ELISABETH MANN BORGESE-Berichte

# Cruise No. EMB268

18.06.2021 – 21.06.2021,
Rostock (Germany) – Rostock (Germany)
MGF


**AUTHORS**

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2021

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# 1 Cruise Summary

## 1.1 Summary in English

The cruise EMB268 is closely related to an interdisciplinary research project funded by the German Federal Ministry of Education and Research (BMBF) on "Investigation of the expected impact of the exclusion of mobile, bottom-dwelling fisheries in marine protected areas of the Baltic Sea" (abbreviation: "MGF-Ostsee"). This is also a pilot project of the German Alliance for Marine Research (DAM) (DAM Pilot Mission - Protected Areas Baltic Sea, FKZ: 03F0848A). In this research project, a consortium of scientists is investigating how the ecosystems of Natura 2000 sites in the German Exclusive Economic Zone (EEZ) of the Baltic Sea develop after exclusion of mobile bottom-dwelling fisheries (MGF). The main objectives are to better understand the sustainability of seabed habitats and biota in Natura 2000 areas under current bottom trawling operations, a general assessment of the impact of bottom-touching fisheries on benthic communities and sediment functions, and their evolution after fisheries exclusion. During EMB268, a trawl experiment was conducted in cooperation with the Thünen Institute as well as the HRO. The changes in morphology, geology, biology and geochemistry were induced by trawling recorded by targeted sampling.

## 1.2 Zusammenfassung

Die Reise erfolgt in Anbindung an ein vom Bundesministerium für Bildung und Forschung (BMBF) geförderten interdisziplinärem Forschungsprojektes zur „Untersuchung der erwarteten Auswirkung des Ausschlusses mobiler, grundberührender Fischerei in marinen Schutzgebieten der Ostsee“ (Kürzel: „MGF-Ostsee“). Dies ist gleichzeitig ein Pilotprojekt der Deutschen Allianz für Meeresforschung (DAM) (DAM Pilotmission - Schutzgebiete Ostsee, FKZ: 03F0848A). In diesem Forschungsprojekt untersucht ein Konsortium von WissenschaftlerInnen wie sich die Ökosysteme der Natura 2000-Gebiete in der deutschen ausschließlichen Wirtschaftszone (AWZ) der Ostsee nach Ausschluss der mobilen grundberührenden Fischerei (MGF) entwickeln. Hauptziele sind ein besseres Verständnis der Nachhaltigkeit von Meeresbodenlebensräumen und Biota in den Natura 2000 Gebieten unter dem derzeitigen Grundschleppnetzbetrieb, eine generelle Bewertung der Auswirkungen der bodenberührenden Fischerei auf benthische Gemeinschaften und Sedimentfunktionen sowie deren Entwicklung nach Fischerei-Ausschluss. Während dieser Fahrt soll in Kooperation mit dem Thünen-institut sowie der HRO ein Schleppspurexperiment durchgeführt werden. Die Änderungen in Morphologie, Geologie, Biologie und Geochemie sollen durch gezielte Probennahme erfasst werden.

# 2 Participants

## 2.1 Principal Investigators

| Name | Institution |
|---|---|
| Prof. Klaus Jürgens (PI MGF Ostsee) | IOW |
| Dr. Peter Feldens (Applicant EMB268) | IOW |

### 2.2 Scientific Party

| Name | Discipline | Institution |
|---|---|---|
| Dr. Feldens, Peter | Geophysics, Chief Scientist | IOW |
| Frahm, Andreas | Technician | IOW |
| Dr. Gogina, Mayya | Biology | IOW |
| Dr. Röser, Patricia | Biogeochemistry | IOW |
| Clemens, David | Geochemistry | GEOMAR |
| Giese, Tabea | Biology | Uni Rostock |
| Meeske, Christian | Biology | IOW |
| Neumann, Elsa | Geology | IOW |
| Emde, Annalena | Biology | IOW |
| Wagenhöfer, Julian | Biogeochemistry | IOW |
| Dr. Kern, Ramona | Biogeochemistry | Uni Rostock |

‘ To account for Corona-Regulations, the cruise was carried out as day cruises and personnel was exchanged as required for sampling, following a strict testing regime. No more than 8 person were onboard EMB per day.

### 2.3 Participating Institutions

| | |
|---|---|
| IOW | Leibniz Institute for Baltic Sea Research Warnemünde |
| GEOMAR | GEOMAR Helmholtz Zentrum für Ozeanforschung |
| Uni Rostock | Universität Rostock |

## 3 Research Program

### 3.1 Description of the Work Area

The research area is located offshore Kühlungsborn, near Rostock. Here, water depths of 15-20 m are located in close vicinity to the coastline (approx. 3 sm). The seafloor is composed of muddy sand which is comparable to seafloor in the main investigation sites of the MGF-Ostsee pilot mission in the Fehmarn Belt area. Closer towards the coastline, sand prevails, which was the target of the last day of the experimental cruise and is similar to seafloor encountered in the MGF-Ostsee investigation site “Oderbank”. The close vicinity to the coastline allows the target area to be reached by small vessels for purposes of the experiment and the subsequent monitoring following EMB268.

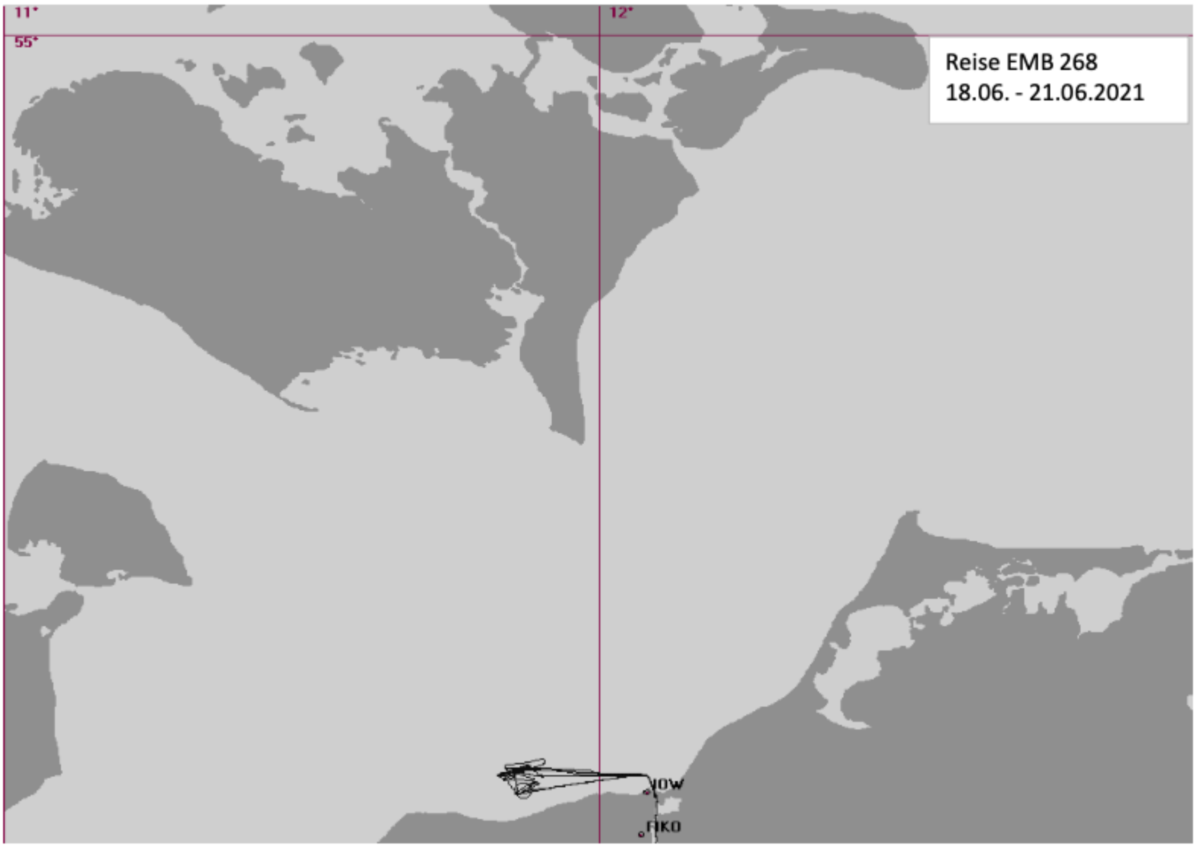



**Fig. 3.1** Track chart of R/V EMB Cruise 268 from the captains report.

## 3.2 Aims of the Cruise

The major aim of the proposed cruise under the framework of the BMBF funded project "Consequences of the exclusion of bottom trawl fishing from the marine protected areas (Natura 2000) in the German EEZ of the Baltic Sea (MPA-DAM)" is to identify the immediate impact of bottom trawling on local physical properties, benthic communities and biogeochemical processes. This survey is a counterpart to and complements monitoring activities carried out in designated marine protected areas within the MGF-Ostsee project.

Specifically, the proposed research survey aimed to address the following objectives:

- Determine sediment suspension and redeposition caused by MGF and impact on internal sediment microstructure, bioturbation tracer distribution as well as microbial communities and associated activities like sulfate reduction.
- Determine the impact of MGF on pore water profiles, geochemical surface sediment composition, and its impact on redox gradients and mineralization of organic material.
- Quantify the exchange of oxygen at the sediment-water interface following MGF.
- Detection of immediate trawling effects on macrobenthic communities, their state and functional composition and quantify the damage on key habitat species (including Arctica islandica)

- Investigate the short-term effects of MGF on heterotrophic bacterial carbon processing by the analysis of benthic bacterial abundance and biomass along with rates of hydrolytic extracellular enzyme activity in the sediment and in the plume of re-suspended material before and after dredging.
- Molecular biology tools will be used to explore effects on community composition and on the activity of key players.

### 3.3 Agenda of the Cruise

The cruise took place in a framework of an experiment including 5 vessels: A commercial trawler to create a bottom trawl mark, diving vessel LIMANDA of Rostock University, research Katamaran Klaashahn of EMB, fishery research Vessels SOLEA of the Thünen Institute and EMB for multi-purpose sampling and hydroacoustic surveying. The number of involved vessels and disciplines allowed a holistic sampling of a freshly created trawl mark.

## 4 Narrative of the Cruise

18.06.2021
Cast off at 08:00 in Marienehe. The cruise track is shown in Figure 3.1. The working area is reached at 09:45, a first CTD is run. All day long calm weather conditions with outside temperatures above 30°. Following the CTD, 3 MUCs are run in silty fine sand and successfully sampled. The EC lander is deployed in the profile line trawled the following day. After noon, 5 more MUC. After one last MUC station, the EC lander is recovered, EMB arrives at Warnemünde at 17:45, and part of the samples are transferred to IOW for further processing. The evening on EMB is spent processing the cores remaining on board.

19.06.2021
Departure at 08:00. Deployment of the EC-lander at 09:00. Subsequently, trawl mark is created by trawler Freedom, EMB follows and maps acoustically. The trawl mark is difficult to find in acoustic data. Two CTDs apparently catch the suspension cloud, a repeat CTD at noon shows no sign of suspension. Subsequently MUC stations in the area of the grounding net. After 5 MUC stations, 8 van grabs are taken in the trawl mark and for reference outside. Then EMB recovers the lander, and take over cores from Limanda and return to Warnemünde. Laboratory work will continue on EMB and at IOW until night (02:00).

20.06.2021
In the area at 09:00. Mapping newly created tow track Solea with MBES (54°12.191 11°51.551 to 54°12.388 11°52.830), which used heavier weights to increase visibility. Transmit station coordinates to divers following analysis of acoustic data. CTD, then one MUC before lunch. Over lunch video profiles transverse and longitudinal to previous day's trawl mark are recorded. Trawl doors and net weights identified in video data, confirming the positioning of yesterday stations. Subsequently, further MUC in net area, and a test of penetration depth of the MUC in the southern area to be worked on the 21st. Subsequent 5 Van Ven grabs for grain size determination, and a

video profile in the area of the Solea-trawled tracks. The trawl mark can be identified optically. Return Warnemünde 18:00, takeover of diver samples. Lab work will be continued until 01:30.

21.06.2021
In area 09:00. Pre-survey in the area of the southern trawl mark by 2xMUC and CTD. Then follow the trawler Freedom in the southern towing lane. Wind min 6Bft from NE, borderline weather conditions for the trawler. Net has to be lifted early due to blocks and weather conditions, the southern limit of the planned trawl mark is not quite reached. During the trawl water column surveys with WCI. Afterwards 2 CTD stations in the southern part of the trawl. Subsequently 4 MUC stations with 7 MUCS are sampled, then return to Warnemünde at 16:00, followed by processing of the samples in the laboratory until about 24:00.

# 5 Preliminary Results

## 5.1 Geophysics (P. Feldens, M. Schönke)

The main task of the acoustic mapping during the cruise was to visualize the impacts of bottom fisheries on seafloor morphology and composition, to find the newly created trawl marks to submit positions to divers and to locate the suspension cloud created during trawling.

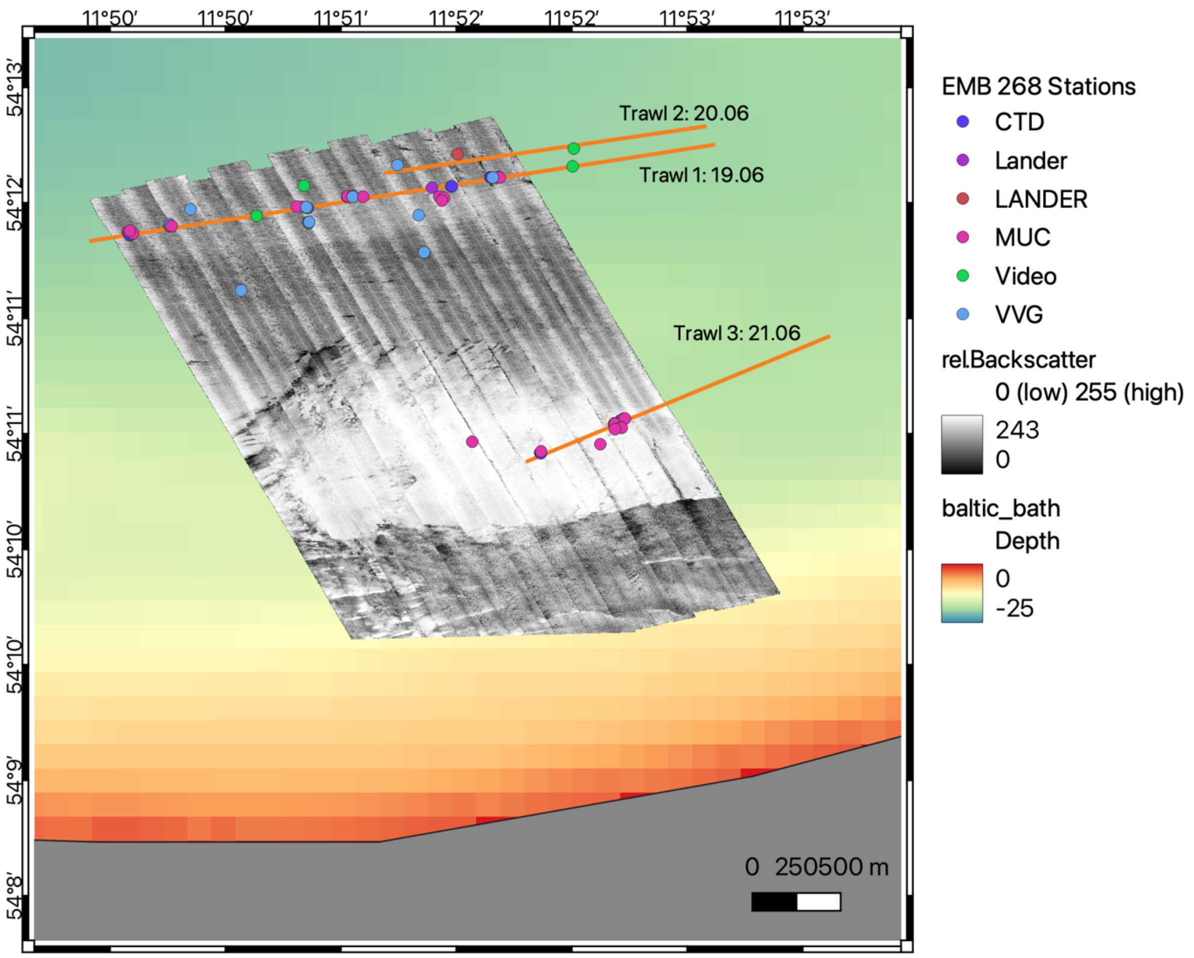



**Fig. 5.1** The working area with stations of EMB268. Three experimental trawl lines were surveyed: Trawl 1 on June 19th, trawl 2 on June 20th and trawl 3 on June 21st.

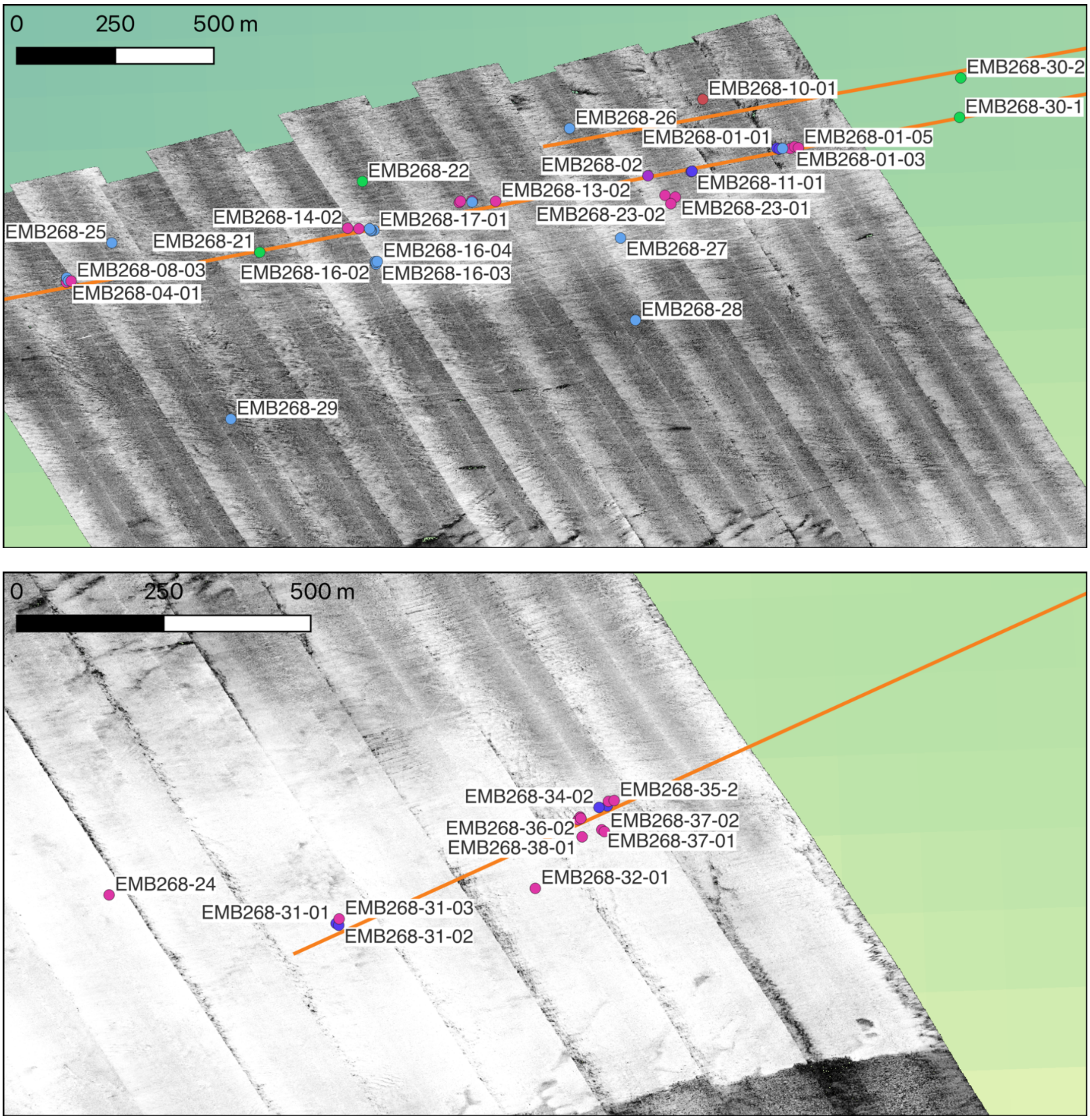



**Fig. 5.2** Magnified views of trawls 1 and 2 (top) and trawl 3 (bottom), including station IDs. See figure 5.1 for legend.

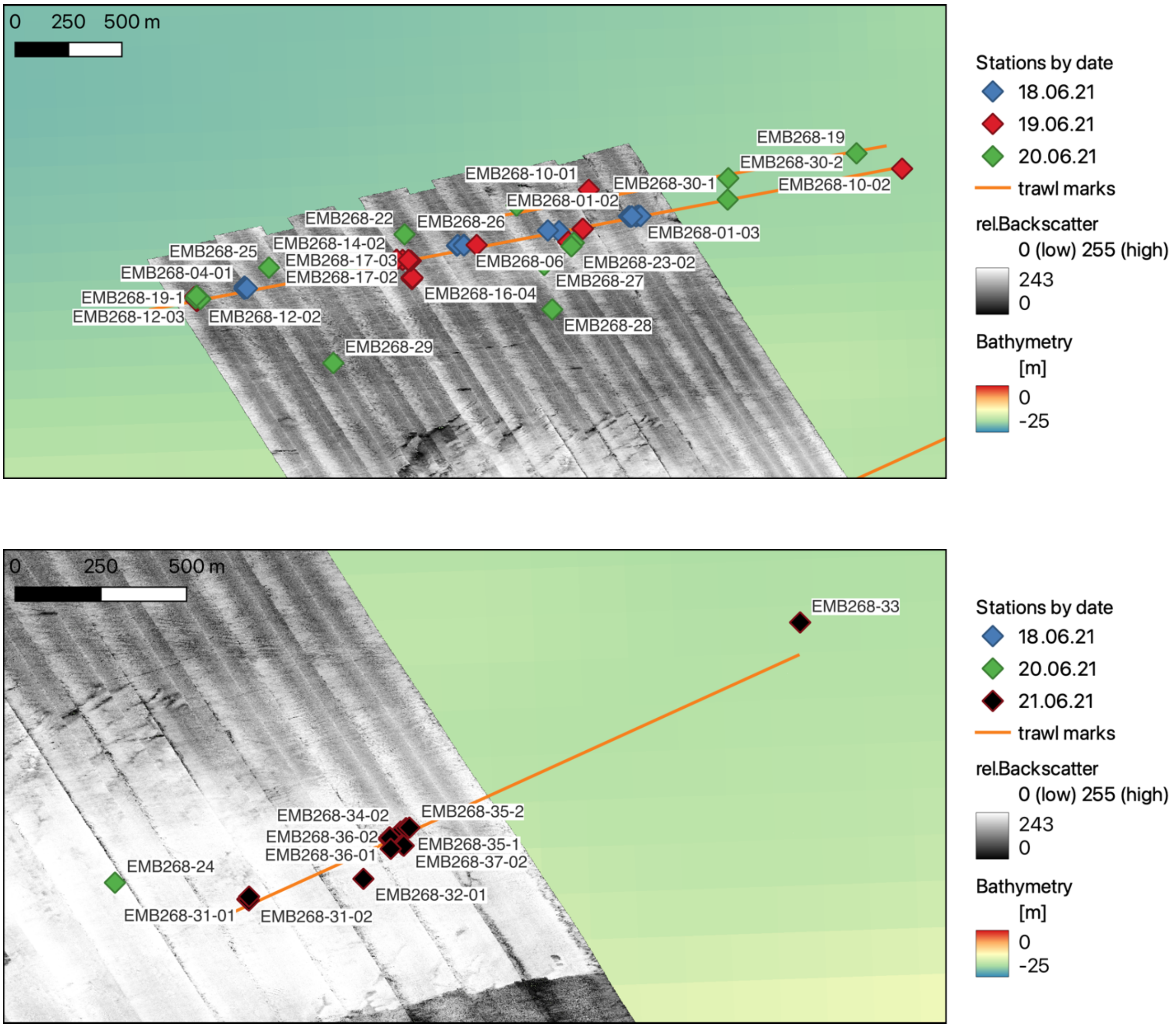



**Fig. 5.3** Stations by date for Trawl 1 and 2 (top) and 3. For trawl 1, stations on the 18th were taken prior to the experiment. For trawl 3, station EMB268-31, EMB268-32 and EMB268-24 were taken prior to the experiment.

The following instruments were used:

Multibeam system (MBES) R2Sonic

Seafloor bathymetry and multifrequency backscatter data were recorded by using the hull mounted MBES R2Sonic. The MBES was operated by (mostly) using a swath width of 140 deg and a 400 kHz recording frequency. TruePix data was recorded. Vessel speed during MBES data acquisition was 4.5-5 knots. For processing the software QPS Marine software solution was used. When following the trawler during the trawling experiment, water column scatter information was recorded to capture eventual suspension plumes.

EvoLogics S2C R ultrashort baseline (USBL) positioning System

The ultrashort baseline (USBL) positioning System is an underwater positioning system designed for shallow water operation to a maximum operation depth of 200 m and an operation range of 3500 m. The USBL transceiver is mounted to the vessel hull and communicates (13,9 kbps) within a frequency range of 18 -34 kHz with a transponder attached to a target device. The USBL measures the travel time between the transceiver and the transponder to determine the distance between the instruments. By using the phase-difference method, the transceiver (consisting of multiple hydrophones) computes the angle to the transponder to calculate the relative position. By implementing the USBL SINAPS client recording software (by EvoLogics GmbH) to the AHRS and GPS ship sensor, the positions of the transponders are displayed and recorded as real-world coordinate. Due to the unfavourable angle from the USBL to the MUC in the shallow waters of the operation site, localization of sampling gear did not work at most stations. To correct for this, the offset between MUC and the USBL transponder was determined during test deployments (the offset is x=-30.4 m to the aft), and the location of the sampling will be corrected taking into account the heading of EMB at the time of sampling. Prior tests indicted that samples can be located within approx. 3 m on the seafloor using this method in shallow waters depths and corresponding short rope lengths.

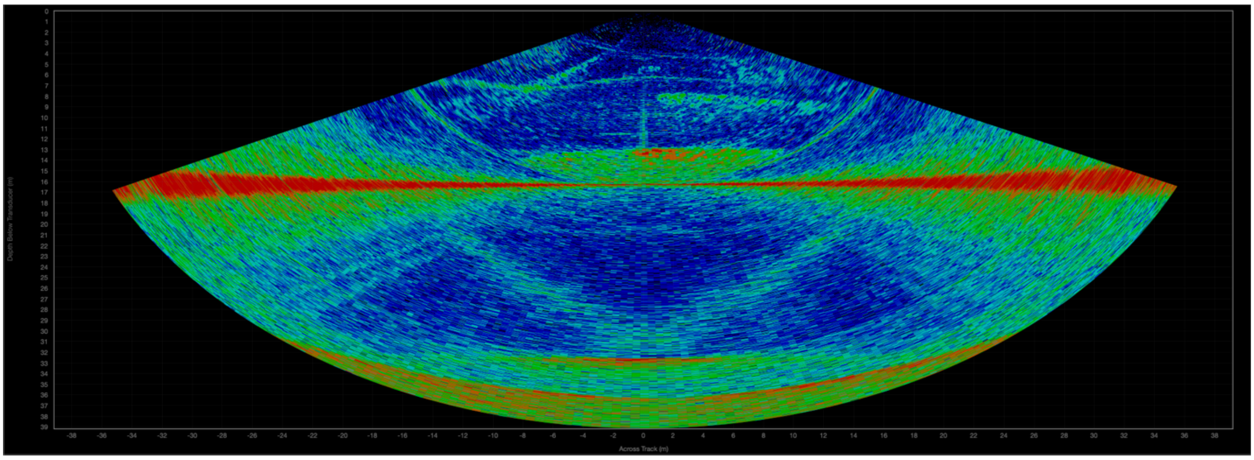


**Fig. 5.4** Potential suspension cloud observed prior to first site lobes at station EMB268-17.

**First Results and expected outcome:**

During the cruise, the suspension cloud of the trawler could be monitored in multibeam echo sounder data (Fig. 5.4) extending above 2 m above the seafloor. This is in line with observations by CTD at station EMB268-17, and profiles recorded by LISST from the research catamaran Klaashahn (not shown in this report). The trawl-marks of FS Solea on the 20$^{th}$ could be clearly observed and will be subject to monitoring by MBES echosounding following the cruise to determine the time required for the seafloor to regenerate. In contrast, the trawl marks created on the 19$^{th}$ could not be clearly seen onboard, presumably due to low weight of the trawl doors (less than 50 kg) at the minimal impact on the seafloor morphology. This had implications for the planned work of the diving vessel Limanda on June 19th that are discussed in the following: While the suspension cloud could be identified and hopefully sampled, and video data clearly show both the impact of trawl doors and ground line also during the 19$^{th}$ (Figure 5.14), the identification of the trawl marks on the 19th proved to be difficult, with subsequent problems in dive operations. While heavy enough to create the suspension cloud and leave impact visible in video data, the marks of the trawl door were very difficult to identify acoustically. Both the uncertainty in acoustic identification and the very small dimension of the trawl mark (making them difficult to find for divers) made it impossible for the divers to sample trawl mark positions, and only the ground net area could be sampled on the 19th (trawl 1, Fig. 5.1).

To account for the problem, the experiment was repeated on the 20th from FS Solea (trawl 2, Fig 5.1), using heavier weights of more than 400 kg. The corresponding trawl marks are clearly observed in backscatter information (Fig. 5.5).

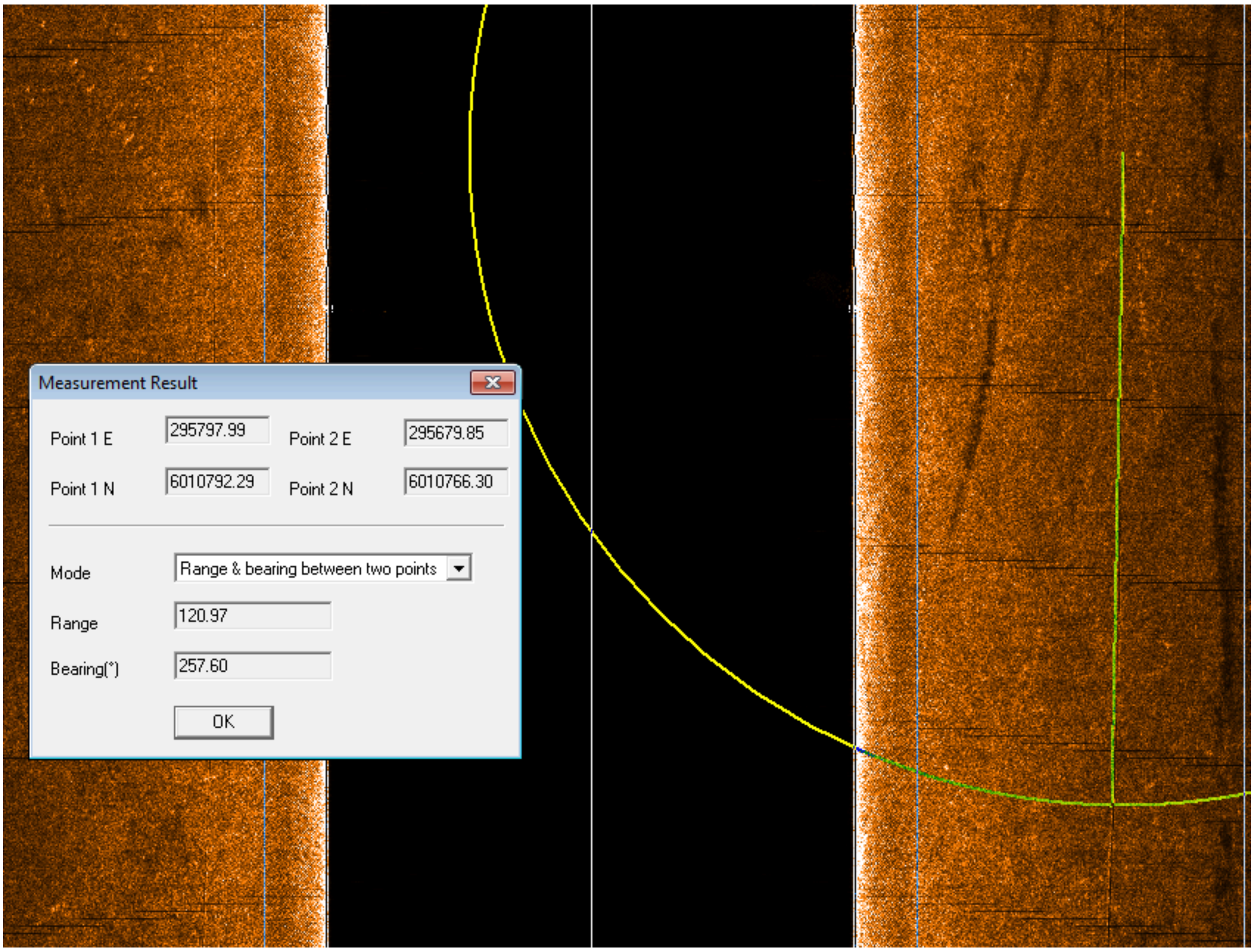



**Fig. 5.5** Trawl Mark observed in live backscatter data on June 20th (Trawl Mark 2, Fig. 5.1).

To derive the diving positions, a bathymetric map was created of the trawl mark area, with the assumption that the freshly created trawl mark would be visible in bathymetric data as well. This assumption turned out to be incorrect in hindsight analysis, with new trawl marks barely visible in bathymetric data. It was a surprise that older fishing trawl marks are obviously much clearer to recognize in acoustic data (Fig. 5.6). It is likely that a relatively fresh (but of unknown exact age) trawl mark not created by FS Solea was sampled on June 20th during diving activities (Fig. 5.7). Therefore, while the divers were able to sample the ground net area on the 19th, a sampling of the fresh Solea trawl marks on the 20th was not achieved. This observation will be further analyzed in the future, considering the differing fishing gears. In summary, it is recommended for comparable future experiments that a) care is taken to obtain realistic fishing gear, which requires to take into account the operational time of the fishing vessels (also controlled by allowed yearly amount of fishing) in the scheduling of the cruise. In addition, at least several hours should be allowed for creating the trawl mark and subsequent analysis by acoustic surveys, video information and exact diver buoy placement.

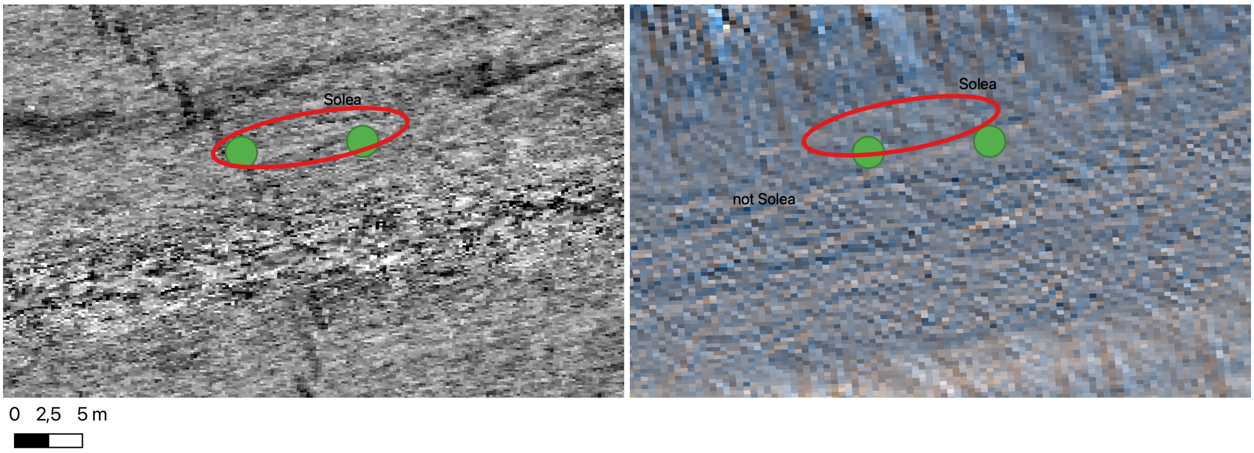



**Fig. 5.6** New trawl mark created on June 20th and observed in backscatter data is barely visible in bathymetric grids. Green dots mark the position recorded for the trawl marks during live data observation.

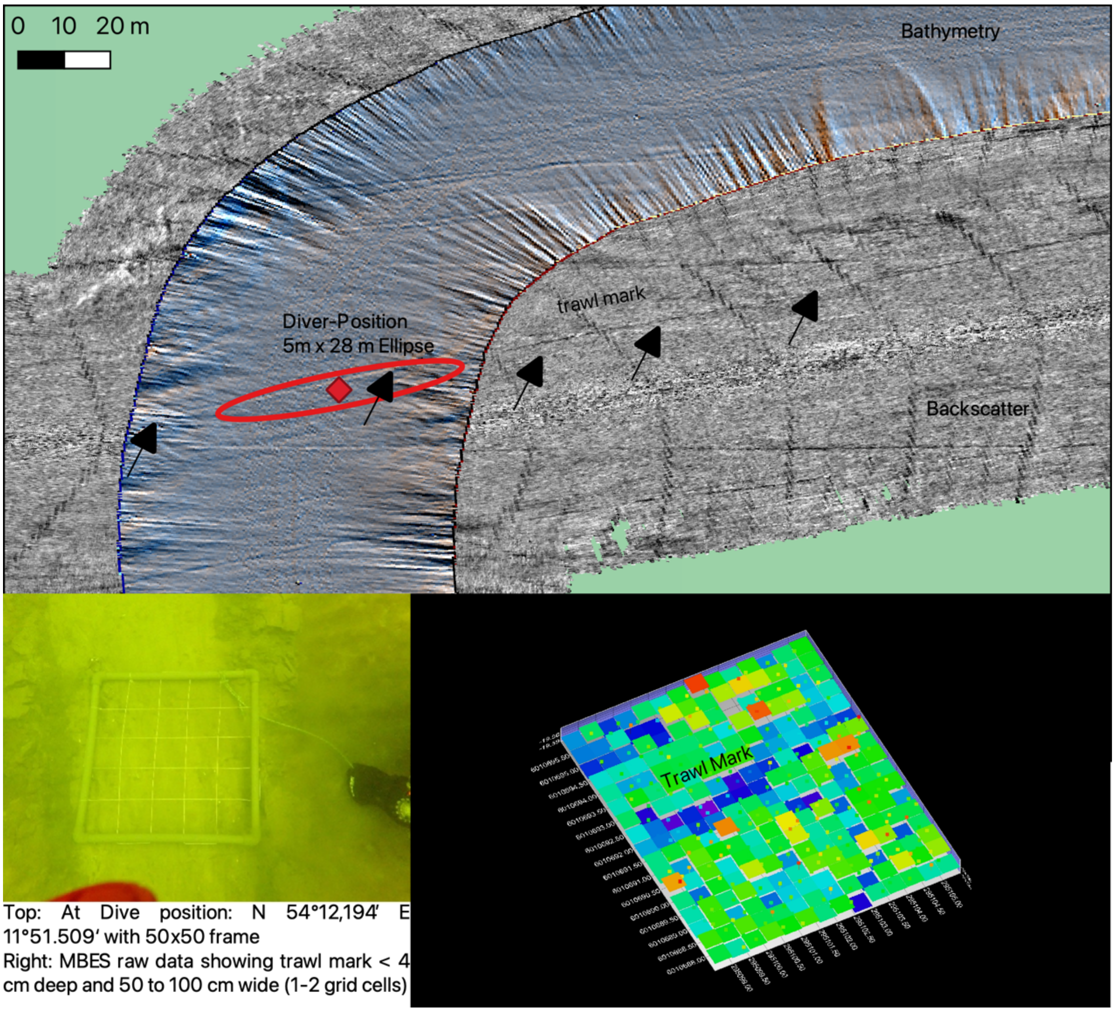



**Fig. 5.7** Detailed view of the dive position on June 20th onboard Limanda. Dive photo provided by Stefan Forster. Top: combined backscatter and bathymetric map. The most likely position of the dive is within the red ellipse. Bottom left: Five photo of relatively young trawl mark. Right: the same position in MBES raw data.

## 5.2 Biogeochemical processes (P. Roeser, M. A. Zeller, M. E. Böttcher)

### Methods

*Sediments and pore-waters*

MUC cores for further assessing the sediments' particulate phase and pore waters' composition and stable isotope signatures, were always taken from the same MUC casts and as close as possible to the cores used for sulfate reduction rate (SRR) investigations (also WP 1.2), and selectively in parallel to cores used for microbiome/prokaryote investigations (WP 2.1). Also, all cores used for pore water extraction were later sampled by slicing the solid phase, for assessing the biodiversity of the macrofauna (WP 3.2). In addition, cores taken by divers from mounts and furrows of trawl marks were also sampled for pore waters and sediments. All cores sampled on board of EMB268 for sediments and pore-waters were photo-documented. Given the number of cores and samples to be processed during the expedition time, and the

limitation of scientists on board of the EMB due to sanitary reasons, part of the cores was further processed/sampled on land at the facilities of the IOW, at the same day of sampling.

Sediment cores for solid phase analysis were sliced in 1cm steps in the upper 5 cm interval, and in 2 cm steps below until core bottom. Sediment slices were split in two major fractions which were both frozen (-20°C), one of which was conserved in 10 ml Zinc acetate solution. For the upper slices (1 cm thick), each fraction was made of half a slice. For the 2 cm thick slices, ¼ of a slice was enough for each sub-sample. Any remaining material was discarded. The freeze-dried sediments will undergo selected geochemical analysis for their inorganic and organic composition, e.g., total organic carbon (TOC), total inorganic carbon (TIC), and Mercury contents. In the fraction preserved in Zinc acetate, the contents of Chromium-reducible Sulfur (CRS) and Acid volatile Sulfur (AVS) will be determined. Aside that, a third sub-sample type from each sediment slice with a defined volume of 2 mL was sampled with a syringe (plastic, top cut off) during slicing procedures. This latter sample will be used for determination of sample dry weight, and calculations of dry bulk density and porosity. Afterwards it will be used for grain size determinations by laser analysis. In addition, pH values were measured from the sediments for each sampled depth, with an ion selective electrode introduced directly into the moist sediment before slicing the individual samples. In case of spatial heterogeneity of pH values, at least the maximum and minimum values were noted. The sampling of the sediments from the diver cores followed the overall concept from the MUC sampling. In addition, given the limited number of diver cores, the sediments of each diver core were shared between the different working groups (e.g. WP 2.1); thus, slice thicknesses were slightly different than those of the MUC cores, in order to optimize the sampling scheme to obtain aliquots for all working groups (e.g. Table S1). Likewise the MUC cores, the diver cores which had pore waters extracted were also later sampled for biodiversity of macrofauna (WP3.2). A total of 6 MUC cores and 3 diver cores were sliced for sediment sampling, making 126 sampled depths, and a total of ca. 380 sediment sub-samples (Table S1).

The sampling resolution for pore water extraction was of 1cm steps in the upper 5 cm – beginning at the sediment water interface, 2 cm steps below that until 15 cm depth, and 5 cm steps below that. The exact sampling depths may vary +/-2cm according to the core characteristics, e.g. sediment surface inclination, lithology, and pore water flow rates. Pore waters were extracted from pre-perfured liners, using rhizones (Rhizosphere,Wageningen, The Netherlands, 0.2um pore width) and 10 mL syringes. The pore water extraction was undertaken in a cold room, with temperatures regulated between 12 and 15°C. Water above the sediment water interface (SWI) was sifonated and further sampled for selected stations. Topmost waters were sifonated to an approximate distance of 5 to 8 cm from the SWI. Pore water sampling was initiated from the topmost samples, usually extracted one-by-one until 5cm, below which, extraction was either undertaken for individual samples or in parallel. Pore waters were sub-sampled for distinct future analysis: (a) metals by ICP-OES, (b) dissolved inorganic carbon (DIC) and its' stable isotope signature (DI13C) by continuous-flow isotope-ratio-monitoring mass spectrometry, (c) sulfides, by spectralphotometry, (d) nutrients by an QuAAtro autoanalyzer, (e) total alkalinity by titration and (f) water isotopes by laser CRDS. The sub-samples were preserved and/or treated according to the analysis to follow with (a) HNO3, (b) HgCl, (c) Zn acetate, (d) frozen, (e) HCl. Aside the nutrient samples, all samples were stored at 4°C. Usually, an approximate volume of 15 mL guaranteed obtaining all sub-samples. Values of pore waters' pH were obtained directly after extraction measured with an ion selective electrode, either from individual samples if enough water was available, or measured in the same vial-sample which will be used for nutrient analysis. Pore waters were extracted from 8 MUC cores and 4 diver cores, accounting for replicates in selected stations, making 141 sampled depths, and about 950 pore water sub-samples.

*Water column*

Knowledge on the bottom waters and their interaction with the upper water column are essential to assess potential elements sources and fluxes when aiming to assess benthic and sedimentary biogeochemical processes. Water column characterization was undertaken mainly with the CTD equipped at the EMB, through which double sensor measurements of the following parameters were obtained: conductivity, temperature, salinity, dissolved oxygen, in addition to chlorophyl-a, turbity, and density values. Aside the automatized sensor measurements, water samples were taken at selected water depths. A first profile was run as pre-survey, to have an overview of water column characteristics and stratification, also allowing to identify sampling depths of interest. Still during the pre-survey, water was sampled in a second run during the downcast, and by automatized bottle closing. The only manually closed bottles were those of the bottom water, in order to allow closest proximity to the sediment water interface through visual inspection using the equipped cross laser system. Similar procedure was undertaken in the CTD runs after the trawling experiment, in this case, with a higher water sampling resolution in the lower water column, i.e. every meter in the lowermost 5 meters, where the most extreme influence of the trawling is expected. During the pre-survey of the first site, one additional bottom waters sample was obtained from the collected MUC. For the biogeochemistry working group, water samples were taken for similar future analysis as the pore waters, however in larger volumes; (a) metals by ICP-OES, (b) dissolved inorganic carbon (DIC) and its' stable isotope signature (DI13C) by continuous-flow isotope-ratio-monitoring mass spectrometry, (c) nutrients by an QuAAtro autoanalyzer, (d) total alkalinity via titration and (e) water isotopes by laser CRDS. The sub-samples were preserved and/or treated according to the analysis to follow with (a) HNO3, (b) HgCl, (c) frozen, (d) HCl. In addition, pH values were measured on site, and filter samples were obtained for analysis of the suspended matter. For the latter, selected samples were filtered through a 0.45 micron CA filter on board (Table S3); and alternatively, a volume of 180 mL water was filtered through 0.45 micron syringe filters for determination of the proportions of reactive Fe, Mn and P in the suspended matter. All filters were kept frozen. A total of 7 water column stations was processed, with 4 to 7 water depths sampled in each. Two of the stations were run as pre-survey for the two trawling experiments (1_2 on the 18.06; and 31_2 on the 21.06). For the first trawling experiment, a time series of CTD data after the experiment was produced with three stations within the next two hours following the trawling (11_2, 12_2 and 12_3), and a fourth station after the experiment on the next day (19_1). For the second trawling site, two stations were run shortly after the trawling (34_1, 34_2). A total of 39 water depths were sampled during EMB268, generating, only for WP1.2, about 230 water column sub-samples.

**Preliminary and expected results**

*Sediments and pore waters*

On ship, only pH measurements were taken, and samples are to date being processed for the planned analyses. Preliminary results herein show some of the lithology observations of cores from the site of the first trawling experiment (north, Figure 5.1), and overall results on bulk sediment characterization (Table 5.1) and selected dissolved elements obtained with ICP-OES, for the overall pore waters samples of EMB268.

The lithology of the cores from the site of the northern (first) trawling experiment is rather muddy, in contrary to the southern, shallower trawling site, which has sandier sediments. In general, these northern cores show 2-3 cm of light brown sediments, which become spotted with the typical black sulfidic staining below 3 cm core depth. In addition to that, a characteristic few millimeters-thick layer of dark brown and finer, somewhat clayey sediment, is found throughout the cores from the northern site, typically directly at the sediment water interface (e.g. pre-survey station 5_3, Figure 5.8 A, right core). To date it is assumed that this fine layer may be composed of organic matter, Fe-Mn-oxides, or a combination of both. Detailed SEM particle analyses will provide more data to resolve its composition. Notably, this fine layer is not encountered in the MUC cores taken at the trawling site, within few hours after the trawling experiment (13_1 and 14_2, e.g. Figure 5.8 B), assumably due to resuspension of the surface sediments because of the trawling. In the diver cores taken from trawl mounts and furrows, this characteristic layer is present often burrowed a couple of cm below of the surface, leading to its double appearance in some of the diver cores where it occurs also at the surface (herein exemplary, Figure 5.8 C, and D). In the MUC cores obtained in the next day after the trawling (e.g. station 20_1, Figure 5.8 A, middle) the layer is present at surface, which may be due to sediment re-deposition, although spatial variability of surface sediments cannot be excluded at this point. The latter needs further assessment with the corrected GPS coordinates of sample locations with respect to the trawl marks.

The water content and porosity of the MUC cores are very variable (Table 5.1). With porosities from 0.28 to 0.69, averaging 0.48 (Figure 1.2 A), the values are quite lower to those encountered somewhat northern in the Bay of Mecklenburg, where the average porosity values correspond to the maxima found for EMB268 sediments (e.g. Lipka et al. 2018).

The pH measurements of sediments and extracted pore-waters are overall consistent (Figure 5.9 B), with a tendency of the pore water's pH to be in the range of the maxima values obtained from sediment measurements.

**Table 5.1** Bulk sediment characterization (n=127): gravimetric water contents estimated in doubles, from whole frozen samples and samples with defined volume; calculated dry bulk density; calculated porosity. Assuming a particle density of 2.65 g/cm$^3$

| Parameter | Water Cont. Grav. [%] Whole sample | Water Cont. Grav. [%] 2 mL sample | Dry Bulk Density [g.cm$^{-3}$] | Porosity |
|---|---|---|---|---|
| Average | 34.7 | 35.1 | 1.37 | 0.48 |
| Stdev | 8.9 | 9.3 | 0.16 | 0.06 |
| Median | 33.2 | 33.5 | 1.38 | 0.48 |
| Maximum | 82 | 86.6 | 1.91 | 0.69 |
| Minimum | 33.2 | 22.9 | 0.81 | 0.28 |

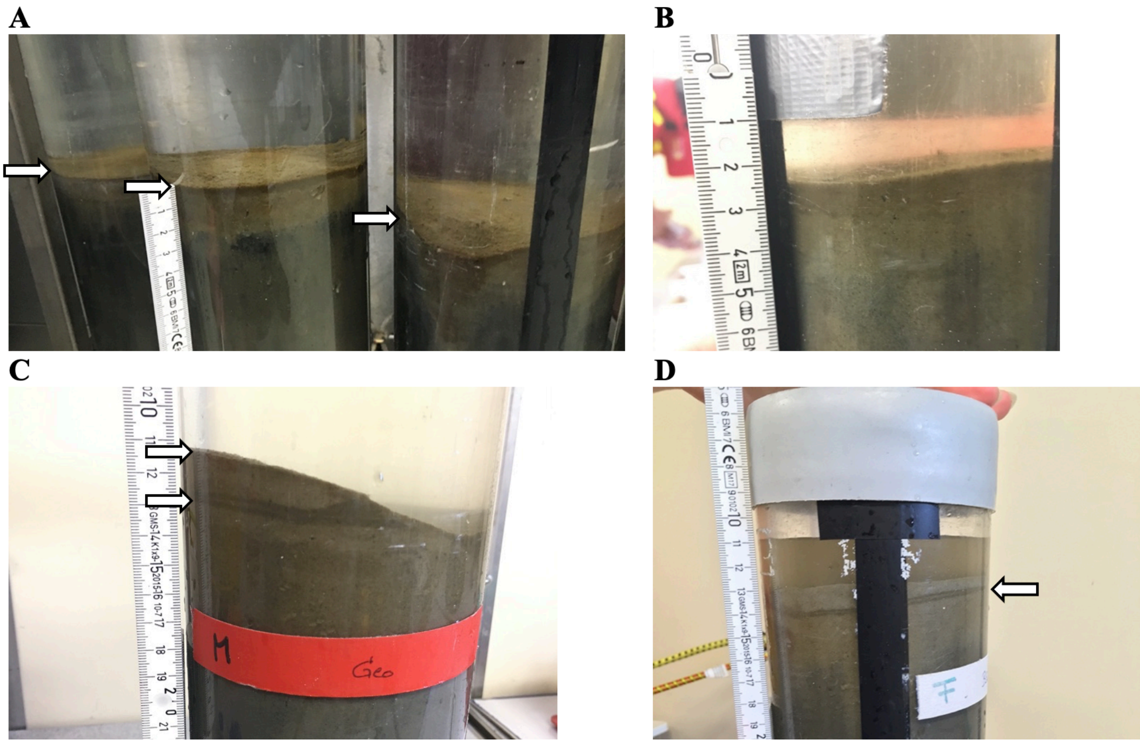



**Fig. 5.8** Details of the lithology directly below the sediment water interface for different cores. (A) MUC cores from station 20_01 (middle & left) and 5_3 (right); (B) MUC from station 13_1 (D) Diver core from trawl mount (id: M_Geo); (D) diver core from furrow (id: F_BGC_Rhiz_A). Each arrow indicates a clearly identifiable few mm thick dark layer of finer material at the SWI, or buried close to the sediment surface (present as doublet in C; absent in B).

A B

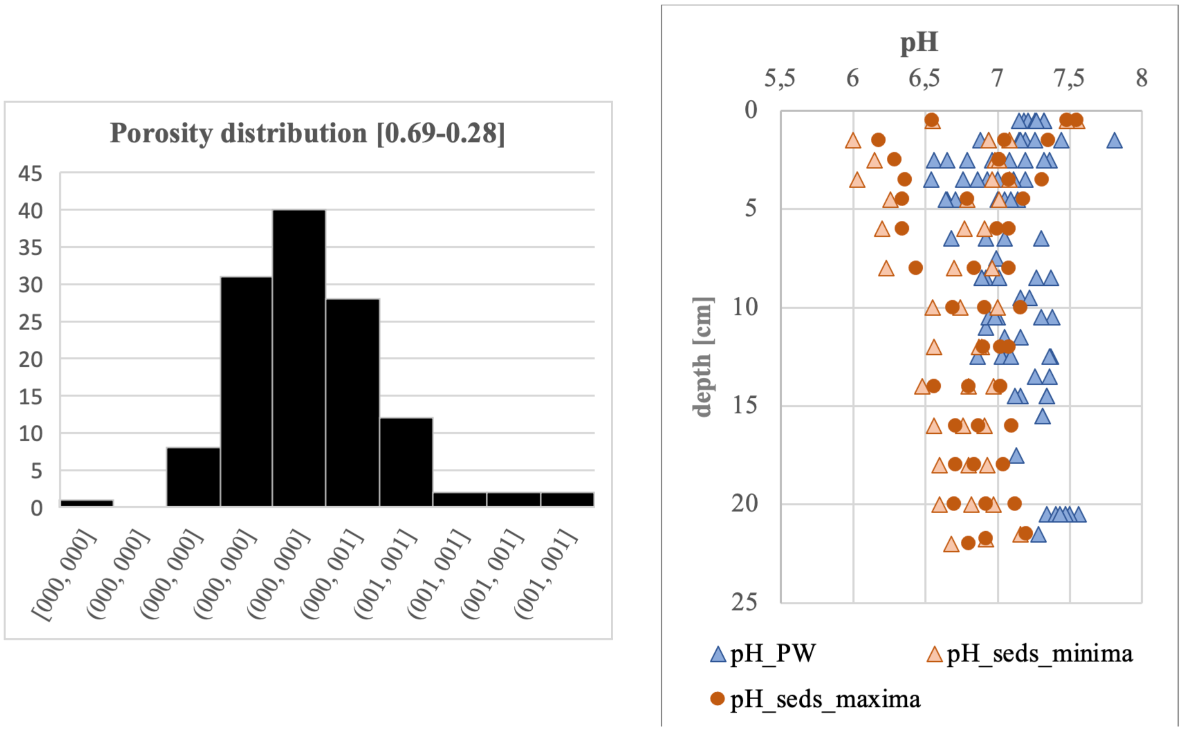



**Fig. 5.9** (A) Overall porosity distribution of MUC sediment slices (n=127), and (B) pH values from dissolved pore waters and moist sediments. Due to spatial heterogeinity of the latter within one sediment slice, maxima and minima were documented.

Vertical pore-water profiles of dissolved Iron, Phosphorous, Manganese and sulfides outline the high variability encountered in the data-set (Figure 5.10). There are overall lower amounts of dissolved Fe, P and Mn in the southern, shallower trawling site, which has rather sandy sediments, than in the northern site, expected to hold also relatively enhanced organic matter concentrations. This difference is best visualized for the Phosphorous concentrations (Figure 5.10 C). The inverse trend of concentrations of dissolved Fe - enriched in the uppermost 5 cm, and sulfides – enriched below 5 cm, highlights the zone of Fe sulfide precipitation where the diffusive gradients of these substances meet (Figure 5.10 A, B).
Expectations are that the trawling directly affects the sediment surface and has a short-term effect on the pore-water profiles, either due to introduction of oxygen below the sediment water interface (SWI) or due to disruption of diffusion gradients at the SWI, potentially affecting benthic biogeochemical processes. In a preliminary analysis, there are no clear patterns emerging from the dissolved Fe or sulfide data, before and after the trawling. From dissolved P and Mn concentrations, there are also no clear patterns. Nevertheless, it seems that, in the northern trawling site, a change in the gradients of P might become apparent after the trawling (Figure 5.10 C). Also, for both, Phosphorous and Manganese, the diver cores have distinguished profile shapes than the MUC cores. Especially for Mn, the dissolved concentrations are more enriched in the upper cm of diver cores (Figure 5.10 D). When considering the upper 4 cm of the pore water profiles, which are more likely to be physically affected by trawling, the concentrations of dissolved Mn are in the lowermost range before trawling takes place (Figure 5.10 D, pre-survey). When considering only the MUC cores before and after the northern trawling experiment, the ratio of dissolved Fe/Mn is more elevated before the trawling, lowermost shortly after the trawling, and potentially re-established in the next day (Figure 5.11). These short-term effects and differences between the

divers and MUC cores might be related to the remobilization of Mn-oxides at the sediment surface followed by mobilization of reactive Mn.
Still, given the intrinsic high-spatial-variability and heterogeneity also of dissolved substances in the Baltic Sea sediments, an evaluation of the trawling effects will improve from an individual assessment of the core locations with respect to trawl marks using the corrected sampling coordinates in elaboration by the Geophysics research group at IOW.

*Water column*

Short-term effects of the trawling in the lower water column could be observed especially through the turbidity values obtained from the CTD measurements. In two measurements up to one hour after the trawling, an increase in at least ten times the pre-survey turbidity values was observed in the lowermost meter of the water-column, showing the re-suspension of surface sediments (Figure 5.12). In general, also for the pre-survey, turbidity values are in correlation with the chlorophyll-a data; for the trawling highlighting also differences registered between 14 to 17 meters water depth after the experiment. Although it is discussable whether the latter are due to a natural daily variability in the area, it remains conceivable that a portion of finer suspended matter has been disturbed by the trawling net. Additional planned analyses for the water samples (Table S3) shall allow more inferences about the extent of potential effects of the trawling in the lower water column.

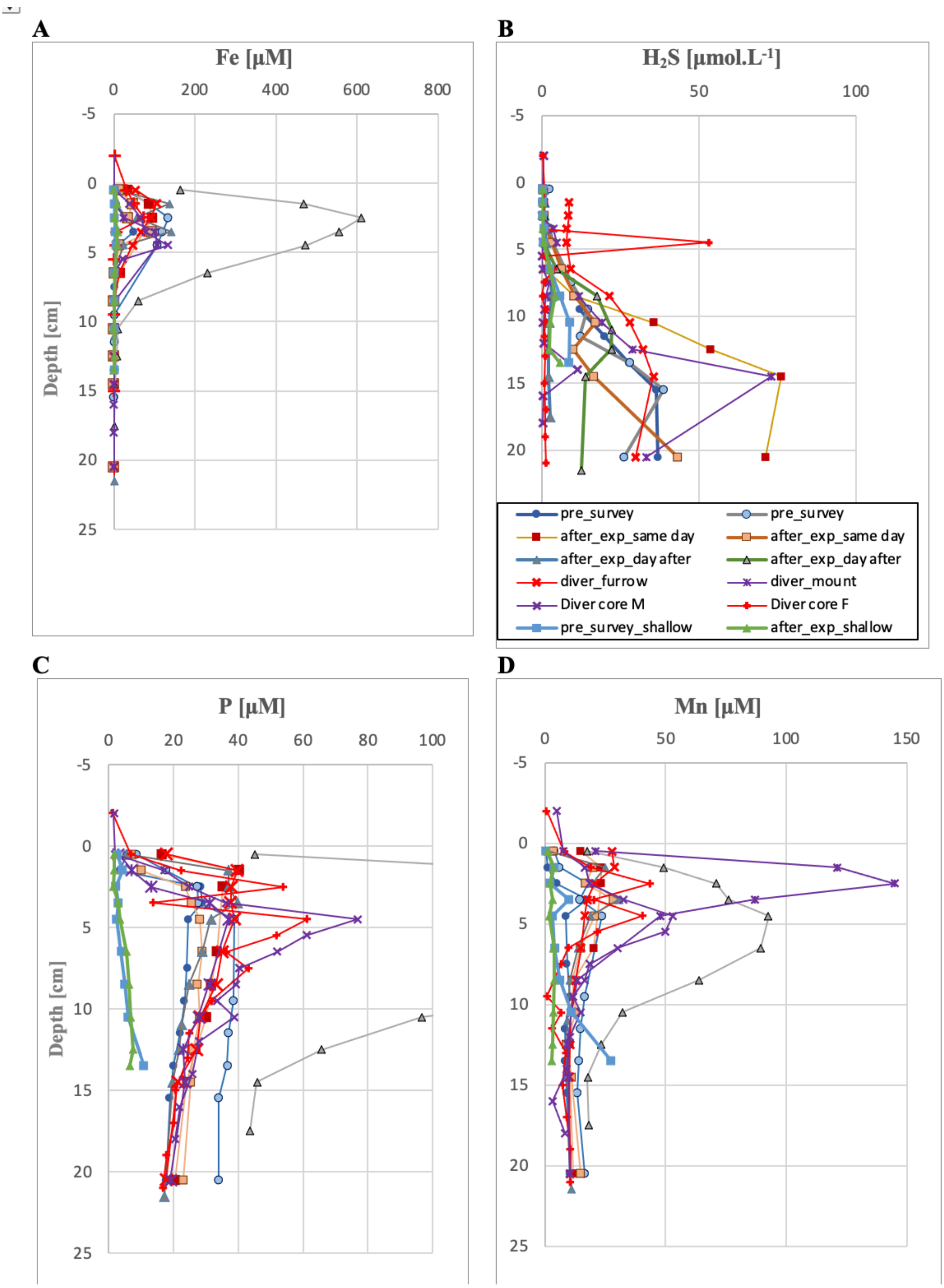



**Fig. 5.10** Pore water profiles of selected substances for all EMB268 sites. Values obtained for bottom waters are indicated above the sediment water interface (SWI). Scale of Phosphorous values is adapted to highlight variability of most sites; maximum P value is of 240 µM.

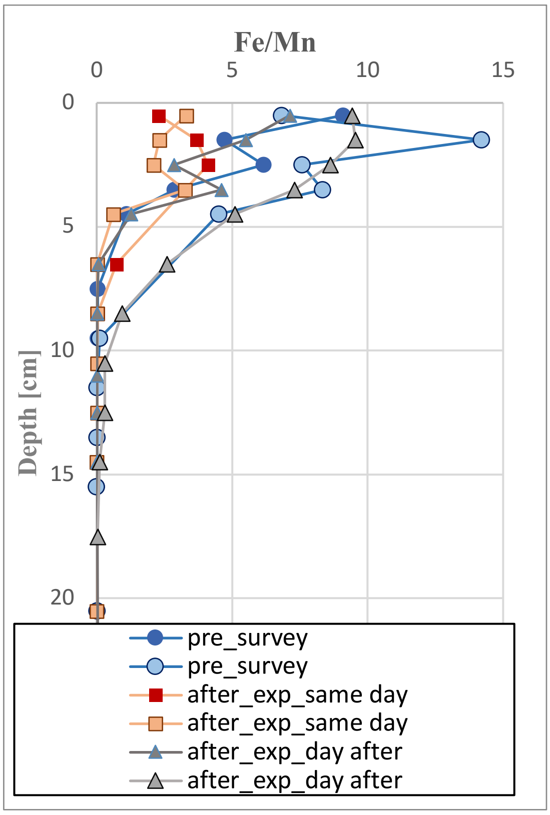



**Fig. 5.11** Ratio of dissolved Fe/Mn of pore waters from selected sites of EMB268

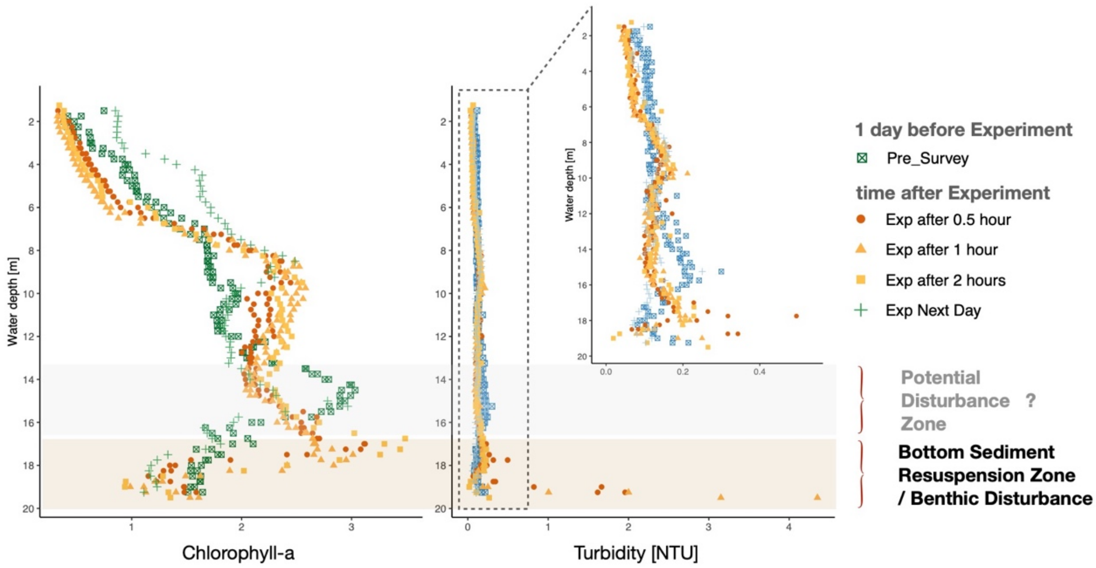



**Fig. 5.12** Water column profiles of chlorophyll-a and turbidity data of the northern trawling site at pre-survey, shortly after the trawling experiment, and on the next day.

## 5.3 Prokaryotes (Judith Piontek, Christian Meeske, Tabea Giese, Annalena Emde)

### Aims

The major goal of this work package is to investigate how bottom trawl fisheries affect the composition and functioning of benthic prokaryotic communities. For this purpose, prokaryotic cell numbers, the phylogenetic composition and the functional potential of communities in sediment samples from the surface to 20 cmbsf will be analysed. Furthermore, the suspended sediment plumes induced by bottom trawls are investigated.

### Methods

Total abundances of prokaryotes will be quantified by fluorescence microscopy using a DNA-binding dye. Fluorescence in situ hybridization combined with catalyzed reporter deposition (CARD-FISH) will be used to quantify specific taxonomic groups. The phylogenetic community composition will be analyzed by partial sequences of the 16S rRNA using high-throughput sequencing. Furthermore, metagenomic and -transcriptomic approaches will be used to assess the functional potential of the communities. The analysis of gene abundances and gene expression patterns will be focused on metabolic processes that are directly linked to important sediment ecosystem services. These processes include carbon remineralization, the release of inorganic nutrients and transformations within the sulfur cycle at the sediment-water interface.

### Work on Board

Both sediment and bottom water samples were collected before the trawling activity and immediately after to assess short-term effects induced by the disturbance. Table 5.2 summarizes the sediment sampling.

**Table 5.2.** Sediment sampling by divers and the multicorer for the analysis of benthic prokaryotic communities

| | Date | Station ID | Type | Sampling Depth [cm] |
|---|---|---|---|---|
| Pre-Survey | 18/06/2021 | EMB268-01-03 | MUC Core | 0-1, 1-2, 2-3, 3-4, 6-7, 9-10- 14-15 |
| | 18/06/2021 | EMB268-04-01 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 18/06/2021 | EMB268-05-04 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 18/06/2021 | EMB268-08-03 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| Trawl 1 | 19/06/2021 | EMB268-13-01 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 19/06/2021 | EMB268-14-02 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 19/06/2021 | EMB268-15-01 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 19/06/2021 | M P+P 1 (rot) | Divers' Core Trawling Area | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 17-18 |
| | 19/06/2021 | M P+P 2 (rot) | Divers' Core Trawling Area | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 17-18 |
| | 19/06/2021 | F P+P 3 (weiß) | Divers' Core Trawling Area | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 19/06/2021 | F P+P 1 (weiß) | Divers' Core Trawling Area | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 19/06/2021 | M P+P 3. | Divers' Core Trawling Area | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 19/06/2021 | F P+P 2. (weiß) | Divers' Core Trawling Area | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| Trawl 2 | 20/06/2021 | EMB268-20-1 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 20/06/2021 | EMB268-23-01 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 17-18 |
| | 20/06/2021 | F P+P 2 (weiß) | Divers' Core Furrow | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| | 20/06/2021 | M Geo (rot) | Divers' Core Mount | 0-1, 1-2, 2-3, 3-4, 8-9, 13-14- 18-19 |
| Trawl 3 | 21/06/2021 | EMB268-35-2 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 12-13 |
| | 21/06/2021 | EMB268-37-02 | MUC Core | 0-1, 1-2, 2-3, 3-4, 8-9, 11-12 |

MUC hauls sampled the area between the trawl boards that was disturbed by the net. Divers were further able to collect samples in the furrow of the trawl boards and from the dredged material that accumulated next to it. The sequential filtering of material re-suspended into the bottom water after trawling will allow a size-fractionated analysis of the phylogenetic community composition. Filters with pore sizes of 10 µm, 3 µm and 0.2 µm were used. Table 5.3 compiles the sampling of the sediment plume.

**Table 5.3** Sampling of the sediment plume by the rosette sampler.

| | Date | Station ID | Type | Sampling Depth [m] |
|---|---|---|---|---|
| **Pre-Survey** | 18/06/2021 | EMB268-01-02 | Pre-Trawl Reference | 2, 6, 14, Bottom |
| **Trawl 1** | 19/06/2021 | EMB268-11-02 | Plume | 17, 18, Bottom |
| | 19/06/2021 | EMB268-12-02 | Plume | 17, 18, Bottom |
| | 19/06/2021 | EMB268-12-03 | Reference outside the trawling area | 2.4, 6.4, 14.4, 17.4, 18.4, 19.4 |
| **Trawl 2** | 20/06/2021 | EMB268-19-1 | Plume | 17, 18, Bottom |
| | 21/06/2021 | EMB268-31-02 | Pre-Trawl Reference | 12, 13, Bottom |
| **Trawl 3** | 21/06/2021 | EMB268-34-01 | Plume | 12, 13, Bottom |
| | 21/06/2021 | EMB268-34-02 | Plume | 12, 13, Bottom |

## 5.4 Microphytobenthos (Ramona Kern)

In work package microphytobenthos, biomass and primary production of microphytobenthos (MPB) will be investigated before and directly after a trawling event. The MPB is mainly composed of diatoms, some of which have the ability to migrate in the sediment up to several centimeters. Preliminary studies in our laboratory have shown that the ability to move up and down in the sediment can help to quickly reach the photic zone of the sediment again after a vertical sediment rearrangement induced by trawling. In contrast, diatoms did not reach the sediment surface after overlaying of 2 cm sterile sediment within 8 h (Jonas Rasim, bachelor thesis). The aim of trawling experiment is the investigation of the change in biomass and productivity of the MPB before the trawling event (Pre-survey) and after the trawling event. Therefore we took sediment cores before trawling and after trawling from area between the trawl marks (vertical sediment rearrangement, foot rope) and beside the trawl track (horizontal sediment rearrangement, control).

The primary production was measured in vitro via oxygen consumption in the overlaying water phase in sediment cores (diameter 5 cm) using planar oxygen sensor spots (diameter: 5 mm) in combination with an OXY-4 Mini optode (Figure 5.13). The sediment cores were directly subsampled from multi corer cores (diameter 10 cm). The oxygen measurements took place in the lab the days after sampling (5.4). We sampled 4 station in the MPA and 3 station in the reference area. For each station 4 replicate cores were analyzed. In total we got 28 sediment cores (Table 5.4).

After the incubation experiment the upper centimeter of the sediment cores were cut off, homogenized and divided into sub-samples for water content and organic matter. Furthermore, the chlorophyll a, carbon and nitrogen content will be analyzed. One subsample will be used for morphological identification of diatoms.

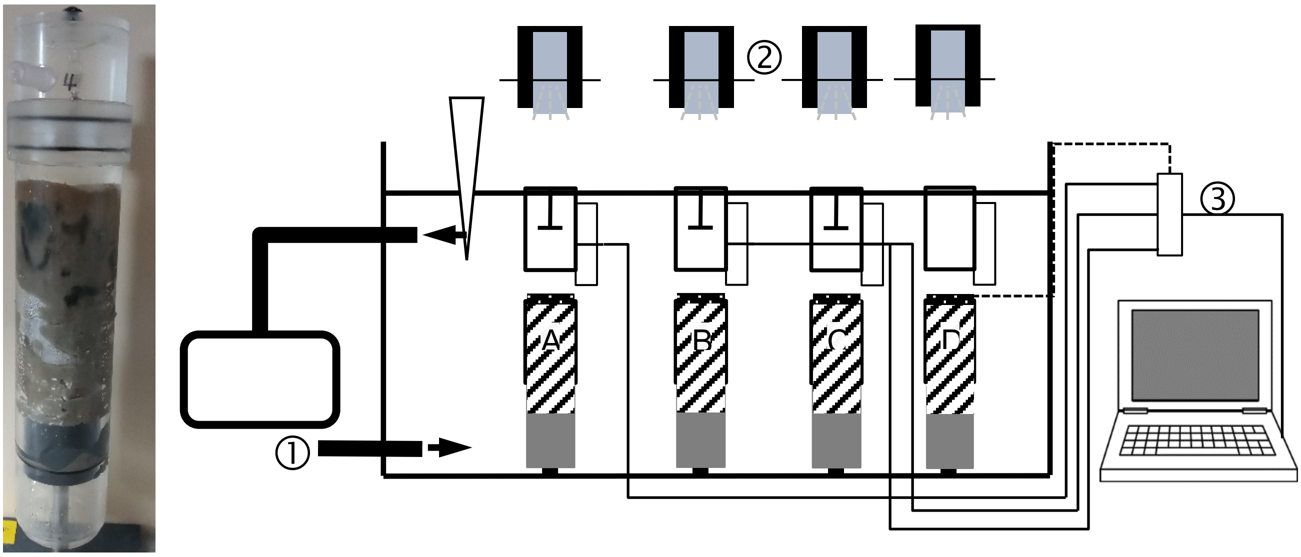



**Fig. 5.13** Sediment core with a measuring module on the top and closed with adjustable rubber plug (left) and the experimental set-up. A-D: sediment cores, 1: flow-through thermostat, 2: light source, 3: control unit.

**Table 5.4** List of stations where samples for primary production were taken including sampling and measuring dates.

| Area | Station-Cast | Sampling date | Measuring date | # |
|---|---|---|---|---|
| Pre-Survey | 31-3 | 21.06.2021 | 26.06.2021 | E18 |
| Pre-Survey | 31-3 | 21.06.2021 | 26.06.2021 | E20 |
| Pre-Survey | 31-3 | 21.06.2021 | 26.06.2021 | E22 |
| Pre-Survey | 32-1 | 21.06.2021 | 23.06.2021 | E5 |
| Pre-Survey | 32-1 | 21.06.2021 | 23.06.2021 | E6 |
| Pre-Survey | 32-1 | 21.06.2021 | 23.06.2021 | E8 |
| Foot Rope | 35-1 | 21.06.2021 | 22.06.2021 | E4 |
| Foot Rope | 35-1 | 21.06.2021 | 23.06.2021 | E7 |
| Foot Rope | 35-1 | 21.06.2021 | 25.06.2021 | E13 |
| Foot Rope | 36-2 | 21.06.2021 | 26.06.2021 | E17 |
| Foot Rope | 36-2 | 21.06.2021 | 26.06.2021 | E19 |
| Foot Rope | 36-2 | 21.06.2021 | 26.06.2021 | E21 |
| Foot Rope | 36-3 | 21.06.2021 | 22.06.2021 | E3 |
| Foot Rope | 36-3 | 21.06.2021 | 24.06.2021 | E9 |
| Foot Rope | 36-3 | 21.06.2021 | 25.06.2021 | E16 |
| Control | 37-1 | 21.06.2021 | 22.06.2021 | E1 |
| Control | 37-1 | 21.06.2021 | 22.06.2021 | E2 |

| | | | | |
|---|---|---|---|---|
| Control | 37-1 | 21.06.2021 | 25.06.2021 | E14 |
| Control | 38-1 | 21.06.2021 | 24.06.2021 | E10 |
| Control | 38-1 | 21.06.2021 | 24.06.2021 | E11 |
| Control | 38-1 | 21.06.2021 | 24.06.2021 | E12 |
| Control | 38-1 | 21.06.2021 | 25.06.2021 | E15 |

### 5.4 Sulfate reduction rates (Jens Kallmeyer)

Sulfate reduction rates (SRR) were quantified using incubations of intact sediment cores with radioactive 35SO42- radiotracer (Jørgensen, 1978), followed by cold chromium distillation (Kallmeyer et al., 2004). Due to COVID-related restrictions on the number of scientists on board the research vessel, it was not possible to carry out the subsampling and incubations on board. Instead, MUC cores retrieved by EMB and push cores recovered by divers were brought to IOW every evening and subsampled in IOW's radioisotope lab.
The following cores were incubated:
18.06.2021: 0803, 0104, 0503;
19.06.2021: 14-02, 15-01, 13-01, F BGC 2, M BGC 2;
20.06.2021: 20-1, 23-01, F PRP 3, M PRP 1.
The site sampled on 21.06.20201 was not sampled for SRR. Into each MUC or push core three 40 cm-long acrylic tubes (30 mm OD, 24 mm ID) were inserted vertically into the sediment to retrieve mechanically undisturbed sub-cores. Each tube has a single row of 2 mm diameter holes sealed with silicone in 1 cm intervals along its side to allow injection of radiotracer with a syringe but retain the pore water. To avoid compression of the sediment when inserting the acrylic tubes, suction was applied. Most subsampling tubes contained at least 20 cm of sediment, some cores were a few cm shorter. Bottom water was siphoned off except for approximately 5 mL to keep the sediment-water interface well under water but limit the volume of water into which tracer could diffuse.
Because the cores could not be stored at in-situ temperature on board the research vessels, the acrylic tubes were stored over night at approx. in-situ temperature (10°C) for thermal re-equilibration. Next morning 15 µl of radiotracer was injected into each hole from the sediment-water interface down to a depth of 20 cm. Initially we used an activity of 200 kBq per injection but had to lower the activity to 66 kBq to accommodate for the greater number of samples than expected. Immediately after injection of radiotracer, the core tube was put back into the incubator and incubated for 24 hrs. Incubations were terminated by pushing the sediment out of the core tubes, slicing them into depth sections and transferring them into 50 ml centrifuge tubes filled with 10 ml of 20% (w/v) zinc acetate solution. Prior to slicing, the remaining bottom water was sucked off with a syringe and treated the same way as sediment samples. The following depth resolution was used on all cores
0-6 cm: 1 cm
6-10 cm: 2 cm
10-20 cm: 5 cm
The vials were thoroughly shaken to form a homogenous suspension with the zinc acetate and effectively stop all microbial activity. A total of 383 samples were collected. Due to space

limitations in the laboratory the samples could not be frozen but were stored at room temperature until they were brought to GFZ.

## 5.5 Macrozoobenthos (Mayya Gogina)

**Aims**

The major goal of this work package is to investigate how bottom trawl fisheries affect macrobenthic communities, their state and functional composition. Immediate trawling effects were in focus of the experimental campaign that EMB268 was part of. Macrofauna samples collected from RV ELISABETH MANN BORGESE (EMB) will also contribute to quantification of damage on key habitat species (in this study area - Arctica islandica), coordinated by the University of Rostock and mainly carries out by divers from board of RV Limanda.

**Methods**

Due to time limits, macrofauna samples were mostly collected using 4-cores multicorer from the IOW (with 60 cm long acrylic tubes, each with a sampling area of 0.00785 m²; its penetration into the sediment was sufficient to obtain approximately 30 cm long sediment cores). However, for pre-survey, to be able to characterize the state of community before disturbance, cover natural biodiversity and its variability, and to allow comparison of newly obtained samples against existing data with minimal effort, 3 Van Veen garb (75 kg, sieve lid, sampling area 0.1 m²) samples and 9 MUC core samples were taken at locations along the planned experimental sampling from EMB mostly targeted presurvey (undisturbed control area, C) and foot rope-impacted area (I), whereas divers-driven sampling from RV Limanda aimed to cover, with precise manual positioning of samples, the furrow (F) and mount (M) imprints of the trawl-door.
In total 41 samples were collected before and after trawling in various areas along the trawling marks. Sampling position of Van Veen grab and multicorer gears will be corrected using offset values obtained by Ultra Short Baseline Acoustic System (USBL). Three grab samples were taken for sediment grain size analysis and determination of organic content (by loss on ignition), environmental parameters such as near-bottom water salinity and oxygen concentrations were obtained from CTD casts.
With some exceptions most of the core-samples were sliced for separate analysis of different sediment layers, to resolve vertical distribution of fauna and assess its role in altering ecosystem processes and fluxes.
For macrofauna analysis sediment was sieved using a 1.0 mm sieve mesh size and samples were preserved in 4% buffered formaldehyde–seawater solution. In the laboratory at IOW individuals were sorted, identified to lowest taxonomic level, counted and weighted. Sample exchange with University of Rostock aimed to particularly to capture the effects on key species and increase sampling size of the dataset (MSc work of Claudia Runkel).

**Table 5.5** List of samples collected during the cruise for the analysis of benthic macrofauna

| Station/ Cast EMB268 | Date | Gear | Sample number | Sampling depths of sliced cores | Area/aim |
|---|---|---|---|---|---|
| 6-1 | 18.06. | VV | 1 | whole sample | Presurvey |
| 7-1 | 18.06. | VV | 2 | whole sample | Presurvey |
| 8-2 | 18.06. | VV | 3 | whole sample | Presurvey |
| 1-3 | 18.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Presurvey |
| 1-3 | 18.06. | MUC | Kern 2 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Presurvey |
| 1-3 | 18.06. | MUC | Kern 3 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Presurvey |
| 1-4 | 18.06. | MUC | Kern (4) PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Presurvey |
| 4-1 | 18.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Presurvey |
| 4-1 | 18.06. | MUC | Kern 2 | whole sample | Presurvey |
| 4-1 | 18.06. | MUC | Kern 3 | whole sample | Presurvey |
| 5-3 | 18.06. | MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Presurvey |
| 5-4 | 18.06. | MUC | Kern 1 | whole sample | Presurvey |
| 5-4 | 18.06. | MUC | Kern 2 | whole sample | Presurvey |
| 13-2 | 19.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 13-2 | 19.06. | MUC | Kern 2 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 13-2 | 19.06. | MUC | Kern 3 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 13-1 | 19.06. | MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 15-1 | 19.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 15-1 | 19.06. | MUC | Kern 2 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 14-2 | 19.06. | MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 14-1 | 19.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 16-1 | 19.06. | VV | 1 | whole sample | Ground gear area, along north trawl trawl mark |
| 16-2 | 19.06. | VV | 2 | whole sample | Ground gear area, along north trawl trawl mark |
| 16-3 | 19.06. | VV | 3 | whole sample | Ground gear area, along north trawl trawl mark |
| 17-1 | 19.06. | VV | 1 | whole sample | Ground gear area, along north trawl trawl mark |
| 17-2 | 19.06. | VV | 2 | whole sample | Ground gear area, along north trawl trawl mark |
| 17-3 | 19.06. | VV | 3 | whole sample | Ground gear area, along north trawl trawl mark |
| 14-1 | 19.06. | MUC | Kern 2 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 14-1 | 19.06. | MUC | Kern 3 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |

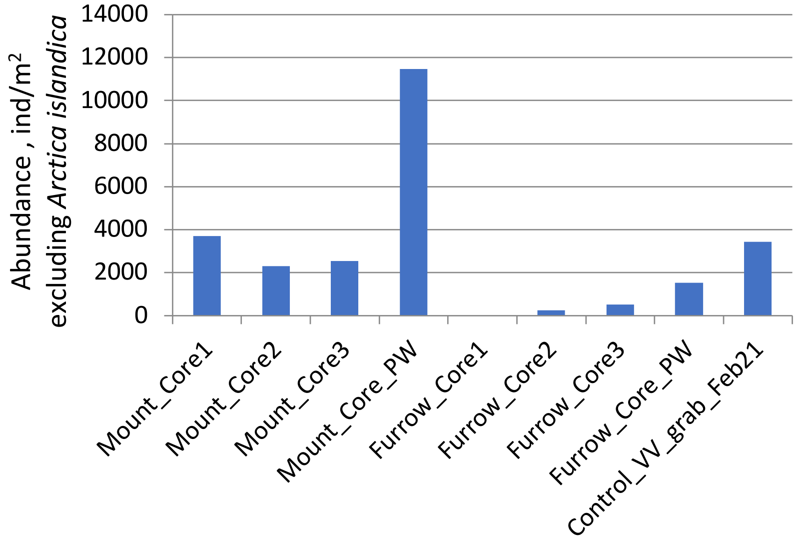
| | | | | | |
|---|---|---|---|---|---|
| 23-2 | 20.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 23-2 | 20.06. | MUC | Kern 2 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 23-2 | 20.06. | MUC | Kern 3 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 20-2 | 20.06. | MUC | Kern 1 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 20-2 | 20.06. | MUC | Kern 2 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 20-2 | 20.06. | MUC | Kern 3 | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 20-1 | 20.06. | MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| 23-1 | 20.06. | MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Ground gear area, along north trawl trawl mark |
| Limanda F | 20.06. | Divers | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Furrow area - otter board mark |
| Limanda M | 20.06. | Divers | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15, >15 cmbsf | Mount area - otter board mark |
| 35-2 | 21.06. | MUC MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10 cmbsf | Ground gear area, along north trawl trawl mark |
| 37-2 | 21.06. | MUC | Kern PW | 0-2, 2-4, 4-6, 6-8, 8-10, 10-15 cmbsf | Ground gear area, along north trawl trawl mark |

**Preliminary results**

Preliminary results indicate that on average abundance in the mount area created by trawl door is higher compared to control before trawling, and significantly exceed values in the furrow area (chi-squared = 5.33, df = 1, p-value = 0.02, see also Fig. 5.14 A). With small sampling size, differences in biomass are not significant (for WW p-value = 0.08), but generally values are higher in samples from the mount area, and lower (down to no macro fauna individuals found) in the samples collect in the furrow created by the trawl door (Fig. 5.14 B). Sampling area of coring tubes is rather small, and key species A. islandica is not necessarily captures in every sample, but for those where it was present its contribution to total wet weight biomass exceeded 90%.

Samples were mostly obtained at depth of 20.3-20.6 m. Grain size analysis indicated well sorted fine sand with median grain size of 180±19 µm (mean±sd) and organic content of 0.91±0.16%. Near-bottom water salinity was 19.4, oxygen concentrations was 4.29 ml/l.

A




B

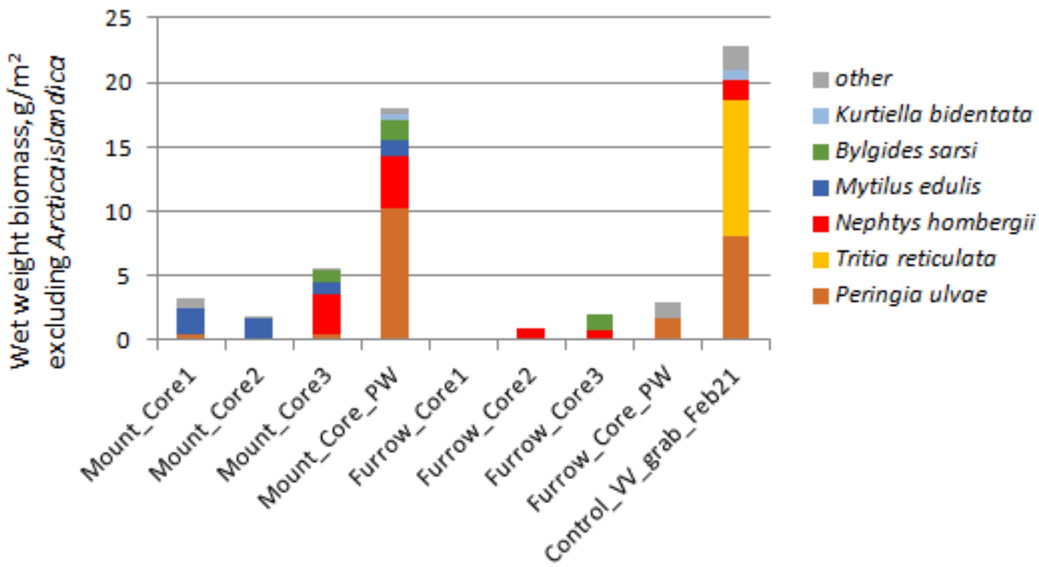



**Fig. 5.14** Preliminary estimates of macrofauna abundance and wet weight biomass in samples collected from the mount and furrow areas created by the trawl-door (exemplary values without A. islandica are presented, laboratory analysis is still in progress).

Habitat characteristics and visual effects of disturbance were investigated using a hand-held SeaViewer HD underwater video systems. In total during the EMB268 cruise four short transects with a summed length of about 1 km, each with a duration of 7 to 20 minutes, were recorded (Fig. 5.15). On the pre survey day (18.6.2021) another 4 video transects were conducted from board of boat Klaashahn in the south- west part of the targeted trawling area (unfortunately, due to malfunction of GPS antenna software exact coordinated of video records were not preserved).

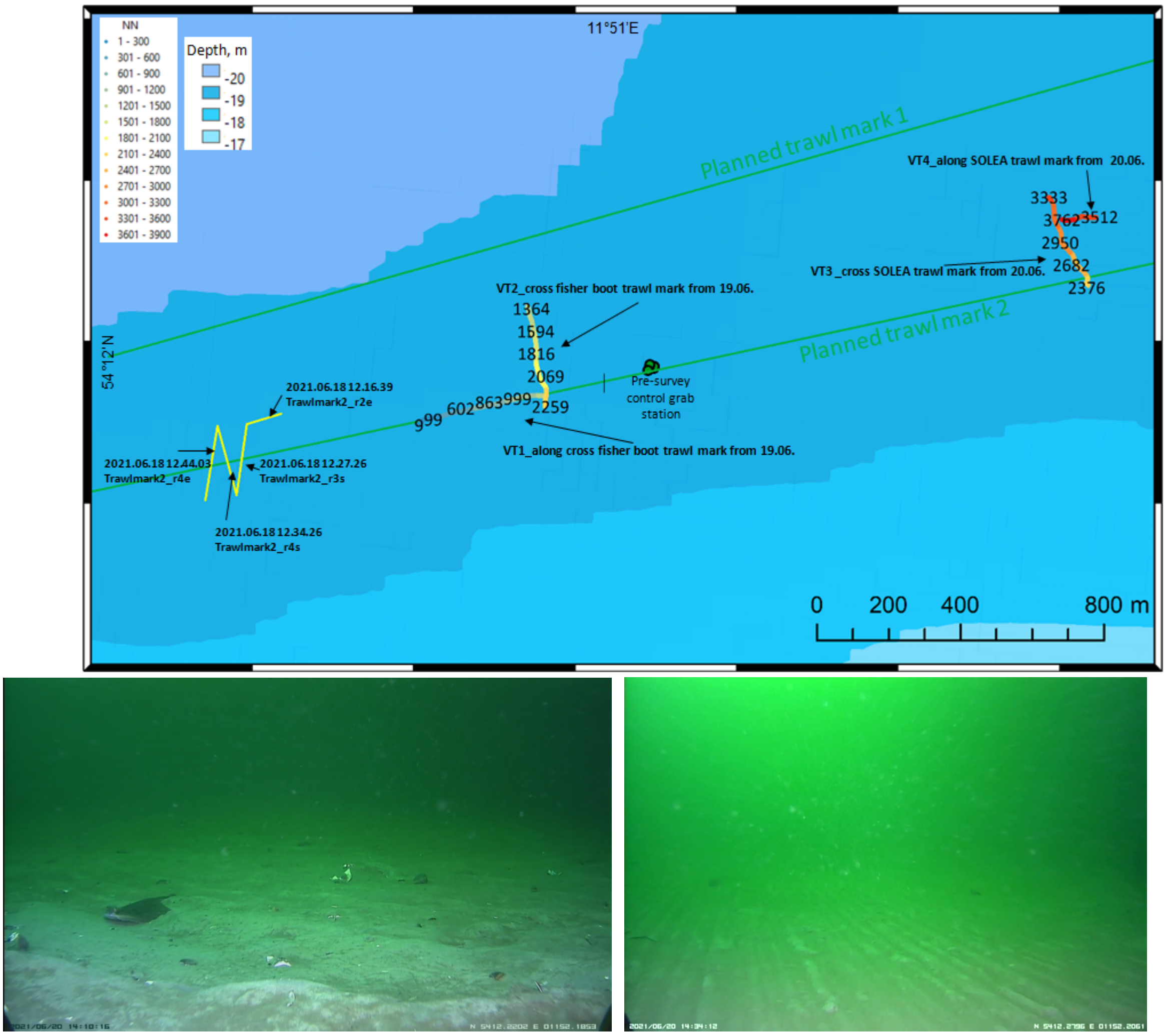



**Fig. 5.14** Map showing locations of conducted under-water video transects (above) and exemplary still images (below) illustrating the visible effects of trawling on bottom sediment habitat in the area presumably impacted by trawl door (left) and foot rope (right) of the trawling gear.

## 5.6 Benthic flux measurements (D. Clemens)

### Method

Similar to the previous cruise EMB267, in-situ oxygen fluxes across the sediment-water interface were measured using the GEOMAR aquatic eddy correlation (EC) lander (Fig. 5.16). The lander's centerpieces are a Nortek acoustic doppler velocimeter (ADV) in combination with 2 Pyroscience Piccolo2 ultra-high-speed fiber-optic oxygen (O2) probes. Together they are used to measure turbulent vertical fluxes of oxygen close to the sediment-water interface (Berg et al. 2003, Huettel et al. 2020). The O2 sensors were 2-point calibrated whilst they were installed on the lander before and after each deployment with seawater of 0 and 100 % air saturation. Additionally, auxiliary sensors are attached to the lander's frame include an independent Aanderaa oxygen optode, a SBE 37-SM CTD and a GoPro camera. After each lander deployment, its position at the seafloor was precisely mapped using the ship's Multibeam Echosounder.

### Expected results

We performed 2 daytime EC deployments, a control deployment one day before the experimental trawl and a second one during the trawl. With the upcoming analysis, we will determine oxygen (O2) fluxes in combination with oceanographic parameters. Our goal was to investigate any short-term effects on the O2 fluxes during the experiment and compare them to our control deployment. The precise position data of the lander on the sediment will allow to set the O2 fluxes into context with the results of the geophysical working group concerning trawl mark positions.

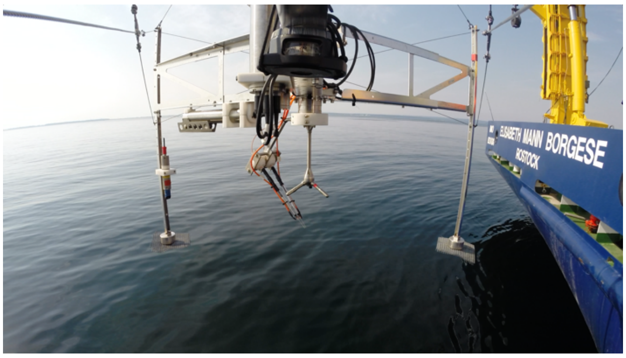



**Fig. 5.16** The EC lander during deployment.

## 6 Ship's Meteorological Station

Not applicable

## 7 Station List EMB268

### 7.1 Overall Station List

Refer to Figs 5.1 to 5.3 for a graphical representation of stations.

| Station ID | Ship ID | Date | Lat | Long | Gear |
|---|---|---|---|---|---|
| EMB268-01-01 | EMB268-01-01 | 18.06.21 | 54°12.133 | 11°51.776 | CTD |
| EMB268-01-02 | EMB268-01-01 | 18.06.21 | 54°12.1309 | 11°51.7813 | CTD |
| EMB268-01-03 | EMB268-01-02 | 18.06.21 | 54°12.131 | 11°51.807 | MUC |
| EMB268-01-04 | EMB268-01-03 | 18.06.21 | 54°12.135 | 11°51.817 | MUC |
| EMB268-01-05 | EMB268-01-04 | 18.06.21 | 54°12.132 | 11°51.826 | MUC |
| EMB268-02 | EMB268-2-1 | 18.06.21 | 54°12.079 | 11°51.473 | Lander |
| EMB268-03 | EMB268-3-1 | 18.06.21 | 54°11.625 | 11°53.460 | MBES |
| EMB268-04-01 | EMB268-4-1 | 18.06.21 | 54°11.878 | 11°50.109 | MUC |
| EMB268-05-01 | EMB268-5-1 | 18.06.21 | 54°12.032 | 11°51.031 | MUC |
| EMB268-05-02 | EMB268-5-2 | 18.06.21 | 54°12.035 | 11°51.034 | MUC |
| EMB268-05-03 | EMB268-5-3 | 18.06.21 | 54°12.033 | 11°51.062 | MUC |
| EMB268-05-04 | EMB268-5-4 | 18.06.21 | 54°12.035 | 11°51.061 | MUC |
| EMB268-06 | EMB268-5-5 | 18.06.21 | 54°12.032 | 11°51.061 | VVG |
| EMB268-07 | EMB268-6-1 | 18.06.21 | 54°12.132 | 11°51.789 | VVG |
| EMB268-08-01 | EMB268-4-2 | 18.06.21 | 54°11.888 | 11°50.110 | VVG |
| EMB268-08-02 | EMB268-4-3 | 18.06.21 | 54°11.881 | 11°50.114 | VVG |
| EMB268-08-03 | EMB268-4-4 | 18.06.21 | 54°11.880 | 11°50.120 | MUC |

| | | | | | |
|---|---|---|---|---|---|
| EMB268-09 | - | 18.06.21 | 54°12.084 | 11°51.425 | MBES, LANDER |
| EMB268-10-01 | EMB268-7-1 | 19.06.21 | 54°12.253 | 11°51.607 | LANDER |
| EMB268-10-02 | EMB268-8-1 | 19.06.21 | 54°12.297 | 11°52.960 | MBES |
| EMB268-11-01 | EMB268-9-1 | 19.06.21 | 54°12.085 | 11°51.574 | CTD |
| EMB268-11-02 | EMB268-9-1 | 19.06.21 | 54°12.086 | 11°51.576 | CTD |
| EMB268-12-01 | EMB268-10-01 | 19.06.21 | 54°11.833 | 11°49.902 | CTD |
| EMB268-12-02 | EMB268-10-01 | 19.06.21 | 54°11.834 | 11°49.904 | CTD |
| EMB268-12-03 | EMB268-10-02 | 19.06.21 | 54°11.835 | 11°49.900 | CTD |
| EMB268-13-01 | EMB268-11-01 | 19.06.21 | 54°12.032 | 11°51.511 | MUC |
| EMB268-13-02 | EMB268-11-02 | 19.06.21 | 54°12.032 | 11°51.116 | MUC |
| EMB268-14-01 | EMB268-12-01 | 19.06.21 | 54°11.979 | 11°50.795 | MUC |
| EMB268-14-02 | EMB268-12-02 | 19.06.21 | 54°11.981 | 11°50.769 | MUC |
| EMB268-15-01 | EMB268-13-01 | 19.06.21 | 54°11.850 | 11°49.892 | MUC |
| EMB268-16-01 | EMB268-14-01 | 19.06.21 | 54°11.895 | 11°50.832 | VVG |
| EMB268-16-02 | EMB268-14-02 | 19.06.21 | 54°11.901 | 11°50.830 | VVG |
| EMB268-16-03 | EMB268-14-03 | 19.06.21 | 54°11.899 | 11°50.832 | VVG |
| EMB268-16-04 | EMB268-14-04 | 19.06.21 | 54°11.901 | 11°50.835 | VVG |
| EMB268-17-01 | EMB268-15-1 | 19.06.21 | 54°11.974 | 11°50.830 | VVG |
| EMB268-17-02 | EMB268-15-2 | 19.06.21 | 54°11.973 | 11°50.824 | VVG |
| EMB268-17-03 | EMB268-15-3 | 19.06.21 | 54°11.974 | 11°50.822 | VVG |
| EMB268-17-04 | EMB268-15-4 | 19.06.21 | 54°11.978 | 11°50.820 | VVG |
| EMB268-18 | | 19.06.21 | | | Lander, MBES |
| EMB268-19 | EMB268-16-1 | 20.06.21 | 54°12.370 | 11°52.766 | MBES |
| EMB268-19-1 | EMB268-17-1 | 20.06.21 | 54°11.845 | 11°49.898 | CTD |
| EMB268-20-1 | EMB268-18-1 | 20.06.21 | 54°11.841 | 11°49.918 | MUC |
| EMB268-20-2 | EMB268-18-2 | 20.06.21 | 54°11.855 | 11°49.902 | MUC |
| EMB268-21 | EMB268-19-1 | 20.06.21 | 54°11.932 | 11°50.562 | Video |
| EMB268-22 | EMB268-19-2 | 20.06.21 | 54°12.089 | 11°50.807 | Video |
| EMB268-23-01 | EMB268-20-1 | 20.06.21 | 54°12.027 | 11°51.535 | MUC |
| EMB268-23-02 | EMB268-20-2 | 20.06.21 | 54°12.012 | 11°51.524 | MUC |
| EMB268-24 | EMB268-21 | 20.06.21 | 54°10.759 | 11°51.682 | MUC |
| EMB268-25 | EMB268-22 | 20.06.21 | 54°11.966 | 11°50.218 | VVG |
| EMB268-26 | EMB268-23 | 20.06.21 | 54°12.196 | 11°51.294 | VVG |
| EMB268-27 | EMB268-24 | 20.06.21 | 54°11.936 | 11°51.404 | VVG |
| EMB268-28 | EMB268-25 | 20.06.21 | 54°11.743 | 11°51.432 | VVG |
| EMB268-29 | EMB268-26 | 20.06.21 | 54°11.545 | 11°50.481 | VVG |
| EMB268-30-1 | EMB268-27-1 | 20.06.21 | 54°12.190 | 11°52.204 | Video |
| EMB268-30-2 | EMB268-27-2 | 20.06.21 | 54°12.282 | 11°52.210 | Video |
| EMB268-31-01 | EMB268-28-1 | 21.06.21 | 54!10.702 | 11°52.035 | CTD |
| EMB268-31-02 | EMB268-28-1 | 21.06.21 | 54°10.699 | 11°52.039 | CTD |
| EMB268-31-03 | EMB268-28-2 | 21.06.21 | 54°10.709 | 11°52.040 | MUC |

| | | | | | |
|---|---|---|---|---|---|
| EMB268-32-01 | EMB268-29-1 | 21.06.21 | 54°10.746 | 11°52.348 | MUC |
| EMB268-33 | EMB268-30-1 | 21.06.21 | 54°11.3923 | 11°53.542 | MBES |
| EMB268-34-01 | EMB268-31-1 | 21.06.21 | 54°10.871 | 11°52.465 | CTD |
| EMB268-34-02 | EMB268-31-2 | 21.06.21 | 54°10.869 | 11°52.452 | CTD |
| EMB268-35-1 | EMB268-31-3 | 21.06.21 | 54°10.878 | 11°52.467 | MUC |
| EMB268-35-2 | EMB268-31-4 | 21.06.21 | 54°10.879 | 11°52.476 | MUC |
| EMB268-36-01 | EMB268-32-1 | 21.06.21 | 54°10.851 | 11°52.419 | MUC |
| EMB268-36-02 | EMB268-32-2 | 21.06.21 | 54°10.855 | 11°52.422 | MUC |
| EMB268-36-03 | EMB268-32-3 | 21.06.21 | 54°10.853 | 11°52.423 | MUC |
| EMB268-37-01 | EMB268-33-1 | 21.06.21 | 54°10.834 | 11°52.455 | MUC |
| EMB268-37-02 | EMB268-33-2 | 21.06.21 | 54°10.831 | 11°52.459 | MUC |
| EMB268-38-01 | EMB268-34-1 | 21.06.21 | 54°10.824 | 11°52.424 | MUC |

* The location of the stations is not yet correct against USBL readings.

Positions of Limanda during dive operations were:
19.06.2021 N 54°12,105’ E 11°51.871‘
20.06.2021 N 54°12,194’ E 11°51.509‘

## 8 Data and Sample Storage and Availability

Data collected during the cruise EMB268 will be used in MGF-Ostsee project. The raw and processed acoustic data will be archived on the dedicated data servers at IOW until publication on PANGEA. For the data collected at the Leibniz Institute for Baltic Sea Research Warnemünde, the metadata information system IOWMETA (http://iowmeta.io-warnemuende.de) is available. In addition, research data of the project from various sub-projects are archived in the PANGEA database or DNA / RNA sequence data in the public databases Genbank, GFBio, NCBI and/or IOW database "BenthosDB" (for details see MGF-Ostsee data management plan).

## 9 Acknowledgements

We thank captain Dirk Thürsam, his officers and crew of R/V Elisabeth Mann Borgese for their hospitality and support in the achievement of the cruise objectives. We thank the BMBF as well as the members of the GPF advisory board for funding and revising the application for the cruise. The expedition is related to the DAM Pilotmission “MGF-Ostsee”. We benefited from financial contributions by all the research institutes involved and gratefully acknowledge this support.

## 10 References

Berg P, et al. (2003) Oxygen uptake by aquatic sediments measured with a novel non-invasive eddy-correlation technique. MEPS 261:75–83.

Huettel M, Berg P, Merikhi A (2020) Technical note: Measurements and data analysis of sediment–water oxygen flux using a new dual-optode eddy covariance instrument. Biogeosciences 17(17):4459–4476.

## 11 Abbreviations

# 12 Appendices

**Table S1** Sediment samples EMB268, research group (Isotope) Biogeochemistry at IOW. Asterisks indicate samples shared with WP2.1. *Por: porosity, GS: grain size. (1/3)*

| SampleNr. | | Infos | | | Depth [cm] | | Existing Sample? (Y/N) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION | MUC core nr | from | to | F. Drying | ZnOAc | Por. & GS (2mL) |
| EMB268 | Exp-1 | 18.06.21 | 1 | 1_4 | 0 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-2 | 18.06.21 | 1 | 1_4 | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-3 | 18.06.21 | 1 | 1_4 | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-4 | 18.06.21 | 1 | 1_4 | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-5 | 18.06.21 | 1 | 1_4 | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-6 | 18.06.21 | 1 | 1_4 | 5 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-7 | 18.06.21 | 1 | 1_4 | 7 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-8 | 18.06.21 | 1 | 1_4 | 9 | 11 | 1 | 1 | 1 |
| EMB268 | Exp-9 | 18.06.21 | 1 | 1_4 | 11 | 13 | 1 | 1 | 1 |
| EMB268 | Exp-10 | 18.06.21 | 1 | 1_4 | 13 | 15 | 1 | 1 | 1 |
| EMB268 | Exp-11 | 18.06.21 | 1 | 1_4 | 15 | 17 | 1 | 1 | 1 |
| EMB268 | Exp-12 | 18.06.21 | 1 | 1_4 | 17 | 19 | 1 | 1 | 1 |
| EMB268 | Exp-13 | 18.06.21 | 1 | 1_4 | 19 | 21 | 1 | 1 | 1 |
| EMB268 | Exp-14 | 18.06.21 | 1 | 1_4 | 21 | 22 | 1 | 1 | 1 |
| EMB268 | Exp-15 | 18.06.21 | 5 | 5_3 | 0 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-16 | 18.06.21 | 5 | 5_3 | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-17 | 18.06.21 | 5 | 5_3 | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-18 | 18.06.21 | 5 | 5_3 | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-19 | 18.06.21 | 5 | 5_3 | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-20 | 18.06.21 | 5 | 5_3 | 5 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-21 | 18.06.21 | 5 | 5_3 | 7 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-22 | 18.06.21 | 5 | 5_3 | 9 | 11 | 1 | 1 | 1 |
| EMB268 | Exp-23 | 18.06.21 | 5 | 5_3 | 11 | 13 | 1 | 1 | 1 |
| EMB268 | Exp-24 | 18.06.21 | 5 | 5_3 | 13 | 15 | 1 | 1 | 1 |
| EMB268 | Exp-25 | 18.06.21 | 5 | 5_3 | 15 | 17 | 1 | 1 | 1 |
| EMB268 | Exp-26 | 18.06.21 | 5 | 5_3 | 17 | 19 | 1 | 1 | 1 |
| EMB268 | Exp-27 | 18.06.21 | 5 | 5_3 | 19 | 21 | 1 | 1 | 1 |
| EMB268 | Exp-28 | 18.06.21 | 5 | 5_3 | 21 | 23 | 1 | 1 | 1 |
| EMB268 | Exp-29 | 18.06.21 | 5 | 5_3 | 23 | 24 | ? | | |
| EMB268 | Exp-30 | 20.06.21 | 13 | 13_01 | 0 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-31 | 20.06.21 | 13 | 13_01 | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-32 | 20.06.21 | 13 | 13_01 | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-33 | 20.06.21 | 13 | 13_01 | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-34 | 20.06.21 | 13 | 13_01 | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-35 | 20.06.21 | 13 | 13_01 | 5 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-36 | 20.06.21 | 13 | 13_01 | 7 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-37 | 20.06.21 | 13 | 13_01 | 9 | 11 | 1 | 1 | 1 |
| EMB268 | Exp-38 | 20.06.21 | 13 | 13_01 | 11 | 13 | 1 | 1 | 1 |
| EMB268 | Exp-39 | 20.06.21 | 13 | 13_01 | 13 | 15 | 1 | 1 | 1 |
| EMB268 | Exp-40 | 20.06.21 | 13 | 13_01 | 15 | 17 | 1 | 1 | 1 |
| EMB268 | Exp-41 | 20.06.21 | 13 | 13_01 | 17 | 19 | 1 | 1 | 1 |
| EMB268 | Exp-42 | 20.06.21 | 13 | 13_01 | 19 | 21 | 1 | 1 | 1 |
| EMB268 | Exp-43 | 20.06.21 | 13 | 13_01 | 21 | 22.5 | 1 | 1 | 1 |

**Table S1:** continued. *(2/3)*

| SampleNr. | | Infos | | | Depth [cm] | | Existing Sample? (Y/N) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION | MUC core nr | from | to | F. Drying | ZnOAc | Por. & GS (2mL) |
| EMB268 | Exp-44 | 20.06.21 | 20 | 20_01 | 0 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-45 | 20.06.21 | 20 | 20_01 | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-46 | 20.06.21 | 20 | 20_01 | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-47 | 20.06.21 | 20 | 20_01 | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-48 | 20.06.21 | 20 | 20_01 | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-49 | 20.06.21 | 20 | 20_01 | 5 | 6 | 1 | 1 | 1 |
| EMB268 | Exp-50 | 20.06.21 | 20 | 20_01 | 6 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-51 | 20.06.21 | 20 | 20_01 | 7 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-52 | 20.06.21 | 20 | 20_01 | 9 | 11 | 1 | 1 | 1 |
| EMB268 | Exp-53 | 20.06.21 | 20 | 20_01 | 11 | 13 | 1 | 1 | 1 |
| EMB268 | Exp-54 | 20.06.21 | 20 | 20_01 | 13 | 15 | 1 | 1 | 1 |
| EMB268 | Exp-55 | 20.06.21 | 20 | 20_01 | 15 | 17 | 1 | 1 | 1 |
| EMB268 | Exp-56 | 20.06.21 | 20 | 20_01 | 17 | 19 | 1 | 1 | 1 |
| EMB268 | Exp-57 | 20.06.21 | 20 | 20_01 | 19 | 21 | 1 | 1 | 1 |
| EMB268 | Exp-58 | 20.06.21 | 20 | 20_01 | 21 | 23 | 1 | 1 | 1 |
| EMB268 | Exp-59 | 20.06.21 | 20 | 20_01 | 23 | 25 | 1 | 1 | 1 |
| EMB268 | Exp-60 | 20.06.21 | 20 | 20_01 | 25 | 26 | 1 | 1 | 1 |
| EMB268 | Exp-61 | 20.06.21 | F P&P 2 | Diver Core | 0 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-62 | 20.06.21 | F P&P 2 | Diver Core | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-63 | 20.06.21 | F P&P 2 | Diver Core | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-64 | 20.06.21 | F P&P 2 | Diver Core | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-65 | 20.06.21 | F P&P 2 | Diver Core | 5 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-66 | 20.06.21 | F P&P 2 | Diver Core | 7 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-67 | 20.06.21 | F P&P 2 | Diver Core | 9 | 10 | 1 | 1 | 1 |
| EMB268 | Exp-68 | 20.06.21 | F P&P 2 | Diver Core | 10 | 12 | 1 | 1 | 1 |
| EMB268 | Exp-69 | 20.06.21 | F P&P 2 | Diver Core | 12 | 13 | 1 | 1 | 1 |
| EMB268 | Exp-70 | 20.06.21 | F P&P 2 | Diver Core | 13 | 14 | 1 | 1 | 1 |
| EMB268 | Exp-71 | 20.06.21 | F P&P 2 | Diver Core | 14 | 16 | 1 | 1 | 1 |
| EMB268 | Exp-72 | 20.06.21 | F P&P 2 | Diver Core | 16 | 18 | 1 | 1 | 1 |
| EMB268 | Exp-73 | 20.06.21 | F P&P 2 | Diver Core | 18 | 19 | 1 | 1 | 1 |
| EMB268 | Exp-74 | 20.06.21 | F P&P 2 | Diver Core | 19 | 21 | 1 | 1 | 1 |
| EMB268 | Exp-75 | 20.06.21 | F P&P 2 | Diver Core | 21 | 23 | 1 | 1 | 1 |
| EMB268 | Exp-76 | 20.06.21 | M Geo | Diver Core | 0 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-77 | 20.06.21 | M Geo | Diver Core | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-78 | 20.06.21 | M Geo | Diver Core | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-79 | 20.06.21 | M Geo | Diver Core | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-80 | 20.06.21 | M Geo | Diver Core | 5 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-81 | 20.06.21 | M Geo | Diver Core | 7 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-82 | 20.06.21 | M Geo | Diver Core | 9 | 10 | 1 | 1 | 1 |
| EMB268 | Exp-83 | 20.06.21 | M Geo | Diver Core | 10 | 12 | 1 | 1 | 1 |
| EMB268 | Exp-84 | 20.06.21 | M Geo | Diver Core | 12 | 13 | 1 | 1 | 1 |
| EMB268 | Exp-85 | 20.06.21 | M Geo | Diver Core | 13 | 14 | 1 | 1 | 1 |
| EMB268 | Exp-86 | 20.06.21 | M Geo | Diver Core | 14 | 16 | 1 | 1 | 1 |
| EMB268 | Exp-87 | 20.06.21 | M Geo | Diver Core | 16 | 18 | 1 | 1 | 1 |
| EMB268 | Exp-88 | 20.06.21 | M Geo | Diver Core | 18 | 19 | 1 | 1 | 1 |
| EMB268 | Exp-89 | 20.06.21 | M Geo | Diver Core | 19 | 21 | 1 | 1 | 1 |
| EMB268 | Exp-90 | 20.06.21 | M Geo | Diver Core | 21 | 22.5 | 1 | 1 | 1 |

**Table S1:** continued. *(3/3)*

| SampleNr. | | Infos | | | Depth [cm] | | Existing Sample? (Y/N) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION | MUC core nr | from | to | F. Drying | ZnOAc | Por. & GS (2mL) |
| EMB268 | Exp-121 | 19.06.21 | M | Diver Core | 0 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-122 | 19.06.21 | M | Diver Core | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-123 | 19.06.21 | M | Diver Core | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-124 | 19.06.21 | M | Diver Core | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-125 | 19.06.21 | M | Diver Core | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-126 | 19.06.21 | M | Diver Core | 5 | 6 | 1 | 1 | 1 |
| EMB268 | Exp-127 | 19.06.21 | M | Diver Core | 6 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-128 | 19.06.21 | M | Diver Core | 7 | 8 | 1 | 1 | 1 |
| EMB268 | Exp-129 | 19.06.21 | M | Diver Core | 8 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-130 | 19.06.21 | M | Diver Core | 9 | 10 | 1 | 1 | 1 |
| EMB268 | Exp-131 | 19.06.21 | M | Diver Core | 10 | 12 | 1 | 1 | 1 |
| EMB268 | Exp-132 | 19.06.21 | M | Diver Core | 12 | 14 | 1 | 1 | 1 |
| EMB268 | Exp-133 | 19.06.21 | M | Diver Core | 14 | 16 | 1 | 0 | 1 |
| EMB268 | Exp-134 | 19.06.21 | M | Diver Core | 16 | 18 | 1 | 1 | 1 |
| EMB268 | Exp-135 | 19.06.21 | M | Diver Core | 18 | 20 | 1 | 1 | 1 |
| EMB268 | Exp-136 | 21.06.21 | 37 | 37_2 | 0 | 1 | | | |
| EMB268 | Exp-137 | 21.06.21 | 37 | 37_2 | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-138 | 21.06.21 | 37 | 37_2 | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-139 | 21.06.21 | 37 | 37_2 | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-140 | 21.06.21 | 37 | 37_2 | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-141 | 21.06.21 | 37 | 37_2 | 5 | 6 | 1 | 1 | 1 |
| EMB268 | Exp-142 | 21.06.21 | 37 | 37_2 | 6 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-143 | 21.06.21 | 37 | 37_2 | 7 | 8 | 1 | 1 | 1 |
| EMB268 | Exp-144 | 21.06.21 | 37 | 37_2 | 8 | 9 | | | |
| EMB268 | Exp-145 | 22.06.21 | 35 | 35_2 | 0 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-146 | 22.06.21 | 35 | 35_2 | 1 | 2 | 1 | 1 | 1 |
| EMB268 | Exp-147 | 22.06.21 | 35 | 35_2 | 2 | 3 | 1 | 1 | 1 |
| EMB268 | Exp-148 | 22.06.21 | 35 | 35_2 | 3 | 4 | 1 | 1 | 1 |
| EMB268 | Exp-149 | 22.06.21 | 35 | 35_2 | 4 | 5 | 1 | 1 | 1 |
| EMB268 | Exp-150 | 22.06.21 | 35 | 35_2 | 5 | 6 | 1 | 1 | 1 |
| EMB268 | Exp-151 | 22.06.21 | 35 | 35_2 | 6 | 7 | 1 | 1 | 1 |
| EMB268 | Exp-152 | 22.06.21 | 35 | 35_2 | 7 | 8 | 1 | 1 | 1 |
| EMB268 | Exp-153 | 22.06.21 | 35 | 35_2 | 8 | 9 | 1 | 1 | 1 |
| EMB268 | Exp-154 | 22.06.21 | 35 | 35_2 | 9 | 10 | 1 | 1 | 1 |
| EMB268 | Exp-155 | 22.06.21 | 35 | 35_2 | 10 | 11 | 1 | 1 | 1 |
| EMB268 | Exp-156 | 22.06.21 | 35 | 35_2 | 11 | 12 | 1 | 1 | 1 |

**Table S2** Pore-water samples EMB268, research group (Isotope) Biogeochemistry at IOW. *Met: metals, DIC: dissolved inorganic carbon, nut: nutrients, T.A.: total alkalinity, DOC: dissolved organic carbon, w.i.: water isotopes. (1/3)*

| SampleNr. | | Infos | | Depth [cm] | | Sampled? (Y/N/w:wenig,few) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION_GearNr | from | to | Met. | DIC | Sulf. | Nut. | T.A. | DOC | w.i. |
| EMB268 | Exp-1 | 18.06.21 | 1_4 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-2 | 18.06.21 | 1_4 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-3 | 18.06.21 | 1_4 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-4 | 18.06.21 | 1_4 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-5 | 18.06.21 | 1_4 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-6 | 18.06.21 | 1_4 | 7 | 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-7 | 18.06.21 | 1_4 | 9 | 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-8 | 18.06.21 | 1_4 | 11 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-9 | 18.06.21 | 1_4 | 13 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-10 | 18.06.21 | 1_4 | 15 | 16 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-11 | 18.06.21 | 1_4 | 20 | 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-12 | 18.06.21 | 5_3 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-13 | 18.06.21 | 5_3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-14 | 18.06.21 | 5_3 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-15 | 18.06.21 | 5_3 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-16 | 18.06.21 | 5_3 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-17 | 18.06.21 | 5_3 | 7 | 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-18 | 18.06.21 | 5_3 | 9 | 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-19 | 18.06.21 | 5_3 | 11 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-20 | 18.06.21 | 5_3 | 13 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-21 | 18.06.21 | 5_3 | 15 | 16 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-22 | 18.06.21 | 5_3 | 20 | 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-23 | 19.06.21 | 13_1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-24 | 19.06.21 | 13_1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-25 | 19.06.21 | 13_1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-26 | 19.06.21 | 13_1 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-27 | 19.06.21 | 13_1 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-28 | 19.06.21 | 13_1 | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-29 | 19.06.21 | 13_1 | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-30 | 19.06.21 | 13_1 | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-31 | 19.06.21 | 13_1 | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-32 | 19.06.21 | 13_1 | 14 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-33 | 19.06.21 | 13_1 | 20 | 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-34 | 19.06.21 | 14_2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-35 | 19.06.21 | 14_2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-36 | 19.06.21 | 14_2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-37 | 19.06.21 | 14_2 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-38 | 19.06.21 | 14_2 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-39 | 19.06.21 | 14_2 | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-40 | 19.06.21 | 14_2 | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-41 | 19.06.21 | 14_2 | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-42 | 19.06.21 | 14_2 | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-43 | 19.06.21 | 14_2 | 14 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-44 | 19.06.21 | 14_2 | 20 | 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table S2:** *continued. (2/3)*

| SampleNr. | | Infos | | Depth [cm] | | Sampled? (Y/N/w:wenig,few) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION_GearNr | from | to | Met. | DIC | Sulf. | Nut. | T.A. | DOC | w.i. |
| EMB268 | Exp-45 | 20.06.21 | 20_1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-46 | 20.06.21 | 20_1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-47 | 20.06.21 | 20_1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-48 | 20.06.21 | 20_1 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-49 | 20.06.21 | 20_1 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-50 | 20.06.21 | 20_1 | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-51 | 20.06.21 | 20_1 | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-52 | 20.06.21 | 20_1 | 10 | 12 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-53 | 20.06.21 | 20_1 | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-54 | 20.06.21 | 20_1 | 14 | 15 | 1 | 1 | 1 | 1 | 1 | ? | 1 |
| EMB268 | Exp-55 | 20.06.21 | 20_1 | 21 | 22 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-56 | 20.06.21 | 23_1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-57 | 20.06.21 | 23_1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-58 | 20.06.21 | 23_1 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-59 | 20.06.21 | 23_1 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-60 | 20.06.21 | 23_1 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-61 | 20.06.21 | 23_1 | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-62 | 20.06.21 | 23_1 | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-63 | 20.06.21 | 23_1 | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-64 | 20.06.21 | 23_1 | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-65 | 20.06.21 | 23_1 | 14 | 15 | 1 | 1 | 1 | ? | 1 | ? | 1 |
| EMB268 | Exp-66 | 20.06.21 | 23_1 | 17 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-67 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-68 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-69 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-70 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-71 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-72 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-73 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-74 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-75 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-76 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 14 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-77 | 20.06.21 | Diver: F_BGC_Rhiz A Furrow | 20 | 21 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-78 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-79 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-80 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-81 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-82 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-83 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 6 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EMB268 | Exp-84 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-85 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-86 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-87 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 14 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-88 | 21.06.21 | Diver: M BGC_Rhiz B Mount | 20 | 21 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-89 | 21.06.21 | 37_2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-90 | 21.06.21 | 37_2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-91 | 21.06.21 | 37_2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table S2:** *continued. (3/3)*

| SampleNr. | | Infos | | Depth [cm] | | Sampled? (Y/N/w:wenig,few) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION_GearNr | from | to | Met. | DIC | Sulf. | Nut. | T.A. | DOC | w.i. |
| EMB268 | Exp-92 | 21.06.21 | 37_2 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-93 | 21.06.21 | 37_2 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-94 | 21.06.21 | 37_2 | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-95 | 21.06.21 | 37_2 | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-96 | 21.06.21 | 37_2 | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-97 | 21.06.21 | 37_2 | 13 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-98 | 21.06.21 | 35_2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-99 | 21.06.21 | 35_2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-100 | 21.06.21 | 35_2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-101 | 21.06.21 | 35_2 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-102 | 21.06.21 | 35_2 | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-103 | 21.06.21 | 35_2 | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-104 | 21.06.21 | 35_2 | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-105 | 21.06.21 | 35_2 | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-106 | 21.06.21 | 35_2 | 12 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-107 | 21.06.21 | 35_2 | 13 | 14 | 1 | 1 | 1 | ? | 1 | ? | 1 |
| EMB268 | Exp-200 | 19.06.21 | Diver core M | BW | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-201 | 19.06.21 | Diver core M | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-202 | 19.06.21 | Diver core M | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-203 | 19.06.21 | Diver core M | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-204 | 19.06.21 | Diver core M | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-205 | 19.06.21 | Diver core M | 4 | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-206 | 19.06.21 | Diver core M | 5 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-207 | 19.06.21 | Diver core M | 6 | 7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-208 | 19.06.21 | Diver core M | 7 | 8 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-209 | 19.06.21 | Diver core M | 8 | 9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-210 | 19.06.21 | Diver core M | 9 | 10 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-211 | 19.06.21 | Diver core M | 10 | 11 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-212 | 19.06.21 | Diver core M | 11 | 13 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-213 | 19.06.21 | Diver core M | 13 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-214 | 19.06.21 | Diver core M | 15 | 17 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-215 | 19.06.21 | Diver core M | 17 | 19 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-216 | 19.06.21 | Diver core F | BW | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-217 | 19.06.21 | Diver core F | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-218 | 19.06.21 | Diver core F | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-219 | 19.06.21 | Diver core F | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-220 | 19.06.21 | Diver core F | 3 | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| EMB268 | Exp-221 | 19.06.21 | Diver core F | 4 | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-222 | 19.06.21 | Diver core F | 5 | 6 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-223 | 19.06.21 | Diver core F | 6 | 7 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-224 | 19.06.21 | Diver core F | 7 | 8 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-225 | 19.06.21 | Diver core F | 8 | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| EMB268 | Exp-226 | 19.06.21 | Diver core F | 9 | 10 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| EMB268 | Exp-227 | 19.06.21 | Diver core F | 10 | 11 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-228 | 19.06.21 | Diver core F | 11 | 12 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-229 | 19.06.21 | Diver core F | 12 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-230 | 19.06.21 | Diver core F | 14 | 16 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-231 | 19.06.21 | Diver core F | 16 | 18 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| EMB268 | Exp-232 | 19.06.21 | Diver core F | 18 | 20 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-233 | 19.06.21 | Diver core F | 20 | 22 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table S3:** Water column samples EMB268, research group (Isotope) Biogeochemistry at IOW. *BW: bottom water, Met: metals, DIC: dissolved inorganic carbon, nut: nutrients, T.A.: total alkalinity, DOC: dissolved organic carbon, w.i.: water isotopes.*

| SampleNr. | | cruise and general | | | | Water Depth [m] | Existing Sample? (Y/N) | | | | | | Filter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | DATE | STATION_Gear | Gear Type | bottle nr./core nr. | from | Met. | DIC | Nut. | T.A. | DOC | w.i. | Nr. |
| EMB268 | Exp-1 | 18.06.21 | 1_2 | CTD | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | SS1 |
| EMB268 | Exp-2 | 18.06.21 | 1_2 | CTD | 4 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | SS2 |
| EMB268 | Exp-3 | 18.06.21 | 1_2 | CTD | 6 (7) | 14 | 1 | 1 | 1 | 1 | 1 | 1 | SS3 |
| EMB268 | Exp-4 | 18.06.21 | 1_2 | CTD | 9 (10) | BW (˜18m) | 1 | 1 | 1 | 1 | 1 | 1 | SS4 |
| EMB268 | Exp-5 | 18.06.21 | 1_4 | MUC | 1_4 | BW | 1 | 1 | 1 | 0 | 1 | 1 | SS5 |
| EMB268 | Exp-6 | 19.06.21 | 11_2 | CTD | 1 | 6 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-7 | 19.06.21 | 11_2 | CTD | 2 | 14 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-8 | 19.06.21 | 11_2 | CTD | 3 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-9 | 19.06.21 | 11_2 | CTD | 4 | 16 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-10 | 19.06.21 | 11_2 | CTD | 7 | 17 | 1 | 1 | 1 | 1 | 1 | 1 | |
| EMB268 | Exp-11 | 19.06.21 | 11_2 | CTD | 10 | 18 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-12 | 19.06.21 | 11_2 | CTD | 13 | BW (>18m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-13 | 19.06.21 | 12_3 | CTD | 1 | 2 | 1 | 1 | 1 | 1 | k | 1 | |
| EMB268 | Exp-14 | 19.06.21 | 12_3 | CTD | 7 | 14 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB282 | Exp-38 | 21.06.21 | 12_3 | CTD | 4 | 15 | 1 | 1 | 1 | 0 | k | 1 | 1 |
| EMB283 | Exp-39 | 21.06.21 | 12_3 | CTD | 5 | 16 | 1 | 1 | 1 | 0 | k | 1 | 1 |
| EMB268 | Exp-15 | 19.06.21 | 12_3 | CTD | 9 | 17 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-16 | 19.06.21 | 12_3 | CTD | 10 | 18 | 1 | 1 | 1 | 0 | k | 1 | |
| EMB268 | Exp-17 | 19.06.21 | 12_3 | CTD | 13 | BW (>18m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| EMB268 | Exp-18 | 19.06.21 | 12_2 | CTD | 1 | 6 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-19 | 19.06.21 | 12_2 | CTD | 2 | 14 | 1 | 1 | 1 | 0 | 1 | 1 | |
| EMB268 | Exp-20 | 19.06.21 | 12_2 | CTD | 3 | 15 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-21 | 19.06.21 | 12_2 | CTD | 4 | 16 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-22 | 19.06.21 | 12_2 | CTD | 7 | 17 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-23 | 19.06.21 | 12_2 | CTD | 10 | 18 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB268 | Exp-24 | 19.06.21 | 12_2 | CTD | 13 | BW (>18m) | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB269 | Exp-25 | 20.06.21 | 19_1 | CTD | 4 | 14 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB270 | Exp-26 | 20.06.21 | 19_1 | CTD | 7 | 17 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB271 | Exp-27 | 20.06.21 | 19_1 | CTD | 10 | 18 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB272 | Exp-28 | 20.06.21 | 19_1 | CTD | 13 | BW (>18m) | 1 | 1 | 1 | 1 | ? | 1 | 1 |
| EMB273 | Exp-29 | 21.06.21 | 31_2 | CTD | 4 | 12 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB274 | Exp-30 | 21.06.21 | 31_2 | CTD | 7 | 13 | 1 | 1 | 1 | | 1 | 1 | 1 |
| EMB275 | Exp-31 | 21.06.21 | 31_2 | CTD | 10 | BW (˜14m) | 1 | 1 | 1 | | 1 | 1 | 1 |
| EMB276 | Exp-32 | 21.06.21 | 34_1 | CTD | 4 | 12 | 1 | 1 | 1 | 0 | k | 1 | 1 |
| EMB277 | Exp-33 | 21.06.21 | 34_1 | CTD | 7 | 13 | 1 | 1 | 1 | | 1 | 1 | 1 |
| EMB278 | Exp-34 | 21.06.21 | 34_1 | CTD | 9 | BW (˜14m) | 1 | 1 | 1 | | 1 | 1 | 1 |
| EMB279 | Exp-35 | 21.06.21 | 34_2 | CTD | 3 | 13 | 1 | 1 | 1 | 0 | k | 1 | 1 |
| EMB280 | Exp-36 | 21.06.21 | 34_2 | CTD | 7 | 12 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| EMB281 | Exp-37 | 21.06.21 | 34_2 | CTD | 13 | BW (˜14m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |