomass in Mtwara was 134 tonnes. The langust, *Linuparus Somniosus* is a commercial species, most probably not harvested in the United Republic of Tanzania. The biomass in Mtwara was relatively low at 3 tonnes. Other species were of little importance.

Mafia Island (central south)

The Mafia Island strata had the highest biomass of all strata with a total of 23 451 tonnes. The group of sharks was important with a biomass of 2 604 tonnes, and most of this biomass from one species, the smallfin gulper shark, *Centrophorus moluccensis*.

The group of commercially important demersal species had a biomass of 2 487 tonnes, of which 1 627 tonnes was goatfish. Pelagic species were also abundant with a biomass of 1 321 tonnes. The "other" category had a biomass of 15 524 tonnes. *Saurida lessepsianus* biomass in the Mafia Island stratum was estimated at 2 235 tonnes. The smallfin gulper shark had its highest biomass in deep waters around Mafia Island with a biomass of 2 006 tonnes. The shark was also common further north but its biomass was low.

The two goatfish species *Upeneus suahelicus* and *Upeneus sulphureus* were also common in shallow waters in the trawl stations around Mafia Island, with a biomass of 800 tonnes and 467 tonnes, respectively. *Linuparus somniosus* was abundant around Mafia Island at depths greater than 200 m and 871 tonnes were estimated, especially in trawl stations close to the coast on muddy substrates.

The United Republic of Tanzania, Zanzibar (central north)

The biomass in the United Republic of Tanzania, Zanzibar stratum was lower than in Mafia, with an overall biomass of 13 999 tonnes. Of these, 8 549 tonnes were part of the "other" category. The group of commercially important demersal species registered a biomass of 3 720 tonnes, of which 3 025 tonnes were goatfish, while 183 tonnes of snappers were also reported.

Pelagic species were common in demersal trawl catches in this region and a biomass of 917 tonnes was estimated. In this stratum the biomass of *Saurida lessepsianus* was estimated to be 442 tonnes, reduced compared to further south. The goatfish species were also common in shallow waters in the trawl stations here. Several species were found but *Upeneus sulphureus* was abundant with a biomass of 1 720 tonnes. Some *Linuparus somniosus* were also found in this stratum and 56 tonnes were estimated.

Pemba (north)

Overall, the biomass around Pemba Island was lower than in the two central strata (Mafia Island and the United Republic of Tanzania, Zanzibar) with 6 356 tonnes. The most common group was "other" with 4 585 tonnes. Among the main groups, sharks were most common with 493 tonnes, followed by cephalopods (493 tonnes), rays (340 tonnes), demersal species (238 tonnes) and shrimps (207 tonnes). In the Pemba stratum, the *Saurida lessepsianus* biomass was estimated at 146 tonnes. This was the lowest

biomass of the strata in the region. Some *Centrophorus moluccensis* and *Linuparus Somniosus* were also found and 12 tonnes were estimated for each species. The biomass of the other selected species was low.

Table 10. Swept area biomass per stratum in tonnes, including 5 percent and 95 percent confidence intervals and a coefficient of variance of main species groups in the survey area

Stratum	Species	Biomass	CI5	CI95	CV
United Republic of Tanzania, north, 50 m to 200 m_I	Demersal	2	–	–	–
United Republic of Tanzania, north, 50 m to 200m_I	Goatfish	1	–	–	–
United Republic of Tanzania, north, 50 m to 200_I	Pelagic	47	–	–	–
United Republic of Tanzania, north, 50 m to 200 m_II	Groupers	183	–	–	–
United Republic of Tanzania, north, 50 m to 200 m_II	Rays	13	–	–	–
United Republic of Tanzania, north, 50 m to 200 m_II	Snappers	30	–	–	–
United Republic of Tanzania, north, 200 m to 500 m_I	Demersal	2	–	–	–
United Republic of Tanzania, north, 200 m to 500 m_I	Pelagic	3	–	–	–
United Republic of Tanzania, north, 200 m to 500 m_I	Sharks	276	–	–	–
United Republic of Tanzania, north, 200 m to 500 m_I	Snappers	13	–	–	–
United Republic of Tanzania, north, 200 m to 500 m_II	Demersal	6	2	11	0.42
United Republic of Tanzania, north, 200 m to 500 m_II	Pelagic	2	0	5	0.7
United Republic of Tanzania, north, 200 m to 500 m_II	Rays	327	57	624	0.6
United Republic of Tanzania, north, 200 m to 500 m_II	Sharks	217	75	371	0.41
United Republic of Tanzania, north, 200 m to 500 m_II	Shrimps	207	104	301	0.3
United Republic of Tanzania, north, 20 m to 50 m	Demersal	296	106	504	0.42
United Republic of Tanzania, central north, 20 m to 50 m	Goatfish	2 652	1 166	4 326	0.36
United Republic of Tanzania, central north, 20 m to 50 m	Groupers	40	2	91	0.69
United Republic of Tanzania, central north, 20 m to 50 m	Grunts	74	23	132	0.46
United Republic of Tanzania, central north, 20 m to 50 m	Pelagic	389	205	588	0.3
United Republic of Tanzania, central north, 20 m to 50 m	Shrimps	122	40	216	0.45
United Republic of Tanzania, central north, 20 m to 50 m	Snappers	181	6	358	0.62
United Republic of Tanzania, central north, 50 m to 200 m_I	Demersal	27	6	53	0.52
United Republic of Tanzania, central north, 50 m to 200 m_I	Goatfish	382	119	698	0.46
United Republic of Tanzania, central north, 50 m to 200 m_I	Groupers	3	1	5	0.56
United Republic of Tanzania, central north, 50 m to 200 m_I	Pelagic	519	103	1 069	0.56
United Republic of Tanzania, central north, 50 m to 200 m_I	Rays	39	0	116	0.93
United Republic of Tanzania, central north, 50 m to 200 m_I	Seabreams	25	0	74	0.93
United Republic of Tanzania, central north, 50 m to 200 m_I	Sharks	1	0	3	0.73
United Republic of Tanzania, central north, 50 m to 200 m_I	Shrimps	17	2	37	0.62
United Republic of Tanzania, central north, 50 m to 200 m_I	Snappers	2	0	4	0.7
United Republic of Tanzania, central north, 200 m to 500 m	Demersal	3	1	5	0.47
United Republic of Tanzania, central north, 200 m to 500 m	Pelagic	9	0	26	0.82
United Republic of Tanzania, central north, 200 m to 500 m	Rays	13	5	24	0.43
United Republic of Tanzania, central north, 200 m to 500 m	Seabreams	6	0	18	0.92
United Republic of Tanzania, central north, 200 m to 500 m	Sharks	203	82	336	0.38
United Republic of Tanzania, central north, 200 m to 500 m	Shrimps	164	58	277	0.4

Stratum	Species	Biomass	CI5	CI95	CV
United Republic of Tanzania, central south, 20 m to 50 m_II	Demersal	185	18	459	0.72
United Republic of Tanzania, central south, 20 m to 50 m_II	Goatfish	1 414	625	2 294	0.36
United Republic of Tanzania, central south, 20 m to 50 m_II	Groupers	123	0	277	0.67
United Republic of Tanzania, central south, 20 m to 50 m_II	Grunts	145	23	331	0.65
United Republic of Tanzania, central south, 20 m to 50 m_II	Pelagic	985	405	1 696	0.4
United Republic of Tanzania, central south, 20 m to 50 m_II	Seabreams	7	0	21	0.96
United Republic of Tanzania, central south, 20 m to 50 m_II	Shrimps	148	25	284	0.53
United Republic of Tanzania, central south, 20 m to 50 m_II	Snappers	36	0	106	0.96
United Republic of Tanzania, central south, 50 m to 200 m_I	Goatfish	213	20	416	0.67
United Republic of Tanzania, central south, 50 m to 200 m_I	Groupers	62	0	121	0.71
United Republic of Tanzania, central south, 50 m to 200 m_I	Grunts	105	31	176	0.5
United Republic of Tanzania, central south, 50 m to 200 m_I	Pelagic	168	141	193	0.11
United Republic of Tanzania, central south, 50 m to 200 m_I	Shrimps	23	1	46	0.73
United Republic of Tanzania, central south, 50 m to 200 m_I	Snappers	66	0	129	0.71
United Republic of Tanzania, central south, 200 m to 500 m_II	Demersal	17	2	32	0.55
United Republic of Tanzania, central south, 200 m to 500 m_II	Pelagic	168	19	414	0.73
United Republic of Tanzania, central south, 200 m to 500 m_II	Rays	305	30	657	0.64
United Republic of Tanzania, central south, 200 m to 500 m_II	Sharks	2 604	557	5 627	0.61
United Republic of Tanzania, central south, 200 m to 500 m_II	Shrimps	277	119	480	0.4
United Republic of Tanzania, south, 200 m to 500 m	Demersal	6	0	13	0.58
United Republic of Tanzania, south, 200 m to 500 m	Pelagic	160	0	316	0.56
United Republic of Tanzania, south, 200 m to 500 m	Rays	65	26	110	0.41
United Republic of Tanzania, south, 200 m to 500 m	Seabreams	5	0	16	0.88
United Republic of Tanzania, south, 200 m to 500 m	Sharks	247	143	349	0.25
United Republic of Tanzania, south, 200 m to 500 m	Shrimps	64	15	143	0.6
Total	Demersal	544	264	864	0.33
Total	Goatfish	4 663	2 959	6 530	0.24
Total	Groupers	411	265	580	0.24
Total	Grunts	324	163	516	0.34
Total	Pelagic	2450	1 650	3 374	0.22
Total	Rays	763	346	1 255	0.36
Total	Seabreams	44	7	92	0.6
Total	Sharks	3 548	1 447	6 608	0.45
Total	Shrimps	1 022	758	1 330	0.17
Total	Snappers	328	143	542	0.38

Table 11. Swept area biomass per stratum in tonnes

Notes: Including 5 percent and 95 percent confidence intervals and coefficient of variance of selected species in the survey area.

Stratum	Species	Biomass	CI5	CI95	CV
United Republic of Tanzania, north, 50 m to 200 m_I	*Saurida lessepsianus*	2	–	–	–
United Republic of Tanzania, north, 200 m to 500 m_I	*Saurida lessepsianus*	65	65	65	–
United Republic of Tanzania, north, 200 m to 500 m_II	*Centrophorus moluccensis*	12	0	25	0.91
United Republic of Tanzania, north, 200 m to 500 m_II	*Linuparus somniosus*	12	0	24	0.53
United Republic of Tanzania, north, 200 m to 500 m_II	*Saurida lessepsianus*	79	26	130	0.42
United Republic of Tanzania, central north, 20 m to 50 m	*Pomadasys stridens*	50	7	103	0.59
United Republic of Tanzania, central north, 20 m to 50 m	*Saurida lessepsianus*	265	159	384	0.26
United Republic of Tanzania, central north, 20 m to 50 m	*Upeneus suahelicus*	61	3	149	0.75
United Republic of Tanzania, central north, 20 m to 50 m	*Upeneus sulphureus*	1 719	146	3 471	0.57
United Republic of Tanzania, central north, 50 m to 200 m_I	*Saurida lessepsianus*	98	44	171	0.41
United Republic of Tanzania, central north, 50 m to 200 m_I	*Upeneus suahelicus*	3	0	7	0.93
United Republic of Tanzania, central north, 50 m to 200 m_I	*Upeneus sulphureus*	0	0	0	0.93
United Republic of Tanzania, central north, 200 m to 500 m	*Centrophorus moluccensis*	18	0	37	0.62
United Republic of Tanzania, central north, 200 m to 500 m	*Linuparus somniosus*	56	11	115	0.57
United Republic of Tanzania, central north, 200 m to 500 m	*Saurida lessepsianus*	79	35	141	0.42
United Republic of Tanzania, central south, 20 m to 50 m_II	*Pomadasys stridens*	54	2	110	0.61
United Republic of Tanzania, central south, 20 m to 50 m_II	*Saurida lessepsianus*	150	22	331	0.64
United Republic of Tanzania, central south, 20 m to 50 m_II	*Upeneus suahelicus*	714	276	1 180	0.39
United Republic of Tanzania, central south, 20 m to 50 m_II	*Upeneus sulphureus*	467	66	921	0.57
United Republic of Tanzania, central south, 50 m to 200 m_I	*Saurida lessepsianus*	236	113	355	0.37
United Republic of Tanzania, central south, 50 m to 200 m_I	*Upeneus suahelicus*	86	0	175	0.74
United Republic of Tanzania, central south, 200 m to 500 m_II	*Centrophorus moluccensis*	2 006	234	4 841	0.74
United Republic of Tanzania, central south, 200 m to 500 m_II	*Linuparus somniosus*	871	417	1 359	0.33

Stratum	Species	Biomass	CI5	CI95	CV
United Republic of Tanzania, central south, 200 m to 500 m_II	*Saurida lessepsianus*	2 235	1 226	3 287	0.29
United Republic of Tanzania, south, 200 m to 500 m	*Centrophorus moluccensis*	134	60	221	0.38
United Republic of Tanzania, south, 200 m to 500 m	*Linuparus somniosus*	3	0	10	0.91
United Republic of Tanzania, south, 200 m to 500 m	*Saurida lessepsianus*	656	262	1 135	0.4
Total	*Centrophorus moluccensis*	2 170	378	5 048	0.68
Total	*Linuparus somniosus*	942	476	1 435	0.31
Total	*Pomadasys stridens*	104	38	178	0.42
Total	*Saurida lessepsianus*	3 865	2 711	5 026	0.18
Total	*Upeneus suahelicus*	864	413	1 335	0.33
Total	*Upeneus sulphureus*	2 186	619	4 062	0.46

3.4.4 Diversity

In total, about 540 species of fishes were caught in the trawl; 516 fish taxa were documented with about 1 000 photographs of fresh specimens; 925 specimens were tissue sampled; and about 1 000 specimens were frozen or preserved for transfer to and further taxonomic work at SAIAB.

Most species caught were demersal, but pelagic and mesopelagic species were also caught. The most species-rich families of deepwater fishes were Macrouridae, Ophidiidae and Congridae (15 to 20 species in each) while coastal fishes were Mullidae and Carangidae (more than ten species in each). The species richness per station varied from a few species up to 59 species (station 351, depth ~ 350 m) in deep water and from 6 up to 50 species (station 393, ~ 25 m) in coastal waters.

The most frequently recorded species in deep trawls were *Champsodon capensis*, *Chlorophthalmus punctatus* (both recorded at 28 stations), *Diaphus watasei* and *Synagrops japonicus* (both recorded at 27 stations). In coastal waters the most common species were *Fistularia petimba* and *Saurida lessepsianus* (recorded at 20 stations). The most abundant deep-water species were the mesopelagic sternoptychid *Polyipnus bruuni* and *Polyipnus indicus* with a total of around 45 700 specimens (26 057 specimens were counted at station 431) and the myctophid *Benthosema fibulatum* (recorded at 23 stations with a total of 36 800 specimens (station 431 with 13 960 specimens). In shallow waters the most abundant were two species of engraulids *Encrasicholina intermedia* and *Encrasicholina pseudoheteroloba* (total of both around 60 260 specimens).

Fish species were divided into two large categories: 199 species of coastal fishes (depth of the collection 15 m to 200 m); and 317 deepwater species. Unexpected results were found among deepwater fishes where more than 60 percent (around 200 species) were new records for the United Republic of Tanzania. The number of new records of coastal fishes was also high (around 60 species). Furthermore, at least ten species are new to science. About 10 percent (52 species) of the species richness belongs to sharks and rays with half of them new for the United Republic of Tanzania and three of the species new to science. Most of the specimens were tentatively identified on board, while some species were identified only to genus level, thus requiring further study after the survey.

Further genetic study and morphological examinations are necessary for positive identification of each specimen to complete the inventory of all trawled species, a full overview of the new records of marine fish species for the United Republic of Tanzania and records of species new to science. Preliminary results of the survey show that the ichthyofauna of the United Republic of Tanzania is still poorly studied, especially in deep water and further surveys can increase the number of new species and/or new records.

3.4.5 Other trawl-related sampling

Not relevant for this survey.

3.5 Benthos and benthic habitats

3.5.1 Epibenthos sampling from demersal trawl catches

Not relevant for this survey.

3.5.2 Sampling with Van Veen grab

Not relevant for this survey.

3.6 Microplastics

In general, the amount of microplastics found in the samples was low. A total of 26 microplastics was isolated from seven samples collected with the Manta trawl. The microplastics were photographed and preserved in freshwater in 2 mL Eppendorf tubes that were sent to IMR in Bergen, Norway for polymer identification by ATR FTIR.

3.7 Marine debris

Marine debris was recorded from the trawl catches routinely and registered according to the sampling protocol. Generally, plastic waste and other waste was common in the survey area and at the very deep stations far from the coast. No analyses of the material were made during the survey.

3.8 Bottom habitat mapping

Not relevant for this survey.

3.8.1 Bathymetry

Not relevant for this survey.

3.8.2 Sediment composition

Not relevant for this survey.

3.8.2.1 Granulometry

Not relevant for this survey.

3.8.2.2 Chemical composition

Not relevant for this survey.

3.8.2.3 Contaminants

Not relevant for this survey.

3.9 Vulnerable marine ecosystems

Not relevant for this survey.

3.10 Top predators

Whales were not systematically registered during the survey, but the navigation officers reported two sightings. The first was an unidentified whale south of Mafia Island and the second was a family of humpback whales (two adults and one calf) immediately north of Pemba Island at 4°42'9" south, 39°37'3" east. The group was with around 20 unidentified dolphins. The observations were made directly where the two branches of currents from each side of Pemba Island meet each other, a position that coincides with observations of localized upwelling.

3.11 Food safety

One of the objectives of the survey was to obtain information on nutrition and food safety from selected small pelagic species. Data was collected according to the Sailing Order. The summed number of collected fish species is provided in Table 12. The material was shipped to Norway and was analysed at IMR in Bergen in 2024.

Table 12. Overview of samples collected for nutrition and food safety analysis (by fish species, and number of individuals preserved)

Species	No of samples
Encrasicholina intermedia	20
Encrasicholina pseudoheteroloba	15
Spratelloides gracilis	6
Dussumeiria acuta	3
Restelliger kanarguta	7
Total sample number	51

3.12 Additional sampling

Not relevant for this survey.

3.13 Capacity development

Capacity development and practical training in scientific sampling and reporting were conducted in survey planning, in procedures and standardized survey methodology, species identification, use of state-of-the art scientific equipment, as well as in the execution and reporting of the survey. In addition, assistance was given to the national scientists in the compilation of survey data and in conducting preliminary data analyses. Several scientific meetings were arranged during the survey and an overview of these can be found in Annex 2.

Basic training in acoustics was given to selected participants with some background in the field.

3.14 Data recorded and collected samples

In line with the Nansen Data Policy the cruise leader ensured that the representative of the national institution (cruise co-leader) on board the vessel received a copy of the draft report and the basic data pertaining to the particular survey and for their national waters, prior to leaving the vessel. FAO ensured that the cruise participants signed the Data Policy and agreed to collaborate with scientists from other partner countries and through the EAF-Nansen Science Plan.

An overview of samples collected, people responsible for the analysis and the status of the analysis by the time of the post-survey meeting can be found in Annex 3. Persons responsible for samples collected

reported on the status of the analysis at the post-survey meeting. A copy of the analysis/results was sent to IMR (Nansen_data@hi.no) so as to ensure that IMR, as a data custodian, has an overview of the samples for various purposes, including:

- data custodian purposes;
- for use in capacity building and workshops;
- collaboration and publication through the EAF-Nansen Science Plan;
- for reference libraries and DNA barcoding; and
- for more efficient planning of future surveys in the same area.

IMR has a responsibility to develop and maintain a functioning and updated system for the storage, management and retrieval of all the data collected during the surveys, or produced from activities performed during the surveys, and to make available any part of these data and scientific information as and when required. All requests for data should be sent to FAO at www.fao.org/in-action/eaf-nansen/data-access-requests/en. Data collected and an overview of procedures for the data handover to partners can be found in Annex 4.

4. CONCLUDING REMARKS

The survey in the marine waters of the United Republic of Tanzania (Leg. 4.2) was organized from 28 June to 25 July 2023. During the one-month survey the entire Tanzanian coastline was covered from the south to the north.

The vessel left Dar es Salaam on 28 June and returned to port on 25 July. The ecosystem survey off the United Republic of Tanzania had multiple objectives and all were achieved. A port call was successfully arranged midway through the survey on 11 July, and a calibration of the scientific echo sounders was conducted on 21 July off the United Republic of Tanzania, Zanzibar.

All acoustic transects were completed as planned and 85 pelagic and demersal fishing stations were conducted within the survey area as part of the swept area coverage and to identify acoustic targets in the water column.

The planned CTD stations were all executed and all plankton stations were completed. The information presented in this report summarizes the results of the data compiled during the survey. Samples and data have been transferred to the United Republic of Tanzania according to the plan in the Sailing Order, while some remained on board to be shipped to IMR in Bergen, Norway (see Annex 3). These samples will be analysed and reported on at a later stage.

4.1 Main findings from the survey

The survey was conducted during the dry season towards the end of the southeast monsoon. The weather was mostly calm but often overcast with a few rain showers. The wind varied between 5 m/s and 13 m/s generally coming from the southeast. Currents were northward directed and strong in the upper 100 m outside of the islands, often exceeding 3 knots. The surface ocean temperature was mostly between 26 °C and 27 °C.

Generally, trawling conditions in the United Republic of Tanzania are difficult with strong current conditions, a rugged and steep topography and coral reefs and sponge beds that limit trawlable areas. The southern region and the outside of all the islands are mostly inaccessible to demersal trawlers.

Pelagic fish were assessed from the acoustic survey coverage while demersal resources were estimated from the swept area trawl coverage.

The abundance of pelagic resources observed during the survey was relatively low. The species were divided into categories, namely PEL1 and PEL2. The most abundant species in the PEL1 group were the Engraulides, especially *Encrasicholina heteroloba*, *Stolephorus commersonnii* and *Stolephorus indicus*, the Clupeid, *Sardinella gibbosa* and the Dussumierid *Dussumieria acuta,* while the PEL2 group was diverse but dominated by the Carangid species. The biomass estimate of the two species groups was 2 935 tonnes and 9 582 tonnes, respectively.

The demersal component of the ecosystem was assessed in a swept area trawl survey. All in all, 85 trawl stations were conducted covering a depth range from 20 m to 1 083 m, 40 stations from the coast to 200 m and 45 stations deeper than 200 m. Overall, the biomass was estimated at 46 000 tonnes. The largest part of this biomass was species of low commercial importance, but a total biomass of 6 490 tonnes of valuable commercial species was estimated, in addition to 3 500 tonnes of sharks, 2 450 tonnes of pelagic species, 1 700 tonnes of cephalopods and 1 000 tonnes of shrimps (Table 13). The highest biomass was found in the central part of the United Republic of Tanzania, especially in the Mafia Island strata where about half of the overall estimated biomass was found. The lowest biomass was observed in the south in the Mtwara district where it was estimated to be 2 700 tonnes. However, it should be noted that this region is characterized by very difficult trawling conditions.

Table 13. Summary of swept area biomass estimates for the different species groups per main strata

Main group	Mtwara	Mafia	United Republic of Tanzania, Zanzibar	Pemba	Total
Cephalopods	289	762	253	440	1 745
Shrimps	64	448	303	207	1 022
Pelagic	160	1 321	917	52	2 450
Rays	65	305	53	340	763
sharks	247	2 604	204	493	3 548
Demersal species	45	2 487	3 720	238	6 490
Other	1 806	15 524	8 549	4 585	30 463
Total	**2 676**	**23 451**	**13 999**	**6 356**	**46 481**

In total, about 540 species of fishes were observed in the trawl catches and the survey area displayed a very high biodiversity. The survey observed several new species for the United Republic of Tanzania and several species new to science. This material is of particular importance and was transferred to SAIAB in South Africa for further investigations.

As part of the survey, large areas of coral reefs and sponge beds were observed, especially in between the mainland of the United Republic of Tanzania and the United Republic of Tanzania, Zanzibar, but also in several other places. These are well known and are important recruitment and nursery areas with high species diversity that should be protected from all trawling operations.

Trawl catches in coastal waters in the northern part of the United Republic of Tanzania contained about 75 percent of juveniles and subadults, including commercial species. This indicates high fishing pressure and overfishing. A comparison of the swept area biomass estimates from Leg 4.2 to the estimates made in 1982 to 1983 was not undertaken, but the catch rates of both pelagic and demersal species reported from those earlier surveys (using the same demersal trawl gear) were considerably higher than those recorded in this survey and there is reason to believe that the biomass of most fish species on the shelf has declined considerably. A retrospective comparison with previous surveys is recommended.

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ANNEX 1. DESCRIPTION OF INSTRUMENTS AND FISHING GEAR

Acoustic instruments

The Simrad EK80 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz and 333 kHz scientific sounder was run during the survey. Scrutinizing was done in LSSS using the data from the 38 kHz transducer. The standard sphere calibrations were checked on 22 July 2023 off the northwest coast of the United Republic of Tanzania, Zanzibar. Conditions were fine but due to increasing plankton quantities in the water in the evening, only the 38 kHz, 70 kHz 120 kHz and 200 kHz echo sounder were calibrated using the Cu60 for the 38 kHz and WC38.1 for the 70 kHz, 120 kHz and 200 kHz. Calibration results will be set after the survey.

The 18 kHz and 333 kHz echo sounders were last calibrated together with all other frequencies during the calibration in Namibia in May. The details of the settings for the 38 kHz echo sounder were as follows:

Table A1.1. Echosounder settings used during the survey

Transducer depth	6.84 m	SA correction	−0.34 dB
Absorption coeff.	9.2 dB/km	Angle sensitivity	18
Pulse duration	medium (1.024ms)	3 dB beamwidth	6.70º along ship
Bandwidth	34-38kHz		6.76º athwart ship
Max power	2000 Watt	Alongship offset	−0.09º
Two-way beam angle	0	Athwardship offset	0.00º
Gain	26.44 dB	Bottom detection menu	Minimum level −40dB
Calibration date	45129		
Place	Zanzibar, Tanzania		

Fishing gear

The vessel has one small four-panel Åkrahamn pelagic trawl (Figure A1.1), one multipurpose pelagic ecosystem trawl (Multpelt) 624 (Figure A1.2), new in 2017 and one Gisund Super bottom trawl (Figure A1.3). All trawls were used during the survey. The smallest pelagic trawl has an 8 m to 12 m vertical opening under normal operation, whereas the Multpelt 624 trawl has a 25 m to 35 m opening.

The bottom trawl has a 31 m headline and a 47 m footrope fitted with 12” rubber bobbins. The codend has 24 mm meshes. The vertical opening is about 5.5 m. The distance between the wing tips is about 18 m during towing. The sweeps are 40 m long. The trawl doors are Thyborøen combi, 8 m^2 and weigh 2 000 kg. The door spreading is about 45 m when using restraining rope. However, trawling was conducted for species identification only and no restraining rope was therefore used during the survey.

The SCANMAR system was used during all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and the vessel ship is based on acoustic transmission. The doors are fitted with sensors to provide information on their interdistance and angle, while a height sensor is fitted on the bottom trawl to measure the trawl opening and provide information on clearance and bottom contact.

All trawls are equipped with a trawl eye that provides information about the trawl opening and the distance of the footrope to the bottom. A pressure sensor is used to show the depth on the headline.

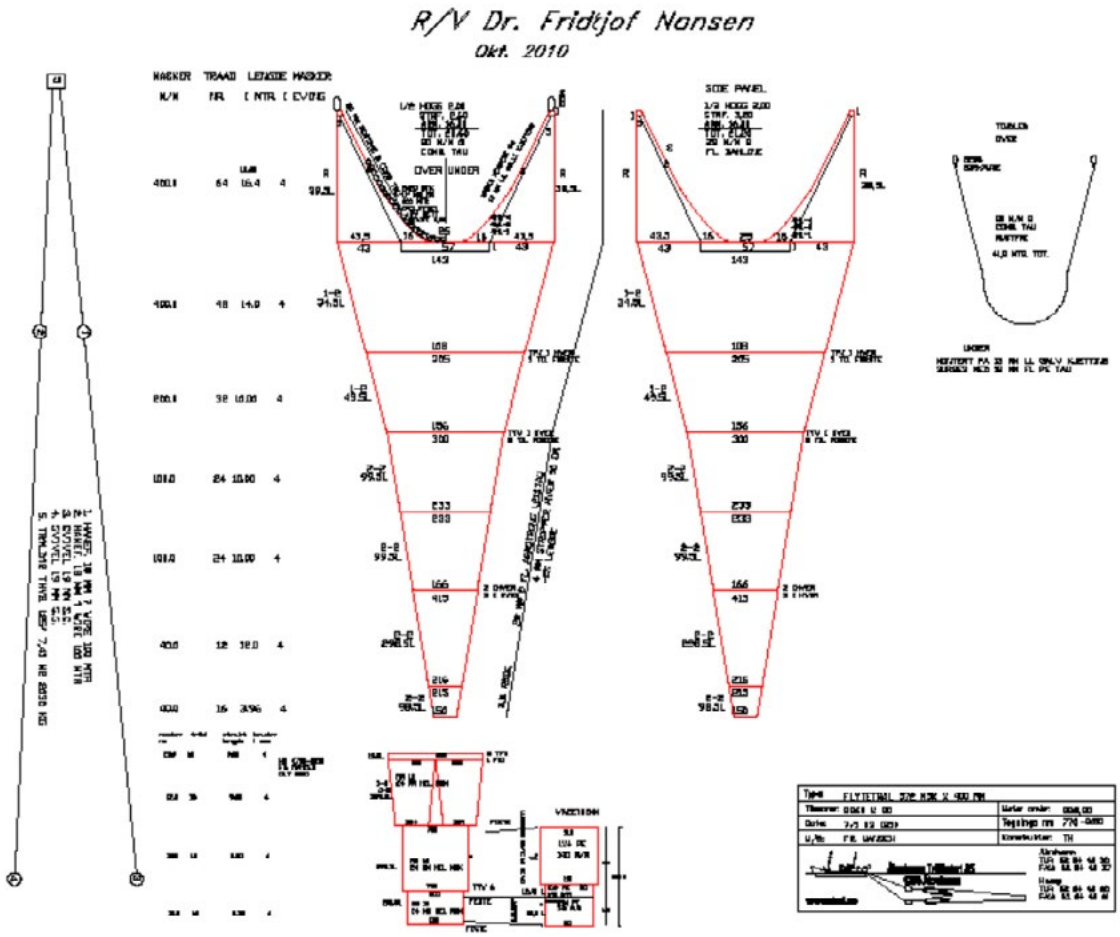

Figure A1.1. Technical drawing of the small pelagic Åkratrawl

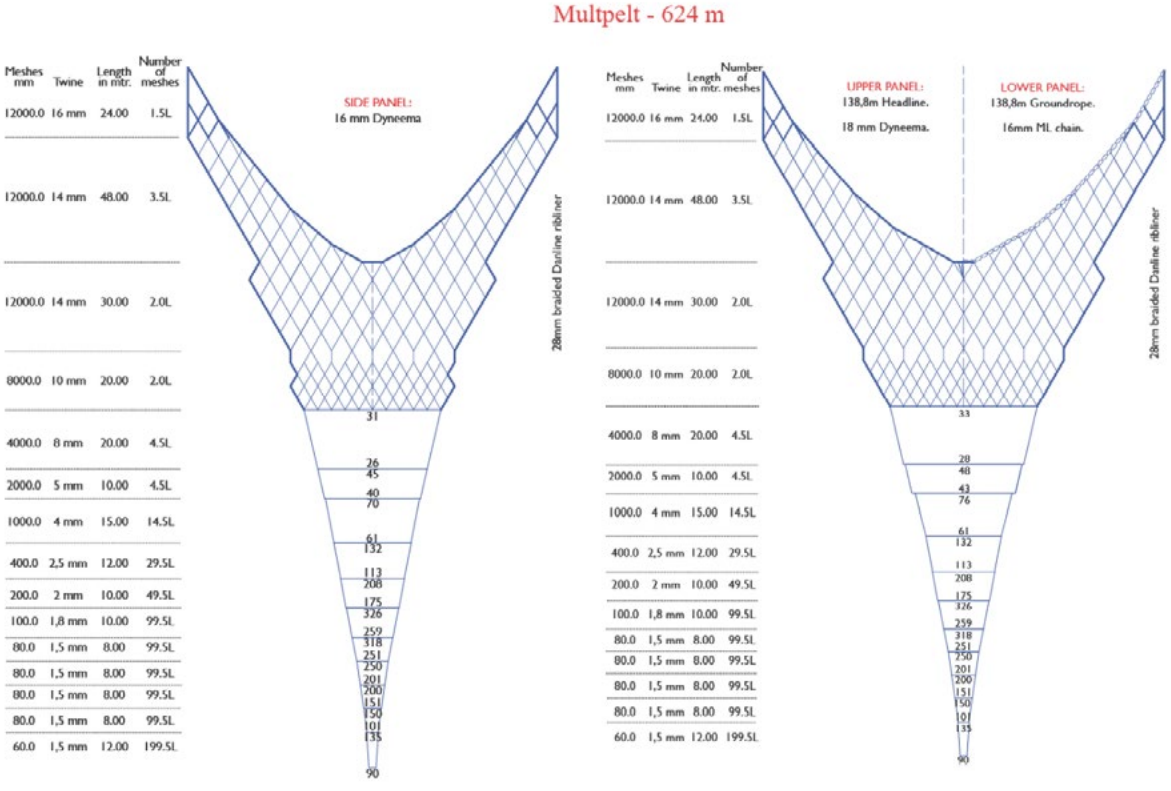

Figure A1.2. Technical drawing of the Multpelt 624 trawl

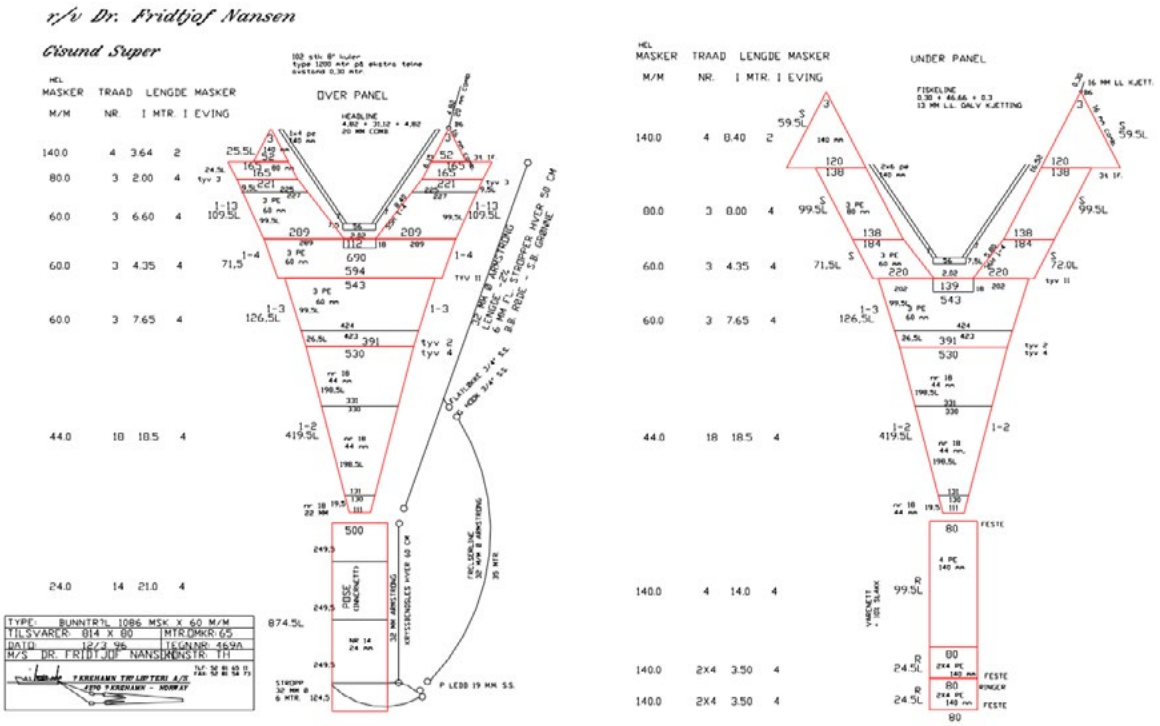

Figure A1.3. Technical drawing of the Gisund Super trawl

Conductivity, temperature and depth sensors

Table A1.4. Conductivity, temperature and depth sensors used throughout the survey

Type	Serial Number	Model	Calibration Date	Stations
Deck unit	11-1082	SBE 11plus	N/A	0194-0343
Pressure sensor	127957	DigiQuartz	20.11.2018	0194-0343
Underwater unit	09P75372-1160	SBE 9plus 6800m	20.11.2018	0194-0343
Water sampler	32-0972	SBE 32 6800m	N/A	0194-0343
Conductivity sensor	4798	SBE 4C 6800m	25.10.2022	0194-0343
Conductivity sensor	2799	SBE 4C 6800m	25.10.2022	0194-0343
Oxygen sensor	3635	SBE 43 7000m	09.11.2022	0194-0343
Submersible pump	52147	SBE 5T	December 2022	0194-0343
Submersible pump	54196	SBE 5T	December 2022	0194-0343
Temperature sensor	6211	SBE 3plus 6800m	19.10.2022	0194-0343
Temperature sensor	4306	SBE 3plus 6800m	19.10.2022	0194-0343
Fluorometer sensor	FLNTURTD-7352	WET-LABS	11.02.2022	0194-0343
Turbidity sensor	FLNTURTD-7352	WET-LABS	11.02.2022	0194-0343
Altimeter	76741	Valeport VA500	6 April 2021	0194-0343
PAR sensor	1123	PAR-LOG ICSW	12 October 2017	0194-0343

Table A1.5. Validation of conductivity and dissolved oxygen sensors by water samples collected throughout the survey

Notes: Despite a good agreement between both conductivity sensors, sensor 2799 was more stable than 4798 (except at station 286). Dissolved oxygen sensor 3635 agreed well with the Winkler titrations performed on board. However, it was difficult to measure the hypoxic and anoxic waters in the laboratory as some values recorded by the sensor were below 0.10 ml/l, which is near the minimum detection limit of the Winkler titration.

Type	Serial number	Validation samples	Water samples - 4798	2799/4798	Water samples/3635
Conductivity sensor	4798	70	0,0099	1,001	N/A
Conductivity sensor	2799	0	N/A	N/A	N/A
Oxygen sensor	3635	266	N/A	N/A	0,9955

Thermosalinograph sensors – 4 m water intake

Table A1.6. Thermosalinograph sensors on the 4 m water intake used throughout the survey

Type	Serial number	Model	Calibration date	Usage dates
Thermosalinograph	3418	SBE21	7 July 2020	27 March to 3 April 2023
Conductivity sensor	3418	SBE21	7 July 2020	27 March to 3 April 2023
Temperature sensor (int.)	3418	SBE21	7 July 2020	27 March to 3 April 2023
Temperature sensor (ext.)	0903	SBE38	5 February 2020	27 March to 3 April 2023
Not in use				

Thermosalinograph sensors – 6 m drop keel water intake

Table A1.7. Thermosalinograph sensors on the 6 m water intake used throughout the survey

Type	Serial number	Model	Calibration date	Usage dates
Thermosalinograph	3419	SBE21	9 March 2021	27 March to 3 April 2023
Conductivity sensor	3419	SBE21	9 March 2021	27 March to 3 April 2023
Temperature sensor (int.)	3419	SBE21	9 March 2021	27 March to 3 April 2023
Temperature sensor (ext.)	0880	SBE38	26 November 2020	27 March to 3 April 2023
Fluorometer	WS1S-257S	Wet labs	20 April 2015	27 March to 3 April 2023

ANNEX 2. CAPACITY DEVELOPMENT

Table A2.1. Overview of the presentations given during the survey

Date	Title	Name
28.06.2023	Safety briefing and welcome word	Jens-Otto Krakstad
28.06.2023	Daily life on board	Jens-Otto Krakstad
29.06.2023	Presentation of the Sailing Order	Jens-Otto Krakstad
11.07.2023	Presentation of the Nansen programme during the port call	Jens-Otto Krakstad
16.07.2023	Presentation of the oceanographic data of the survey	Prisca Mziray, Benedicto Bonipace Kashindye, Athman Salim Hussein, Talhiya Maulid Ali
18.07.2023	PhD proposals Samaki project	James Magoto and Atuganile Malambugi
20.07.2023	PhD thesis in plankton biology in the United Republic of Tanzania, Zanzibar	Barnabas Tarimo
22.07.2023	The United Republic of Tanzania	Mary Alphonce Kishe
24.06.2023	Survey end meeting, survey report	All

ANNEX 3. SAMPLE OVERVIEW

Table A3.1. Samples collected, preservation and follow-up work

Sampling equipment	Analysis	Samples	Preservation	Estimated amount of preservative needed	Port of offloading	Type of transportation	Institution address	Contact details, name, email, phone	Deadline for analysis	Data and sampling types for future usage and reference
Rosette water bottles	Nutrients. Will be analysed on board after the survey	Water samples	Frozen	–	–	–	IMR - Nansen	David Cervantes, david.cervantes@hi.no		
Rosette water bottles	Phytoplankton	Water samples	2% formaldehyde (buffered?)	–	Dar es Salaam	–	TAFIRI	Sihaba Ramadhan Mwaitega, sihabamwaitega@gmail.com		
Phytoplankton net	Phytoplankton community identification	Bottles with bulk samples	2% formaldehyde (buffered?)	–	Dar es Salaam	–	TAFIRI	Sihaba Ramadhan Mwaitega, sihabamwaitega@gmail.com		
WP2 (180 µm) from max 200 m, ½ split	Zooplankton biomass estimation	Aluminium trays	Dried and then frozen	–	Not decided	Air freight	IMR, Bergen	Stamatina Isari, stamatina.isari@hi.no		
WP2 (180 µm) from max 200 m, ½ split	Zooplankton community identification	Bottles with ½ of bulk WP2 sample	4% formaldehyde (buffered?)	600 mL	Dar es Salaam	–	IMS, Zanzibar	Barnabas Tarimo, tarimobarnabas@yahoo.com		
Bongo H (405 µm)	Ichthyoplankton community identification, genetics	Bottles with bulk sample	96% ethanol (unmethylated)	15 to 20 litres	Dar es Salaam	–	IMS, Zanzibar	Barnabas Tarimo, tarimobarnabas@yahoo.com		
Bongo V (405 µm)	Ichthyoplankton community identification	Bottles with bulk sample	4% formaldehyde	3 litres	Dar es Salaam	–	IMS, Zanzibar	Barnabas Tarimo, tarimobarnabas@yahoo.com		

Sampling equipment	Analysis	Samples	Preservation	Estimated amount of preservative needed	Port of offloading	Type of transportation	Institution address	Contact details, name, email, phone	Deadline for analysis	Data and sampling types for future usage and reference
Bongo V (405 µm)	Species identification	Scintillation vials with sorted larval fish from the bulk Bongo sample	4% formaldehyde	–	Dar es Salaam	–	IMS, Zanzibar	Barnabas Tarimo, tarimobarnabas@yahoo.com		
Manta trawl (335 µm)	Neuston community identification	Bottles with bulk sample	96% ethanol (methylated)	15 to 20 litres	Dar es Salaam	–	IMS, Zanzibar	Barnabas Tarimo, tarimobarnabas@yahoo.com		
	Species identification, genetics	Scintillation vials with sorted larval fish and eggs from the bulk Manta sample	96% ethanol (unmethylated)	600 mL	Dar es Salaam	–	IMS, Zanzibar	Barnabas Tarimo, tarimobarnabas@yahoo.com		
	Abundance and chemical composition of microplastics	Eppendorf tubes with the microplastics sorted from the bulk Manta sample	Photographed, stored in Eppendorf tubes at room temperature	–	Not decided	Not decided	IMR, Bergen	Bjørn Einar Grøsvik, bjorn.grosvik@hi.no		
Trawl samples	Taxonomic identification – Unidentified species	Whole fish	Frozen	–	Cape Town	Road	SAIAB, South Africa	Peter Psomadakis, Peter.Psomadakis@fao.org		
Trawl samples	Taxonomic identification – unidentified species	Whole fish	Formaldehyde	–	Cape Town	Road	SAIAB, South Africa	Peter Psomadakis, Peter.Psomadakis@fao.org		
Trawl samples	Taxonomic identification – unidentified species, genetic samples	finclip or tissue	Ethanol	–	Cape Town	Road	SAIAB, South Africa	Peter Psomadakis, Peter.Psomadakis@fao.org		

Sampling equipment	Analysis	Samples	Preservation	Estimated amount of preservative needed	Port of offloading	Type of transportation	Institution address	Contact details, name, email, phone	Deadline for analysis	Data and sampling types for future usage and reference
Trawl samples (selected pelagic species) for students	Nutrition and food safety	Whole fish	Frozen	–	Not decided	Not decided	IMR, Bergen	Mariann Kjellevold, marian.kjellevold@hi.no, Talhiya Maulid Ali		
Trawl samples	Fish samples for parasites analysis	Whole fish	Frozen	–	Not decided	Not decided	IMR, Bergen	Mariann Kjellevold, marian.kjellevold@hi.no		
Trawl samples	Fish samples for microplastics analysis	Whole fish	Frozen	–	Not decided	Not decided	IMR, Bergen	Dr. Bjørn Einar Grøsvik, bjorn.grosvik@hi.no		
	Taxonomic identification – unidentified species	Whole fish	frozen	–	Dar es Salaam	–	TAFIRI	Mary Kishe, mariakishe@tafiri.go.tz		
Trawl samples	Taxonomic identification – unidentified species	Whole fish	Formaldehyde	–	Dar es Salaam	–	TAFIRI	Mary Kishe, mariakishe@tafiri.go.tz		
Trawl samples	Taxonomic identification – unidentified species, genetic samples	Finclip or tissue	Ethanol	–	Dar es Salaam	–	TAFIRI	Mary Kishe, mariakishe@tafiri.go.tz		
Rastelliger kanugurta	Genetic samples for PhD student	Finclip or tissue	Ethanol	–	Not decided	Not decided	IMR, Bergen	James Magoto, Jeppe Kolding		
Slurry sample; *E. punctifer, S. gibbosa*	Genetic samples for PhD student	Eppendorf tube with slurry in ethanol	Ethanol	–	Not decided	Not decided	IMR, Bergen	Atuganile Malambugi, Jeppe Kolding		
Frozen round fish or goatfish	Taxonomic study of Mullidae	Whole fish	Frozen	–	Dar es Salaam	–	TAFIRI	Patroba Matiku, putni2p@yahoo.com		

ANNEX 4. DATA COLLECTED AND OVERVIEW OF PROCEDURES FOR DATA HANDOVER TO PARTNERS

Table A4.1. Data collected and overview of procedures for data handover to partners
Notes: All collected data will be stored at the IMR server.

Data type	Data sources	After the survey	At the post-survey meeting	On request	Not collected and equipment is turned off	Analysed by partner country	Analysed through the EAF-Nansen Science Plan
Acoustic data	EK80 narrowband (CW)			x			
Acoustic data	EK80 broadband (FM)				x		
Acoustic data	MS70			x			
Acoustic data	ME70				x		
Acoustic data	SU90				x		
Acoustic data	SH90				x		
Acoustic data	SBP300				x		
Acoustic data	EM302			x	x		
Acoustic data	EM710				x		
Physics	CTD probe	x					
Physics	CTD underway				x		
Physics	ADCP 75 kHz	x					
Physics	ADCP 150 kHz	x					
Physics	LADCP				x		
Physics	Thermosalinograph	x					
Chemistry	Nutrients		x				

Data type	Data sources	After the survey	At the post-survey meeting	On request	Not collected and equipment is turned off	Analysed by partner country	Analysed through the EAF-Nansen Science Plan
Chemistry	pH			x			
Chemistry	Total alkalinity			x			
Chemistry	PCO2			x			
Biology	Chlorophyll	x					
Biology	Trawl catch data	x					
Biology	Zooplankton biomass		x				
Biology	Phytoplankton		x				x
Pollution	Microplastics		x				x
Observation platforms	VAMS				x		
Observation platforms	WBAT				x		
Observation platforms	Deep vision				x		
Observation platforms	Activity diary (cruise logger)	x					
Observation platforms	Nansis survey backup			x			