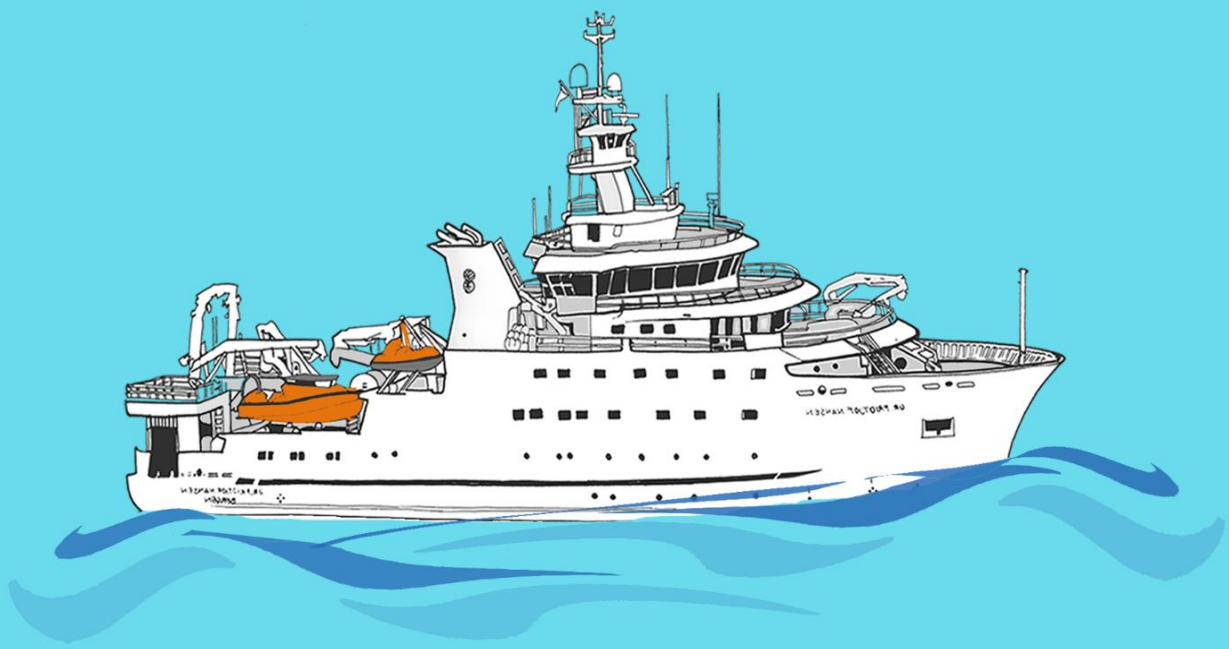
NORAD-FAO PROGRAMME
GCP/GLO/690/NOR

CRUISE REPORTS *DR FRIDTJOF NANSEN*
EAF-Nansen/CR/2018/10



SURVEY OF REGIONAL RESOURCES AND ECOSYSTEM OFF BAY OF BENGAL

Survey no 2018410

Bangladesh

2 – 17 August 2018

Department of Fisheries
Ministry of Fisheries & Livestock, Bangladesh

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" (GCP/GLO/690/NOR) aims to further strengthen the knowledge base and the overall institutional capacity for the implementation of the Ecosystem Approach to Fisheries (EAF) in developing countries, with additional attention to the impact of climate variability and change, pollution and other anthropogenic stressors.

The programme, that started implementation in May 2017, builds on earlier phases, and is governed by an agreement between the Food and Agriculture Organization of the United Nations (FAO), the Institute of Marine Research (IMR), Norway and the Norwegian Agency for Development Cooperation (Norad). The three pillars of the new programme are: Science, Fisheries management, and Capacity development. A new state of the art research vessel, *Dr Fridtjof Nansen* is an integral part of the programme. A science plan, covering 11 research themes, guides the programme scientific work.

The programme works in partnership with countries, regional organizations, other UN agencies as well as other partner projects and institutions.

Le Programme EAF-Nansen

Le Programme EAF-Nansen "Appuyer la mise en oeuvre de l'approche écosystémique de la gestion des pêches en tenant compte des impacts du climat et de la pollution" (GCP/GLO/690/NOR), vise à renforcer la base de connaissances et la capacité institutionnelle pour la mise en oeuvre de l'approche écosystémique des pêches (AEP) dans les pays en développement, en accordant une attention particulière aux effets de la variabilité et du changement climatique, de la pollution et d'autres facteurs de stress anthropiques.

Le programme, qui a débuté en mai 2017, s'appuie sur les phases précédentes et est régi par un protocole d'accord entre l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO), l'Institut de recherche marine (IMR) de Norvège et l'Agence norvégienne de Coopération au développement (Norad). Les trois piliers du nouveau programme sont: la science, l'aménagement de la pêche et le développement des capacités. Un navire de recherche à la pointe de la technologie, le nouveau *Dr Fridtjof Nansen*, fait partie intégrante du programme. Un plan scientifique, couvrant 11 thèmes de recherche, guide les travaux scientifiques du programme.

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

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By

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Institute of Marine Research
Bergen, 2019

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EXECUTIVE SUMMARY

This survey was part of a synoptic coverage of the Bay of Bengal marine resources and ecosystems to be conducted by the RV *Dr Fridtjof Nansen* under the framework of the EAF-Nansen Programme (2017-2021). Survey objectives represented a wide scope of research areas linked to the EAF-Nansen Science Plan and encompassing marine resources, pollution and climate. Therefore, in addition to providing key information on the abundance and distribution of main pelagic stocks, the survey programme was designed to also support longer term research projects under the EAF-Nansen science plan.

This report documents the scientific scope of the survey, the sampling methods used and provides preliminary results while the broader set of results is expected to come as part of the activites under the EAF-Nansen Science Plan and will be published separately.

The environmental conditions reflected what to be expected during this season, with surface temperatures approaching 30 degrees C, with an east-west gradient and warmer sea surface temperatures towards the west. A surface front between the fresh water plume and shelf waters of oceanic origin was observed where fish (probably hilsa shad) was concentrating and where numerous fishing boats were observed. Very low oxygen levels (< 0.1 ml/l) were observed below the thermocline at depths of about 70 to 100 m. These conditions are similar to what found in the Arabian Sea. Downwelling conditions suggesting that during that period oceanic nutrients were in poor supply and therefore the open ocean played a limited role in driving the biological productivity over the shelf. Productivity, at least during this season, seems to be driven by the river outflow.

According to survey objectives, biomass estimates were only possible for pelagic fish and resulted in a total of about 158 000 tonnes. These results are comparable to what found in previous surveys with the RV *Dr Fridtjof Nansen* in 1979 and 1980. It should be noted that shallow parts of the shelf (shallower than 20 m) were not covered by these surveys and that herefore the estimates represent an underestimate of the total pelagic fish biomass available.

Scientific results based on the samples collected on various aspects or marine ecology and pollution will be reported separately through collaborative work at the national, regional and interregional levels.

CHAPTER 1 INTRODUCTION

This survey was planned as part of a synoptic coverage of the Bay of Bengal marine resources and ecosystems to be conducted by the RV *Dr Fridtjof Nansen* in 2018 as part of the EAF-Nansen Programme (2017-2021). In connection with this phase of the Programme, a Science Plan has been developed those addresses 11 different topics within three main lines of research related to resources, impacts of oil/mining activities and pollution on resources and ecosystems and climate change. Therefore, in addition to providing key information on the abundance and distribution of main pelagic stocks, the survey programme was designed to also support the research projects under the EAF-Nansen science plan. Within this framework, the survey scope and objectives for the Bay of Bengal were discussed and agreed to during a regional meeting held in Colombo (Sri Lanka) in August 2017. A post-survey meeting was held in Yangon on 19-21 February and this version includes comments and suggestions provided in that connection.

This report is intended to document the scientific scope of the survey, the sampling methods used and to provide preliminary results. A broader set of results are expected as part of the activites under the EAF-Nansen SciencePlan and will be published separately.

1.1 The survey area

The area surveyed in 2018 by the RV *Dr Fridtjof Nansen* included the continental shelf and upper slope of East Africa (continental) (Leg 1), the Mascarene Bank (Leg 2) and parts of the Bay of Bengal region (Leg 3). Transfer of the vessel between the different legs were used as an opportunity to carry out studies of specific oceanographic features and mesopelagic communities. Figure 1 provides an overview of the surveys undertaken as part of Leg 3.

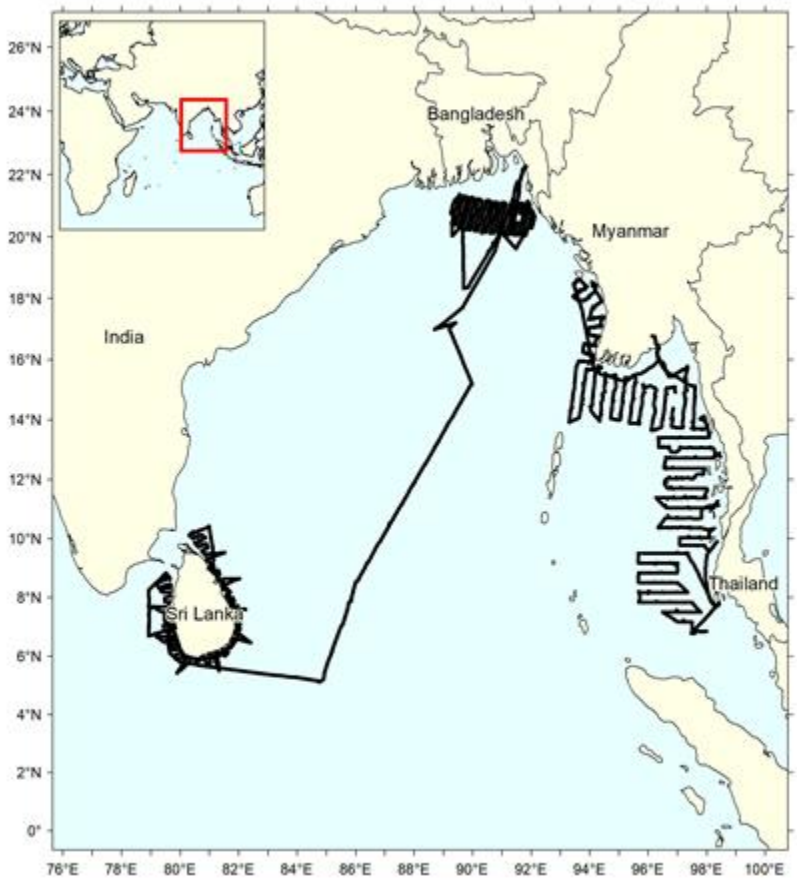


Figure 1. The survey plan for *Dr Fridtjof Nansen*, leg 3

Leg 3 started in Colombo (Sri Lanka) on 24 June 2018 and covered the continental shelf and upper slope of Sri Lanka until 16 July. After completion of the survey off Sri Lanka the vessel moved northwards to complete oceanographic sampling in the international waters of the Bay of Bengal. In Bangladesh, the main emphasis has been on pelagic resources, while in Myanmar on distribution of eggs and larvae. Off Thailand the priority has been to sample the deep waters of the Andaman Sea.

This report describes the ecosystem survey on the continental shelf of Bangladesh EEZ, and extending offshore into deeper waters for a mesopelagic transects, to cover hydrographic conditions, phyto-, zoo- and ichthyoplankton, abundance of pelagic resources, biodiversity from trawl catches, pollution (micro plastics and food safety), and nutritional value of fish. The survey design prepared by the Bangladesh Marine Fisheries Survey Design Working Group was provided prior to the survey by the Department of Fisheries of Bangladesh (Fig. 2).

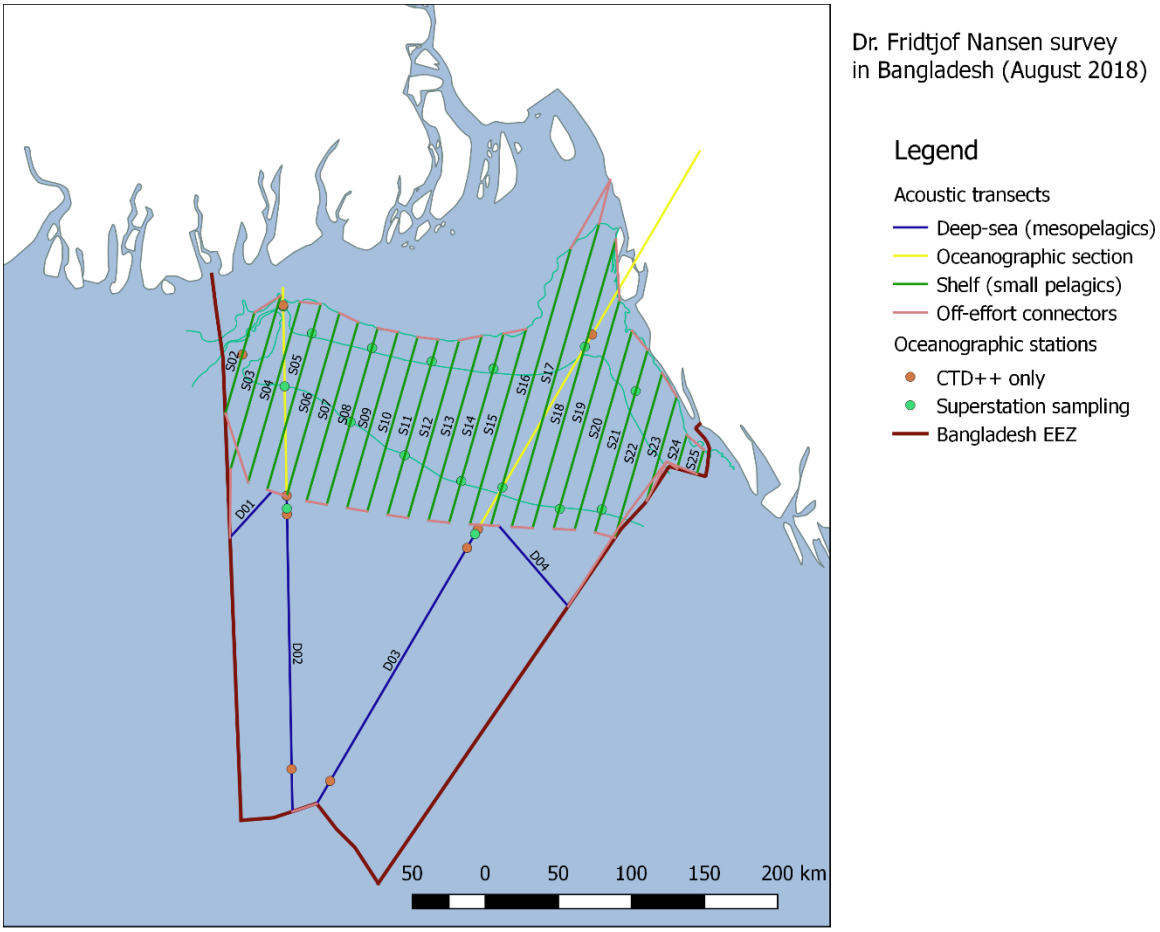


Figure 2. Proposed survey plan for the RV *Dr Fridtjof Nansen*, Leg 3.3, Bangladesh, 2018

1.2 Survey objectives

Hydrography:

- To observe the hydrographic conditions off the coast of Bangladesh and on the continental shelf. Hydrographic stations were conducted in connection with the pelagic trawls to provide information on the environmental conditions within which fish was found. Two oceanographic transects from the continental shelf to the coast were also performed to assess the change in water parameters from the river outlets to the Bay of Bengal. The following hydrographic parameters were collected for analysis: temperature, salinity, dissolved oxygen, fluorescence, chlorophyll a, nutrients, pH and total alkalinity.

Phytoplankton, zooplankton, ichthyoplankton and jellyfish:

- To observe the distribution, abundance and composition of phytoplankton, zooplankton, ichthyoplankton and jellyfish off the coast of Bangladesh and on the continental shelf. Sampling for these biological parameters was also performed in connection with pelagic trawl stations. This was intended to provide data to better

understand acoustic backscatter from zooplankton as compared to acoustic back scatter due to fish and jellyfish.

Pelagic and demersal fish stocks:

- To obtain information on abundance, distribution (also by size) of the main pelagic fish species, using the acoustic method, including targeted trawling, in a systematic grid survey strategy.
- To collect information on biodiversity of fish from trawl catches.
- To collect samples for genetic analysis for selected species.
- To collect stomach samples for analysis of contents (diet) including micro plastics.
- To collect species for taxonomic analysis and classification

Mesopelagic fish:

- To identify the main species of mesopelagic fish off the continental shelf and on the shelf break
- To determine the acoustic densities of mesopelagic fish off the continental shelf and on the shelf break

Contaminants:

- To collect samples of fish species consumed locally for analysis of contaminant levels and nutrient values.

Parasites:

- To determine the burden of macroparasites in fish species

Marine debris and pollution:

- To record occurrences and locations of surface marine debris and microplastics and to describe the neuston communities in the associated collected samples.

1.3 Participation

A total of 30 scientists and technicians from Bangladesh, India and Norway participated in the survey. The full list of the participants and their affiliations is given in Table 1 below.

Table 1. List of participants, their role and affiliation during the period of 02.08.2018 to 17.08.2018

Name	**Institute**	**Role**
Erik OLSEN	IMR	Cruise leader
Md Abdullah AL-MAMUN	DoF, Bangladesh	Regional Cruise leader
Ines DIAS BERNARDES	IMR	Scientist
Sarah Ann BRUCK	IMR	Scientist
David CERVANTES	IMR	Scientist
Miguel Bao DOMINGUEZ	IMR	Scientist
Geir LANDA	IMR	Instrument chief

Hege ROGNALDSEN	IMR	Instrument operator
Anna NORDHAGEN	IMR	Scientist
Marek OSTROWSKI	IMR	Scientist
Bineesh KINATTUM KARA	ZSI, India	Scientist
Anil MOHAPATRA	ZSI, India	Scientist
Subhrendu Sekhar MISHRA	ZSI, India	Scientist
Abu Sayeed Muhammad SHARIF	BORI, Bangladesh	Scientist
Abu Ansar Mohammad RIZWAN	WF, Bangladesh	Scientist
K M Shahriar NAZRUL	DoF, Bangladesh	Scientist
Suman BARUA	DoF, Bangladesh	Scientist
Al MAMUN	DoF, Bangladesh	Scientist
Nripendra Kumar SINGHA	DoF, Bangladesh	Scientist
Md Sharif UDDIN	DoF, Bangladesh	Scientist
Moin Uddin AHMAD	DoF, Bangladesh	Scientist
Md Mahmudul Islam CHOWDHURY	DoF, Bangladesh	Scientist
Mohammad Mohidul ISLAM	BFRI, Bangladesh	Scientist
Sk Humaun KABIR	DoF, Bangladesh	Scientist
Mohammad Ashraful ALAM	BFRI, Bangladesh	Scientist
Sayedur Rahman CHOWDHURY	IMS, CU, Bangladesh	Scientist
Syed Shoeb MAHMUD	Navy, Bangladesh	Scientist
Md Jahangir SARKER	NSTU, Bangladesh	Scientist
Farhana Lovely	DoF, Bangladesh	Scientist
Mosammat Rashida AKTER	DoF, Bangladesh	Scientist

List of institution abbreviations:

- IMR: Institute of Marine Research, Bergen, Norway
- ZSI: Zoological Survey of India, Kolkata, India
- NSTU: Noakhali Science and Technology University, Noakhali, Bangladesh
- DoF: Department of Fisheries, Bangladesh
- BORI: Bangladesh Oceanographic Research Institute
- BFRI: Bangladesh Fisheries Research Institute
- WF: WorldFish
- IMS, CU: Institute of Marine Sciences, University of Chittagong

1.4 Narrative

The scientific team arrived on the vessel on the evening of 1st August. The next day a 'Nansen event' was organized with about 50 participants including the minister of fisheries, the Mayor of Chattagram, the member of parliament of a local constituency, officials from the Ministry of Fisheries and Livestock, officials from the Department of Fisheries, FAO Country Representative, the Charge d'Affairs of the Royal Norwegian Embassy, national press and more. As the event lasted into the afternoon the Nansen missed the tide and had to wait for departing Chittagong harbour until the 3rd August.

The Nansen left Chattagram harbour at 13:00 on 3rd August, and arrive at the start of the first pelagic transect in the afternoon. From the 3rd to 7th August the easternmost part of the pelagic

survey area was covered. From 7th to 10th August the vessel carried out four mesopelagic transects off the continental shelf break in the southern part of the Bangladesh EEZ. After finishing the mesopelagic transects the vessel continued with the pelagic transects on the shelf, starting in the westernmost part of the EEZ, over the submarine canyon area 'Swatch of no ground'. The Nansen continued with the pelagic transects towards the east according to the survey plan (figure 2) with sampling locations selected according to depth strata and observations of fish aggregations on the echosounder. In select locations some demersal trawl hauls were made for biodiversity studies and collection of samples as reference specimens.

During the survey six open science seminars were held by the Norwegian, Indian and Bangladeshi scientists.

Sampling on stations ended in the afternoon of 16th August, after which the vessel headed north along the last pelagic transect (S16) towards port. On 17th August the vessel was at the anchorage site outside of Chattagram harbour waiting for the pilot who took the vessel to quay in Chattagram Harbour (Grain Silo Jetty) at 14:30.

Upon arrival in Chattagram the local scientific crew departed and samples destined for Bangladesh institutions were offloaded.

In the evening of 17th August the Ministry of Fisheries and Livestock hosted a welcome reception for all crew and scientists at the Chattagram Boat Club.

1.5 Survey effort

Hydrographic and biological parameters were sampled and measured to coincide with the pelagic trawls on the survey. At these "Super Stations" several different deployments were performed for extensive sampling. Table 2 displays the quantifiable survey effort for the hydrographic, plankton, microplastic, bottom and pelagic trawl sampling events during the survey.

Table 2. Survey effort for hydrographic, plankton and microplastic events during the survey.

Region	CTD with Water Sampling	CTD Only Station	Phytoplankton Net	WP-2 Net (Zooplankton) (≤ 30 m)	WP-2 Net (Zooplankton) (> 30 m)	Mammoth Multinet (Ichthyo-plankton)	Manta Trawl (Micro-plastics)	Pelagic trawl	Bottom Trawl
Bay of Bengal	36	2	31	32	30	22	29	37	5

The positions of the sampling events (stations) listed in Table 2 above are plotted on maps of the Bay of Bengal below, with the course track and trawl stations plotted in Figure 3, and CTD and plankton stations plotted in Figure 4.

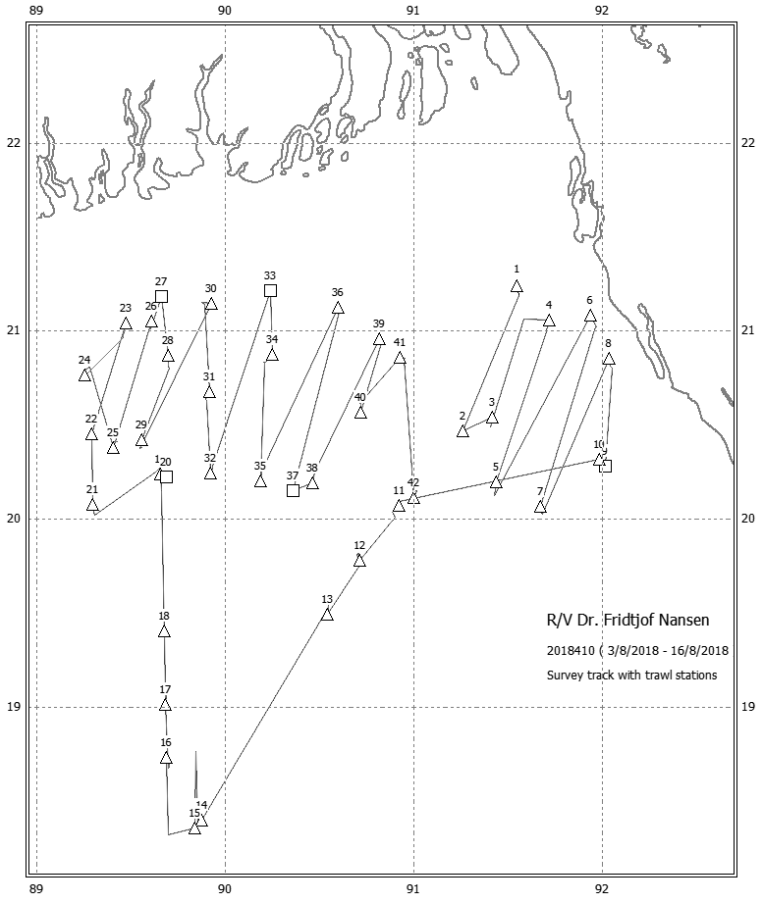


Figure 3. Course track and trawl stations

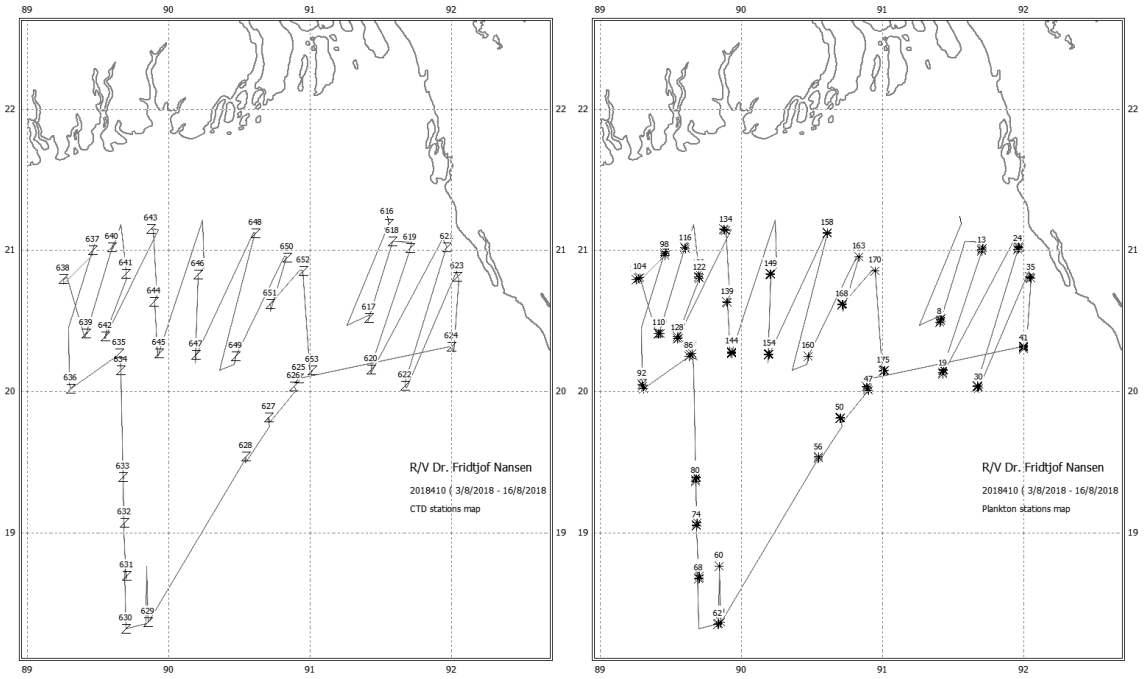


Figure 4. CTD (left) and plankton (right) stations map.

CHAPTER 2 Methods

2.1 Oceanography

2.1.1 Underway sampling

The core of the underway water sampling system is an SBE-21 thermosalinograph (TSG), manufactured by Seabird Inc. (Bellevue, Wa, USA). It measures the temperature and conductivity of seawater of the engine cooling water; salinity is derived computationally in the data logging software; the sampling rate is 10 seconds. Each sample is referenced by UCT time and geographical position obtained from the onboard differential GPS. Seawater is supplied through the vessel's piping system from the intake located midships on the starboard side at 4m depth. Another temperature sensor is installed as close as possible to the water intake to measure the true temperature of the ambient ocean. In addition to the standard sensors, the TSG onboard the vessel is fitted a Turner Design C3 Submersible Fluorometer to measure turbidity and fluorescence levels. During the survey the TSG operated continuously, providing the data covering the entire survey track from the 3rd to 17th of August.

The data restrictions affected the ADCP-derived current observation, limited to one section only, collected during the final survey stage.

2.1.2 Station sampling

To get a depiction of the chemical and biological makeup in the pelagic zone, hydrographic and biological station sampling was carried out to coincide with each pelagic trawl. Although most stations were shallower than 200 m, eight stations did have a maximum sampling depth of 500 m. Figure 5 below depicts the sampling events that occur at each of these "Super Stations" based on maximum depth. Only two stations during the survey were CTD-only stations. Table gives an overview of the hydrographic samples collected.

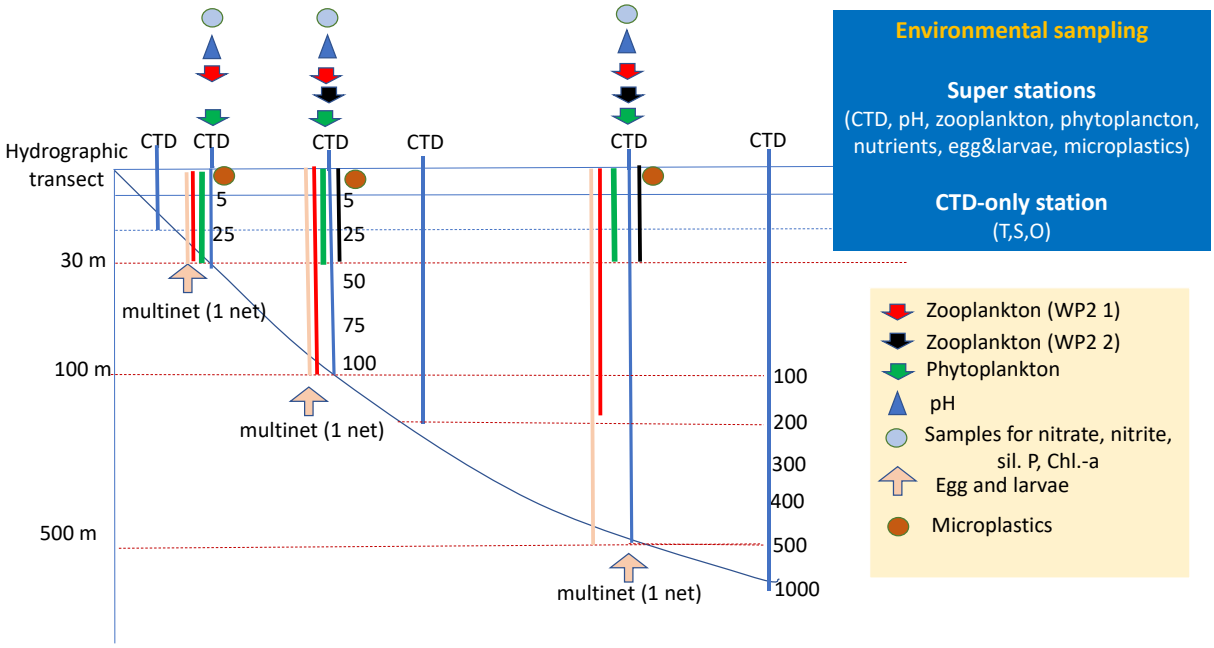


Figure 5. Super Station sampling diagram based on depth.

Table 3. Quantity of samples collected for hydrographic parameters

Survey area	CTD Only Station	CTD with Water Sampling	pH & Total Alkalinity	Nutrients IMR	Chlorophyll a	Dissolved Oxygen	Salinity
Bay of Bengal	2	36	201	201	173	9	15

2.1.3 CTD sensors – temperature, salinity, oxygen and fluorescence

Hydrographic parameters were monitored at 36 Super Stations and 2 CTD only stations throughout the survey (**Error! Reference source not found.**). The CTD and additional sensors mounted on the 12-bottle rosette collected vertical profiles for conductivity (salinity), temperature, pressure (depth), dissolved oxygen, fluorescence, and photosynthetically active radiation (PAR).

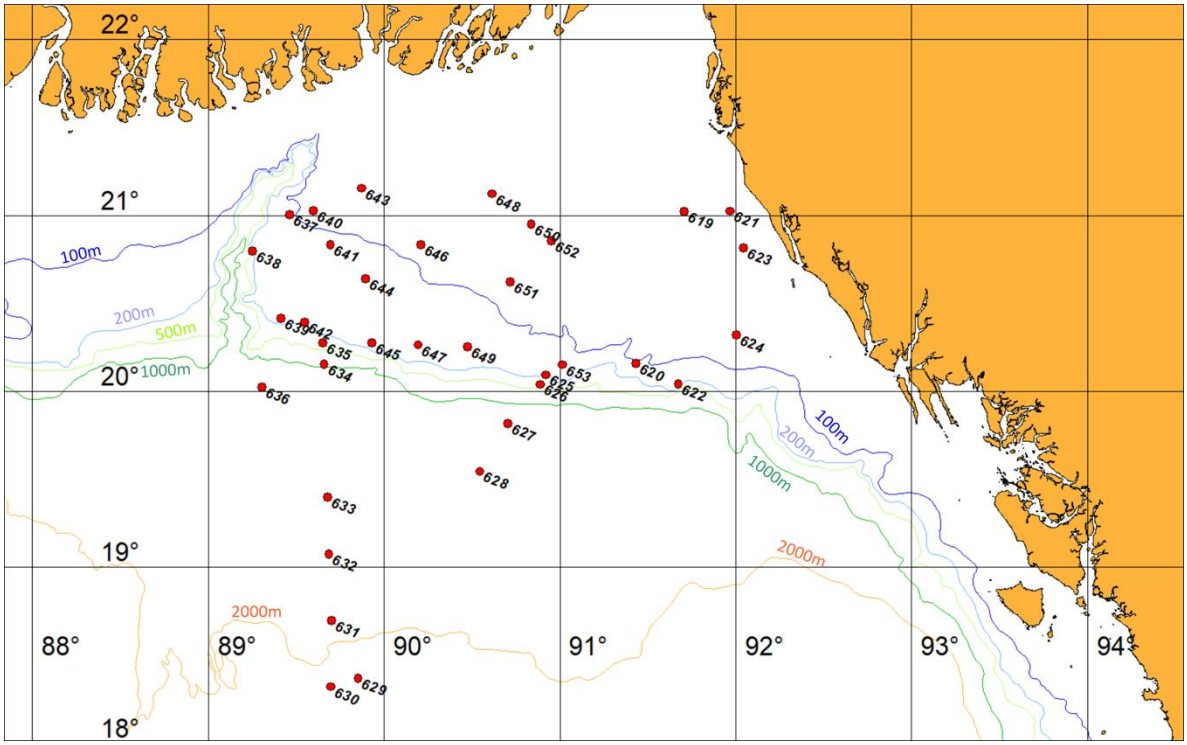


Figure 6. Distribution of the 38 CTD stations occupied during the survey. The station numbers shown in italics; the bottom contours of 100, 200, 500, 1000 and 2000 m are color coded. All CTD stations collected vertical profiles for salinity, temperature, oxygen, fluorescence and Photosynthetically Active Radiation (PAR).

Vertical temperature and salinity profiles were obtained by a Seabird 911plus CTD containing a SBE 3plus temperature sensor, SBE 4C conductivity sensor and a Digiquartz® pressure sensor. In addition, *in situ* concentrations of dissolved oxygen were measured using a CTD-mounted SBE 43 dissolved oxygen sensor. Attached to the CTD was also an uncalibrated Chelsea III Aquatracka fluorometer, which measures *in situ* fluorescence on a relative scale. Lastly, a LI-COR Biospherical Photosynthetic Active Radiation (PAR) Sensor is also attached

to measure the downwelling irradiance in the water column. Real time logging and plotting was performed using the Seabird Seasave software.

Water bottle samples for salinity and dissolved oxygen for sensor validation were obtained at the end of the survey due to data restrictions in force during most of the survey. Water samples were collected and measured on board with a Guildline Portasal Salinometer 8410A to validate the salinity calculated from the CTD conductivity sensor (Figure). The dissolved oxygen sensor measurements were validated via Winkler titration (Grasshoff et al. 1983) (Figure) which was also performed on the vessel. Ideally, validations would take place throughout the survey. However, a limited number of validations were performed near the end of the survey due to initial data restrictions. Both the dissolved oxygen and salinity sensor measurements were validated successfully on the survey.

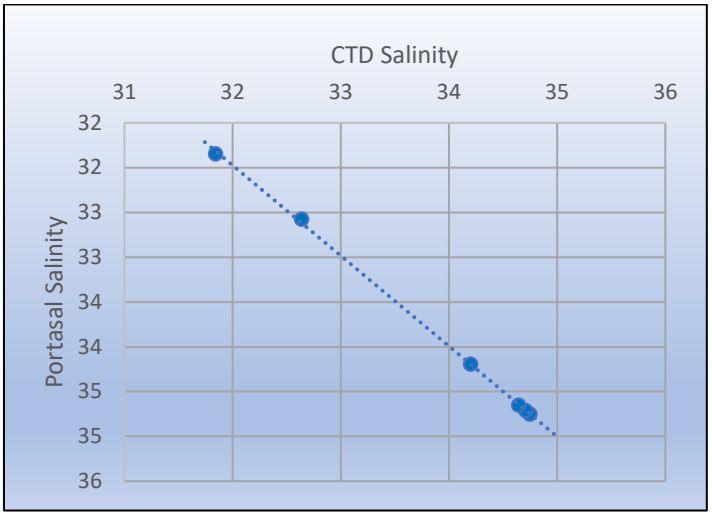


Figure 7. CTD calculated salinity values compared to Portasal calculated salinity values from water collected at the same depths.

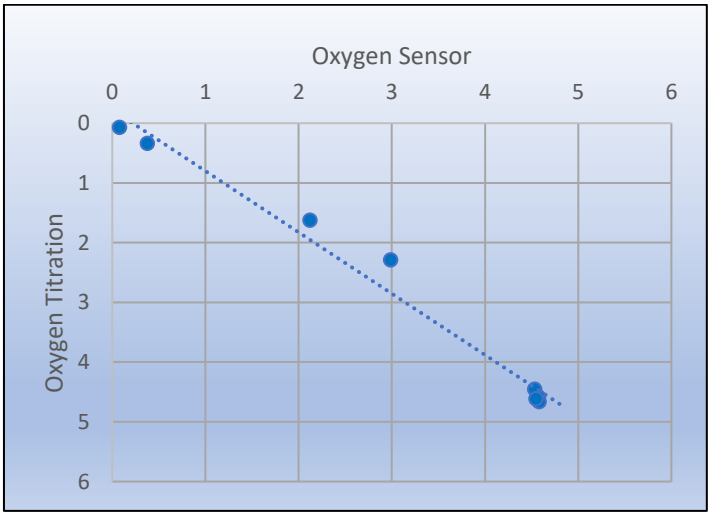


Figure 8. CTD mounted SBE 43 dissolved oxygen sensor measurements compared to Winkler titration measurements from water collected at the same depths.

2.1.4 Rosette Water Sampling

Dr. Fridtjof Nansen is equipped with a 12 Niskin bottle (10 L) rosette that is used to collect water samples from pre-defined depths. The standard water sampling depths were set to: 5, 25, 50, 75, 100, 200, 300, 400 and 500 m.

Ocean acidification parameters (pH and total alkalinity)

In addition to the CTD profiles, the vertical profiles of pH and total alkalinity were obtained from the onboard analysis of water bottle samples. Seawater samples for pH and total alkalinity analyses were collected at each Super Station in borosilicate glass bottles (250 ml) using silicone tubing to reduce air exchange. Both pH and total alkalinity were analysed on board the vessel. pH was determined spectrophotometrically using a diode array spectrophotometer and a pH sensitive indicator, m-cresol purple in 2 mM solution, as described by Clayton and Byrne, 1993; Chierici *et al*., 1999. Total alkalinity was measured by potentiometric titration with acid (0.05M HCl) and changes in pH were measured with an electrode (potential in mV) using the Metrohm tiamo software. Further processing of the data will be at the Institute of Marine Research and will provide more information on the marine carbonate system and parameters for ocean acidification and will be used for collaborative studies with partners from the countries where the data have been collected.

Nutrients

Seawater samples for nutrient analyses (nitrate, nitrite, silicate and phosphate) were collected at each Super Station in 20 ml polyethylene vials, preserved with 0.2 ml chloroform, and kept cool and dark in a refrigerator. The analyses will be made on shore at the Institute of Marine Research, using a modified Alpkem AutoAnalyzer C (O.I. Analytical, USA) and following standard procedures (Grasshoff, 1965). Another batch of the nutrient samples went to the Bangladesh Ocean Research Institute (BORI) for a comparative analysis.

Storage may introduce loss of accuracy of the results, especially when the concentrations of nitrate, nitrite, silicate and phosphate are low.

2.2 Plankton sampling

2.2.1 Chlorophyll a

Seawater samples for chlorophyll a analyses (an indicator of phytoplankton biomass) were collected from Niskin bottles corresponding to depths from 200 m to the surface at each Super Station. Samples were collected in 500 ml polyethylene bottles and immediately filtered with a 0.7µm filter (25 mm Munktell glass-fibre filters Grade: MGF) and vacuum pump at 200 mm Hg. Due to a lack of time and personnel, filters were stored at -20°C for subsequent chlorophyll a analysis post-survey.

2.2.2 Phytoplankton Net

Qualitative phytoplankton samples were collected at each Super Station with a 10 µm net with a 35 cm diameter. The net was hauled vertically at a speed of 0.1 ms-1 from a depth of 30 m to the surface (or 5 m above bottom at the ≤ 30 m stations). These samples are not quantitative, but used to establish the taxonomic composition of the phytoplankton community. After sampling, the cod-end was rinsed and the sample was preserved with Lugol's Iodine.

A total of 31 phytoplankton net deployments were performed during the survey. On board analysis of the samples did not take place but the samples were sent to the Bangladesh Ocean Research Institute for taxonomic analysis. WP2 net (180 µm) – vertical hauls (only at super-stations. Additionally, 5 litres of water from each Niskin bottle were filtered over a 10 µm sieve to collect a concentrated sample for plankton analyses at the Bangladesh Ocean Research Institute. The specific analysis has not yet been determined for these 32 concentrated plankton samples.

2.2.3 Zooplankton sampling

Zooplankton were collected at each Super Station with a WP2 net (mesh size 180 µm, 56 cm diameter) (Fraser 1966) and hauled vertically at a speed of ~0.5 ms-1. At stations with bottom depths ≤ 30 m, the WP2 net was lowered to 5 m above the bottom. At stations of depths of at least 100 m, a second WP2 net was deployed to 5 m above the bottom. For the much deeper stations, the maximum bottom depth for the second WP2 net was 200 m. The purpose of the second WP2 deployment at 30 m was to enable a direct comparison of the zooplankton composition and concentrations in the uppermost layer of the water-column to the bottom-depth gradient.

Each of the 62 zooplankton net deployment samples was divided into two equal parts using a Motoda plankton splitter (Motoda 1959). The first part of the sample was size-fractioned by using a series of sieves with decreasing mesh-sizes of 2000 µm, 1000 µm and 180 µm. The zooplankton retained on each sieve were dried on aluminium trays at ~60ºC for 24 h. These samples are undergoing a second pass drying and weighing at the Institute of Marine Research for biomass estimation for the different size-groups. The second part of the sample was preserved in seawater with concentrated formalin buffered with borax for subsequent species identification at the Bangladesh Oceanographic Research Institute.

2.2.4 Ichthyoplankton

Ichthyoplankton (fish eggs and larvae) were collected at each Super Station using a Multinet Mammoth net (1 m2) with a mesh size of 300 µm. Oblique MultiNet Mammoth (300 µm-mesh) tows to collect fish eggs and larvae were conducted at 22 super stations. The samples were taken obliquely from ~25 - 0 m at 30 m bottom depth, and 100 - 0 m at greater depths using a single net. The samples were rinsed from the net, collected in the cod-end, and preserved with formalin. Fish larvae visible with "the naked eye" are usually removed from the total sample, photographed and transferred to Eppendorf tubes in 96% ethanol, but limited time and personnel did not allow for this processing on this survey. Instead, the whole cod-end sample was collected in 100 ml polyethylene bottles with concentrated formalin to be analysed at the Bangladesh Oceanographic Research Institute.

2.2.5 Microplastics

Microplastics were collected at each Super Station by towing a Manta trawl at the surface. The Manta trawl has a rectangular opening of 19 cm × 61 cm, mesh-size 335 µm and two wings to keep it balanced at the surface during towing. Trawls were hauled horizontally at a speed of ~1.5 ms-1 for 15 minutes. The counts of a manual flowmeter attached in the lower part of the trawl opening were recorded at the start and end of each trawl. Trawling was performed some meters away from of the starboard side, about mid-ship, attempting to avoid the wake of the vessel. Each of the cod-ends from the 29 Manta trawl was washed in filtered seawater over a sieve with a mesh-size of 180 µm. Because the Institute of Marine Sciences, University of Chittagong and the Institute of Marine Research both had interest analysing the samples for microplastics and neuston, the whole sample was split in halves and preserved with ethanol so both institutions can perform analyses post-cruise.

2.3 Bottom mapping echo sounder

The EM 710 and EM 302 multibeam echo sounders are both belonging to a high to very high-resolution seabed mapping system. The EM 302 is hull mounted whereas the EM 710 is mounted on the drop keel. The operational depths of the EM 710 are 3 to 2000 m and of the EM302 are 10 to 7000 m. Across track coverage (swath width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. The operating frequencies are between 70 to 100 kHz. There are 128 beams with dynamic focusing employed in the near field. The transmitting fan is divided into three sectors to maximize range capability and to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping and use distinct frequencies or waveforms. The along track beam width is 1 degree. Ping rate is set according to depth. The receiving beam width is 2 degrees. Sound profiles were set manually in the system according to the area of operation. The EM710 was not operational for most of the survey. Data from the EM302 was logged to the on-board Olex plotting system and to rawdata files.

The EM 710 and EM 302 were not allowed to be used until 12th August. During the survey, swath coverage and depth range settings were adjusted accordingly to optimize the mapping. The measured sound speed profile was also input in the system when CTD measurements were carried out. Tide correction was not done.

The recorded data was viewed on Seafloor Information System (SIS), Kongsberg real time software designed to be the user interface and the realtime data processing system for its hydrographic instruments, and on Olex, the onboard navigation planning system. An offloaded copy of the Olex bathymetric data is later loaded onto the Olex chartplotter of the national research vessel R.V. Meen Sandhani.

2.4 Biological trawl sampling

2.4.1 Fish sampling

Biological sampling of the fish was carried out using pelagic and bottom trawls. Pelagic trawls were conducted using the MultPelt trawl and a few bottom trawls were also done. All catches were sampled for composition by weight and numbers of each species caught. For the selected

target species, length (total length to the nearest cm) and weight (to the nearest 0,5 g) were also recorded. The list of species chosen for collection of length, weight, stomach or genetics is found in Annex VI. In additional, all families used for the acoustic abundance like Scombridae, Carangidae, Trichiuridae and Clupeidae would be also selected for the lengthweight measurements. Other specimens were collected and frozen for later stomach content analysis and genetics.

All catches were sampled for composition by weight and numbers of each species caught. Species identification was based on the FAO Species Catalogues. For the selected target species length (total length to the nearest cm), weight (to the nearest 0,5 g) were recorded. When the size distribution of the target species in the catch was seemingly narrow (similarly sized individuals), a total of 50 to 100 individuals were selected for the measurement of length and weight. Length and weight measurements were used to estimate the length-weight relationship and together with length frequency distributions applied in biomass calculations.

2.4.2 Taxonomy

Fish and invertebrate species identification was made to the lowest taxonomic level possible by experienced taxonomists and followed FAO species identification sheets for Fishery purposes, Fishing Area 51 (Fischer and Bianchi, 1984) and several online databases especially the catalog of fishes (Eschmeyer et al. 2018), WoRMS database (WoRMS Ed. Board 2018) and FishBase (Froese and Pauly 2018).

High resolution pictures were taken of uncommon species of both fish and some invertebrates for the photo database onboard *Dr Fridtjof Nansen* and for help in identification by specialists.

2.4.3 Jellyfish

Jellyfish caught as part of the trawl haul were identified to the lowest taxonomical level possible, and counted and weighed. Jellyfish specimens that were in a good condition were photographed (top and bottom sections), before being processed and preserved for future analysis. A small piece of the oral arm tissue as well as one gonad was removed and preserved in 96% ethanol (EtOH), and stored at -20°C. Tissue samples stored in EtOH were collected for genetic studies, aimed at determining species and population structure, as well as establishing regional and global connectivity. The rest of the specimen was preserved in 10% formalin. These samples formed part of a greater morphological identification and taxonomic study.

2.5 Acoustic sampling and biomass estimation

2.5.1 Sonar data

The SU 93 sonar was used for searching for schools, but no data was logged.

2.5.2 Echo sounder

Acoustic data were recorded using a Simrad EK80 Scientific Split Beam Echo Sounder equipped with keel-mounted transducers at nominal operating frequencies of 18, 38, 70, 120, 200 and 333 kHz. The last calibration was conducted in Bergen on the 23rd January, 2017. Annex I gives the details of the acoustic settings used during the survey.

2.5.3 Allocation of acoustic energy to species group

Acoustic data were logged and post-processed on board using the latest acoustic data post-processing software, the Large-Scale Survey System (LSSS) Version 2.0.

Scatters were displayed at 38 kHz. The mean 5 nautical miles (nm) area backscattering coefficient sA (m2/NM2) was allocated to a predefined set of species groups on the basis established echogram features and stored as mean values per 1 nautical mile (nm). Allocation of acoustic densities to species groups and respective species are listed in Table 3. Ground truthing and estimation of mean length and weight were accomplished by means of targeted pelagic trawling. In cases where the integrated echo contained more than one category of fish (see Table 3), the mean sA-value allocated to each category was in the same ratio as their contribution to the abundance in trawls in that area. Table 3 list the target groups used.

The acoustic backscatter was scrutinized daily and allocated to the various target groups. The sV threshold used when sardinellas occurred to filter out other species and plankton was -45 dB, or in regions where the plankton layer was extremely dense and even lower threshold had to be used. For Pelagic I, Pelagic II and "other pelagic species" -50 dB was used, or even lower is the plankton layer was extremely dense. To identify mesopelagic layers a threshold of -60 dB was used. Biomass estimates can only be estimated for those acoustic groups in which length and weight were recorded (see Table 3 below).

Table 3. Allocation of acoustic densities to species groups. Most common taxa are listed for the groups of Pel1 and Pel2 while for other groups only families are listed.

Group	**Taxon**	**Species**
SARDINELLA	Clupeidae	*Sardinella sp.*
Pelagic species group 1 (Pel1)	Clupeidae	*Anodontostoma chacunda*
	Engraulididae	Coilia dussumieri
		Setipinna phasa
		Setipinna tenuifilis
		Stolephorus andhraensis
		Stolephorus commersonnii
		Thryssa dussumieri
	Chirocentridae	*Chirocentrus spp*
	Dussumeridae	*Dussumieria elopsoides*
Pelagic species group 2 (Pel2)	Carangidae	*Megalaspis cordyla*
		Atule mate
		Alepes kleinii
		Atropus atropos
		Selar crumenophthalmus
		Scomberoides commersonnianus
		Scomberoides tol
		Parastromateus niger
		Decapterus macrosoma
		Decapterus russelli
	Scombridae	*Rastrelliger brachysoma*
		Rastrelliger kanagurta
		Auxis thazard
		Auxis rochei
		Thunnus tonggol

Group	Taxon	Species
		Euthynnus affinis
		Scomberomorus guttatus
		Scomberomorus guttatus
	Sphyraenidae	*Sphyraena spp.*
	Trichiuridae	*Trichiurus lepturus*
		Trichiurus gangeticus
		Lepturacanthus savala
		Eupleurogrammus muticus
Mesopelagic species	Myctophidae	
	Other mesopelagic fish	
Main demersal species	all demersal fishes	
Plankton	all plankton	

2.5.4 Estimation of biomass from acoustic measurements

The target strength (TS) function used to convert mean area backscattering coefficient sA (m2/NM2) at 38 kHz to number of fish corresponds to:

$$TS = 20 \log L - 72 \text{ (dB)} \quad (1)$$

or

$$CF = \frac{10^{7.2}}{4\pi} \cdot \overline{L}^{-2} \quad (2)$$

and in the simplest form

$$CF = \frac{1.2612 \cdot 10^{6}}{\overline{L}^{2}} \quad (3)$$

where CF is the conversion factor from acoustic density to fish biomass and $\overline{L}^2$ is the mean of squared fish lengths. This target strength function was originally established for North Sea herring, but has later been attributed to clupeids in general (Foote et al., 1986; Foote, 1987).

No specific target strength relations presently are available for the species at hand, and equation (3) has therefore been applied consequently for all targeted species in this time series. The biomass was calculated by multiplying the number of fish by the expected length at weight, estimated by regression of the log-length (total) against total weight. Separate length-weight relationships were worked for each region (north, central, south), pooling all data within each region.

The boundaries of encountered fish aggregations (post strata) were determined by means of contouring within the inner and outer zero-value limits of the transect lines. The strata contours were digitised using Nansis Maptool Version 2.1.4. Sub-stratification was used to isolate areas of similar densities, using the following pre-defined, standard categories:

1: $0 < s_A < 300$;

2: $300 \leq s_A < 1000$;

3: $1000 \le s_A < 3000$;

4: $3000 \le s_A \le 10000; 5 : 10000 \le s_A \le \infty$ (m2/NM2)

The basis for contouring is averages of five 1NM values along transects. At the end of transects and in connection with trawl stations the averaging may include fewer (from 1 to 4 single NM observations). This is a source of bias, but this bias is limited due to observations within strata having similar values. Other sources of bias of concern are the shallow distribution pattern (above integration limit), vessel avoidance behaviour of sardinella (Misund and Aglen, 1992) and inshore distribution (at depths smaller than 20meters). All estimates should consequently be considered as relative indices of abundance.

The overall length frequency distributions within strata were estimated by weighting the sample-distributions with the nearest valid 1 NM integrator value, or the average of two adjacent values. Target species of the same genus, i.e. S. aurita / S. maderensis and T. trecae / T. trachurus capensis, are not acoustically distinguishable, and the sA values were therefore split according to the relative distributions of the two species in each length group. The total number of fish in each length group was estimated as:

$$\rho_i = \frac{< s_A > t_{i,j} \cdot u_i}{\sum_i \frac{u_i}{C_{Fi}}} \cdot A_s \quad = \quad \frac{10^{7.2} \cdot t_{i,j} \cdot u_i \cdot < s_A > \cdot A_s}{4\pi \sum_i u_i \cdot (L_i + 0.5)^2} \qquad (4)$$

where: ρi = estimated number of fish in length group i
<sA> = mean recorded area backscattering coefficient (m2/NM2)
ti,j = proportion of species j in length group i
ui = proportion of sampled fish in length group i
As = horizontal area of stratum s
CFi = conversion factor for length group i
Li = length group i (nearest full cm below total length)
Li+0.5 = mean length in Li.

The basis for contouring is averages of 1NM values along transects. One sources of bias of concern are the shallow distribution pattern (above integration limit), vessel avoidance behaviour of sardinella (Misund and Aglen, 1992) and inshore distribution (at depths smaller than 20meters). All estimates should consequently be considered as relative indices of abundance.

The above equations show that the conversion from sA-values to number of fish is dependent on the length composition of the fish. It was therefore important to get representative length distributions from the key species groups in the whole distribution area.

When the size classes (of e.g. young fish and older fish) were well mixed, the various length distributions were pooled together with equal importance. Otherwise, when the size classes were segregated, the total distribution area was post-stratified, according to length distributions, and separate estimates were made for the strata containing fish with equal size.

For a stratum representing a distribution of a target group, the following basic data are needed for the estimation of abundance;

1) The average sA-value for the region,

2) The surface area (usually square nautical miles, NM^2), and

3) A representative length distribution of the fish in the region.

If the targeted fish was a mixture of more than one species, for example sardinellas, representative distributions of all the species within the stratum, as shown in the trawl catches, was used. Length distributions representing the various species for each catch was calculated and normalized to a unit number (usually 100). These were then averaged without weighting. Very small catches (normally less than about 20 fish) were not included. The total catch of each species from all the trawls in a stratum was used as a proxy for estimating the proportion of the total biomass of each species present. While it is recognised that catch is a poor indicator of relative abundance, especially for pelagic fish, no other method is accessible from the data available.

The process followed was therefore to

a) divide the sA-value between groups of fish and/or species,

b) produce pooled length distributions of a target species/category for use in the above equation and

c) calculate the biomass estimates for a region,

using the following procedure:

- The length-frequency samples of the species in the category were respectively pooled together with equal importance (normalized).
- The mean back scattering strength (ρ/sA) of each length frequency distribution of the target group/ species was calculated and summed. This was automatically done in the Excel spread-sheet made available for acoustic abundance estimation on board RV "*Dr. Fridtjof Nansen*".
- The pooled length distribution was used, together with the mean sA-value, to calculate the density (numbers per square NM) by length groups and species, using the above formula. The total number by length group in the area was obtained by multiplying each number by the area.
- The numbers were then converted to biomass using the estimated weight at length.

2.6 Food safety and nutrition

Fisheries are almost invisible in strategies to achieve SDG2, and nutrition and food security are not the primary focus in SDG14. Fisheries, however, support people either directly or indirectly through food and income and the unique nutrient content of fish plays a significant role in combating the triple burden of hunger, micronutrient deficiencies and non-communicable diseases. Nevertheless, the qualities of fish are not recognized in the global food

security discourse, and fish is strikingly missing from strategies for nutrient deficiency reduction. Having relevant, reliable and up-to-date food composition data are the basis for assessing nutrient intake, nutrient requirements and food based dietary guidelines.

The aim is to sample and analyse fish that are caught in pelagic-, mesopelagic- and demersal trawl. The main aim is the commercial, pelagic fish with a nutritional value. Pelagic fish are often the more common types (herring, mackerel) and will be analysed as filets or pooled samples, depending on size. The aim is to analyse the fishes species by species.

Samples of one or a few dominant species in each catch were taken. In case only a few individuals of each species were available, samples were pooled from catches of multiple stations.

Pelagic species (>25 cm) will be be analysed as individual samples. To get enough sample material, sample 25 individual fish, or at least 15 if it is difficult to get as many as 25 in one area. The sample contains the muscle tissue. In addition, it will be liver samples from the first 15 fishes, and 5 pooled samples of the 25 fillets (1-5, 6-10 and so on). If the species are shorter than 25 cm, a composite sample should contain at least 25 individuals or 120 g wet sample material. Some samples could contain more than 25 fish in order to get 120 g. If there are very many of the same species in one haul, up to 3 parallell composite samples were taken. One pooled sample is sufficient if there is a limited amount of fish.

The samples were homogenised by using a food processor. Approximately 20 g of the homogenised paste were transferred to a labelled 50 ml tubes. The rest of the homogenised samples were added to labelled salad tray for further freeze-drying. All samples were stored at -20 °C pending shipment to Institute of Marine Research for chemical analysis of selected nutrients and undesirables.

Samples of whole fish and fillet were sampled and stored pending analysis. The priority will be on selected nutrients and metals. Samples for other nutrients and contaminants will be stored pending budget for analysis.

The analyses will be carried out at Institute of Marine Research in Bergen, Norway. Typical analyses will include:

1. Nutrients: energy, water content, total fat, proteins, ash, fatty acids, cholesterol, vitamins (D, A, B12,), iodine, selenium and other minerals. Samples will be stored pending budget for analysis of amino acids and other vitamins.

2. Contaminants: Analyses of heavy metals will be carried out. Samples will be stored pending budget for analysis of inorganic arsenic, methyl mercury, PCB, dioxins, furans, PBDE, pesticides, and PAH.

All samples were stored at -20 °C pending shipment to Institute of Marine Research for chemical analysis of selected nutrients and undesirables.

2.7 Parasitological sampling

With the purpose of providing new knowledge about the parasites present in fish species of the region, an opportunistic parasitological sampling was carried out. The sampling was mainly focussed on the detection of zoonotic nematodes of the genus *Anisakis*, due to their medical and economic importance worldwide, since they are responsible of human disease (i.e. anisakiasis and allergy). The UV-press methodology was applied for parasite detection (Karl & Leinemann, 1993). Briefly, the method uses the fluorescence of frozen nematodes (Pippy, 1970) and is based on visual inspection of pressed viscera and/or fish fillets under UV light, i.e. tissues are 1) introduced in plastic bags, 2) flattened by hydraulic press, 3) deep-frozen, and finally thawed before inspection (Karl and Leinemann, 1993; Levsen and Lunestad, 2010). Results showed absence or low infection values of parasitic nematodes in many of the fish species sampled, e.g. *Cubiceps pauciradiutus*, *Dussumieria elopsoides*, *Megalaspis cordyla*, *Mene maculata*, *Sardinella fimbriata* and *Selar crumenophthalmus*. The species *Trichiurus lepturus* (prevalence= 76% (29 fish infected out of 34)) and *Harpadon nehereus* (prevalence= 32% (16 out of 50)) showed higher infection values. The majority of the nematodes were present in the viscera, while very few were found in the muscle. Further work is recommended (i.e. sampling higher numbers of specimens from different sea areas and period of the year) to confirm the infection values found in this study. In addition, the spiral valve of *Mobula tarapacana* was found parasitized by helminths (likely cestodes), and myctophids of the genus *Benthosema* were found to be infected by helminths (probably trematodes). All parasite samples will be identified by morphological and/or molecular means at the facilities of the IMR in Bergen, and results will be further analysed and discussed.

CHAPTER 3 Survey Results

3.1 Oceanography

3.1.1 Underway sampling

The continuous, underway sampling at 4 m depth by means of the on board thermosalinograph covered the length of entire survey track. The collected parameters included temperature, salinity, fluorescence (chlorophyll a) and turbidity. Figure 8 depicts the color-coded levels of these parameters along the the survey track from 3 August 2018 to 17 August 2018.

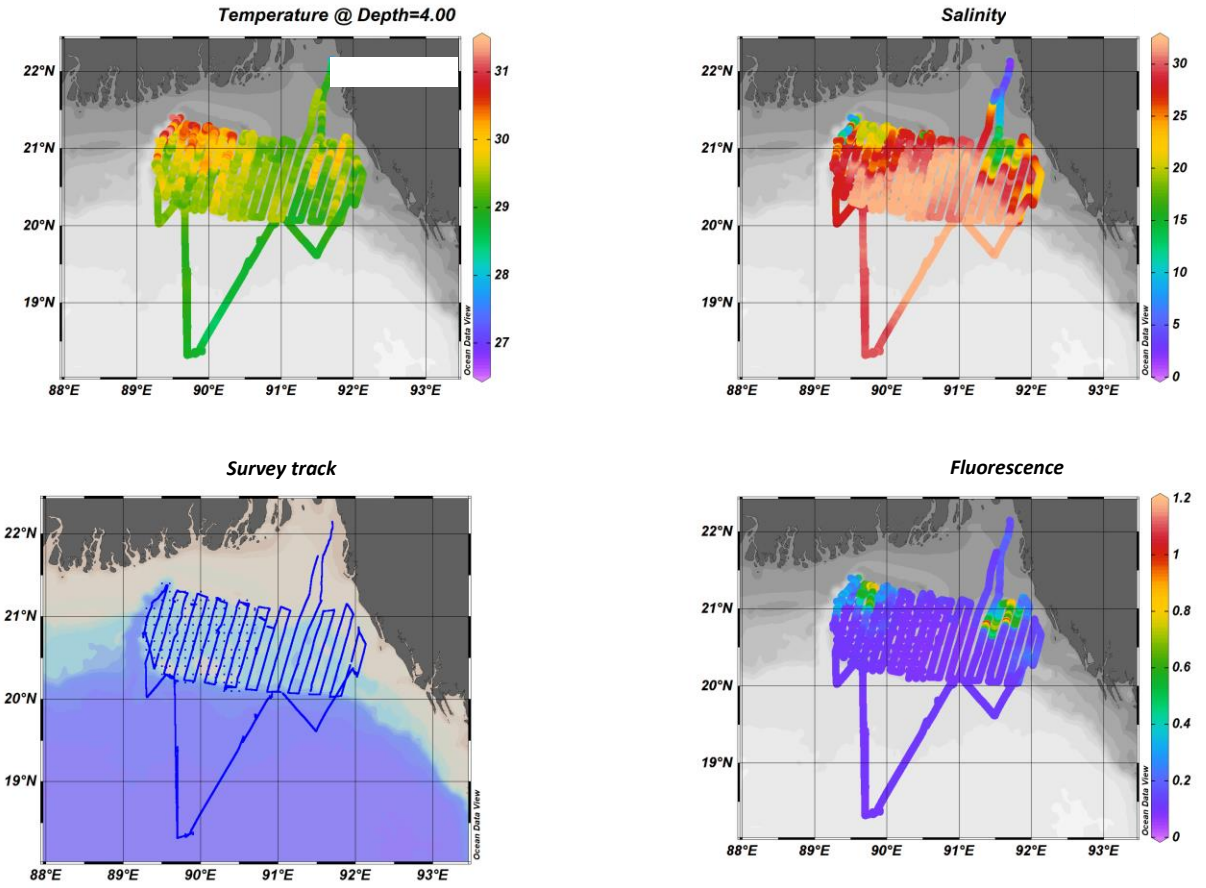


Figure 9. The survey track (bottom-left) and along-track distributions of temperature (top-left), salinity (top-right), survey and fluorescence (bottom-right) at 4m depth from the thermosalinograph observations.

Figure 9 shows the sea surface very warm, approaching almost 30°C across the surveyed area. The western part of the survey area is generally warmer. The cooler surface waters towards the east coast observed in this figure is consistent with the August climatology of the northern Bay of Bengal derived from satellite observations (Figure 10).

In addition to the overall east-west temperature increase, Figure 10A exhibits two regions of locally warmer water pools towards the northern boundary of the surveyed region. Noteworthly, the salinity and chlorophyll distributions (Figure 10B and 10C, respectively) and exhibit stong contrasts with surrounding ocean at the same locations. The sharp increase in the surface temperature, decrease in salinity in connection with the primary productivity increase

suggests that at these two locations, the survey ecountered the fronts of river the plume expanding into the oceanic waters.

The survey took place in the Meghna estuary region during August. During this period the river discharge is the annual maximum, and therefore the connection of the two low salinity surface water pools observed in Figure 9 is obvious. What is intriguing, however, is how the presence of such large pools of brackish water impacts the coastal circulation and how it contributes to overall shelf productivity, including fish production.

By analogy to other coastal regions where the dynamics of buoyant coastal plumes have been better studied, we interpret the observations in Figure 9 in the frame of the coastal buoyancy plume dynamics. In brief, when water plume is of fluvial origin, it is much lighter from ambient oceanic waters. It would therefore expand from the river mouth on top of the oceanic layer. Under the Earth rotation, the flow becomes deflected to the right of the discharge source, leading to the formation of the coastal buoyancy current (CBC) associated with density and salinity fronts at the sea surface. The coastal buoyancy fronts tend to develop a meandering pattern along the affected coasts. The observation of the fluvial origin water pools forming a meandering pattern within the area covered by the survey as shown Figure 10 suggest for a role of the CBC and the associated frontal mechanisms in the bottom-up control over the ocean productivity in this sector of the Bangladeshi shelf.

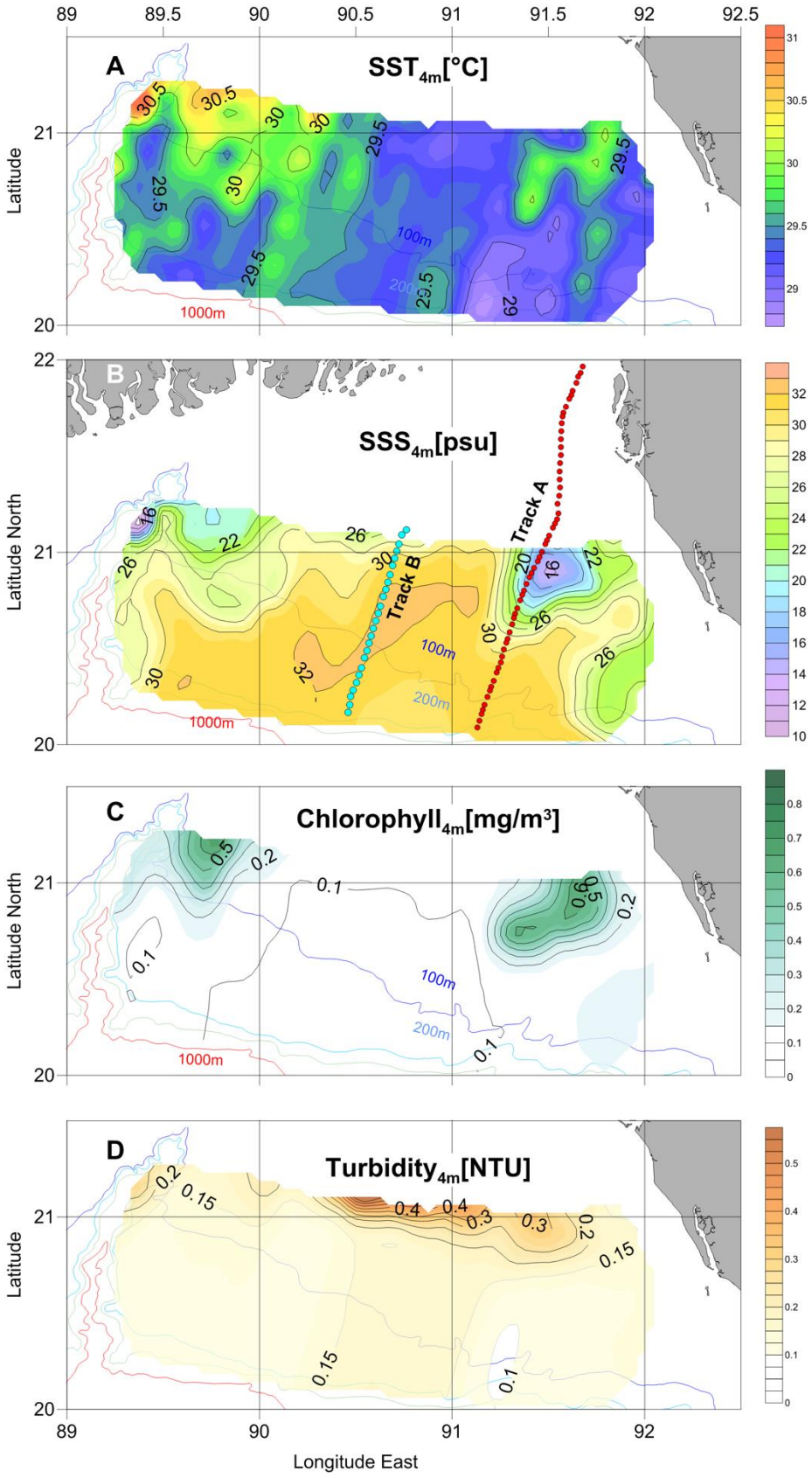


Figure 6. The statistically interpolated distributions of salinity (A) temperature (B) fluorescence (C) and turbidity (D) based on the underway data presented in Figure 9. Track A shows the vessel track between the mouth of the Karnaphuli River and outer shelf. The distribution of surface properties along that track are shown in Figure 2. Track B shows the ADCP line collected on August 14 (see Figure 4).

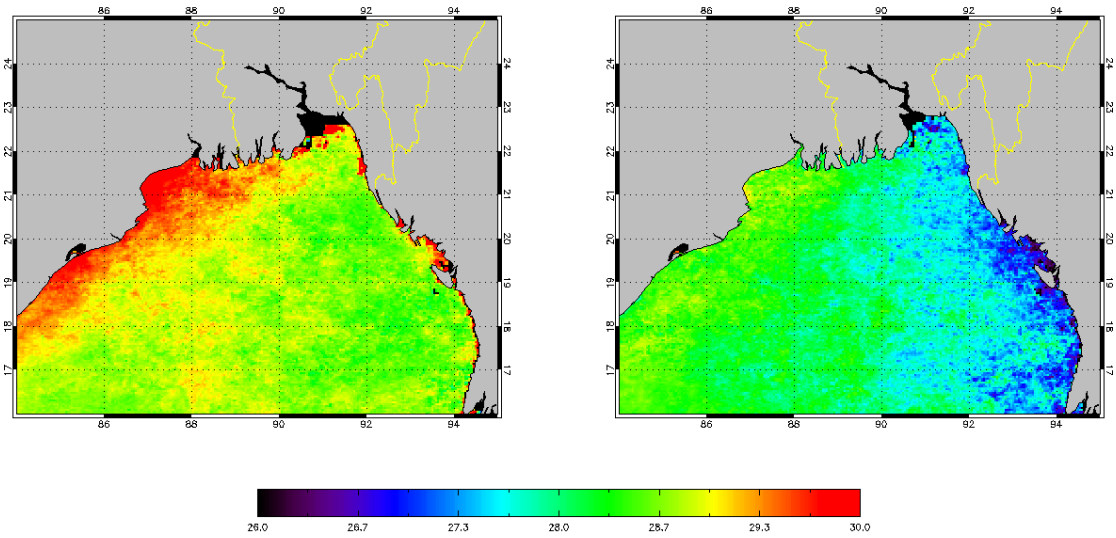


Figure 7. Satellite-derived sea surface temperature climatology 2002-2018 during August for the northern Gulf of Bengal. The daytime and night-time climatologies shown in the left and right panels, respectively. Both figures use the same colour scale in degrees Celsus depicted below the figures. The result is derived from the monthly AQUA Modis SST data product obtainded from NASA OceanColor Web *(https://oceancolor.gsfc.nasa.gov).*

Figure 11 shows hydrographic sections from the CTD stations occupied nearest to the 21°N latitude line. The section covers the eastward ascending sector of the continental shelf bottom. The pools of the fluvial origin water pool identified in the TSG data, can be observed in the salinity and fluorescence distributions, centered at stations 643 and 619, respectively. Noteworthy, there is also a region of supersaturated oxygen concentrations (O2 > 5 ml/l), which is located between stations 618 and 621. However, the river plume is indistinguishable in the potential temperature data, elucidating the fact that the dynamics of these plumes is driven by fresh water input, rather than by temperature gradients.

The surface front between the fresh water plume and oceanic origin shelf waters was clearly observed from the deck as a sharp change in the sea surface colour (Figure 11). The front apparently attracted the Hilsa shad (Tenualosa ilisha) fishers, as fishing boats were numerous and all were deploying gillnets precisely along the line of separation between the brackish and oceanic waters presented in Figure 13.

The florescence signatures of the plumes revealed by Figure 12 are very shallow. From the chlorophyll distributions it is clear that that the plume does not extend vertically beyond the top ten meters of the water column. The deep chlorophyll peak observed in the same figure, at 50 m depth, Sta. 646, is a case of the oceanic deep chlorophyll maximum that is not connected to the fluvial water inputs (see Figure 12).

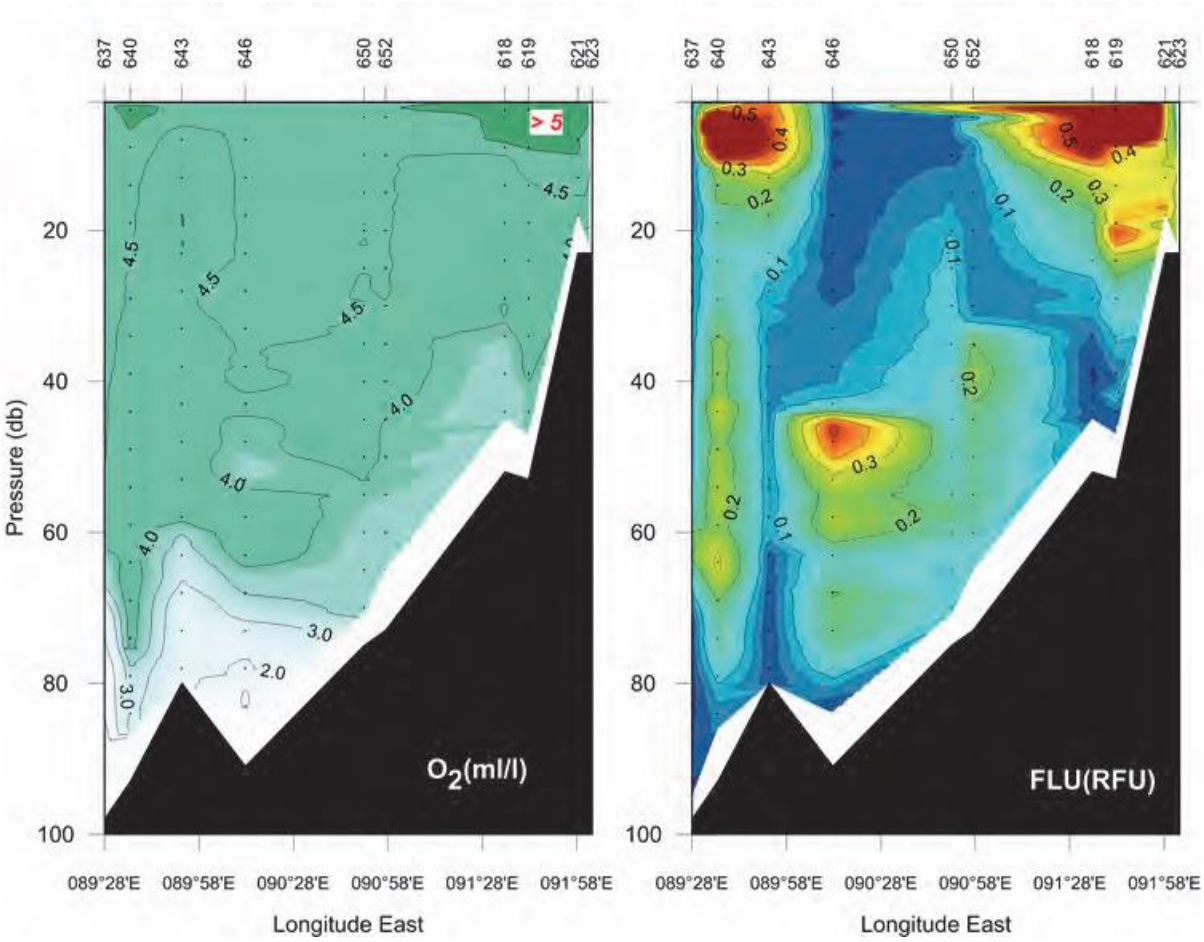


Figure 12. Zonal hydrographic section of potential temperature, salinity, oxygen concentration and chlorophyll along the northern perimeter of the survey area presented in Figure 10. The stations numbers are described along the top edges of each transect. The horizontal axis represents the stations' longitude.

Figure 8 A snapshot of the coastal buoyancy front captured on August 13 from the *RV Dr. Fridtjof Nansen*. The waters of fluvial origin are on the greener side of the front. The local fishermen examine the frontal area in search of Hilsa shad (*Tenualosa ilisha*) concentrations.

3.1.2 Observations at the transition between the coastal and open Bay of Bengal

The hydrographic section occupied between 8th and 9th of August extended to 18°20' N, covering the oceanic portion of the Bangladeshi EEZ. The observations along that section are hereby combined with the results from CTD casts preformed at the later time over the shelf area in order to study the transition from the open to coastal ocean. Figure 15 shows the resulting distributions of potential temperature, salinity oxygen concentration and chlorophyll (fluorescence). All distributions exhibit a clear separation between the open ocean conditions (Stas. 630-633) and continental shelf characteristics (Stas. 641, 643 and 644).

The temperature distribution on the open ocean side (seaward of Sta. 627) exhibits the top thermostad region of the water column, extending to a depth of 35-40 meters, is characterized by the narrow temperature range of 28-28.5°C. In contrast, the salinity distribution in the same depth region displays a strong gradient already at the depth of 20 meters. The mismatch between the depth of the maximum temperature and salinity gradient leads to the formation of a dual density stratification. The top region, controlled by the salinity gradient, is termed the barrier layer. The barriers layers are the ubiquitous feature of the surface waters in the Bay of Bengal (BoB). Under intense solar radiation, these layers heat up, increasing the stratification, which in turn drawfs the upward flux of the underlying nutrient-rich waters to the euphotic zone. Copious rainfalls during the summer monsoon season decrease the surface salinity, increasing further the vertical stratification. As the result, the top 20 meters of the water column during the summer monsoon are devoid of biological production and are characterized by excessive sea surface temperatures, uniform across the Bay.

The oxygen distribution presented in Figure 14 (bottom, left) shows the separation between the supersaturated layers above the main thermocline and the poorly aerated waters below. This pattern is a typical to the tropical ocean. In the Atlantic and Pacific Ocean case, however, the oxygen distributions display a distinct oxygen minimum zone (OMZ), typically between located 200 and 400 m. In contrast, along the observed section, the classical OMZ was not observed. Rather, the uniform anoxic conditions at less than 0.1 ml/l dominated the entire sub-thermocline water layer below the thermocline depth (50-70 m). The observed oxygen distribution resembled more the conditions found in poorly ventilated seas such as the Arabian Sea.

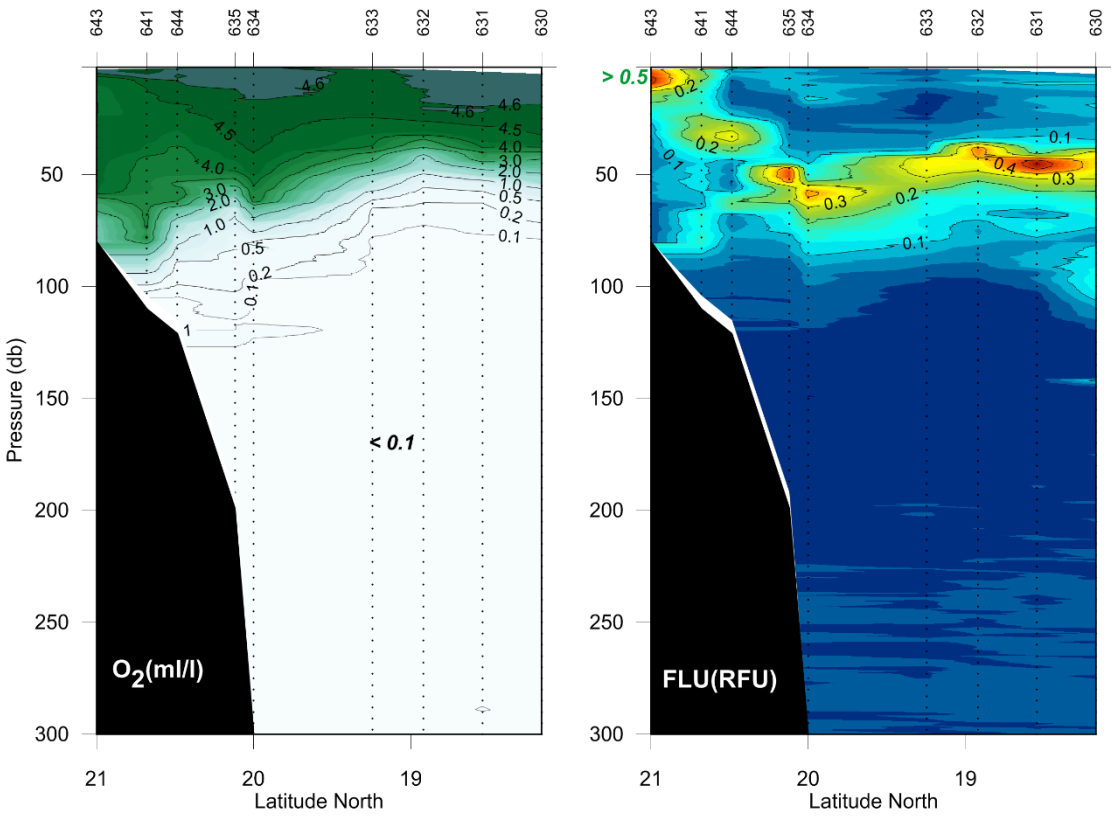


Figure 14 Distributions of oxygen concentrations and chlorophyll (fluorescence) along the open to coastal ocean section. The stations along this section were occupied between 8 and 12 August 2018. The station numbers are shown at the top of each figure. The bottom axis describes the stations' longitude.

The primary productivity in the open BoB region, as indicated by Figure 14, was concentrated within the Deep Chlorophyll Maximum (DCM), located at a depth of 60 m, thus just below the main thermocline. It is a typical situation for an oligotrophic ocean where ocean productivity is nutrient-limited and develops just below the main thermocline where the deep nutrient pool becomes available, and a fraction of the sunlight energy still reaches these depths.

Moving closer towards the Bangladesh coast along the sections in Figure 14, the survey entered the coastal transition zone (Stas. 633-635). That zone is characterised by the largescale downward tilt of the thermocline towards the coast, manifesting the downwelling conditions. The likely causes of downwelling at this section of the coast include large scale wind-patterns over the BoB or propagation of Kelvin waves along the eastern boundaryof the Bay. More detailed studies are necessary to understand the mechanisms causing the observed downwelling. Our data only indicate its presence during the survey period, suggesting that during that period oceanic nutrients were in poor supply and therefore the open ocean played a limited role in driving the biological productivity over the shelf.

3.2 Phytoplankton, zooplankton and microplastics

3.2.1 Phytoplankton, zooplankton, ichthyoplankton

The samples collected are still under processing.

Although very little on board analysis was done on the survey, the Bangladesh representatives did manage to photograph and identify various types of plankton and jellyfish (Figure 95).

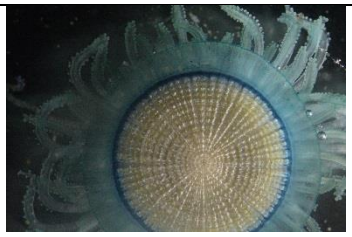
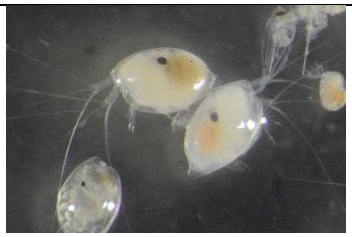
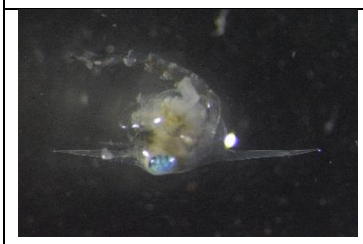
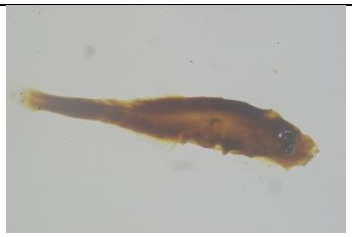
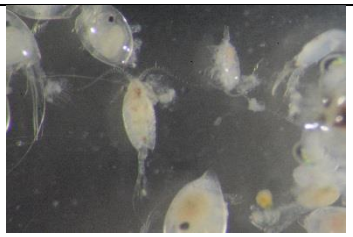
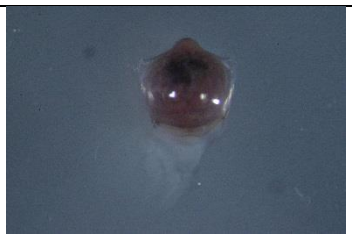
		
Copepod	Blue button jellyfish	Acetes shrimp
		
Crab larvae	ostracods	Acetes shrimp
		
Crab larvae	Fish larvae	Copepod and ostracods
		
Amphipoda	Sand dollar	Jellyfish larvae
		
cephalopods larvae	Squid larvae	Fish larvae

Figure 9 Photographic depictions of some of the plankton identified in the samples collected.

3.2.2 Microplasticc

Halves of the split-samples are still under processing at the Institute of Marine Research, Norway. As of writing this report, the other halves of 14 stations have been analysed at the Institute of Marine Sciences, University of Chittagong, Bangladesh (IMSCU). Upon full completion of laboratory analyses data will be scrutinized and organized by plastic type, color, shape and size group. The final results will be reported afterwards. IMSCU has completed analysis of 14 samples drawn on the continental shelf. Composition of plastic particles by type and size is shown in figure

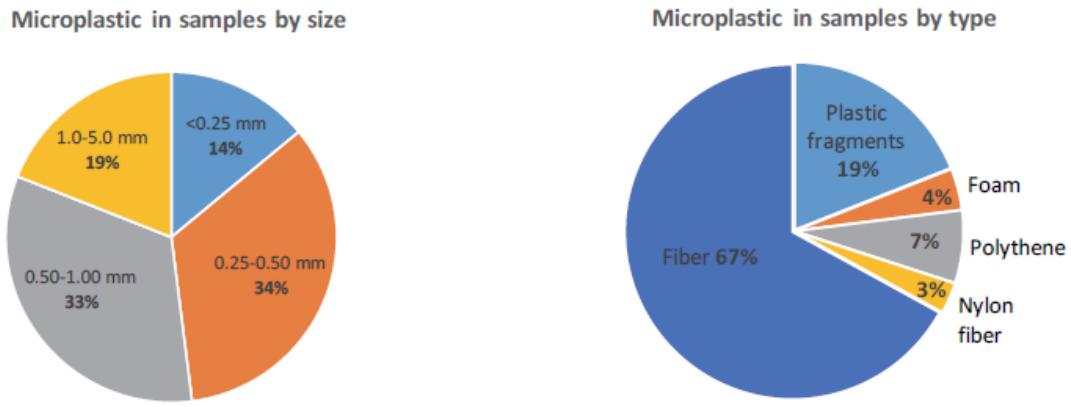


Figure 10. Overall composition of microplastics from 14 sampling stations by size (left) and type (right).

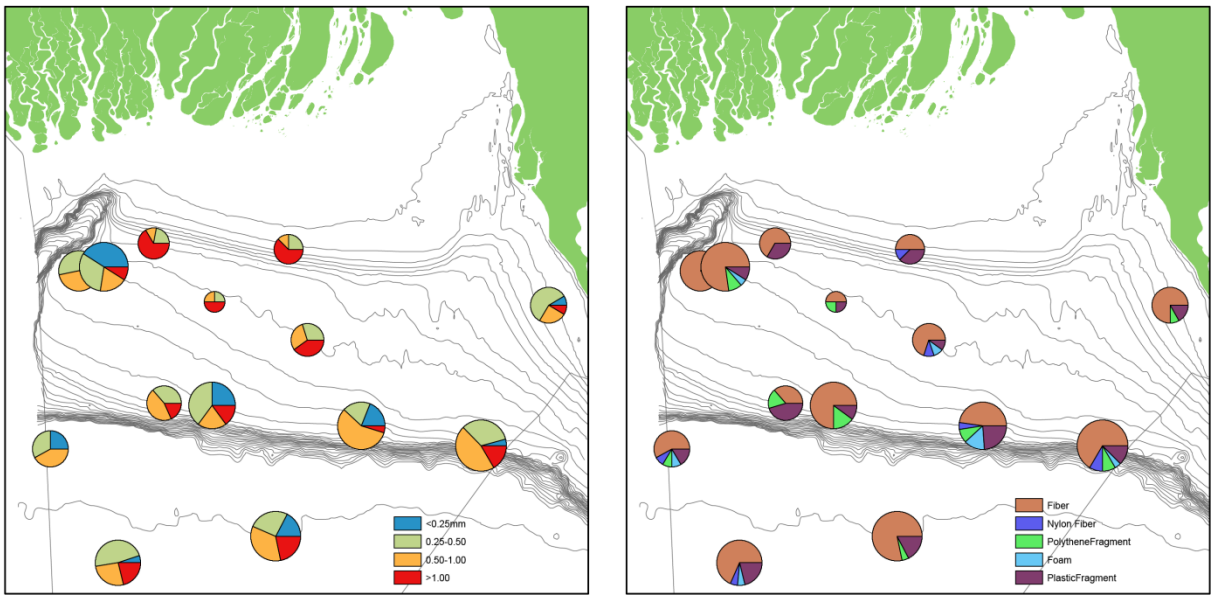


Figure 11. Relative abundance of microplastics in 14 locations shown by size (left) and type (right).

3.3 TRAWL SAMPLING

3.3.1 Biological sampling of trawl catches

Myctophidae comprised the largest group caught with a total of 2554 kg for all trawls, being found in 20 stations in total. Bragmacerotidae catches comprised a total of 430 kg, for all the 18 stations in which they were caught. Carangidae were caught in 45 stations with a total of 419 kg, with *Selar crumenophthalmus* and *Megalaspis cordyla* being the species most frequently caught. Clupeidae catch, for all stations, was 135 kg and were found 24 stations. Of these, *Dussumeieria elopsoides* was the most abundant, followed by *Sardinella fimbriata*. Scombridae were caught in 23 stations with a total of 85 Kg. Of the scombrids, *Scomberomorous* was the genus with highest abundance. Carangids, cephalopods, clupeids and scombrids were the groups caught more often in the trawl, being caught in 45, 36, 24 and 23 stations, respectively.

The L-W figures (Annex IX) show the length-weight relationship for the commercially most important species, as well as Myctophidae which was the most abundant species caught. Length and weight from myctophids were taken even if the fish were only identified to genus or family level. Benthosema and Diaphus were the most frequently caught genus. The plots where it is observed two distribution patterns are likely to show two different species.

3.3.2 Taxonomy

A total of about 172 different species were recorded during the survey of which 136 species were fishes followed by crustaceans (23 species). Among the fish species the bony fish with 131 different species was the dominant in the catch, along with only 5 cartilaginous species (Table). A total of 16 species were preserved in formaldehyde for the identification conformation by experts.

It is too early to conclude regarding the number of new records observed for Bangladesh. However, it is likely that several species found during the survey may result as new records for Bangladesh. These were handed over to expert taxonomist at Sher-e-Bangla Agriculture University, Dhaka for identification and description.

Samples were taken of whole specimens to confirm the species identification (ANNEX VIII, Table 53). All samples were sent for identification, description and genetic analyses to Shere-Bangla Agricultural University, Dhaka. Twentynine (29) specimens have been identified by combined morpho-meristic and molecular analysis (i.e., analysis of mtDNA COI or 16S rRNA sequence). Five species, namely Champsodon snyderi (Franz 1910), Upeneus supravittatus (Uiblein & Heemstra, 2010) Tentoriceps cristatus (Klunzinger, 1884) Lestrolepis japonica (Tanaka, 1908) and Vinciguerria lucetia (Garman, 1899) are testified by the laboratory to be first reported occurrence from Bangladesh. Detailed accounts of the studied fishes and the result of the genetic analyses and genetic barcoding will be presented in a separate data report.

Table 5. List of species collected during the survey in Bangladesh waters.

Sl. No	Order	Family	Species
1	Carchaniformes	Sphyrnidae	*Sphyrna lewini* (Griffith & Smith 1834)
2			*Sphyrna mokarran* (Rüppell 1837)
3		Carcharhinidae	*Scoliodon laticaudus* Müller & Henle 1838
4	Torpediniformes	Narkidae	*Narke dipterygia* (Bloch & Schneider 1801)

5	Myliobatiformes	Mobulidae	*Mobula tarapacana* (Philippi 1892)
6	Anguilliformes	Ophichthidae	*Pisodonophis cancrivorus* (Richardson 1848)
7		Muraenidae	*Strophidon dorsalis* (Seale 1917)
8			*Ariosoma* sp
9			Anguilliformes sp unidentified
10			Leptocephalus larvae
11	Myctophiformes	Myctophidae	*Benthosema pterotum* (Alcock 1890)
12			*Benthosema fibulatum* (Gilbert & Cramer 1897)
13			*Diaphus sp.1*
14			*Diaphus sp.2*
15		Phosichthyidae	*Vinciguerria attenuata* (Cocco 1838).
16	Aulopiformes	Synodontidae	*Harpadon nehereus* (Hamilton 1822)
17			*Saurida longimanus* Norman 1939
18			*Saurida tumbil* (Bloch 1795)
19			*Saurida undosquamis* (Richardson 1848)
20			*Saurida* sp
21	Gadiformes	Bregmacerotidae	*Bregmaceros mcclellandi* Thompson 1840
22	Clupeiformes	Engraulidae	*Coilia dussumieri* Valenciennes 1848
23			*Setipinna phasa* (Hamilton 1822)
24			*Setipinna tenuifilis* (Valenciennes 1848)
25			*Stolephorus andhraensis* Babu Rao 1966
26			*Stolephorus commersonnii* Lacepède 1803
27			*Thryssa dussumieri* (Valenciennes 1848)
28		Clupeidae	*Sardinella fimbriata* (Valenciennes 1847)
29			*Sardinella albella* (Valenciennes 1847)
30			*Anodontostoma chacunda* (Hamilton 1822)
31		Pristigasteridae	*Raconda russeliana* Gray 1831
32			*Pellona ditchela* Valenciennes 1847
33			*Ilisha melastoma* (Bloch & Schneider 1801)
34			*Ilisha striatula* Wongratana 1983
35			*Ilisha filigera* (Valenciennes, 1847)
36		Dussumieriidae	*Dussumieria elopsoides* Bleeker 1849
37		Chirocentridae	*Chirocentrus dorab* (Forsskål 1775)
38	Mugiliformes	Mugilidae	*Osteomugil cunnesius* (Valenciennes, 1836)
39	Perciformes	Terapontidae	*Terapon jarbua* (Forsskål 1775)
40			*Terapon puta* Cuvier 1829
41			*Terapon theraps* Cuvier 1829
42		Polynemidae	*Eleutheronema tetradactylum* (Shaw 1804)
43			*Polynemus paradiseus* Linnaeus 1758
44			*Polydactylus sextarius* (Bloch & Schneider 1801)
45		Champsodontidae	*Champsodon vorax* Günther, 1867
46		Stromateidae	*Pampus argenteus* (Euphrasen 1788)
47			*Pampus chinensis* (Euphrasen 1788)
48		Trichiuridae	*Trichiurus lepturus* Linnaeus 1758
49			*Trichiurus gangeticus* Gupta 1966
50			*Lepturacanthus savala* (Cuvier 1829)
51			*Eupleurogrammus muticus* (Gray 1831)
52		Lobotidae	*Lobotes surinamensis* (Bloch 1790)
53		Mullidae	*Upeneus moluccensis* (Bleeker 1855). Mullidae
54			*Upeneus taeniopterus* Cuvier 1829
55			*Upeneus* sp1
56		Callionymidae	*Callionymus* sp1
57		Drepaneidae	*Drepane longimana* (Bloch & Schneider, 1801)
58		Gerreidae	*Pentaprion longimanus* (Cantor, 1849)
59		Scombridae	*Rastrelliger brachysoma* (Bleeker, 1851)
60			*Rastrelliger faughni* Matsui, 1967
61			*Rastrelliger kanagurta* (Cuvier, 1816)
62			*Auxis thazard* (Lacepède, 1800)
63			*Auxis rochei* (Risso, 1810)
64			*Thunnus tonggol* (Bleeker 1851)
65			*Euthynnus affinis* (Cantor, 1849)
66			*Scomberomorus guttatus* (Bloch & Schneider 1801)
67			*Scomberomorus commerson* (Lacepède 1800)
68		Sciaenidae	*Pennahia anea* (Bloch, 1793)
69			*Johnius coitor* (Hamilton, 1822)
70			*Otolithes ruber* (Bloch & Schneider, 1801)
71			*Otolithoides pama* (Hamilton, 1822)

72			*Johnius dussumieri* (Cuvier, 1830)
73			*Chrysochir aureus* (Richardson, 1846)
74			*Pterotolithus maculatus* (Cuvier, 1830)
75		Gempylidae	*Gempylus serpens* Cuvier, 1829
76			*Neoepinnula orientalis* (Gilchrist & von Bonde 1924)
77		Rachycentridae	*Rachycentron canadum* (Linnaeus, 1766)
78		Priacanthidae	*Priacanthus* sp1
79		Coryphaenidae	*Coryphaena equiselis* Linnaeus 1758.
80		Caesionidae	*Dipterygonotus balteatus* (Valenciennes 1830)
81		Carangidae	*Megalaspis cordyla* (Linnaeus, 1758)
82			*Decapterus russelli* (Rüppell, 1830)
83			*Decapterus macrosoma* Bleeker 1851
84			*Atule mate* (Cuvier, 1833)
85			*Alepes kleinii* (Bloch 1793)
86			*Atropus atropos* (Bloch & Schneider, 1801)
87			*Selar crumenophthalmus* (Bloch, 1793)
88			*Scomberoides commersonnianus* Lacepède, 1801
89			*Scomberoides tol* (Cuvier, 1832)
90			*Parastromateus niger* (Bloch, 1795)
91		Acropomatidae	*Acropoma* sp 1
92			*Acropoma* sp 2
93			*Synagrops* sp1
94		Siganidae	*Siganus canaliculatus* (Park, 1797)
95			*Siganus javus* (Linnaeus, 1766)
96		Nemipteridae	*Nemipterus nematophorus* (Bleeker 1854)
97			*Nemipterus japonicus* (Bloch 1791)
98		Echeneidae	*Echeneis naucrates* Linnaeus, 1758
99			*Remora remora* (Linnaeus, 1758)
100		Menidae	*Mene maculata* (Bloch & Schneider, 1801)
101		Leiognathidae	*Equulites lineolatus* (Valenciennes 1835)
102			*Photopectoralis bindus* (Valenciennes 1835)
103			*Secutor ruconius* (Hamilton 1822)
104			*Leiognathus sp.*
105		Apogonidae	*Jaydia striata* (Smith & Radcliffe 1912)
106			*Ostorhinchus fasciatus* (White, 1790)
107		Sphyraenidae	*Sphyraena obtusata* Cuvier 1829
108			*Sphyraena putnamae* Jordan & Seale 1905
109			*Sphyraena forsteri* Cuvier 1829
110		Nomeidae	*Cubiceps pauciradiatus* Günther 1872
111			*Cubiceps whiteleggii* (Waite 1894)
112			*Psenes cyanophrys* Valenciennes, 1833
113			*Psenes* sp1
114		Acanthuridae	*Acanthurus* sp1
115		Paralepididae	*Lestrolepis japonica* (Tanaka, 1908)
116		Uranoscopidae	*Uranoscopus cognatus* Cantor, 1849
117	Tetradontiformes	Tetraodontidae	*Lagocephalus guentheri* Miranda Ribeiro 1915
118			*Arothron immaculatus* (Bloch & Schneider 1801)
119			*Takifugu oblongus* (Bloch 1786)
120			*Lagocephalus spadiceus* (Richardson 1845)
121		Triacanthidae	*Triacanthus nieuhofii* Bleeker 1852
122		Balistidae	*Canthidermis maculata* (Bloch, 1786)
123			*Melichthys niger* (Bloch, 1786)
124	Siluriformes	Ariidae	*Osteogeneiosus militaris* (Linnaeus 1758)
125			*Plicofollis argyropleuron* (Valenciennes, 1840)
126			*Plicofollis dussumieri* (Valenciennes, 1840)
127	Pleuronectiformes	Cyanoglossidae	*Cyanoglossus* sp
128			*Cynoglossus arel* (Bloch & Schneider, 1801)
129		Bothidae	*Laeops* sp.
130		Citharidae	*Brachypleura novaezeelandiae* Günther 1862
131		Soleidae	*Zebrias altipinnis* (Alcock 1890)
132			*Solea ovata* Richardson, 1846
133	Scorpaeniformes	Platycephalidae	*Suggrundus macracanthus* (Bleeker 1869)
134			*Kumococius rodericensis* (Cuvier 1829)
135		Scorpaenidae	*Brachypterois serrulifer* Fowler 1938
136			*Neomerinthe sp.*
	Crustacea		
1			*Harpiosquilla* sp 1

2			*Harpiosquilla* sp 2
3	Decapoda	Shrimp	*Metapenaeus brevicornis* (H. Milne Edwards, 1837)
4			*Metapenaeus monoceros* (Fabricius, 1798)
5			*Metapenaeus affinis* (H. Milne Edwards, 1837)
6			*Metapenaeus lysianassa* (de Man, 1888)
7			*Penaeus monodon* Fabricius, 1798
8			*Penaeus indicus* H. Milne Edwards, 1837
9			*Penaeus merguiensis* de Man, 1888
10			*Palaemon styliferus* H. Milne Edwards, 1840
11			*Penaeus* sp1
12			*Solenocera crassicornis* (H. Milne Edwards, 1837)
13			Solenocera sp
14			Red shrimp
15			banded shrimp
16		Portunidae	*Portunus pelagicus* (Linnaeus, 1758)
17			*Portunus sanguinolentus* (Herbst, 1783)
18			*Charybdis feriata* (Linnaeus, 1758)
19			*Calappa guerini* Brito Capello, 1870
20			*Calappa* sp
21			Crab
22			*Scylla olivacea* (Herbst, 1796)
23		Sand lobster	*Thenus orientalis* (Lund, 1793)
	Mollusca		
1			*Octopus vulgaris* Cuvier, 1797
2			Sepia
3			*Sepia esculenta* Hoyle 1885
4			Jelly fish sp1
5			*Uroteuthis duvaucelii* (d'Orbigny, 1835)
6			Onychoteuthidae
7			*Sthenoteuthis oualaniensis* (Lesson, 1830)
8			Cephalopod unidentified
9			Oceanic squid
10			*Ommastrephes bartramii* (Lesueur, 1821)
	Reptiles		
1	Snake		*Hydrophis platurus* (Linnaeus 1766)
2			Hydrophis sp.
1			Pyrosoma

3.3.3 Stomach content

Quantitative analysis of the stomach content of pelagic fishes showed similarity in the food and feeding habits among species and families. Index of stomach fullness for pelagic species was found as: 40% bursting, 25% filled, 15% medium filled, 10% poorly filled and 10% nearly empty. The index of preponderance revealed that most fish species preyed mainly on zooplankton and fish. 35% of total studied fishes including Sardinella fimbriata, Dussumieria elopsoides, Parastromateus niger, Setipinna tenuifilis, Diaphus sp., Benthosoma sp., Vinciguerria sp. were zooplankton feeders, preying mainly on crustaceans, especially copepods and shrimps. 40% of the fish species were carnivores and zooplankton feeders, e.g. Decapterus macrosoma, Euthynnus affinis, Auxis thazard, Cubiceps pauciradiatus, Psenes whiteleggi, Lestrolepis japonica, Lestidium sp., and Dipterygonotus balteatus. Only 5% fish including Sphyraena obtusata were found to be carnivore praying mainly on other fish species. Food content of the rest (20%) of the fish species which include Raconda russeliana, Magalaspis cordyla, Echeneis naucrates, and Acanthurus sp. could not be determined due to near complete digestion of the content.

Majority of the demersal fish species preyed on zooplankton, crustaceans, benthic animals and fishes. 35% fish species preyed on zooplankton, 15% preyed on different types of fishes, 40%

fish species preferred both zooplankton and fishes, 5% species preferred benthic macroorganisms and 5% species preferred both animals and plant matters. Stomach fullness states were: 35% bursting, 10% filled, 20% medium filled, 20% poorly filled and 15% almost empty.

3.4 Acoustic biomass estimates and distribution of fish species

The hydro acoustic survey covered the shelf and slope from roughly 20 m depth to 250 m depth. Continuous acoustic recording and analysis were carried out throughout the survey. Acoustic distribution and abundance was estimated for three species groups during the survey. These were Sardinella, Pelagic 1 (Pel1) and Pelagic 2 (Pel2). The Pel1 group of species consists of pelagic fish of the families Clupeidae, Dussumieriidae and Engraulididae, while the Pel2 species consist of the families Carangidae, Scombridae, Barracuda and Hairtails. Table 2.1 gives an overview of the most common species belonging to each of these groups. The Pel1 species are typically separated from the Pel2 species based on the presence of the two groups in the trawl catches, and based on the acoustic signal as seen during the scrutinizing process, e.g. the fact that the Clupeidae and Engraulididae has a much stronger backscattering signal and a stronger schooling behaviour then the Carangidae and other Pel2 species (although few schools were detected and most differentiation between the three groups were done on the basis of catch composition). Length distributions of all species groups and length-weigh relationships were calculated for all acoustic groups for which biomass was estimated.

In addition the acoustic backscatter strength of mesopelagic fish were estimated and mapped.

Summary of backscattered sA values and biomass estimates for the three species categories can be found in Table , Table and Table respectively.

3.4.1 Sardinella

Sardinella (S. fimbriata) were found in the shallower parts of the shelf and it is likely that the survey only covered the southernmost part of the species distribution area (see Figure 18).

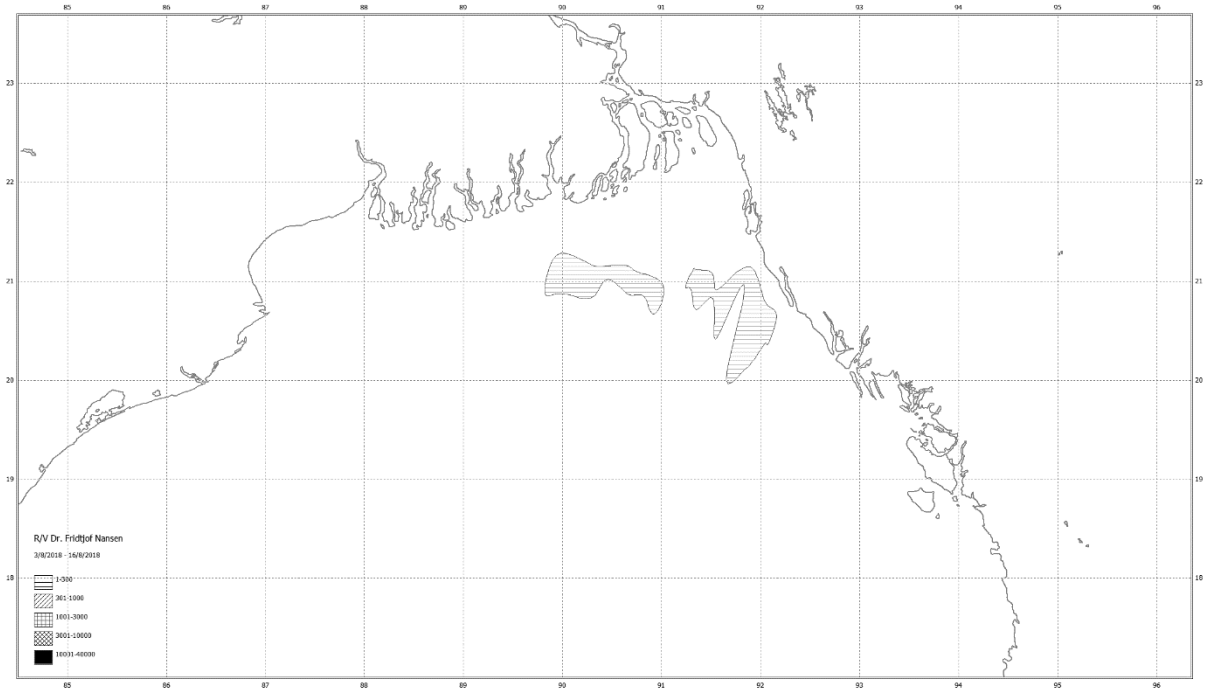


Figure 18. Acoustic backscatter strength of the sardinella acoustic group determined from scrutinizing multi-frequency echograms using LSSS software and plotted in Nansis Maptool.

3.4.2 Pelagic 1

The pelagic 1 group (Clupeids excluding Sardinella, Engraulidae, Chirocentridae and Dussumeridae) were distribued on the shelf, overlapping with both sardinella, pel 1 and mesopelagic fish (see Figure 9).

Figure 19. Acoustic backscatter strength of the PELAGIC 1 acoustic group determined from scrutinizing multi-frequency echograms using LSSS software and plotted in Nansis Maptool.

3.4.3 Pelagic 2

The Pel 2 group had the widest distribution of the shelf-pelagic species, which is as expected the variety of species that were included in this group (see Figure 20).

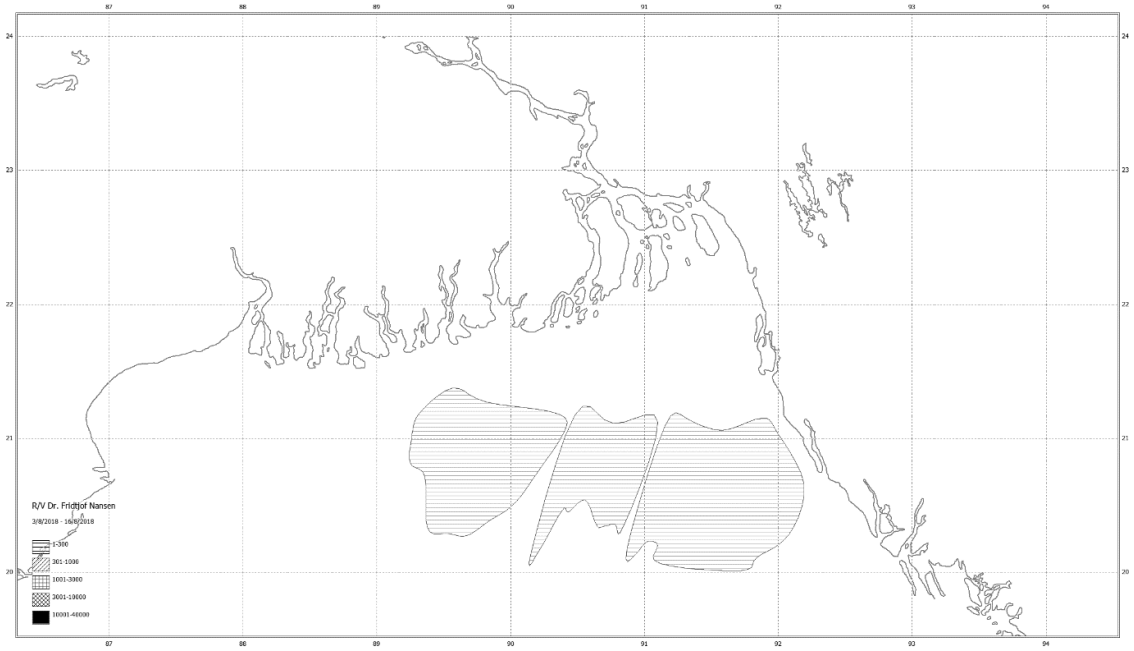


Figure 20. Acoustic backscatter strength of the PELAGIC 2 acoustic group determined from scrutinizing multi-frequency echograms using LSSS software and plotted in Nansis Maptool.

3.4.4 Mesopelagic fish

Mesopelagic fishe were distributed mostly on the deeper parts of the shelf, the shelf break and over deeper waters, although the mesopelagic transects were not included in the analysis for Figure 1 below.

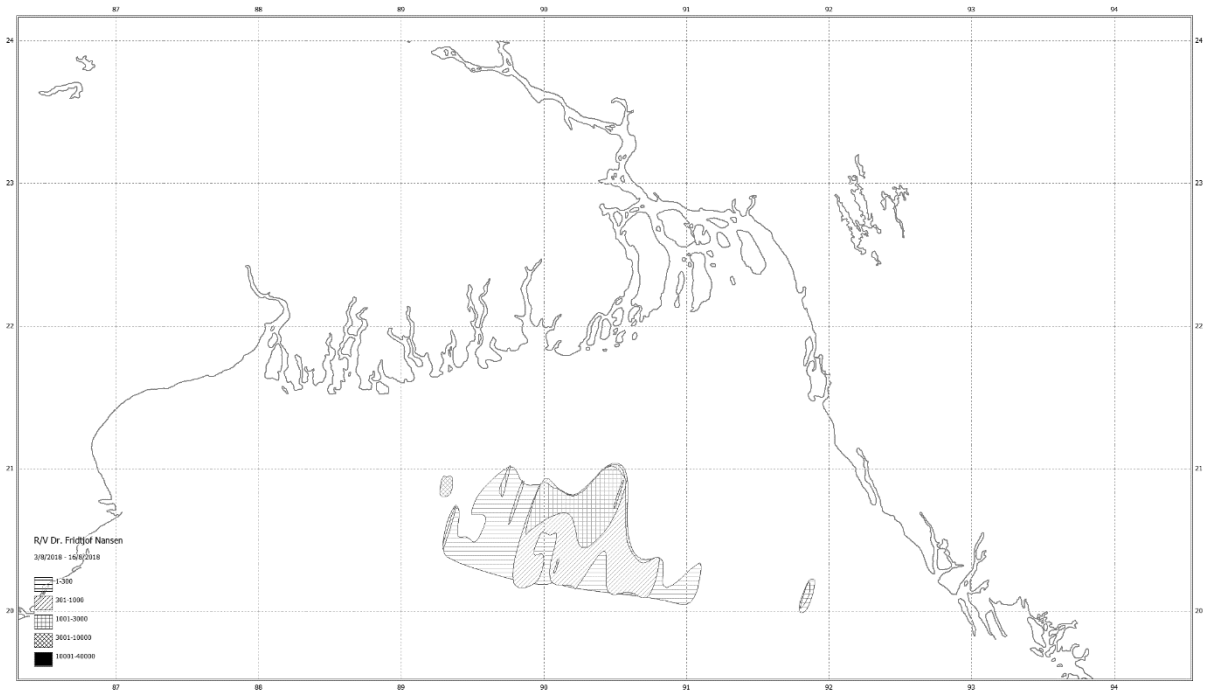


Figure 21. Acoustic backscatter strength of the Mesopelagic Fish acoustic group determined from scrutinizing multi-frequency echograms using LSSS software and plotted in Nansis Maptool.

3.4.5 Biomass estimates

The total acoustic biomass estimate for all three groups (Sardinella, Pel 1 and Pel 2) was 158 100 (see Table , Table and Table below) tonnes which is comparable to the 1979 RV *Dr. Fridtjof Nansen* estimate and two other surveys in the 1980's.

Table 6. The acoustic estimate of Sardinella fish (SARDINELLA)

Stratum	1	2	Total:
Area (nm^2)	1171.1	1565.5	2736.6
$<s_A>$:	10.9	7.2	18.1
Biomass (1000t):	2.41	2.10	4.51

Table 7. The acoustic estimate of Clupeoid fish (Pel1)

Stratum	1	2	3	4	5	6	Total:
Area (nm^2)	1386.8	40.4	55.1	862.2	171.3	131.0	2646.7
$<s_A>$:	217.1	713.3	0.9	1.8	1.0	2.8	936.9
Biomass (1000t):	64.7	6.2	0.0	0.3	0.0	0.1	71.3

Table 8. The acoustic estimate of Pel2 species

Stratum	1	2	3	Total:
Area (nm2)	2844.9946	1786.3043	3877.381	8508.68
<sA>:	12.493	19.729	19.56	51.782
Biomass:	19.39	21.92	41.38	82.70

3.5 Food safety and nutrition

Samples of whole fish, fillet and liver of various fish species were sampled and prepared for analysis by filleting, homogenising and freeze-drying. The samples will be analysed for selected nutrients and metals. Samples will be stored pending budget for analyses for other nutrients and contaminants. Table 9 shows the number of samples taken for the different kinds of analyses of fish for food safety and nutrition. The analyses will be carried out at Institute of Marine Research in Bergen, Norway.

Table 9. Number of samples taken for the different kinds of analyses of fish for food safety and nutrition for a) big fish and b) small fish.

Nr	Station	Species	Length (cm)	N (total)	N (pooled samples)	Total weight of sample (g)	LIMS-nr
1	4	*Sardinella fimbriata*	16.3 cm	68	3	820g	2018-928
2	6	*Sardinella fimbriata*	16.3 cm	75	3	765g	2018-929

3	9	*Pentapyrion longimanus*	11.44 cm	75	3	720	2018-930
4	10	*Dussumieria elopsoides*	17 cm	75	3	690g	2018-931
5	23	*Dussumieria elopsoides*	20,26 cm	75	3	1260g	2018-932
6	23	*Megalaspis cordyla*	25,5 cm	25	13	1470g	2018-357
7	24	*Benthoserma fibulatum*	<5cm	750	3	487g	2018-945
8	27	*Herpadon neherius*	25,5 cm	60	3	1030g	2018-946
9	30	*Sardinella fimbriata*	16,34 cm	75	3	822g	2018-947
10	31	*Bregmaceros mcclellandi*	<6 cm	840	3	460g	2018-948
11	33	*Herpadon neherius*	24,16 cm	60	3	1070g	2018-949
12	39	*Dussumieria elopsoides*	19,31 cm	68	3	855g	2018-950

3.6 Parasites

Results showed absence or low infection values of parasitic nematodes in many of the fish species sampled, e.g. Cubiceps pauciradiutus, Dussumieria elopsoides, Megalapsis cordyla, Mene maculata, Sardinella fimbricata and Sellar crumenophthalmus. The species Trichiurus lepturus (prevalence= 76% (29 fish infected out of 34)) and Harpadon nehereus (prevalence=32%, i.e.16 out of 50) showed higher infection values. The majority of the nematodes were present in the viscera, while very few were found in the muscle. Further work is recommended (i.e. sampling higher numbers of specimens from different sea areas and period of the year) to confirm the infection values found in this study. In addition, the spiral valve of Mobula tarapacana was found parasitized by helminths (likely cestodes), and myctophids of the genus Benthosema were found to be infected by helminths (probably trematodes). All parasite samples will be identified by morphological and/or molecular means at the facilities of the IMR in Bergen, and results will be further analysed and discussed as part of Theme 8 of the EAF-Nansen Science Plan.

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ANNEX I DESCRIPTION OF SAMPLING AT SUPER STATIONS

Super Station

1. CTD-mounted rosette equipped with 12 Niskin bottle (10 L). The standard water sampling depths are: 5, 25, 50, 75, 100, 200, 300, 400 and 500 m.

2. Phytoplankton net to 30 m (or 5 m above bottom at ≤ 30 m stations) - maximum haul speed 0.1 m^{-s}

3. WP2 beyond 30 m with a maximum depth of 200 m – maximum haul speed 0.5 m^{-s}

4. WP2 to 30m when deeper WP2 deployment is performed – maximum haul speed 0.5 m^{-s}

5. MultiNet Mammoth to bottom or maximum depth of 200 m – maximum speed 1.5 m^{-s}

6. Manta trawl at surface for 15 minutes - maximum speed 1-1.5 m^{-s}

ANNEX II DESCRIPTION OF ACOUSTIC INSTRUMENTS AND FISHING GEAR

The Simrad EK80/18, 38, 70,120, 200 and 333 kHz scientific sounder was run during the survey. Scrutinizing was done in LSSS using the data from the 38-kHz transducer. Last standard sphere calibrations were checked on the 23.01.2017 in Sandviksflaket, Bergen, Norway using Cu64 for the 18 kHz, Cu60 for the 38 kHz, WC38.1 for the 70, 120 and 200 kHz, and the WC22 for the 333 kHz. The details of the settings for the 38-kHz echo sounder were as follows:

Transceiver2 menu (38 kHz)	
Transducer depth	5 - 8 m
Absorption coeff.	8.3 dB/km
Pulse duration	medium (1,024ms)
Bandwidth	2.43 kHz
Max power	2000 Watt
2way beam angle	20,6dB
gain	26,95 dB
SA correction	0.03 dB
Angle sensitivity	21.9
3 dB beamwidth	6.22° along ship
	6.28° athwart ship
Alongship offset	0.10°
Athwardship offset	0.06°
Bottom detection menu	Minimum level 50 Db

Fishing gear

The vessel has one small four-panel Åkrahamn pelagic trawl, one MultPelt 624 trawl (Figure 21, new in 2017) and one 'Gisund super bottom trawl'. The smallest pelagic trawl has 8 to 12 m vertical opening under normal operation, whereas the MultPelt 624 trawl has 25 to 35 m opening. During the 2018410 survey only the MultPelt 624 trawl was used for pelagic trawling, except in shallow waters where the bottom trawl rigged with floats was used.

The bottom trawl has a 31-m headline and a 47-m footrope fitted with a 12" rubber bobbins gear. The codend has 20 mm meshes, and has an inner net with 10 mm mesh size. 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 m2 and weigh 2000 kg. The door spreading is about 45 m when using restraining rope. 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 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.

The 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.

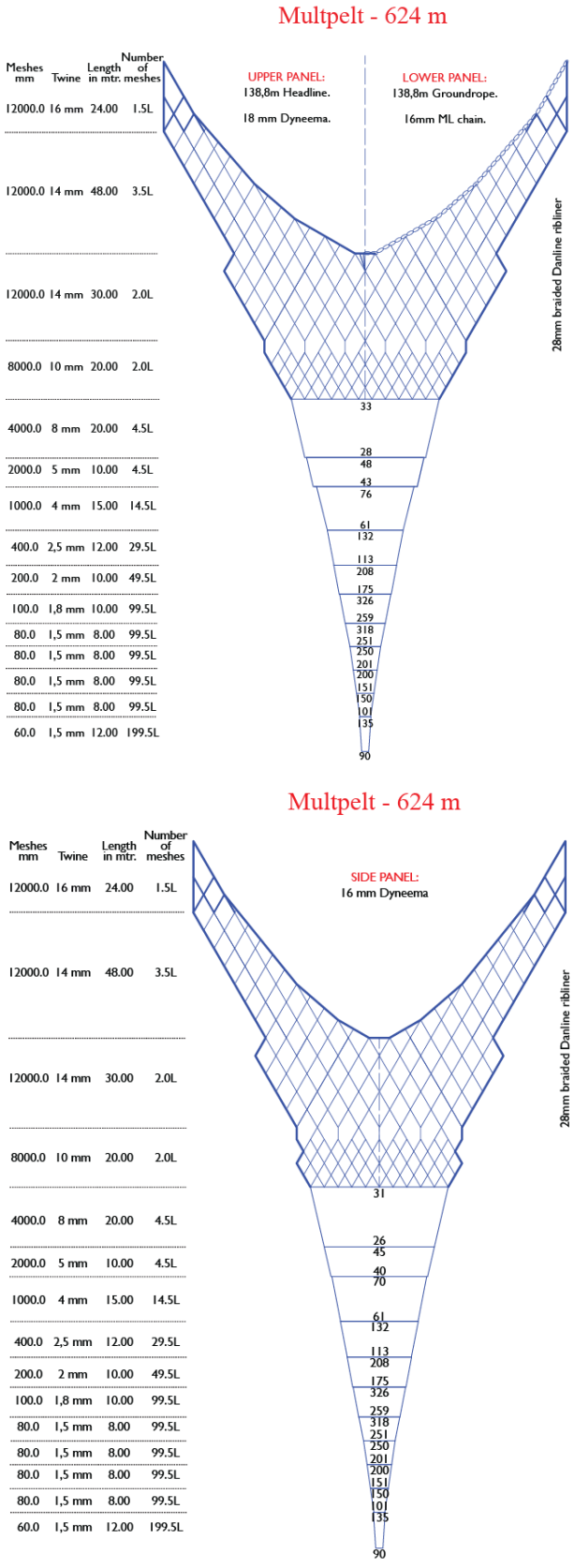


Figure 1. Schematic drawing of the MultPelt 624.

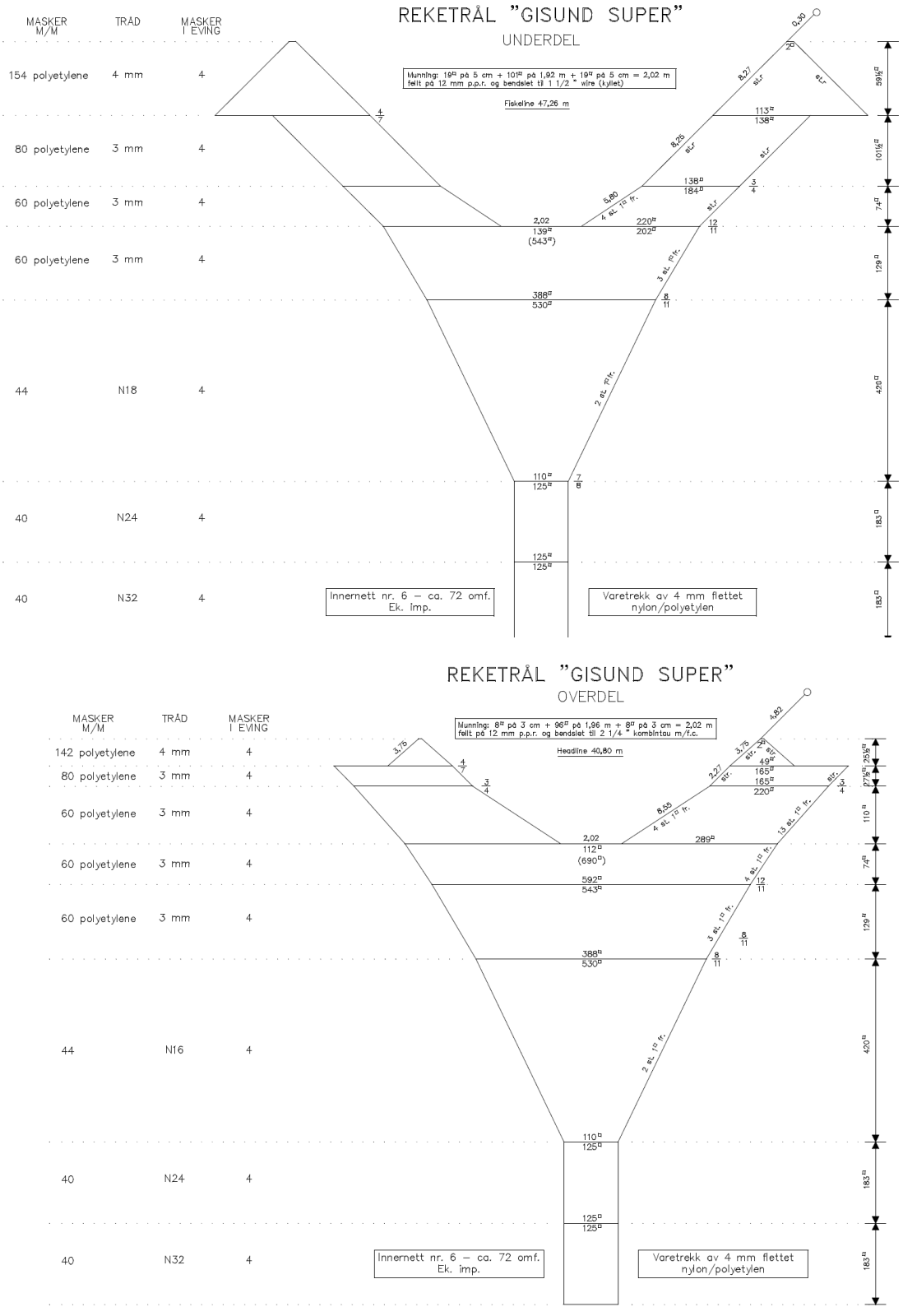


Figure 2. Schematic drawing of the Super Gisund bottom trawl.

ANNEX III BIOLOGY SCALES

Sexual maturity

Stage	State	Description
I	Immature	Ovary and testis about 1/3rd length of body cavity. Ovaries pinkish, translucent, testis whitish. Ova not visible to naked eye.
II	Maturing virgin and recovering spent	Ovary and testis about ½ length of body cavity. Ovary pinkish, translucent, testis whitish, symmetrical. Ova not visible to naked eye.
III	Ripening	Ovary and testis is about 2/3rds length of body cavity. Ovary pinkish yellow colour with granular appearance, testis whitish to creamy. No transparent or translucent ova visible.
IV	Ripe	Ovary and testis from 2/3rds to full length of body cavity. Ovary orange-pink in colour with conspicuous superficial blood vessels. Large transparent, ripe ova visible. Testis whitish-creamy, soft.
V	Spent	Ovary and testis shrunken to about ½ length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe Ova, darkened or translucent. Testis bloodshot and flabby

Stomach content

Scale	Designation	Description
0	Empty	Stomach empty except for water.
1	Very little content	Stomach is almost empty. Only traces of small organisms can be found.
2	Some content	Stomach not completely full and not dilated.
3	Stomach full	Stomach full, but not bloated/dilated.
4	Bloated/dilated	The stomach is visibly expanded and tight. Content can be observed from the outside.

ANNEX IV PH, ALKALINITY AND ARAGONITE SATURATION STATE

Water samples were collected throughout the water column at all Super Stations that coincided with a pelagic trawl. Samples were analysed on board for pH and total alkalinity, whereas nutrient analysis will take place on shore at Institute of Marine Research. Preliminary calculations are shown here, final results can only be calculated when nutrient concentrations are known. These variables will be used to characterize the inorganic carbon components of the waters, which also show the status of ocean acidification.

Saturation state of calcium carbonates is an indicator used for monitoring development of ocean acidification in seawater. A saturation state value below one for a calcium carbonate mineral, means the water is under-saturated for the mineral. Under-saturation predicts that over time the mineral will dissolve. For some marine organisms that construct shells of aragonite, saturation state below 2 has been shown to slow down the process of shell formation.

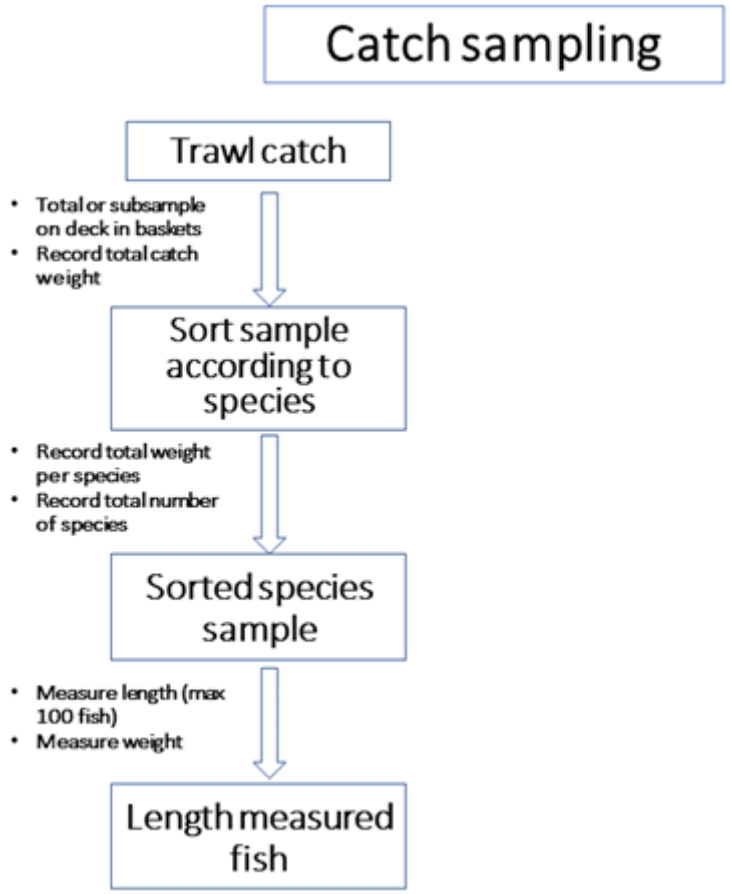
ANNEX V LIST OF PRIORITY SPECIES AND BIOLOGICAL SAMPLES COLLECTED FOR FUTURE ANALYSIS

Table 1. list of priority species selected for length and weight and biological samples

Main Groups	Families	Typical Species	Species Code	Fishmeter code	Length and Weight	Microplastics	Stomach	Genetics	Fish Nutrient
Pelagic	Carangidae (Jacks, Queen fish, Pompanos)	*Megalaspis cordyla*	CARME01	1	√				
		Parastromateus niger	CARPA01	2	√		√	√	√
		Scomberoides commersonianus	CARSC02	3	√		√	√	√
	Chirocentridae	*Chirocentrus dorab*	CHRCH01	4	√				
	Clupeidae	*Ilisha filigera*	CLUIL05	5	√				
		Thryssa mystax	ENGTH02	6	√				
		Sardinella fimbriata	CLUSL06	7	√		√	√	√
		Tenualosa ilisha	CLUTE03	8	√		√	√	√
		Dussumieria acuta	CLUDU01	9	√				
		Anodontostoma chacunda	CLUAM01	10	√				
	Scombridae	*Scomberomorus commerson*	SCMSM03	11	√				
		Scomberomorus guttatus	SCMSM04	12	√		√	√	√
		Thunnus obesus	SCMTH01	13	√				
		Auxis thazard	SCMAU01	14	√				
		Thunnus tonggol	SCMTH05	15	√				
		Katsuwanus pelamis	SCMKA01	16	√				
		Rastrelliger kanagurta	SCMSM04	17	√		√	√	√
	Sphyraenibae	*Sphyraenae forsteri*	SPHSP04	18	√				
		Sphyraenae barracuda	SPHSP05	19	√				
	Istiophoridae	*Istiophorus platyterus*	ISTIS02	20	√				
		Makaira indica	ISTMA02	21	√				
	Mesopelagic					√			
	Uncommon							√	
Demersal	Drepanidae	*Drepane longimanna*	DREDR03	22	√				
	Ephippidae	*Ephippus orbis*	EPHEP01	23	√				
	Harpadontidae	*Harpadon nehereus*	SYNHA01	24	√		√	√	√
	Lactariidae	*Lactarius lactarius*	LACLA01	25	√				
	Lutjanidae	*Lutjanus sanguineus*	LUTLU22	26	√				
		Lutjanus johnii	LUTLU10	27	√		√	√	√

Main Groups	Families	Typical Species	Species Code	Fishmeter code	Length and Weight	Microplastics	Stomach	Genetics	Fish Nutrient
		Latjanus malabaricus	LUTLU15	28	√				
	Mullidae	*Upeneus sulphureus*	MULUP05	29	√				
	Nemipteridae	*Nemipterus japonicus*	NEMNE03	30	√		√	√	√
	Pomadasyidae	*Pomadasys hasta*	PODPO29	31	√				
		Pomadasys maculates	PODPO06	32	√				
	Polynemidae	*Polynemus indicus*	PLNPO04	33	√				
		Eleutheronema tetradactylum	PLNEL01	34	√				
	Psettodidae	*Psettodes erumei*	PSEPS02	35	√				
	Synodontidae	*Saurida tumbil*	SYNSA02	36	√				
	Sillagonidae	*Sillago domina*	SILSI99	37	√				
	Sciaenidae	*Pterotolithus maculatus*	SCIPU02	38	√		√	√	√
		Pennahia argentata	SCIPE01	39	√		√	√	√
		Otolithes cuvieri	SCIOT02	40	√				
	Sparidae	*Argyrops spinifer*	SPAAR01	41	√				
	Arridae	*Arius – spp.*	ARDAR00	42	√		√	√	√
	Stromateidae	*Pampus chinensis*	STRPA02	43	√		√	√	√
		Pampus argenteus	STRPA01	44	√		√	√	√
	Trichiuridae	*Lepturacanthus savala*	TRILT01	45	√		√	√	√
	Theraponidae	*Therapon jarbua*	THETH01	46	√				
	Shark and rays	*Scoliodon laticaudus*	SHACA71	47	√				
		Himantura uarnak	RAYDA23	48	√				
		Rhinobatus granulatus	RAYRB23	49	√				
		Eusthyra blochii	SHASP21	50	√				
	Muraenesocidae	*Muraenesox talabonides*	MUXCU01	51	√		√	√	√
	Cephalopods	*Sepia esculenta*	SQUSE18	52	√				
		Uroteuthis duvaucelli	SQULO71	53	√				
		Octopus vulgaris	SQUOC11	54	√				
	Shrimps	*Metapenaeus monoceros*	SHRPE71	55	√		√	√	√
		Penaeus indicus	SHRPE64	56	√				
		Penaeus monodon	SHRPE63	57	√		√	√	√

ANNEX VI OVERVIEW OF SAMPLING PROCEDURES IN THE FISH LAB



ANNEX VII OVERVIEW OF THE SAMPLES

Table 2. List of species collected for stomach content analysis

Sl. No.	St. no.	Species name	Species code	Collection date	Remarks
1	1	*Harpadon nehereus*	SYNHA01	04.08.18	
2	1	*Setipinna tenuifilis*	ENGSE03	04.08.18	
3	1	*Osteogeneiosus militaris*	ARDOS01	04.08.18	
4	1	*Raconda russeliana*	PRSRA01	04.08.18	
5	2	*Euthynnus affinis*	SCMEU02	04.08.18	
6	2	*Megalaspis cordyla*	CARME01	04.08.18	
7	4	*Lepturacanthus savala*	TRILT01	04.08.18	
8	5	*Decapterus macrosoma*	CARDE05	05.08.18	
9	5	*Echeneis naucrates*	ECNEC01	05.08.18	
10	6	*Pampus chinensis*	STRPA02	05.08.18	
11	6	*Terapon jarbua*	THETH01	05.08.18	
12	7	*Myctophidae*	MYCAA00	06.08.18	
13	7	*Bregmaceros mcclellandi*	BREBR01	06.08.18	
14	7	*Sthenoteuthis oualaniensis*	SQUMOC1	06.08.18	
15	7	*Champsodon vorax*	CHMCH03	06.08.18	
16	8	*Sardinella fimbriata*	CLUSL06	06.08.18	
17	8	*Lepturacanthus savala*	TRILT01	06.08.18	
18	8	*Parastromateus niger*	CARPA01	06.08.18	
19	9	*Nemipterus nematophorus*	NEMNE07	06.08.18	
20	9	*Nemipterus japonicus*	NEMNE03	06.08.18	
21	9	*Selar crumenophthalmus*	CARSA01	06.08.18	
22	9	*Upeneus moluccensis*	MULUP03	06.06.18	
23	9	*Saurida tumbil*	SYNSA02	06.06.18	
24	12	*Vinciguerria spp.*	GONVI00	07.08.18	
25	13	*Cubiceps pauciradiatus*	NOMCU05	07.08.18	
26	16	*Acanthurus sp.*	ACAAC00	08.08.18	
27	16	*Dipterygonotus balteatus*	CAEDI01	08.08.18	
28	16	*Benthosema*	MYCBE00	08.08.18	
29	16	*Priacanthus sp.*	PRIPR00	08.08.18	

30	17	*Lestidium sp,*	PARLE00	08.08.18	
31	18	*Psenes sp*	NOMPS00	09.08.18	
32	18	*Neoepinnula orientalis*	GEMNP01	09.08.18	
33	18	*Lestrolepis japonica*	PARLP03	09.08.18	
34	18	*Diaphus sp.*	MYCDI00	09.08.18	
35	22	*Synagrops japonicus*	ACRSY02	10.08.18	
36	23	*Mene maculata*	MENME01	10.08.18	
37	23	*Dussumieria elopsoides*	CLUDU02	10.08.18	
38	27	*Sphoeroides dorsalis*	TETSP11	11.08.18	
39	27	*Grammoplites scaber*	PLAGR04	11.08.18	
40	27	*Johnius sp.*	SCIJO00	11.08.18	
41	29	*Auxis thazard*	SCMAU01	12.08.18	
42	29	*Acropomatidae*	ACRAA00	12.08.18	
43	41	*Sphyraena obtusata*	SPHSP06	16.08.18	
44	41	*Siganus canaliculatus*	SIGSI01	16.08.18	

Table 3. list of samples collected for genetical identification

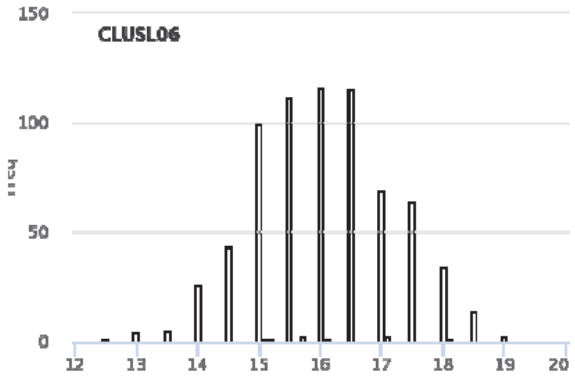
Sl. No.	**St. no.**	**Number of specimens**	**Collection date**	**Remarks**
1	4	7	04.08.18	
2	5	1	05.08.18	
3	6	11	05.08.18	
4	7	3	06.08.18	
5	8	7	06.08.18	
6	9	10	06.08.18	
7	12	1	07.08.18	
8	13	3	07.08.18	
9	17	2	08.08.18	
10	18	3	09.08.18	
11	20	1	09.08.18	
12	21	1	09.08.18	
13	23	2	10.08.18	
14	27	1	11.08.18	
15	28	2	11.08.18	

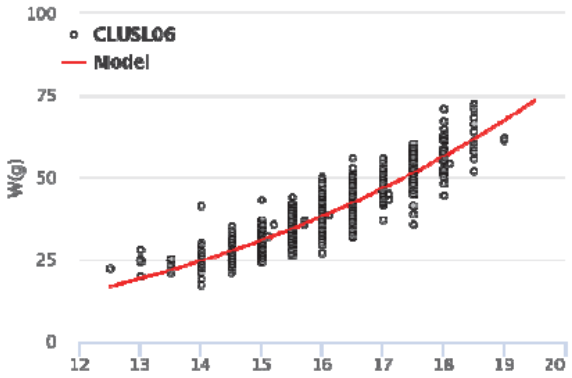
16	31	4	12.08.18	
Total		59	-	

Table 4. List of specimens collected for analysis of microplastics gut content

Sl. No.	St. no.	Species name	Species code	Collection date	Remarks
1	13	*Cubiceps pauciradiatus*	NOMCU05	07.08.18	
2	15	*Vinciguerria spp.*	GONVI00	08.08.18	
3	18	*Lestrolepis japonica*	PARLP03	09.08.18	
4	18	*Diaphus sp.*	MYCDI00	09.08.18	
5	18	*Psenes sp*	NOMPS00	09.08.18	
6	19	*Benthosema*	MYCBE00	09.08.18	
7	21	*Myctophidae*	MYCAA00	10.08.18	
8	21	*Priacanthus sp.*	PRIPR00	10.08.18	
9	21	*Neoepinnula orientalis*	GEMNP01	10.08.18	

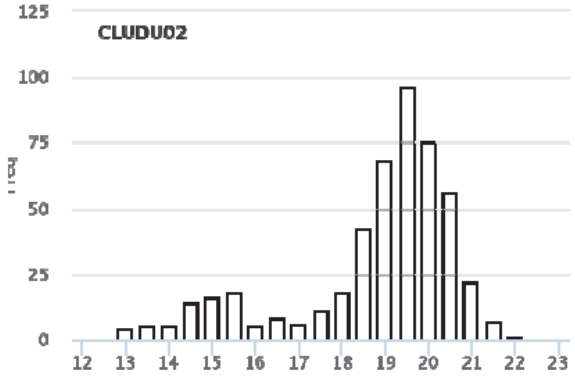
ANNEX VIII LENGTH-FREQUENCY & LENGTH-WEIGHT FIGURES FOR FISH SPECIES

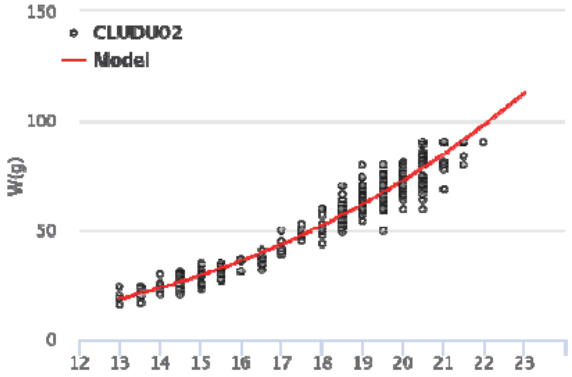




Sardinella fimbriata

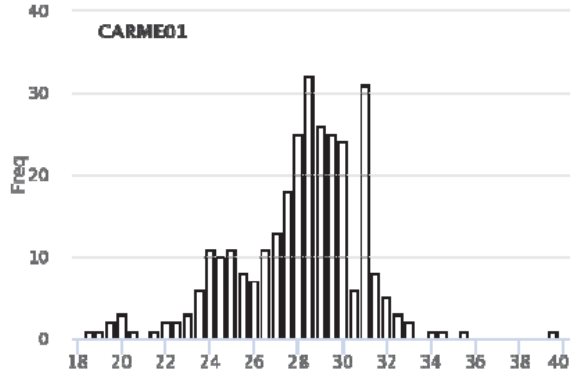
$W = 0.004*L^{3.314}$, $R^2=0.8147$ (0.9026^2), N=709

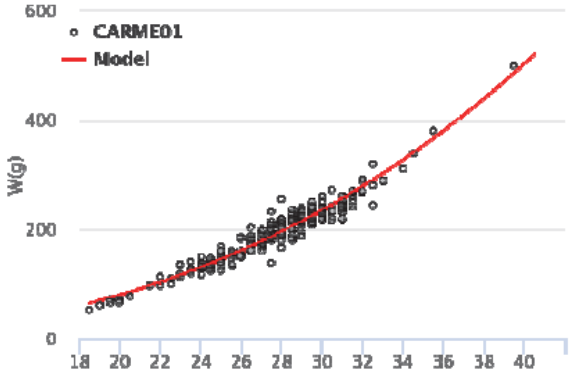




Dussumieria elopsoides

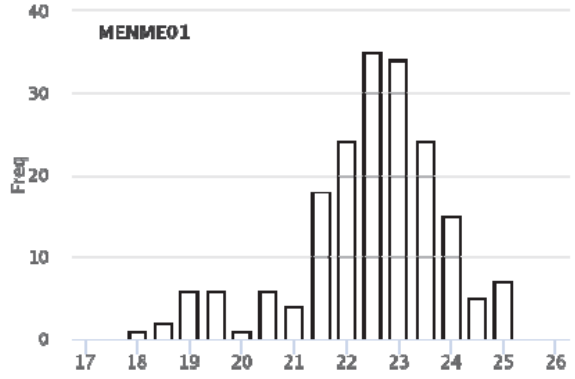
$W = 0.006*L^{3.148}$, $R^2=0.938$ (0.9685^2), N=477

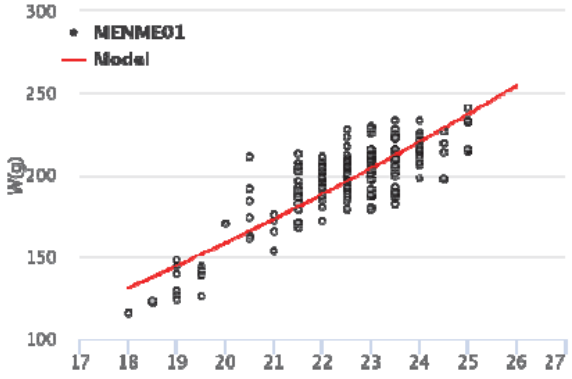




Megalapsys cordyla

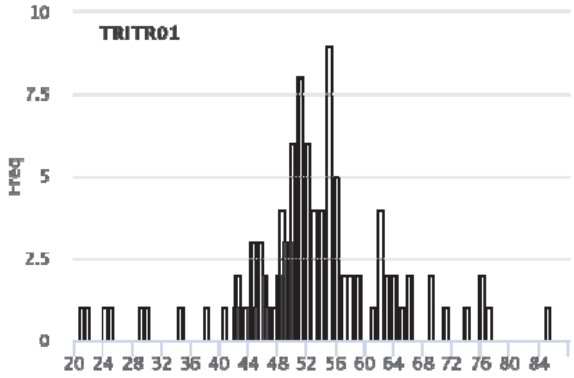
$W = 0.029*L^{2.645}$, $R^2=0.9369$ (0.968^2), N=302

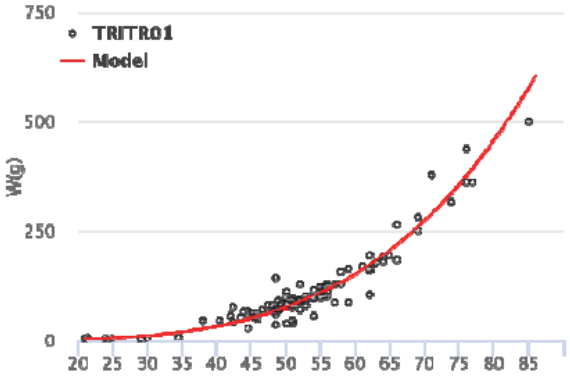




Mene maculata

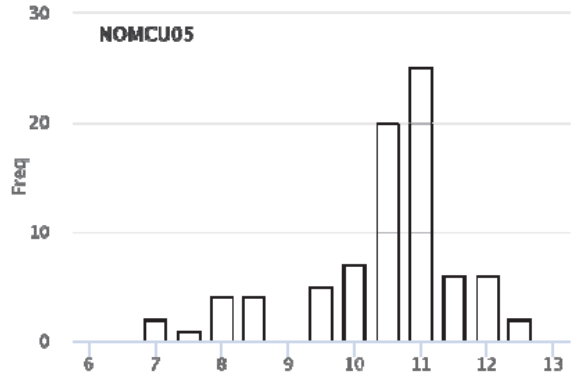
$W = 0.719*L^{1.801}$, $R^2=0.727$ (0.8526^2), N=188

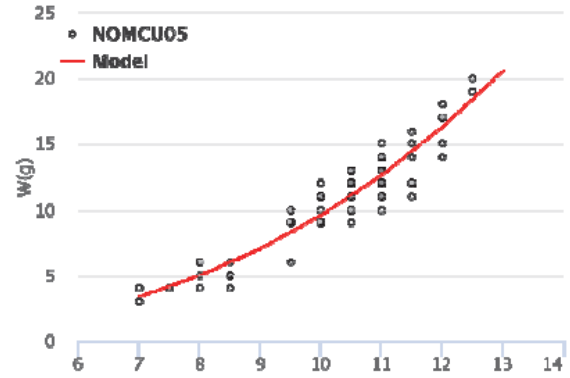




Trichiurus lepturus

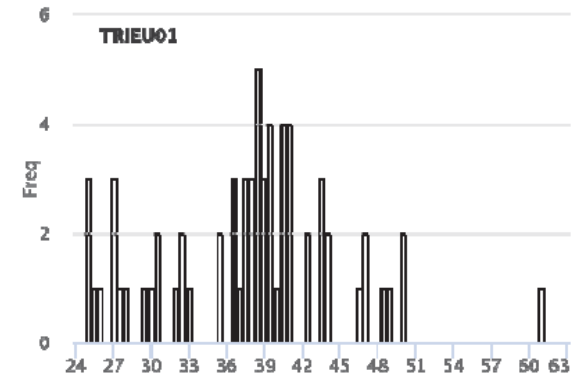
$W = 0*L^{3.839}$, $R^2=0.8948$ (0.946^2), N=105

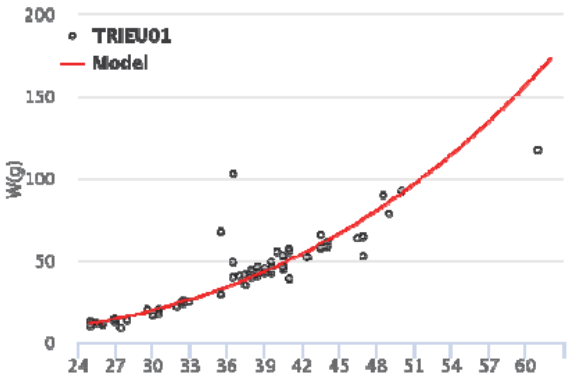




Cubiceps pauciradiatus

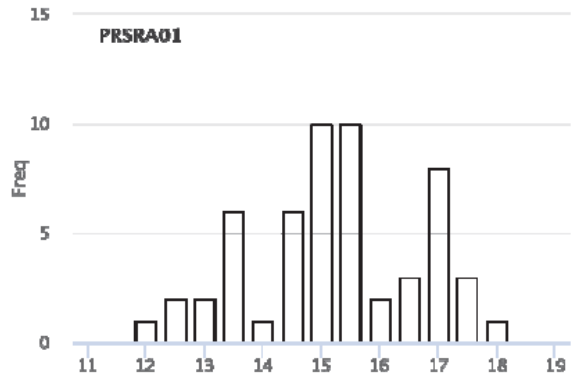
$W = 0.012*L^{2.919}$, $R^2=0.8882$ (0.9424^2), N=82

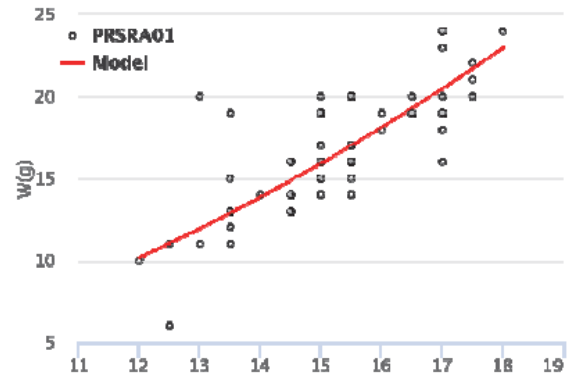




Eupleurogrammus muticus

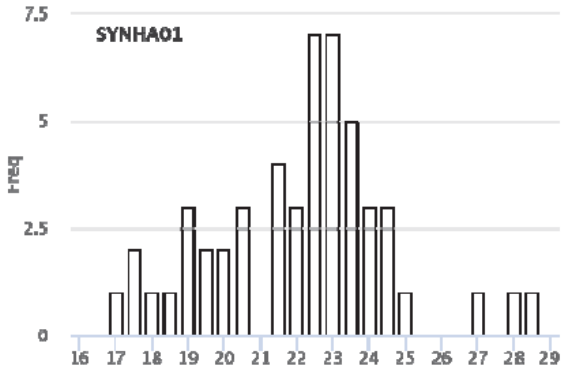
$W = 0.001*L^{2.988}$, $R^2=0.8859$ (0.9412^2), N=66

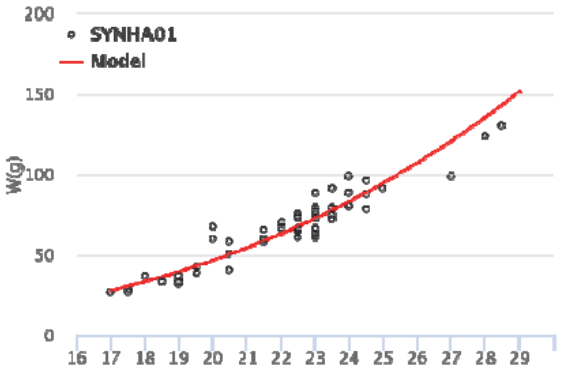




Raconda russeliana

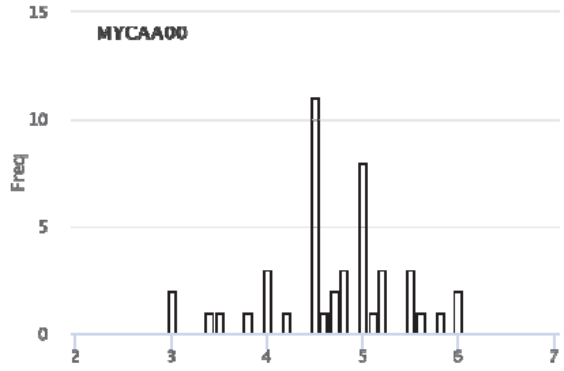
$W = 0.069*L^{2.01}$, $R^2=0.6048$ (0.7777^2), N=55

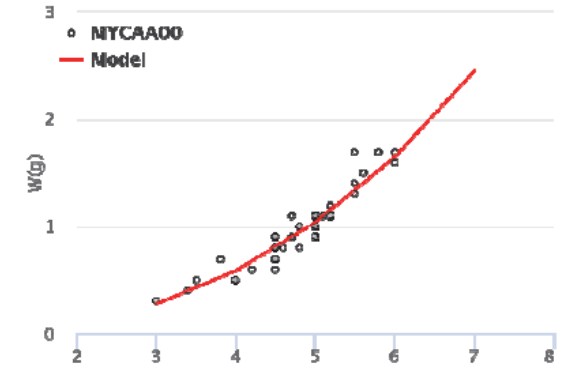




Harpadon nehereus

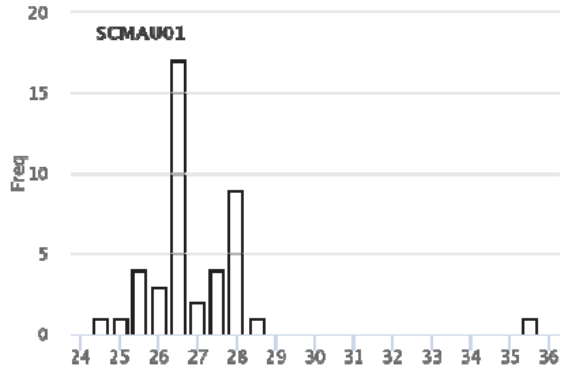
$W = 0.004*L^{3.167}$, $R^2=0.8984$ (0.9478^2), N=51

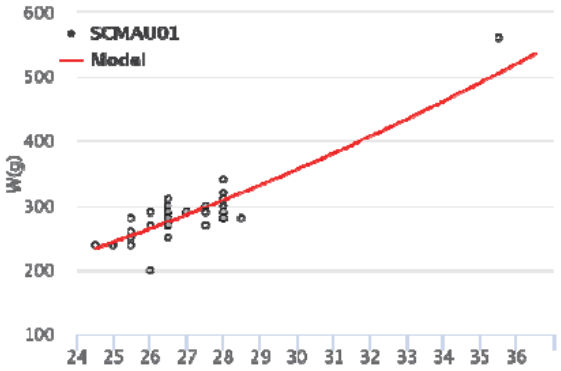




MYCTOPHIDAE

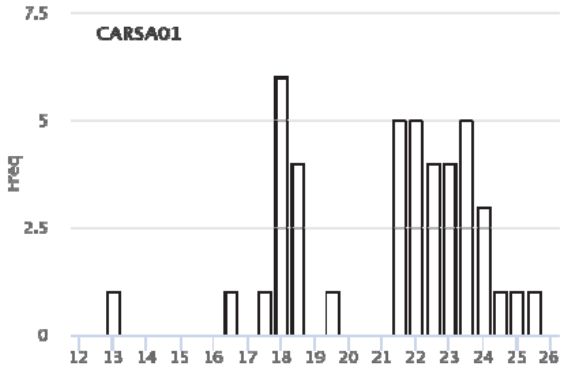
$W = 0.018*L^{2.537}$, $R^2=0.9177$ (0.958^2), N=45

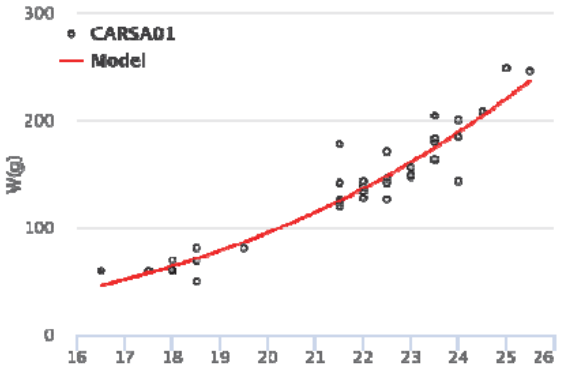




Auxis thazard

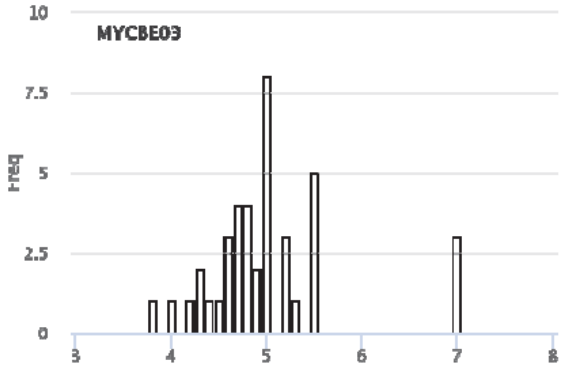
$W = 0.3*L^{2.082}$, $R^2=0.6941$ (0.8332^2), N=43

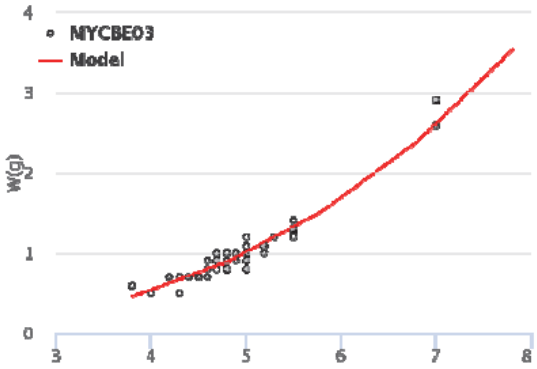




Selar crumenophthalmus

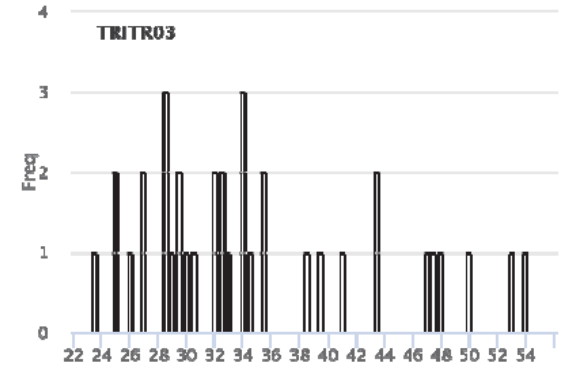
$W = 0.001*L^{3.759}$, $R^2=0.9317$ (0.9652^2), N=42

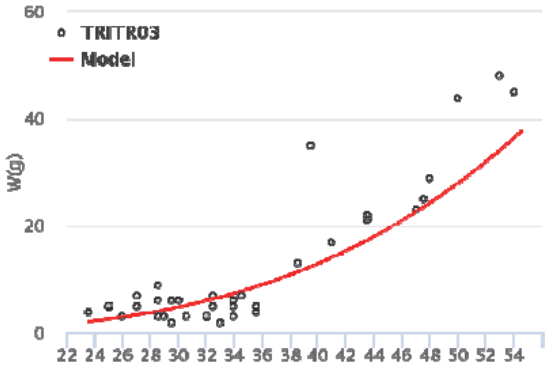




Benthosema suborbital

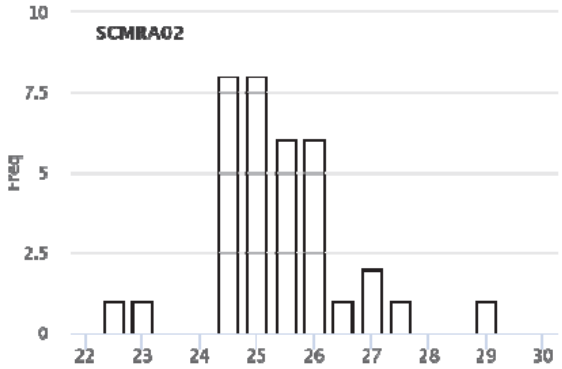
$W = 0.01*L^{2.838}$, $R^2=0.9138$ (0.9559^2), N=40

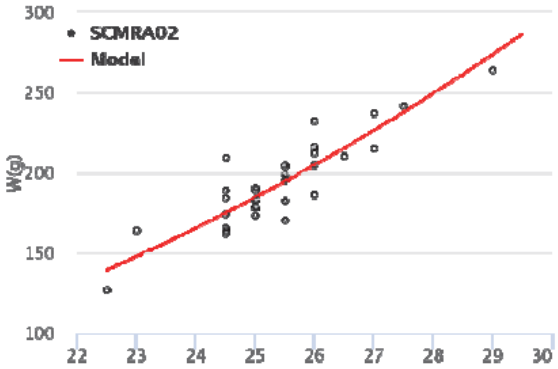




Trichiurus gangeticus

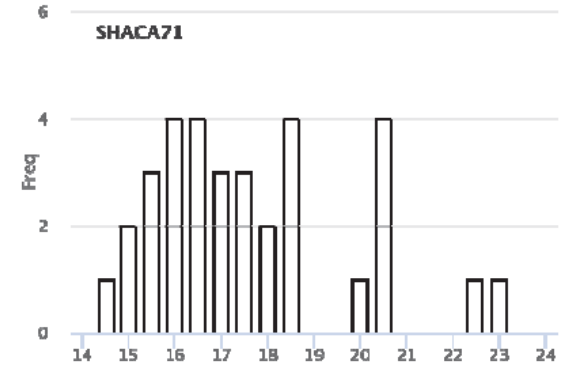
$W = 0*L^{3.432}$, $R^2=0.676$ (0.8222^2), N=36

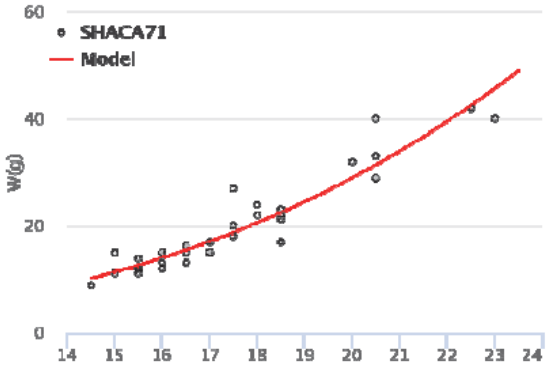




Rastrelliger brachysoma

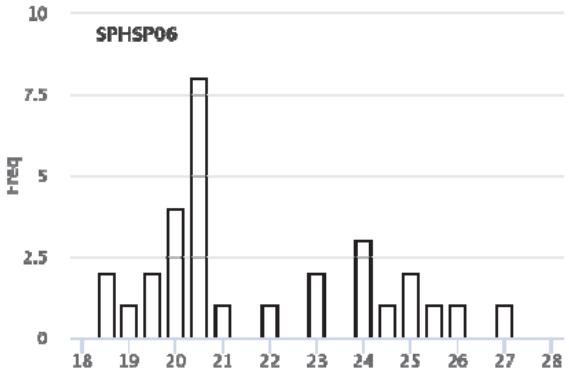
$W = 0.036*L^{2.658}$, $R^2=0.7715$ (0.8784^2), N=34

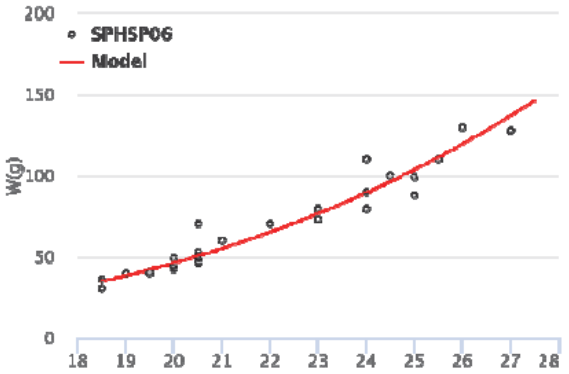




Scoliodon laticaudus

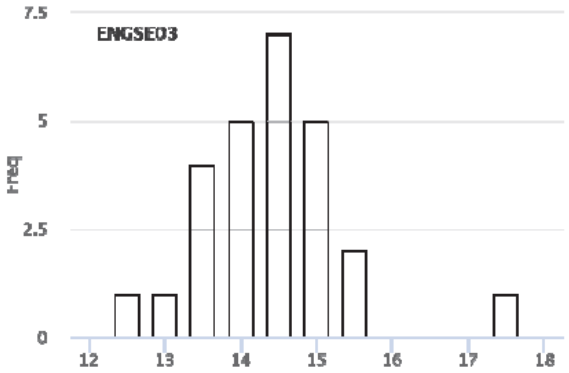
$W = 0.002*L^{3.261}$, $R^2=0.8903$ (0.9435^2), N=33

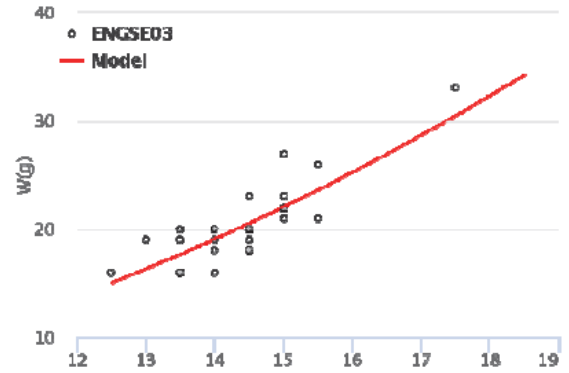




Sphyrnaea obtusata

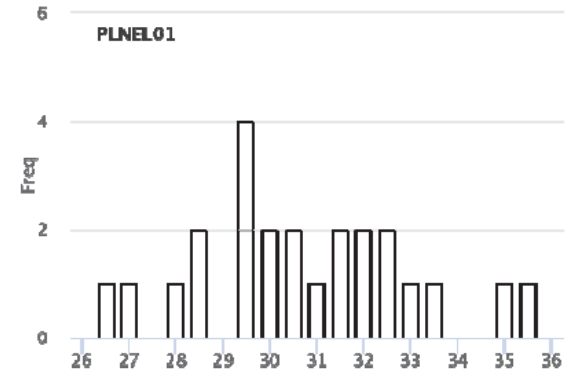
$W = 0.001*L^{3.617}$, $R^2=0.943$ (0.9711^2), N=30

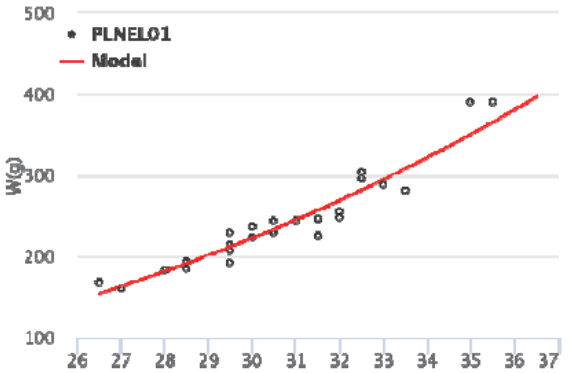




Setipinna tenuifilis

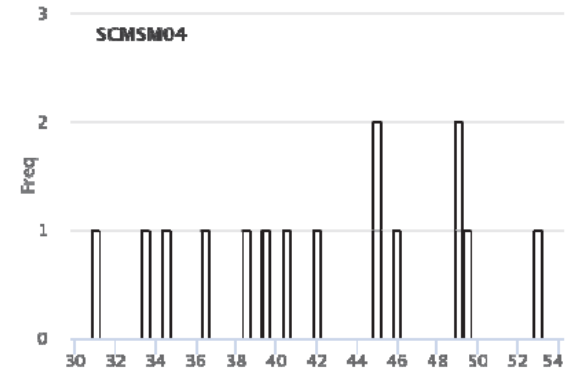
$W = 0.076*L^{2.096}$, $R^2=0.6687$ (0.8177^2), N=26

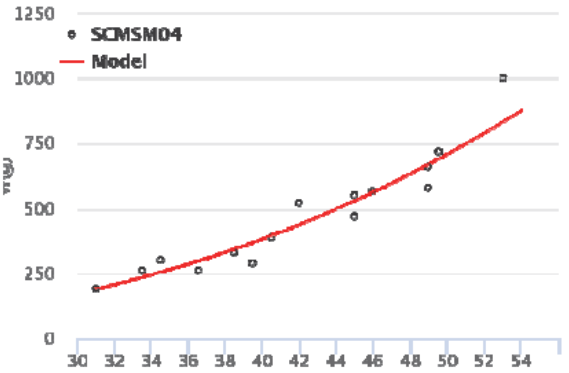




Eleutheronema tetradactylum

$W = 0.01*L^{2.941}$, $R^2=0.9251$ (0.9618^2), N=24





Scomberomorus guttatus

$W = 0.014*L^{2.764}$, $R^2=0.9263$ (0.9625^2), N=15

ANNEX IX OVERVIEW OF SAMPLES AND INSTITUTIONS

Gear/equipment	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person Leg 3.3 (e-mail, phone no)	Deadline for analysis
Niskin bottles on CTD		Nutrients	0.2 ml chloroform (keep cool)	Chittagong	Airfreight	Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	Kjell.gundersen@hi.no	
Niskin bottles on CTD		Chlorophyll a	Frozen (-18 to -20 C, best -80)					Processed onboard
WP2 (180 µm) 30 m 1/2 split		Zooplankton Biomass	dried	Phuket	Airfreight	Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	Kjell.gundersen@hi.no	
WP2 (180 µm) 30 m 1/2 split	Species identification	Zooplankton Taxonomy	4% formaldehyde	Chittagong	By road	BORI, SBAU	Abu Sayeed Muhammad Sharif, Dr. Kaji Ahsan Habib	
WP2 (180 µm) from max 200 m 1/2 Split		Zooplankton Biomass	dried	Phuket	Airfreight	Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	Kjell.gundersen@hi.no	
WP2 (180 µm) from max 200 m 1/2 Split	Species identification	Zooplankton Taxonomy	4% formaldehyde	Chittagong	By road	BORI, SBAU	Abu Sayeed Muhammad Sharif, Dr. Kaji Ahsan Habib	
MultiNet (Midi, 1 or 5 x 405 µm), oblique tow from max 200 m	Species identification	zooplankton taxonomy (depth related)	4% formaldehyde	Chittagong	By road	BORI, SBAU	Abu Sayeed Muhammad Sharif, Dr. Kaji Ahsan Habib	
MultiNet (Midi, 1 or 5 x 405 µm), oblique tow from max 200 m	Species identification	Ichthyoplankton egg	4% formaldehyde	Chittagong		BORI, SBAU, BFRI		

Gear/equipment	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person Leg 3.3 (e-mail, phone no)	Deadline for analysis
MultiNet (Midi, 1 or 5 x 405 µm), oblique tow from max 200 m	Species identification	Ichthyoplankton larvae	4% formaldehyde	Chittagong		BORI, SBAU, BFRI		
MultiNet (Midi, 1 or 5 x 405 µm), oblique tow from max 200 m	Abundance and chemical composition	plastic particles	Frozen	Phuket		Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	Bjorn.einar.grosvik@hi.no	
MultiNet (Midi, 1 or 5 x 405 µm), oblique tow from max 200 m	Species identification	or bulk sample	4% formaldehyde			BORI, SBAU, BFRI		
Manta trawl (375 µm): surface tow for 15 mins	Species identification	Neuston community identification	4% formaldehyde					
Manta trawl (375 µm): surface tow for 15 mins	Abundance and chemical composition	Microplastics	Photographed and freezed			Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	Bjorn.einar.grosvik@hi.no	NEEDS TO BE CLARIFIED.
Surface water pump inlett (2 m) 405 µm	Abundance and chemical composition	Microplastic samples	Frozen			Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	Bjorn.einar.grosvik@hi.no	Not taken
Trawl samples	Species identification	Jellyfish whole individual	Dried + frozen	Chittagong	By road	IMSFCU		
Trawl samples	Genetic analyses?	Jellyfish arm	96% Ethanol + frozen	Chittagong	By road	SBAU		
Trawl samples	??	Jellyfish the rest	4% formaldehyde					

Gear/equipment	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person Leg 3.3 (e-mail, phone no)	Deadline for analysis
Trawl samples	Genetic analyses (stock identity)	Finclips of priority species	96% Ethanol	Chittagong	By road	SBAU		
Trawl samples	Diet analyses	Stomachs	frozen	Chittagong	By road	Noakhali Science and technology university (NSTU) /World fish center (WFC)		
Trawl samples	Morphomethric analyses	whole specimens	Frozen/4% formaldehydee	Chittagong	By road	DOF/IMSFCN		
Trawl samples	chemical analyses	Otoliths	dry					
Trawl samples	Taxonomy (course)	whole specimens for morphometric analysis (Taxonomic course, Bergen)	Frozen	Phuket	Rupert Wienerroither	Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen Norway	rupert.wienerroither@hi.no	
Trawl samples	Museum collection	Whole specimen Museum coollection	4% formaldehyde					Not taken
Trawl samples	Museum collection	Fin clips or other flesh sample museum collection from each specimen	96% Ethanol	Chittagong	By road	DOF		
Trawl samples	chemical composition	Food safety samples	freezed dried / vacum packed	Phuket	Air freight	Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen		
Trawl samples	chemical composition	fish liver - food safety	Frozen -80	Phuket	Air freight	Institute of Marine Research, P.O. Box 1870 Nordnes, Bergen		
Trawl sediment pipe	chemical analyses /granulomethric analyses	Trawl cylinder sediment	Frozen / 4% formaldehyde	Chittagong	By road	IMSCU, BORI		

Gear/equipment	Analyses	Samples	Preservation	Port of offloading	Type of transportation	Institution address	Contact person Leg 3.3 (e-mail, phone no)	Deadline for analysis
Supplementary sampling/requested by participants								
Phytoplankton (from niskin bottle)	Species identification	phytoplankton taxonomy	4% formaldehyde /lugol	Chittagong	By road	Bangladesh Ocean Research Institute, COX BAZAR	Abu Sayeed Muhammad Sharif	
Trawl samples	Mesopelagic taxonomy identification	Whole mesopelagic specimens for morphometric analysis (Taxonomic identification, Bangladesh)	Frozen	Chittagong	By road	SBAU, Dhaka	Dr. Kaji Ahsan Habib	
Niskin bottles on CTD (2nd set o samples)		Nutrients	0.2 ml chloroform (keep cool)	Chittagong	By road	Bangladesh Ocean Research Institute, COX BAZAR	Abu Sayeed Muhammad Sharif	
WPII	Spcies identification	Jellyfish samples	Formalin	Chittagong	By road	Institute of marine Sciences and Fisheries IMSFC, Chittagong	Sayedur	
Trawl samples	Stomach samples	Stomach for microplastics analysis	Frozen			BAU	Dr. Harun	