Cruise report

R.V. Pelagia cruise 64PE340

North Sea Monitoring

Texel - Texel, 17 June - 4 July 2011

Henk de Haas
and shipboard scientific crew

Royal Netherlands Institute for Sea Research

Sources of cover images:

Fish:
www.natuurinformatie.nl

Viruses:
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Zooplankton:
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Phytoplankton:
www.wikipedia.org

Gas seep:
Henk de Haas/NIOZ

Bathymetric data:
IOC, IHO, and BODC, 2003 , "Centenary Edition of the GEBCO Digital Atlas", published on CDROM on behalf of the Intergovernmental Oceanographic Commission and the International Hydrographic Organization as part of the General Bathymetric Chart of the Oceans; British Oceanographic Data Centre, Liverpool.

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NIOZ Royal Netherlands Institute for Sea Research

Contents

Introduction

NIOZ has a long lasting tradition in North Sea research, whereby always monitoring surveys have been embedded and combined with innovative research. During the past few years however, no monitoring surveys have been carried out in the North Sea by NIOZ, and therefore it has become hard for NIOZ to remain leading on North Sea matters and to advise colleagues at other institutes, government agencies and industry on North Sea matters. Because of this NIOZ has decided to start with a program of annual North Sea monitoring surveys by RV Pelagia which will revitalise and strengthen the involvement of NIOZ with North Sea matters.
Since in the shallow North Sea processes in the sediment, in the water column and on the sea-atmosphere interface influence each other, the monitoring surveys should have, by definition, a multi-disciplinary character. The additional use of automatically operating sensor systems, like the multibeam echosounder, the online hydrographic sensors, and the landers will enhance the possibilities to carry out a substantial amount of work in a reasonable amount of time. The cruises will not only be used as monitoring surveys, but also for initiating innovative research and test new technical equipment/developments.

Three NIOZ departments participated in the 2011 NIOZ North Sea Monitoring cruise. These departments are the departments of Marine Ecology (MEE), Biological Oceanography (BIO) and Marine Geology (GEO).
During this first NIOZ North Sea Monitoring cruise the participants of the above mentioned departments not only aimed to perform a set of well planned measurements on pre-decided locations, but also used this cruise to look for possibilities to perform interdisciplinary studies in the future within this program.

Cruise plan

Geological monitoring (GEO)

The main geological topic of this cruise is the seepage of methane from the sea bed. Methane is a strong greenhouse gas (23x more effective in trapping of heat than carbondioxide). At present very little is known about the amount of methane reaching the atmosphere through marine seeps, and thus about the role of this gas in the global atmospheric heat flux. The shallow water depth in the North Sea allows methane to be transported from the sea bed into the atmosphere via bubbles or as dissolved gas phase. Methane seepage from the sea bed of the North Sea has been reported from several (for instance Judd et al. (1997) for the UK sector of the North Sea and Schroot et al. (2005) for the Dutch sector). The shallow water depth allows methane to be transported into the atmosphere via bubbles or as dissolved gas phase. The above mentioned sites show strong differences in methane fluxes, bubble size changes and area/spatial dimensions on the seafloor regarding seep indications (bacteria, bubble vents, carbonates, clams). Water samples from CTD casts will be analyzed for their methane (and higher hydrocarbon) concentrations and isotopic signatures. Hydroacoustic investigations of the water column and sea bed (Kongsberg EM302 multibeam and EK500 fisheries echo sounders) and sea bed high definition video surveys can be used to target bubble release areas to map the extent of the active seep area and investigate changes over the years, seasonal variability, and tide-related changes. At the same time, hydroacoustics (single and multibeam echo sounding) might allow to pick up internal waves/the thermocline and thus are an ideal tool to interpolate between different CTD stations and define those sections of the CTD transect that need to be sampled in higher resolution. Bubble sampling at the sea surface (planned for future cruises) will help to determine how much methane is dissolved and replaced by stripped gases from the water column (an important piece of information to evaluate the efficiency of methane bubble transport). Box- and gravity core transects are planned to gain insight into possible changes in sediment distribution at seep sites and to look for possible changes in chemistry (possibly related to microbial activity). During the first year it is planned to survey the main target areas also by GI-gun seismic and ORETech 3010 3.5 kHz sub-bottom profiler to acquire a thorough knowledge on the subsurface structures on local scale.

The aim of the present cruise is to re-visit the areas described by Schroot et al. (2005, blocks A11, B13 and F6) and find suitable sites for further detailed studies. In a later stage more detailed monitoring will be carried out, also including the use of one or more landers.

Biological monitoring (BIO)

The aim is to study phytoplankton production and loss by grazing and viral lysis, comparison of primary and secondary production, phytoplankton composition and zooplankton biomass. This will be done at 9 main stations of which 3 are in UK-territory. These stations are part of already existing and past projects. Re-visiting these stations will allow for better production and loss estimates on longer time scales and thus fits very well in the main goal of this current program, which is monitoring.
Samples will be taken using a CTD rosette sampler and vertical nets. On board analysis will be carried out using a flow cytometer container placed in a thermo containers that can be set at in situ temperature. Growth experiments will be carried out in an incubator, placed on deck.
Because light conditions play an important role in algal growth, the sampling has to be done during a strict schedule:

- CTD at 06.30 AM
- CTD at 8 AM
- Vertical nets 4x at 9 AM
- CTD at 3.30 PM
- CTD around 9 PM,
- followed by vertical nets

The complete list of variables that will be analysed:
Inorganic nutrient concentrations
Primary production (radioisotope 14C)
Pigment composition phytoplankton – HPLC
Phytoplankton abundance – FCM
Phytoplankton composition by light microscopy
Phytoplankton photosynthetic capacity - PAM
Phytoplankton grazing by mesozooplankton
Phytoplankton grazing by microzooplankton
Phytoplankton viral lysis rates
Phytoplankton sinking rates
Bacterial and viral abundances - FCM
Microzooplankton composition - microscopy
mesozooplankton biomass and composition
mesozooplankton secondary production by chitobiase assay

Biological monitoring (MEE)

In accordance with European agreements, several areas in the Dutch Sector of the North Sea will be designated as NATURA2000 areas. The objective of NATURA2000 is '...to maintain and if necessary to restore a favourable conservation status for all naturally occurring species and habitats by establishing special protection for those natural habitats and wild flora and fauna...' The areas selected as NATURA2000 include several that are characterized by a rich and/or diverse benthic fauna and which have been subject of physical, biological, and chemical studies by NIOZ in past years.

Protection of the NATURA2000 areas in the North Sea so far is limited to regulation of new activities. The future of established bottom fishery is presently a point of discussion. Especially the Frisian Front forms an area where interests of the fishing industry and NATURA 2000 conflict.
Concurrently with changes in protection level of parts of the North Sea, ecosystems changes have been observed that seem to be linked to the rising trend in water temperature. Changes include shifts in the distribution of resident species, occurrence of new species, and the performance of species (Portner et al., 2001; Perry et al., 2005; Dulvy ea 2008; Neumann ea 2009; Kirby ea 2008; Lindley & Kirby 2010). The warming trend is most prominent in the southern North Sea including coastal waters (van Aken 2008) which are important areas for commercial fisheries. The rising temperature however also impacts the deeper stratified Oystergrounds especially the oxygen dynamics near the bottom (Greenwood ea 2010) with potential consequences for bottom dwelling fauna especially fish which are most sensitive tot hypoxia. Continuation of the warming trend will undoubtedly lead to more intense perturbations.

In the light of the changes described above, the following activities are planned:

- monitor developments of biodiversity and ecosystem services (biomass) in NATURA2000 and selected sensitive areas. For this purpose, samples of the macro - and megafaunal invertebrates and fish will be collected. Further, video records of the seabed will be made with a hopper camera to study small scale features (stones, gravel - Klaverbank), topography (ripples, burrows etc) and fauna-seabed interactions. To upscale this information, video data will be collated with seismic data (multibeam, sidescan) to arrive at habitat maps (cooperation with dept. GEO)
  In 2011 a pilot quasi-synoptic survey will be organized whereby all areas of interest will be visited. In following years we propose to focus on the individual areas with each year a different area. During these cruises there will be more time for detailed fauna surveys and process studies.
- Monitor changes in the T, O_2 and other physico-chemical parameters in sensitive areas by means of permanent moorings. Target locations for these activities are: 1) stratified Oystergrounds where both CEFAS and NIOZ have deployed long-term moorings in the past (e.g. BSIK programme).
  2) the Dutch coast which is important from economic and ecological perspective. NIOZ has operated mooring in the coastal zone since 2007 in the nearshore OWEZ and Egmond aan Zee. Other process- oriented ecological and physical studies can be easily tied in to these moorings.

The present cruise is also used to replace a mooring at the above mentioned Egmond aan Zee monitoring site. In addition some boxcores will be taken at this site.

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Methods and initial results

Phytoplankton Viral Lysis and Zooplankton Grazing Rates
(Paul O'Connor, Anna Noordeloos)

A modification of the original dilution assay (Landry & Hassett 1982) was used to calculate virally mediated mortality rates and microzooplankton grazing rates simultaneously in this transect study in the North Sea. Sample collection was conducted from 7m, every day, and the chlorophyll maximum, where present, using 12 l (L) Niskin bottles mounted on the Rosette sampler. Seawater sampling was carried out at the same time of day (5.30, 6.30 and 8.00 am) throughout the cruise because of the synchronicity of phytoplankton cell division and potential diel effects on viral infection processes.
The seawater was gently collected, using silicon tubing, into clean (acid-washed) polycarbonate carboys (Fig. 1). The carboys were wrapped in grey plastic to protect the phytoplankton communities within the seawater sample from excessive light (light-shock). Samples were gravity filtered through a 0.45 µm filter (Sartopore 2 300) to create the grazer-free fraction and passed through a 30 kDa tangential flow filtration system (Sartorious Vivaflow 200) to create the virus-free diluent. These 0.45 µm and 30 kDa diluents were then poured into 1 l polycarbonate bottles in the appropriate volumes, before whole water was gently added to create the parallel t_0 dilution series, i.e. 20, 40, 70 and 100% whole water at the beginning of the experiment (t_0). From each t_0 bottle, a sample was taken for determination of phytoplankton composition and abundance, before being placed randomly into an incubator to match *in situ* sampling conditions. Final time point samples were also taken from every bottle after 24 h (t_{24}) at the end of the experimental period.

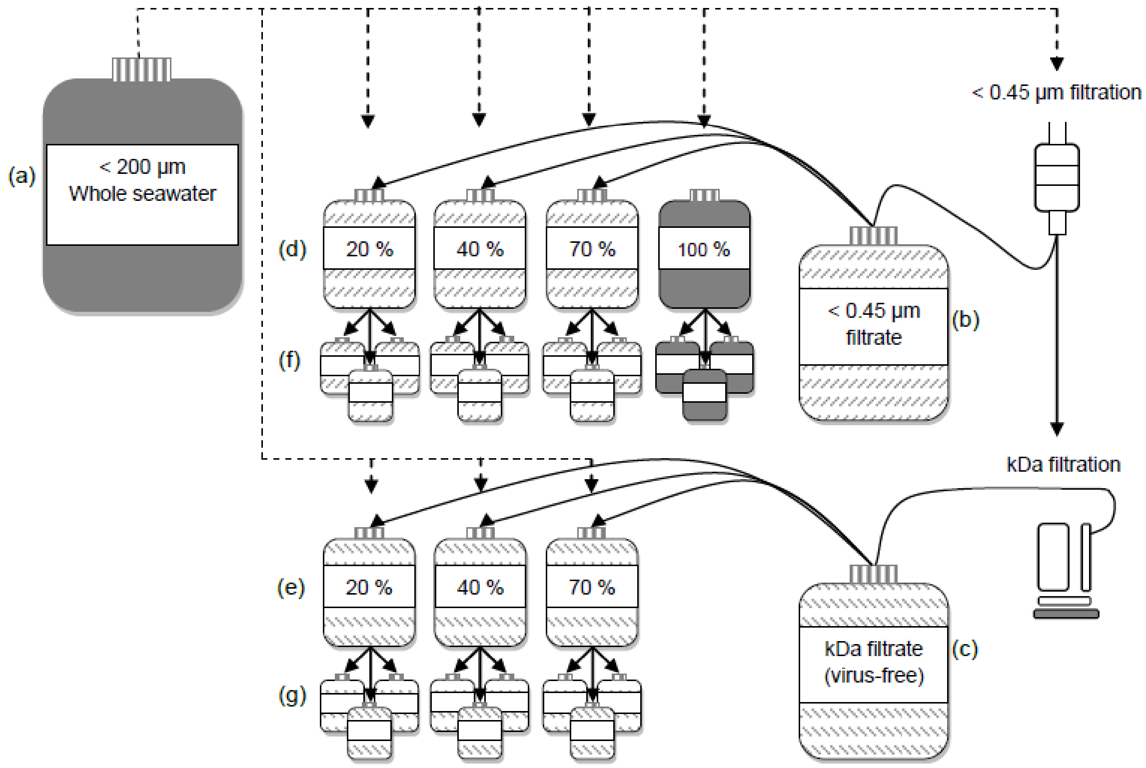

Fig. 1. Experimental design of the modified dilution approach. Mesoplankton-free whole seawater (a) was combined with either < 0.45 µm filtrate (b) or 30 kDa filtrate (c) in the correct proportions to create the parallel *to* dilution series: < 0.45 µm series, with reduced grazing mortality (d) kDa series, with reduced grazing and viral mortality (e). Replicate sample bottles from the < 0.45 µm and kDa dilution series were then created (f and g) and incubated under experimental conditions.

Enumeration of phytoplankton cells was performed with a bench top flow cytometer (Becton Dickinson FACSCalibur) equipped with a 15mW Argon laser (488nm excitation), which has an emission in the green, orange and red light spectrum. For photosynthetic-cell enumeration, samples were run for 15, 10, 10 and 5 minutes for each of the three replicates for the 20, 40, 70 and 100% dilutions respectively. Specific phytoplankton groups were discriminated by differences in side scatter and red/orange fluorescence. Flow rates of the flow cytometer were calibrated daily to maintain quality control.

What can be observed is that the growth rate is low when both the grazers and viruses are present i.e. in the 100% seawater bottles. However, when the mortality agents are removed, the growth rates increase sequentially in the 70, 40 and 20% seawater bottles (Fig. 2). This provides us with both a grazing and a viral lysis rate of the phytoplankton at each of the stations.

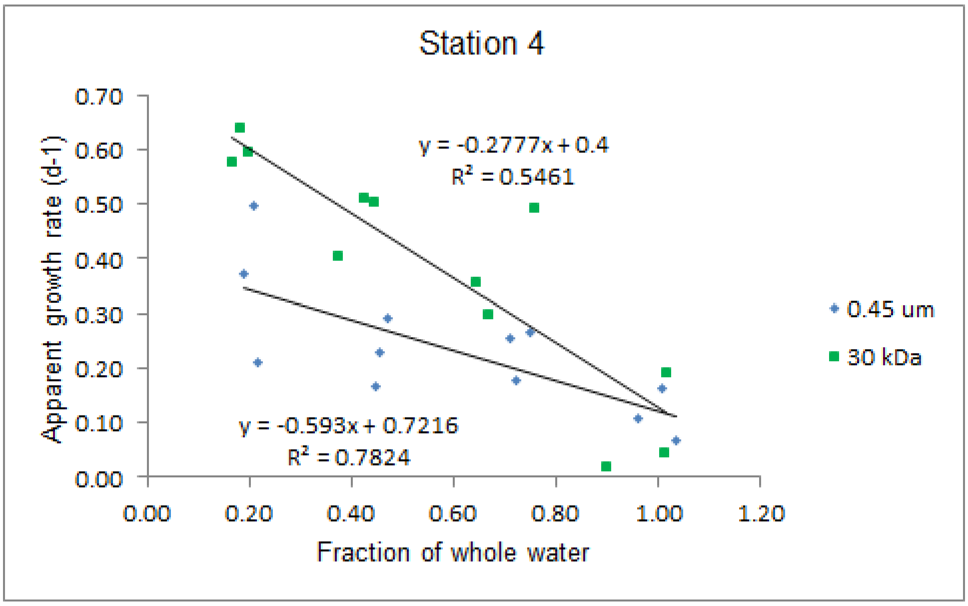

Fig.2. Plots of apparrent growth rate (d⁻¹) versus fraction of whole water in the parrallel dilition experiments.

Reference

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Phytoplankton Sinking Rates
(Paul O'Connor, Anna Noordeloos)

The sinking rates of phytoplankton were determined at several main stations over the course of the cruise. Sinking rates were permitted by the use of specially designed ship-board SETCOL devices, wherein a settling column is held in a 2-dimensional gimbal apparatus which eliminates the turbulence induced by the ship's roll. The column is gently filled with a homogeneous seawater sample and allowed to settle undisturbed for a set period of time under in-situ light and temperature conditions. A control consisting of a 1 L clear plastic Nalgene bottle was also filled and incubated under in-situ conditions for the duration of settlement. A 1 L sample was also filtered onto a GF/F filter for HPLC analysis (storage of filters at -80 degrees Celsius until analysis in the NIOZ home lab). A 2 ml sample was also analyzed for flow cyometric analysis of phytoplankton. After settling, the upper portion of the column is slowly sampled by opening a valve located on the side of the column. The middle fraction is then drained and the remaining bottom fraction sampled via a valve located on the bottom of the column. Two millilitre subsamples of both the bottom fraction and the control were taken for flow cytometric analysis of phytoplankton and the remaining volume was filtered onto a GF/F filter for HPLC analysis.

Methane survey
(Henk de Haas, Peter Urban)

Although initially it was planned to visit three known seep sites, located in off-shore blocks A11, B13 and F6, time permitted only to visit sites A11 and B13. In both areas a multibeam survey was carried out using the EM302 multibeam echo sounder installed onboard R.V. Pelagia. Not only the bathymetry and sea bed back scatter signal was recorded, but also the water column reflections of the sound signal were logged. Because of the strong density difference between gas and water, methane (and other gas) bubbles in the water column are extremely strong reflectors and can easily be picked up by the EM302. At the same time the Kongsberg EK500 fisheries echo sounder was recording data of water column reflectors at three different frequencies (38, 120 and 200 kHz) simultaneously. The planned 3.5 kHz survey was not carried out, since the ringing of the transducers appeared to be too long for the shallow water depths at this part of the North Sea (in the order of 40 metres). The ringing in combination with the multiples blurred the entire image.
At the site in block A11 no gas was detected in the water column and it was decided not to continue the investigations in the area. Instead focus was concentrated on the site in block B13. Here gas was found bubbling from the sea bed and rising upwards through the water column. Not only on the acoustic images (Figs. 3 and 4) but also on high definition towed video recordings (Fig. 5). The video also showed the presence of bacterial mats around seeps, suggesting indeed the leakage of hydrocarbons at these sites (Fig. 6).

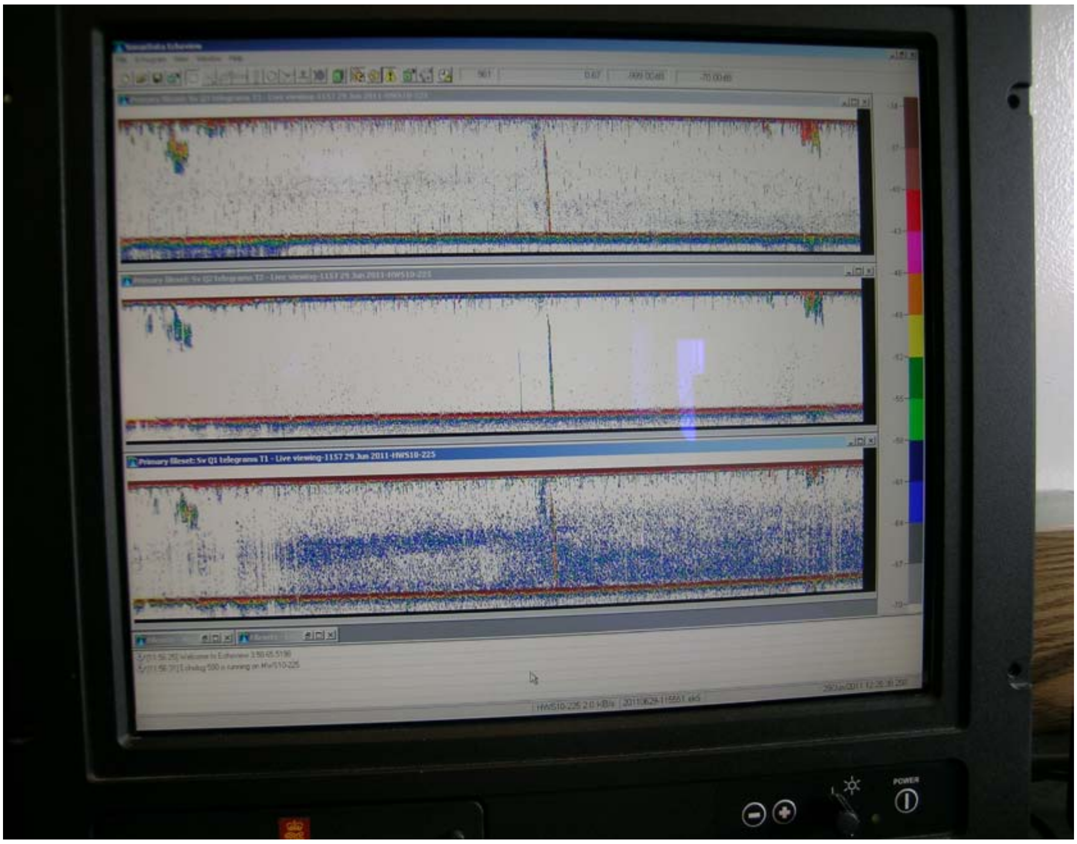


Fig. 3. Photograph of the online data of the EK500. The 3 windows show the results of the 38, 120 and 200 kHz signal respectively (top to bottom). The two spikes in the middle represent gas bubbles. Blobs in the upper left and right corners are probably fish. Blue clouds on the 200 kHz image could be plankton.

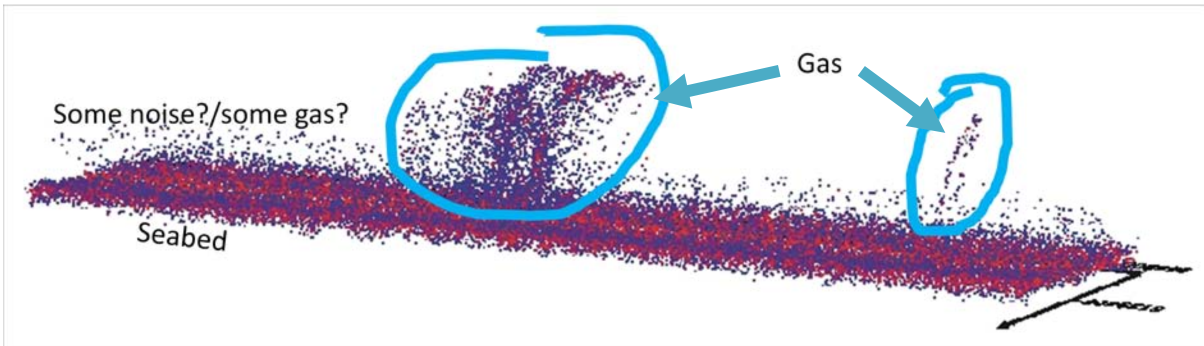


Fig. 4. Example of EM302 multibeam water column backscatter data in the B13 area.

A set of 8 seismic lines (GI-gun, 6 channel streamer, 100 bar pressure, shot interval 10.5 m) was recorded to image the deeper geological structure of the seep site.
A planned transect of gravity cores could not be completed. The sediments turned out to be too sandy and too hard to perform gravity coring. Instead a series of box cores was taken to get an impression on the type of sediments and variability therein going from the centre of the site outwards. A quick on board analysis of these surface sediments suggests there is a relationship between the distance to the centre of the seep site and the type of fauna (more species and more individuals further away from the seep). This might be a good location for a future combined geological/benthic biological monitoring activity.

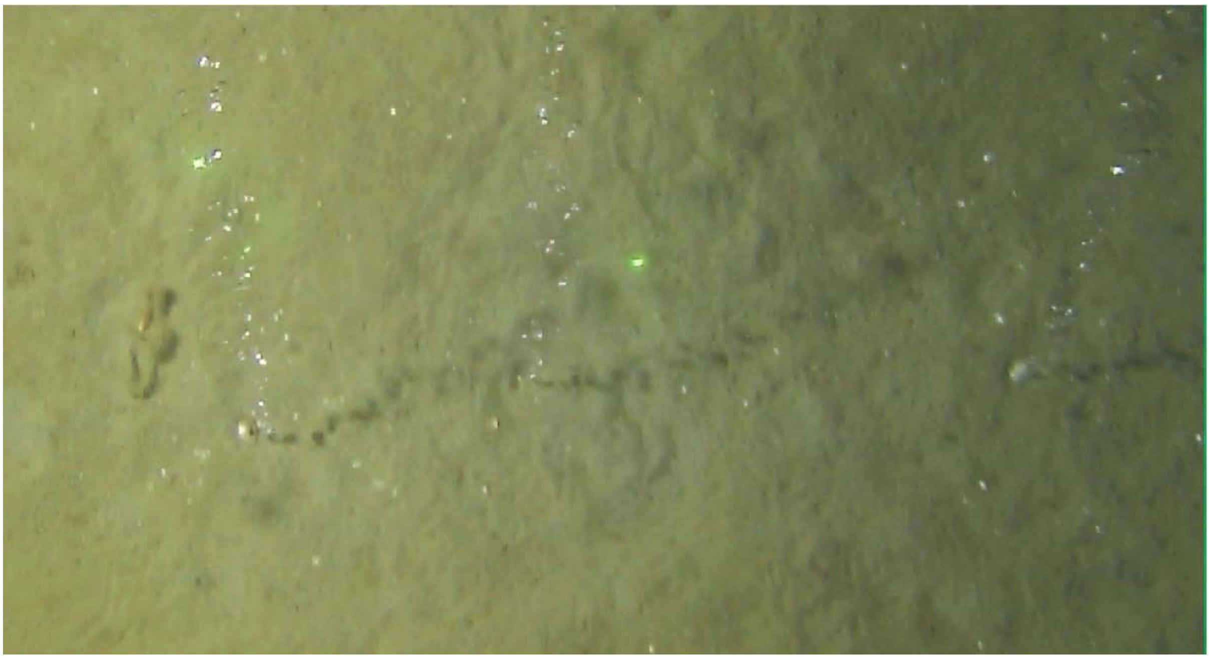


Fig.5. Still of the high definition video survey showing methane seeping from the sea bed.

Finally a set of CTDs was taken forming a transect across the seep site. Water was sampled at the sea bed, just below and just above the temperature transition zone and just below the water surface. The water was sampled for methane and other hydrocarbon gas analysis by means of gas chromatography.
The gas chromatograph (GC) used was a Thermo Scientific FOCUS GC run with direct injection. Hydrogen was used as carrier gas as well as zero air and zero N2 to run the FID (N2 was the mask-gas which helps to keep the flame stable). The injector temperature was set to 150°C and the septum was constantly purged to avoid bleeding of septum into the column flow. FID temperature was set to 170 °C and the oven

temperature was ramped from 40 °C to 120 °C with the following ramping intervals: 40°C for 4min, ramping to 70°C (15°C/min), 70°C for 3 min, ramping to 100°C (15°C/min), 100°C for 3 min, ramping to 120 °C (20°C/min), 120°C for 5 min.

Fig.6. Still of the high definition video survey showing bacterial mats around seep holes at the sea bed.

The flow through the column (RESTECK Packed Column HS-Q 80/100, 2 m length 2 mm inner diameter) was set to constant pressure of 40 kP and the entire injection was run in a split-less mode. The software used for recording the data and integration was Chrome Card 6.01.

Glass bottles (118.4 ml volume) were completely filled with sample fluid carefully avoiding any air inclusion and bubbling of the water (put the tubing at the very bottom of the bottle and fill it slowly from bottom to top, let sufficient water run through and pull out the tube slowly). The water was poisoned with 50 µl of super saturated HgCl solution immediately after the sample was taken and closed with a butyl rubber stopper crimp seal. The bottles were stored at 4 °C before emplacement of a 5 ml Argon headspace. For this a silicon tube with needle was attached to the Ar gas bottle pressure regulator and adjusted to a little bit of overpressure relative to the ambient pressure (just enough to create slow bubbling in a water filled beaker). This needle is pierced into the headspace vial and 5 ml of water are taken out from the headspace vial with a syringe finally introducing the gas headspace. The headspace volume of 5 ml has been chosen as it gives quite high absolute ppm concentrations which increase the detection limit; it allows for repeated measurements of the same sample if an error occurred during the GC analyses; it allows easy handling with extracting the gas volume for the GC analyses and it extracts about 65% of the methane from the water already.

Before analysis the samples were warmed to ambient laboratory temperature (~28°C) and shaken for two hours. Analyses of 0.5 ml headspace (or 1 ml in the lowest concentration range) were undertaken with the GC.
The actual methane contents still have to be calculated at the time of writing this report.

Benthic biology survey
(Marc Lavaleye, Magda Bergman, Gerard Duineveld)

The benthic biological activities during this cruise started with a day dedicated to the coastal monitoring site located near the village of Egmond aan Zee, along the Dutch coast. The activities at this site are not related to the North Monitoring Program, but had to be included because the original ship chartered for the Egmond aan Zee project could not sail because of technical problems. At this location a benthic lander had to be recovered and replaced by another one and a set of box cores had to be taken.
During the remainder of the cruise numerous high definition video surveys (hopper camera), deep digging (sample opening 20x20 cm, mesh 5x5 mm) and triangular (3x 1 m, 2x2 cm mesh) dredge hauls and beam trawl (3.2 m wide, mesh 5x5 mm) hauls and box core sampling activities were carried out at various stations throughout the Dutch sector of the North Sea. These stations were located in areas representing specific habitats defined by the local type of sediment and/or oceanographic conditions: Frisian Front, Oystergrounds, Cleaver Bank and Dogger Bank.
All material sampled by the box core deployments, and dredge and beam trawl hauls were either directly sorted, or (in case of a very large catch) subsampled and sorted. Because of the large number of samples no results suitable for publication in this report are available at the moment this cruise report is written.

Fig. 7. Hauling in the deep digging dredge...........

......and sorting the catch

Primary production, secondary production, meso zooplankton biomass, meso zooplankton grazing rates and HPLC pigment sampling
(Swier Oosterhuis)

Primary production was measured using a photosynthotron (method according to the protocol from Groningen University).
Secondary production, i. e. growth of crustaceans, was determined by means of the enzyme chitobiase. In the process of moulting, crustaceans use an enzyme, chitobiase, that plays a role in the degradation of the old exoskeleton into mono aminosugars. These are in turn used for building the new exoskeleton underneath the old skeleton. Once the old exuvium is shed, the enzyme is released freely into the ambient water. A relation between the released enzyme activity and the increase in biomass (secondary production) was found by Oosterhuis et. al. (MEPS, 2000). During the cruise water was sampled from the rosette sampler at discrete depths and used for the enzyme assay.
Grazing rates of meso-zooplankton was measured by estimating the gut passage time of the food taken in by copepods on a daily base (Arinardi et. al. Neth. J. of Sea Research 1990). Copepods were sampled using a WP2 net equipped with a 200 µm mesh sized plankton net. The catch was divided in different portions which were added to bottles filled with 0.7 µm filtered seawater. At discrete time intervals the bottles were filtered using 200 µm plankton gauze and frozen at -80 for later analysis on gut fluorescence.
To estimate the zooplankton biomass and taxonomy, vertical net hauls were done at each station using a WP2 net equipped with a 200 um mesh sized plankton net. Catches were stored in a 4% formaldehyde solution.
At all stations, HPLC samples were taken from the water column at discrete depths to estimate phytoplankton biomass and composition.

Station on Inset map	$mgDW.m^2.day^{-1}$	$mgC.m^2.day^{-1}$
2	273.5	115.0
3	335.4	141.0
4	350.5	147.0
5	288.7	121.0
6	197.5	83.0
7	661.2	278.0
9	55.7	23.0
10	164.5	69.0

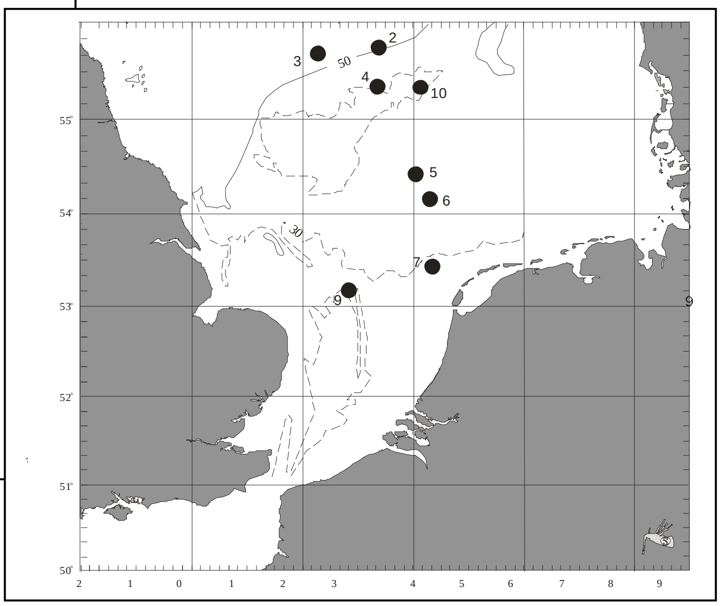


Fig. 8. Some first results on secondary production.

Acknowledgements

The members of the shipboard scientific crew like to thank the captain and the crew of the research vessel Pelagia for their assistance during the cruise and the pleasant voyage. The scientists thank the NIOZ mechanical and electronic engineers for the cruise preparations and on board support and their efforts to have the high definition camera system ready in time for this cruise. The members of the NIOZ logistic and administrative departments are thanked for their efforts to make this cruise possible.
We thank the authorities of the United Kingdom for the permission to carry out the work in waters under British jurisdiction. The ship time was made available by the Royal Netherlands Institute for Sea Research.

Appendix 1

Participants

Scientific crew (all NIOZ)

Magda Bergman	Benthic biologist
Gerard Duineveld	Benthic biologist
Henk de Haas	Geologist (chief scientist)
Bob Koster	Electronic engineer
Marc Lavaleye	Benthic biologist
Reinier Nauta	Student (biology)
Anna Noordeloos	Laboratory technician
Paul O'Connor	Viral ecologist
Swier Oosterhuis	Scientific assistant
Jack Schilling	Marine technician
Peter Urban	Student (engineering)
Jan Dirk de Visser	Marine technician
Rob Witbaard	Benthic biologist

Ships Crew

Wim Jan Boon	Ships technician
John Ellen	Master
Roel van der Heide	Ships technician
Fred Hiemstra	AB
Tommy Jas	Second officer
Marcel de Kleine	Second engineer
Arend Nieboer	Cook
Alex Popov	Stewart
Bert Puijman	Chief officer
Jaap Seepma	Chief engineer
Ger Vermeulen	AB

Appendix 2

Station list (in chronological order)

Station	Date	Time	Latitude		Longitude		Depth (m)	Activity	Event
Friese Front	18/06/2011	04:16:11	53 °	24.051 'N	4 °	18.028 'E	25.2	CTD	Bottom
	18/06/2011	06:08:17	53 °	24.006 'N	4 °	18.036 'E	25.4	CTD	Bottom
	18/06/2011	06:21:54	53 °	24.079 'N	4 °	18.099 'E	25.0	Vertical plankton net	Start Heave
	18/06/2011	06:28:19	53 °	24.215 'N	4 °	18.335 'E	25.3	Vertical plankton net	Start Heave
	18/06/2011	06:36:36	53 °	24.333 'N	4 °	18.650 'E	25.2	Vertical plankton net	Start Heave
	18/06/2011	13:44:27	53 °	24.101 'N	4 °	17.926 'E	24.4	CTD	Bottom
	18/06/2011	19:03:07	53 °	24.023 'N	4 °	18.351 'E	25.2	Vertical plankton net	Start Heave
BIO9	19/06/2011	04:04:32	53 °	9.950 'N	2 °	48.478 'E	28.3	CTD	Bottom
	19/06/2011	06:05:20	53 °	9.932 'N	2 °	48.436 'E	29.0	CTD	Bottom
	19/06/2011	06:20:17	53 °	9.864 'N	2 °	48.383 'E	29.3	Vertical plankton net	Start Heave
	19/06/2011	06:26:50	53 °	9.837 'N	2 °	48.562 'E	29.4	Vertical plankton net	Start Heave
	19/06/2011	06:33:22	53 °	9.794 'N	2 °	48.743 'E	28.8	Vertical plankton net	Start Heave
	19/06/2011	13:10:56	53 °	9.949 'N	2 °	48.467 'E	27.4	CTD	Bottom
BIO3	20/06/2011	05:04:22	55 °	40.971 'N	2 °	16.802 'E	80.1	CTD	Bottom
	20/06/2011	07:07:11	55 °	41.018 'N	2 °	16.789 'E	80.3	CTD	Bottom
	20/06/2011	07:56:38	55 °	40.982 'N	2 °	16.817 'E	80.7	Vertical plankton net	Start Heave
	20/06/2011	08:09:19	55 °	40.966 'N	2 °	16.821 'E	80.6	Vertical plankton net	Start Heave
	20/06/2011	08:21:08	55 °	40.976 'N	2 °	16.826 'E	80.3	Vertical plankton net	Start Heave
	20/06/2011	14:09:08	55 °	40.973 'N	2 °	16.802 'E	79.0	CTD	Bottom
	20/06/2011	19:07:22	55 °	40.983 'N	2 °	16.856 'E	80.1	CTD	Bottom
	20/06/2011	19:23:49	55 °	40.965 'N	2 °	16.837 'E	80.3	Vertical plankton net	Start Heave
BIO2	21/06/2011	04:00:44	55 °	42.992 'N	3 °	22.497 'E	47.0	CTD	Bottom
	21/06/2011	06:02:11	55 °	42.994 'N	3 °	22.505 'E	46.9	CTD	Bottom
	21/06/2011	06:14:35	55 °	43.009 'N	3 °	22.534 'E	46.8	Vertical plankton net	Start Heave
	21/06/2011	06:21:41	55 °	43.021 'N	3 °	22.536 'E	47.0	Vertical plankton net	Start Heave
	21/06/2011	06:28:32	55 °	43.013 'N	3 °	22.527 'E	50.1	Vertical plankton net	Start Heave
	21/06/2011	07:31:26	55 °	43.029 'N	3 °	23.007 'E	47.3	Multibeam	Begin
	21/06/2011	12:45:40	55 °	43.702 'N	3 °	22.978 'E	47.3	Multibeam	End
	21/06/2011	13:07:17	55 °	43.007 'N	3 °	22.495 'E	46.3	CTD	Bottom
	21/06/2011	13:43:15	55 °	42.988 'N	3 °	22.603 'E	46.1	Vertical plankton net	Start Heave
	21/06/2011	13:49:50	55 °	42.957 'N	3 °	22.602 'E	46.3	Vertical plankton net	Start Heave
	21/06/2011	13:55:49	55 °	42.948 'N	3 °	22.581 'E	46.0	Vertical plankton net	Start Heave
	21/06/2011	14:04:24	55 °	42.946 'N	3 °	22.388 'E	46.4	Vertical plankton net	Start Heave
	21/06/2011	19:05:02	55 °	43.012 'N	3 °	22.504 'E	47.0	CTD	Bottom
	21/06/2011	19:16:54	55 °	43.004 'N	3 °	22.525 'E	47.2	Vertical plankton net	Start Heave

Appendix 2 - Continued
Station list (in chronological order)

Station	Date	Time	Latitude		Longitude		Depth (m)	Activity	Event
BIO5	22/06/2011	04:04:44	54 °	24.843 'N	4 °	2.525 'E	42.4	CTD	Bottom
	22/06/2011	06:07:47	54 °	24.843 'N	4 °	2.511 'E	42.9	CTD	Bottom
	22/06/2011	06:23:20	54 °	24.815 'N	4 °	2.564 'E	42.6	Vertical plankton net	Start Heave
	22/06/2011	06:31:17	54 °	24.853 'N	4 °	2.579 'E	42.7	Vertical plankton net	Start Heave
	22/06/2011	06:38:48	54 °	24.811 'N	4 °	2.531 'E	42.6	Vertical plankton net	Start Heave
	22/06/2011	13:08:05	54 °	24.883 'N	4 °	2.619 'E	43.4	CTD	Bottom
	22/06/2011	16:34:05	54 °	24.845 'N	4 °	2.524 'E	42.6	CTD	Bottom
	22/06/2011	16:46:47	54 °	24.813 'N	4 °	2.580 'E	42.7	Vertical plankton net	Start Heave
Egmond	24/06/2011	06:17:15	52 °	38.243 'N	4 °	36.289 'E	12.7	Lander ALTRAP	Recovery
Egmond-LNO_1	24/06/2011	06:42:25	52 °	38.280 'N	4 °	36.349 'E	12.5	Box core	Bottom
Egmond-LNO_2	24/06/2011	06:57:46	52 °	38.287 'N	4 °	36.355 'E	12.5	Box core	Bottom
Egmond-LZO_1	24/06/2011	07:12:43	52 °	38.211 'N	4 °	36.395 'E	12.1	Box core	Bottom
Egmond-LZO_2	24/06/2011	07:25:24	52 °	38.217 'N	4 °	36.386 'E	12.4	Box core	Bottom
Egmond-LZW_1	24/06/2011	08:05:13	52 °	38.199 'N	4 °	36.199 'E	14.1	Box core	Bottom
Egmond-LZW_2	24/06/2011	08:14:15	52 °	38.214 'N	4 °	36.179 'E	14.3	Box core	Bottom
Egmond-LNW_1	24/06/2011	08:25:11	52 °	38.261 'N	4 °	36.214 'E	14.2	Box core	Bottom
Egmond-LNW_2	24/06/2011	08:40:33	52 °	38.293 'N	4 °	36.237 'E	14.4	Box core	Bottom
Egmond	24/06/2011	08:55:10	52 °	38.299 'N	4 °	36.219 'E	14.3	Box core	Bottom
	24/06/2011	08:59:06	52 °	38.302 'N	4 °	36.222 'E	14.3	Box core	Bottom
	24/06/2011	09:02:29	52 °	38.310 'N	4 °	36.225 'E	14.5	Box core	Bottom
	24/06/2011	09:06:04	52 °	38.282 'N	4 °	36.214 'E	14.1	Box core	Bottom
	24/06/2011	09:09:23	52 °	38.272 'N	4 °	36.211 'E	14.3	Box core	Bottom
	24/06/2011	09:13:07	52 °	38.277 'N	4 °	36.196 'E	14.4	Box core	Bottom
	24/06/2011	09:16:31	52 °	38.263 'N	4 °	36.216 'E	14.3	Box core	Bottom
	24/06/2011	09:19:48	52 °	38.262 'N	4 °	36.219 'E	14.5	Box core	Bottom
	24/06/2011	09:23:31	52 °	38.280 'N	4 °	36.246 'E	14.1	Box core	Bottom
	24/06/2011	09:26:27	52 °	38.271 'N	4 °	36.242 'E	13.9	Box core	Bottom
	24/06/2011	09:29:28	52 °	38.268 'N	4 °	36.209 'E	14.4	Box core	Bottom
	24/06/2011	09:32:15	52 °	38.276 'N	4 °	36.206 'E	14.6	Box core	Bottom
	24/06/2011	09:35:05	52 °	38.283 'N	4 °	36.220 'E	14.0	Box core	Bottom
	24/06/2011	09:38:54	52 °	38.288 'N	4 °	36.238 'E	14.0	Box core	Bottom
	24/06/2011	09:42:15	52 °	38.285 'N	4 °	36.215 'E	14.2	Box core	Bottom
	24/06/2011	09:45:13	52 °	38.278 'N	4 °	36.194 'E	14.5	Box core	Bottom
	24/06/2011	09:48:44	52 °	38.268 'N	4 °	36.185 'E	14.7	Box core	Bottom
	24/06/2011	09:51:47	52 °	38.271 'N	4 °	36.197 'E	14.3	Box core	Bottom
	24/06/2011	09:54:57	52 °	38.278 'N	4 °	36.218 'E	14.0	Box core	Bottom
	24/06/2011	11:10:31	52 °	38.276 'N	4 °	36.228 'E	13.9	Box core	Bottom
	24/06/2011	11:13:20	52 °	38.277 'N	4 °	36.226 'E	14.0	Box core	Bottom
	24/06/2011	11:16:47	52 °	38.278 'N	4 °	36.226 'E	13.9	Box core	Bottom

Appendix 2 - Continued
Station list (in chronological order)

Station	Date	Time	Latitude				Longitude				Depth (m)	Activity	Event
Egmond	24/06/2011	11:26:55	52	°	38.279	'N	4	°	36.382	'E	12.4	Box core	Bottom
	24/06/2011	11:30:00	52	°	38.273	'N	4	°	36.374	'E	12.5	Box core	Bottom
	24/06/2011	11:33:11	52	°	38.272	'N	4	°	36.366	'E	12.5	Box core	Bottom
	24/06/2011	11:36:10	52	°	38.279	'N	4	°	36.367	'E	12.5	Box core	Bottom
	24/06/2011	11:39:10	52	°	38.275	'N	4	°	36.366	'E	12.8	Box core	Bottom
	24/06/2011	11:42:33	52	°	38.284	'N	4	°	36.355	'E	13.2	Box core	Bottom
	24/06/2011	11:49:43	52	°	38.289	'N	4	°	36.361	'E	12.6	Box core	Bottom
	24/06/2011	12:03:54	52	°	38.320	'N	4	°	36.403	'E	12.5	Box core	Bottom
	24/06/2011	12:07:19	52	°	38.286	'N	4	°	36.412	'E	12.1	Box core	Bottom
	24/06/2011	12:11:08	52	°	38.264	'N	4	°	36.407	'E	12.0	Box core	Bottom
	24/06/2011	12:15:07	52	°	38.298	'N	4	°	36.408	'E	12.1	Box core	Bottom
	24/06/2011	12:19:12	52	°	38.289	'N	4	°	36.404	'E	12.1	Box core	Bottom
	24/06/2011	12:22:39	52	°	38.282	'N	4	°	36.425	'E	11.8	Box core	Bottom
	24/06/2011	12:26:26	52	°	38.267	'N	4	°	36.413	'E	11.8	Box core	Bottom
	24/06/2011	12:30:20	52	°	38.291	'N	4	°	36.395	'E	12.1	Box core	Bottom
	24/06/2011	13:01:24	52	°	38.281	'N	4	°	36.399	'E	12.1	Box core	Bottom
	24/06/2011	13:05:05	52	°	38.282	'N	4	°	36.405	'E	12.1	Box core	Bottom
	24/06/2011	13:08:08	52	°	38.267	'N	4	°	36.387	'E	12.0	Box core	Bottom
	24/06/2011	13:11:35	52	°	38.278	'N	4	°	36.350	'E	12.5	Box core	Bottom
	24/06/2011	13:14:52	52	°	38.261	'N	4	°	36.382	'E	12.1	Box core	Bottom
	24/06/2011	13:18:33	52	°	38.268	'N	4	°	36.368	'E	12.1	Box core	Bottom
	24/06/2011	13:22:57	52	°	38.251	'N	4	°	36.392	'E	12.0	Box core	Bottom
	24/06/2011	13:41:22	52	°	38.237	'N	4	°	36.301	'E	12.8	Lander ALTRAP	Deployment
648	25/06/2011	06:51:45	53	°	33.104	'N	4	°	30.108	'E	24.4	Hopper camera	Begin
	25/06/2011	08:03:43	53	°	34.185	'N	4	°	29.966	'E	26.6	Hopper camera	End
	25/06/2011	08:27:47	53	°	33.103	'N	4	°	30.101	'E	27.5	Box core	Bottom
	25/06/2011	08:39:36	53	°	33.102	'N	4	°	30.135	'E	24.7	Box core	Bottom
	25/06/2011	09:03:12	53	°	33.123	'N	4	°	30.172	'E	26.1	Deep digging dredge	End lower
	25/06/2011	09:07:59	53	°	32.971	'N	4	°	29.892	'E	26.3	Deep digging dredge	Start Heave
649	25/06/2011	11:12:02	53	°	36.888	'N	4	°	17.663	'E	35.9	Box core	Bottom
	25/06/2011	11:57:01	53	°	36.851	'N	4	°	17.675	'E	36.2	Deep digging dredge	End lower
	25/06/2011	12:01:06	53	°	36.671	'N	4	°	17.507	'E	36.0	Deep digging dredge	Start Heave
650	25/06/2011	13:17:45	53	°	41.498	'N	4	°	28.645	'E	39.0	Box core	Bottom
	25/06/2011	13:42:52	53	°	41.474	'N	4	°	28.639	'E	38.4	Deep digging dredge	End lower
	25/06/2011	13:46:52	53	°	41.333	'N	4	°	28.344	'E	39.2	Deep digging dredge	Start Heave
	25/06/2011	14:24:40	53	°	41.489	'N	4	°	28.655	'E	38.7	Hopper camera	Begin
	25/06/2011	15:28:06	53	°	41.719	'N	4	°	28.294	'E	4.0	Hopper camera	End

Appendix 2 - Continued
Station list (in chronological order)

Station	Date	Time	Latitude		Longitude		Depth (m)	Activity	Event
651	25/06/2011	16:55:09	53 °	50.159 'N	4 °	30.819 'E	41.9	Deep digging dredge	End lower
	25/06/2011	16:59:09	53 °	49.989 'N	4 °	30.685 'E	41.6	Deep digging dredge	Start Heave
	25/06/2011	17:29:12	53 °	50.215 'N	4 °	30.849 'E	41.7	Hopper camera	Begin
	25/06/2011	18:25:15	53 °	49.624 'N	4 °	30.367 'E	-1.0	Hopper camera	End
	25/06/2011	18:41:23	53 °	49.465 'N	4 °	30.619 'E	-1.0	Box core	Bottom
BIO6	26/06/2011	03:06:46	54 °	8.098 'N	4 °	20.042 'E	49.7	CTD	Bottom
	26/06/2011	04:59:35	54 °	8.095 'N	4 °	20.059 'E	50.1	CTD	Bottom
	26/06/2011	05:20:46	54 °	8.101 'N	4 °	20.045 'E	49.3	Vertical plankton net	Start Heave
	26/06/2011	05:28:44	54 °	8.098 'N	4 °	20.052 'E	50.0	Vertical plankton net	Start Heave
	26/06/2011	05:36:34	54 °	8.094 'N	4 °	20.058 'E	50.4	Vertical plankton net	Start Heave
652	26/06/2011	08:22:37	54 °	22.979 'N	4 °	15.340 'E	51.7	Box core	Bottom
	26/06/2011	08:37:47	54 °	22.989 'N	4 °	15.313 'E	50.8	Box core	Bottom
	26/06/2011	09:04:21	54 °	23.012 'N	4 °	15.375 'E	50.9	Deep digging dredge	End lower
	26/06/2011	09:08:20	54 °	23.131 'N	4 °	15.659 'E	52.4	Deep digging dredge	Start Heave
	26/06/2011	09:36:16	54 °	23.015 'N	4 °	15.301 'E	51.2	Hopper camera	Begin
	26/06/2011	09:48:36	54 °	22.955 'N	4 °	15.181 'E	50.5	Hopper camera	End
653	26/06/2011	11:10:29	54 °	30.014 'N	4 °	15.006 'E	50.6	Hopper camera	Begin
	26/06/2011	12:14:30	54 °	30.555 'N	4 °	15.365 'E	50.7	Hopper camera	End
	26/06/2011	12:35:12	54 °	29.920 'N	4 °	14.964 'E	50.9	Deep digging dredge	End lower
	26/06/2011	12:39:13	54 °	29.730 'N	4 °	14.863 'E	51.2	Deep digging dredge	Start Heave
	26/06/2011	13:10:36	54 °	30.008 'N	4 °	14.995 'E	50.9	Box core	Bottom
654	26/06/2011	14:28:37	54 °	39.382 'N	4 °	15.344 'E	50.6	Box core	Bottom
	26/06/2011	14:52:56	54 °	39.316 'N	4 °	15.278 'E	50.8	Deep digging dredge	End lower
	26/06/2011	14:57:00	54 °	39.145 'N	4 °	15.125 'E	50.5	Deep digging dredge	Start Heave
	26/06/2011	15:36:06	54 °	39.385 'N	4 °	15.347 'E	50.2	Hopper camera	Begin
	26/06/2011	16:36:34	54 °	38.806 'N	4 °	14.611 'E	50.1	Hopper camera	End
	26/06/2011	16:51:01	54 °	39.008 'N	4 °	14.999 'E	50.4	Beam trawl	Stop lower
	26/06/2011	17:01:05	54 °	39.414 'N	4 °	15.459 'E	50.8	Beam trawl	Start Heave
BIO6	26/06/2011	19:06:17	54 °	39.006 'N	4 °	14.544 'E	49.8	CTD	Bottom
	26/06/2011	19:19:41	54 °	39.167 'N	4 °	14.611 'E	50.0	Vertical plankton net	Start Heave
655	27/06/2011	06:29:51	54 °	0.304 'N	2 °	57.703 'E	43.3	Hopper camera	Begin
	27/06/2011	08:05:14	54 °	0.121 'N	2 °	58.526 'E	42.7	Hopper camera	End
	27/06/2011	08:26:05	54 °	0.323 'N	2 °	57.431 'E	43.6	Triangular dredge	Bottom
	27/06/2011	08:38:03	54 °	0.215 'N	2 °	57.664 'E	43.2	Triangular dredge	Start Heave

Appendix 2 - Continued
Station list (in chronological order)

Station	Date	Time	Latitude		Longitude		Depth (m)	Activity	Event
656	27/06/2011	09:54:24	53 °	52.928 'N	3 °	5.857 'E	58.1	Triangular dredge	Bottom
	27/06/2011	10:07:11	53 °	52.727 'N	3 °	6.010 'E	57.7	Triangular dredge	Start Heave
	27/06/2011	11:06:56	53 °	52.554 'N	3 °	6.405 'E	57.4	Hopper camera	Begin
	27/06/2011	11:57:41	53 °	52.972 'N	3 °	6.385 'E	58.5	Hopper camera	End
	27/06/2011	12:29:57	53 °	52.573 'N	3 °	7.273 'E	57.3	Beam trawl	Stop lower
	27/06/2011	12:33:53	53 °	52.396 'N	3 °	7.413 'E	57.0	Beam trawl	Start Heave
657	27/06/2011	14:01:20	54 °	0.510 'N	3 °	10.445 'E	35.9	Hopper camera	Begin
	27/06/2011	14:59:56	53 °	59.870 'N	3 °	10.533 'E	37.0	Hopper camera	End
	27/06/2011	15:21:08	54 °	0.430 'N	3 °	10.500 'E	35.4	Triangular dredge	Bottom
	27/06/2011	15:31:21	54 °	0.257 'N	3 °	10.504 'E	34.3	Triangular dredge	Start Heave
658	27/06/2011	16:55:12	54 °	9.199 'N	3 °	11.194 'E	39.2	Hopper camera	Begin
	27/06/2011	17:55:42	54 °	8.522 'N	3 °	11.152 'E	36.4	Hopper camera	End
BIO4	28/06/2011	03:02:45	55 °	18.006 'N	3 °	20.002 'E	29.8	CTD	Bottom
	28/06/2011	04:59:21	55 °	17.997 'N	3 °	20.003 'E	29.7	CTD	Bottom
	28/06/2011	05:10:39	55 °	18.003 'N	3 °	20.006 'E	29.5	Vertical plankton net	Start Heave
	28/06/2011	05:16:38	55 °	17.998 'N	3 °	20.012 'E	29.3	Vertical plankton net	Start Heave
	28/06/2011	05:22:02	55 °	17.990 'N	3 °	20.014 'E	29.5	Vertical plankton net	Start Heave
659	28/06/2011	06:21:49	55 °	14.984 'N	3 °	30.029 'E	28.7	Hopper camera	Begin
	28/06/2011	07:20:13	55 °	14.490 'N	3 °	30.209 'E	28.4	Hopper camera	End
	28/06/2011	07:44:45	55 °	15.031 'N	3 °	30.067 'E	28.6	Deep digging dredge	End lower
	28/06/2011	07:48:47	55 °	14.896 'N	3 °	29.836 'E	28.5	Deep digging dredge	Start Heave
	28/06/2011	08:11:54	55 °	15.000 'N	3 °	30.013 'E	28.5	Box core	Bottom
660	28/06/2011	09:53:13	55 °	26.981 'N	3 °	29.971 'E	35.2	Box core	Bottom
	28/06/2011	11:21:50	55 °	26.960 'N	3 °	29.989 'E	35.1	Deep digging dredge	End lower
	28/06/2011	11:25:54	55 °	26.981 'N	3 °	30.334 'E	35.0	Deep digging dredge	Start Heave
	28/06/2011	11:58:34	55 °	26.973 'N	3 °	29.923 'E	35.2	Hopper camera	Begin
	28/06/2011	12:59:23	55 °	27.473 'N	3 °	29.630 'E	35.5	Hopper camera	End
661	28/06/2011	14:36:58	55 °	27.194 'N	3 °	50.645 'E	33.1	Hopper camera	Begin
	28/06/2011	15:03:23	55 °	27.182 'N	3 °	51.098 'E	32.7	Hopper camera	End
	28/06/2011	15:17:58	55 °	26.948 'N	3 °	50.652 'E	33.0	Deep digging dredge	End lower
	28/06/2011	15:22:17	55 °	26.827 'N	3 °	50.388 'E	33.2	Deep digging dredge	Start Heave
BIO4	28/06/2011	18:59:53	55 °	17.994 'N	3 °	19.960 'E	28.9	Vertical plankton net	Start Heave
	28/06/2011	19:10:25	55 °	17.992 'N	3 °	19.985 'E	29.1	CTD	Bottom
A11	28/06/2011	20:15:31	55 °	23.006 'N	3 °	28.620 'E	32.8	Multibeam	Begin
	28/06/2011	22:46:37	55 °	23.399 'N	3 °	29.238 'E	33.9	Multibeam	End
661	29/06/2011	06:03:40	55 °	27.180 'N	3 °	50.654 'E	32.8	Box core	Bottom

Appendix 2 - Continued
Station list (in chronological order)

Station	Date	Time	Latitude		Longitude		Depth (m)	Activity	Event
662	29/06/2011	07:27:14	55 °	15.205 'N	3 °	51.026 'E	44.4	Box core	Bottom
	29/06/2011	08:25:41	55 °	15.253 'N	3 °	50.942 'E	41.3	Deep digging dredge	End lower
	29/06/2011	08:29:39	55 °	15.411 'N	3 °	50.775 'E	40.8	Deep digging dredge	Start Heave
	29/06/2011	08:58:40	55 °	15.157 'N	3 °	50.957 'E	41.5	Hopper camera	Begin
	29/06/2011	09:58:55	55 °	15.108 'N	3 °	50.662 'E	40.7	Hopper camera	End
B13	29/06/2011	11:23:40	55 °	18.367 'N	4 °	3.012 'E	43.5	CTD	Bottom
	29/06/2011	12:01:56	55 °	18.347 'N	4 °	3.254 'E	43.7	Multibeam	Begin
	29/06/2011	18:14:32	55 °	18.749 'N	4 °	5.427 'E	44.3	Multibeam	End
B13-1	30/06/2011	09:35:33	55 °	18.412 'N	4 °	5.612 'E	44.5	Hopper camera	Begin
	30/06/2011	10:16:12	55 °	18.299 'N	4 °	5.045 'E	44.0	Hopper camera	End
B13-2	30/06/2011	11:18:10	55 °	18.618 'N	4 °	3.565 'E	43.6	Hopper camera	Begin
	30/06/2011	12:19:23	55 °	18.607 'N	4 °	3.585 'E		Hopper camera	End
B13-3	30/06/2011	13:03:18	55 °	18.370 'N	4 °	5.096 'E		Hopper camera	Begin
	30/06/2011	14:25:41	55 °	18.378 'N	4 °	5.425 'E		Hopper camera	End
B13-1s	30/06/2011	16:10:20	55 °	19.406 'N	4 °	3.586 'E		Seismic line	Begin
	30/06/2011	16:47:00	55 °	17.455 'N	4 °	3.574 'E		Seismic line	End
B13-2s	30/06/2011	17:05:45	55 °	17.530 'N	4 °	4.755 'E		Seismic line	Begin
	30/06/2011	17:44:00	55 °	19.491 'N	4 °	4.760 'E		Seismic line	End
B13-3s	30/06/2011	18:07:57	55 °	19.468 'N	4 °	6.793 'E		Seismic line	Begin
	30/06/2011	18:47:00	55 °	17.472 'N	4 °	6.783 'E	44.9	Seismic line	End
B13-4s	30/06/2011	19:35:06	55 °	17.703 'N	4 °	8.770 'E	44.6	Seismic line	Begin
	30/06/2011	20:19:43	55 °	17.703 'N	4 °	4.827 'E	44.3	Seismic line	End
B13-5s	30/06/2011	21:07:43	55 °	17.639 'N	4 °	1.844 'E	43.2	Seismic line	Begin
	30/06/2011	22:30:21	55 °	19.062 'N	4 °	8.651 'E	44.9	Seismic line	End
B13-6s	30/06/2011	23:06:21	55 °	18.006 'N	4 °	8.756 'E	44.6	Seismic line	Begin
	01/07/2011	00:44:28	55 °	18.001 'N	3 °	59.967 'E	42.8	Seismic line	End
B13-7s	01/07/2011	01:15:57	55 °	19.067 'N	4 °	0.060 'E	42.1	Seismic line	Begin
	01/07/2011	02:59:31	55 °	17.963 'N	4 °	8.596 'E	44.5	Seismic line	End
B13-8s	01/07/2011	03:15:52	55 °	18.385 'N	4 °	8.726 'E	44.7	Seismic line	Begin
	01/07/2011	04:54:35	55 °	18.379 'N	4 °	0.000 'E	43.0	Seismic line	End
Seep-1	01/07/2011	06:28:38	55 °	18.355 'N	4 °	5.445 'E	44.3	CTD	Bottom
	01/07/2011	06:43:47	55 °	18.350 'N	4 °	5.458 'E	44.3	Vertical plankton net	Start Heave
	01/07/2011	06:51:15	55 °	18.333 'N	4 °	5.428 'E	44.8	Vertical plankton net	Start Heave
	01/07/2011	06:59:45	55 °	18.357 'N	4 °	5.465 'E	44.8	Vertical plankton net	Start Heave
Seep-2	01/07/2011	07:16:13	55 °	18.365 'N	4 °	5.925 'E	44.4	Box core	Bottom
	01/07/2011	07:22:22	55 °	18.372 'N	4 °	5.921 'E	45.1	Box core	Bottom
	01/07/2011	07:37:50	55 °	18.345 'N	4 °	5.943 'E	44.3	Box core	Bottom

Appendix 2 - Continued
Station list (in chronological order)

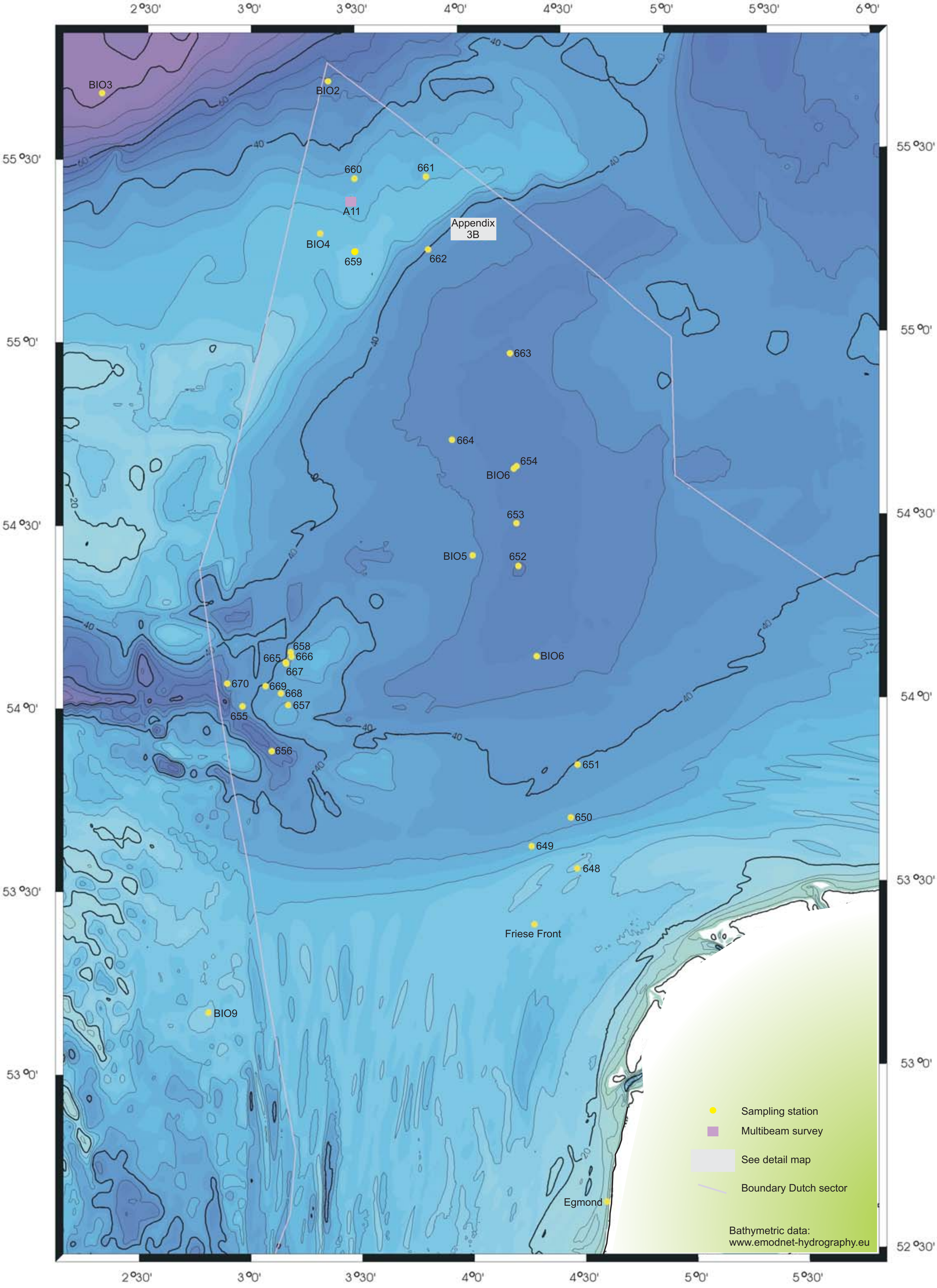
Station	Date	Time	Latitude		Longitude		Depth (m)	Activity	Event
Seep-3	01/07/2011	08:30:34	55 °	18.361 'N	4 °	5.448 'E	44.2	CTD	Bottom
	01/07/2011	08:42:40	55 °	18.349 'N	4 °	5.460 'E	44.1	Vertical plankton net	Start Heave
	01/07/2011	08:50:45	55 °	18.329 'N	4 °	5.417 'E	44.3	Vertical plankton net	Start Heave
	01/07/2011	08:58:46	55 °	18.351 'N	4 °	5.441 'E	44.3	Vertical plankton net	Start Heave
	01/07/2011	09:08:26	55 °	18.342 'N	4 °	5.469 'E	44.3	Box core	Bottom
	01/07/2011	09:22:54	55 °	18.385 'N	4 °	5.396 'E	44.4	Box core	Bottom
	01/07/2011	09:35:00	55 °	18.404 'N	4 °	5.397 'E	44.2	Box core	Bottom
	01/07/2011	09:48:33	55 °	18.390 'N	4 °	5.375 'E	44.5	Box core	Bottom
	01/07/2011	09:59:10	55 °	18.384 'N	4 °	5.394 'E	43.9	Box core	Bottom
Seep-4	01/07/2011	11:26:23	55 °	18.354 'N	4 °	5.456 'E	44.0	CTD	Bottom
Seep-5	01/07/2011	12:04:23	55 °	18.359 'N	4 °	5.551 'E	43.8	CTD	Bottom
Seep-6	01/07/2011	12:33:42	55 °	18.366 'N	4 °	5.679 'E	44.1	CTD	Bottom
Seep-7	01/07/2011	12:52:59	55 °	18.356 'N	4 °	5.802 'E	44.8	CTD	Bottom
Seep-8	01/07/2011	13:11:08	55 °	18.351 'N	4 °	5.920 'E	44.0	CTD	Bottom
Seep-9	01/07/2011	13:36:38	55 °	18.336 'N	4 °	6.413 'E	44.2	Box core	Bottom
	01/07/2011	13:42:41	55 °	18.350 'N	4 °	6.403 'E	43.9	Box core	Bottom
	01/07/2011	13:51:54	55 °	18.369 'N	4 °	6.341 'E	44.8	Box core	Bottom
Seep-10	01/07/2011	14:01:49	55 °	18.354 'N	4 °	5.925 'E	45.3	Box core	Bottom
Seep-11	01/07/2011	14:18:56	55 °	18.356 'N	4 °	5.548 'E	44.5	Box core	Bottom
Seep-12	01/07/2011	14:24:47	55 °	18.353 'N	4 °	5.552 'E	44.6	Box core	Bottom
Seep-13	01/07/2011	14:31:20	55 °	18.359 'N	4 °	5.549 'E	44.2	Box core	Bottom
Seep-14	01/07/2011	14:46:40	55 °	18.357 'N	4 °	5.450 'E	45.0	Box core	Bottom
Seep-15	01/07/2011	14:56:21	55 °	18.358 'N	4 °	5.452 'E	44.4	Box core	Bottom
Seep-16	01/07/2011	15:09:17	55 °	18.358 'N	4 °	5.452 'E	44.2	Box core	Bottom
Seep-17	01/07/2011	15:18:58	55 °	18.357 'N	4 °	5.452 'E	45.1	Box core	Bottom
Seep-4	02/07/2011	06:11:18	55 °	18.354 'N	4 °	5.456 'E	44.4	Gravity core	Bottom
	02/07/2011	06:36:33	55 °	18.361 'N	4 °	5.454 'E	45.1	Gravity core	Bottom
Seep-5	02/07/2011	07:02:08	55 °	18.356 'N	4 °	5.569 'E	44.9	Gravity core	Bottom
Seep-8	02/07/2011	07:26:29	55 °	18.356 'N	4 °	5.919 'E	45.0	Gravity core	Bottom
Seep-4	02/07/2011	08:18:41	55 °	18.363 'N	4 °	5.442 'E	44.5	Box core	Bottom
Seep-5	02/07/2011	08:47:22	55 °	18.368 'N	4 °	5.559 'E	44.4	Box core	Bottom
Seep-6	02/07/2011	09:10:08	55 °	18.377 'N	4 °	5.689 'E	44.6	Box core	Bottom
Seep-7	02/07/2011	09:31:37	55 °	18.368 'N	4 °	5.803 'E	44.6	Box core	Bottom
Seep-8	02/07/2011	09:52:31	55 °	18.357 'N	4 °	5.913 'E	43.8	Box core	Bottom
Seep-18	02/07/2011	11:18:08	55 °	18.339 'N	4 °	5.461 'E	43.8	Box core	Bottom
Seep-19	02/07/2011	11:28:21	55 °	18.380 'N	4 °	5.369 'E	44.3	Box core	Bottom
Seep-20	02/07/2011	11:35:21	55 °	18.380 'N	4 °	5.415 'E	44.0	Box core	Bottom
Seep-21	02/07/2011	11:41:22	55 °	18.378 'N	4 °	5.402 'E	44.3	Box core	Bottom
Seep-22	02/07/2011	11:47:07	55 °	18.372 'N	4 °	5.391 'E	43.9	Box core	Bottom

Appendix 2 - Continued
Station list (in chronological order)

Station	Date	Time	Latitude			Longitude			Depth (m)	Activity	Event
Seep-23	02/07/2011	11:51:59	55 °	18.370	'N	4 °	5.393	'E	43.9	Box core	Bottom
Seep-24	02/07/2011	11:57:17	55 °	18.373	'N	4 °	5.435	'E	44.4	Box core	Bottom
663	02/07/2011	14:41:53	54 °	57.965	'N	4 °	14.040	'E	50.7	Beam trawl	Stop lower
	02/07/2011	14:52:00	54 °	58.364	'N	4 °	13.562	'E	50.5	Beam trawl	Start Heave
664	02/07/2011	17:07:24	54 °	43.895	'N	3 °	57.156	'E	48.8	Beam trawl	Stop lower
	02/07/2011	17:17:27	54 °	44.305	'N	3 °	56.624	'E	49.3	Beam trawl	Start Heave
665	03/07/2011	06:26:32	54 °	7.531	'N	3 °	9.780	'E	40.1	Hopper camera	Begin
	03/07/2011	07:24:39	54 °	8.096	'N	3 °	9.749	'E	41.5	Hopper camera	End
666	03/07/2011	07:57:07	54 °	8.455	'N	3 °	11.449	'E	37.5	Triangular dredge	Bottom
	03/07/2011	08:10:12	54 °	8.690	'N	3 °	11.117	'E	37.9	Triangular dredge	Start Heave
	03/07/2011	08:31:35	54 °	8.570	'N	3 °	11.473	'E	37.7	Triangular dredge	Bottom
	03/07/2011	08:43:26	54 °	8.653	'N	3 °	11.124	'E	37.5	Triangular dredge	Start Heave
667	03/07/2011	09:07:07	54 °	7.326	'N	3 °	9.913	'E	39.6	Triangular dredge	Bottom
	03/07/2011	09:19:34	54 °	7.499	'N	3 °	9.732	'E	39.8	Triangular dredge	Start Heave
668	03/07/2011	11:18:07	54 °	2.433	'N	3 °	8.443	'E	39.1	Hopper camera	Begin
	03/07/2011	12:16:48	54 °	2.843	'N	3 °	8.149	'E	39.1	Hopper camera	End
	03/07/2011	12:34:18	54 °	2.292	'N	3 °	8.486	'E	38.6	Triangular dredge	Bottom
	03/07/2011	12:44:21	54 °	2.438	'N	3 °	8.472	'E	39.1	Triangular dredge	Start Heave
	03/07/2011	13:07:56	54 °	2.490	'N	3 °	8.214	'E	38.9	Triangular dredge	Bottom
	03/07/2011	13:11:22	54 °	2.517	'N	3 °	8.092	'E	38.5	Triangular dredge	Start Heave
669	03/07/2011	13:46:56	54 °	3.619	'N	3 °	4.142	'E	40.5	Hopper camera	Begin
	03/07/2011	14:47:23	54 °	4.000	'N	3 °	4.116	'E	41.2	Hopper camera	End
	03/07/2011	15:04:07	54 °	3.608	'N	3 °	4.191	'E	41.0	Triangular dredge	Bottom
	03/07/2011	15:14:30	54 °	3.606	'N	3 °	4.518	'E	40.9	Triangular dredge	Start Heave
670	03/07/2011	16:37:22	54 °	4.050	'N	2 °	53.428	'E	51.0	Hopper camera	Begin
	03/07/2011	17:39:33	54 °	4.446	'N	2 °	53.431	'E	49.7	Hopper camera	End

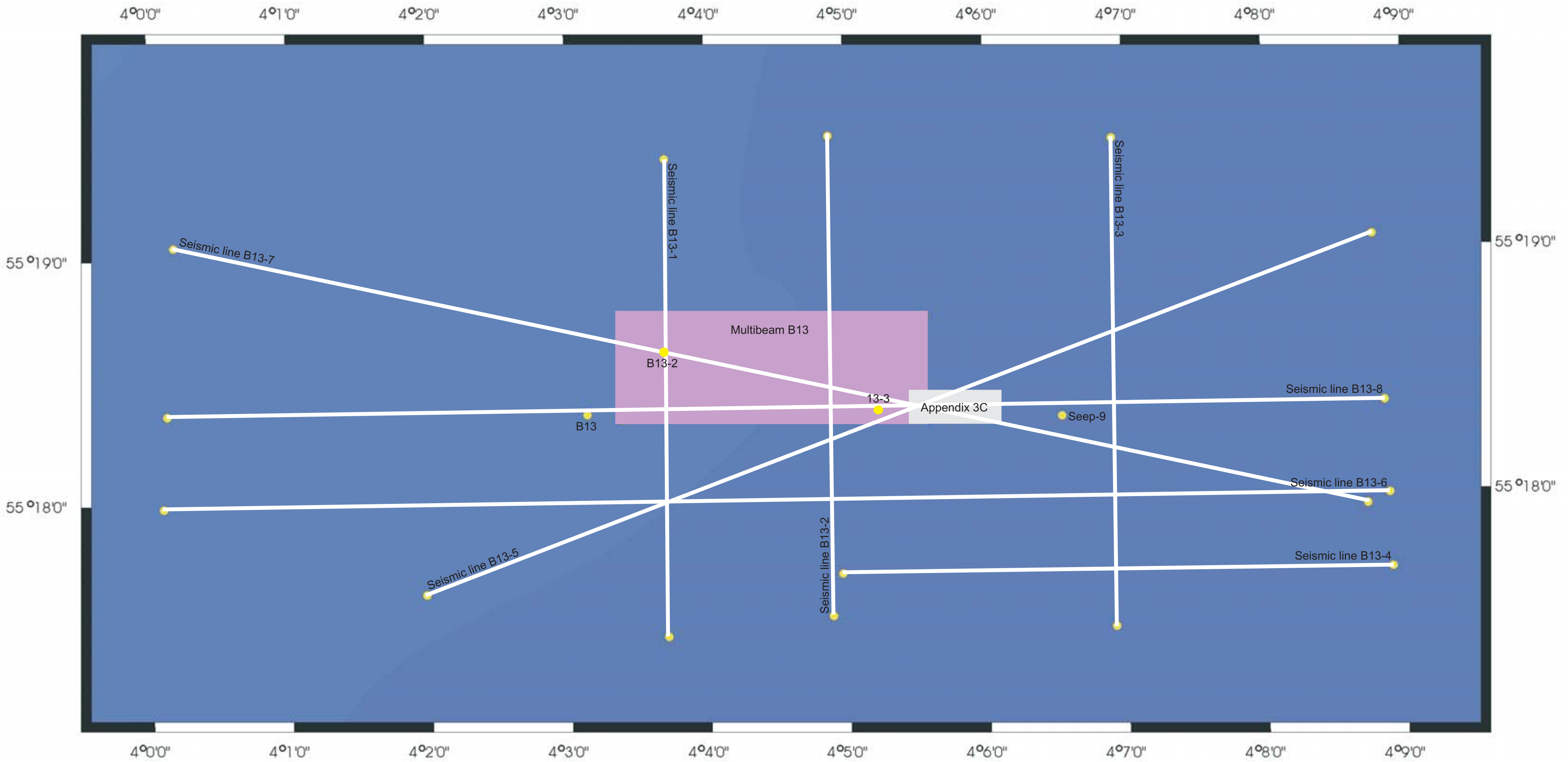
Appendix 3A

Station map - Dutch sector



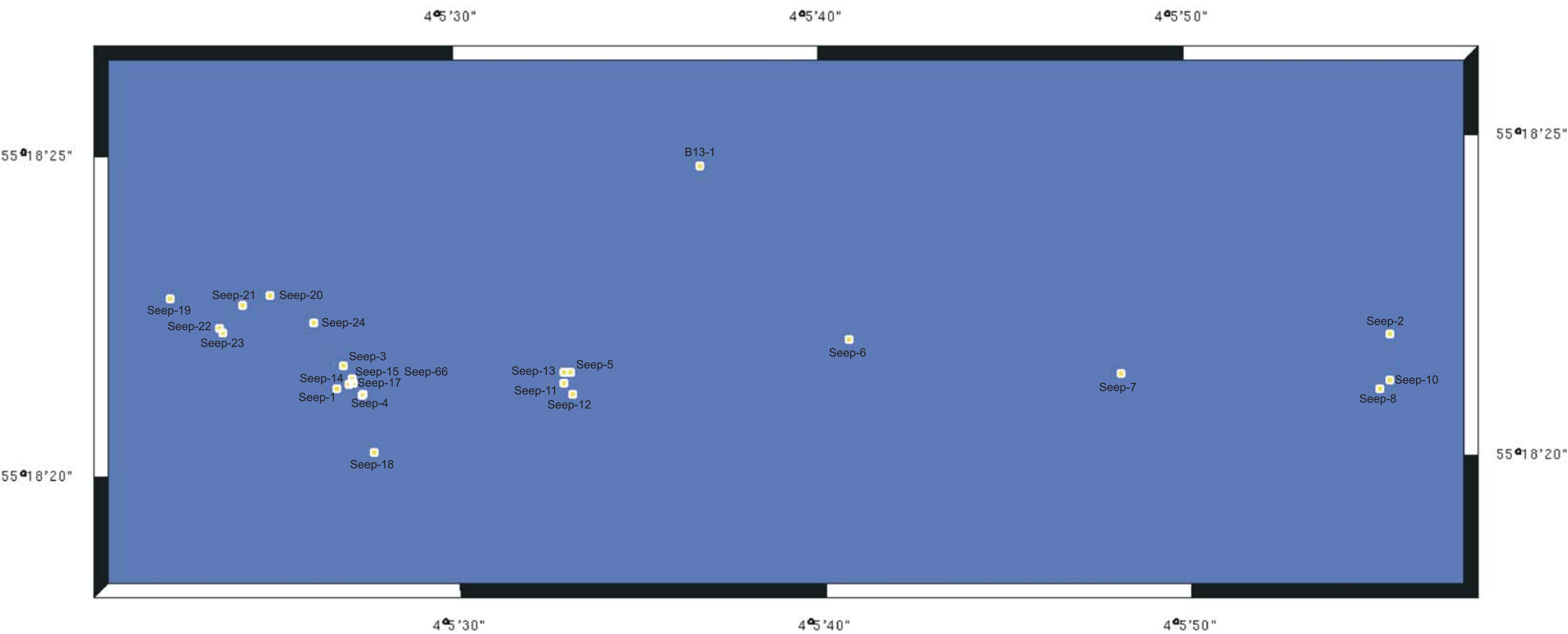
Appendix 3B

Station map - Block B13



Appendix 3C

Station map - Block B13, detail



Appendix 4

CTD bottles closure depth

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fries Front	1	15	15	15	15	15												
	2	27.5	15	15	15	5	2											
	3	15.5	15.5	15.5														

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO9	1	14.8	14.8	14.8	14.8	14.8	14.8											
	2	31	31	14.7	14.7	14.7	2											
	3	31	15	15	15													

Did not close properly

Appendix 4 - Continued

CTD bottles closure depth

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO3	1	70	43	24	24	24	24	24	21	10	1							
	2	70	48	25.5	25.5	25.5	25.5	12.5	1									
	3	24.5	24.5	24.5														
	4	70	48	37	27	2												

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO2	1	10	10	10	10	10												
	2	49	38	33	26	10	10	10	2									
	3	10	10	10														
	4	48	38	31	27	11	2											

Appendix 4 - Continued

CTD bottles closure depth

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO5	1	45	28	28	28	28	28	10	10	10	10	10						
	2	44	34	34	34	34	34	23	23	23	23	19	10	10	10	2		
	3	45	28	28	28	28	10	10	10	3	3							
	4	44	36	25	18	10	2											

(shaded: bottle 14) not closed

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO6	1	27	27	27	27	27	10	10	10	10	10							
	2	46	44	35	40	27	27	27	24	10	10	10	10	2				
	3	47	35	23	23	23	10	10	10	2								

(shaded: bottle 11) not closed

Appendix 4 - Continued

CTD bottles closure depth

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO4	1	23	23	23	23	23	10	10	10	10	10							
	2	23	23	23	18	10	10	10	2									
	3	23	18	10	2													

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
BIO10	1	40	32	32	32	32	32.0	32.0	24.0	10.0	10.0		10.0	2.0				
	2	40.0	33	33	33	22	10	10.0	10.0	2.0								

Bottle not in use, does not close properly

Appendix 4 - Continued

CTD bottles closure depth

Station	Cast	Bottle closed at depth (m)																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Seep 04	1	43	28	17	2													
Seep 05	1	42	28	17	2													
Seep 06	1	43	30	16	2													
Seep 07	1	42	30	17	2													
Seep 08	1	42	30	17	2.5													

Appendix 5

Internet cruise diary

Research Cruises

RV Pelagia North Sea Monitoring Diary

Diary overview

Saturday, 18 June

After 2 days during which the Pelagia crew and the NIOZ technical department have unloaded the equipment from the previous cruise and loaded the tools and laboratory containers we will use during our first week at sea, we (the algae biology group and the gas group mentioned in the introduction) left Texel yesterday evening at 8 o'clock and set sail to an area in the North Sea known as the Frisian Front.

For those of you who or less familiar with the North Sea road map, this area is located at approximately 53°25' north and 4°20' east (about 30 nautical miles, or 55 km, northwest of Texel) . We have spend the entire day at this location. All our sampling activities were devoted to one single subject: the activity of the algae in this part of the North Sea. At the moment, while I am writing the text you are reading now, it is 7 o'clock in the evening and we are waiting for the clock to strike nine. At exactly that time we will start the last sampling of today.

Most of us had an early start this morning. At 6 o'clock the CTD (a device that measures water temperature, salinity and other properties and takes water samples throughout the water column) was deployed for the first time. With intervals of several hours this was done throughout the day, in combination with hauls of the plankton net. The latter is a fishing net with a very small mesh size, so it is possible to catch even the smallest algae. By repeatedly measuring the activity (growth) of the algae during the course of the day, when the sun rises, reaches its highest point in the sky, and settles, biologist try to understand how the algae system works, and whether and how it changes over time.

In the next 4 days we will do the same type of measurements at different locations, before we go back to Texel to pick up more people and more equipment. So that is plenty of time to tell you in detail who of the biology group is doing exactly what with these algae. And what are the geologists, who are looking for methane gas, doing? Curious? Read more in the days to come.

Henk de Haas

Roel (in the background) helping Swier with the plankton net

Research Cruises

RV Pelagia North Sea Monitoring Diary

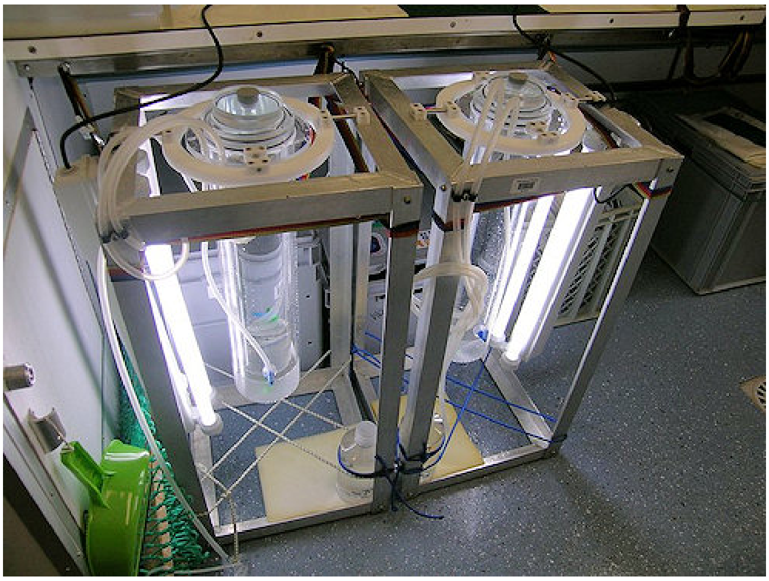
Diary overview

Sunday, 19 June

Yesterday I promised to explain a bit more about what all these people on board are doing here. Today `here' means the Southern Bight of the North Sea (about 60 nautical miles west of yesterdays location.). Today I will tell something about Paul his work. Paul is a biologist. This morning he sampled water from a depth of 15 metres by means of the CTD. Paul is interested in the algae living in this water, and more specific in how they die. So he determined how much of them are being eaten in a certain period of time by small animals (called zooplankton), and how many die and fall apart because they are infected by viruses (yes, there are also viruses in the sea, plenty of them, and they can make algae that sick that they die from it).

This afternoon Paul took more water samples and determined the settling velocity. This means that he puts the seawater containing the algae in a transparent plastic tube to see how fast they fall down through the water column. This is not an easy job on a moving ship, because as soon as you (accidently) shake the tube the algae are brought back into suspension again. Furthermore Paul used a device called an HPLC to determine the different types of algae. All algae make a slightly different type of pigment and the HPLC can determine which pigments are present in the water. So once you find certain pigments in the sea water, you know which algae live there. In addition to all this he (and Anna helped him doing it) uses a flowcytometer to determine the size of the algae. More about this later on.

Henk de Haas



Paul his tubes to determine the settling velocity. The tubes have a cardanic suspension so they are not shaken by the waves and the algae can settle.
The TL-lights are there to make the algae grow under controlled light conditions.

RV Pelagia North Sea Monitoring Diary

Diary overview

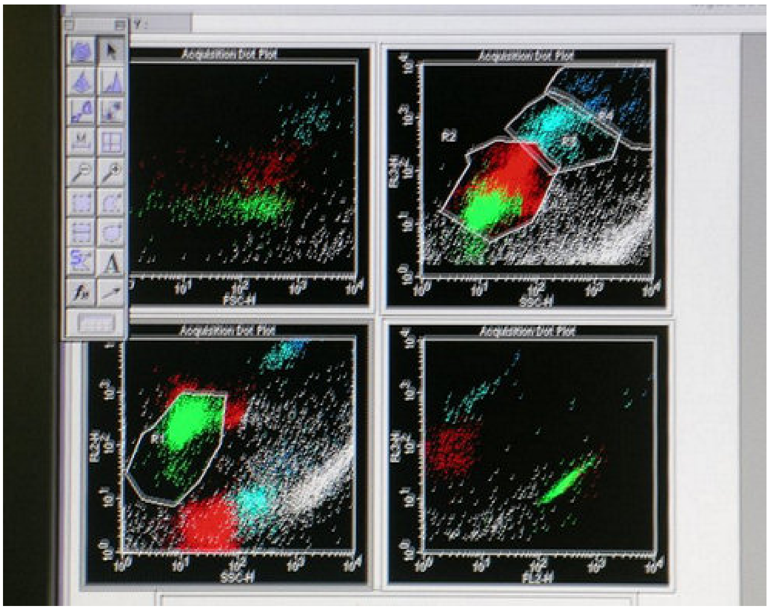
Monday, 20 June

Yesterday I mentioned that Anna was (and she still is) helping Paul with the work on the algae. What Anna does is operating a machine called the flowcytometer. What is a flowcytometer?, you might ask yourself. This piece of marine biologists equipment uses a laser beam to count the number of algae in a water sample. It not only counts them, it also determines (within a certain range) how big they are. In addition to this the machine determines the colour of the light that it transmitted by the algae after they are hit by the laser beam, a phenomenon known as fluorescence. The combination of size and fluorescence data for each individual cell gives an indication for the group of algae it belongs to. By comparing this type of information from several cruises carried out within a range of years biologists can get an impression about the variability in the amount and type of algae in the North Sea over a certain time span.

Anna in her container.

And this is what Anna has been doing the first three days of this cruise. Day in, day out, from the morning until late in the evening. All alone, in a container, in the container hull. That sounds lonely, doesn't it? But it isn't as bad as it sounds. Of course she comes on deck every now and then and also joins us for breakfast, lunch and dinner. And after she has put in a new sample and the flowcytometer is doing its work, she takes her book to read a few a pages, than the bell rings and it is time for another sample..

Henk de Haas



Some graphs showing the results of the measurements of different types of algae present in one single water sample. The algae belonging to the same group have the same colour.

RV Pelagia North Sea Monitoring Diary

Diary overview

Tuesday, 21 June

You might have the impression that we are we only doing biology these days. I can tell you, we are not. There still is some geology being done here on board. Although at present it is more on a theoretical level. These first 4 days of the cruise Peter has been working on two subjects that might at first hand look miles apart, but are in fact closely related. The first day he has spend a lot of time on setting up equipment to measure methane gas in water which we will sample later during this cruise. I will explain more about this in a later issue of this diary.

After dealing with this specific equipment, he has been working on a computer program. This does not involve any sampling, no mud on his fingers and no salt water in his face. He is just sitting behind a desk and typing computer code. The program Peter is working on will be used to help us detecting methane gas bubbles (there is the connection to his activities on the first day) in multibeam echo sounder (in short: multibeam) data. Maybe this sounds complicated, but the basic idea is fairly simple. An echo sounder sends sound into the water. The sound is reflected by the sea bed and the time it takes for the sound to go from the ship to the seabed and back is a measure for the water depth.

A multibeam echo sounder has not one sound beam but many. Our multibeam not only detects the seabed, but also reflectors in the water column, for instance schools of fish or, the stuff we (the geology group) are looking for, methane gas bubbles leaking from the sea bed into the water of the North Sea. With Peter his program it will be possible to distinguish the gas bubbles from all the other reflectors in the water. In this way it will be much easier for us in the future to find the places were methane gas is leaking from the sea floor (places also known as seeps). In order to test his program we needed some test files, so we recorded some multibeam data in between the sampling events of our biology colleagues.

Henk de Haas

Peter working on his computer program

RV Pelagia North Sea Monitoring Diary

Diary overview

Wednesday, 22 June

If you have read the previous episodes of this diary, you have seen that we sometimes use equipment you will not find on many places. Some of these machines can be bought, but others are designed and built at NIOZ. Bob is one of the people at NIOZ who designs and builds new tools for us, the scientists. The last few months he has been working on a high definition under-water video system. In this case he did not design and build it completely from scratch, but bought some of the components of the system (why should you build your own camera if you can buy a really good one for a reasonable price).

The heart of the system however is his own work. This heart is best described as a big titanium can (which is very strong and is able to withstand deep-ocean pressure) with a wall thickness of about 2 cm, 70 cm long and almost 20 cm diameter. On the outside there are 15 connectors for different kinds of cables. Inside the can is a lot of electronics. This electronic heart makes that the power cables coming from the ship, under-water lights, camera, compass (so we know in which direction we are filming), the fibre optic cable sending the on-line video signal to the ship, and all sorts of control electronics work nicely together.

Bob busy writing manuals for his new equipment so his colleagues would know how to solve problems in the unlikely event that his electronic camera heart would fail.

These last few days on board Bob has been busy trying to fit everything in a frame (that was built by the NIOZ mechanical workshop). The frame will be used to tow the system just above the sea floor. This week the video camera has been tested while connected to the more than 9 km long fibre optic cable of the Pelagia which we will use to lower it to, during this cruise, the shallow North sea, but in the future also to the deep ocean. The system is almost ready. I think tomorrow the last details can be fixed. Within a few days we will use it for the first time. With this camera we will be able to see in detail how the seabed looks like, which animals live down there and (in my case) whether indeed there is methane gas bubbling from the sea bed. You will hear from it.

Henk de Haas

Video screens, cables, a 575 volts power supply, other electronic stuff and a pile of manuals, all belonging to the high definition under-water video system.
This part stays on board, there is much more going down into the sea.

RV Pelagia North Sea Monitoring Diary

Diary overview

Thursday, 23 June

This morning at 7:30 John, our captain, moored our ship in our home port Texel. This does not mean that our cruise is over. We are not even half way yet. We are just in today to pick up four of our colleagues (all benthic biologists) and a lot of equipment we will need during the rest of this cruise. Around 8 o'clock the men from the marine technology department started to bring 2 containers for seismic studies, one container with tools for benthic biological work, a lander, a gravity corer, and a lot more equipment. Don't worry if you have no idea what all these things might be, I will explain it during future episodes of this diary.

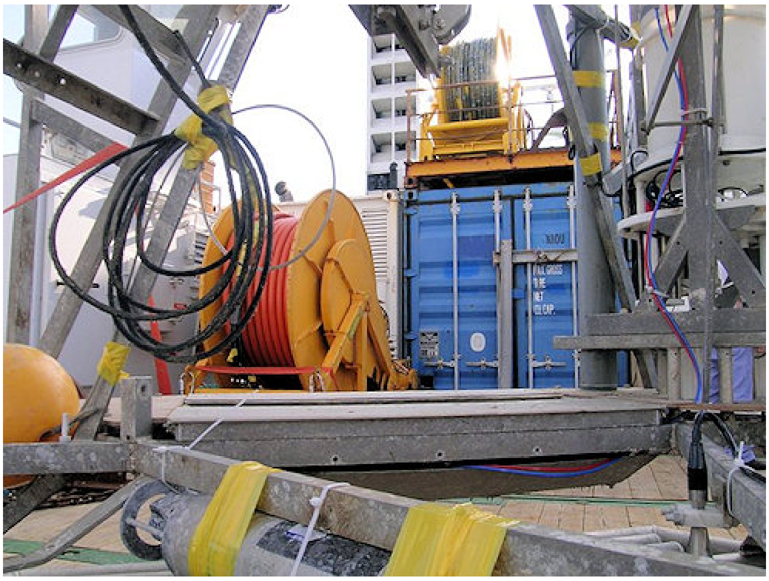
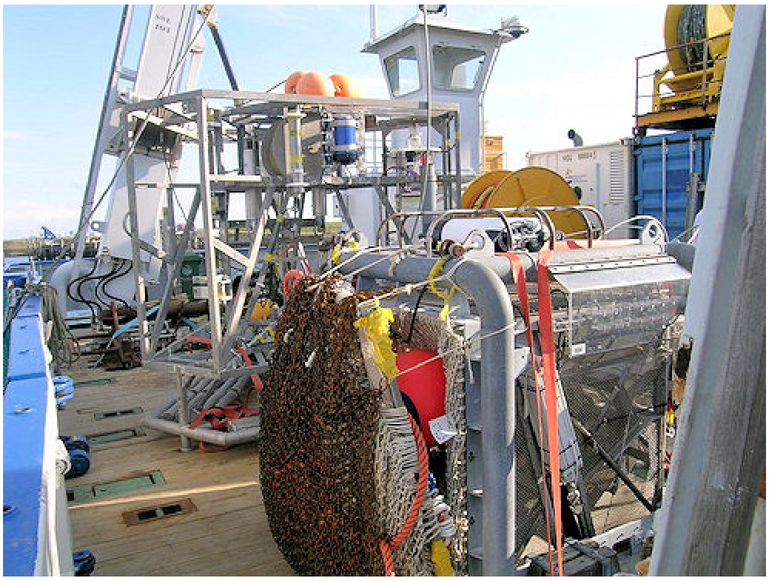


Photo from the aft deck, taken from about the same location as the photograph shown in the introduction. Note how much more stuff we have on board today compared to a week ago.

Up to this moment the ships crew is still busy to store everything in the proper place. It has been quite a puzzle to find a suitable location for everything. When you do not need it, is has to stand not in the way, but it should also be easily available when we want to use it. Some of the equipment is several hundreds to much more than a thousand kilos in weight, so it has to be placed in a location where it can be reached by crane. During the first week of this cruise there was a lot of space on deck, but now we only have some narrow paths left. In less than half an hour, at 8 o'clock (in the evening) we will leave again. The ship will set course in a southern direction, towards a location which is just a few ours steaming from Texel. There we will start working tomorrow morning at 9 o'clock. Why there, why starting at 9:00, and what will we do? You can read that tomorrow.

Henk de Haas



Another view of the aft deck showing a benthic dredge on front, a lander (the frame behind the dredge), followed by a beam trawl (the rusty thing on the left, behind the lander) and an umbilical winch (the round yellow thing in front of the white container), just to mention some of the equipment hoisted on board today.

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Friday, 24 June

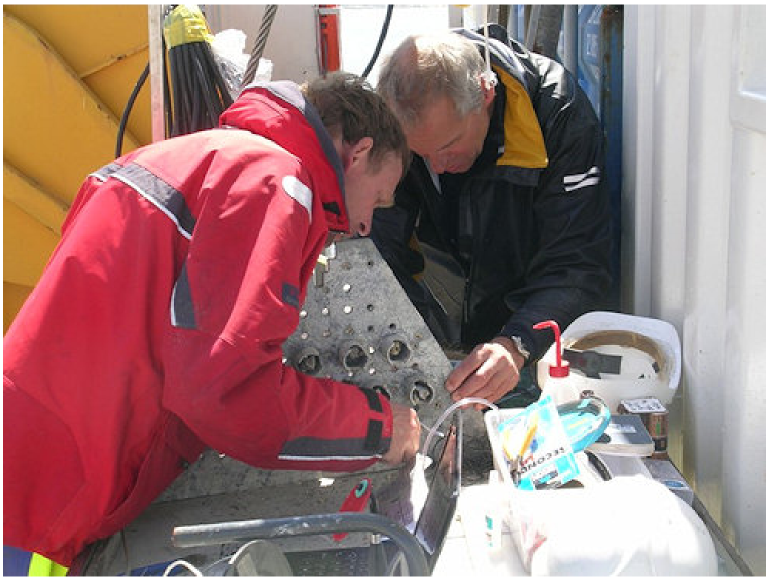
Today we had a little scientific intermezzo. Our activities were not related to the monitoring cruise we are doing at the moment. Despite this, it was still serious science. Rob, one of the biologists that came on board yesterday, was supposed to be on another ship earlier this week to do some work off the Dutch coast (for those of you who know the place: near to the Egmond wind park). Unfortunately, just like cars, also ships do have serious technical problems every now and then. The ship 'Rob' was supposed to work on did have these serious problems this week. In other words, that specific ship did not sail. But the work had to be done urgently. So 'Rob' joined our trip and today we went to his working area to get a lander out of the water and replace it with another one.

A lander is a frame we put at the seafloor. This frame contains devices like current meters, devices measuring the amount of sediment that is suspended in the water column, thermometers, salinity sensors, etc. These landers come in different versions each with its own combination of sensors, depending on the scientific question we want to answer. 'Rob' is working on a project in which he has to determine the amount of sediment that is transported along the Dutch coast and the influence this has on bivalves that live in the sea bed. The location of his lander is just 800 meter from the beach. In this area, all kind of small animals living here grow very fast. The result of this is that the instruments in the lander are overgrown rapidly and stop functioning after a few weeks already. As a result of this 'Rob' has to recover his lander and replace it by a clean one every three weeks. This is why 'Rob' joined us and we had to make room in our program to let him exchange his equipment.

Left: Detail of the clean lander we deployed near the coast at 10 metres water depth. Right: The same detail of the recovered lander that had been under water at this site for 3 weeks. It is completely overgrown with barnacles.

And I should not forget the special occasion that took place today. Two days ago I told you about the high definition under-water video Bob was working on. Today we tested it for the very first time under water. It worked perfectly well. Unfortunately we tested it on the lander site near to the coast. At this site there is a lot of sediment suspended in the water column. The only thing we saw was sand and mud passing by, in very high concentrations. We could not even see the sea floor when the camera frame was standing on it. Tomorrow we will arrive in an area where the water is much clearer and we expect to see how the sea floor looks like in high definition video.

Henk de Haas



Rob (left) and Gerard preparing some of the equipment
that had to be installed in the lander that we deployed today.

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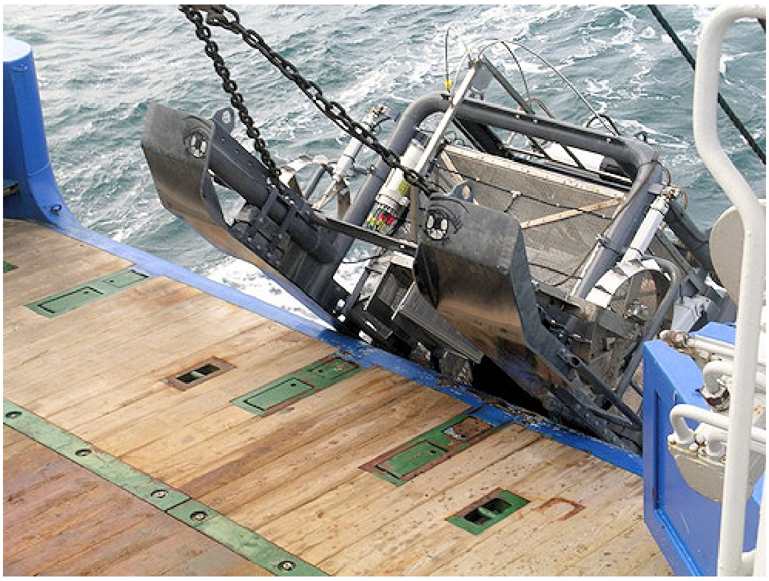
Saturday, 25 June

This morning the group of benthic biologists (Magda, Marc, Gerard and Rob) started their monitoring work of creatures living at and in the sea floor sediments of the North Sea. They do this by means of a box corer (a device that grabs bucket-size sediment samples from the sea bed), our much discussed high definition video system and a machine called deep digging dredge (or triple D), but here on board usually referred to as The Beast. The sediment samples taken with the box corer are sieved and the animals they find in there are counted, measured, described, etc. Marc is our specialist in determining the names of the animals that live in the North Sea, so he describes the animals that show up on the 1 hour video transects. But most of the attention is focussed on 'The Beast'. It consists of a big cubic frame mounted on two wide metal skies, with a fishing net behind it.

Willem, Jan-Dirk, Fred and Ger discussing what to do when The Beast shows up.

The cube is covered in a fine mesh and at the front is a small, about 20 cm wide, opening. This whole system is towed over the seabed behind the ship. The opening cuts also about 20 cm into the seabed, scooping up sediments. The distance the device is towed is measured, the size of the opening is known, so Magda and her team know exactly how big the volume of sediments is that was swallowed by The Beast. The sediments are flushed out through the net, but the animals stay behind. When the catch is brought on deck, the animals are sorted, counted, measured, weight, and stored. So they know exactly how many animals of which species and which size are present at which part of the North Sea. By doing this during several times per year during many years they not only find out where the animals lives, but also whether their numbers change over time.

Henk de Haas



Beware!! 'The Beast' is coming!!!

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Sunday, 26 June

After a while, when you do things over and over again, even on a ship things become routine. Box core sampling becomes routine, making high definition videos of the seabed becomes routine, even getting 'The Beast' (remember yesterday) in and out becomes routine. However, looking at the results never becomes a routine. Always there is this little excitement around. What will we see in the box core this time? Of course you know, it is most likely sand or mud, but is there anything else? Are there any animals, which species, and how many? And what is the quality? It may look easy, but taking a good box core requires a lot of experience. After a while a winch operator might do the technical handling as such routinely, but he still needs to concentrate on what he is doing. The same holds for any equipment that is being used on board. Concentration is needed, not only in order to get a good result, but also for safety. The winches are powered by hydraulics and very strong, so if anybody doesn't pay any attention things might go very wrong.

Roel waiting to haul in The Beast on the aft deck.

As the work is (partly) turning into a routine, the daily house- (or ship-)hold also continues. Cooking, cleaning everything has to be done, just as at it has to be done at home. Day in, day out. Of course on a ship there is this little extra that needs attention. Just to give you an example: today Tommy (our second officer) did his routine checks on the life vests. Everybody on board has one in his cabin, in case we have to leave the ship during an emergency. These vests have to be top condition (nothing broken, is the whistle attached to it, is the light still there, etc?). During the check it appeared that some of them were a bit damp, so Tommy has put all of them in the sun to dry. Just like hanging the laundry out to dry. Just Routine.

auteur

Some of the life vests hanging in front of the bridge to dry.

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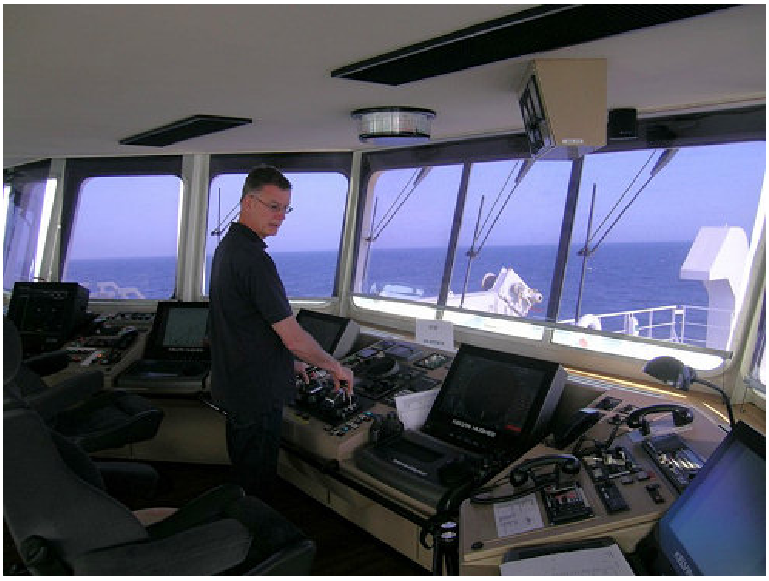
Who is the boss on board? Two people are boss on a research vessel. Of course there is the captain (during this cruise on the Pelagia it's John), but there also is a scientific boss, or chief scientist, and that is me. Both bosses have their own responsibilities. Even though the ships crew consists of in total 12 people, in the end the captain is responsible for all things related to the sailing of the ship, the safety of the ship and the well being of all people on board. This makes that the captain is the ultimate boss.
My work as a chief scientist is first to organise the cruise. This includes talking to other scientists and technicians who will join the cruise about what they would like to do on board and the type of equipment needed to do this. Then comes talking to technicians to get the equipment arranged (especially the larger and heavier things that scientists do not have under their own direction).

Typical desk of a chief scientist (I hope may daily programs are less chaotic).

And, I think nobodies favourite, there is the paperwork: collecting passport numbers of everybody that will be on board, collecting forms about chemicals we will use, ask diplomatic clearance to be allowed to do research in foreign coastal waters, etc. And once all these things have been arranged, the ship has been loaded (months after the cruise paperwork started) and is out at sea, the more practical part of being the chief scientist starts. At sea I have to make a daily program which tells the other people on board (scientists and crew) what the work plan is for that day.

The difficult part is to arrange the cruise in such a way that everybody will get his/her share of ships time to collect the data and samples they have planned for. For some reason scientists always come up with plans that are bigger than the available ships time allows. So the chief scientist has to start cutting, after consulting his colleague scientists on board of course. And then, in the evening before the day of that particular plan, I bring it to the bridge. The captain has the final word, because if for instance I want something to be done that is too dangerous to be carried out (because of bad weather, etc.) the captain will say "no". I may be the chief scientist, but the captain is the ultimate boss.

Henk de Haas



Bert, our first officer, who is the boss of the bridge between
4 and 8 o'clockin the morning and afternoon/evening.

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Tuesday, 28 June	

If you wouldn't know any better you might think that all the action on the Pelagia takes place on deck and on the bridge. However this is not true. In addition to the world upstairs, there also is a world downstairs. While today in the upstairs world there was a lot of ships handling going on on the bridge so that on deck the CTD, plankton net, video camera, box corer and 'The Beast' could be deployed several times, plenty of activities took place in the downstairs world as well.

The upstairs world: The harvest of the 'The Beast' has been put on the table and everybody who is in the mood to help is welcome separate the animals from the shell debris.

If you walk from the Pelagia working deck through the workshop and take a left turn, you will walk into the door leading to the downstairs world, better known as the engine room. This is the domain of Jaap and Marcel, our chief and 2nd engineer respectively. Ships engineers not only keep the engine running, the do much more. There is the maintenance and repairs on not only the engines, but the entire technical installation of the ship. A part of the maintenance and repairs is done by the deck crew, but most of the work is done by the chief and second engineer. Earlier this week Marcel was working on the ships internal telephone system. They have to keep an eye on the system for the special gases we use for our scientific work, check the drinking water supply and daily oil consumption by the engines. The filters of the air conditioning system have to be cleaned every week. If there is a problem with the hydraulic system that controls the cranes and winches, Jaap and Marcel have to solve it. This list goes on and on. In this manner Jaap and Marcel keep the ship running (or better, keep it afloat), to make sure that the science party on board can do its job.

Henk de Haas

The nerve centre of the downstairs world: Jaap in his control room in the belly of the ship.

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RV Pelagia North Sea Monitoring Diary

Diary overview

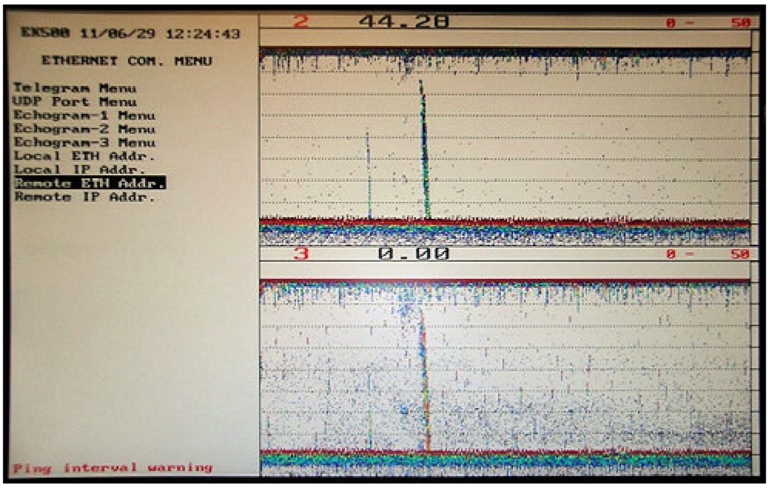
Wednesday, 29 June

Today (to be honest, we already started yesterday evening) we did something new, for this cruise at least. After having finished the benthic biology stations here at the Dogger Bank this morning, we started hunting for gas. Peter and I want to find locations in the North Sea were methane gas is coming out of the sea bed, so called methane seeps. In the future we want to go back to one of these locations and place equipment at the seafloor that measures the amount of gas coming out and whether this changes over time.

Methane is a strong greenhouse gas, so in order to understand how climate might change in the future, we have to understand the contribution of methane to this process. Of course with measuring at only one location we can never solve this complicated question, but it will be one piece added to the puzzle. Finding the methane seeps is done with different types of echo sounders. These echo sounders send a sound pulse into the water. The sound is reflected by the seabed (this is how the water depth is normally measured by ships), but also by gas bubbles in the water column. The reflected sound is picked up by the receiving part of the echo sounder and a computer produces an image of the gas in the water.

Before we could start this, Bob has spent quite some time in improvising some electronic solutions to get all these instruments running. At those places where a lot of gas comes out of the sea floor a flame-like structure, or flare, can be seen. Later during this cruise we will study these locations with our high definition video camera and take samples from the sea bed..

Henk de Haas



Flares (the coloured vertical lines) as shown by the computer.

RV Pelagia North Sea Monitoring Diary

Diary overview

Thursday, 30 June

Sometimes things just go slightly different than planned. The plan for today was to do a seismic survey of the area in which yesterday we had done the echo sounder studies. By the way a seismic survey is the big brother of an echo sounder survey. All the equipment is bigger, heavier and produces a stronger signal. We tow a device behind the ship which is called an air gun. Every 10 metres it produces a sound wave by releasing a small volume of pressurised are. The sound travels to the seabed and into the sediments below the seabed. The sound reflects on the different sand and clay layers (the sediments) and is received again by a streamer (think of a thick garden hose with microphones in it) that is towed behind the ship.

The sound signal goes to a computer that draws from the recorded echos an image of a cross section through the sea bed sediments. In this way we can see how the sediment layers are built up and how the methane gas migrates from the deeper sediment layers upwards to the sea floor. As said this plan did not work out, at least not this morning. First the computer failed, but Bob managed to repair it. Then the air gun failed, but Jack and Wim Jan managed to repair that one. The repairs took quite some work, so I had to come up with an alternative program.

The alternative was doing high definition video surveys on the gas seep sites we found yesterday. We have recorded some very clear videos of gas bubbling from the sea floor, and also found certain species of bacteria that are known to live in gas seep sites. This made Gerard, Magda and Marc very happy and they have already planned to take box core samples in this area tomorrow morning. Peter and I will be sleeping then, because the two of us will run the seismic survey this night. All the equipment has been repaired, so this night we can make up for the lost time earlier today. Good night.

Henk de Haas

Our neighbours: a drill rig drilling for, no joke, gas.

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Friday, 1 July

Yesterday I told you about the video recordings in the area where the methane was bubbling out of the sea bed. So this morning, while Peter and I were still in bed, because we worked throughout the night on the seismic survey until 8 o'clock this morning, Magda, Gerard and Marc took the opportunity to make a sampling transect across a bubble field. Also Paul, Anna and Swier took their standard morning CTD and algae net samples in the methane bubble area. The idea of the sampling transect is to look whether differences occur in the number and type of animals if you go from a methane bubble area towards the normal surrounding sea bed. In the area where methane comes out of the sea floor special types of bacteria live (we have seen their colonies on the video). Maybe these bacteria serve as food for larger animals that live on and in the sediments. So maybe the release of methane from the sea bed causes a change in the type of animals that live at and in the sea floor sediments at this part of the North Sea.

Pelagia crew and biologists gathered around a box core that just came on deck.

To further investigate the relationship between methane seepage and the distribution of animals, this afternoon Peter and I took water samples with the CTD to measure the amount of methane in the water along the same transect. We will also use these measurements to determine how fast the methane rises through the water column and reaches the atmosphere (or not). Tomorrow we will complete the measurements on this transect by taking long sediment cores and measure the methane in the sediments. By combining the biological and geological observations and measurements we will be able to better understand which processes are going on in the North Sea than by keeping the world of biology and geology apart.

Henk de Haas

Peter preparing his samples for the methane measurements.

RV Pelagia North Sea Monitoring Diary

Diary overview

Saturday, 2 July

Today was our last day on the Dogger Bank. Again, like two days ago, things did not go according to plan. This time the trouble maker was the gravity corer. A gravity corer is a very simple instrument that is used to take several metres long cores from the sea bed sediments. It consists of a heavy weight (in our case 1500 kg) attached to a steel pipe. In the steel pipe is a plastic pipe, and this is closed off by a device called a core catcher. The latter consists of a ring with thin finger-like metal plates that point upwards into the plastic pipe. The gravity corer is vertically lowered to the sea bed on a cable (the pipe is at the lower end). Because of the weight the pipe sinks into the sea bed, you hoist it up and the sediments are trapped in the plastic pipe by the core catcher. My idea was to take gravity cores along a transect from the centre of a methane seep outwards. In this manner it is possible to study the amount of methane in the sea floor sediments at the seep site and how it changes if you go further away towards the `normal' sea floor.

Reinier filtering water samples before it will be further analysed by Paul.

Unfortunately the sand making up the sea bed sediments are so fine grained that they flush through the fingers of the core catcher. If there would have been only the tiniest amount of clay present, the sediment would have been sticky enough to be trapped inside the pipe, but unfortunately there was no clay at all. So instead of using the gravity corer we took samples with the box corer. These were only about 20-30 cm long, but that was still much longer than the ones taken with the first instrument. Now we are on our way to the Cleaver Bank, southwest of our current position. On our way there we take some fish trawls so Marc, Rob, Magda and Gerard can get an impression of the distribution of fish and other animals at the sea bed. While on deck Wim Jan, Jack, Roel, Ger, Fred and Jan Dirk were taking samples for the geology and benthic biology groups, Anna, Swier, Reinier and Paul were busy analysing samples they had taken earlier this week and Bob was working on his manual for the high definition camera. So it is clear that when you do not get new samples or do not have to operate any equipment during a day at sea, this doesn't mean that you have nothing to do and might get bored.

Henk de Haas

Final view on the waters at Dogger Bank, heading towards Cleaver Bank.
The Pelagia crew has made the beam trawl ready for action.

RV Pelagia North Sea Monitoring Diary

Diary overview

Sunday, 3 July

While on the aft deck the last dredge of this cruise is being taken, Peter is measuring the methane concentrations in his last water samples, Swier is packing his last equipment in his last boxes and Arend is preparing the last evening meal of this cruise, I am writing the last episode of this cruise diary. Our trip is practically over. Tomorrow morning we will arrive at Texel. The morning will be filled with carrying boxes around the ship and putting them in containers, cleaning labs and cleaning our cabins. While especially the scientific part of the crew is busy with the end of this cruise, the technicians and officers of the Pelagia are also already working on the next cruise, and beyond. Jack has already made lists of equipment needed for future cruises, John is working on the paper work for customs (what leaves the ship on Texel, and what will come on board for the next cruise) and Tommie has already laid out a first version of the cruise track that will start four days from now.

As you see, planning a cruise is more than just have a scientific question, get your equipment and step on board. Many people, on the ship but also on land, are involved in organising it. And when the cruise has been done, then the real scientific work starts. Measurements that could not have been performed at sea will be done at NIOZ on Texel. And when all the data has been collected the data analysis starts. What do these numbers and observations really mean? The results of this cruise will be combined with existing data obtained during previous research programs and data that will be collected during future North Sea monitoring cruises. From the data we have gathered so far we will be able to say something about the present day processes active in the North Sea, but to really be able to say more about the (possible) future changes in these processes we have to re-visit the same sites in the years to come and measure the same variables we have measured during the past weeks. We have work to do.

Henk de Haas

Jan Dirk operating the winch during the last high definition video survey.