

HEINCKE-Berichte

CONMAR MuniSpot I

Cruise No. HE669

27. September – 10. October 2025,
Bremerhaven (Germany) – Bremerhaven (Germany)
CONMAR & REMARCO



Authors

Matthias Brenner*, Leonie Buchele, Andrey Vedenin & Wyona Schütte

*Dr. Matthias Brenner, Chief Scientist
Alfred-Wegener-Institute Helmholtz Centre for Polar and Marine
Research (AWI)

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1 Cruise Summary

1.1 Summary in English

The RV HEINCKE left September 27 from AWI pier in Bremerhaven with participants from the AWI, MPI Bremen, DSM, Senckenberg, VLIZ (BE), GEOMAR, and a journalist from DLF towards the wreck of the MS Brummer in the Skagerrak at the entrance to the Oslo Fjord. After 36 hours of sailing, we arrived in the evening of September 29 and surveyed the wreck with the ship's multibeam echo sounder. The following morning, we picked up partners from FFI and an employee of the Norwegian Coastal Administration in Nevlunghavn. Back on HEINCKE, the deep-sea lander was placed as a monitoring platform southwest of the stern at a depth of approximately 120 m close to the wreck. Afterwards, a sediment transect was carried out for benthic fauna and microbial analysis. The Norwegian colleagues were brought back ashore and HEINCKE steamed back to the German Bight, where the first water, sediment, and organism samples were taken with a bottom trawl on the morning of October 1 at the munition dumping area (MVG) west of Sylt. After completing the work near Sylt, HEINCKE steamed on towards Helgoland, where the sampling program was repeated the following day (October 2/3) at the dump site Steingrund and later at the wreck site of the Vigo. After completing the work in the German Bight HEINCKE steamed back to MS Brummer wrecks site where the lander was successfully recovered. On the way back, the reference area near Borkum Riffgrund was then sampled at October 8, before HEINCKE steamed back to Bremerhaven, where she arrived at around 4:00 p.m. on the evening of October 9.

1.2 Zusammenfassung

Die FS HEINCKE lief am 27. September vom AWI-Pier in Bremerhaven mit Teilnehmern des AWI, MPI Bremen, DSM, Senckenberg, VLIZ (BE), GEOMAR und einem Journalisten des DLF in Richtung des Wracks der MS Brummer im Skagerrak an der Einfahrt zum Oslofjord aus. Nach 36 Stunden Fahrt kamen wir am Abend des 29. September an und vermessen das Wrack mit dem Multibeam-Echolot des Schiffes. Am nächsten Morgen holten wir Partner vom FFI und einen Mitarbeiter der norwegischen Küstenverwaltung in Nevlunghavn ab. Zurück auf der HEINCKE wurde der Tiefsee-Lander als Überwachungsplattform südwestlich des Hecks in einer Tiefe von etwa 120 m in der Nähe des Wracks platziert. Anschließend wurde ein Sedimenttransekt für die benthische Fauna und die mikrobielle Analyse durchgeführt. Die norwegischen Kollegen wurden wieder an Land gebracht und die HEINCKE fuhr zurück in die Deutsche Bucht, wo am Morgen des 1. Oktober mit einem Grundschleppnetz die ersten Wasser-, Sediment- und Organismenproben im Munitionsversenkungsgebiet (MVG) westlich von Sylt entnommen wurden. Nach Abschluss der Arbeiten in der Nähe von Sylt fuhr die HEINCKE weiter nach Helgoland, wo das Probenahmeprogramm am folgenden Tag (2./3. Oktober) am Deponiegebiet Steingrund und später am Wrack der Vigo wiederholt wurde. Nach Abschluss der Arbeiten in der Deutschen Bucht fuhr die HEINCKE zurück zum Wrack der MS Brummer, wo der Lander erfolgreich geborgen wurde. Auf dem Rückweg wurde am 8. Oktober das Referenzgebiet in der Nähe des Borkumer Riffgrunds beprobt, bevor die HEINCKE am 09. Oktober gegen 16:00 Uhr in Bremerhaven einlief.

2 Participants

2.1 Principal Investigators

Name	Institution
Brenner, Matthias, Dr.	AWI

2.2 Scientific Party

Name	Discipline	Institution
Brenner, Matthias, Dr.	Marine Biology/ Chief Scientist	AWI
Marx, Ute	Marine Biology/ Technician	AWI
Schuster, Romina, M.Sc.	Marine Biology/ PhD Student	AWI
Mohrmann, Jochen, M.Sc.	Deep Sea Monitoring, M.Sc.	GEOMAR
Schütte, Wyona, M.Sc.	Marine Biologist/PhD Student	VLIZ
Nordhausen, Axel	Technician	MARUM
Fidan, Tülin, M.Sc.	Social Scientist	DSM
Vedenin, Andrey, Dr.	Marine Biologist	Senckenberg
Nickoleit, Katharina	Journalist	DLF Radio

Day trips

Ljønes, Marita	Scientist,	FFI
Bolsønes, Marianne	Scientist,	FFI
Hammer, Stine Eriksen	Senior Adviser	NCA

2.3 Participating Institutions

AWI	Alfred-Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany
DSM	German Maritime Museum, Leibnitz Institute for Maritime History, Bremerhaven, Germany
GEOMAR	Helmholtz Centre for Ocean Research, Kiel, Germany
Senckenberg	Senckenberg am Meer, Wilhelmshaven, Germany
MARUM	Center for Marine Environmental Sciences, Bremen, Germany
VLIZ	Flanders Marine Institute, Ostende, Belgium
DLF	Deutschlandfunk, Köln, Germany
FFI	Forsvarets forskningsinstitutt, Norwegian Defence Research Establishment
NCA	Kystverket, Norwegian Coastal Administration

Sample & Data recipients:

AWI	Dr. Matthias Brenner, Romina Schuster, AWI, Department of Ecological Chemistry & Leonie Buchele, AWI, Deep Sea Ecology, Bremerhaven, Germany
UKSH	Prof. Dr. Edmund Maser, Institute of Toxicology and Pharmacology for Natural Scientists, University Medical School Schleswig-Holstein, Kiel
Senckenberg	Dr. Andrey Vedenin, Senckenberg am Meer, Department Marine Science, Wilhelmshaven, Germany
VLIZ	Wyona Schütte, Flanders Marine Institute, Ostend, Belgium

3 Research Program

3.1 Description of the Work Area

The first working area is the wreck of the mine layer and navy school ship MS Brummer located in the Skagerrak at the entrance to the Oslo Fjord. In addition, we will work on several hotspots of dumped munitions in the southern German Bight. Next to the MS Brummer, we will approach the wreck of the barrier breaker Vigo west of Helgoland and the dump site for conventional munitions west of Sylt and Steingrund near the island of Helgoland. Further, a reference area south of the nature reserve of Borkum Riffgrund will be visited- and sampled.

3.2 Aims of the Cruise

The aims of the cruises are cross disciplinary investigations of munition hotspots, such as dump and wreck sites in the southern German Bight and the Skagerrak. Therefore, the known dump site west of Sylt and Steingrund as well as the wrecks of Vigo and MS Brummer will be approached and sampled. We will apply a state-of-the-art monitoring platform at the wreck of MS Brummer close to the wreck at approx. 120-meter depths. The platform is equipped with passive sampler, two caged mussel species, water sampling devices, a benthic chamber and a Seaguard measuring current direction, current speed and pressure. Both wreck and dump sites will be sampled according to a dense transect for the analysis of benthos and microbial communities. Further, the dump and wreck sites (except for MS Brummer) will also be fished for bottom dwelling organisms, such as macro-zoobenthos species and fish to trace the transfer of explosives via the food web. All samples (water, passive sampler, sediment and biota) will also be analysed for dissolved explosives.

3.3 Agenda of the Cruise

The cruise HE669 with RV HEINCKE was carried out as a joint venture between the German national project CONMAR and the EU Interreg project REMARCO. For CONMAR research is focussed to munition dump sites in the German Bight, whereas the assessment of the wreck of MS Brummer is a pilot of REMARCO. In addition, REMARCO joint up with the BSR sister project MUNIMAP by using a remotely operated platform, developed by the MUNIMAP consortium, for the assessment of the REMARCO pilot wreck site of MS Brummer in Skagerrak. This platform equipped with sensors, passive samplers, sampling devices and caged mussels is a prototype of a monitoring device for munition hotspots, developed by the MUNIMAP project consortium.

Further, the cruise will be used to survey several other munition hotspots such as wrecks and dump sites in the German Bight to complete sampling started already during HE665-2 for tracing explosive through the food web of bottom dwelling organisms (Fig. 3.1).

R.V. Heincke: HE669

Bremerhaven, Germany (27.09.2025) - Bremerhaven, Germany (09.10.2025)

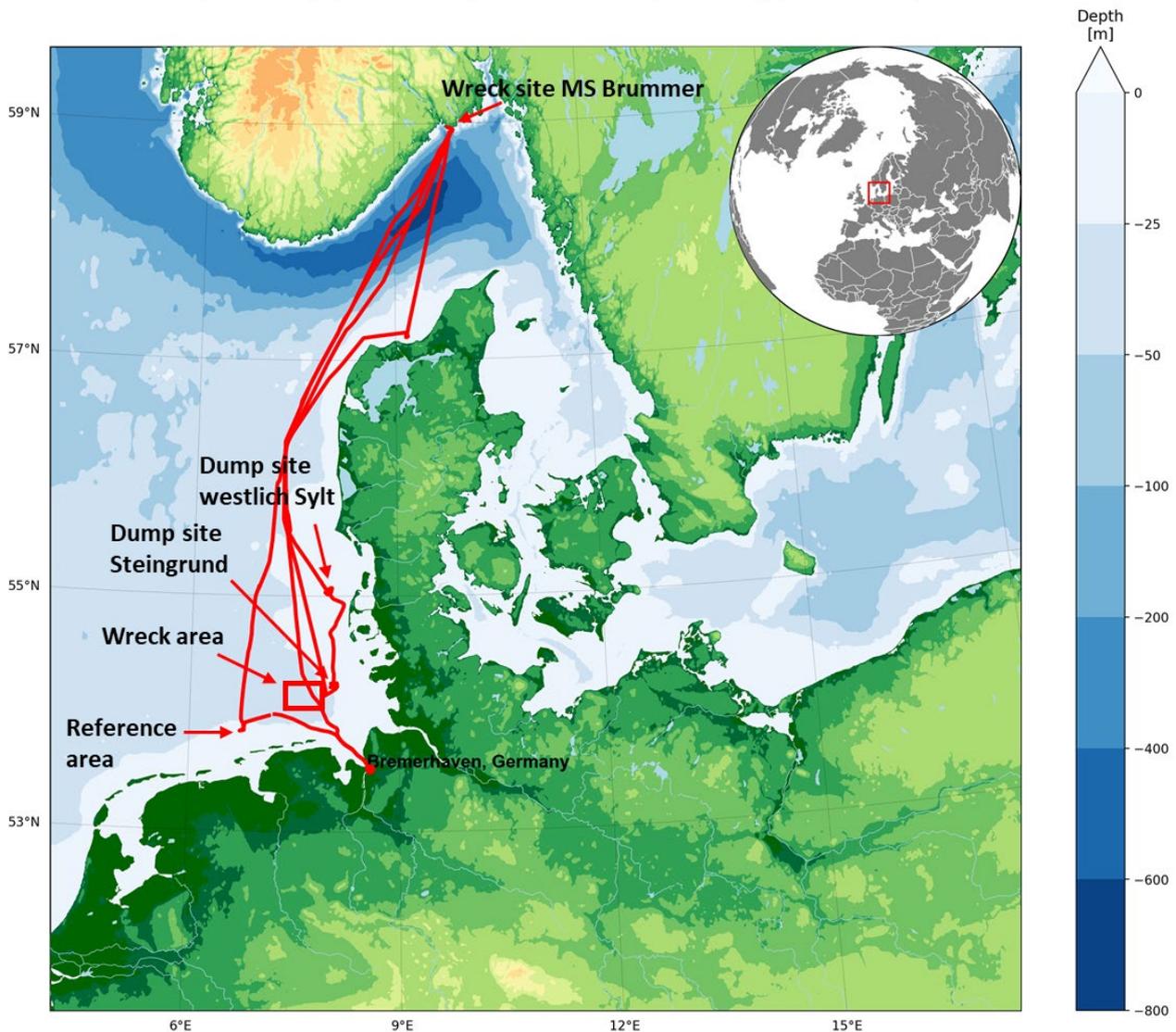


Fig. 3.1 Areas in the Skagerrak and the German Bight visited during the RV HEINCKE cruise HE669 (CONMAR-REMARCO MuniSpot I).

We appreciate the uniqueness and complexity of the marine environment and are particularly interested in preserving this scientifically, aesthetically, ecologically, and potentially economically valuable environment. Accordingly, the research activities for this cruise were fully consistent with the “Code of Conduct for Responsible Marine Research in Deep Seas and High Seas of the OSPAR Maritime Area” and with the “Erklärung zu einer verantwortungsvollen Meeresforschung” of the Senatskommission für Ozeanographie der Deutschen

Forschungsgemeinschaft and the Konsortium Deutsche Meeresforschung (KDM). Further, specific mitigation measures that were considered during the cruise HE 616 were the following:

- Because of the small size of deployed sampling gear (0.1 m² van Veen grab; 5m beam trawl) and the short trawling distances (15-20 minutes at 2-3 nm) the spatial extent of our extractive activities is relatively small. Accordingly, the disturbance of habitats and populations is limited to the necessary minimum.
- We reduced the number of stations to a minimum in order to avoid unnecessary extraction of natural material.
- The handling and dissection of life specimens on board follows national and international guideline of animal welfare and is reviewed by the institute's animal welfare officer.
- We will not transport live biota between different regions. Accordingly, we will not risk changes in the environment and the composition of marine communities.
- The data collected during our research cruise will be stored and made available in open access databases and subsequently in open access publications.
- Furthermore, we will share our data with national and international collaborators.

4 Narrative of the Cruise

The RV HEINCKE was loaded as planned on the afternoon of September 26 at the AWI pier in Bremerhaven by participants from the AWI, MPI Bremen, DSM, Senckenberg, VLIZ (BE), GEOMAR, and a journalist from DLF. The voyage began the following day at 8:30 a.m., heading for the wreck of the MS Brummer in the Skagerrak at the entrance to the Oslo Fjord. After approximately 36 hours of sailing, we arrived at the wreck site on the evening of September 29 and surveyed it with the ship's multibeam echo sounder. The following morning, we picked up REMARCO project colleagues from FFI and an employee of the Norwegian Coastal Administration in Nevlunghavn with the working boat and brought them on board of HEINCKE. There, water samples were taken with CTD at the wreck and the deep-sea lander was placed as a monitoring platform southwest of the stern at a depth of approximately 120 m close to the wreck. Afterwards, a sediment transect was carried out for our colleagues from Senckenberg and VLIZ for benthic fauna and microbial analysis. The Norwegian colleagues were then brought back ashore and HEINCKE steamed back to the German Bight, where the first water, sediment, and organism samples were taken with a bottom trawl on the morning of October 1 at the munition dumping area (MVG) west of Sylt. After completing the work near Sylt, HEINCKE steamed on towards Helgoland, where the sampling program was repeated the following day (October 2/3) at the dump site Steingrund and later at the wreck site of the Vigo. Due to the impending drastic deterioration in weather conditions and the fact that the Polish ROV pilots scheduled for the second leg of the voyage had cancelled their participation due to illness, it was decided to let the participants from Senckenberg, DSM, VLIZ, and the journalist disembark in Helgoland and return directly to the Skagerrak to recover the lander. After 34 hours of steaming and another day of

waiting out the weather off the north Danish coast, HEINCKE returned to the wreck site on the morning of October 6, where the lander was successfully recovered in moderate weather conditions. The reference area near Borkum Riffgrund was then sampled on October 8, before HEINCKE steamed back to Bremerhaven, where she arrived at around 4:00 p.m. on the evening of October 9.

5 Preliminary Results

5.1 Deployment of a Remote Operating Lander at the Wreck of MS Brummer

Leonie Buchele (AWI, Bremerhaven, Germany), Frank Wenzhöfer (AWI, Bremerhaven, Germany), Axel Nordhausen (MARUM, Bremen Germany) & Matthias Brenner, (AWI, Bremerhaven, Germany)

The lander was built to measure environmental parameters at the seafloor. Its objective was to provide an overview of the oceanographic conditions at the wreck over an extended period. To also assess biological parameters, cages containing different mussel species, the common blue mussel (*Mytilus edulis*) and the deep-sea adapted giant file clam (*Acesta excavata*) as well as passive samplers were mounted on the frame. To measure temperature, pressure, and currents, a SeaGuard© was mounted on the lander 2.5 m above the seafloor. Measurements were recorded at 10-minute intervals. For later chemical analysis, four water samples were collected over the time of deployment. The first sample was taken one day after the lander was deployed, and the remaining three samples were taken at three-day intervals. To measure oxygen exchange between the sediment and the overlying water in an enclosed area, a benthic chamber was installed close to the seafloor. Unfortunately, a problem with the motor prevented the chamber from starting, and therefore no measurements were obtained from this instrument. To power the instruments, a battery was mounted on the lander frame (Fig. 5.1.1).

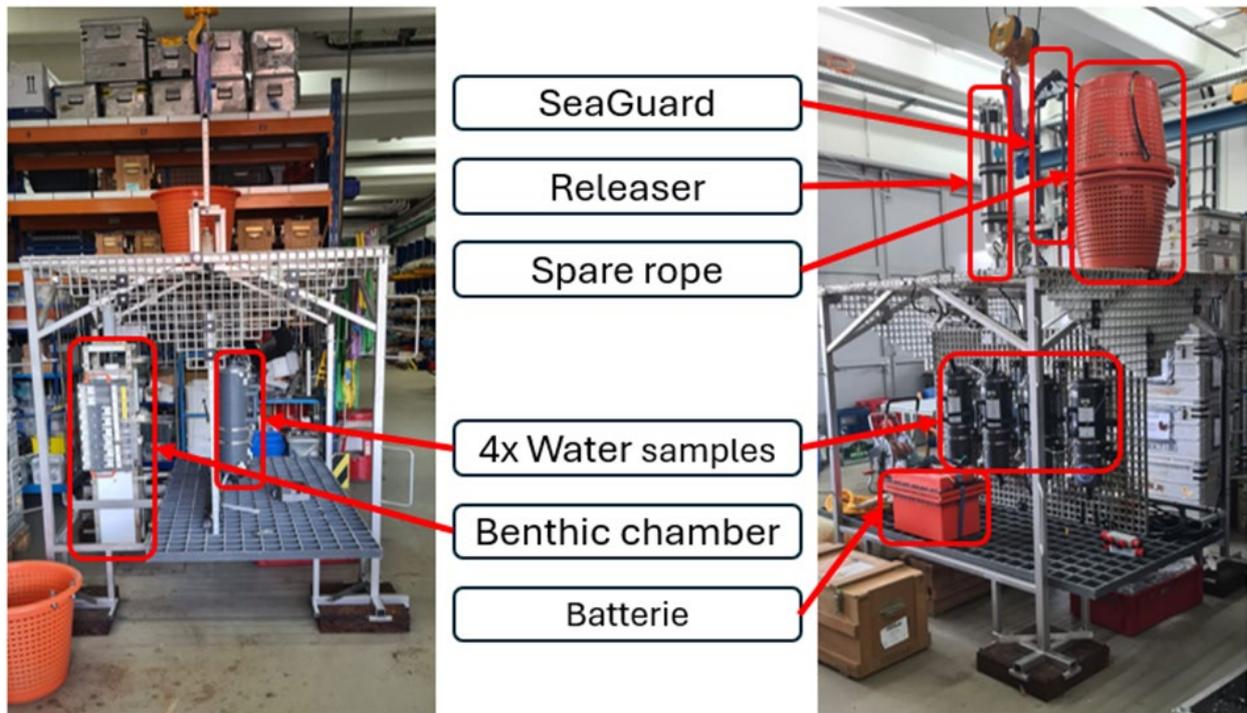


Fig. 5.1.1 Remote controlled lander platform equipped with SeaGuard©, passive sample, mussel cages, water sampling devices and a benthic chamber placed by the research vessel HEINCKE at the southwestern tip of the wreck of MS Brummer in ca. 120-meter depths in the Skagerrak near the entrance of Oslo (Photo copyright Leonie Buchele/AWI 2025)

The lander was positioned on the seafloor on 29.09.25 at approximately 09:00 using a rope to ensure a fixed and well-defined location at 125 m depth close to the southwest side of the wreck (stern). For recovery on 06.10.25 at approximately 08:00, an acoustic signal triggered the release, attached to a rope with buoys. The buoys surfaced after release and were recovered at the surface, allowing the lander to be retrieved. The SeaGuard© data were read out: the average temperature over the deployment period was 9.42 °C, with a minimum of 8.48 °C and a maximum of 14.35 °C at the end of the period. The current speed and direction over time is shown in the following plot (Fig. 5.1.2). To better understand the data, the weather situation changed toward the end of the deployment, and a major storm was approaching.

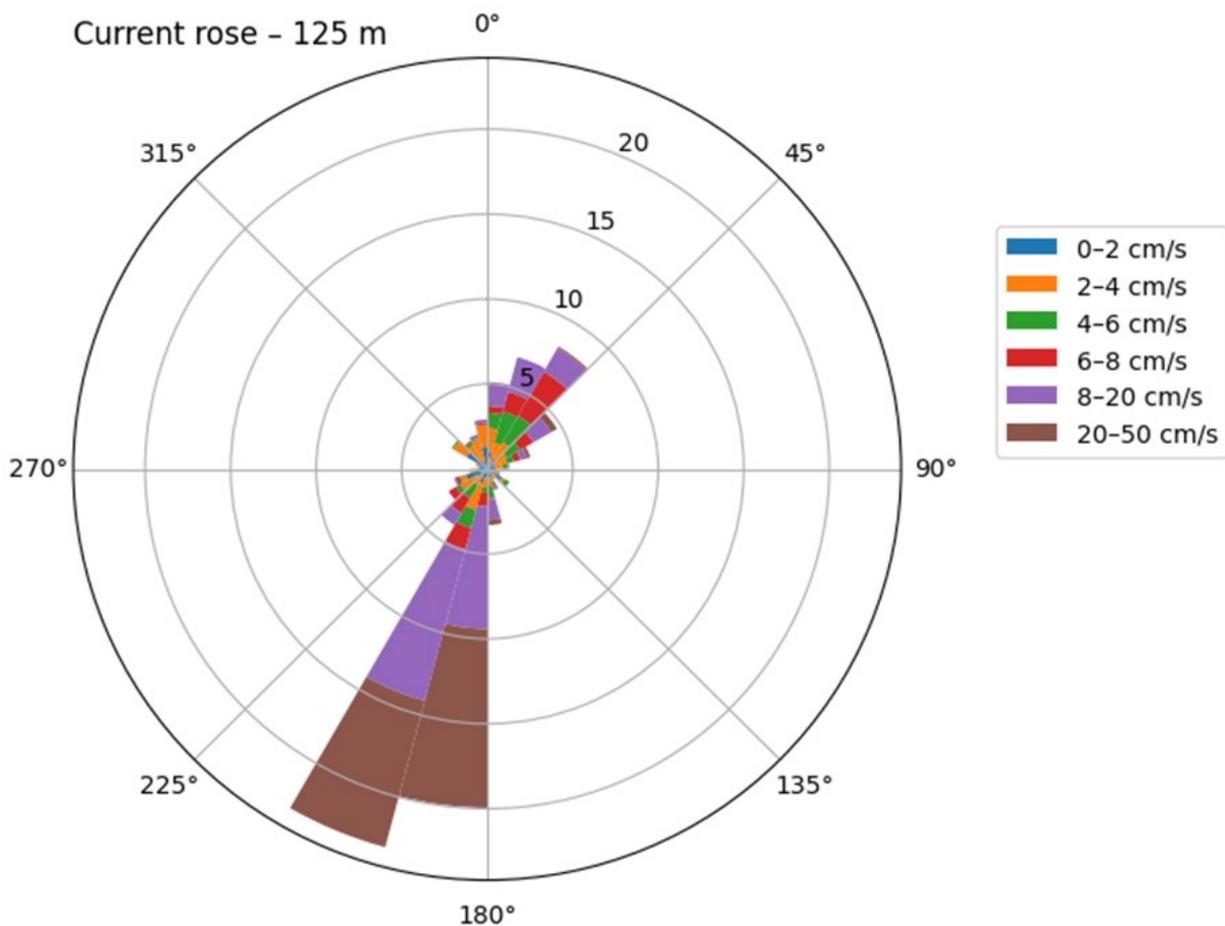


Fig. 5.1.2 Current direction and absolute speed over time displayed for the deployment period (Data from SeaGuard© sensor: Doppler Current Sensor 4520)

After retrieval water samples were stored for further studies, passive samplers were saved and mussels were dissected for both chemical and biological analysis (Fig. 5.1.3).



Fig. 5.1.3 Two mussel species, the common blue mussel (*Mytilus edulis*) and the deep-sea adapted giant file clam (*Acesta excavata*), were caged at the lander (A & B), exposed at 120m depths at the wreck of MS Brummer and dissected (C, D, E & F) after retrieval in the wet lab of RV HEINCKE (Photo copyright Ute Marx/AWI 2025).

5.2. Sediment Sampling for Explosives and Microbial Community Analysis

Wyona Schütte, (VLIZ, Ostende, Belgium))

Surface sediment samples for microbial and chemical analysis (measurements of explosive compounds such as 2,4,6-trinitrotoluene and its metabolites) were collected with a Van Veen grab sampler at five different sampling sites. Ten sediment samples were collected at the wreck site of MS Brummer in Norwegian waters. Closest samples were collected less than 50m distance from the wreck site, furthest samples, following a transect to assess potential spread of pollution, up to 500m distance. In the German Bight, eleven sediment samples were taken at the outside borders of the munition dumping area westlich Sylt. Based on a sample collected during a previous research cruise (HE635) that indicated elevated explosive contamination north of the dumping area, a closer grid of sampling points was established and sampled in that area to further investigate a potential hotspot of pollution. Next, seven sediment samples were collected at the outside borders of the munition dumping area Steingrund, in close proximity to Helgoland. Additional samples were taken at the wreck site of the barrier breaker Vigo (five samples) and the reference area southeast of Borkum Riffgrund (two samples). Samples were directly frozen to stop/slow down microbial activity and degradation of explosive compounds until further analysis. Currently, analysis of microbial communities in sediments is taking place at the Flanders Marine Institute

(VLIZ, Belgium), using 16S full-length rRNA sequencing (nanopore). Chemical analysis for munition compounds using gas chromatography coupled with mass spectrometry (GC-MS) is conducted at the Institute of Toxicology and Pharmacology for Natural Scientists, University Medical School Schleswig-Holstein (Kiel, Germany). Concentrations of munition compounds in sediments will be related to shifts in microbial communities to find potential indicators for explosives leaking from wrecks and munition dumping areas (Fig. 5.2.1).

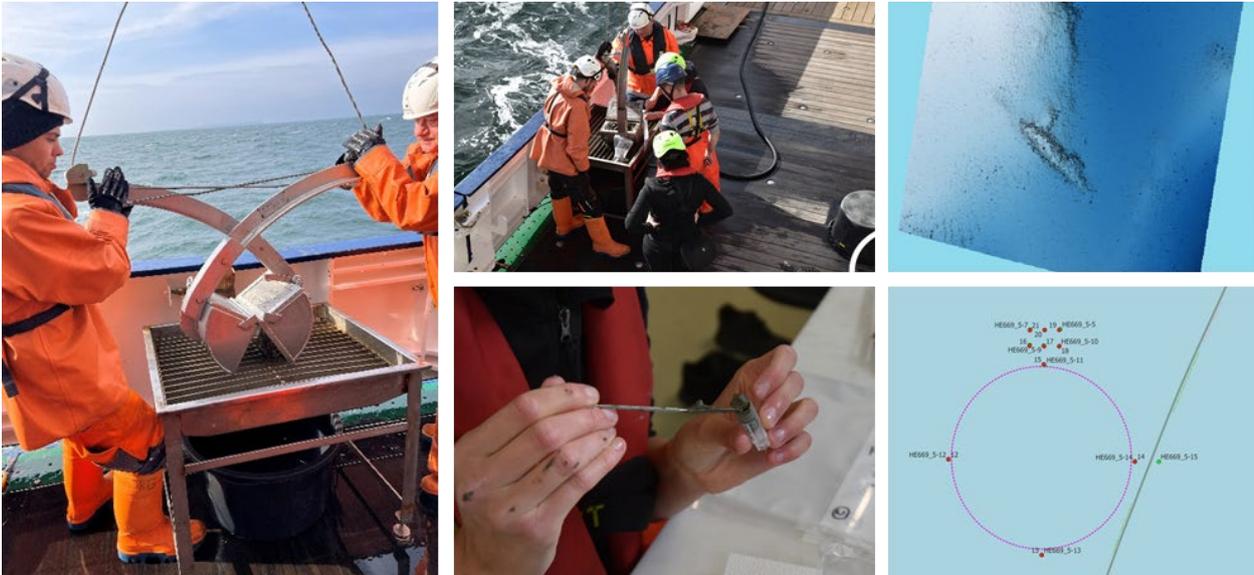


Fig. 5.2.1 Clockwise: Sediment sampling with the Van Veen. Multibeam to locate the wreck of MS Brummer. Map with sampling points for munition dumping area westlich Sylt. Preparation of sediment samples for microbial community analysis (Photo copyright Wyona Schütte/VLIZ 2025).

5.3 Fishing for Biota Using Bottom Trawl

M. Brenner, Romina Schuster (AWI, Bremerhaven, Germany) & E. Maser (UKSH, Kiel, Germany)

Fishing for bottom living macro zoobenthos, bottom dwelling and pelagic fish was conducted at the edge of the dump sites west of Sylt and Steingrund in the vicinity of Helgoland. In addition, the wreck site of the barrier breaker Vigo southwest of Helgoland and a reference area southeast of the nature reserve Borkum Riffgrund were fished (Fig. 5.3.1). The aim of this investigation is to track the concentrations of dissolved explosive according to the habitat of exposed organisms, living directly on and from the benthos of feeding pelagically in the water column. Organisms were collected from the catches and directly frozen. Fish were dissected first before frozen for further analysis. Samples were sent to project partner and will be analysed for traces of explosives at UKSH in Kiel, Germany (E. Maser, University of Kiel).



Fig. 5.3.1 RV HEINCKE's bottom trawl net used during HE669 (Photo copyright Ute Marx/AWI 2025).

5.4 Macrofauna Sampling

Andrey Vedenin (Senckenberg am Meer, Wilhelmshaven)

During the expedition of HE669 a total of 35 stations were sampled at five locations, around the ship wrecks of MS Brummer in the Norwegian coastal waters (9 stations) and Barrier Breaker 10 Vigo in German waters (6 stations), around the munition dumpsites of Sylt (10 stations) and Helgoland Steingrund (7 stations) and in the reference area free of munition compounds (Borkum Riffgrund, 2 stations). Their position is shown in Fig. 5.4.1. Stations were arranged around each wreck/dumpsite with several more stations forming a transect along the most likely current direction at a distance of ~100-200 m from each other. Sampling was performed using a 0.1 m² Van-Veen grab, with three replicates per station. Two replicates were used for the biological analysis of macrofauna, and one for the sediment analysis (one for the grain-size and an additional sample for the analysis of munition compounds). The samples for macrofauna analysis were sieved through 1-mm mesh size sieve and fixed with 4% formaldehyde buffered with hexamethylenetetramin (Fig. 5.4.2). Further in the laboratory all the macrobenthic taxa will be identified, calculated and weighted to collect raw data on the macrofauna. Samples for the sediment analysis were taken for further grain-size analysis and for the content of munition compounds. Specifically, a small amount of sediment (~200 g) was taken from each sediment grab, packed in zip-bags and frozen. The data on the grain size and the concentrations of munition compounds will be collected in the laboratory. The rest of the sediment from these samples was washed through the same 1 mm sieve and surveyed immediately after sampling under a stereo magnifier. All living macrofauna organisms were taken and frozen individually for further analysis of the munition compounds in tissue. The analysis will be provided by the Institute of Toxicology und Pharmacology in the University Clinic of Schleswig-Holstein. After processing the macrofauna samples we expect to understand, whether there are some regularity and/or gradient in the fauna distribution around the ship wrecks and dumpsites, which can be possibly related to the presence of the munition in the area and to the contamination by the trinitrotoluene and other munition compounds. Preliminary results show the patterns of the macrofauna distribution around the Vigo wreck site, typical for most of the large submerged artificial hard substrates with a gradual increase of abundance towards the shipwreck. At another wreck site of SMS Ariadne, investigated in one of the previous HEINCKE expeditions, the applied Random Forests algorithm resulted in

an overall decrease of the macrofauna abundance within <10 m from the shipwreck of SMS Ariadne, still containing several tons of explosives. Different abundance distribution around the SMS Ariadne and Vigo may suggest that the contamination of munition compounds around the Vigo is less severe than around the Ariadne.

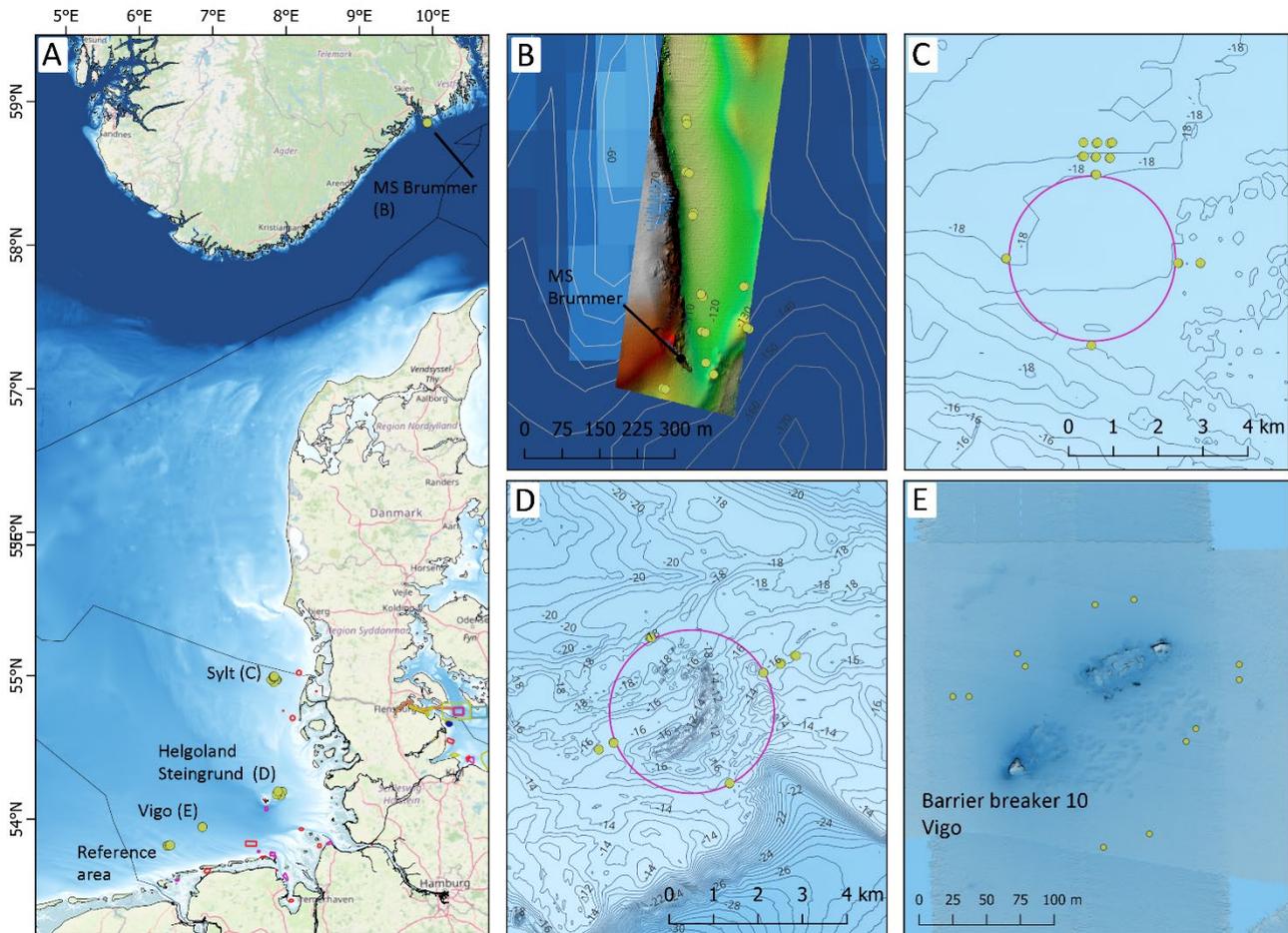


Fig. 5.4.1. Macrofauna samples taken during HE669 expedition. A – overview of the study area; B – enclosed sample locations at the MS Brummer wreck with the MBES bathymetry (provided by FFI); C – Sylt munition dumpsite and sample locations; D - Helgoland Steingrund dumpsite and sample locations; E – locations of Vigo wreck and samples.

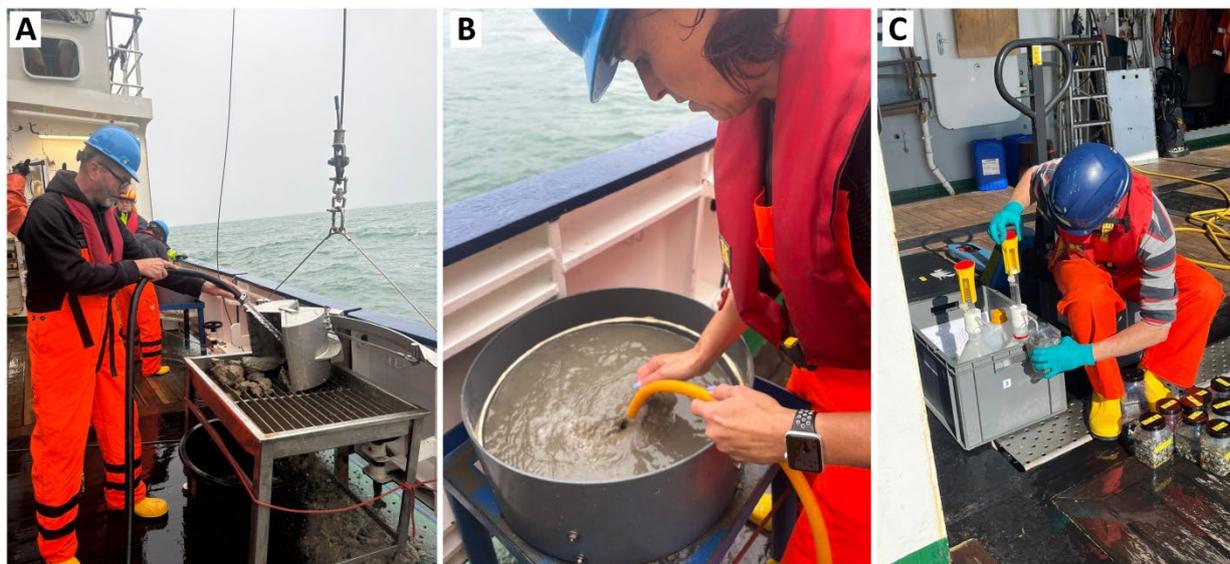


Fig. 5.4.2. Macrofauna sampling. A – washing the sediment sample out from the van-Veen grab; B – sieving through 1 mm mesh size; C – fixation process (Photo copyright R. Schuster and U. Marx/AWI).

6 Ship's Meteorological Station (*n.a.*)

7 Station List HE669

7.1 Overall Station List

RV HEINCKE	Device	Event Time	Event Comment	Action	Latitude	Longitude	Depth [m]
HE669_1-1	MB	28.09.2025 17:32		station start	58° 54' N	009° 55' E	
HE669_1-1	MB	28.09.2025 17:42		profile start	58° 55' N	009° 55' E	
HE669_1-1	MB	28.09.2025 19:47		profile end	58° 55' N	009° 54' E	
HE669_1-1	MB	28.09.2025 19:47		station end	58° 55' N	009° 54' E	
HE669_2-1	CTD	29.09.2025 06:14		station start	58° 55' N	009° 54' E	
HE669_2-1	CTD	29.09.2025 06:39		max depth/on ground	58° 55' N	009° 54' E	
HE669_2-2	CTD	29.09.2025 07:07		max depth/on ground	58° 55' N	009° 54' E	
HE669_2-3	CTD	29.09.2025 07:35		max depth/on ground	58° 55' N	009° 54' E	
HE669_2-3	CTD	29.09.2025 07:35		station end	58° 55' N	009° 54' E	
HE669_3-1	LANDER	29.09.2025 07:48		station start	58° 55' N	009° 54' E	
HE669_3-1	LANDER	29.09.2025 08:09		in the water	58° 55' N	009° 54' E	
HE669_3-1	LANDER	29.09.2025 08:19		max depth/on ground	58° 55' N	009° 54' E	
HE669_3-1	LANDER	29.09.2025 08:19		station end	58° 55' N	009° 54' E	
HE669_4-1	GRAB	29.09.2025 08:26		station start	58° 55.216' N	009° 54.831' E	113
HE669_4-1	GRAB	29.09.2025 08:29		max depth/on ground	58° 55.217' N	009° 54.835' E	113
HE669_4-1	GRAB	29.09.2025 08:41		max depth/on ground	58° 55.228' N	009° 54.823' E	116
HE669_4-1	GRAB	29.09.2025 08:49		max depth/on ground	58° 55.215' N	009° 54.839' E	114
HE669_4-2	GRAB	29.09.2025 10:32		max depth/on ground	58° 55.254' N	009° 54.811' E	111
HE669_4-2	GRAB	29.09.2025 10:40		max depth/on ground	58° 55.262' N	009° 54.815' E	114
HE669_4-2	GRAB	29.09.2025 10:48		max depth/on ground	58° 55.260' N	009° 54.823' E	121
HE669_4-3	GRAB	29.09.2025 11:05		max depth/on ground	58° 55.197' N	009° 54.748' E	107
HE669_4-3	GRAB	29.09.2025 11:13		max depth/on ground	58° 55.200' N	009° 54.732' E	104
HE669_4-3	GRAB	29.09.2025 11:20		max depth/on ground	58° 55.200' N	009° 54.738' E	106
HE669_4-4	GRAB	29.09.2025 11:49		max depth/on ground	58° 55.226' N	009° 54.893' E	121
HE669_4-5	GRAB	29.09.2025 12:12		max depth/on ground	58° 55.265' N	009° 54.912' E	104
HE669_4-5	GRAB	29.09.2025 12:21		max depth/on ground	58° 55.264' N	009° 54.914' E	105
HE669_4-5	GRAB	29.09.2025 12:27		max depth/on ground	58° 55.265' N	009° 54.909' E	104
HE669_4-6	GRAB	29.09.2025 12:41		max depth/on ground	58° 55.306' N	009° 54.904' E	115
HE669_4-6	GRAB	29.09.2025 12:48		max depth/on ground	58° 55.310' N	009° 54.907' E	114
HE669_4-6	GRAB	29.09.2025 12:57		max depth/on ground	58° 55.310' N	009° 54.904' E	115
HE669_4-7	GRAB	29.09.2025 13:11		max depth/on ground	58° 55.300' N	009° 54.812' E	113
HE669_4-7	GRAB	29.09.2025 13:20		max depth/on ground	58° 55.299' N	009° 54.819' E	125
HE669_4-7	GRAB	29.09.2025 13:28		max depth/on ground	58° 55.302' N	009° 54.815' E	117
HE669_4-8	GRAB	29.09.2025 13:41		max depth/on ground	58° 55.477' N	009° 54.786' E	122
HE669_4-8	GRAB	29.09.2025 13:51		max depth/on ground	58° 55.492' N	009° 54.789' E	120
HE669_4-8	GRAB	29.09.2025 13:59		max depth/on ground	58° 55.487' N	009° 54.790' E	127
HE669_4-9	GRAB	29.09.2025 14:09		max depth/on ground	58° 55.446' N	009° 54.789' E	118
HE669_4-9	GRAB	29.09.2025 14:18		max depth/on ground	58° 55.435' N	009° 54.786' E	120
HE669_4-9	GRAB	29.09.2025 14:30		max depth/on ground	58° 55.433' N	009° 54.794' E	124
HE669_4-10	GRAB	29.09.2025 14:40		max depth/on ground	58° 55.395' N	009° 54.798' E	120
HE669_4-10	GRAB	29.09.2025 14:48		max depth/on ground	58° 55.390' N	009° 54.802' E	124
HE669_4-10	GRAB	29.09.2025 14:55		max depth/on ground	58° 55.387' N	009° 54.800' E	122
HE669_4-10	GRAB	29.09.2025 14:58		station end	58° 55.390' N	009° 54.792' E	104
HE669_5-1	CTD	01.10.2025 05:43		station start	55° 01.869' N	007° 58.031' E	14
HE669_5-1	CTD	01.10.2025 05:51		max depth/on ground	55° 01.864' N	007° 58.042' E	15
HE669_5-2	CTD	01.10.2025 06:16		max depth/on ground	55° 02.876' N	007° 58.041' E	15
HE669_5-3	CTD	01.10.2025 06:48		max depth/on ground	55° 01.860' N	007° 56.217' E	15
HE669_5-4	CTD	01.10.2025 07:27		max depth/on ground	55° 01.822' N	008° 00.259' E	14
HE669_5-5	GRAB	01.10.2025 07:32		max depth/on ground	55° 01.812' N	008° 00.263' E	14
HE669_5-5	GRAB	01.10.2025 07:35		max depth/on ground	55° 01.814' N	008° 00.265' E	14
HE669_5-5	GRAB	01.10.2025 07:38		max depth/on ground	55° 01.816' N	008° 00.263' E	14
HE669_5-6	GRAB	01.10.2025 07:50		max depth/on ground	55° 01.809' N	007° 59.805' E	14
HE669_5-6	GRAB	01.10.2025 07:53		max depth/on ground	55° 01.810' N	007° 59.805' E	14
HE669_5-6	GRAB	01.10.2025 07:58		max depth/on ground	55° 01.811' N	007° 59.794' E	14
HE669_5-7	GRAB	01.10.2025 08:24		max depth/on ground	55° 00.800' N	007° 58.009' E	13
HE669_5-7	GRAB	01.10.2025 08:26		max depth/on ground	55° 00.790' N	007° 58.003' E	13
HE669_5-7	GRAB	01.10.2025 08:29		max depth/on ground	55° 00.789' N	007° 58.009' E	13
HE669_5-8	GRAB	01.10.2025 08:50		max depth/on ground	55° 01.833' N	007° 56.193' E	14
HE669_5-8	GRAB	01.10.2025 08:53		max depth/on ground	55° 01.836' N	007° 56.198' E	14
HE669_5-8	GRAB	01.10.2025 08:55		max depth/on ground	55° 01.837' N	007° 56.204' E	14

HE669_5-9	GRAB	01.10.2025 09:30		max depth/on ground	55° 02.870' N	007° 58.041' E	14
HE669_5-9	GRAB	01.10.2025 09:32		max depth/on ground	55° 02.868' N	007° 58.054' E	14
HE669_5-9	GRAB	01.10.2025 09:35		max depth/on ground	55° 02.869' N	007° 58.038' E	14
HE669_5-10	GRAB	01.10.2025 09:48		max depth/on ground	55° 03.070' N	007° 58.331' E	14
HE669_5-10	GRAB	01.10.2025 09:50		max depth/on ground	55° 03.072' N	007° 58.341' E	14
HE669_5-10	GRAB	01.10.2025 09:53		max depth/on ground	55° 03.074' N	007° 58.349' E	14
HE669_5-11	GRAB	01.10.2025 10:06		max depth/on ground	55° 03.079' N	007° 58.037' E	14
HE669_5-11	GRAB	01.10.2025 10:08		max depth/on ground	55° 03.080' N	007° 58.037' E	14
HE669_5-11	GRAB	01.10.2025 10:11		max depth/on ground	55° 03.082' N	007° 58.047' E	14
HE669_5-12	GRAB	01.10.2025 10:26		max depth/on ground	55° 03.086' N	007° 57.762' E	14
HE669_5-12	GRAB	01.10.2025 10:28		max depth/on ground	55° 03.087' N	007° 57.774' E	14
HE669_5-12	GRAB	01.10.2025 10:31		max depth/on ground	55° 03.087' N	007° 57.792' E	14
HE669_5-13	GRAB	01.10.2025 10:42		max depth/on ground	55° 03.256' N	007° 57.765' E	14
HE669_5-13	GRAB	01.10.2025 10:44		max depth/on ground	55° 03.254' N	007° 57.779' E	14
HE669_5-13	GRAB	01.10.2025 10:47		max depth/on ground	55° 03.249' N	007° 57.787' E	14
HE669_5-14	GRAB	01.10.2025 10:57		max depth/on ground	55° 03.245' N	007° 58.047' E	14
HE669_5-14	GRAB	01.10.2025 11:00		max depth/on ground	55° 03.250' N	007° 58.060' E	14
HE669_5-14	GRAB	01.10.2025 11:03		max depth/on ground	55° 03.254' N	007° 58.075' E	14
HE669_5-15	GRAB	01.10.2025 11:14		max depth/on ground	55° 03.250' N	007° 58.337' E	14
HE669_5-15	GRAB	01.10.2025 11:16		max depth/on ground	55° 03.258' N	007° 58.363' E	14
HE669_5-15	GRAB	01.10.2025 11:19		max depth/on ground	55° 03.258' N	007° 58.378' E	13
HE669_5-16	BT	01.10.2025 11:47		in the water	55° 03.838' N	008° 02.022' E	13
HE669_5-16	BT	01.10.2025 11:53		max depth/on ground	55° 03.620' N	008° 01.849' E	14
HE669_5-16	BT	01.10.2025 12:20		on deck	55° 02.571' N	008° 01.212' E	13
HE669_5-17	BT	01.10.2025 12:38		in the water	55° 02.717' N	008° 01.510' E	13
HE669_5-17	BT	01.10.2025 12:42		max depth/on ground	55° 02.553' N	008° 01.403' E	13
HE669_5-17	BT	01.10.2025 13:12		on deck	55° 01.385' N	008° 00.516' E	13
HE669_5-17	BT	01.10.2025 13:20		station end	55° 01.434' N	008° 00.394' E	13
HE669_6-1	CTD	02.10.2025 05:55		station start	54° 14.216' N	008° 03.123' E	13
HE669_6-1	CTD	02.10.2025 06:01		max depth/on ground	54° 14.215' N	008° 03.093' E	13
HE669_6-1	CTD	02.10.2025 06:26		max depth/on ground	54° 13.825' N	008° 01.578' E	13
HE669_6-1	CTD	02.10.2025 07:01		max depth/on ground	54° 14.696' N	008° 04.629' E	13
HE669_6-2	GRAB	02.10.2025 07:07		max depth/on ground	54° 14.688' N	008° 04.626' E	13
HE669_6-2	GRAB	02.10.2025 07:12		max depth/on ground	54° 14.688' N	008° 04.628' E	13
HE669_6-2	GRAB	02.10.2025 07:18		max depth/on ground	54° 14.687' N	008° 04.622' E	13
HE669_6-3	GRAB	02.10.2025 07:29		max depth/on ground	54° 14.805' N	008° 04.984' E	13
HE669_6-3	GRAB	02.10.2025 07:35		max depth/on ground	54° 14.797' N	008° 04.974' E	13
HE669_6-3	GRAB	02.10.2025 07:37		max depth/on ground	54° 14.796' N	008° 04.969' E	13
HE669_6-4	GRAB	02.10.2025 07:47		max depth/on ground	54° 14.903' N	008° 05.265' E	13
HE669_6-4	GRAB	02.10.2025 07:53		max depth/on ground	54° 14.902' N	008° 05.287' E	13
HE669_6-4	GRAB	02.10.2025 07:57		max depth/on ground	54° 14.902' N	008° 05.296' E	13
HE669_6-5	GRAB	02.10.2025 08:19		max depth/on ground	54° 13.328' N	008° 03.948' E	12
HE669_6-5	GRAB	02.10.2025 08:24		max depth/on ground	54° 13.330' N	008° 03.950' E	12
HE669_6-5	GRAB	02.10.2025 08:28		max depth/on ground	54° 13.332' N	008° 03.951' E	12
HE669_6-6	GRAB	02.10.2025 08:50		max depth/on ground	54° 13.812' N	008° 01.534' E	12
HE669_6-6	GRAB	02.10.2025 08:53		max depth/on ground	54° 13.801' N	008° 01.540' E	12
HE669_6-6	GRAB	02.10.2025 08:56		max depth/on ground	54° 13.804' N	008° 01.542' E	12
HE669_6-7	GRAB	02.10.2025 09:30		max depth/on ground	54° 13.722' N	008° 01.233' E	12
HE669_6-7	GRAB	02.10.2025 09:33		max depth/on ground	54° 13.722' N	008° 01.232' E	12
HE669_6-7	GRAB	02.10.2025 09:37		max depth/on ground	54° 13.722' N	008° 01.234' E	12
HE669_6-8	GRAB	02.10.2025 10:15		max depth/on ground	54° 15.098' N	008° 02.259' E	14
HE669_6-8	GRAB	02.10.2025 10:17		max depth/on ground	54° 15.102' N	008° 02.274' E	14
HE669_6-8	GRAB	02.10.2025 10:19		max depth/on ground	54° 15.098' N	008° 02.288' E	14
HE669_6-9	BT	02.10.2025 11:24		in the water	54° 15.609' N	008° 01.409' E	15
HE669_6-9	BT	02.10.2025 11:31		max depth/on ground	54° 15.579' N	008° 01.820' E	15
HE669_6-9	BT	02.10.2025 12:02		on deck	54° 15.766' N	008° 03.754' E	13
HE669_6-10	BT	02.10.2025 12:17		in the water	54° 15.568' N	008° 04.131' E	13
HE669_6-10	BT	02.10.2025 12:22		max depth/on ground	54° 15.532' N	008° 04.504' E	13
HE669_6-10	BT	02.10.2025 12:53		on deck	54° 15.692' N	008° 06.458' E	13
HE669_6-10	BT	02.10.2025 12:58		station end	54° 15.675' N	008° 06.510' E	13
HE669_7-1	MB	06.10.2025 05:30		station start	58° 55' N	009° 54' E	
HE669_7-1	MB	06.10.2025 06:11		station end	58° 55' N	009° 54' E	
HE669_7-2	LANDER	06.10.2025 06:14	Ausgelöst 1	information	58° 55' N	009° 54' E	
HE669_7-2	LANDER	06.10.2025 06:39		hoisting	58° 55' N	009° 54' E	
HE669_7-2	LANDER	06.10.2025 06:48		on deck	58° 55' N	009° 54' E	
HE669_7-2	LANDER	06.10.2025 07:05		station end	58° 55' N	009° 54' E	

HE669_8-1	CTD	08.10.2025 05:26		station start	53° 51.438' N	006° 46.649' E	22
HE669_8-1	CTD	08.10.2025 05:37		max depth/on ground	53° 51.446' N	006° 46.608' E	21
HE669_8-2	CTD	08.10.2025 05:57		max depth/on ground	53° 51.316' N	006° 45.739' E	22
HE669_8-3	CTD	08.10.2025 06:16		max depth/on ground	53° 51.168' N	006° 44.788' E	24
HE669_8-4	GRAB	08.10.2025 06:28		max depth/on ground	53° 51.157' N	006° 44.760' E	24
HE669_8-4	GRAB	08.10.2025 06:32		max depth/on ground	53° 51.158' N	006° 44.765' E	23
HE669_8-4	GRAB	08.10.2025 06:36		max depth/on ground	53° 51.154' N	006° 44.753' E	24
HE669_8-5	GRAB	08.10.2025 06:50		max depth/on ground	53° 51.320' N	006° 45.781' E	23
HE669_8-5	GRAB	08.10.2025 06:53		max depth/on ground	53° 51.322' N	006° 45.765' E	23
HE669_8-5	GRAB	08.10.2025 06:57		max depth/on ground	53° 51.318' N	006° 45.757' E	23
HE669_8-6	GRAB	08.10.2025 07:10		max depth/on ground	53° 51.460' N	006° 46.839' E	23
HE669_8-6	GRAB	08.10.2025 07:13		max depth/on ground	53° 51.458' N	006° 46.827' E	23
HE669_8-6	GRAB	08.10.2025 07:18		max depth/on ground	53° 51.463' N	006° 46.814' E	23
HE669_8-7	BT	08.10.2025 07:31		in the water	53° 51.510' N	006° 46.445' E	23
HE669_8-7	BT	08.10.2025 07:38		profile start	53° 51.495' N	006° 46.061' E	24
HE669_8-7	BT	08.10.2025 08:10		profile end	53° 51.267' N	006° 44.125' E	23
HE669_8-8	BT	08.10.2025 08:25		in the water	53° 51.467' N	006° 46.556' E	23
HE669_8-8	BT	08.10.2025 08:31		profile start	53° 51.449' N	006° 46.141' E	24
HE669_8-8	BT	08.10.2025 08:51		profile end	53° 51.278' N	006° 44.703' E	24
HE669_8-8	BT	08.10.2025 09:01		on deck	53° 51.189' N	006° 44.368' E	24
HE669_8-9	BT	08.10.2025 09:36		in the water	53° 51.455' N	006° 46.618' E	23
HE669_8-9	BT	08.10.2025 09:43		profile start	53° 51.404' N	006° 46.173' E	25
HE669_8-9	BT	08.10.2025 10:13		profile end	53° 51.135' N	006° 44.170' E	24
HE669_8-9	BT	08.10.2025 10:25		on deck	53° 51.005' N	006° 43.692' E	23
HE669_8-9	BT	08.10.2025 10:40		station end	53° 50.983' N	006° 43.428' E	23
HE669_9-1	MB	08.10.2025 14:30		station start	53° 59' N	007° 08.867' E	25
HE669_9-1	MB	08.10.2025 14:32		profile start	53° 59' N	007° 09.138' E	25
HE669_9-1	MB	08.10.2025 15:25		profile end	53° 59' N	007° 09.086' E	24
HE669_9-2	CTD	08.10.2025 15:48		in the water	53° 59' N	007° 09.143' E	26
HE669_9-2	CTD	08.10.2025 15:52		max depth/on ground	53° 59' N	007° 09.137' E	26
HE669_9-3	CTD	08.10.2025 16:07		in the water	53° 59' N	007° 09.079' E	25
HE669_9-3	CTD	08.10.2025 16:09		max depth/on ground	53° 59' N	007° 09.068' E	26
HE669_9-4	CTD	08.10.2025 16:23		in the water	53° 59' N	007° 09.022' E	25
HE669_9-4	CTD	08.10.2025 16:28		max depth/on ground	53° 59' N	007° 09.005' E	25
HE669_9-1	MB	08.10.2025 16:50	Profil fortgesetzt	profile start	53° 59' N	007° 09.081' E	24
HE669_9-1	MB	08.10.2025 17:45		profile end	53° 5' N	007° 09.493' E	24
HE669_9-5	GRAB	09.10.2025 04:55		max depth/on ground	53° 59.534' N	007° 09.044' E	25
HE669_9-5	GRAB	09.10.2025 04:59		max depth/on ground	53° 59.534' N	007° 09.032' E	25
HE669_9-5	GRAB	09.10.2025 05:03		max depth/on ground	53° 59.534' N	007° 09.032' E	25
HE669_9-6	GRAB	09.10.2025 05:09		max depth/on ground	53° 59.554' N	007° 09.082' E	25
HE669_9-6	GRAB	09.10.2025 05:12		max depth/on ground	53° 59.552' N	007° 09.082' E	25
HE669_9-6	GRAB	09.10.2025 05:17		max depth/on ground	53° 59.548' N	007° 09.088' E	25
HE669_9-7	GRAB	09.10.2025 05:25		max depth/on ground	53° 59.577' N	007° 09.143' E	25
HE669_9-7	GRAB	09.10.2025 05:29		max depth/on ground	53° 59.577' N	007° 09.161' E	26
HE669_9-7	GRAB	09.10.2025 05:33		max depth/on ground	53° 59.579' N	007° 09.174' E	25
HE669_9-8	GRAB	09.10.2025 05:43		max depth/on ground	53° 59.549' N	007° 09.256' E	25
HE669_9-8	GRAB	09.10.2025 05:46		max depth/on ground	53° 59.551' N	007° 09.262' E	25
HE669_9-8	GRAB	09.10.2025 05:51		max depth/on ground	53° 59.542' N	007° 09.256' E	25
HE669_9-9	GRAB	09.10.2025 05:56		max depth/on ground	53° 59.519' N	007° 09.222' E	25
HE669_9-9	GRAB	09.10.2025 06:00		max depth/on ground	53° 59.512' N	007° 09.218' E	25
HE669_9-9	GRAB	09.10.2025 06:04		max depth/on ground	53° 59.513' N	007° 09.215' E	26
HE669_9-10	GRAB	09.10.2025 06:14		max depth/on ground	53° 59.464' N	007° 09.150' E	25
HE669_9-10	GRAB	09.10.2025 06:17		max depth/on ground	53° 59.464' N	007° 09.162' E	24
HE669_9-10	GRAB	09.10.2025 06:22		max depth/on ground	53° 59.470' N	007° 09.186' E	25
HE669_9-11	BT	09.10.2025 06:38		in the water	53° 59.141' N	007° 08.037' E	24
HE669_9-11	BT	09.10.2025 06:44		profile start	53° 59.353' N	007° 08.412' E	25
HE669_9-11	BT	09.10.2025 07:05		profile end	53° 59.839' N	007° 09.688' E	25
HE669_9-11	BT	09.10.2025 07:15		on deck	54° 00.005' N	007° 10.244' E	25
HE669_9-12	BT	09.10.2025 07:30		in the water	53° 59.905' N	007° 10.404' E	26
HE669_9-12	BT	09.10.2025 07:34		profile start	53° 59.809' N	007° 10.212' E	26
HE669_9-12	BT	09.10.2025 07:58		profile end	53° 59.288' N	007° 08.823' E	25
HE669_9-12	BT	09.10.2025 08:07		on deck	53° 59.187' N	007° 08.571' E	26
HE669_9-12	BT	09.10.2025 08:20		station end	53° 59.295' N	007° 09.331' E	25

*exact wreck positions are confidential. Resolution of wreck stations is therefore reduced.

Legend: CTD = water rosette + CTD, GRAB= Van Veen Grabber, BT = bottom trawl, MB = multibeam echosounder, LANDER = Lander/Platform)

8 Data and Sample Storage and Availability

Event list (<https://www.pangaea.de/expeditions/events/HE669>) and CTD data (<https://doi.pangaea.de/10.1594/PANGAEA.966440>) are available via PANGAEA. All other data and samples obtained from the cruise will be processed and subsequently published on the data portal PANGAEA within two years after the end of the cruise at the latest. We will pay attention to the fact that third party rights do not conflict with publication. Subsequently to publishing in PANGAEA the data may be marked with a blocking notice for two more years. Thereafter the data will be at the disposal for the scientific public for citation.

Table 8.1 Overview of Data Availability

Type	Database	Available	Free Access	Contact
Hydrographic data (CTD)	PANGAEA			sandra.tippenhauer@awi.de
Zoobenthos community		Apr 26	Dec 26	andrey.vedenin@senckenberg.de
Microbial data		Apr 26	Dec 26	wyna.schutte@vliz.be
Chemical Analysis water, sediment & biota		Apr 26	upon request	maser@toxi.uni-kiel.de
MBES data MS Brummer		Apr. 26	upon request	John-Aa.Tornes@ffi.no

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