Cruise Report

JR18007

PSO: David Pond

Report compiled by Geraint A. Tarling

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1: Cruise summary

Cruise JR18007 comprised sampling operations for the following CAO projects.

DIAPOD: examining how the biomass dominant marine zooplankton taxon *Calanus* will be affected by future climate change in the Arctic through synthesising past datasets of *Calanus* in the Arctic alongside satellite-derived data on primary production to examine whether smaller, more temperate species have been increasingly colonising the Arctic. Furthermore, it will consider how the timing of life-cycle events may have changed over past decades and between different Arctic regions.

PETRA: investigating the impact of three stressors (temperature, ocean acidification and elevated irradiation) on the production and consumption of the climatically active gases nitrous oxide (N_2O), methane (CH_4), dimethyl sulphide (DMS) and carbon monoxide (CO) in the marine environment.

Micro-ARC: focussing on understanding of how short-term (e.g. seasonal) and long-term (e.g. climate-driven) changes in the physical environment of the Arctic Ocean are impacting pelagic microbial ecosystems and how these affect current and future organic matter (OM) biogeochemistry.

CHASE: investigating the behaviour, physiology and genetic responses of copepods and krill to their natural and new photoperiodic environments, with a focus on the circadian biological clock, central in day-length measurement and in orchestrating key seasonal life-cycle events.

Research summary for DIAPOD: Copepod species of the genus *Calanus* (*Calanus* hereafter) are rice grain size crustaceans that occur throughout the Arctic Ocean consuming enormous quantities of phytoplankton. These tiny animals represent the primary food source for many Arctic fish, seabirds and whales. During early spring, they gorge on extensive seasonal blooms of diatoms, fat-rich phytoplankton that proliferates both beneath the sea ice and in the open ocean. This allows *Calanus* to rapidly obtain sufficient fat to survive during the many months of food scarcity during the Arctic winter. Diatoms also produce one of the main marine omega-3 polyunsaturated fatty acids that *Calanus* require to successfully survive and reproduce in the frozen Arctic waters. *Calanus* seasonally migrate into deep waters to save energy and reduce their losses to predation in an overwintering process called diapause that is fuelled entirely by carbon rich fat (lipids). This vertical lipid pump transfers vast quantities of carbon into the oceans interior and ultimately represents the drawdown of atmospheric carbon dioxide. Continued global warming throughout the 21st century is expected to exert a strong influence on the timing, magnitude and spatial distribution of diatom productivity in the Arctic Ocean. Little is known about how *Calanus* will respond to these changes, making it difficult to understand how the wider Arctic ecosystem and its biogeochemistry will be affected by climate change. The overarching goal of this project is to develop a predictive understanding of how *Calanus* in the Arctic will be affected by future climate change.

The focus of JR18007 was the Fram Strait, where deep basins coincide with seasonal sea-ice generating ideal conditions for *Calanus* to accumulate large fat stores and enter diapause in deep ocean layers. At each station, there was a series of activities to address the objectives of DIAPOD. Specifically, a series of nets (including Bongo, MOCNESS, Hydrobios opening and closing nets and ring nets) were deployed to different depth horizons to study the depth distribution of *Calanus* and collect specimens. Furthermore, physiological experiments were carried out to assess rates of ingestion, turn-over and respiration. Chl-a and phytoplankton samples were collected to ground-

truth corresponding satellite images of surface productivity. *Calanus* samples were also collected to assess body condition and feeding history through stable isotope analysis

Research Summary for PETRA: The overall aim of PETRA is to investigate the role of (multiple) stressors for future trace gas (i.e. N_2O, CH_4, DMS and CO) cycling in the Arctic Ocean. Specific aims to be addressed are (listed in order of priority):

- to determine how stressors (warming, acidification, light) affect future trace gas production and consumption pathways,
- to determine the surface ocean and depth distributions of the trace gases listed above,
- to determine the relevance of air/sea gas emissions for the regional (Arctic) and global atmospheric trace gas budgets,
- to provide improved models of the mechanistic understanding of stressors on trace gas fluxes, which will provide the basis for increased understanding of the regional and global importance of these gases.

As part of JR18007, PETRA carried out six incubation experiments, at selected locations ranging from Atlantic to Arctic waters with contrasting sea ice conditions. To characterize each station over down to (~100m), discrete samples of CO, DMS, N_2O, CH_4, pH, CDOM (colored dissolved organic matter), pigments and DNA (functional genes for DMS and N cycling) were taken.

Research summary for Micro-ARC: The Micro-Arc project studies the microbial components of the Arctic food web, focusing specifically on planktonic microorganisms that inhabit the water column. Using a range of contemporary tools, it will determine how planktonic microbes regulate organic matter biogeochemical cycling and establish how these processes vary through the dramatic Arctic seasonal cycle.

As part of JR18007, Micro-ARC carried out sampling and protocols (1) to determine the abundance and size distribution of microgels; (2) to extract DNA and RNA of the water column and on microgels; (3) to sample for fungi cultivation in the water column; (4) to sample for phospholipid fatty acid (PLFA); and (5) to incubate $^{12}C/^{13}C$-labelled TEP.

Research summary for CHASE: The focus of JR18007 was to obtain specimens and carry out incubations to address the following CHASE objectives (1) to determine individual copepod and krill behavioural phenotypes with latitude and season; (2) to determine the metabolic status of behavioural phenotypes; (3) provide seasonal characterization of gene expression with a focus on clock mechanisms and the influence of light

For JR18007, CHASE collected community samples seasonal gene expression analysis over two separate 36-hour stations; carried out *Calanus* copepod swimming behaviour experiments using Trikinetics Locomotor Activity Monitors (LAMS); conducted copepod respiration experiments to provide a physiological correlate to rhythmic activity measurements made on individual *Calanus* copepods; and performed northern krill swimming behaviour experiments.

1.1 Science party

David Pond (Stirling Uni)

Anna Belcher (BAS)

Stephanie Sargent (AWE)

Jennifer Freer (BAS)

Patrick Downes (PML)

Tina Fiedler (GEOMAR)

Mehmet Can Köse (GEOMAR)

Oban Jones (PML)

Zara Botterell (PML)

Claudia Castellani (PML)

Tim Brand (SAMS)

Birthe Zaencker (MBA)

Hanna Campen (GEOMAR)

Holly Jenkins (U. Southampton)

Florence Atherton (U. Southampton)

Jordan Grigor (SAMS)

Joana Beja (BODC)

Gabriele Stowasser (BAS)

Geraint Tarling (BAS)

Dan Mayor (NOC)

Dave Conway (MBA)

Aidan Hunter (U. Strathclyde)

1.2 Technical support

AME Mechanical	Gareth Flint
AME Electrical	Ross Sanders

	Seth Thomas
IT support	Sean Vincent
Lab Manager	Aisling Smith

1.3 Officers and crew

CHAPMAN Graham P	Master
WALLACE, Simon J	Chief Officer
FLYNN Peter	2nd Officer
CRAMMAN, Scott	3rd Officer
MACGREGOR, Gail K	3rd Officer
O'HARA, Patrick M	ETO Comms
KUBULINS Andris	Chief Engineer
DONALDSON Christopher	2nd Engineer
HARDY Aleksandr J W	3rd Engineer
EADIE Steven J M	4th Engineer
SUTTON, Robert T	Deck Engineer
STEVENS Douglas J	ETO
LIDDY John S C	Purser
SUTTON Lloyd S	Purser
CHADWICK Amber N	Doctor
MULLANEY Clifford	Bosun Science
O'DUFFY John	Bosun
LENNON Craig T	Bosun's Mate
PICTOR Stephen J S	Motorman
VARGAS LEON Carlos E	Motorman
MACANS, Arnis	Motorman
BONSU Samuel K	SG1A
McMAHON Mark D	SG1A
PECK Daelyn R	SG1B

MUNOZ Paula	SG1B
HOWARD, Alan S	SG1A
STONE, Victoria V P	Chief Cook
NOBLE David G	2nd Cook
LEE Derek W	Senior Stwd
BOURNE Eric K	Steward
WILLIAMS David V	Steward
BURCH Oliver M	Steward

1.4 Map of stations for cruise JR18007

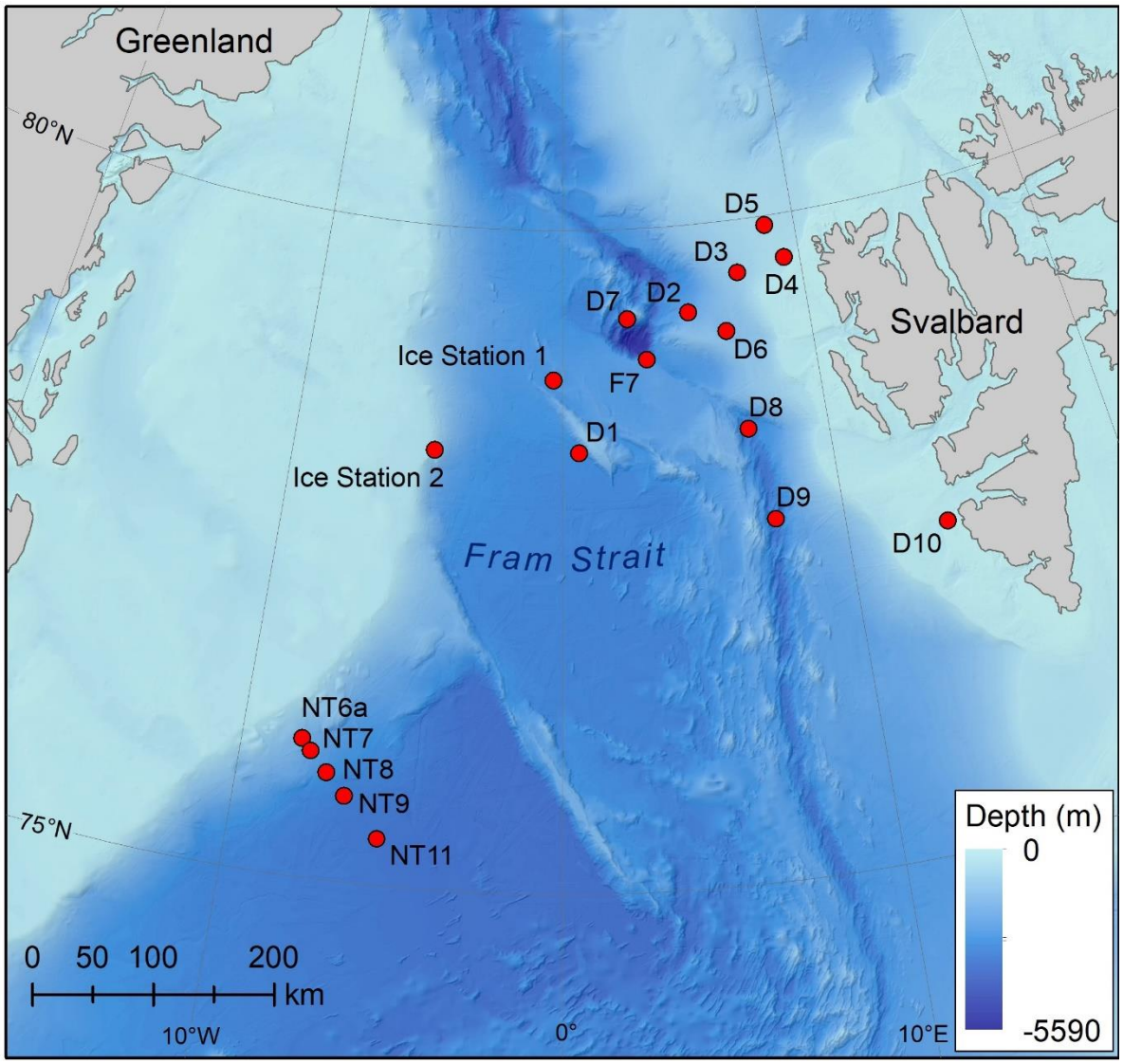


Fig. 1.4.1 Map showing location of major sampling stations during cruise JR18007. Bathymetry extracted from IBCAO (https://www.gebco.net/about_us/committees_and_groups/scrum/ibcao/). Map generated by Laura Gerrish from MAGIC at the British Antarctic Survey"

2.Hydrography and physics

2.1 On board instrumentation

Systems used on cruise

Instrument	#SN if Used	Make and Model	Comments
Lab Instruments			
AutoSal	63360	OSIL 8400B	
Scintillation counter	SGTC20150612	PERKINELMER TRI-CARB 2910TR	Used by external Scientist
XBT	NO		
Acoustic			
ADCP	Yes		
EM122	No		
TOPAS	No		
EK60/80	Yes		
K-Sync	Yes		
SSU	No		
USBL	Yes	Sonardyne Ranger 2	
10kHz IOS Pinger	No		
Benthos 12kHz Pinger	No		
Benthos 14kHz Pinger	No		
Mors 10kHz Transponder	No		
EA600	Yes		Bridge Equipment but logged
Oceanlogger			
Barometer1	V145002	VAISALA PTB210B1A2B	Inside the UIC
Barometer2	V145003	VAISALA PTB210B1A2B	Inside the UIC
Air humidity & temp1	61019333	Rotronic Hygroclip 2	On Foremast
Air humidity & temp2	61019251	Rotronic Hygroclip 2	On Foremast
TIR1 sensor (pyranometer)	172882	Kipp & Zonen Sp Lite2	On Foremast
TIR2 sensor (pyranometer)	172883	Kipp & Zonen Sp Lite2	On Foremast
PAR1 sensor	160959	Kipp & Zonen PQS-1	On Foremast
PAR2 sensor	160960	Kipp & Zonen PQS-1	On Foremast
Thermosalinograph	4524698-0018	SBE45	PrepLab
Transmissometer	1497DR	CST	PrepLab
Fluorometer	1498	WSCHL-1498	PrepLab
Flow meter	05/811950	LitreMeter F112-P-HC-AP-OR-PP	PrepLab
Seawater temp 1	0765	SBE38	Sea Inlet
Seawater temp 2	0771	SBE38	Sea Inlet

(Continued on next page)

Instrument	#SN if Used	Make and Model	Comments
CTD			
Deck unit 1	0458	SBE11plus	
Underwater Comms/ Depth	0541	SBE9plus	
Temp1	5043	SBE3plus	
Temp2	4874	SBE3plus	
Cond1	1913	SBE 4C	
Cond2	3491	SBE 4C	
Pump1	1807	SBE5T	
Pump2	4458	SBE5T	
Standards Thermometer	0051	SBE35	
Transmissometer	CST-527DR	C-Star	
Oxygen sensor	0242	SBE43	Plumbed on T2&C2 line.
PAR sensor	70688	QCP2350	
Fluorometer	12-8513-001	CTG Aqua Tracker MkIII	
Altimeter	163162	Tritech S10127 232	
CTD swivel linkage	196115	Focal Technologies Group	
LADCP Master Down	14443	TeleDyne WHM300	
LADCP Slave Up	15060	TeleDyne WHM300	
Pylon	0636	SBE32	
Other ship's systems (non-AME)			
Anemometer	Yes		Bridge Equipment, logged
Ships Gyro	Yes		Bridge Equipment, logged
System(s) brought by science team (non-AME)			
EXTRA NOTEWORTHY Sensors	No		

Notes for Lab Instruments used

AutoSal

No problems were reported by the scientists. Used in the passage between the prep lab and main lab. Moved to the Rad lab for the next cruise.

Scintillation Counter

The Scintillation counter was used by Patrick Downes of PML. No Problems.

Notes for Deck Systems

Winch Counter

No problems.

SUCS

Not used

XBT

Not used.

Notes for Acoustic Systems used

The Acoustic systems on the ship were started and maintained during the cruise by Sean Vincent (ICT). They were all configured to operate through the K-Sync unit.

ADCP

Not used.

EM122

Not used.

EK60/80

The system was run and operated by Sean Vincent. No issues were reported.

USBL

Used on CTD and Mammoth net.
Beacons 1, 4 and 5 used in rotation.
No problems.

EA600

No problems.

Notes about the Oceanlogger

Flurometer giving full scale output. Investigation involved check of ADC unit. Resolved by cleaning the flurometer of biological matter with a cotton bud and milli-q.

Ocean logger off on 06/08/2019 from 5am to 12am and from 27/08/2019 from 2am.

Notes about the CTD

Basic Stats			
Number Of Casts	48	Number of Successful Casts	48
Max Depth	3700	Min Depth	50
Cable Removed (m)	0	Number of Re-terminations (elect.)	0

CTD Deployment Procedure

Prior to deployment all bottles are cocked and the deionised water is vented from the T/C sensors. The lenses for Transmissometer, Fluorometer and PAR and wiped clean with milliQ and Kimtech, and then dried with Kimtech. Pre-deployment technical tests are carried out on the LADCP's and are logged. The LADCP is then activated and starts logging.

Once the Deck crew and winch operator are ready the CTD is lifted into the water and lowered to 10m, where power is started and logging begins. It is held here until the operator sees the difference between T1/T2 and C1/C2 stabilize. This can take some time, especially if the air temperature and

sea temperature are far apart. In some circumstances such as turbulent surface waters or areas with large thermoclines, it can be necessary to lower the CTD to 20m or further to a depth where the temperature is more stable. Once stable, the CTD is lifted to as near to the surface as the winch operator deems safe then is lowered to the required depth or near bottom without stopping (attempting to maintain a constant velocity of 60m/min). The bottom depth is an approximation from the best echo sounder available, commonly the EM122. If bottom depth is required then the altimeter will start working from within 100m of the sea bed and is used to stop approximately 10m from the sea bed. From here some adjustment can be made to get closer, but is done at the operator's discretion. Once the down cast is complete bottles are fired at requested depths, in order of deepest first. After each bottle is fired at least 15 seconds are given to ensure that the independent standards thermometer has time to take a reading (The minimum is 8 seconds as defined in the manual).

Once on the surface the CTD is returned to the vessel, the C/T sensors are filled with deionised water to avoid damage. All data is backed up as soon as possible.

Information about CTD physical configuration

Name	Purpose	Distance from Base of Frame to Sensor (m)
Altimeter	Distance to sea bed (max 100m)	0.045
LADCP Master	Downward Facing LADCP	0.09
Temp1/Temp2	Temperature at 24Hz	0.3
Fluorimeter	Measures Florescence	0.165
9+	Communications and Pressure measurement	0.39
C1/C2	Conductivity Cells	0.345
Dissolved Oxygen	Oxygen in the Water	0.365
Bottles Bottom End Cap	Water collection (24)	0.56
Bottles Top End Cap	Water collection (24)	1.66
Transmissometer	Measure of light transmitted through water	0.27
SBE35 Top	Accurate Temperature sensor	1.43 (1.39)
SBE35 Bottom	Accurate Temperature sensor	0.75
Par	Radiation Sensor	1.61

Operational Log Summary

This is a shortened list of the CTD operational logs. The rest can be found on the JCR AME WIKI. The logs are listed from newest to oldest.

CTD Points of Discussion

Dissolved Oxygen Sensor Placement

The Dissolved Oxygen (DO) Sensor is normally plumbed on the same pump as Conductivity Sensor 1 (C1) and Temperature Sensor 1 (T1). However early on in the JR18 season it was incorrectly plumbed on to the T2 and C2 pump. This mistake was not picked up until late in the JR18 season, and a decision was made to keep the configuration and just make it known for all JR18 season cruises. This will be rectified in the JR19 season.

20L Niskin Leaks

All bottles leaked on cast 15 on 14/08/2019. Original O-rings (believed to be nitrile 70) removed and replaced with silicone (polymax part number: BS345SR70). No leaks during all casts from this point.

PTFE O-rings were ordered but not installed.

O-ring size is 100mm I.D. x 5.3mm CS.

CTD maintenance

Bottle leak

On recovery of cast 12 (11/08/2019) bottle 23 was leaking, all other were sealing well. The bottle was found to have a large chip in the bottom cap seat and a small chip in the top cap seat. The bottle was replaced with a spare which resolved the leak. All other bottles were inspected and no faults were found.

SBE35 date incorrect

On the 15/08/2019 it was noticed that the date stored on the SBE35 was incorrectly set to July. All other parameters were correct including day of month and time. The date and time were corrected.

Bottle failure to seal

On cast 36 (22/08/2019) bottles 10 and 11 failed to seal. This was caused by the lanyard from bottle 10 getting caught in the lid of 11. This stopped 11 from sealing and pulled 10 open slightly.

LADCP cable

Around cast 40 comms to the slave began to degrade. The instrument could be set up and deployed but had to be recovered at a lower baud rate. This degraded to the point where the slave was unusable for the last few casts. This was caused by water entering a repair joint in the submerged cable.The LADCP cable was removed at the end of the cruise and taken to Cambridge for test and repair.

Sea End Cable Termination

No re-terminations were carried out.

Optic Sensor Calibration

It is good practice to test the optic sensors at the beginning and end of the cruise to evaluate drift. More specifically for the Transmissometer and PAR sensors who require testing to define their calibration constants.

This is done by turning on the CTD and allowing everything to stabilise for 10 minutes. During this time it is important to clean the Transmissometer and PAR lenses. Wet kimtech with milliQ and wipe lenses clean, then dry with kimtech. After 10 minutes, completely cover the PAR sensor (so that no light can reach its lense), and then completely block the transmissiometer beam. Leave like this for 5 minutes. Then remove the covers and leave for a further 5 minutes.

After this you can shut off the CTD, and review the archived data in “seasave”. Pull up a plot of voltage 0 (transmissometer voltage measurements) and voltage 6 (PAR voltage measurements). For the transmissometer zoom in to the plot to find the stable peak and trough voltages. The stable peak voltage is measured when there is no beam attenuation, and is defined as “A1”. The stable trough voltage is measured when there is full beam attenuation (blocked), and is defined as “Y1”. Similarly for PAR, plot the measured voltage and look for the trough stable voltage. This is defined as the “Voltage in Dark Value”.

These measured values and the values provided in their calibration documents, are used to calculate the calibration constants needed in “Seasave” XMLCON. These are shown in the following tables.

PAR Parameter	Start of Cruise	End of Cruise
Date	06/07/2019	30/07/2019
Voltage in Dark	0.008547009	0.00854701
Calibration Constant	1.926782E+10	1.926782E+10
Offset	-5.29315E-2	-5.29315E-2

Transmissometer Parameter	Start of Cruise	End of Cruise
Date	06/07/2019	30/07/2019
Tw%	100%	100%
A1	4.797313V	4.7828V
Y1	0.003663V	0.003663V
M	21.23828	21.29832
B	-0.07779583	-0.07801575

2.2 CTD data

Joana Beja (BODC)[a], Ross Sandlers (BAS-AME), Aiden Hunter (Strath Uni), Seth Thomas (BAS-AME)
a. Dataset originator and author

Data Acquisition

A total of 48 CTD casts were done during the cruise, with 18 of them sampling the full water column column and the remaining to no more than 200 m, depending on which team, parameters were being sampled.

For water collection for DIAPOD-NOCS team, the CTD was lowered to 50 m and water collection at the chlorophyll maximum was performed during the upcast.

For the physics profile, the CTD package was deployed to full depth and stopped at different depths during the upcast to collect water samples for Nutrients, Oxygen, Salinity, Gels, POM, Chlorophyll, lugols and fatty acids.

For the PML and GEMOAR PETRA team, the CTD package was deployed twice. The first deployment was to 200 m depth and bottles were fired at specified depths during the upcast and both teams collected water for their samples. The second deployment was to 100 m and all bottles were sampled at the same depth for the PML incubation experiments.

For all CTD casts, the deployment procedure was standard and is described in the AME report. The CTD instrumentation is described on the AME report, including sensor make/model, serial number and calibration dates, so will not be repeated on this section.

The table below is an extract of the cruise event log with the metadata pertinent to the CTD casts.

ID	SITE	EVENT #	Start time (UTC)	Start Lat (+N)	Start Lon (+E)	End time	End Lat (+N)	End Lon (+E)	Wdepth (m)	Comments
CTD001		1	07/08/2019 11:20	69.52319	-2.9238	07/08/2019 11:54	69.5232	-2.92379	3570	Shakedown cast, samples collected for DIAPOD-NOCS
CTD002		3	07/08/2019 13:27	69.52321	-2.92385	07/08/2019 13:53	69.52319	-2.92375	3571	Samples for PETRA
CTD003	NT11	5	08/08/2019 21:02	75.33563	-5.46446	08/08/2019 21:22	75.33562	-5.46444	3570	Samples collected for DIAPOD NOCS. Deployed to 50m
CTD004	NT11	10	09/08/2019 00:43	75.33557	-5.46415	09/08/2019 03:16	75.33555	-5.46428	3570	Physics
CTD005	NT9	14	09/08/2019 14:30	75.64241	-6.62673	09/08/2019 16:30	75.64241	-6.62669	3282	Physics
CTD006	NT8	15	09/08/2019 21:09	75.79555	-7.21911	09/08/2019 21:31	75.79555	-7.21911	2695	Samples for DIAPOD-NOCS
CTD007	NT8	22	10/08/2019 01:31	75.79556	-7.21916	10/08/2019 03:30	75.79558	-7.21915	2694	Physics
CTD008	NT7	26	10/08/2019 14:39	75.94947	-7.81646	10/08/2019 16:02	75.94945	-7.81637	2037	Physics
CTD009	NT6a	27	10/08/2019 21:07	76.03862	-8.09524	10/08/2019 21:32	76.03862	-8.09518	1636	Deployed to 50m. Samples for DIAPOD-NOCS
CTD010	NT6a	33	11/08/2019 00:20	76.03591	-8.1369	11/08/2019 01:50	76.03518	-8.1502	1572	Physics

ID	SITE	EVENT #	Start time (UTC)	Start Lat (+N)	Start Lon (+E)	End time	End Lat (+N)	End Lon (+E)	Wdepth (m)	Comments
CTD011	NT6a	34	11/08/2019 03:07	76.0352	-8.15024	11/08/2019 03:41	76.03516	-8.15053	1572	Deployed to 100m. Samples for PETRA
CTD012	NT6a	35	11/08/2019 04:52	76.03515	-8.15045	11/08/2019 05:23	76.03496	-8.15298	1572	Deployed to 75m. Samples for PETRA
CTD013	F7	39	12/08/2019 14:21	79.00021	3.33068	12/08/2019 14:52	79.0002	3.33079	3022	Deployed to 250m. Samples for CHASE
CTD014	F7	49	13/08/2019 22:24	78.99987	3.33376	13/08/2019 22:47	78.99987	3.33381	3023	Deployed to 50m. Samples for DIAPOD-NOCS
CTD015	F7	53	14/08/2019 02:39	79.00002	3.33316	14/08/2019 05:04	79.00002	3.3331	3021	Physics
CTD016	Ice Station 1	59	14/08/2019 21:11	78.91531	-0.28817	14/08/2019 21:37	78.91229	-0.29398	2527	Deployed to 55m. Samples for DIAPOD-NOCS
CTD017	Ice Station 1	62	14/08/2019 23:50	78.87103	-0.31714	15/08/2019 01:37	78.844	-0.35682	2657	Physics. Samples for salinity at depth only
CTD018	Ice Station 1	64	15/08/2019 03:58	78.78386	-0.48256	15/08/2019 04:34	78.77402	-0.50622	2526	Deployed to 200m. Physics
CTD019	Ice Station 2	65	15/08/2019 21:06	78.36376	-4.64363	15/08/2019 21:30	78.35681	-4.66174	837	Deployed to 200m. Samples for DIAPOD-NOCS
CTD020	Ice Station 2	68	15/08/2019 23:19	78.33007	-4.72773	16/08/2019 00:10	78.31976	-4.75201	672	Deployed to 658m. Physics
CTD021	Ice Station 2	69	16/08/2019 01:38	78.30135	-4.78202	16/08/2019 02:15	78.29441	-4.79097	608	Deployed to 200m. Samples for PETRA

ID	SITE	EVENT #	Start time (UTC)	Start Lat (+N)	Start Lon (+E)	End time	End Lat (+N)	End Lon (+E)	Wdepth (m)	Comments
CTD022	Ice Station 2	70	16/08/2019 03:55	78.27185	-4.80775	16/08/2019 04:27	78.26511	-4.81674	586	Deployed to 100m. Samples for PETRA
CTD023	D1	74	16/08/2019 21:06	78.31705	0.61618	16/08/2019 21:28	78.31706	0.61615	2962	Deployed to 50m. Samples for DIAPOD-NOCS
CTD024	D1	77	16/08/2019 23:40	78.31706	0.61605	17/08/2019 02:10	78.31705	0.61615	2962	Physics
CTD025	D2	81	17/08/2019 21:06	79.33322	5.16727	17/08/2019 21:35	79.33325	5.16721	2125	Deployed to 200m. Samples for DIAPOD-NOCS
CTD026	D2	85	18/08/2019 00:02	79.33321	5.16726	18/08/2019 02:12	79.33321	5.16734	2125	Physics
CTD027	D2	90	18/08/2019 12:34	79.36926	4.84121	18/08/2019 13:22	79.36927	4.8413	2418	Deployed to 575m. Samples for DIAPOD-NOCS
CTD028	D3	91	18/08/2019 21:08	79.59994	7.33298	18/08/2019 21:30	79.59995	7.33296	881	Deployed to 60m. Samples for NOCS
CTD029	D3	94	18/08/2019 23:12	79.59994	7.33224	19/08/2019 00:10	79.59993	7.33226	881	Physics
CTD030	D4	100	19/08/2019 21:06	79.66659	9.39961	19/08/2019 21:30	79.6666	9.39959	341	Deployed to 50m. Samples for DIAPOD-NOCS
CTD031	D4	103	19/08/2019 23:14	79.66658	9.39954	19/08/2019 23:53	79.66661	9.39961	341	Physics
CTD032	D5	108	20/08/2019 12:30	79.90432	8.88788	20/08/2019 12:42	79.90458	8.85881	469	Deployed to 50m. Samples for micro-ARC

ID	SITE	EVENT #	Start time (UTC)	Start Lat (+N)	Start Lon (+E)	End time	End Lat (+N)	End Lon (+E)	Wdepth (m)	Comments
CTD033	D5	109	20/08/2019 13:33	79.9211	8.8522	20/08/2019 14:06	79.92325	8.78759	474	Deployed to 100m. Samples for PETRA
CTD034	D5	113	20/08/2019 16:25	79.93454	8.61978	20/08/2019 16:58	79.9372	8.59846	485	Deployed to 75m. Samples for PETRA
CTD035	D6	114	20/08/2019 22:07	79.1666	6.59987	20/08/2019 22:32	79.16659	6.60002	1491	Deployed to 250m. Samples for CHASE
CTD036	D6	128	22/08/2019 21:05	79.16651	6.59987	22/08/2019 21:36	79.16649	6.59984	1491	Deployed to 50m. Samples for DIAPOD-NOCS
CTD037	D6	131	22/08/2019 23:29	79.16656	6.59985	23/08/2019 01:04	79.16655	6.59981	1491	Physics
CTD038	D7	135	23/08/2019 21:08	79.31692	2.64929	23/08/2019 21:32	79.31693	2.64924	3235	Deployed to 50m. Samples for DIAPOD-NOCS
CTD039	D7	138	23/08/2019 23:13	79.31693	2.64927	24/08/2019 02:49	79.31697	2.64902	3235	Physics
CTD040	D7	139	24/08/2019 03:58	79.31695	2.6491	24/08/2019 04:41	79.31695	2.64904	3235	Deployed to 200m. Samples for PETRA
CTD041	D7	140	24/08/2019 06:12	79.31695	2.64918	24/08/2019 06:40	79.31693	2.64917	3235	Deployed to 100m. Samples for PETRA
CTD042	D8	145	25/08/2019 00:33	78.41663	6.99986	25/08/2019 00:55	78.4166	6.99984	3362	Deployed to 50m. Samples for DIAPOD-NOCS
CTD043	D8	148	25/08/2019 02:48	78.41662	6.99995	25/08/2019 05:26	78.41661	6.99999	3362	Physics

ID	SITE	EVENT #	Start time (UTC)	Start Lat (+N)	Start Lon (+E)	End time	End Lat (+N)	End Lon (+E)	Wdepth (m)	Comments
CTD044	D9	153	25/08/2019 21:32	77.71672	7.58313	25/08/2019 21:54	77.71671	7.58305	3539	Deployed to 50m. Samples for DIAPOD-NOCS
CTD045	D9	156	25/08/2019 23:45	77.71672	7.58316	26/08/2019 03:10	77.71671	7.58312	3539	Physics
CTD046	D10	160	26/08/2019 21:23	77.46681	13.49352	26/08/2019 21:49	77.46682	13.49353	211	Physics
CTD047	D10	163	26/08/2019 23:15	77.4668	13.4936	26/08/2019 23:45	77.46683	13.49358	211	Deployed to 200m. Samples for PETRA
CTD048	D10	164	27/08/2019 01:04	77.46681	13.49359	27/08/2019 01:33	77.46681	13.49362	211	Deployed to 100m. Samples for PETRA

Table 2.2.1 CTD casts during JR18007

DATA PROCESSING

The CTD processing was done using the SeaBird Data Processing software version 7.26.7.1 and followed established procedures that are briefly described below.

DATCNV: Converts the binary data to ascii (.cnv) and generates .ros files

BOTLLESUM: Creates bottle files (.btl), from the files containing the sensor information when bottles were fired during the upcast (.ros and .bl)

FILTER: Smoothes out response time issues in the sensors, which may affect processing at later stages such as for Cell TM.

ALIGN CTD: Aligns parameter data in time, relative to pressure, ensuring that calculations of salinity, dissolved oxygen concentration, and other parameters are made using measurements from the same parcel of water. Two seconds were chosen as the best alignment time for the Oxygen data.

CENTRAL THERMAL MASS: filters conductivity cell thermal mass effects from the measured conductivity. Values used for Alpha and 1/beta were 0.03 and 7.0, respectively

SECTION: Removes the soak and upcast data from the files

LOOPEDIT: marks scans with a bad flag wherever there is a pressure slowdown or reversal (typically caused by ship heave)

DERIVE: Derives new salinity and oxygen channels after corrections were implemented with previous procedures

BIN AVERAGE: Averages the data to 1db.

The data are uncalibrated at this stage and further processing will take place at BODC, including calibration for temperature, salinity and oxygen.

Below are two graphs for uncalibrated Temperature and Salinity for all CTD stations.

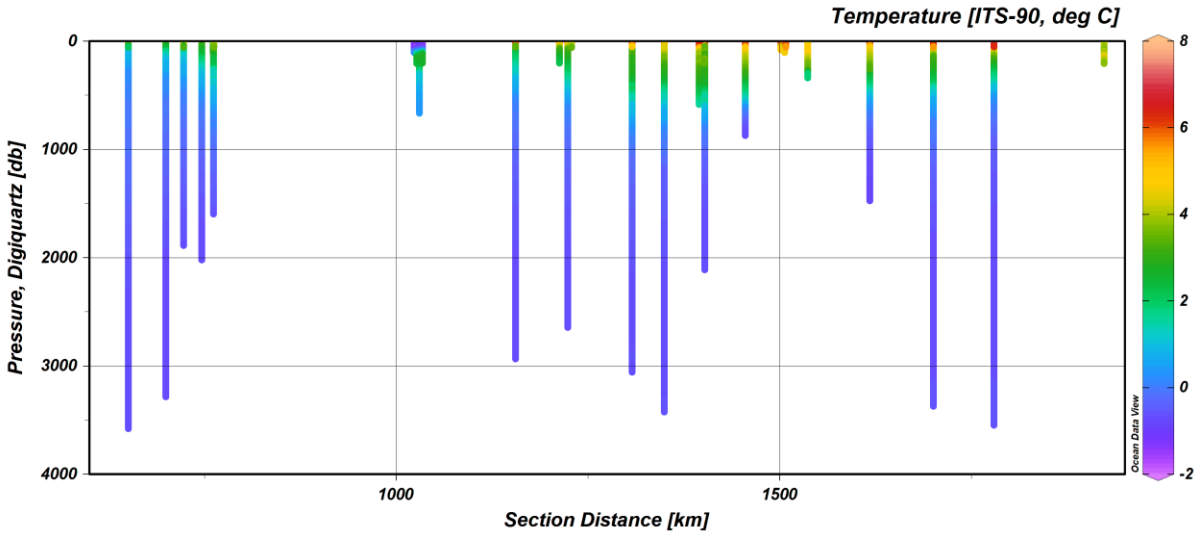


Fig. 2.2.1 Temperature for all JR18007 CTD stations (primary sensor)

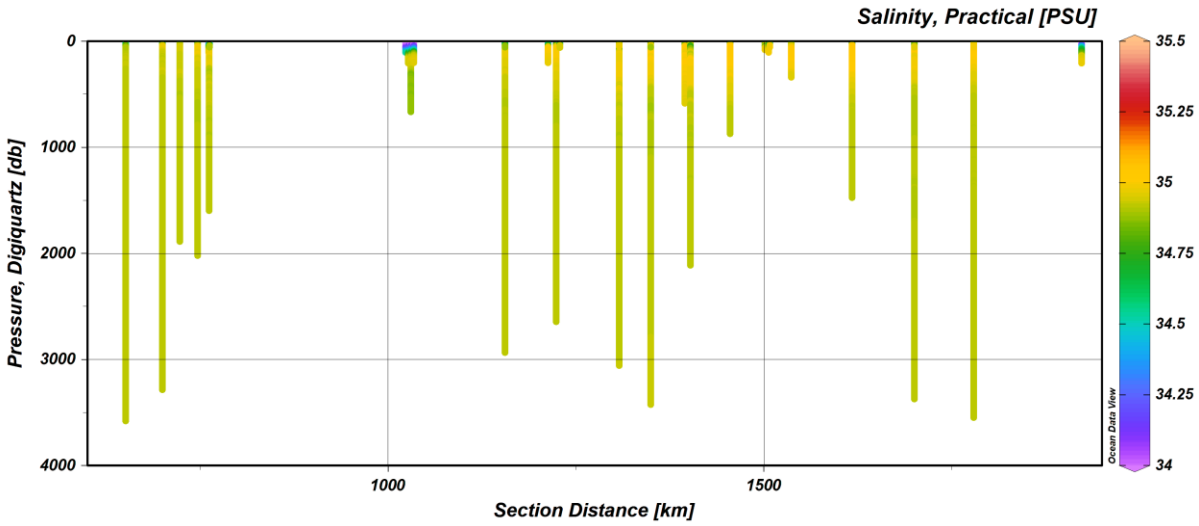


Fig 2.2.2 Salinity for all JR18007 CTD stations (primary sensor)

2.3 Underway data

Joana Beja (BODC)[a], Ross Sandlers (BAS-AME), Seth Thomas (BAS-AME)
a. Dataset originator and author

The ship's fitted systems collected navigation, bathymetry, meteorology and surface hydrography data throughout the cruise. The sensors' details for these systems are included in the AME report and users should refer to that section for more information.

There are a number of gaps identified throughout the cruise data, two of those gaps refer to when the ship was transiting through Faroese and Norwegian national waters and the remaining when the ship was sailing through ice.
The period from 05:00 hours to 12:00 hours (UTC) on August 6th refer to when the ship was sailing in Faroese national waters. The second period dates from August 28th at 09:00 to August 29th 23:00 (UTC) when the ship was within the 4 mile zone in Norwegian waters. No data collection was done during these periods.

No processing was done on board. The data will be processed and calibrated by BODC.

Below are the plots for the main meteorological (primary sensors only) and surface hydrography data.

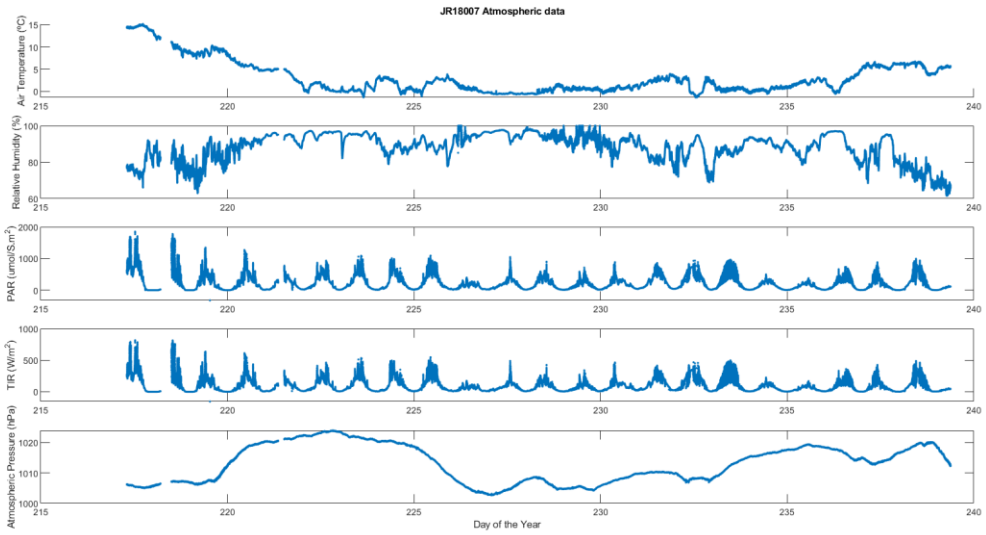


Fig. 2.3.1 Primary sensor meteorological data for JR18007

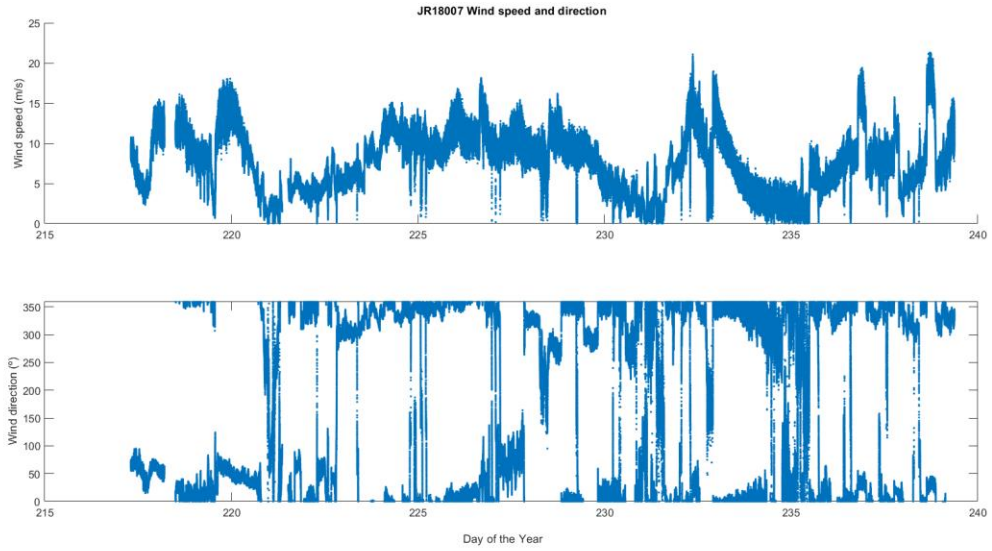


Fig. 2.3.2 Anemometer data for JR18007

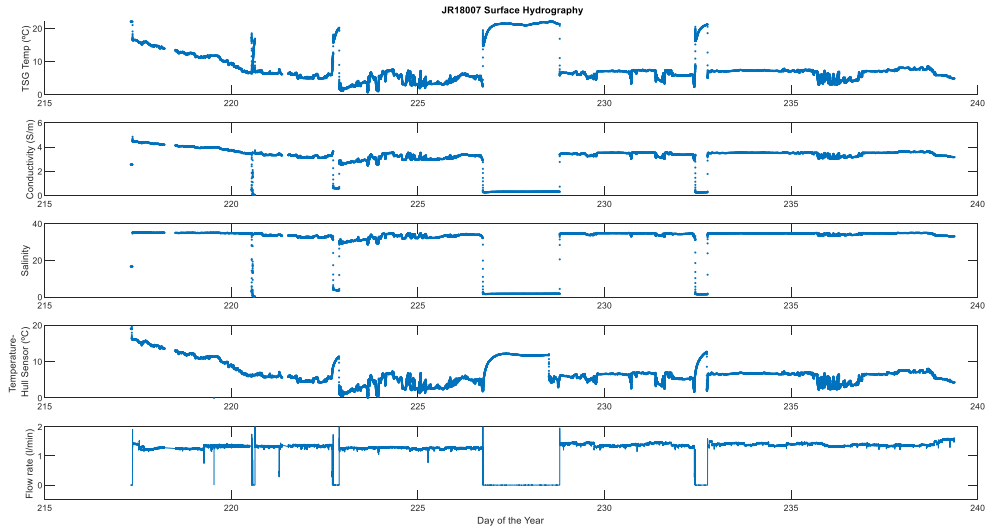


Fig. 2.3.3 Surface Hydrography data for JR18007

2.4 Salinometer

Aisling Smith

Salinity samples were collected every 6 hours from the ship's underway system during the cruise and 6 depths were sampled at each CTD deployment. Samples were collected according to cruise protocol and stored at room temperature for 24 hours prior to analysis.

Samples were analysed on a BAS owned Guildeline Autosal, Serial number 63360, which are calibrated annually. The instrument was standardised (R set) during the previous cruise, JR18006, and CRM readings were within range so the instrument was not re-standardised during JR18007. Bath and room temperature were set to 24 degrees.

CRM used were supplied by OSIL (Ocean Scientific International Limited) and were run at the start and end of each crate of 24 samples. Results were consistent and repeatable with little drift observed during analysis. CRM batch 161 was used for analysis of the 116 cruise samples.

3. Nutrient analysis

Tim Brand
The Scottish Association for Marine Science

The principle water column dissolved nutrients, ammonium, phosphate, silicate (reactive silica), total oxidised nitrogen (TON) and nitrite were measured in 221 samples collected from 15 CTD casts, (Table 3.1). Standard depths for sampling were used throughout the cruise and were those chosen on the ARISE-DIAPOD cruise JR17006 in May of 2018 and are shown in the CTD section of this report. In addition to the samples analysed on board, duplicate and triplicate samples were also collected for future analysis at Liverpool University.

Table 3.1

Station	CTD	No. of depths	Station	CTD	No. of depths
NT11	4	17	D3	29	12
NT8	7	15	D4	31	10
NT6	10	16	D6	37	14
F7	15	17	D7	39	18
Ice station 1	18	17	D8	43	17
Ice station 2	20	12	D9	45	17
D1	24	16	D10	46	8
D2	26	15			

Methodology

Samples were collected in 50ml acid cleaned polythene vials from the CTD rosette spigots using an Acropak filter with 0.45 pore size connected to the CTD spigot with a length of silicone tubing. The filter was used for 5 CTD casts with reverse flushing with DI water between casts and kept sealed with DI water in and in a laboratory fridge at 4C. Once collected, samples were allowed to equilibrate to room temperature in the dark before analysis and always analysed within 12 hours of collection. Measurement was conducted using a Lachat QuikChem 8500 flow injection autoanalyser (Hach Lange) using the manufacturers recommended methods: Ammonium, 31-107-06-1-B; Orthophosphate, 31-115-01-1-G; Silicate, 31-114-27-1-A and Nitrate/Nitrite, 31-107-04-1-A.

Individual stock standard solutions of nitrate, phosphate and silicate were prepared at SAMS in deionised water immediately prior to the cruise from oven dried (110C) salts. A primary mixed working standard solution was prepared in a Grade A glass volumetric flasks each day from the stock solutions using the ship's DI water and from which five calibration standard solutions were prepared in Grade A glass volumetric flasks using OSIL Low Nutrient Sea Water as a dilution matrix, (OSIL, http://www.osil.co.uk, Batch LNS 27, Salinity 35 psu), for which the nutrient concentrations were supplied by the manufacturer.

All samples were measured twice, in triplicate. The first analysis measured ammonium, phosphate, silicate and total oxidised nitrogen (NO3+NO2) and then nitrite was measured in the subsequent run. An OSIL LNSW seawater blank and the five calibration standards were prepared to encompass the sample concentration range, with the top standard targeted to be 10-20% greater than the most concentrate sample. Calibration was followed by 2 KANSO seawater reference materials run in triplicate (Batch CI and CD) and then 2 internal standard solutions collected on the preceding cruise JR18006 which had been similarly filtered and stored frozen. A standard drift was run every 10 samples (~1 hour of analyses) standard using calibration standard No.5 (80% of standard range) throughout the sequence of samples and internal and reference materials. The 2 internal standard reference materials were rerun at the end of the sample sequence and a final drift standard was run in either duplicate or triplicate was run at the very end sequence. Analytical drift of the calibration was typically <5% and accounted for in the data processing in MS Excel. Recovery of the KANSO CI standard for NH4, PO4, SiO2 and NOx is shown below in Figures 3.1 to 3.4 and Table 3.2. No accredited value is supplied by KANSO for the ammonium concentrations so only the observations and mean are shown

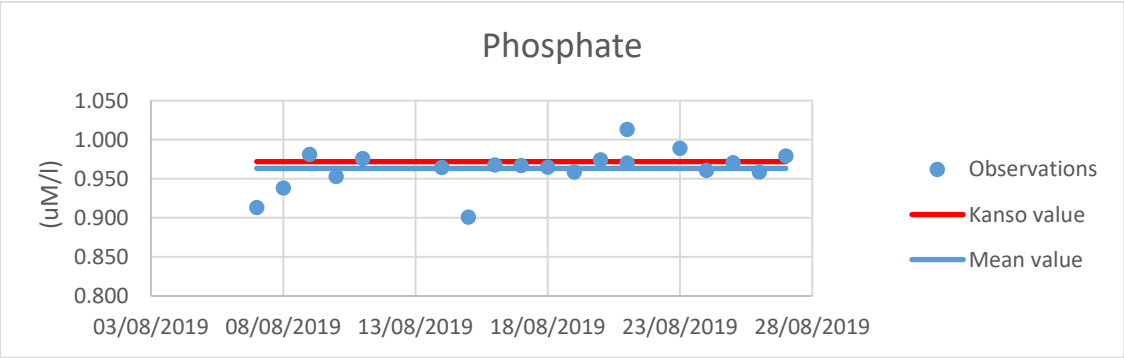


Figure 3.1: Analysis of KANSO Batch CI Standard Reference material, phosphate results

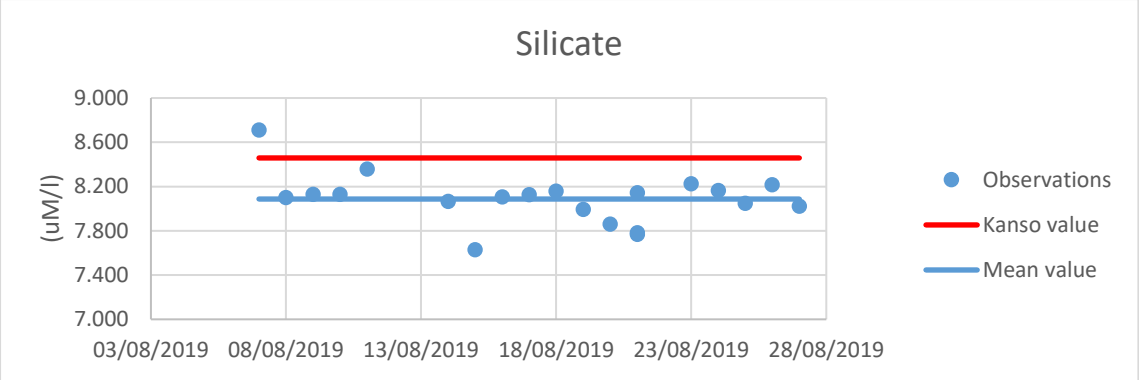


Figure 3.2: Analysis of KANSO Batch CI Standard Reference material, silicate results.

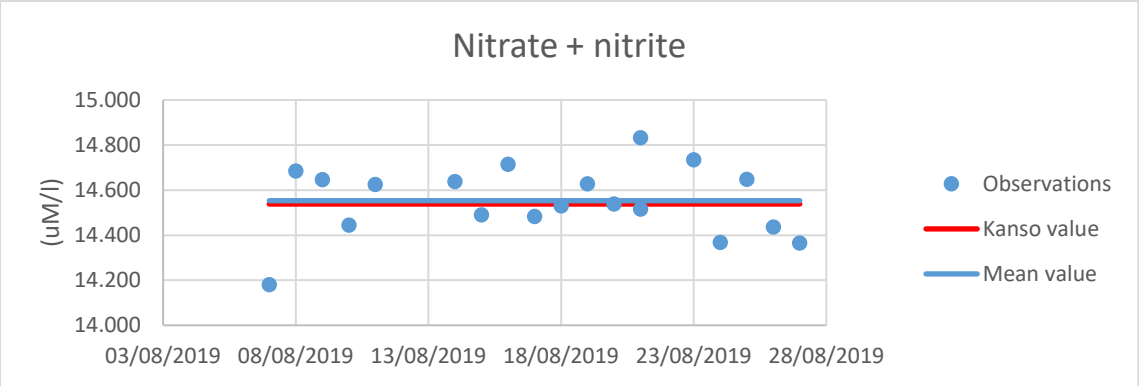


Figure 3.3: Analysis of KANSO Batch CI Standard Reference material, Nitrate + nitrite results.

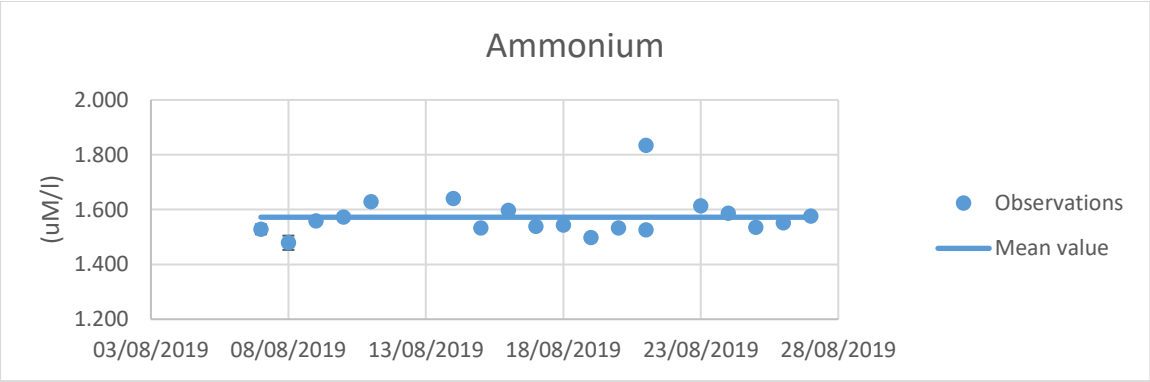


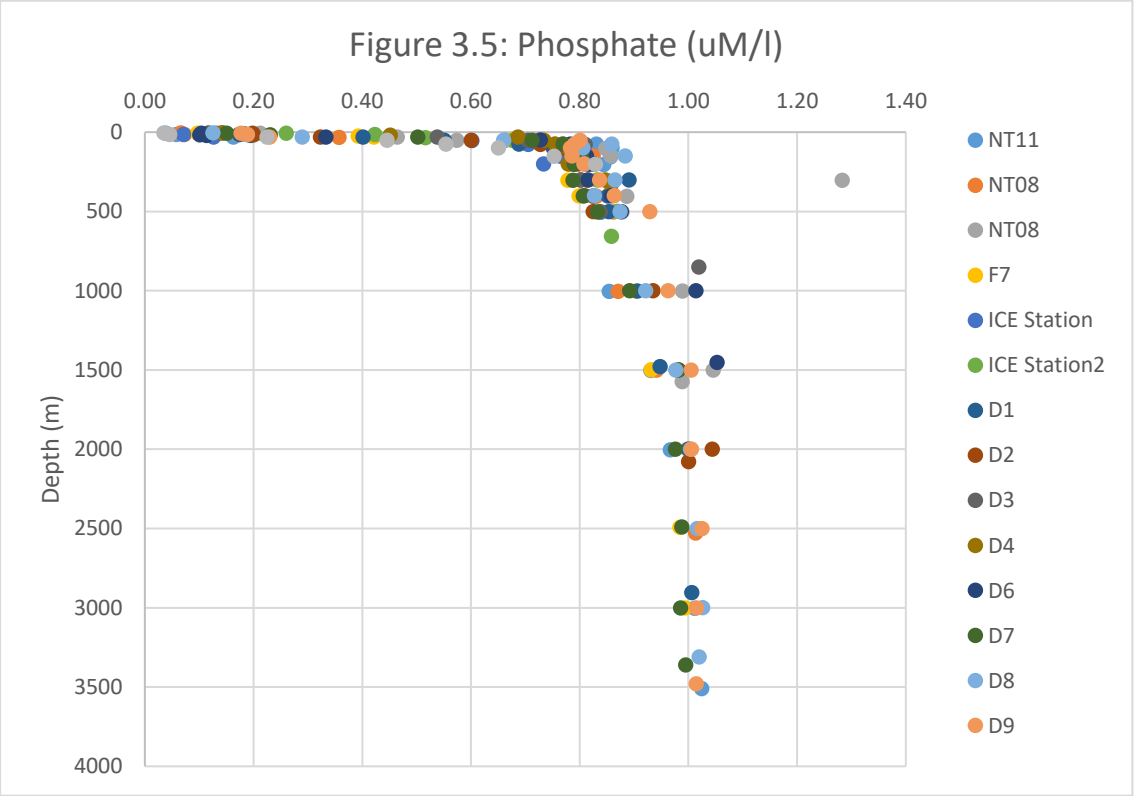
Figure 3.4: Analysis of KANSO Batch CI Standard Reference material, Ammonium results.

Table 3.2. Summary of nutrient analysis performance data.

Nutrient	Precision (RSD %)	Accuracy (%)
Ammonium	4.8	No data
Phosphate	2.6	98.2
Silicate	2.8	95.3
Nitrate + nitrite	1.1	99.2
Nitrite	6.1	95.3

No major issues regarding the analysis were encountered although it was noted early on that periodic temperature drops in the laboratory influenced the flow rates of the ammonium analysis reagents in the manifold tubing leading to spikey spectrophotometer response. Subsequently during the working day, the lab was kept around 22C with the use of a wall mounted fan heater.
The cadmium copper nitrate reduction column used in the NOx analysis was changed twice during the course of the cruise.

Preliminary results for all casts are shown in Figures 3.5-3.10 below



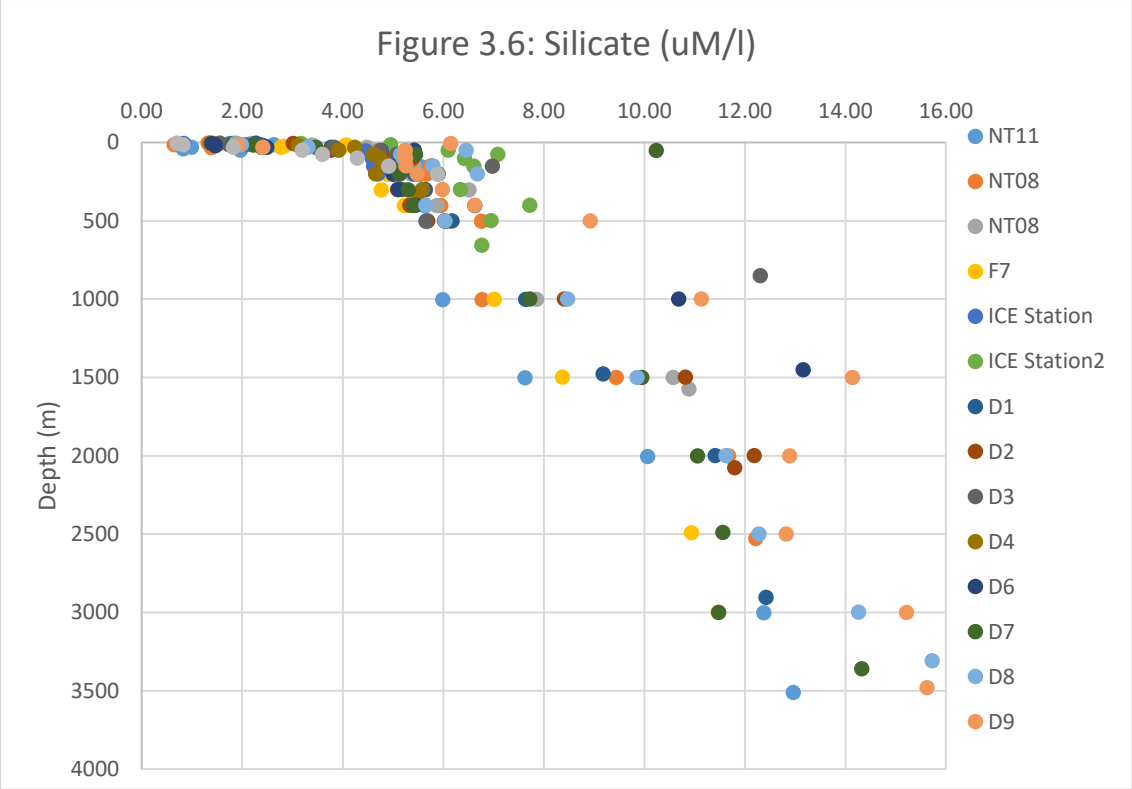


Figure 3.6: Silicate (uM/l)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
0
500
1000
1500
2000
2500
3000
3500
4000
Depth (m)
NT11
NT08
NT08
F7
ICE Station
ICE Station2
D1
D2
D3
D4
D6
D7
D8
D9

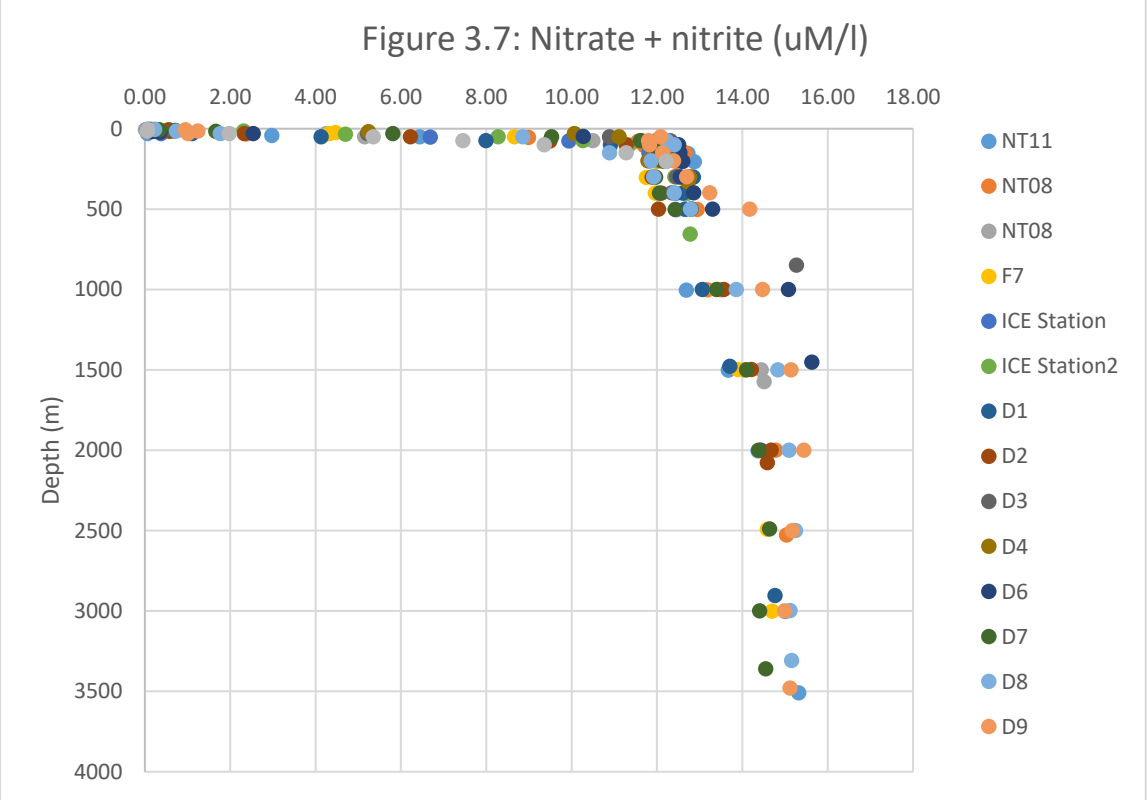


Figure 3.7: Nitrate + nitrite (uM/l)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
0
500
1000
1500
2000
2500
3000
3500
4000
Depth (m)
NT11
NT08
NT08
F7
ICE Station
ICE Station2
D1
D2
D3
D4
D6
D7
D8
D9

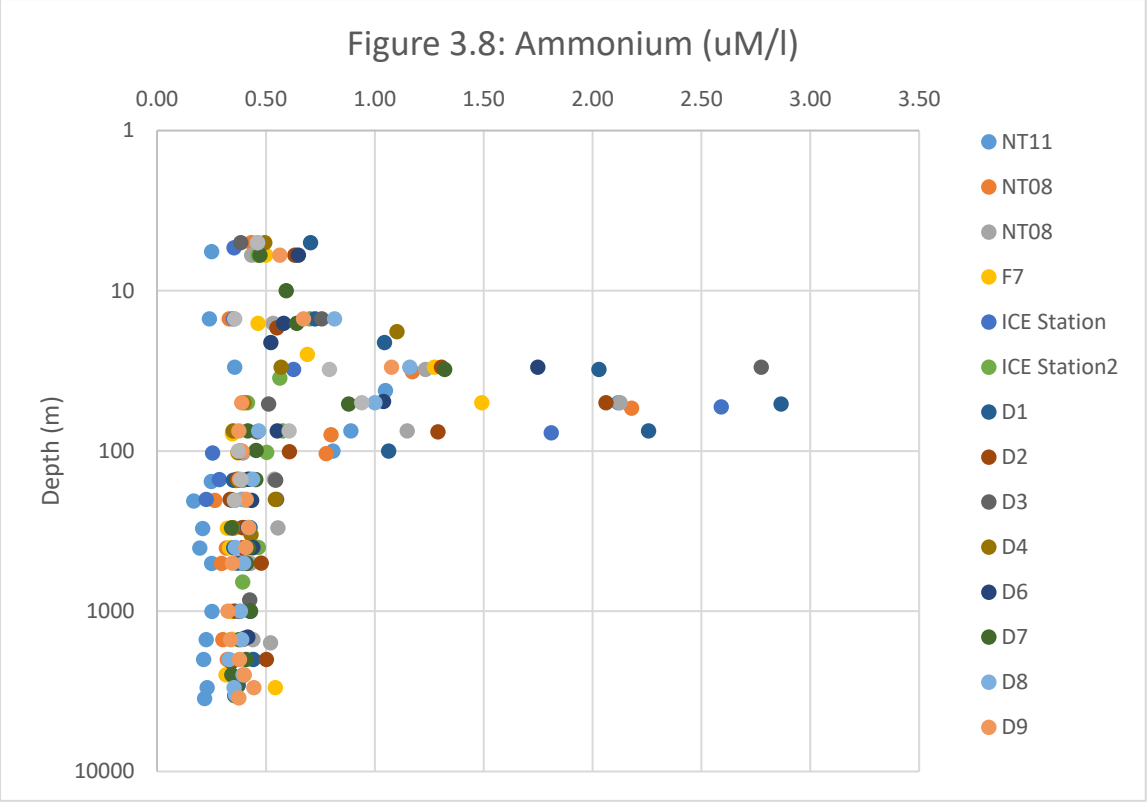


Figure 3.8: Ammonium (uM/l)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
1
10
100
1000
10000
Depth (m)
NT11
NT08
NT08
F7
ICE Station
ICE Station2
D1
D2
D3
D4
D6
D7
D8
D9

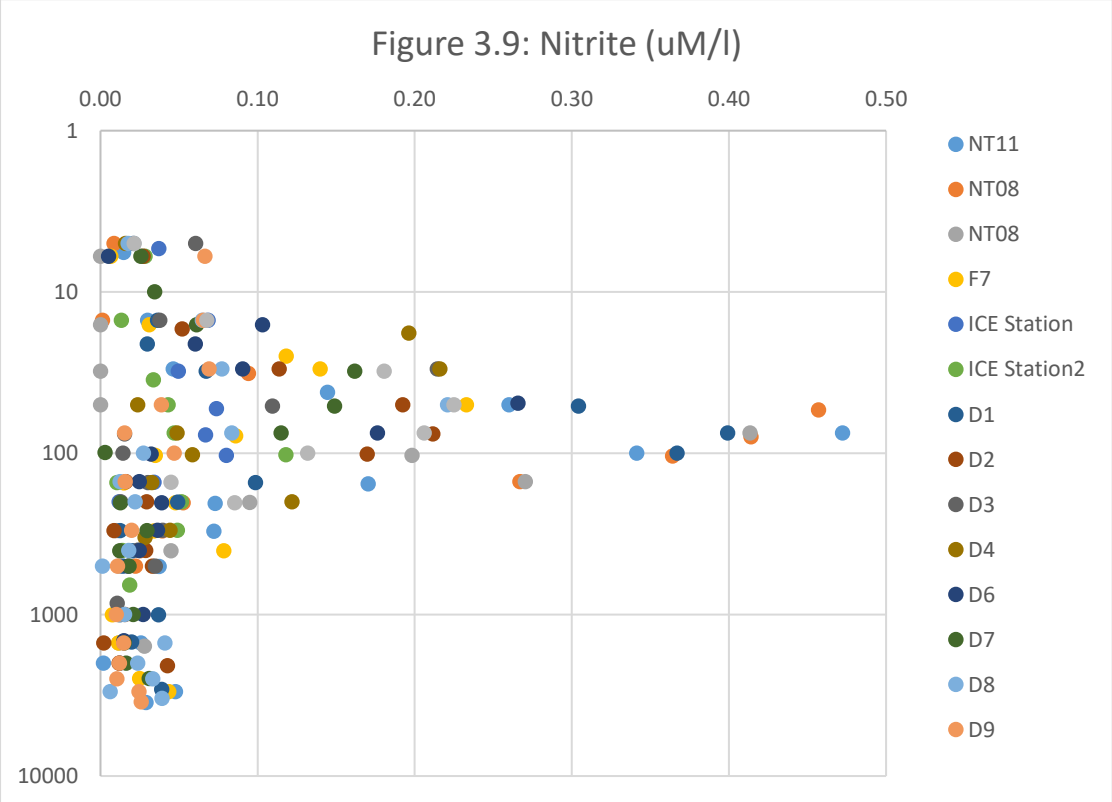


Figure 3.9: Nitrite (uM/l)
0.00
0.10
0.20
0.30
0.40
0.50
1
10
100
1000
10000
NT11
NT08
NT08
F7
ICE Station
ICE Station2
D1
D2
D3
D4
D6
D7
D8
D9

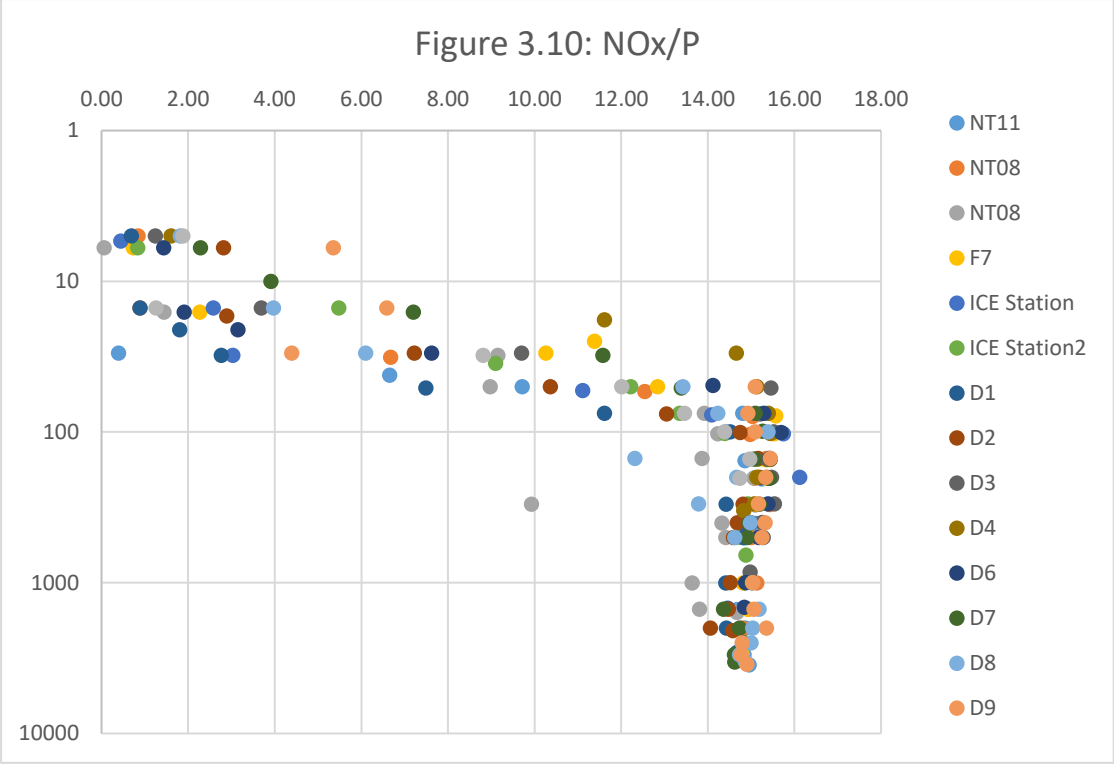


Figure 3.10: NOx/P
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
1
10
100
1000
10000
NT11
NT08
NT08
F7
ICE Station
ICE Station2
D1
D2
D3
D4
D6
D7
D8
D9

4. Chlorophyll-a and phytoplankton sampling

4.1 Chlorophyll-a analysis

Anna Belcher (BAS)

Introduction

Aim: To make measurements of chlorophyll (size fractionated) in the Fram Strait to tie into satellite estimates of surface chlorophyll. Concentrations of chlorophyll at the surface and chlorophyll maximum will also provide environmental context data for the on board experiments of others.

Objectives:

- To assess the chlorophyll concentration of water column phytoplankton at the surface and chlorophyll maximum at each station sampled.
- To measure the chlorophyll concentration in the following size classes >20, 2-20, and 0.2-2 µm, as well as total chlorophyll on a GF/F (nominally 0.7 µm)

Methods

Water Sampling

Seawater was collected from two depths from the CTD taken in the early hours of each day. Sampling depths were selected based on the fluorescence readings obtained from the downcast of the CTD. 1.5 L of water were collected in dark bottles from each depth, and were immediately filtered onto the appropriate filters. 250-500 ml of water were filtered for each size fraction. Filters used were as follows:

20 µm: Polycarbonate

2 µm: Polycarbonate

0.2 µm: polycarbonate

Total: GF/F

Once filtered, the filters were placed individual into glass vials, 6ml of 90% acetone added, and left for 18-24 hours in a fridge in the dark. Samples were analysed onboard using a Turner fluorometer (Chl-NA mode), with blank and solid standard readings taken at the start and end of each measurement set.

Event No.	Date and Time recovered (GMT)	Latitude (°N)	Longitude (°E)	Station	Niskin Bottle	Depth (m)	Fraction (µm)	Chlorophyll concentration (mg m-3)	Comments
10	09/08/2019 03:15	75.33555	-5.46429	NT11	19	42	0.2-20	0.72	Chlorophyll maximum
10	09/08/2019 03:15	75.33555	-5.46429	NT11	19	42	Total	1.3	Chlorophyll maximum
10	09/08/2019 03:15	75.33555	-5.46429	NT11	19	42	>20	0.06	Chlorophyll maximum
10	09/08/2019 03:15	75.33555	-5.46429	NT11	23	5.7	Total	0.28	
10	09/08/2019 03:15	75.33555	-5.46429	NT11	23	5.7	>20	0.107	
10	09/08/2019 03:15	75.33555	-5.46429	NT11	23	5.7	>0.2	0.25	
22	10/08/2019 03:30	75.79558	-7.21915	NT8	34	34	>2	0.72	Chlorophyll maximum
22	10/08/2019 03:30	75.79558	-7.21915	NT8	34	34	>0.2	1.44	Chlorophyll maximum
22	10/08/2019 03:30	75.79558	-7.21915	NT8	34	34	>20	0.52	Chlorophyll maximum
22	10/08/2019 03:30	75.79558	-7.21915	NT8	34	34	Tot	1.41	Chlorophyll maximum
22	10/08/2019 03:30	75.79558	-7.21915	NT8	5	5	Tot	0.3	
22	10/08/2019 03:30	75.79558	-7.21915	NT8	5	5	>20	0.14	

22	10/08/2019 03:30	75.79558	-7.21915	NT8	5	5	>2	0.12	
22	10/08/2019 03:30	75.79558	-7.21915	NT8	5	5	>0.2	0.31	
33	11/08/2019 01:50	76.03518	-8.1502	NT6	31	31	Tot	1.33	Chlorophyll max
33	11/08/2019 01:50	76.03518	-8.1502	NT6	31	31	>0.2	1.33	Chlorophyll max
33	11/08/2019 01:50	76.03518	-8.1502	NT6	5	5	>20	0.19	
33	11/08/2019 01:50	76.03518	-8.1502	NT6	5	5	Tot	0.55	
33	11/08/2019 01:50	76.03518	-8.1502	NT6	5	5	>2	0.32	
33	11/08/2019 01:50	76.03518	-8.1502	NT6	5	5	>0.2	0.5	
33	11/08/2019 01:50	76.03518	-8.1502	NT6	31	31	>2	1.06	Chlorophyll max
33	11/08/2019 01:50	76.03518	-8.1502	NT6	31	31	>20	0.97	Chlorophyll max
39	12/08/2019 14:52	79.0002	3.33079	F7	25	25	Tot	1.5	Chlorophyll max
39	12/08/2019 14:52	79.0002	3.33079	F7	25	25	>20	0.17	Chlorophyll max
39	12/08/2019 14:52	79.0002	3.33079	F7	25	25	>2	0.49	Chlorophyll max
39	12/08/2019 14:52	79.0002	3.33079	F7	25	25	>0.2	1.36	Chlorophyll max

39	12/08/2019 15:00	79.0002	3.33075	F7	6	6	Tot	0.23	From Underway
39	12/08/2019 15:00	79.0002	3.33075	F7	6	6	>20	0.04	From Underway
39	12/08/2019 15:00	79.0002	3.33075	F7	6	6	>2	0.07	From Underway
39	12/08/2019 15:00	79.0002	3.33075	F7	6	6	>0.2	0.21	From Underway
53	14/08/2019 05:04	79.00002	3.3331	F7	25	25	Tot	2.39	Chlorophyll max
53	14/08/2019 05:04	79.00002	3.3331	F7	5	5	Tot	0.84	
53	14/08/2019 05:04	79.00002	3.3331	F7	25	25	>20	0.37	Chlorophyll max
53	14/08/2019 05:04	79.00002	3.3331	F7	5	5	>20	0.03	
53	14/08/2019 05:04	79.00002	3.3331	F7	25	25	>2	0.56	Chlorophyll max
53	14/08/2019 05:04	79.00002	3.3331	F7	5	5	>2	0.5	
53	14/08/2019 05:04	79.00002	3.3331	F7	25	25	>0.2	2.51	Chlorophyll max
53	14/08/2019 05:04	79.00002	3.3331	F7	5	5	>0.2	0.88	
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	31	31	Tot	1.67	Chlorophyll max
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	31	31	>20	0.17	Chlorophyll max

64	15/08/2019 04:34	78.77402	-0.50622	ICE1	31	31	>2	0.93	Chlorophyll max
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	31	31	>0.2	1.56	Chlorophyll max
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	5	5	Tot	0.47	
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	5	5	>20	0.09	
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	5	5	>2	0.21	
64	15/08/2019 04:34	78.77402	-0.50622	ICE1	5	5	>0.2	0.45	
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	35	35	Tot	1.07	Chlorophyll max
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	35	35	>20	0.31	Chlorophyll max
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	35	35	>2	0.59	Chlorophyll max
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	35	35	>0.2	0.98	Chlorophyll max
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	5	5	Tot	0.55	
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	5	5	>20	0.1	
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	5	5	>0.2	0.53	
68	16/08/2019 00:10	78.31976	-4.75201	ICE2	5	5	>2	0.27	

77	17/08/2019 02:10	78.31705	0.61615	D1	21	21	Tot	1.02	Chlorophyll max
77	17/08/2019 02:10	78.31705	0.61615	D1	21	21	>20	0.03	Chlorophyll max
77	17/08/2019 02:10	78.31705	0.61615	D1	21	21	>2	0.32	Chlorophyll max
77	17/08/2019 02:10	78.31705	0.61615	D1	21	21	>0.2	0.98	Chlorophyll max
77	17/08/2019 02:10	78.31705	0.61615	D1	5	5	Tot	1.32	
77	17/08/2019 02:10	78.31705	0.61615	D1	5	5	>20	0.04	
77	17/08/2019 02:10	78.31705	0.61615	D1	5	5	>2	0.34	
77	17/08/2019 02:10	78.31705	0.61615	D1	5	5	>0.2	1.09	
85	18/08/2019 00:10	79.33321	5.16722	D2	6	6	Tot	2.71	
85	18/08/2019 00:10	79.33321	5.16722	D2	6	6	>20	0.06	
85	18/08/2019 00:10	79.33321	5.16722	D2	6	6	>2	0.66	
85	18/08/2019 00:10	79.33321	5.16722	D2	6	6	>0.2	2.4	
85	18/08/2019 00:10	79.33321	5.16722	D2	17	17	Tot	2.7	Chlorophyll max
85	18/08/2019 00:10	79.33321	5.16722	D2	17	17	>20	0.06	Chlorophyll max

85	18/08/2019 00:10	79.33321	5.16722	D2	17	17	>2	0.7	Chlorophyll max
85	18/08/2019 00:10	79.33321	5.16722	D2	17	17	>0.2	2.46	Chlorophyll max
94	19/08/2019 00:10	79.59993	7.33226	D3	15	15	Tot	2.29	Chlorophyll Max
94	19/08/2019 00:10	79.59993	7.33226	D3	15	15	>20	0.06	Chlorophyll Max
94	19/08/2019 00:10	79.59993	7.33226	D3	15	15	>2	0.83	Chlorophyll Max
94	19/08/2019 00:10	79.59993	7.33226	D3	15	15	>0.2	2.25	Chlorophyll Max
94	19/08/2019 00:10	79.59993	7.33226	D3	5	5	Tot	2.29	
94	19/08/2019 00:10	79.59993	7.33226	D3	5	5	>20	0.06	
94	19/08/2019 00:10	79.59993	7.33226	D3	5	5	>0.2	2.32	
94	19/08/2019 00:10	79.59993	7.33226	D3	5	5	>2	1.07	
103	19/08/2019 23:53	79.66661	9.39961	D4	18	18	Tot	1.9	Chlorophyll Max
103	19/08/2019 23:53	79.66661	9.39961	D4	18	18	>20	0.02	Chlorophyll Max
103	19/08/2019 23:53	79.66661	9.39961	D4	18	18	>2	0.47	Chlorophyll Max
103	19/08/2019 23:53	79.66661	9.39961	D4	18	18	>0.2	1.75	Chlorophyll Max

103	19/08/2019 23:53	79.66661	9.39961	D4	5	5	Tot	1.86	
103	19/08/2019 23:53	79.66661	9.39961	D4	5	5	>20	0.01	
103	19/08/2019 23:53	79.66661	9.39961	D4	5	5	>2	0.4	
103	19/08/2019 23:53	79.66661	9.39961	D4	5	5	>0.2	1.42	
131	23/08/2019 01:04	79.16655	6.59981	D6	25	25	Tot	1.98	Chlorophyll maximum
131	23/08/2019 01:04	79.16655	6.59981	D6	25	25	>20	0.08	Chlorophyll maximum
131	23/08/2019 01:04	79.16655	6.59981	D6	25	25	>2	0.72	Chlorophyll maximum
131	23/08/2019 01:04	79.16655	6.59981	D6	25	25	>0.2	1.84	Chlorophyll maximum
131	23/08/2019 01:04	79.16655	6.59981	D6	5	5	Tot	2.3	
131	23/08/2019 01:04	79.16655	6.59981	D6	5	5	>20	0.12	
131	23/08/2019 01:04	79.16655	6.59981	D6	5	5	>2	0.71	
131	23/08/2019 01:04	79.16655	6.59981	D6	5	5	>0.2	2.14	
138	24/08/2019 02:49	79.31697	2.64902	D7	10	10	Tot	1.93	Chlorophyll max

138	24/08/2019 02:49	79.31697	2.64902	D7	10	10	>20	0.08	Chlorophyll max
138	24/08/2019 02:49	79.31697	2.64902	D7	10	10	>2	0.72	Chlorophyll max
138	24/08/2019 02:49	79.31697	2.64902	D7	10	10	>0.2	1.88	Chlorophyll max
138	24/08/2019 02:49	79.31697	2.64902	D7	5	5	Tot	1.93	
138	24/08/2019 02:49	79.31697	2.64902	D7	5	5	>20	0.09	
138	24/08/2019 02:49	79.31697	2.64902	D7	5	5	>2	0.73	
138	24/08/2019 02:49	79.31697	2.64902	D7	5	5	>0.2	1.84	
148	25/08/2019 05:26	78.41661	6.99999	D8	15	15	Tot	1.87	Chlorophyll Maximum
148	25/08/2019 05:26	78.41661	6.99999	D8	15	15	>20	0.1	Chlorophyll Maximum
148	25/08/2019 05:26	78.41661	6.99999	D8	15	15	>2	0.72	Chlorophyll Maximum
148	25/08/2019 05:26	78.41661	6.99999	D8	5	15	>0.2	1.75	Chlorophyll Maximum
148	25/08/2019 05:26	78.41661	6.99999	D8	5	5	Tot	2.72	
148	25/08/2019 05:26	78.41661	6.99999	D8	5	5	>20	0.07	

148	25/08/2019 05:26	78.41661	6.99999	D8	5	5	>2	1.06	
148	25/08/2019 05:26	78.41661	6.99999	D8	15	5	>0.2	2.41	
156	26/08/2019 03:10	77.71671	7.58312	D9	30	30	Tot	0.71	Chlorophyll maximum
156	26/08/2019 03:10	77.71671	7.58312	D9	30	30	>20	0.05	Chlorophyll maximum
156	26/08/2019 03:10	77.71671	7.58312	D9	30	30	>2	0.24	Chlorophyll maximum
156	26/08/2019 03:10	77.71671	7.58312	D9	30	30	>0.2	0.68	Chlorophyll maximum
156	26/08/2019 03:10	77.71671	7.58312	D9	5	5	Tot	1.69	
156	26/08/2019 03:10	77.71671	7.58312	D9	5	5	>20	0.07	
156	26/08/2019 03:10	77.71671	7.58312	D9	5	5	>2	0.8	
156	26/08/2019 03:10	77.71671	7.58312	D9	5	5	>0.2	1.59	
160	26/08/2019 21:49	77.46682	13.49353	D10	31	31	Tot	1.65	Chlorophyll maximum
160	26/08/2019 21:49	77.46682	13.49353	D10	31	31	>20	0.09	Chlorophyll maximum

160	26/08/2019 21:49	77.46682	13.49353	D10	31	31	>2	0.65	Chlorophyll maximum
160	26/08/2019 21:49	77.46682	13.49353	D10	31	31	>0.2	1.74	Chlorophyll maximum
160	26/08/2019 21:49	77.46682	13.49353	D10	5	5	Tot	0.77	
160	26/08/2019 21:49	77.46682	13.49353	D10	5	5	>20	0.02	
160	26/08/2019 21:49	77.46682	13.49353	D10	5	5	>2	0.35	
160	26/08/2019 21:49	77.46682	13.49353	D10	5	5	>0.2	0.76	

Table 4.1.1 Chla analysis carried out on cruise JR18007

4.2 Phytoplankton sampling

Samples were also taken at ~midnight CTD stations for

1. Phytoplankton taxonomy – for surface and chlorophyll maximum depths 250ml of sample was fixed with 2.5ml Lugol's iodine (1% final concentration) and stored in 250ml clear plastic bottles at 5^{o}C.

2. Coccolithophore samples – for surface and chlorophyll maximum depths 250ml fixed with 5mls of 37% Formaldehyde (1% final concentration) and stored in 250ml clear plastic bottles at 5^{o}C.

Table 4.2.1 lists all stations where the above samples were taken. Note there was likely a scribing error for the first sample, noted as Event 7 but most likely Event 10 at location NT11

All of these samples will undergo analysis back at SAMS.

Samples analysed for Phytoplankton enumeration & identification

Aug-19

SURFACE

Event	Location	CTD	Depth	Date	Latitude	Longtitude	Vol. settled	Bottle type	Original sample vol.	Vol.Lugols' iodine added to original sample	Final concentration of Lugol's iodine	Enumeration	Identification	C:N ratio	Biomass
~~E7~~ (E10)	NT11	CTD004	5m	09/08/2019 00:43	75.33557	-5.4641	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E22	NT8	CTD007	5m	10/08/2019 01:31	75.79556	7.21916	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E33	NT6a	CTD10	5m	11/08/2019 00:20	76.03591	76.03591	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E53	F7	CTD15	5m	14/08/2019 02:39	79.00002	3.33316	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E64	Ice Station 1	CTD018	5m	15/08/2019 03:58	78.78386	-0.48256	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E68	Ice Station 2	CTD020	5m	15/08/2019 23:19	78.33007	-4.72773	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E77	D1	CTD024	5m	16/08/2019 23:40	78.31706	0.61605	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E85	D2	CTD026	5m	18/08/2019 00:02	79.33321	5.16726	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E94	D3	CTD029	5m	18/08/2019 23:12	79.59994	7.33224	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E103	D4	CTD031	5m	19/08/2019 23:14	79.66658	9.39954	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E131	D6	CTD037	5m	22/08/2019 23:29	79.16656	6.59985	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E138	D7	CTD039	5m	23/08/2019 23:13	79.31693	2.64927	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E148	D8	CTD043	5m	25/08/2019 02:48	78.41662	6.99995	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E156	D9	CTD045	5m	25/08/2019 23:45	77.71672	7.58316	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√

Chl. max

Location		*CTD*	*Depth*	*Date*	Latitude	Longtitude	*Vol. settled*	Bottle type	Original sample vol.	Vol.Lugols' iodine added to original sample	Final concentration of Lugol's iodine	Enumeration	Identification	C:N ratio	Biomass
~~E7~~ (E10)	NT11	CTD004	C.Max	09/08/2019 00:43	75.33557	-5.4641	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E22	NT8	CTD007	C.Max	10/08/2019 01:31	75.79556	7.21916	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E33	NT6a	CTD10	C.Max	11/08/2019 00:20	76.03591	76.03591	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E53	F7	CTD15	C.Max	14/08/2019 02:39	79.00002	3.33316	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E64	Ice Station 1	CTD018	C.Max	15/08/2019 03:58	78.78386	-0.48256	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E68	Ice Station 2	CTD020	C.Max	15/08/2019 23:19	78.33007	-4.72773	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E77	D1	CTD024	C.Max	16/08/2019 23:40	78.31706	0.61605	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E85	D2	CTD026	C.Max	18/08/2019 00:02	79.33321	5.16726	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E94	D3	CTD029	C.Max	18/08/2019 23:12	79.59994	7.33224	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E103	D4	CTD031	C.Max	19/08/2019 23:14	79.66658	9.39954	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E131	D6	CTD037	C.Max	22/08/2019 23:29	79.16656	6.59985	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E138	D7	CTD039	C.Max	23/08/2019 23:13	79.31693	2.64927	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E148	D8	CTD043	C.Max	25/08/2019 02:48	78.41662	6.99995	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√
E156	D9	CTD045	C.Max	25/08/2019 23:45	77.71672	7.58316	50ml	white plastic	250ml	2.5ml	1%	√	√	√	√

Table 4.2.1 Locations of Lugols and formalin samples taken for phytoplankton analysis

5. Multinet sampling

Geraint Tarling, Gabi Stowasser, Anna Belcher, Gareth Flint, Jennifer Freer, Aisling Smith, Amber Chadwick

Two different types of multinet were used during this cruise: 1) The MOCNESS net and 2) The Mammoth net

1) The MOCNESS has a mouth opening area of 1 m^2 and contains 9 x 330 µm meshed nets. It was nominally trawled at between 2 and 3 knots. The angle of the net in the water was logged throughout the deployment to determine the effective mouth opening area. The device also contained a flow meter (to measure effective distance travelled through the water), temperature and salinity probes. The system was operated through the BAS Down Wire Net Monitor (DWNM) system.

In open ocean regions, the maximum depth of the deployments was 1000 m (although some earlier trawls went to 1200 m), with net 1 being open during the downward trajectory and nets 2 to 9 incremented during the upward haul, splitting the water column into 125 m depth intervals. Where the sea-bed was shallower, the maximum depth was between 50 to 100 m above the bottom, and a smaller number of nets were open and closed during the upward trajectory so that each depth increment was roughly equivalent to the upper depth intervals of the open ocean deployments. The net was paid out between 20 and 30 m per minute. Hauling in was 10 m per minute (on average).

Two MOCNESS deployments were made per station, one shortly following the other, mostly separated by around 60 to 90 minutes by Bongo net hauls. The majority of hauls were carried out in the morning with a small number in the early afternoon. The catches of the first deployment were used for picking out animals (*Calanus* spp) for biochemical and physiological analysis (lipid, CHN, respiration). The remainder of these catches were not retained. The catches of the second deployment were either volumetrically split from graduated buckets after thorough mixing or split using a Folsom splitter. One half was preserved in 96% Ethanol, the other half in 4% formalin. For larger samples, the preserved fraction may have been a ¼ to $1/8^{th}$.

The MOCNESS was also used for the first few deployments of the 1st 36 h series (a net deployed every ~4 h for a 36 h period, with contents being preserved in RNA Later for clock gene analysis or frozen for metabolomic analysis – see Reports of Grigor and Mayor respectively). A failure preventing the nets from releasing led to the MOCNESS being replaced by the Mammoth net for the remainder of the 1st 36 h series and the entire 2nd 36 h series.

The net performed well throughout the cruise barring the failure referred to above. Fault investigation on the DWNM, release unit and stepper motor didn't reveal a fault; however, DWNM data showed an unusual voltage drop during net firing and the battery was replaced with a newer one. The MOCNESS was then tested to 500 m and all nets fired. The biowire was also re-terminated as its measured insulation value was lower than ideal. No further issues occurred. Another issue was that the net software did not show the net going beyond 997 m in certain deployments. This was an intermittent problem and was not resolved by pressure sensor replacement. This issue was not resolved by end of cruise.

There was no loss of cod-ends or samples over the entire course of the cruise.

Sampling log is detailed in Table 5.1

2) Mammoth net

The Mammoth net has a mouth opening area of 1 m^2 and contains 9 x 300 µm meshed nets. It was deployed vertically with the ship holding position on DP. Deployment involved the lifting of the carousel containing 9 cod ends using side wires while the main net body was simultaneously lifted. Both items were then moved over stern ramp in a controlled manner and the side wires disengaged. The safety mechanism (preventing premature closure of the net springs) was then disengaged before the net was lowered to depth.

Direct communication with the Mammoth could not be established through the biowire in initial trials, so the net was deployed in autonomous mode throughout the cruise. Set depths were uploaded onto the in-situ net control unit via the OEM's *OceanLab* software through an RS232 cable. The system was switched off after uploading of the instruction. It was switched on again just prior to deployment. Batteries were regularly changed throughout the cruise.

Descent depths were 30 m minute (on average). Ascent depths were mainly 10 m/min although this was speeded up to 20 m/min during the latter stages of the cruise, particularly for the deep deployments.

The net was most heavily used during the 2 x 36 h series, where it was deployed every 4 hours. Maximum depth was around 550 m in the majority of these deployments, the depth chosen as the deeper layer of maximum of copepod abundance. 3 nets were closed in close succession within this deeper layer before larger depth intervals rising to the surface layers, where a further 3 nets were closed in close succession.

The Mammoth was also used for a series of deep deployment (maximum depth of 2500m) in the latter part of the cruise (wire out around 2700 m, trigger depth 2550 m), with the majority of nets closed below 1000 m (ie. the depths not sampled by the MOCNESS in deployments immediately prior to the deep Mammoth deployment – all these deployments were preserved in 4% formalin without splitting).

In the initial part of the cruise, sample quality was variable, some samples in good condition, others with a lot of squashed material. It was believed the main reason was twisting of the nets just above the carousel. This was resolved through a number of adjustments to the bridle arrangements and undoing twists on the nets before re-clamping to the cod end holders in the carousel. A colour coding system for the attachment of bridles was also put in place. Bridle lengths were lengthened to prevent bunching of nets. Sample quality was much improved towards latter part of the cruise. There remained the issue of a fraction of the sample remaining in the net after recovery. It is imperative that the nets are rinsed before the cod end is removed in any deployment intending to obtain a quantitative sample.

Sampling logs is detailed in Table 5.2

Fig 5.1: MOCNESS net at point of deployment

Fig. 5.2. Recovery of MOCNESS - codends being lifted over the stern ramp

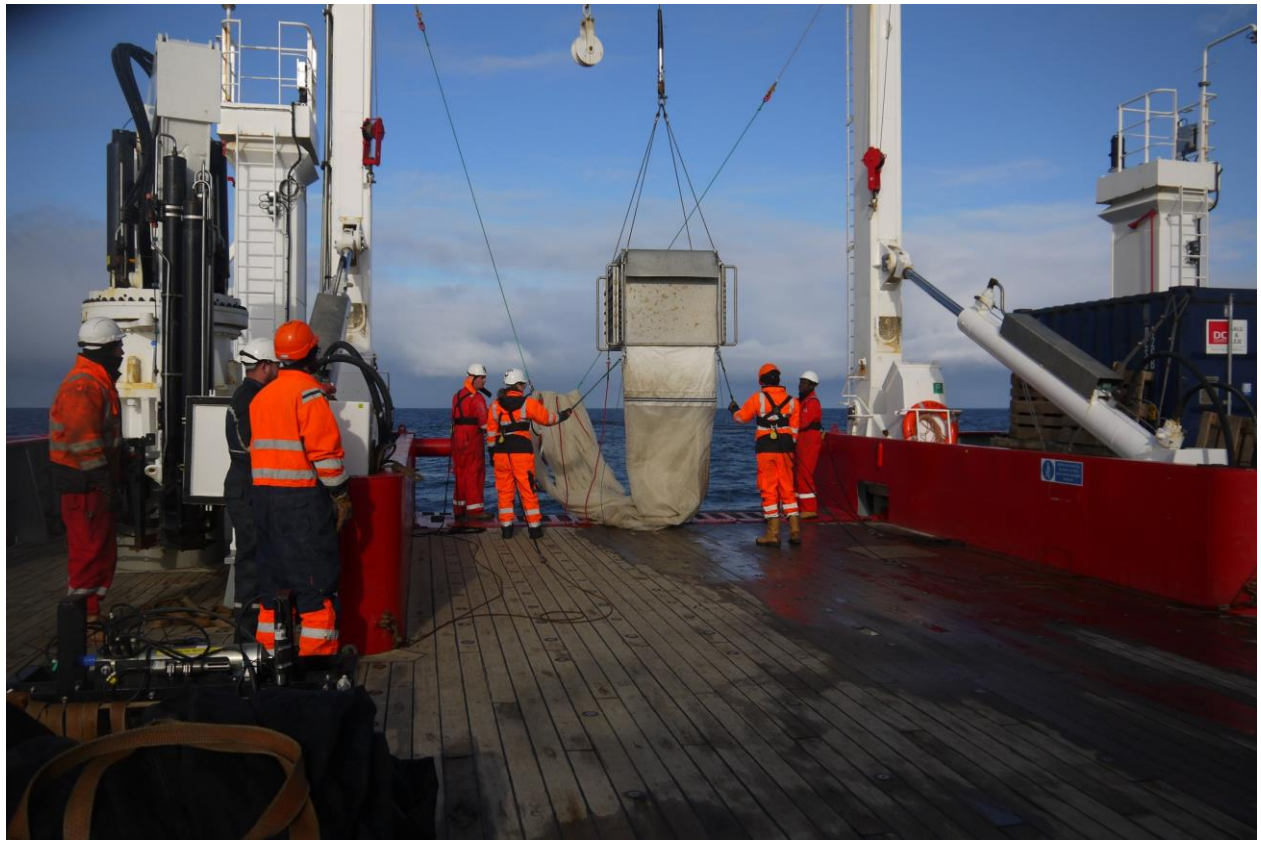


Fig 5.3: Mammoth net being deployed

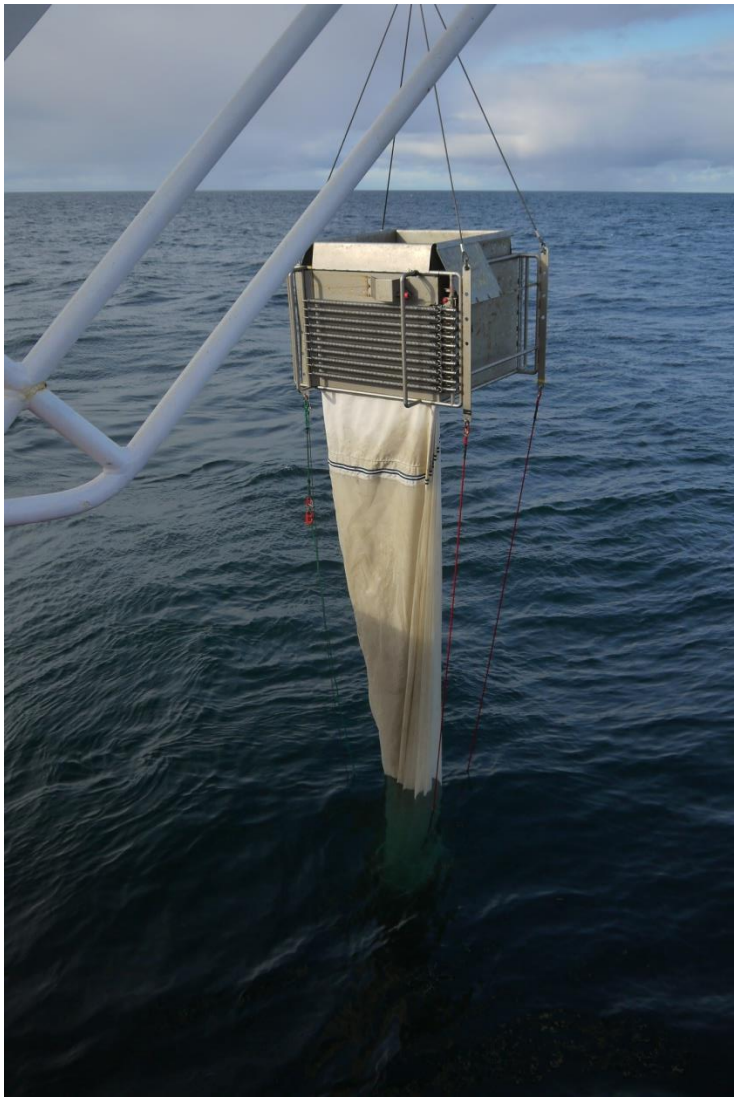


Fig 5.4: Mammoth at point of deployment

Table 5.1: MOCNESS deployment on JR18007

Time	Latitude(furuno-gga - furuno-gga-lat)	Longitude(furuno-gga - furuno-gga-lon)	Water depth(ea600 - ea600-depth)	Event(Built In - String)	Open depth(Built In - String)	Close depth(Built In - String)	Opening time or closing time(Built In - String)	Comment
09:50:00 26/08/2019	77.6329	7.26016	2710.92	158	125	5	10:03	Net 9
09:36:00 26/08/2019	77.64003	7.28789	2826.96	158	250	125	9:50	Net 8
09:22:00 26/08/2019	77.64683	7.31435	2963.96	158	375	250	9:36	Net 7
09:06:00 26/08/2019	77.65511	7.34298	3077.74	158	500	375	9:22	Net 6, 1/4 sample
08:57:00 26/08/2019	77.66051	7.35911	3154.42	158	625	500	9:06	Net 5
08:49:00 26/08/2019	77.66513	7.37266	3214.98	158	750	625	8:57	Net 4
08:38:00 26/08/2019	77.67091	7.39073	3307.01	158	875	750	8:49	Net 3
08:20:00 26/08/2019	77.67883	7.41794	3409.41	158	1000	875	8:38	Net 2
07:06:00 26/08/2019	77.7139	7.57023	3553.48	158	0	1000	8:20	Net 1

06:04:00 26/08/2019	77.64183	7.37097	3125.6	157	125	5	6:15	Net 9
05:51:00 26/08/2019	77.64816	7.38568	3271.68	157	250	125	6:04	Net 8
05:41:00 26/08/2019	77.65345	7.39733	3326.98	157	375	250	5:51	Net 7
05:28:00 26/08/2019	77.65978	7.41193	3379.2	157	500	375	5:41	Net 6
05:19:00 26/08/2019	77.66438	7.42169	3419.07	157	598	500	5:28	Net 5
05:05:00 26/08/2019	77.67175	7.43783	3452.95	157	750	598	5:19	Net 4, fired net a bit late
04:52:00 26/08/2019	77.67831	7.45372	3450.87	157	875	750	5:05	Net 3
04:42:00 26/08/2019	77.68318	7.46607	3454.77	157	1000	875	4:52	Net 2
03:36:00 26/08/2019	77.71337	7.56909	3552.34	157	0	1000	4:42	Net 1
12:47:00 25/08/2019	78.3237	6.78107	3231.36	151	125	5	13:00	Net 9, 1/4 sample preserved
12:31:00 25/08/2019	78.33529	6.79625	3315.43	151	250	125	12:47	Net 8
12:14:00 25/08/2019	78.34749	6.81083	3378.34	151	375	250	12:31	Net 7, 1/4 sample preserved
12:01:00 25/08/2019	78.35714	6.82707	3374.04	151	500	375	12:14	Net 6, 1/4 sample preserved

11:51:00 25/08/2019	78.36383	6.84245	3367.99	151	625	500	12:01	Net 5
11:41:00 25/08/2019	78.37004	6.85738	3365.99	151	750	625	11:51	Net 4
11:29:00 25/08/2019	78.37679	6.87435	3365.49	151	875	750	11:41	Net 3
11:21:00 25/08/2019	78.38114	6.88675	3363.03	151	1000	875	11:29	Net 2
10:11:00 25/08/2019	78.41369	6.9927	3362.04	151	0	1000	11:21	Net 1
08:08:00 25/08/2019	78.33265	6.82528	3351.11	149	125	5	8:19	Net 9
07:52:00 25/08/2019	78.34198	6.837	3368.35	149	250	125	8:08	Net 8
07:41:00 25/08/2019	78.34962	6.84682	3374.13	149	375	250	7:52	Net 7
07:30:00 25/08/2019	78.3564	6.8565	3372.08	149	500	375	7:41	Net 6
07:20:00 25/08/2019	78.36236	6.86429	3368.04	149	625	500	7:30	Net 5
07:08:00 25/08/2019	78.36878	6.87623	3369.22	149	875	750	7:20	Net 4
06:58:00 25/08/2019	78.37367	6.89057	3364.01	149	875	750	7:08	Net 3
06:49:00 25/08/2019	78.37802	6.90207	3361.92	149	999	871	6:58	Net 2

05:46:00 25/08/2019	78.41114	6.98084	3364.39	149		1000	6:49	Net 1
								Pressure sensor stopped working at 999m
13:38:00 24/08/2019	79.23919	2.54713	4850.69	143	125	5	13:50	Net 9
13:27:00 24/08/2019	79.24522	2.55608	4543.18	143	248	125	13:38	Net 8
13:14:00 24/08/2019	79.25172	2.56858	4420.61	143	375	248	13:27	Net 7
13:03:00 24/08/2019	79.2577	2.57688	4336.13	143	500	375	13:14	Net 6
12:53:00 24/08/2019	79.26288	2.58365	4334.59	143	625	500	13:03	Net 5
12:41:00 24/08/2019	79.26908	2.59143	4350.86	143	750	625	12:53	Net 4
12:30:00 24/08/2019	79.27477	2.59931	4286.15	143	875	750	12:41	Net 3
12:22:00 24/08/2019	79.27899	2.60391	4217.86	143	1000	875	12:30	Net 2
11:19:00 24/08/2019	79.31315	2.64731	3393.02	143	0	1000	12:22	Net 1
09:21:00 24/08/2019	79.26529	2.29107	3666.25	141	125	5	9:34	Net 9
09:07:00 24/08/2019	79.26892	2.33045	3740.49	141	250	125	9:21	Net 8

08:54:00 24/08/2019	79.27275	2.36664	3778.56	141	375	250	9:07	Net 7
08:41:00 24/08/2019	79.27688	2.40115	3502.5	141	500	375	8:54	Net 6
08:30:00 24/08/2019	79.28056	2.42926	3705.73	141	625	500	8:41	Net 5
08:22:00 24/08/2019	79.28348	2.44928	3675.9	141	750	625	8:30	Net 4
08:12:00 24/08/2019	79.28697	2.47209	3629.57	141	875	750	8:22	Net 3
08:03:00 24/08/2019	79.28977	2.49053	3633.84	141	1000	875	8:12	Net 2
07:00:00 24/08/2019	79.31199	2.62055	0	141	0	1000	8:03	Net 1
								water depth reading missing
11:14:00 23/08/2019	79.15942	7.12058	1350.85	134	125	5	11:29	Net 9
								1/4 sample preserved
10:58:00 23/08/2019	79.1599	7.07156	1361.01	134	250	125	11:14	Net 8
10:45:00 23/08/2019	79.1603	7.03059	1368.83	134	375	250	10:58	Net 7
10:31:00 23/08/2019	79.16115	6.98939	1377.1	134	500	375	10:45	Net 6
								1/4 sample preserved

10:18:00 23/08/2019	79.16198	6.94958	1384.94	134	625	500	10:31	Net 5
10:08:00 23/08/2019	79.16247	6.91907	1391.01	134	750	625	10:18	Net 4
09:56:00 23/08/2019	79.16278	6.88386	1398.52	134	875	750	10:08	Net 3
09:42:00 23/08/2019	79.16305	6.84576	1407.04	134	1000	875	9:56	Net 2
08:25:00 23/08/2019	79.16646	6.61876	1481.06	134	0	1000	9:42	Net 1
06:04:00 23/08/2019	79.17987	7.1172	1340.53	132	125	5	6:18	Net 9
05:48:00 23/08/2019	79.17846	7.06815	1351.72	132	250	125	6:04	Net 8
05:35:00 23/08/2019	79.17762	7.02841	1360.43	132	375	250	5:48	Net 7
05:21:00 23/08/2019	79.17684	6.98691	1369.73	132	500	375	5:35	Net 6
05:07:00 23/08/2019	79.17596	6.94499	1379.06	132	625	500	5:21	Net 5
04:53:00 23/08/2019	79.17493	6.90274	1389.28	132	750	625	5:07	Net 4
04:40:00 23/08/2019	79.17392	6.86399	1399.07	132	875	750	4:53	Net 3
04:30:00 23/08/2019	79.17328	6.83326	1406.69	132	1000	875	4:40	Net 2

03:17:00 23/08/2019	79.16706	6.6192	1480.09	132	0	1000	4:30	Net 1
08:02:00 20/08/2019	79.64551	9.29959	333.44	107	125	5	8:24	Net 9
								1/4 sample preserved (Formalin and Ethanol each)
07:42:00 20/08/2019	79.63881	9.25219	346.25	107	250	125	8:02	Net 8
								1/4 sample preserved (Formalin and Ethanol each)
07:40:00 20/08/2019	79.63813	9.24778	349.19	107	225	250	7:42	Net 7
								Closed on descent
07:39:00 20/08/2019	79.63778	9.24566	349.46	107	200	225	7:40	Net 6
								Closed on descent
07:35:00 20/08/2019	79.63649	9.23684	351.5	107	150	200	7:39	Net 5
								Closed on descent
07:33:00 20/08/2019	79.63577	9.23219	351.76	107	100	150	7:35	Net 4
								Closed on descent
07:31:00 20/08/2019	79.63504	9.22671	352.77	107	75	100	7:33	Net 3
								Closed on descent
07:29:00 20/08/2019	79.63428	9.222	352.62	107	50	75	7:31	Net 2
								Closed on descent

07:27:00 20/08/2019	79.63367	9.21737	352.56	107		50	7:29	Net 1
								Closed on descent
								MOCNESS deployed with only buckets 8 and 9 attached
00:56:00 20/08/2019	79.67609	9.28869	365.01	104	125	5	1:09	Net 9
00:45:00 20/08/2019	79.67355	9.31714	358.52	104	250	125	0:56	Net 8
00:43:00 20/08/2019	79.67307	9.32224	357.66	104	225	250	0:45	Net 7
								Closed on descent
00:41:00 20/08/2019	79.6726	9.32756	356.51	104	200	225	0:43	Net 6
								Closed on descent
00:38:00 20/08/2019	79.67178	9.33566	351.29	104	150	200	0:41	Net 5
								Closed on descent
00:35:00 20/08/2019	79.67096	9.34413	347.2	104	100	150	0:38	Net 4
								Closed on descent
00:34:00 20/08/2019	79.67067	9.34692	345.56	104	75	100	0:35	Net 3
								Closed on descent
00:32:00 20/08/2019	79.67015	9.3529	342.11	104	50	75	0:34	Net 2
								Closed on descent

00:29:00 20/08/2019	79.66948	9.3627	344.61	104	0	50	0:32	Net 1
								Closed on descent
07:35:00 19/08/2019	79.55341	7.14645	989.17	98	125	5	7:44	Net 9
07:25:00 19/08/2019	79.55763	7.16189	967.12	98	250	125	7:35	Net 8
07:15:00 19/08/2019	79.56151	7.17717	956.11	98	375	250	7:25	Net 7
07:03:00 19/08/2019	79.56602	7.19557	944.56	98	500	375	7:15	Net 6
06:51:00 19/08/2019	79.57078	7.21391	933.81	98	625	500	7:03	Net 5
								Nets 5,6 and 7 may have been strangled, catch integrated from 625m to 250m
06:42:00 19/08/2019	79.57437	7.23062	924.57	98	750	625	6:51	Net 4
06:38:30 19/08/2019	79.57588	7.23724	921.33	98	750	750	6:42	Net 3
06:38:00 19/08/2019	79.57609	7.23821	920.96	98	750	750	6:38	Net 2
05:54:00 19/08/2019	79.59622	7.32041	885.11	98	0	750	6:38	Net 1
02:51:00 19/08/2019	79.5262	7.21323	979.86	95	125	5	3:05	Net 9

02:39:00 19/08/2019	79.53256	7.22015	969.79	95	250	125	2:51	Net 8
02:26:00 19/08/2019	79.53939	7.22895	958.63	95	375	250	2:39	Net 7
								1/2 sample preserved (formalin and ethanol each)
02:16:00 19/08/2019	79.54501	7.23546	948.88	95	500	375	2:26	Net 6
								1/4 sample preserved (formalin and ethanol each)
02:03:00 19/08/2019	79.55161	7.24409	940.88	95	625	500	2:16	Net 5
								1/2 sample preserved (formalin and ethanol each)
01:49:00 19/08/2019	79.55874	7.25664	929.72	95	750	625	2:03	Net 4
01:46:00 19/08/2019	79.56035	7.25967	927.5	95	760	750	1:49	Net 3
								Closed on descent
01:25:00 19/08/2019	79.57253	7.28094	911.59	95	452	760	1:46	Net 2
								Closed on descent
00:52:00 19/08/2019	79.59109	7.31644	889.67	95	0	452	1:25	Net 1
								closed on descent
12:13:00 18/08/2019	79.36807	4.86127	2402.93	89	30	5	12:17	Net 9
								Veered at 10m/min

12:08:00 18/08/2019	79.36702	4.87537	2397.39	89	60	30	12:13	Net 8
								Veered at 10m/min.
11:59:00 18/08/2019	79.36512	4.89929	2384.54	89	100	60	12:08	Net 7
								Veered at 10m/min.
11:33:00 18/08/2019	79.35515	5.02194	2298.11	89	300	100	11:59	Net 6
								Veered at 20m/min
11:19:00 18/08/2019	79.35515	5.02194	2298.11	89	450	300	11:33	Net 5
								Veered at 20m/min
11:16:00 18/08/2019	79.3542	5.03204	2291.57	89	500	450	11:19	Net 4
								Veered at 10m/min.
11:11:00 18/08/2019	79.35288	5.04639	2280.77	89	550	500	11:16	Net 3
								Veered at 10m/min
11:04:00 18/08/2019	79.35101	5.06349	2268.61	89	600	550	11:11	Net 2
								Veered at 10m/min
10:25:00 18/08/2019	79.33761	5.15398	2150.42	89	0	600	11:04	Net 1
09:16:00 18/08/2019	79.37615	4.75059	2483.16	88	125	5	9:26	Net 9
09:01:00 18/08/2019	79.37382	4.79714	2476.99	88	250	125	9:16	Net 8

08:50:00 18/08/2019	79.37156	4.83168	2429.42	88	375	250	9:01	Net 7
08:39:00 18/08/2019	79.3694	4.86216	2406.85	88	500	375	8:50	Net 6
08:25:00 18/08/2019	79.36656	4.89934	2389.42	88	615	500	8:39	Net 5
08:14:00 18/08/2019	79.36382	4.93127	2362.23	88	750	615	8:25	net 4
08:06:00 18/08/2019	79.36152	4.95625	2343.5	88	875	750	8:14	Net 3
07:53:00 18/08/2019	79.35815	4.98479	2320.72	88	993	875	8:06	Net 2
06:45:00 18/08/2019	79.33464	5.15325	2137.63	88	0	993	7:53	Net 1
								Pressure sensor stopped working at 993m
05:02:00 18/08/2019	79.37892	4.82453	2464.76	86	125	5	5:12	Net 9
04:49:00 18/08/2019	79.37628	4.86157	2420.64	86	250	125	5:02	Net 8
04:38:00 18/08/2019	79.37401	4.89323	2408.23	86	375	250	4:49	Net 7
04:27:00 18/08/2019	79.37163	4.92384	2397.23	86	500	375	4:38	Net 6
04:14:00 18/08/2019	79.36846	4.95702	2368.33	86	625	500	4:27	Net 5

04:02:00 18/08/2019	79.36515	4.9872	2343.4	86	750	625	4:14	Net 4
03:54:00 18/08/2019	79.36261	5.00844	2326.76	86	875	750	4:02	Net 3
03:45:00 18/08/2019	79.35991	5.02851	2312.31	86	993	875	3:54	Net 2
02:42:00 18/08/2019	79.33537	5.15595	2139.45	86		993	3:45	Net 1
								faulty depth sensor, leveled out at 993 metres
10:20:00 17/08/2019	78.39662	0.35457	2876.81	80	125	5	10:35	Net 9
10:05:00 17/08/2019	78.38886	0.37567	2895.53	80	250	125	10:20	Net 8
09:58:00 17/08/2019	78.38488	0.3865	2911.99	80	375	250	10:05	Net 7
09:38:00 17/08/2019	78.37605	0.41641	2915.25	80	500	375	9:58	Net 6, vessel slowed at 400m, net 6 open for longer
09:26:00 17/08/2019	78.37045	0.43826	2922.79	80	625	500	9:38	Net 5
09:14:00 17/08/2019	78.36488	0.4606	2926.91	80	750	625	9:26	Net 4
09:02:00 17/08/2019	78.35954	0.48192	2930.21	80	875	750	9:14	Net 3
08:50:00 17/08/2019	78.35438	0.50011	2933.28	80	992	875	9:02	Net 2

07:38:00 17/08/2019	78.32046	0.60473	2960.3	80		992	8:50	Pressure sensor stopped at 992 metres
05:27:00 17/08/2019	78.39553	0.41202	2862.88	78	125	5	5:40	Net 9
05:14:00 17/08/2019	78.38926	0.43023	2871.94	78	250	125	5:27	Net 8
05:01:00 17/08/2019	78.38286	0.44985	2886.1	78	375	250	5:14	Net 7
04:49:00 17/08/2019	78.37684	0.46611	2896.35	78	500	375	5:01	Net 6
04:38:00 17/08/2019	78.37142	0.48187	2899.7	78	625	500	4:49	Net 5
04:25:00 17/08/2019	78.36514	0.50014	2906.97	78	750	625	4:38	Net 4
04:14:00 17/08/2019	78.3596	0.51572	2912.61	78	875	750	4:25	Net 3
04:06:00 17/08/2019	78.35567	0.52759	2916.66	78	991	875	4:14	Net 2
02:58:00 17/08/2019	78.32127	0.60969	2958.12	78		991	4:06	Net 1
								Depth sensor malfunctioned. Reading stopped at 991 meters
03:11:00 13/08/2019	79.00216	3.32766	3073.54	43				Stepper motor changed. Net did not fire. Net discarded. Station F7. Changed to Mammoth net to continue with the 36 h clock gene series

12/8/2019 23:36	79.00361	3.33319	3153.41	42				Net did not trigger - catch discarded. Station F7 36 h clock gene series
12/8/2019 21:09	79.0518	3.43483	4247.04	41	90	50	21:20	Net 9 Fraction preserved for clock gene analysis then picked for metabolomics Haul speed 10 m/min 3/3 Shallow samples
12/8/2019 21:01	79.04814	3.4237	4285.44	41	130	90		Net 8 Fraction preserved for clock gene analysis then picked for metabolomics Haul speed 10 m/min 2/3 Shallow samples
12/8/2019 20:50	79.04253	3.40795	4429.82	41	170	130		Net 7 Fraction preserved for clock gene analysis then picked for metabolomics Haul speed 10 m/min 1/3 Shallow samples
12/8/2019 20:41	79.03794	3.39307	4382.21	41	240	170		Net 6 Discarded Hauled at 20 m/min

12/8/2019 20:26	79.02969	3.37337	4134.91	41	400	240		Net 5 Discarded Hauled at 20 m/min
12/8/2019 20:19	79.02591	3.36571	4036.61	41	440	400		Net 4 Fraction preserved for clock gene analysis then picked for metabolomics Haul speed 10 m/min 3/3 Deep samples
12/8/2019 20:14	79.02328	3.36096	3930.62	41	480	440		Net 3 Fraction preserved for clock gene analysis then picked for metabolomics Haul speed 10 m/min 2/3 Deep samples
12/8/2019 20:10	79.02107	3.35754	3836.93	41	520	480		Net 2 Fraction preserved for clock gene analysis then picked for metabolomics Haul speed 10 m/min 1/3 Deep samples
12/8/2019 19:33	79.00052	3.32697	3021.31	41		520		Net 1 Discarded Station F7 36 h clock gene series
12/8/2019 17:50	79.08675	3.48877	3748.16	40	168	50	18:03	Net 9 Fraction preserved for clock gene analysis then picked for

							metabolomics
							NB. Stern gantry failure at surface (net not out of water) - from 18:09 to 18:34
12/8/2019 17:38	79.08025	3.4806	3694.26	40	286	168	Net 8 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 17:23	79.07268	3.4655	3916.5	40	404	286	Net 7 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 17:08	79.06524	3.44452	0	40	522	404	Net 6 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 16:59	79.05999	3.43277	0	40	640	522	Net 5 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 16:46	79.05341	3.41722	1576.82	40	758	640	Net 4 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 16:32	79.04613	3.40048	2843.73	40	876	758	Net 3 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 16:24	79.04165	3.39138	3604.63	40	994	876	Net 2 Fraction preserved for clock gene analysis then picked for metabolomics
12/8/2019 15:18	79.00601	3.33863	0	40	0	994	Net 1 Discarded
							Station F7

								36 h clock gene series
11/8/2019 13:06	76.05187	-7.82173	1843.14	38	125	5	13:20	Net 9 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 12:52	76.05037	-7.85344	1829.76	38	250	125		Net 8 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 12:39	76.04865	-7.8821	1817.06	38	375	250		Net 7 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 12:27	76.04717	-7.90763	1796.67	38	500	375		Net 6 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 12:14	76.04574	-7.93426	1774.11	38	625	500		Net 5 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 12:03	76.04405	-7.95689	1763.89	38	750	625		Net 4 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 11:51	76.04232	-7.98148	1751.21	38	875	750		Net 3 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 11:38	76.04078	-8.00724	1727.99	38	1000	875		Net 2 Preserved 1/2 Formalin 1/2 Ethanol
11/8/2019 10:28	76.03396	-8.15291	1613.59	38		1000		Net 1 Discarded Station NT6a
								May have been recorded as Event 37
11/8/2019 8:30	76.02729	-7.73797	1945.11	36	125	5	8:44	Net 9 Picked and discarded
11/8/2019 8:15	76.02851	-7.77633	1923.23	36	250	125		Net 8 Picked and discarded
11/8/2019 8:03	76.02927	-7.80663	1896.93	36	375	250		Net 7 Picked and discarded
11/8/2019 7:52	76.02988	-7.83261	1878.87	36	500	375		Net 6 Picked and discarded

11/8/2019 7:39	76.03065	-7.86175	1859.53	36	625	500		Net 5 Picked and discarded
11/8/2019 7:25	76.03141	-7.89294	1832.97	36	750	625		Net 4 Picked and discarded
11/8/2019 7:10	76.03211	-7.92638	1810.01	36	875	750		Net 3 Picked and discarded
11/8/2019 6:59	76.03268	-7.95123	1791.54	36	1000	875		Net 2 Picked and discarded
11/8/2019 5:43	76.03417	-8.13192	1621.67	36		1000		Net 1 Discarded Station NT6a
10/8/2019 13:00	75.93153	-7.63525	2200.86	25	500	5	13:46	Net 9 Picked and discarded Hauled at 20 m/min
10/8/2019 12:53	75.92803	-7.63987	2205.75	25	600	500		Net 8 Picked and discarded Hauled at 20 m/min
10/8/2019 12:45	75.92398	-7.64386	2214.56	25	700	600		Net 7 Picked and discarded Hauled at 20 m/min
10/8/2019 12:35	75.91885	-7.64484	2226.63	25	800	700		Net 6 Picked and discarded Hauled at 20 m/min
10/8/2019 12:30	75.91624	-7.64291	2229.65	25	850	800		Net 5 Picked and discarded

								Hauled at 20 m/min
10/8/2019 12:23	75.91269	-7.63791	2235.41	25	900	850		Net 4
								Picked and discarded
								Hauled at 10 m/min
10/8/2019 12:17	75.90988	-7.6314	2245.79	25	950	900		Net 3
								Picked and discarded
								Hauled at 10 m/min
10/8/2019 12:13	75.90813	-7.62692	2252.79	25	1000	950		Net 2
								Picked and discarded
								Hauled at 10m/min
10/8/2019 11:12	75.88619	-7.53103	2340.12	25	0	1000		Net 1 Discarded
								Station NT8
10/8/2019 10:16	75.86286	-7.43245	2448.9	24	125	5	10:29	Net 9
								1/2 Ethanol, 1/2 Formalin
10/8/2019 10:02	75.8565	-7.40834	2480.43	24	250	125		Net 8
								1/2 Ethanol, 1/2 Formalin
10/8/2019 9:49	75.85068	-7.38627	2502.13	24	375	250		Net 7
								1/2 Ethanol, 1/2 Formalin

10/8/2019 9:39	75.84632	-7.36981	2515.13	24	500	375		Net 6
								1/2 Ethanol, 1/2 Formalin
10/8/2019 9:30	75.84256	-7.35566	2527.87	24	625	500		Net 5
								1/2 Ethanol, 1/2 Formalin
10/8/2019 9:19	75.83835	-7.33917	2542.56	24	750	625		Net 4
								1/2 Ethanol, 1/2 Formalin
10/8/2019 9:06	75.83364	-7.31983	2557.79	24	875	750		Net 3
								1/2 Ethanol, 1/2 Formalin
10/8/2019 8:56	75.83011	-7.30464	2574.2	24	1000	875		Net 2
								1/2 Ethanol, 1/2 Formalin
10/8/2019 7:53	75.80571	-7.19708	2669.05	24	0	1000		Net Discarded
								Station NT8
10/8/2019 6:39	75.87187	-6.99152	2695.86	23	125	5	6:52	Net 9 Picked and discarded
10/8/2019 6:25	75.86449	-7.01122	2692.16	23	250	125		Net 8 Picked and discarded
10/8/2019 6:12	75.85764	-7.0307	2692.11	23	375	250		Net 7 Picked and discarded
10/8/2019 6:02	75.85257	-7.04589	2694.9	23	500	375		Net 6 Picked and discarded
10/8/2019 5:49	75.84668	-7.06343	2684.76	23	625	500		Net 5 Picked and discarded
10/8/2019 5:37	75.84109	-7.08064	2686.63	23	625	500		Net 4 Picked and discarded
10/8/2019 5:26	75.83613	-7.09637	2684.01	23	872	750		Net 3 Picked and discarded

10/8/2019 5:16	75.83164	-7.10986	2665.98	23	1000	872		Net 2 Picked and discarded
10/8/2019 4:10	75.80155	-7.20268	2677.38	23	0	1000		Net 1 Discarded
								Station NT8
9/8/2019 11:54	75.43806	-5.86894	3526.56	13	125	5	12:07	Net 9
								1/2 ethanol, 1/2 formalin
9/8/2019 11:40	75.43806	-5.86894	3526.56	13	250	125		Net 8
								1/2 ethanol, 1/2 formalin
9/8/2019 11:25	75.43806	-5.86894	3526.56	13	375	250		Net 7
								1/2 ethanol, 1/2 formalin
9/8/2019 11:12	75.43806	-5.86894	3526.56	13	500	375		Net 6
								1/2 ethanol, 1/2 formalin
9/8/2019 11:01	75.43806	-5.86894	3526.56	13	625	500		Net 5
								1/2 ethanol, 1/2 formalin
9/8/2019 10:47	75.43806	-5.86894	3526.56	13	750	625		Net 4
								1/2 ethanol, 1/2 formalin
9/8/2019 10:34	75.43806	-5.86894	3526.56	13	875	750		Net 3
								1/2 ethanol, 1/2 formalin
9/8/2019 10:22	75.43806	-5.86894	3526.56	13	1000	875		Net 2
								1/2 ethanol, 1/2 formalin

9/8/2019 9:17	75.43806	-5.86894	3526.56	13		1000		Net 1 Discarded
9/8/2019 6:48	75.25523	-5.26925	3564.37	11	125	5	7:01	Net 9
9/8/2019 6:36	75.26175	-5.28492	3575.37	11	250	125		Picked and discarded Net 8
9/8/2019 6:24	75.2677	-5.30014	3580.6	11	375	250		Picked and discarded Net 7
9/8/2019 6:13	75.273	-5.31484	3583.72	11	500	375		Picked and discarded Net 6
9/8/2019 6:00	75.27916	-5.33031	3589.67	11	625	500		Picked and discarded Net 5
9/8/2019 5:46	75.28577	-5.3471	3588.47	11	750	625		Picked and discarded Net 4
9/8/2019 5:32	75.2925	-5.36237	3582.06	11	875	750		Picked and discarded Net 3
9/8/2019 5:11	75.30247	-5.38389	3576.45	11	1000	875		Picked and discarded Net 2
9/8/2019 4:11	75.33056	-5.45171	3570.67	11		1000		Picked and discarded Net 1 Discarded

NB: Depth meter showing 10 m at surface

Table 5.2: Mammoth deployments on JR18007

Time	Latitude(furuno-gga - furuno-gga-lat)	Longitude(furuno-gga - furuno-gga-lon)	Water depth(ea600 - ea600-depth)	Event(Built In - String)	Open depth(Built In - String)	Close depth(Built In - String)	Opening time or closing time(Built In - String)	Comment
26/08/2019 12:28	77.71698	7.58191	3538.2	159	5	5		DEEP MAMMOTH STATION D9 Last net closed
26/08/2019 12:24	77.71698	7.58191	3538.2	159	250	5		DEEP MAMMOTH STATION D9 Net 9 SAMPLES PRESERVED IN FORMALIN
26/08/2019 12:20	77.71698	7.58191	3538.2	159	500	250		DEEP MAMMOTH STATION D9 Net 8 SAMPLES PRESERVED IN FORMALIN
26/08/2019 12:17	77.71698	7.58191	3538.2	159	1000	500		DEEP MAMMOTH STATION D9 Net 7 SAMPLES PRESERVED IN FORMALIN

26/08/2019 12:13	77.71698	7.58191	3538.2	159	1250	1000	DEEP MAMMOTH STATION D9 Net 6 SAMPLES PRESERVED IN FORMALIN
26/08/2019 12:02	77.71698	7.58191	3538.2	159	1500	1250	DEEP MAMMOTH STATION D9 Net 5 SAMPLES PRESERVED IN FORMALIN
26/08/2019 11:51	77.71698	7.58191	3538.2	159	1750	1500	DEEP MAMMOTH STATION D9 Net 4 SAMPLES PRESERVED IN FORMALIN
26/08/2019 11:47	77.71698	7.58191	3538.2	159	2000	1750	DEEP MAMMOTH STATION D9 Net 3 SAMPLES PRESERVED IN FORMALIN
26/08/2019 11:43	77.71698	7.58191	3538.2	159	2250	2000	DEEP MAMMOTH STATION D9 Net 2

							SAMPLES PRESERVED IN FORMALIN
							DEEP MAMMOTH STATION D9
26/08/2019 11:39	77.71698	7.58191	3538.2	159	2500	2250	Net 1
							SAMPLES PRESERVED IN FORMALIN
							DEEP MAMMOTH STATION D9
26/08/2019 11:09	77.71698	7.58191	3538.2	159	0	2500	Net 0
							Not a sample
25/08/2019 15:16	78.41694	6.99964	3368.59	152	5	5	DEEP MAMMOTH STATION D8 Last net closed
							DEEP MAMMOTH STATION D8
25/08/2019 15:12	78.41694	6.99964	3368.59	152	250	5	Net 9
							SAMPLES PRESERVED IN FORMALIN
							DEEP MAMMOTH STATION D8
25/08/2019 15:08	78.41694	6.99964	3368.59	152	500	250	Net 8
							SAMPLES PRESERVED IN FORMALIN

25/08/2019 15:05	78.41694	6.99964	3368.59	152	1000	500	DEEP MAMMOTH STATION D8 Net 7 SAMPLES PRESERVED IN FORMALIN
25/08/2019 15:01	78.41694	6.99964	3368.59	152	1250	1000	DEEP MAMMOTH STATION D8 Net 6 SAMPLES PRESERVED IN FORMALIN
25/08/2019 14:50	78.41694	6.99964	3368.59	152	1500	1250	DEEP MAMMOTH STATION D8 Net 5 SAMPLES PRESERVED IN FORMALIN
25/08/2019 14:39	78.41694	6.99964	3368.59	152	1750	1500	DEEP MAMMOTH STATION D8 Net 4 SAMPLES PRESERVED IN FORMALIN
25/08/2019 14:35	78.41694	6.99964	3368.59	152	2000	1750	DEEP MAMMOTH STATION D8 Net 3

							SAMPLES PRESERVED IN FORMALIN
							DEEP MAMMOTH STATION D8
25/08/2019 14:31	78.41694	6.99964	3368.59	152	2250	2000	Net 2
							SAMPLES PRESERVED IN FORMALIN
							DEEP MAMMOTH STATION D8
25/08/2019 14:27	78.41694	6.99964	3368.59	152	2500	2250	Net 1
							SAMPLES PRESERVED IN FORMALIN
							DEEP MAMMOTH STATION D8
25/08/2019 13:59	78.41694	6.99964	3368.59	152	0	2500	Net 0
							Not a sample
24/08/2019 15:59	79.31789	2.65245		144	5	5	DEEP MAMMOTH STATION D7
							Last net closed
							DEEP MAMMOTH STATION D7
24/08/2019 15:55	79.31789	2.65245		144	250	5	Net 9
							SAMPLES PRESERVED IN FORMALIN

24/08/2019 15:51	79.31789	2.65245	144	500	250	DEEP MAMMOTH STATION D7 Net 8 SAMPLES PRESERVED IN FORMALIN
24/08/2019 15:48	79.31789	2.65245	144	1000	500	DEEP MAMMOTH STATION D7 Net 7 SAMPLES PRESERVED IN FORMALIN
24/08/2019 15:44	79.31789	2.65245	144	1250	1000	DEEP MAMMOTH STATION D7 Net 6 SAMPLES PRESERVED IN FORMALIN
24/08/2019 15:33	79.31789	2.65245	144	1500	1250	DEEP MAMMOTH STATION D7 Net 5 SAMPLES PRESERVED IN FORMALIN
24/08/2019 15:22	79.31789	2.65245	144	1750	1500	DEEP MAMMOTH STATION D7 Net 4

								SAMPLES PRESERVED IN FORMALIN
								DEEP MAMMOTH STATION D7
24/08/2019 15:18	79.31789	2.65245		144	2000	1750		Net 3
								SAMPLES PRESERVED IN FORMALIN
								DEEP MAMMOTH STATION D7
24/08/2019 15:14	79.31789	2.65245		144	2250	2000		Net 2
								SAMPLES PRESERVED IN FORMALIN
								DEEP MAMMOTH STATION D7
24/08/2019 15:10	79.31789	2.65245		144	2500	2250		Net 1
								SAMPLES PRESERVED IN FORMALIN
								DEEP MAMMOTH STATION D7
24/08/2019 14:40	79.31789	2.65245		144	0	2500		Net 0
								Not a sample
13:17:00 22/08/2019	79.16663	6.60014	1492.02	124	50	5	13:21:27	Net 9 Vol filt = 38 m3

13:13:00 22/08/2019	79.16661	6.59999	1492.02	124	90	50	13:17:25	Net 8 Vol filt = 0 m3
13:10:00 22/08/2019	79.16663	6.60017	1492.03	124	130	90	13:13:49	Net 7 Vol filt = 0 m3
13:06:00 22/08/2019	79.16662	6.60012	1492.01	124	170	130	13:10:13	Net 6 Vol filt = 0 m3
12:55:00 22/08/2019	79.16665	6.60028	1491.98	124	285	170	13:06:33	Net 5 Vol filt = 0 m3
12:44:00 22/08/2019	79.16665	6.60026	1491.99	124	400	285	12:55:46	Net 4 Vol filt = 0 m3
12:40:00 22/08/2019	79.16666	6.60015	1491.89	124	440	400	12:44:39	Net 3 Vol filt = 0 m3
12:36:00 22/08/2019	79.16663	6.6001	1491.92	124	480	440	12:40:43	Net 2 Vol filt = 0 m3
12:32:00 22/08/2019	79.16666	6.60017	1491.84	124	520	480	12:36:42	Net 1 Vol filt = 0 m3
12:02:00 22/08/2019	79.16667	6.6002	1491.81	124		540	12:32:37	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
09:16:00 22/08/2019	79.16665	6.60032	1491.82	123	50	5	9:20:46	Net 9 Vol filt = 0 m3
09:13:00 22/08/2019	79.16664	6.60032	1491.79	123	90	50	9:16:42	Net 8 Vol filt = 0 m3

09:09:00 22/08/2019	79.16665	6.60023	1491.83	123	130	90	9:13:08	Net 7 Vol filt = 0 m3
09:05:00 22/08/2019	79.16659	6.60025	1491.82	123	170	130	9:09:32	Net 6 Vol filt = 0 m3
08:55:00 22/08/2019	79.16665	6.60019	1491.81	123	285	170	9:05:50	Net 5 Vol filt = 0 m3
08:43:00 22/08/2019	79.16666	6.60035	1491.82	123	400	285	8:55:05	Net 4 Vol filt = 43 m3
08:40:00 22/08/2019	79.16665	6.6001	1491.83	123	440	400	8:43:58	Net 3 Vol filt = 38 m3
08:36:00 22/08/2019	79.16664	6.60032	1491.87	123	480	440	8:40:00	Net 2 Vol filt = 39 m3
08:31:00 22/08/2019	79.16664	6.60018	1491.93	123	520	480	8:36:00	Net 1 Vol filt = 37 m3
08:00:00 22/08/2019	79.16672	6.60032	1492.06	123		540	8:31:53	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
05:25:00 22/08/2019	79.16665	6.60015	1492.46	122	50	5	5:29:15	Net 9 Vol filt = 0 m3
05:21:00 22/08/2019	79.16665	6.60017	1492.41	122	90	50	5:25:01	Net 8 Vol filt = 0 m3
05:17:00 22/08/2019	79.16665	6.60013	1492.54	122	130	90	5:21:17	Net 7 Vol filt = 0 m3

05:13:00 22/08/2019	79.16669	6.60017	1492.47	122	170	130	5:17:16	Net 6 Vol filt = 0 m3
05:02:00 22/08/2019	79.16665	6.60028	1492.52	122	285	170	5:13:33	Net 5 Vol filt = 0 m3
04:51:00 22/08/2019	79.16663	6.60036	1492.6	122	400	285	5:02:38	Net 4 Vol filt = 50 m3
04:47:00 22/08/2019	79.16668	6.60024	1492.5	122	440	400	4:51:27	Net 3 Vol filt = 38 m3
04:43:00 22/08/2019	79.16661	6.60017	1492.59	122	480	440	0:47:34	Net 2 Vol filt = 39 m3
04:39:00 22/08/2019	79.16662	6.60011	1492.52	122	520	480	0:43:38	Net 1 Vol filt = 44 m3
04:06:00 22/08/2019	79.16661	6.60016	1492.71	122		540	4:39:29	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
01:26:00 22/08/2019	79.16665	6.60037	1492.32	121	50	5	1:30:12	Net 9 Vol filt = 17 m3
01:22:00 22/08/2019	79.16663	6.60019	1492.31	121	90	50	1:26:18	Net 8 Vol filt = 35 m3
01:18:00 22/08/2019	79.16661	6.59998	1492.18	121	130	90	1:22:41	Net 7 Vol filt = 23 m3
01:15:00 22/08/2019	79.16663	6.60013	1492.2	121	170	130	1:18:58	Net 6 Vol filt = 25 m3

01:04:00 22/08/2019	79.16664	6.60015	1492.15	121	285	170	1:15:14	Net 5 Vol filt = 90 m3
00:53:00 22/08/2019	79.16663	6.60008	1492.17	121	400	285	1:04:18	Net 4 Vol filt = 98 m3
00:49:00 22/08/2019	79.16665	6.60016	1492.14	121	440	400	0:53:09	Net 3 Vol filt = 44 m3
00:45:00 22/08/2019	79.16666	6.6001	1492.11	121	480	440	0:49:08	Net 2 Vol filt = 48 m3
00:40:00 22/08/2019	79.16665	6.60017	1492.12	121	520	480	0:45:02	Net 1 Vol filt = 35 m3
00:07:00 22/08/2019	79.16666	6.60017	1491.97	121		540	0:40:53	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
21:34:00 21/08/2019	79.16665	6.60031	1491.79	120	50	5	21:38:55	Net 9 Vol filt = 6 m3
21:30:00 21/08/2019	79.16661	6.6003	1491.82	120	90	50	21:34:42	Net 8 Vol filt = 10 m3
21:27:00 21/08/2019	79.16663	6.60059	1491.77	120	130	90	21:30:58	Net 7 Vol filt = 17 m3
21:23:00 21/08/2019	79.16664	6.60029	1491.75	120	170	130	21:27:10	Net 6 Vol filt = 19 m3
21:12:00 21/08/2019	79.16665	6.60028	1491.8	120	285	170	21:23:19	Net 5 Vol filt = 91 m3

21:00:00 21/08/2019	79.16659	6.60063	1491.79	120	440	2285	21:12:07	Net 4 Vol filt = 4 m3
20:56:00 21/08/2019	79.1666	6.60043	1491.78	120	440	400	21:00:35	Net 3 Vol filt = 42 m3
20:52:00 21/08/2019	79.16659	6.60045	1491.8	120	480	440	20:56:33	Net 2 Vol filt = 44 m3
20:48:00 21/08/2019	79.16659	6.60048	1491.81	120	520	480	20:52:48	Net 1 Vol filt = 36 m3
20:10:00 21/08/2019	79.16662	6.60027	1491.82	120		540	20:48:58	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
17:26:00 21/08/2019	79.16667	6.60018	1492.34	119	50	5	17:30:51	Net 9 Vol filt = 12 m3
17:22:00 21/08/2019	79.16666	6.60026	1492.29	119	90	50	17:26:38	Net 8 Vol filt = 18 m3
17:19:00 21/08/2019	79.16666	6.60025	1492.22	119	130	90	17:22:51	Net 7 Vol filt = 31 m3
17:15:00 21/08/2019	79.16664	6.60023	1492.21	119	170	130	17:19:01	Net 6 Vol filt = 32 m3
17:03:00 21/08/2019	79.16663	6.60028	1492.22	119	285	170	17:15:08	Net 5 Vol filt = 77 m3
16:52:00 21/08/2019	79.16663	6.60035	1492.21	119	400	285	17:03:48	Net 4 Vol filt = 76 m3

16:48:00 21/08/2019	79.16661	6.6003	1492.27	119	440	400	16:52:36	Net 3 Vol filt = 26 m3
16:44:00 21/08/2019	79.16661	6.60016	1492.21	119	480	440	16:48:41	Net 2 Vol filt = 34 m3
16:40:00 21/08/2019	79.16663	6.60013	1492.28	119	520	480	16:44:39	Net 1 Vol filt = 29 m3
16:04:00 21/08/2019	79.16663	6.60024	1492.34	119		540	16:40:37	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
13:34:00 21/08/2019	79.16663	6.60017	1492	118	50	5	13:39:11	Net 9 Vol filt = 21 m3
13:30:00 21/08/2019	79.16663	6.60028	1491.93	118	90	50	13:34:19	Net 8 Vol filt = 21 m3
13:27:00 21/08/2019	79.16666	6.60024	1491.97	118	130	90	13:30:33	Net 7 Vol filt = 28 m3
13:23:00 21/08/2019	79.16665	6.60022	1491.89	118	170	130	13:27:02	Net 6 Vol filt = 30 m3
13:13:00 21/08/2019	79.16662	6.60008	1491.93	118	285	170	13:23:23	Net 5 Vol filt = 15 m3
13:02:00 21/08/2019	79.16664	6.60027	1491.86	118	400	285	13:13:10	Net 4 Vol filt = 0 m3
12:58:00 21/08/2019	79.16664	6.60034	1491.84	118	440	400	13:02:23	Net 3 Vol filt = 0 m3

12:54:00 21/08/2019	79.16667	6.60019	1491.81	118	480	440	12:58:29	Net 2 Vol filt = 0 m3
12:50:00 21/08/2019	79.16668	6.60015	1491.89	118	520	480	12:54:31	Net 1 Vol filt = 0 m3
12:11:00 21/08/2019	79.16666	6.60042	1491.76	118		540	12:50:19	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
09:12:00 21/08/2019	79.16662	6.60047	1491.6	117	50	5	9:16:21	Net 9 Vol filt = 29 m3
09:08:00 21/08/2019	79.16662	6.60072	1491.51	117	90	50	9:12:05	Net 8 Vol filt = 25 m3
09:04:00 21/08/2019	79.16663	6.60031	1491.42	117	130	90	9:08:20	Net 7 Vol filt = 22 m3
09:00:00 21/08/2019	79.16661	6.60066	1491.49	117	170	130	9:04:20	Net 6 Vol filt = 25 m3
08:49:00 21/08/2019	79.1666	6.60046	1491.52	117	285	170	9:00:26	Net 5 Vol filt = 90 m3
08:39:00 21/08/2019	79.16663	6.60051	1491.57	117	400	285	8:49:20	Net 4 Vol filt = 94 m3
08:35:00 21/08/2019	79.16661	6.60036	1491.49	117	440	400	8:39:06	Net 3 Vol filt = 39 m3
08:31:00 21/08/2019	79.16662	6.60045	1491.45	117	480	440	8:35:21	Net 2 Vol filt = 35 m3

08:27:00 21/08/2019	79.1667	6.60039	1491.55	117	520	480	8:31:29	Net 1 Vol filt = 42 m3
08:00:00 21/08/2019	79.16665	6.6003	1491.56	117		540	8:27:21	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
05:16:00 21/08/2019	79.16665	6.6004	1492.21	116	50	5	5:20:44	Net 9 Vol filt = 0 m3
05:13:00 21/08/2019	79.16665	6.60033	1492.21	116	90	50	5:16:43	Net 8 Vol filt = 0 m3
05:09:00 21/08/2019	79.16662	6.60032	1492.14	116	130	90	5:13:12	Net 7 Vol filt = 0 m3
05:05:00 21/08/2019	79.16663	6.60039	1492.16	116	170	130	5:09:32	Net 6 Vol filt = 0 m3
04:55:00 21/08/2019	79.16657	6.60025	1492.22	116	285	170	5:05:47	Net 5 Vol filt = 0 m3
04:44:00 21/08/2019	79.16663	6.6003	1492.37	116	400	285	4:55:16	Net 4 Vol filt = 0 m3
04:40:00 21/08/2019	79.16662	6.60025	1492.37	116	440	400	4:44:22	Net 3 Vol filt = 0 m3
04:36:00 21/08/2019	79.16664	6.60033	1492.25	116	480	440	4:40:28	Net 2 Vol filt = 0 m3
04:32:00 21/08/2019	79.16661	6.60037	1492.31	116	520	480	4:36:30	Net 1 Vol filt = 0 m3

04:02:00 21/08/2019	79.16663	6.60042	1492.28	116		545	4:32:21	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
01:46:00 21/08/2019	79.16662	6.60051	1491.87	115	125	5	1:57:18	Net 9 Vol filt = 34 m3
01:34:00 21/08/2019	79.16663	6.6004	1493.53	115	250	125	1:46:21	Net 8 Vol filt = 38 m3
01:22:00 21/08/2019	79.16663	6.60052	1491.7	115	375	250	1:34:43	Net 7 Vol filt = 6 m3
01:10:00 21/08/2019	79.16661	6.60023	1491.64	115	500	375	1:22:49	Net 6 Vol filt = 12 m3
00:57:00 21/08/2019	79.16664	6.60039	1491.92	115	625	500	1:10:19	Net 5 Vol filt = 0 m3
00:46:00 21/08/2019	79.16664	6.60035	1491.84	115	750	625	0:57:35	Net 4 Vol filt = 0 m3
00:34:00 21/08/2019	79.16661	6.60029	1493.36	115	875	750	0:46:15	Net 3 Vol filt = 0 m3
00:23:00 21/08/2019	79.16663	6.60032	1491.75	115	1000	875	0:34:45	Net 2 Vol filt = 0 m3
00:18:00 21/08/2019	79.16664	6.60013	1491.77	115	1050	1000	0:23:26	Net 1 Vol filt = 0 m3
23:08:00 20/08/2019	79.16662	6.6004	1491.14	115		1190	0:18:43	36 h clock gene

						Net in autonomous mode No sample (no net open)
11:01 19/08/2019	79.46921	5.99545	99	5	5	Last net closed
10:57 19/08/2019	79.46921	5.99545	99	250	5	DEEP MAMMOTH STATION Net 9 SAMPLES PRESERVED IN FORMALIN
10:53 19/08/2019	79.46921	5.99545	99	500	250	DEEP MAMMOTH STATION Net 8 SAMPLES PRESERVED IN FORMALIN
10:50 19/08/2019	79.46921	5.99545	99	750	500	DEEP MAMMOTH STATION Net 7 SAMPLES PRESERVED IN FORMALIN
10:46 19/08/2019	79.46921	5.99545	99	1000	750	DEEP MAMMOTH STATION Net 6

						SAMPLES PRESERVED IN FORMALIN
10:35 19/08/2019	79.46921	5.99545	99	1100	1000	DEEP MAMMOTH STATION Net 5 SAMPLES PRESERVED IN FORMALIN
10:24 19/08/2019	79.46921	5.99545	99	1200	1100	DEEP MAMMOTH STATION Net 4 SAMPLES PRESERVED IN FORMALIN
10:20 19/08/2019	79.46921	5.99545	99	1300	1200	DEEP MAMMOTH STATION Net 3 SAMPLES PRESERVED IN FORMALIN
10:16 19/08/2019	79.46921	5.99545	99	1400	1300	DEEP MAMMOTH STATION Net 2 SAMPLES PRESERVED IN FORMALIN

10:12 19/08/2019	79.46921	5.99545		99	1500	1400		DEEP MAMMOTH STATION Net 1 SAMPLES PRESERVED IN FORMALIN
09:42 19/08/2019	79.46921	5.99545		99				DEEP MAMMOTH STATION Net 0 Not a sample
15:15:00 14/08/2019	79.00012	3.33318	3027.46	58	125	5	15:26:12	Net 9 Vol filt = 100 m3
15:03:00 14/08/2019	79.00009	3.33309	3024.38	58	250	125	15:15:30	Net 8 Vol filt = 121 m3
14:51:00 14/08/2019	79.00009	3.33306	3027.46	58	375	250	15:03:47	Net 7 Vol filt = 113 m3
14:40:00 14/08/2019	79.0001	3.33317	3025.92	58	500	375	14:51:54	Net 6 Vol filt = 116 m3
14:29:00 14/08/2019	79.00009	3.33337	3035.14	58	625	500	14:40:51	Net 5 Vol filt = 107 m3
14:17:00 14/08/2019	79.0001	3.33318	3024.38	58	750	625	14:29:40	Net 4 Vol filt = 102 m3
14:05:00 14/08/2019	79.00008	3.33303	3013.63	58	875	750	14:17:55	Net 3 Vol filt = 97 m3

13:54:00 14/08/2019	79.00008	3.33303	3013.63	58	1000	875	14:05:48	Net 2 Vol filt = 94 m3
13:50:00 14/08/2019	79.00008	3.33303	3030.53	58	1050	1000	13:54:39	Net 1 Vol filt = 39 m3
12:44:00 14/08/2019	79.00005	3.3329	3030.53	58	0	1050	13:50	
11:54:00 14/08/2019	79.00009	3.33303	3021.31	56	50	5	11:58:46	Net 9 Vol filt = 37 m3
11:50:00 14/08/2019	79.00008	3.33296	3028.99	56	90	50	11:54:18	Net 8 Vol filt = 39 m3
11:47:00 14/08/2019	79.00008	3.33296	3028.99	56	130	90	11:50:31	Net 7 Vol filt = 41 m3
11:43:00 14/08/2019	79.00004	3.33295	3032.06	56	170	130	11:47:01	Net 6 Vol filt = 39 m3
11:33:00 14/08/2019	79.00008	3.33298	3033.6	56	285	170	11:43:27	Net 5 Vol filt = 106 m3
11:22:00 14/08/2019	79.00011	3.33288	3052.03	56	400	285	11:33:04	Net 4 Vol filt = 95 m3
11:18:00 14/08/2019	79.00009	3.33282	3009.02	56	440	400	11:22:19	Net 3 Vol filt = 35 m3
11:14:00 14/08/2019	79.00008	3.33296	3035.14	56	480	440	11:18:30	Net 2 Vol filt = 31 m3
11:11:00 14/08/2019	79.0001	3.33289	3035.14	56	520	480	11:14:43	Net 1 Vol filt = 35 m3

10:31:00 14/08/2019	79.00005	3.33289	3025.92	56	0	520	11:11:02	36 h clock gene Net in autonomous mode No sample (no net open)
09:52:00 14/08/2019	79.00007	3.33303	3027.46	55	125	5	10:02:27	Net 9 Vol filt = 130 m3
09:41:00 14/08/2019	79.00005	3.33299	3022.85	55	250	125	9:52:11	Net 8 Vol filt = 132 m3
09:30:00 14/08/2019	79.00009	3.33298	3028.99	55	375	250	9:41:19	Net 7 Vol filt = 121 m3
09:18:00 14/08/2019	79.00009	3.33298	3028.99	55	500	375	9:30:09	Net 6 Vol filt = 102 m3
09:06:00 14/08/2019	79.00009	3.33299	3033.6	55	625	500	9:18:31	Net 5 Vol filt = 104 m3
08:54:00 14/08/2019	79.00009	3.33299	3033.6	55	750	625	9:06:34	Net 4 Vol filt = 110 m3
08:42:00 14/08/2019	79.00009	3.3331	3035.14	55	875	750	8:54:06	Net 3 Vol filt = 112 m3
08:31:00 14/08/2019	79.00008	3.33286	3032.06	55	1000	875	8:42:48	Net 2 Vol filt = 121 m3
08:26:00 14/08/2019	79.00011	3.33303	3025.92	55	1050	1000	8:31:22	Net 1 Vol filt = 48 m3
07:24:00 14/08/2019	79.00003	3.33293	3027.46	55	0	1200	8:26:51	

06:45:00 14/08/2019	79.00008	3.33303	3025.92	54	50	5	6:49:35	Net 9 Vol filt = 38 m3
06:41:00 14/08/2019	79.00008	3.33297	3022.85	54	90	50	6:45:28	Net 8 Vol filt = 38 m3
06:37:00 14/08/2019	79.00008	3.33306	3025.92	54	130	90	6:41:47	Net 7 Vol filt = 41 m3
06:34:00 14/08/2019	79.00008	3.33308	3028.99	54	170	130	6:37:49	Net 6 Vol filt = 41 m3
06:22:00 14/08/2019	79.00012	3.333	3072	54	285	170	6:34:00	Net 5 Vol filt = 110 m3
06:11:00 14/08/2019	79.00007	3.33306	3030.53	54	400	285	6:22:54	Net 4 Vol filt = 103 m3
06:07:00 14/08/2019	79.00009	3.33299	3076.61	54	440	400	6:11:25	Net 3 Vol filt = 37 m3
06:03:00 14/08/2019	79.00009	3.33296	3025.92	54	480	440	6:07:28	Net 2 Vol filt = 35 m3
05:59:00 14/08/2019	79.00007	3.33319	3033.6	54	520	480	6:03:45	Net 1 Vol filt = 41 m3
05:24:00 14/08/2019	79.00011	3.333	3045.89	54	0	520	5:59:54	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
02:07:00 14/08/2019	79.00007	3.33294	3022.85	52	50	5	2:10:44	Net 9 Vol filt = 49 m3

02:03:00 14/08/2019	79.00004	3.33298	3022.85	52	90	50	2:07:04	Net 8 Vol filt = 41 m3
02:00:00 14/08/2019	79.00004	3.33295	3032.06	52	130	90	2:03:45	Net 7 Vol filt = 39 m3
01:56:00 14/08/2019	79.00005	3.33299	3024.38	52	170	130	2:00:22	Net 6 Vol filt = 45 m3
01:47:00 14/08/2019	79.00005	3.33301	3025.92	52	285	170	1:56:58	Net 5 Vol filt = 115 m3
01:36:00 14/08/2019	79.00007	3.333	3028.99	52	400	285	1:47:02	Net 4 Vol filt = 121 m3
01:33:00 14/08/2019	79.00008	3.33285	3024.38	52	440	400	1:36:47	Net 3 Vol filt = 32 m3
01:29:00 14/08/2019	79.00005	3.33308	3027.46	52	480	440	1:33:07	Net 2 Vol filt = 31 m3
01:25:00 14/08/2019	79.00007	3.33295	3035.14	52	520	480	1:29:26	Net 1 Vol filt = 33 m3
00:32:00 14/08/2019	79.00006	3.33298	3027.46	52		520	1:25:42	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
22:12:00 13/08/2019	78.99996	3.33348	3028.99	48	50	5	22:16:21	Net 9 Vol filt = 37 m3
22:08:00 13/08/2019	78.99994	3.33362	3019.78	48	90	50	22:12:16	Net 8 Vol filt = 27 m3

22:04:00 13/08/2019	78.99993	3.33357	3019.78	48	130	90	22:08:35	Net 7 Vol filt = 29 m3
22:01:00 13/08/2019	78.99993	3.33351	3025.92	48	170	130	22:04:48	Net 6 Vol filt = 24 m3
21:49:00 13/08/2019	78.99995	3.33353	3024.38	48	285	170	22:01:01	Net 5 Vol filt = 89 m3
21:39:00 13/08/2019	78.99995	3.33356	3021.31	48	400	285	21:49:54	Net 4 Vol filt = 82 m3
21:35:00 13/08/2019	78.99987	3.33357	3021.31	48	440	400	21:38:59	Net 3 Vol filt = 34 m3
21:31:00 13/08/2019	78.99985	3.33353	3021.31	48	480	440	21:35:12	Net 2 Vol filt = 30 m3
21:27:00 13/08/2019	78.99986	3.33351	3021.31	48	520	480	21:31:26	Net 1 Vol filt = 25 m3
20:05:00 13/08/2019	78.99995	3.33349	3022.85	48	0	520	21:27:36	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
16:36:00 13/08/2019	78.99996	3.33358	3022.85	47	50	5	16:40:56	Net 9 Vol filt = 43 m3
16:32:00 13/08/2019	78.99994	3.33374	3024.38	47	90	50	16:36:20	Net 8 Vol filt = 27 m3
16:29:00 13/08/2019	78.99994	3.33377	3022.85	47	130	90	16:32:53	Net 7 Vol filt = 27 m3

16:25:48 13/08/2019	78.99994	3.33376	3019.78	47	170	130	16:29:20	Net 6 Vol filt = 25 m3
16:15:00 13/08/2019	78.99997	3.3336	3022.85	47	285	170	16:25:47	Net 5 Vol filt = 80 m3
16:04:00 13/08/2019	78.99994	3.33366	3024.38	47	400	285	16:15:21	Net 4 Vol filt = 72 m3
16:00:00 13/08/2019	78.99994	3.33359	3022.85	47	440	400	16:04:36	Net 3 Vol filt = 24 m3
15:56:00 13/08/2019	78.99994	3.33365	3022.85	47	480	440	16:00:00	Net 2 Vol filt = 23 m3
15:53:00 13/08/2019	78.99995	3.33386	3028.99	47	520	480	15:56:53	Net 1 Vol filt = 31 m3
15:15:00 13/08/2019	78.99997	3.33402	3027.46	47		520	15:52:59	36 h clock gene Net in autonomous mode No sample (no net open)
13:41:00 13/08/2019	78.99997	3.3338	3030.53	46	50	5	13:49:06	Net 9 Vol filt = 24 m3
13:34:00 13/08/2019	78.99994	3.33396	3027.46	46	90	50	13:41:13	Net 8 Vol filt = 18 m3
13:26:00 13/08/2019	78.99997	3.33367	3032.06	46	130	90	13:34:02	Net 7 Vol filt = 15 m3
13:19:00 13/08/2019	78.99999	3.33368	3027.46	46	170	130	13:26:52	Net 6 Vol filt = 15 m3

12:58:00 13/08/2019	78.99993	3.33375	3024.38	46	285	170	13:19:39	Net 5 Vol filt = 50 m3
12:37:00 13/08/2019	78.99993	3.3338	3024.38	46	400	285	12:58:51	Net 4 Vol filt = 49 m3
12:29:00 13/08/2019	78.99995	3.33392	3038.21	46	440	400	12:37:28	Net 3 Vol filt = 19 m3
12:22:00 13/08/2019	78.99991	3.33386	3022.85	46	480	440	12:29:51	Net 2 Vol filt = 18 m3
12:14:00 13/08/2019	78.99994	3.33386	3027.46	46	520	480	12:22:11	Net 1 Vol filt = 22 m3
11:23:00 13/08/2019	78.99995	3.3338	3028.99	46	0	520	12:14:26	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
09:56:16 13/08/2019	78.99998	3.33398	3027.46	45	50	5	10:00:17	Net 9 vol filt = 29 m3
09:52:43 13/08/2019	78.99994	3.33368	3061.25	45	90	50	9:56:15	Net 8 Vol filt = 28 m3
09:49:04 13/08/2019	78.99994	3.33384	3030.53	45	130	90	9:52:42	Net 7 vol filt = 30 m3
09:45:20 13/08/2019	78.99998	3.33394	3021.31	45	170	130	9:49:03	Net 6 Vol filt = 26 m3
09:33:20 13/08/2019	79.00001	3.33375	3025.92	45	285	170	9:45:19	Net 5 Vol filt = 85 m3

09:22:32 13/08/2019	78.99996	3.33385	3030.53	45	400	285	9:33:19	Net 4 Vol filt = 90 m3
09:18:00 13/08/2019	78.99995	3.33388	3021.31	45	440	400	9:22:32	Net 3 Vol filt = 31 m3
09:15:05 13/08/2019	78.99995	3.33373	3038.21	45	480	440	09;18_48	Net 2 Vol filt = 32 m3
09:11:00 13/08/2019	78.99994	3.33387	3022.85	45	520	480	9:15	Net 1 Vol filt = 31 m3
08:40:00 13/08/2019	79	3.33399	3027.46	45	0	520	9:11	36 h clock gene
								Net in autonomous mode
								No sample (no net open)
08:15:00 13/08/2019	79.00001	3.33387	3027.46	44				36 h series
								Net abandoned - wires tangled

6. Bongo net deployments

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Vertical hauls for zooplankton were made using a Motion Compensation Bongo net mechanism, comprising 2 x 57 cm diameter rings and 200 um net meshes. Hauls were made between 200 to 0 m in the open ocean or to within 20 m of the sea-bed in shelf environments. The net was paid out and hauled in at speeds of between 15 and 20 m per minute. The approximate time for a single deployment was around 25 minutes. The net was always rinsed between deployments. Between 2 and 6 deployments were made at each station around midnight. An entire cod-end bucket from one of the deployments was preserved in 96% Ethanol and another in 4% formalin from at least one night-time deployment. The other deployments were made principally to obtain live specimens, mainly of *Calanus* spp.

The cod-end buckets on the Bongo nets were unclasped at the end of every haul so as to enable the catch to be taken off the net in its entirety and then processed in ways that were sympathetic to delicate organisms. The clasping buckets achieved this aim but at the expense of the spillage of a certain fraction of the sample during the unclasping process since there was sometimes a backlog of sample within the net (resulting from phytoplankton clogging). Therefore, none of the preserved samples represent a truly quantitative estimate of the total catch (between 5 and 20% of each catch was spilled).

The Bongo net was set up with the capability to open and close the cod-ends at pre-set depths via a drive system and custom-made cod-end valves. This was operated infrequently, the vast majority of deployments made with the cod ends permanently open (i.e. collecting specimens) during both the up and down phase. Where the open-close mechanism was operated, the cod ends were open during the upward phase only between 150 and 30 m (NB the nominal depth of 30 m may have been varied slightly between stations to match the maximum depth of the mixed layer; wire out was 200 m to ensure that the trigger depth of 160 m was passed). This haul was usually preceded (but sometimes followed) by a haul from 30 m to surface, where the cod-ends were permanently open. In this way, the water column was sampled in a depth stratified manner 200 to 30 m and 30 m to surface. The catches were preserved for later analysis.

Table 6.1: Bongo net deployments during cruise JR18007

Time	Event	Lat	Lon	Comment
22:43:00 26/08/2019	162	77.4668	13.49347	Bongo net recovered
22:32:00 26/08/2019	162	77.46678	13.49348	Bongo net at 200m
22:27:00 26/08/2019	162	77.4668	13.4935	Bongo net deployed
22:23:00 26/08/2019	161	77.4668	13.49348	Bongo net recovered
22:13:00 26/08/2019	161	77.46679	13.49343	Bongo net at 200m
22:08:00 26/08/2019	161	77.4668	13.49348	Bongo net deployed
23:06:00 25/08/2019	155	77.71672	7.58315	Bongo net recovered
22:50:00 25/08/2019	155	77.71671	7.58308	Bongo net at 200m

22:45:00 25/08/2019	155	77.71672	7.58305	Bongo net deployed
22:41:00 25/08/2019	154	77.71671	7.58309	Bongo net recovered
22:24:00 25/08/2019	154	77.71671	7.58311	Bongo net at 200m
22:19:00 25/08/2019	154	77.71673	7.58312	Bongo net deployed
09:54:00 25/08/2019	150	78.41666	7.00044	Bongos recovered
09:32:00 25/08/2019	150	78.41667	7.00038	Bongos at 200m and hauling
09:27:00 25/08/2019	150	78.41667	7.00041	Bongos deployed
02:05:00 25/08/2019	147	78.41661	6.99995	Bongo net recovered
01:48:00 25/08/2019	147	78.4166	7.00001	Bongo net at 200m
01:43:00 25/08/2019	147	78.41659	7	Bongo net deployed
01:39:00 25/08/2019	146	78.4166	7.00003	Bongo net recovered
01:23:00 25/08/2019	146	78.4166	6.99994	Bongo net at 200m
01:19:00 25/08/2019	146	78.41659	6.99994	Bongo net deployed
11:00:00 24/08/2019	142	79.31662	2.64982	Bongo recovered
10:44:00 24/08/2019	142	79.31661	2.64983	Bongo net at 200m
10:38:00 24/08/2019	142	79.31661	2.64985	Bongo net deployed
22:34:00 23/08/2019	137	79.31691	2.64938	Bongo net recovered
22:19:00 23/08/2019	137	79.31691	2.64935	Bongo net at 200m
22:15:00 23/08/2019	137	79.31691	2.64938	Bongo net deployed
22:11:00 23/08/2019	136	79.31692	2.64939	Bongo net recovered
21:58:00 23/08/2019	136	79.31692	2.64934	Bongo net at 200m
21:54:00 23/08/2019	136	79.31692	2.64932	Bongo net deployed
08:05:00 23/08/2019	133	79.16684	6.59672	Bongos recovered
07:40:00 23/08/2019	133	79.16681	6.59659	Bongos at 200m and hauling
07:36:00 23/08/2019	133	79.16679	6.59656	Bongos deployed
22:45:00 22/08/2019	130	79.16652	6.59981	Bongo net recovered
22:26:00 22/08/2019	130	79.16651	6.59968	Bongo net at 200m
22:20:00 22/08/2019	130	79.16651	6.59974	Bongo net deployed
22:17:00 22/08/2019	129	79.1665	6.5997	Bongo net recovered
22:00:00 22/08/2019	129	79.1665	6.59974	Bongo net at 200m
21:55:00 22/08/2019	129	79.1665	6.59977	Bongo net deployed

14:49:00 22/08/2019	127	79.16657	6.60001	Bongo net recovered to deck
14:29:00 22/08/2019	127	79.16658	6.60003	Bongo net stopped at 200m
14:24:00 22/08/2019	127	79.16657	6.6001	Bongo net deployed
14:15:00 22/08/2019	126	79.16658	6.60005	Bongo net recovered to deck
14:10:00 22/08/2019	126	79.16659	6.60002	Bongo net stopped at 30m
14:08:00 22/08/2019	126	79.16659	6.60006	Bongo net deployed
14:05:00 22/08/2019	125	79.16659	6.59998	Bongo net recovered to deck
13:55:00 22/08/2019	125	79.16658	6.60005	Bongo net deployed
16:00:00 20/08/2019	112	79.93125	8.63505	Bongo net recovered to deck
15:41:00 20/08/2019	112	79.92955	8.6552	Bongo net at 200m
15:35:00 20/08/2019	112	79.92909	8.66141	Bongo net deployed
15:31:00 20/08/2019	111	79.92867	8.66643	Bongo net recovered to deck
15:13:00 20/08/2019	111	79.92735	8.69208	Bongo net at 200m
15:07:00 20/08/2019	111	79.92691	8.69558	Bongo net deployed
14:47:00 20/08/2019	110	79.9257	8.7187	Bongo net recovered to deck
14:27:00 20/08/2019	110	79.92453	8.74982	Bongo net at 200m
14:21:00 20/08/2019	110	79.92407	8.76106	Bongo net deployed
06:45:00 20/08/2019	106	79.66694	9.4002	Bongos recovered
06:27:00 20/08/2019	106	79.66694	9.40027	Bongos at 200m and hauling
06:21:00 20/08/2019	106	79.66696	9.40027	Bongos deployed
06:14:00 20/08/2019	105	79.66697	9.40023	Bongos recovered
06:07:00 20/08/2019	105	79.66695	9.40021	Bongos at 30m and hauling
06:06:00 20/08/2019	105	79.66695	9.40021	Bongos deployed
01:48:00 20/08/2019		79.66645	9.39795	Vessel on DP at D4 for bongo deployment
22:38:00 19/08/2019	102	79.66658	9.39963	Bongo net recovered
22:16:00 19/08/2019	102	79.66658	9.39964	Bongo at 200m
22:11:00 19/08/2019	102	79.66658	9.39967	Bongo net deployed
22:09:00 19/08/2019	101	79.66659	9.39957	Bongo net recovered
21:54:00 19/08/2019	101	79.6666	9.39954	Bongo's at 200m
21:49:00 19/08/2019	101	79.66661	9.39951	Bongos deployed

05:28:00 19/08/2019	97	79.60019	7.3306	Bongo net recovered to deck
05:09:00 19/08/2019	97	79.60021	7.33055	Bongo net at 200m
05:02:00 19/08/2019	97	79.60021	7.33052	Bongo net deployed
04:18:00 19/08/2019	96	79.60019	7.33058	Bongo net recovered to deck
04:12:00 19/08/2019	96	79.60019	7.33063	Bongo net stopped at 30m
04:09:00 19/08/2019	96	79.60018	7.33062	Bongo net deployed
22:36:00 18/08/2019	93	79.59989	7.32748	Bongo net recovered
22:20:00 18/08/2019	93			Bongo net at 200m
22:14:00 18/08/2019	93	79.59989	7.33267	Bongo net deployed
22:12:00 18/08/2019	92	79.59989	7.33263	Bongo net recovered
21:55:00 18/08/2019	92	79.59993	7.3328	Bongo net at 200m
21:50:00 18/08/2019	92	79.59995	7.33297	Bongos deployed
06:28:00 18/08/2019	87	79.33281	5.16554	Bongos recovered
06:15:00 18/08/2019	87	79.33279	5.16547	Bongos at 200m and hauling
06:00:00 18/08/2019		79.33279	5.16543	Vessel on DP at D2 for bongo deployments
23:15:00 17/08/2019	84	79.33323	5.16719	Bongo net recovered
22:59:00 17/08/2019	84	79.33322	5.16719	Bongo net at 200m
22:54:00 17/08/2019	84	79.33324	5.16719	Bongo net deployed
22:47:00 17/08/2019	83	79.33325	5.16713	Bongo net recovered
22:28:00 17/08/2019	83	79.33323	5.16718	Bongo net at 200m
22:22:00 17/08/2019	83	79.33323	5.16721	Bongo net deployed
22:19:00 17/08/2019	82	79.33323	5.16723	Bongo net recovered
22:01:00 17/08/2019	82	79.33324	5.1672	Bongo net at 200m
21:56:00 17/08/2019	82	79.33323	5.16721	Bongo net deployed
07:14:00 17/08/2019	79	78.31663	0.61537	Bongos recovered
07:03:00 17/08/2019	79	78.31662	0.61534	Bongos at 200m and hauling
06:52:00 17/08/2019	79	78.31662	0.61537	Bongos deployed
22:42:00 16/08/2019	76	78.31706	0.61611	Bongo net recovered
22:23:00 16/08/2019	76	78.31707	0.61612	Bongo net at 200m
22:18:00 16/08/2019	76	78.31707	0.61617	Bongo net deployed

22:15:00 16/08/2019	75	78.31708	0.61616	Bongo net recovered
21:58:00 16/08/2019	75	78.31707	0.61611	Bongo net at 200m
21:53:00 16/08/2019	75	78.31706	0.61616	Bongo net deployed
06:00:00 16/08/2019	73	78.24874	-4.87764	Bongo net recovered to deck
05:36:00 16/08/2019	73	78.25294	-4.86158	Bongo net at 200m
05:27:00 16/08/2019	73	78.25449	-4.85551	Bongo net deployed
05:23:00 16/08/2019	72	78.25517	-4.85272	Bongo net recovered to deck
05:12:00 16/08/2019	72	78.25704	-4.84513	Bongo net at 200m
05:04:00 16/08/2019	72	78.2584	-4.83958	Bongo net deployed
05:00:00 16/08/2019	71	78.25908	-4.83677	Bongo net recovered to deck
04:39:00 16/08/2019	71	78.26279	-4.82311	Bongo net deployed
22:44:00 15/08/2019	67	78.33832	-4.71006	Bongo net recovered
22:31:00 15/08/2019	67	78.3413	-4.70407	Bongo net at 200m
22:26:00 15/08/2019	67	78.34273	-4.70126	Bongo net deployed
22:19:00 15/08/2019	66	78.34492	-4.69515	Bongo net recovered
22:07:00 15/08/2019	66	78.34782	-4.68708	Bongo net hauling
22:02:00 15/08/2019	66	78.349	-4.6838	Bongo net deployed
22:56:00 14/08/2019	61	78.89304	-0.32685	Bongo net recovered
22:43:00 14/08/2019	61	78.89486	-0.32427	Bongo net at 200m
22:38:00 14/08/2019	61	78.89649	-0.32121	Bongo net deployed
22:21:00 14/08/2019	60			Bongo net recovered
22:08:00 14/08/2019	60	78.90254	-0.30931	Bongo net at 200m
22:03:00 14/08/2019	60	78.90328	-0.30872	Bongo net deployed
12:25:00 14/08/2019	57	79.00001	3.33305	Bongo net recovered
12:15:00 14/08/2019	57	79.00003	3.33309	Bongo net at 200m
12:08:00 14/08/2019	57	79.00003	3.3331	Bongo deployed
23:52:00 13/08/2019	51	78.99999	3.33301	Bongo net recovered
23:38:00 13/08/2019	51	78.99995	3.33339	Bongo net at 200m
23:33:00 13/08/2019	51	78.99989	3.33385	Bongo net deployed
23:30:00 13/08/2019	50	78.99985	3.33395	Bongo net recovered to deck
23:15:00 13/08/2019	50	78.99987	3.33401	Bongo net at 200m

23:10:00 13/08/2019	50	78.99988	3.33373	Bongo net deployed
10:09:00 08/11/2019	37	76.03336	-8.16336	Bongo net recovered
09:56:00 08/11/2019	37	76.03418	-8.15439	Bongo net at 200m
09:45:00 08/11/2019	37	76.03436	-8.15184	Bongos deployed
00:20:00 08/11/2019	32	76.03591	-8.1369	Bongo net recovered
23:58:00 08/10/2019	32	76.03591	-8.13696	Bongo net deployed
23:42:00 08/10/2019	31	76.03591	-8.13684	Bongo net recovered
23:28:00 08/10/2019	31	76.03623	-8.13058	Bongo nets at 200m
23:23:00 08/10/2019	31	76.03634	-8.12838	Bongo net deployed
23:18:00 08/10/2019	30	76.0364	-8.12775	Bongo net recovered
23:02:00 08/10/2019	30	76.03679	-8.12084	Bongo net at 200m
22:57:00 08/10/2019	30	76.03693	-8.11866	Bongo net deployed
22:50:00 08/10/2019	29	76.03699	-8.11741	Bongo net recovered
22:33:00 08/10/2019	29	76.03742	-8.10959	Bongo net at 200m
22:28:00 08/10/2019	29	76.03754	-8.10742	Bongo net deployed
22:23:00 08/10/2019	28	76.03755	-8.10711	Bongo net recovered
22:07:00 08/10/2019	28	76.03829	-8.09874	Bongo net at 200m hauling
21:57:00 08/10/2019	28	76.03864	-8.09517	Bongos deployed
00:48:00 08/10/2019	21	75.79558	-7.21921	Bongo net recovered to deck
00:31:00 08/10/2019	21	75.79558	-7.21918	Bongo net at 200m
00:26:00 08/10/2019	21	75.79558	-7.21921	Bongo net deployed
00:21:00 08/10/2019	20	75.79558	-7.21914	Bongo net recovered
00:04:00 08/10/2019	20	75.79556	-7.21909	Bongo net at 200m
00:00:00 08/10/2019	20	75.79556	-7.21909	Bongo net deployed
23:57:00 08/09/2019	19	75.79556	-7.21911	Bongo net recovered
23:28:00 08/09/2019	19	75.79554	-7.21918	Bongo net at 200m
23:23:00 08/09/2019	19	75.79554	-7.21911	Bongo net deployed
23:18:00 08/09/2019	18	75.79555	-7.21914	Bongo net recovered
22:57:00 08/09/2019	18	75.79557	-7.2191	Bongo net at 200m
22:52:00 08/09/2019	18	75.79557	-7.21913	Bongo net deployed
22:47:00 08/09/2019	17	75.79557	-7.21912	Bongo nets recovered

22:29:00 08/09/2019	17	75.79558	-7.21913	Bongo net stopped at 200m
22:24:00 08/09/2019	17	75.79556	-7.21911	Bongo net deployed
22:19:00 08/09/2019	16	75.79556	-7.21912	Bongo net recovered
21:58:00 08/09/2019	16	75.79555	-7.21908	Bongo nets at 200m
21:53:00 08/09/2019	16	75.79554	-7.21905	Bongo nets deployed
08:44:00 08/09/2019	12	75.43796	-5.86886	Bongo nets recovered
08:34:00 08/09/2019	12	75.33618	-5.46365	Bongo nets at 200m
08:28:00 08/09/2019	12	75.33618	-5.46366	Bongo nets deployed
23:56:00 08/08/2019	9	75.33556	-5.46423	Bongo net recovered
23:40:00 08/08/2019	9	75.33556	-5.46425	Bongo net hauling
23:37:00 08/08/2019	9	75.33555	-5.46423	Bongo net at 200m
23:29:00 08/08/2019	9	75.33555	-5.46423	Bongo net deployed
23:24:00 08/08/2019	8	75.33556	-5.46422	Bongo net recovered
23:06:00 08/08/2019	8	75.33557	-5.46421	Bongo net at 200m
23:01:00 08/08/2019	8	75.33557	-5.46425	Bongo net deployed
22:54:00 08/08/2019	7	75.33557	-5.46422	Bongo net recovered
22:35:00 08/08/2019	7	75.33558	-5.46416	Bongo net hauling
22:30:00 08/08/2019	7	75.33559	-5.46416	Bongo net at 200m
22:25:00 08/08/2019	7	75.33558	-5.46417	Bongo net deployed
22:15:00 08/08/2019	6	75.33564	-5.46413	Bongo net recovered
21:55:00 08/08/2019	6	75.33561	-5.46437	Bongo net hauling
21:50:00 08/08/2019	6	75.33562	-5.46441	Bongo nets stopped at 200m
21:44:00 08/08/2019	6	75.33563	-5.46438	Bongo nets deployed
12:58:00 08/07/2019	2	69.52322	-2.92381	Bongo nets recovered to deck
12:42:00 08/07/2019	2	69.52321	-2.92382	Bongo net hauling
12:38:00 08/07/2019	2	69.52321	-2.92384	Bongo net veered to 200m
12:33:00 08/07/2019	2	69.52321	-2.92378	Bongo nets deployed

7. Zooplankton ecology and physiology

Daniel Mayor, Holly Jenkins and Florence Atherden

Rationale

Zooplankton are the vector through which energy and nutrition are transferred from phytoplankton to higher trophic levels, including fish, birds and mammals. Arctic zooplankton communities are dominated by copepods of the genus Calanus: *Calanus finmarchicus*, *Calanus glacialis* and *Calanus hyperboreus*. Understanding the physiological ecology of these animals is therefore central to understanding the wider ecology and biogeochemistry of the Arctic Ocean, and how it may change in the future.

All *Calanus* species can produce eggs from internal lipid reserves and this aspect of their physiology is central to how they are represented in large-scale population models. 'Capital breeding' in advance of, or during, pronounced periods of primary production increases the reproductive value of each egg but reduces an individual's maximum potential diapause duration. This strategy reduces the population-scale grazing impact during spring and the potential for carbon export via the large, fast sinking faecal pellets produced by adults. It also helps buffer the population's reproductive output from changes in the timing of autotrophic blooms. The largest of the sibling species of *Calanus*, *C. hyperboreus*, is renowned for its ability to undertake lipid-fuelled spawning well in advance of the spring bloom, and both *C. finmarchicus* and *C. glacialis* are also reported to undertake capital breeding at times. By contrast, 'income breeding' via the ingestion of microalgae reduces an individual's requirement for lipid reserves, but potentially reduces the reproductive value of each egg via increased grazing competition between parents and their developing offspring. This strategy necessitates a close coupling between the timing of female ascent from diapause and the onset of bloom conditions, and potentially stimulates regional biogeochemistry via the egestion and excretory activities of the adult population. *C. finmarchicus* and *C. glacialis* are frequently suggested to adopt this strategy, and *C. hyperboreus* may also be able to extend their reproductive period by feeding on the spring bloom. Nevertheless, the lack of empirical data on the rates of production and consumption of lipids in Arctic *Calanus* currently hampers our ability to understand the relative importance of capital and income breeding strategies and hence validate existing life history models and their biogeochemical implications.

The overarching aim of this work is to examine the relative importance of capital- and income breeding in *C. finmarchicus* and *C. glacialis.* Our objectives are to quantify:

- How the food environment influences the rates of egg production and the amounts of carbon, nitrogen and individual fatty acids that are ingested and derived from maternal reserves in female *C. finmarchicus* and *C. glacialis*;

- The reliance upon lipid-based metabolism in female *C. finmarchicus* and *C. glacialis* and how this changes in space and time;

Methods

Experimental seawater was collected from the chlorophyll maximum using the CTD upcast (Table 7.1) and was gently transferred into HDPE carboys using wide-bore silicone tubing. Experimental animals were collected with a motion-compensated bongo net (200µm mesh) using a filtering cod end (Table 7.1) and were subsequently sorted into sterile filtered (0.2µm) seawater (FSW) under dim light using a dissection microscope. Sampling activities

took place at or close to midnight. All experimental work was undertaken in the controlled temperature laboratory set at the ambient seawater temperature. All of the experimental equipment was pre-soaked (>24 hrs) in seawater prior to its first use. All frozen material was stored at -80 °C.

Grazing experiments

Copepod grazing rates were examined using particle-removal experiments. In brief, 2.2l glass incubation bottles were gently filled with un-screened seawater from the chlorophyll maximum (Table 7.1) a little at a time to maximise homogeneity. Visibly discernible copepods were removed from the incubation water via a dip-tube prior to the addition of experimental animals. Ten female *C. finmarchicus*/*C. glacialis* (ID to be verified using molecular markers) were carefully introduced into each of 6 bottles and incubated alongside triplicate control bottles on a plankton wheel rotating at 1 rmp for 24 hr under continuous illumination. Experimental animals were subsequently transferred, via dip-tube, into fresh, un-screened seawater collected from the chlorophyll maximum each day for a total period of five days. At the start (t=0hrs) and end (t=24hrs) of each incubation period 200mls samples from each of the incubated bottles were collected and preserved with 1% acidified Lugols iodine to quantify changes in the microplankton community. The remaining post-incubation water was screened through a 63µm mesh to quantify the number of eggs produced. Additional 1000mls samples at the start (t=0hrs) and end (t=24hrs) of each incubation period were filtered onto pre-combusted (450° overnight) grade 'F' glass fibre filters (GF/F) and stored frozen in 2ml glass vials to quantify changes in the amounts of carbon, nitrogen and fatty acids in the seston. Replicate samples of experimental animals were collected at the beginning (t=0hrs) and very end (t = 120 hrs) of the experimental incubations and stored in tin cups or 2ml glass vials to quantify changes in the carbon, nitrogen and fatty acid content of the incubated animals.

Egg production experiments

Individual female *C. finmarchicus*/*C. glacialis* (ID to be verified using molecular markers) were incubated in 0.2µm FSW for 24 hrs in plexiglass egg production chambers fitted with a 300µm mesh bottom to avoid cannibalism. At the end of the experiment eggs from each chamber were collected on a 63µm mesh, counted, and gently transferred into 50ml centrifuge tubes containing 0.2µm FSW and incubated for a further 120 hrs to determine hatching success.

Metabolomics sample collection

Samples for metabolomic analysis, to determine the relative importance of lipid-based metabolism, were collected at all major stations (Table 7.1). Ten replicate samples of 10 *C.finmarchicus/C. glacialis* were quickly picked into Precellys tubes and stored frozen. Five replicate 2 litre seston samples were collected from the chlorophyll maximum (Table 7.1) and filtered onto pre-combusted GF/F filters and stored frozen in 2ml glass vials.

Table 7.1. Bongo net and CTD stations and event numbers where zooplankton samples were collected. GRZ = grazing experiment, EPR = egg production rate experiment, MTB = metabolomics samples, ETH = ethanol (95%)-preserved net sample, FRM = saline formaldehyde (4%)-fixed samples.

Station	Date	Event	Gear	Depth (m)	GRZ	EPR	MTB	ETH	FRM
NT11	08/07/2019	5	CTD	40	X		X		
NT11	09/07/2019	6-9	Bongo	200-0	X	X	X	X	X
NT8	09/07/2019	15	CTD	35	X		X		

NT8	10/07/2019	16-21	Bongo	200-0	X	X	X	X	X
NT6A	10/07/2019	27	CTD	32	X		X		
NT6A	11/07/2019	28-31	Bongo	200-0	X	X	X	X	X
F7	13/07/2019	49	CTD	18	X		X		
F7	14/07/2019	50-51	Bongo	200-0	X	X	X	X	X
IS1	14/07/2019	59	CTD	24	X		X		
IS1	15/07/2019	60-61	Bongo	200-0	X	X	X	X	X
IS2	16/07/2019	66-67	Bongo	200-0	X	X	X	X	X
IS2	16/07/2019	68	CTD	35	X		X		
D1	16/07/2019	74	CTD	20	X		X		
D1	17/07/2019	75-76	Bongo	200-0	X	X	X	X	X
D2	17/07/2019	81	CTD	15	X		X		
D2	18/07/2019	82-84	Bongo	200-0	X	X	X	X	X
D3	18/07/2019	91	CTD	10	X		X		
D3	19/07/2019	92-93	Bongo	200-0	X	X	X	X	X
D4	19/07/2019	100	CTD	14	X		X		
D4	20/07/2019	101-102	Bongo	200-0	X	X	X	X	X
D6	22/07/2019	128	CTD	20	X		X		
D6	23/07/2019	129-130	Bongo	200-0	X	X	X	X	X
D7	23/07/2019	135	CTD	9	X		X		
D7	24/07/2019	136-137	Bongo	200-0	X	X	X	X	X
D8	24/07/2019	145	CTD	15	X		X		
D8	25/07/2019	146-147	Bongo	200-0	X	X	X	X	X
D9	25/07/2019	153	CTD	27	X		X		
D9	26/07/2019	154-155	Bongo	200-0	X	X	X	X	X
D10	26/07/2019	160	CTD	31	X		X		
D10	27/07/2019	161-162	Bongo	200-0	X	X	X	X	X

Sampling Taurine containing lipids

Rationale:
TCLs are a class of metabolites (products and intermediates of cell metabolism) thought to be involved in fat transport. They consist of a scaffold (containing Taurine, an amino acid) and a variable fatty acid (FA). In copepods, these metabolites are upregulated after 5 days of starvation, possibly indicating the transport of stored fat to mitochondria; the site of lipid catabolism (Mayor et al., 2015). However, the exudation rates of these compounds have been shown to decrease 16 hours after food deprivation, perhaps also indicating their role in transport of newly digested lipid. This associated variable FA is hypothesised to be the fat to be transported. The variable FA changes when copepods are fed different diets. Different phytoplankton often contain a different composition of FAs. As such, FA are used as dietary biomarkers (Sargent et al., 1988). These compounds are exuded from copepods and as such are present in seawater. They have been detected in a 30 m water column off the coast of Tjärnö, Sweden, though it is unknown if they are still detectable in an open ocean environment and at greater depth (Selander et al., 2015).

This work will determine if detectable levels of TCLs are present in deeper water. It will determine whether any patterns in TCL SW concentration are present, for example, are there any differences between the TCL sampled from the surrounding water of copepod populations in surface and deep waters? Are there any patterns at depth with particular FA being present? Possibly providing evidence for selective catabolism? Or do the FA associated with TCLs reflect the FA in the surface Seston? E.g. can they be used as a biomarker for feeding history in an analogous way to FA biomarker analysis?

Water was sampled from the CTD for the extraction of Taurine containing lipids. This was achieved by solid phase extraction using Biotage ENV+ 10–100 mg/3-ml column, adapted from Selander et al., (2015). Polar lipids adsorb onto the column matrix when passed through and are subsequently washed out with methanol. The elutant is then stored for subsequent analysis using LC MS/MS. Throughout sampling 2L of water was collected per depth. Samples were stored in the cold room prior to being run (e.g. when there was a delay in accessing the SPE manifold). Samples were run under pressure using a Visiprep solid phase extraction manifold. A flow rate though the column was maintained at ~10 ml a minute. Each depth sampled had three replicates. Once the samples had been run, the columns were desalted with 2 ml miliQ and then 4 ml of methanol was used to release the column. The elutant was then immediately stored in the -20 °C freezer. In between sampling any glassware used was cleaned by rinsing three times with miliQ, then methanol, and then rinsing a further three times with miliQ. The SPE lines and the Visiprep manifold was cleaned by running 6 L of miliQ through the system, then 100 ml of methanol, and finally a further rinse with 6 L of miliQ. Waste methanol and first rinses were stored in a glass Winchester marked waste.

Method:

Water was sampled from the CTD (Table 2.2.1) for the extraction of Taurine containing lipids. This was achieved by solid phase extraction using Biotage ENV+ 10–100 mg/3-ml column, adapted from Selander et al., (2015). Polar lipids adsorb onto the column matrix when passed through and are subsequently washed out with methanol. The elutant is then stored for subsequent analysis using LC MS/MS. Throughout sampling 2L of water was collected per depth. Samples were stored in the cold room prior to being run (e.g. when there was a delay in accessing the SPE manifold). Samples were run under pressure using a Visiprep solid phase extraction manifold. A flow rate though the column was maintained at ~10 ml a minute. Each depth sampled had three replicates. Once the samples had been run, the columns were desalted with 2 ml miliQ and then 4 ml of methanol was used to release the column. The elutant was then immediately stored in the -20 °C freezer. In between sampling any glassware used was cleaned by rinsing three times with miliQ, then methanol, and then rinsing a further three times with miliQ. The SPE lines and the Visiprep manifold was cleaned by running 6 L of miliQ through the system, then 100 ml of methanol, and finally a further rinse with 6 L of miliQ. Waste methanol and first rinses were stored in a glass Winchester marked waste.

Table 7.2. Stations, CTD event numbers and depths sampled for taurine-containing lipids

Station	Event number	Depths (m)	Bottle number	Water vol run (ml)
2nd Ice station	65	31 (Chl max)	NA	250
2nd Ice Station	65	81	NA	250
2nd Ice Station	65	131	NA	250
D2	81	15 (Chl max)	NA	350
D2	81	75	NA	350
D2	81	150	NA	350
D2	90	15	NA	700
D2	90	45	NA	700
D2	90	80	NA	700
D2	90	200	NA	700
D2	90	300	NA	700
D2	90	475	NA	700
D2	90	525	NA	700
D2	90	575	NA	700
D6	131	5	19	700
D6	131	20 (Chl max)	15	700
D6	131	50	13	700
D6	131	120	10	700
D6	131	240	7	700
D6	131	400	5	700
D6	131	450	4	700
D6	131	500	3	700
D10	160	5	18	700
D10	160	15	16	700
D10	160	31 (Chl max)	11	700
D10	160	50	10	700
D10	160	75	8	700
D10	160	100	6	700

D10	160	150	4	700
D10	160	203 (10 m from bottom)	2	700

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8. Trophic position of Arctic copepods in the Fram Strait

Gabriele Stowasser, Geraint Tarling, Anna Belcher and Gareth Flint

The objective of this study is to use stable isotope biomarkers to identify the trophic position of Arctic copepod species across various depths horizons in Fram Strait waters.

Background:

The use of stable isotopes as dietary tracers is based on the principle that isotopic concentrations of consumer diets can be related to those of consumer tissues in a predictable fashion. It has been extensively applied in the investigation of trophic relationships in various marine ecosystems and has been used to determine feeding migrations in numerous species. The stepwise enrichment of both carbon and nitrogen in a predator relative to its prey suggests that the predator will reflect the isotopic composition in the prey and isotope values can be used to identify the trophic position of species in the food web investigated. Additionally $\delta^{13}C$ values can successfully be used to identify carbon pathways and sources of primary productivity.

Sampling:

In order to establish an isotopic baseline for the depth horizons where copepods originated from corresponding particulate organic matter (POM) was collected. POM samples were obtained through filtering water collected by Niskin bottles deployed via a CTD rosette. Water was taken from various depths at each station (Table 8.1). All water samples collected from Niskin bottles were processed on-board. Depending on the density of particles varying volumes of seawater per depth were filtered onto pre-ashed 47mm GF/F filters and the filters stored frozen at -80°C. Copepod species were sampled from one BONGO net (Event 51, Station F7, 200m, *Calanus* spp. CV, n = 50) and various MOCNESS deployments (Table 8.2).

Table 8.1: POM samples collected for stable isotope analysis on JR18007.

Station	**Event**	**sample depths**
NT11	10	5m, Chlmax (42m), 50m, 100m, 200m, 400m, 1000m
NT6	33	5m, Chlmax (31m), 50m, 100m, 200m, 400m, 1000m, bottom (1573m)

F7	53	5m, Chlmax (25m), 50m, 100m, 200m, 400m, 1000m, bottom (3001m)
Ice Station 1	64	5m, Chlmax (31m), 50m, 100m, 200m
D2	85	5m, Chlmax (17m), 50m, 100m, 200m, 400m, 1000m
D3	94	5m, Chlmax (15m), 50m, 100m, 200m, 400m, bottom (859m)
D4	103	5m, Chlmax (18m), 50m, 100m, 200m, bottom (332m)
D7	138	Chlmax (10m), 50m, 100m, 200m, 400m, 1000m, bottom (3360m)
D9	156	5m, Chlmax (30m), 50m, 100m, 200m, 400m, 1000m, bottom (3480m)

Table 8.2: Copepod species sampled from MOCNESS nets on JR18007

Event	Species	Stage	Net	depth interval (m)	N
11	*C. finmarchicus*	CV	6	500-375	50
11	*C. finmarchicus*	CV	7	375-250	50
11	*C. finmarchicus*	CV	8	250-125	50
11	*C. finmarchicus*	CV	9	125-5	50
11	*Metridia spp.*		8	250-125	50
36	*C. finmarchicus*	CV	6	500-375	50
36	*C. finmarchicus*	CV	6	375-250	50
36	*C. finmarchicus*	CV	6	250-125	50
36	*C. hyperboreus*	Females and CV	2	1000-875	40
55	*C. glacialis*	CV	9	125-5	50
55	*C. glacialis*	CV	8	250-125	45
55	*C. finmarchicus*	CV	8	250-125	50
55	*C. finmarchicus*	CV	7	375-250	50
55	*C. finmarchicus*	CV	6	500-375	50
55	*C. finmarchicus*	CV	5	625-500	50

55	*C. finmarchicus*	CV	4	750-625	25
86	*C. glacialis*	CV	8	250-125	50
86	*C finmarchicus*	CV	7	375-250	50
86	*C finmarchicus*	CV	6	500-375	50
86	*C. finmarchicus*	CV	5	625-500	50
86	*C. finmarchicus*	CV	2	1000-875	50
95	*C. finmarchicus*	CV	4	750-625	50
95	*C. finmarchicus*	CV	6	500-375	45
95	*C. finmarchicus*	CV	7	375-250	50
95	*C. finmarchicus*	CV	8	250-125	50
95	*C. finmarchicus*	CV plus maybe some CIV	9	125-5	50
104	*C. finmarchicus*	CV	8	250-125	50
104	*C. finmarchicus*	CV	9	125-5	50
141	*C. finmarchicus*	CV	9	125-5	50
141	*C. finmarchicus*	CV	8	250-125	50
141	*C. finmarchicus*	CV	7	375-250	50
141	*C. finmarchicus*	CV	6	500-375	50
141	*C. finmarchicus*	CV	3	875-750	50
157	*C. finmarchicus*	CV	8	250-125	50
157	*C. finmarchicus*	CV	7	375-250	50
157	*C. finmarchicus*	CV	6	500-375	40
157	*C. finmarchicus*	CV	5	625-500	45
157	*C. finmarchicus*	CV	3	875-750	50

9. The effect of temperature on the respiration and ammonia excretion of Arctic *Calanus* spp

Claudia Castellani

Rationale: The warming of the Arctic poses increasing physiological challenges to its inhabitants. Increase in water temperature in the Arctic is expected to lead to an increase in the energy demand by these copepods. Higher metabolic rates are likely to result in lower body stored lipid particularly at times and locations where food resources are limited, and in turn to negatively impact the population dynamics, life cycle and persistence of these organisms. Temperature increase is also expected to increase excretion rate and therefore the amount of nitrogen available to phytoplankton and bacteria.

Aim: This project aims to determine the changes in respiration rate and ammonia excretion of *Calanus* spp with temperature to enable projections of energy demand and nitrogen regeneration under a future global warming scenario.

Method: adult female *Calanus hyperboreus, C. glacialis and C. finmarchicus* were picked from sample collected with the Bongo net deployed to 200 M depth at various stations and brought back in a cold room kept at seawater ambient temperature (i.e. between 1 °C and 5 °C). The copepods were put in filtered seawater for a minimum of 8 hours to avoid the added effect of Specific Dynamic Action (SDA) and to measure their routine metabolic rates. After that they were incubated in 0.2 µm filtered sea-water in over a temperature range within a temperature gradient incubator set between 3 °C and 13 °C. An insulated box with ice was used to produce temperature incubation near 0 °C typically around 0.3 °C.

Respiration rate: Up to 24 adult females *Calanus* were incubated in air saturated filtered sea water (0.2 µm) into 4ml screwcap and air tight vials at each temperature. A control i.e. a vial filled with the same seawater but without copepod was also included at each temperature. The vials were placed into 100 ml beakers with water at the set temperature within the incubator. The decline in oxygen concentration in the vial measured at hourly or two hourly intervals over 10 hours using portable oxygen Optode (FIBOX-4). At the end of the incubation the prosome length of each copepod was measured under a WILD binocular microscope and the copepod stored into C and N free aluminium cups at - 80 °C for C/N analysis.

Ammonia excretion: Duplicates groups of between 3 and 6 copepods depending on size and species were picked from the stock and incubated in 40 mls air saturated filtered sea water (0.2 µm) into 100 ml borosilicate glass beaker at each temperature. The copepods were placed into Perspex tubes with false bottom mesh to facilitate the extraction of the animals at the end of the incubation. A control i.e. a vial filled with the same seawater but without copepod was also included at each temperature. Each beaker was covered with aluminium foil to prevent evaporation. The experiments run between 6 and 10 hours. At the end of the incubation the Perspex sieves were removed from the beakers and the water decanted into 10% HCl washed screwcap vials after rinsing with some of the sample. The water samples were then analysed for Ammonia content by a nutrient analyser (Tim Brandt, SAMS). The prosome length of each copepod was measured under a WILD binocular microscope and the copepod stored into C and N free aluminium cups at - 80 °C for C/N analysis.

10. Project PETRA (Pathways and emissions of climate-relevant trace gases in a changing Arctic Ocean) –

Hanna Campen (GEOMAR), Mehmet Can Köse (GEOMAR), Tina Fiedler (GEOMAR), Patrick Downes (PML), Oban Jones (PML), Zara Botterell (PML), Stephanie Sergeant (UWE), I. Brown (PML not on board), G. Tarran (PML, not on board), H. W. Bange (GEOMAR, not on board), A. Rees (PML, not on board), Jon Todd (UEA, not on board)

1. Background

The Arctic Ocean is exceptionally susceptible to climate change, and the ongoing changes have the potential to feedback on the climate. Warming, Ocean Acidification (OA), and the retreat of sea-ice followed by an increase in light penetration, including UV can act as stressors altering ecosystem structure and function. That in turn affects the cycling of climatically active trace gases because their production and consumption pathways are closely associated with several physical and biological processes.
To accurately assess potential future response to climate change in the Arctic it is crucial to investigate the effect of the above-mentioned stressors (warming, OA, increase in light availability) in Arctic trace gas production. The major goal of PETRA is to investigate the role of multiple stressors for future cycling of the trace gases nitrous oxide (N_2O), methane (CH_4), dimethylsulphide (DMS) and carbon monoxide (CO) in the Arctic Ocean.

2. Work program

In order to fulfill the overarching goal of PETRA we carried out six incubation experiments, at selected locations ranging from Atlantic to Arctic waters with contrasting sea ice conditions. To characterize each station over down to (~100m) we took discrete samples of CO, DMS, N_2O, CH_4, pH, CDOM (colored dissolved organic matter), pigments and DNA (functional genes for DMS and N cycling).

2.1 Sampling

In order to decipher depth distribution and cycling of N_2O, CH_4, DMS and CO in this area, seawater samples were collected at six stations. Additional to a depth profile CTD a second CTD was deployed to collected seawater samples from surface and pycnocline depths for multiple stressor incubations.

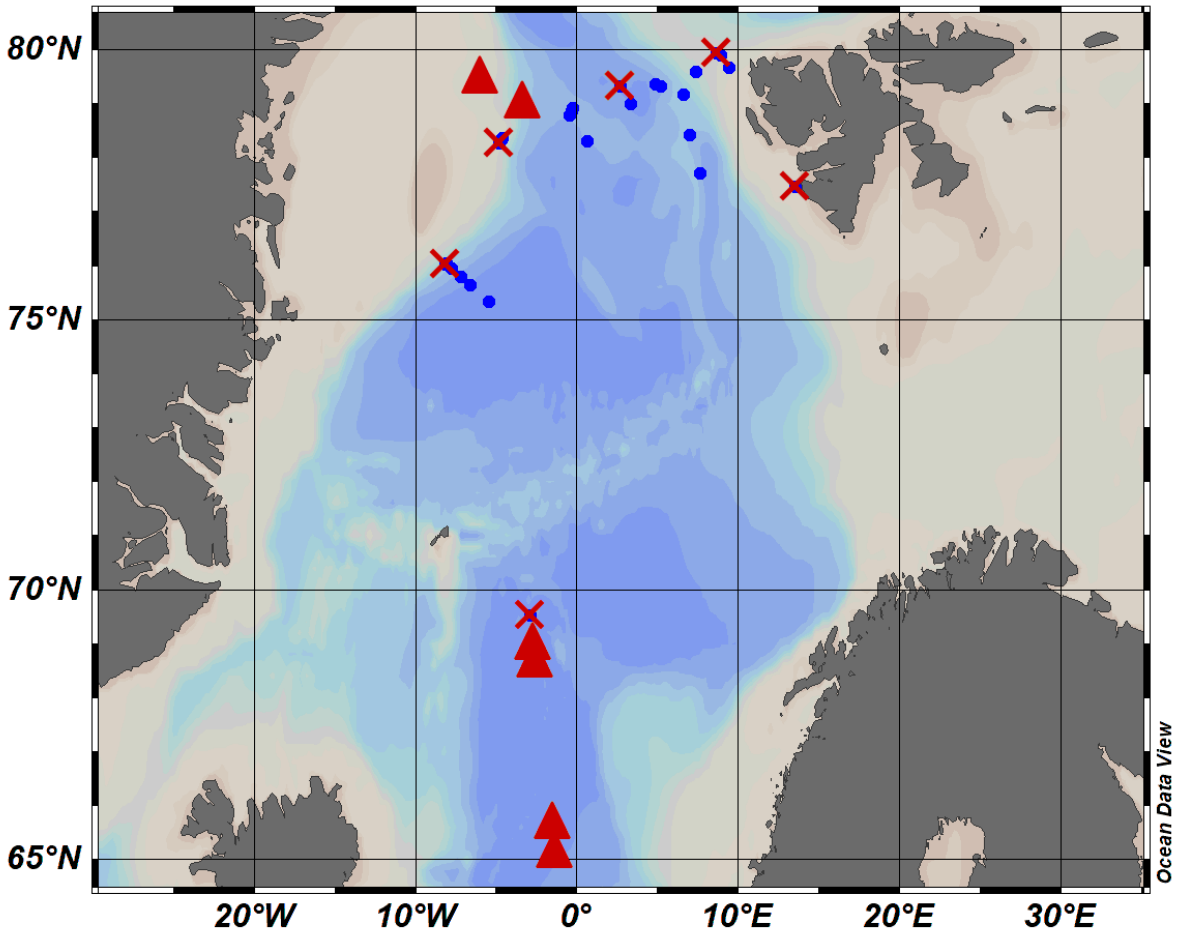


Fig. 9.1 Overview of PETRA sampling locations during JR18007.
Red crosses indicate locations were incubation experiments were sampled and started, red triangles indicate underway samplings (blue dots indicate all CTD stations performed during the cruise).

2.2 N_2O & CH4

For N_2O and CH_4, sea water samples were collected bubble-free from either the CTD or underway seawater supply. Samples were immediately spiked with 50 µL of a saturated mercuric chloride ($HgCl_2$) solution. Gas samples were then generated by the purge and trap method and stored for GC analysis at PML.

Additional N_2O only samples were collected according to the following; bubble-free triplicate samples were collected and immediately sealed by means of butyl stoppers and aluminum crimps. Subsequently 50 µL of a saturated mercuric chloride ($HgCl_2$) solution were added. The samples will be analyzed by means of a headspace equilibrium method and gas chromatographic analysis at the chemical oceanography department of GEOMAR.

2.3 CO

CO was sampled bubble-free and as triplicates into 100 ml glass vials and sealed by means of PTFE covered butyl stoppers. Samples were crimped right after sampling back in the lab. Before analysis a headspace were added to the samples with 10ml of CO-purified gas and samples were equilibrated over 8 minutes on a shaker at 120 rpm. Gas samples were taken from the equilibrated headspace and were injected into a CO analyzer ta3000R (AMETEK, USA). The analyzer separates CO via gas chromatography and subsequently measures the gas concentration by means of a reduction gas detector (RGD=mercury bed combined with a UV lamp).

2.4 DMS

For DMS seawater was collected bubble-free into 500vml glass vials and closed with a glass stopper. DMS gas samples were subsequently taken of the water samples by means of the purge and trap method. Those were injected into a GC-FPD system (Varian 3800) separating DMS chromatographically and determining the amount of gas via pulse flame photometric detection (PFPD-GC). Subsamples of DMSO/P were conserved in 50ml vials by adding 1-2 pellets of NaOH. Those were sealed and crimped right away and will be analyzed back in the home lab.

2.5 Molecular samples

In order to determine the presence and abundance of functional gene markers of DMS, DNA samples were collected at the same depths as DMS samples. Sample processing consisted in filtering water from selected depths into Durapore® membrane filters (0.22 µm) which were immediately frozen at -80°C. In all stations with molecular work, samples for flow cytometry analysis were also taken. Jon Todd (University of East Anglia, UK) will carry out the molecular analysis. To determine the presence and abundance of key nitrogen cycling genes, two liters of sea water was filtered through a 0.22µm sterivex^{TM} filter unit using a peristaltic pump. The filter unit was then immediately stored at -80°C. Filters will be transported to PML for DNA and RNA extraction and analysis.

2.6 Additional parameters

Since characterizing the physical and biogeochemical environment which influences the production/consumption pathways of trace gases in the Arctic is a key aspect of PETRA, sampling for the determination of the depth distribution of a range of additional parameters was carried out at selected locations during the cruise. Table 1 shows an overview of these parameters.

Station	CTD no.	Event no.	Depths sampled (m)	Incubation experiment	DIC/ Alkalinity	Ammonium	Nutrients	Pigments	Primary production	Flow cytometry	POC	CDOM
PETRA_1	1	1	5, 10, 30, 50, 75, 100		✓	✓	✓	✓	✓	✓	✓	✓
PETRA_1	2	2	30	*N_2O & CH4*	✓	✓	✓	✓		✓	✓	
PETRA_2	11	34	5, 10, 20, 30, 60, 100	CO & DMS	✓	✓	✓	✓	✓	✓	✓	✓
PETRA_2	12	35	55	*N_2O & CH4*	✓	✓	✓	✓		✓	✓	
PETRA_3	21	69	5, 10, 35, 75, 100	CO & DMS	✓	✓	✓	✓	✓	✓	✓	✓
PETRA_3	22	70	50	*N_2O & CH4*	✓	✓	✓	✓		✓	✓	
PETRA_4	33	112	5, 10, 25, 40, 75, 100	CO & DMS	✓	✓	✓	✓	✓	✓	✓	✓
PETRA_4	34	113	48	*N_2O & CH4*	✓	✓	✓	✓		✓	✓	
PETRA_5	40	139	5, 10, 25, 55, 75, 100	CO & DMS	✓	✓	✓	✓	✓	✓	✓	✓
PETRA_5	41	140	47	*N_2O & CH4*	✓	✓	✓	✓		✓	✓	
PETRA_6	47	163	5, 10, 35, 65, 80, 100		✓	✓	✓	✓		✓	✓	✓
PETRA_6	48	164	50	*N_2O & CH4*	✓	✓	✓	✓		✓	✓	

Table 10.1. Sampling overview and additional parameters measured.

3. Incubation experiments

In order to assess the impact of ocean warming, ocean acidification and increased light availability in the production/consumption of N_2O, CH_4, DMS and CO in the Arctic, experimental manipulations of temperature, pH and irradiance were performed at four (or six respectively) selected locations during JR18007 (c.f. Fig. 9.1). For all experiments large volumes of water were drawn from the CTD/Rosette. After amendment they were incubated in experimental enclosures for up to 48 h. Subsampling from the incubations for CO, DMS, CH4, N2O, CDOM, DNA & pigments happened after 12, 24 and 48h. Incubations were carried out at ambient temperature and ambient plus 2°C, pH was adjusted by adding 1m hydrochloric acid and 1m bicarbonate solutions. Amounts of the additions needed were calculated based on pH measurements from sea water sampled at the chosen depths for the incubations.

Incubations for N_2O and CH_4 were sampled from the pycnoclyne and conducted in temperature-controlled laboratory containers. Whereas those for CO and DMS simulated surface ocean conditions were sampled from 5m and placed in “on-deck” chambers. Those were flushed with a constant water supply from about 5 m depth to maintain ambient temperature. Light incubations were realized in light transmitting incubation bottles (DURAN®, borosilicate glass) in uncovered on-deck incubators are made of light transmittant acrylic glass allowing the full natural sunlight spectrum (including UVB and UVA) to penetrate. Black and covered water chambers served as dark incubators and excluded any light. Light penetration and temperature in the water was recorded by a HOBO logger (HOBO® data logger, USA) placed in each of the incubators.

4. Additional work – Microbial production under future climate change conditions

Heterotrophic bacteria within the planktonic community play a key role in recycling organic matter and remineralising nutrients. The majority of this organic matter is too large for direct uptake; therefore it must be hydrolyzed by extracellular enzymes. The activity of these enzymes reflects the quantity and composition of the organic matter available. The experimental conditions used during the incubations as part of PETRA, were also used to test the microbial response to future climate conditions, focusing on prokayotic production and extracellular enzyme acitivity. Using subsamples taken at T0 and T24.

Enzyme activity was measured fluorometrically, using substrates which emit fluorescence after hydrolytic cleavage. The substrates and associated enzymes are outlined in table 2. Production rates were measure by 3H labelled leucine uptake, simultaneous measurements were conducted with the addition of an archaeal inhibitor, N1-guanyl-1,7-diaminoheptane (0.8mM) to distinguish the contribution of Archaea from Bacteria.

Table 10.2. Fluorogenic substrates and associated enzymes.

Substrate	Enzyme
4-methylumbelliferyl phosphate	Alkaline phosphatase
4-methylumbelliferyl N-acetyl-β-D-glucosaminide	Chitobiases
4-methylumbelliferyl α-D-glucopyranoside	α - Glucosidase
4-methylumbelliferyl β-D-glucopyranoside	β - Glucosidase
L-Leucine-7-amido-4-methylcoumarin hydrochloride	Leucine - aminopeptidase

10.1 Organic nitrogen and sulphur cycling in Fram Strait

Zara L. R. Botterell, Plymouth Marine Laboratory

Introduction

Dimethylsulphide (DMS) is an organic sulphur compound produced by certain marine phytoplankton e.g. dinoflagellates from its precursor algal compound dimethylsulfoniopropionate (DMSP). Up to 84% of DMS produced is thought to be consumed by marine bacteria in situ; leaving on average 16% to flux across the sea surface interface into the atmosphere. When in the atmosphere DMS undergoes a series of reactions ultimately producing sulphate particles which contribute to the formation of cloud condensation nuclei (CCN). Thus DMS is often considered a climatically active gas, which can help offset the effects of warming though the production of clouds reflecting radiation from the sun. The main oxidation product of DMS in seawater is dimethylsulphoxide (DMSO). However, why DMSO is produced and what factors regulate its rate of formation is unclear. Recently a bacterial enzyme called trimethylamine mono-oxygenase (TMM), thought to occur in approximately 20% of all marine bacteria, has been found in culture to catalyse the formation of trimethylamine N-Oxide from trimethylamine (TMA) in a 1:1 stoichiometry with the formation of DMSO from DMS. This bacterial enzymatic process thus potentially links organic nitrogen and sulphur cycling. However, whether this reaction occurs in situ and the extent of regulation of the oxidation of DMS to DMSO by the TMM enzyme is currently unknown, and was the basis of a successfully funded NERC Discovery science proposal. The Polar Regions are known to be hot spots of DMS production; where arguably their contribution to the formation of CCN is most significant i.e. where anthropogenic sources of CCN are the lowest. Thus the main objective of this fieldwork campaign was to test the hypothesis that 'the availability of methylamines (organic nitrogen species) controls the rate of DMS loss through oxidation to DMSO in Arctic waters.'

Methodology & Approach

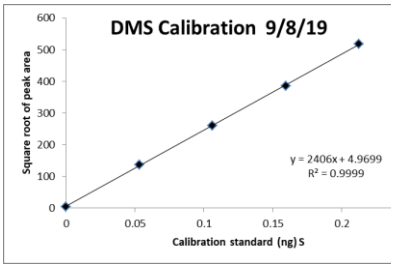
A series of 5 stations were sampled for primary productivity (refer to cruise report by Patrick Downes) and DMS concentrations (Table 10.1.1, Figure 10.1.1). At each station waters were sampled at a depth of 5m. At each station samples were taken to assess the concentration of DMS, dissolved and particulate DMSP, dissolved and particulate DMSO, dissolved and particulate methylamines and particulate N-osmolytes (pre-cursor compounds to methylamines). In addition, at a depth of 5m, 20L of water was sampled in order to set up methylamine addition experiments designed to test the above hypothesis.

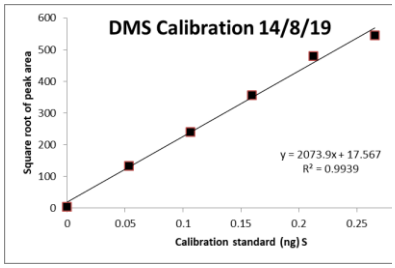
Organic sulphur species

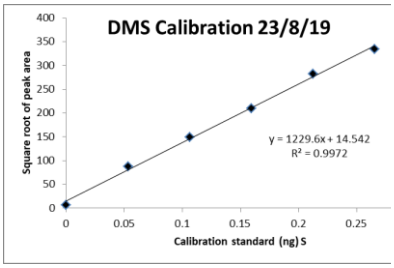
The concentration of DMS was determined in triplicate at the 5m depth on the ship using a purge and trap system attached to a gas chromatograph (Varian 3800) fitted with a pulsed flame photometric detector (GC-PFPD). Weekly calibration curves (Figure 10.1.1) were performed in addition to daily check standards. For a detailed description of the approach refer to Archer et al., (2009). Samples were additionally taken and stored for later analysis of dissolved and particulate DMSP and DMSO by sequential reduction to DMS followed by purge and trap into a proton transfer mass spectrometer (PTR-MS) back at Plymouth Marine Laboratory.

Figure 10.1.1: DMS calibration curves

(a) (b) (c)







Organic nitrogen species

For particulate and dissolved methylamines, triplicate samples from 5m (see Table 1) were gravity filtered through GF/F filters (47 mm diameter) into 10 ml of concentrated Hydrochloric acid (37%). Filters were stored frozen at -80^{0}C. Approximately 1L of acidified filtrate from each replicate was stored at 4^{0}C. Samples will be analysed using the approach of Cree et al (2018) by the University of Plymouth (PI: Dr Mark Fitzsimons).

Particulate samples for nitrogen osmolytes were syringe filtered in triplicate (50 and 2 ml samples) through methanol washed Nucleopore filters (0.2 um, 47 mm diameter) and stored frozen at -80^{o}C. Samples will be analysed as detailed in Beale et al., 2016 at Plymouth Marine Laboratory (PI: Dr Ruth Airs).

Methylamine addition incubation experiments

A series of 5 x 2L Tedlar bags were filled (using a peristaltic pump and 2L measuring cylinder) with water sampled at 5m. Bags were stored in the dark at in situ temperature for approximately 12 hours prior to the start of the experiment. Stable sulphur tracers (d_3-DMS, d_6-DMSP, $^{13}C_2$-DMSO) were added to each bag at <10% in situ concentrations (the in situ concentrations of DMSP and DMSO were assumed based on the amount of DMS determined from the purge and trap GC-PFPD measurements). Two bags acted as controls, whilst 3 were additionally supplemented with trimethylamine and dimethylamine (at 50 nM final concentration). Bags were incubated for 24-48 hours and samples were taken at 4 time points during the incubation. At each time point the concentration of DMS was determined via purge and trap GC-PFPD, and samples collected for dissolved and particulate DMSP and DMSO. These samples will be analysed back at Plymouth Marine Laboratory via proton transfer mass spectrometry (PTR-MS) which will additionally determine the following rates;

1) Microbial consumption of DMSP and DMSO (from loss of d_6-DMSP and $^{13}C_2$-DMSO respectively)
2) Rate of microbial oxidation of DMS to DMSO (from appearance of d_3-DMSO from added d_3-DMS) with and without added methylamines i.e. control bags versus amended +methylamines bags
3) Rate of conversion of DMSP to DMSO (from appearance of d_6-DMSO from added d_6-DMSP)

At the end of the incubation 1 x 50 ml sample was taken from each bag for particulate N-osmolytes and the remaining seawater was filtered using a peristaltic pump through a sterivex and stored at -80^{0}C. These samples will be used to identify microbes containing the *tmm* gene (which encodes the TMM enzyme) and any upregulation in transcription due to the added methylamines (by the University of Warwick Pi: Dr Hendrik Schaefer)

Table 10.1.1. Summary of stations sampled

Station & log details	Depth (m)	Samples taken
1 (07/08/2019) CTD001 Event no: 001	5m	DMS, particulate and dissolved DMSP and DMSO, dissolved and particulate methylamines
		Methylamine incubation experiment (DMS, dissolved and particulate DMSP/DMSO for 4 time points, particulate nitrogen osmolyte sample (50 ml) was taken at the end of the experiment. DNA sterivex sample with remaining seawater)
NT6A (11/08/2019) CTD011 Event no: 034	5m	DMS, particulate and dissolved DMSP and DMSO, dissolved and particulate methylamines
		Methylamine incubation experiment (DMS, dissolved and particulate DMSP/DMSO for 4 time points, particulate nitrogen osmolyte sample (50 ml) was taken at the end of the experiment. DNA sterivex sample with remaining seawater)
Ice station 2 (16/08/2019) CTD020 Event no: 069	5m	DMS, particulate and dissolved DMSP and DMSO, dissolved and particulate methylamines
		Methylamine incubation experiment (DMS, dissolved and particulate DMSP/DMSO for 4 time points, particulate nitrogen osmolyte sample (50 ml) was taken at the end of the experiment. DNA sterivex sample with remaining seawater)
D5 (20/08/2019) CTD033 Event no: 109	5m	DMS, particulate and dissolved DMSP and DMSO, dissolved and particulate methylamines
		Methylamine incubation experiment (DMS, dissolved and particulate DMSP/DMSO for 4 time points, particulate nitrogen osmolyte sample (50 ml) was taken at the end of the

		experiment. DNA sterivex sample with remaining seawater)
D7 24/08/2019 CTD040 Event no: 139	5m	DMS, particulate and dissolved DMSP and DMSO, dissolved and particulate methylamines
		Methylamine incubation experiment (DMS, dissolved and particulate DMSP/DMSO for 4 time points, particulate nitrogen osmolyte sample (50 ml) was taken at the end of the experiment. DNA sterivex sample with remaining seawater)

Preliminary results

The average concentration of DMS at a depth of 5m was low across three of the five stations sampled; IS2 (0.6± 0.06 nM), D5 (0.75± 0.05 nM) and D7 (1.08± 0.12). At stations 1 and NT6A total sulfur samples were taken due to problems with the GC-PFPD. ***[All data reported are provisional and subject to further verification prior to submission to BODC]***

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11. Microplastics and Copepods: samples from the Fram Strait

Zara L. R. Botterell, Plymouth Marine Laboratory

Introduction

Microplastic particles (microscopic plastic; 1 µm – 5mm) are an abundant and widespread pollutant of international environmental and economic concern. Their small size means they are bioavailable to a wide range of species including many species of zooplankton. In both the field and the laboratory microplastics have been shown to be readily ingested by zooplankton. Whilst microplastic presence and ingestion has been widely reported, especially in coastal areas, there are still large gaps in our knowledge regarding microplastic abundance, type and size, particularly in remote areas such as the Arctic. Similarly few studies have investigated the encounter rate between microplastics and zooplankton species, such as copepods, which are an important food source at the base of the marine food web. Thus the main objective of this work is to collect samples of copepods and concurrent water samples to compare the presence and abundance of microplastics and determine encounter rates.

Methodology & Approach

Copepod and concurrent water samples were collected from 6 stations (**Table 11.1**). Copepods were collected using Bongo or Moccness nets and water was collected from the underway system (6.5m depth) or the CTD (5 m) when in the ice. Copepod species and life stage were identified under the microscope and visually examined to ensure that no plastic debris was attached and gently rinsed in MilliQ. Each species are collated in a vial for each station and then 5 mL homogenising buffer is added to begin the digestion process which will be completed at PML. These samples will then be filtered in a microplastic clean lab and analysed using an FT-IR to identify any microplastics present. Background controls during the picking out process were taken for each sample.

Water samples were taken from the underway system at each of the stations sampled (one from CTD whilst in the ice). Two litres of water was filtered onto a 5µm filter at each station using a peristaltic pump and vacuum pump system to minimise contamination from the environment. Controls and background controls were taken at each sampling station. Filters were then retained in a petri dish and frozen at -20^{o}C for analysis back at PML using an FT-IR to identify any microplastics present.

Table 11.1. Summary of stations sampled

Station & log details	Samples taken
NT11 (09/08/2019)	104 *Calanus finmarchicus/glacialis* F -250 m
Moccness	102 *Calanus hyperboreus* F- 750 m
Event no: 011	
	2 L of water filtered from the underway
F7 (14/08/2019)	250 *Calanus finmarchicus/glacialis* C5 -200 m
Bongo	
Event no: 057	2 L of water filtered from the underway

IS2 (16/08/2019)	150 *Calanus finmarchicus/glacialis* C5 -200 m
Bongo	
Event no: 060	2 L of water filtered from CTD (5m)
D1 (17/08/2019)	200 *Calanus finmarchicus/glacialis* C5 -200 m
Bongo	
Event no: 75	2 L of water filtered from the underway
D3 19/08/2019	170 *Calanus finmarchicus/glacialis* C5 -200 m
Bongo	
Event no: 97	2 L of water filtered from underway
D6 23/08/19	215 *Calanus finmarchicus/glacialis* C5 -200 m
Bongo	
Event no. 1302	2 L of water filtered from underway

12. Project Micro-ARC

Bacterial and fungal communities on biogenic microgels

[1]Birthe Zäncker (Marine Biological Association of the UK) and [2]Michael Cunliffe (Marine Biological Association of the UK)
1Author onboard, 2 Dataset PI
Micro-ARC

Background and objectives

Micro-ARC aims at understanding the links between pelagic microbial ecosystems and organic matter cycling in the changing Arctic Ocean. The production and degradation of organic matter by microbes are investigated. Therefore, samples for DNA/RNA in the water column and on microgels, fungal cultivation, phospholipid fatty acids (PLFA) and the abundance of microgels were taken in the Barents Sea.

Abundance and size distribution of microgels

Objectives

Determining the abundance and size distribution of microgels in the water column will give an idea of where the carbohydrate-rich and proteinaceous microgels are being produced and degraded.

Sampling strategy

Between 10ml and 100ml of seawater was subsampled from 10 litre plastic carboys. The seawater was filtered onto 0.45 µm, 25 mm Nuclepore filters. Two replicate filters were taken for all three microscopic methods. Filters for analysis of Transparent Exopolymer Particles (TEP) were stained with 1 ml 0.2 µm filtered Alcian Blue for 3 s. Filters for analysis of Coomassie Stainable Particles (CSP) were stained with 1 ml 0.2 µm filtered Coomassie Brilliant blue for 30 s. Filters for fluorescent analysis were not stained on the ship.

All filters were transferred onto a petri dish and were subsequently frozen at -20°C.

Methods

Frozen samples will be transported back to the Marine Biological Association of the UK (MBA). There the samples will be analysed microscopically using established methods.

Samples collected

At each station, six depths were sampled from the CTD. A complete list of all collected samples is presented in Table 12.1.

Table 12.1 *List of all samples collected during JR18007 in August 2019*

JR18007 event n°	station	date	latitude	longitude	depths sampled [m]	comments

10	NT11	9.8.19	75° 20.1306' N	5° 27.8513' W	5.7, 42, 100, 504, 1004, 3510	
22	NT8	10.8.19	75° 47.7364' N	7° 13.1350' W	5, 32, 110, 500, 1000, 2528	
33	NT6	11.8.19	76° 02.1144' N	8° 08.9239' W	5, 31, 100, 500, 1000, 1501	
53	F7	14.8.19	79° 00.0100' N	3° 19.9800' E	5, 25, 100, 400, 1000, 2000	
64	ice station	15.8.19	78° 46.5800' N	0° 30.0200' W	5, 31, 103, 200	
65	ice station 2	15.8.19	78° 21.9949' N	4° 38.1180' W	51	incubation 1
68	ice station 2	16.8.19	78° 18.8600' N	4° 45.8000' W	5, 35, 75, 102, 499, 656	
77	D1	17.8.19	78° 19.0268' N	0° 36.9619' E	5, 21, 100, 500, 1000, 2498	
91	D3	18.8.19	79° 36.0000' N	7° 19.9800' E	30	incubation 2
94	D3	19.8.19	79° 36.0000' N	7° 19.9200' E	5, 15, 100, 500, 800	
103	D4	20.8.19	79° 39.9968' N	9° 24.0000' E	5, 18, 50, 100, 200, 332	
108	D5	20.8.19	79° 54.2383' N	8° 54.4423' E	45.5	incubation 3
135	D7	23.8.19	79° 19.0100' N	2° 38.9500' E	40	incubation 4
138	D7	24.8.19	79° 19.0200' N	2° 38.9200' E	5, 10, 100, 500, 1000, 3000	

DNA and RNA of the water column and on microgels

Objectives

The analysis of the total and active community of both bacteria and fungi in the water column will be compared to the communities on carbohydrate-rich microgels in order to identify community differences, main degraders of the microgels and other microbes benefiting from the phytoplankton-derived microgels.

Sampling strategy

For the water column DNA/RNA samples, 1L of seawater was subsampled from a 10 litre plastic carboy. For the microgel samples, the same volume as for the microscopy samples from section 7.1 was subsampled from a 10 litre plastic carboy. For water column DNA/RNA, the seawater was filtered onto 0.2 µm, 47 mm cellulose nitrate filters. For microgel DNA/RNA, the seawater was filtered onto two 0.45 µm, 25 mm Nuclepore filters

for each sample. One Nuclepore filter was stained with 1 ml 0.2 µm filtered Alcian Blue for 3 s per sample. None of the other filters were stained. All filters were frozen immediately at -80°C after filtration.

Methods

Frozen samples will be transported back to the Marine Biological Association of the UK (MBA). DNA/RNA will be extracted and sequenced using next generation sequencing methods.

Samples collected

At each station, six depths were sampled from the CTD. A complete list of all collected samples is presented in Table 12.1.

Sampling for fungi cultivation in the water column

Objectives

Cultivation and isolation of Arctic fungi will allow laboratory studies to investigate their physiology e.g. their potential to degrade different food sources.

Sampling strategy

500 ml of seawater was subsampled from a 10 litre plastic carboy. The seawater was filtered through a 0.45 µm, 47 mm MCE membrane. Simultaneously, 18 ml of sample were mixed with 6 ml 100 % glycerol to obtain a 25 % glycerol solution which was subsequently filtered through a 0.2 µm syringe filter. The filter was placed in a 30 ml plastic tube containing the sterile glycerol solution and frozen at -80°C.

Methods

Frozen samples will be transported back to the Marine Biological Association of the UK (MBA). Filters will be thawed and cultivated on different media at *in situ* temperature.

Samples collected

At each station, six depths were sampled from the CTD. A complete list of all collected samples is presented in Table 12.1.

Phospholipid fatty acid (PLFA) sampling

Objectives

The analysis of PLFA will enable the analysis of the microbial food web structure in the Barents Sea.

Sampling strategy

4 L of seawater was subsampled from a 10 litre plastic carboy. The seawater was filtered through a 47 mm GF/F filter. The filter was stored in ashed aluminium foil and stored at -20°C.

Methods

Frozen samples will be transported back to the Marine Biological Association of the UK (MBA). The PLFA will be extracted and subsequently analysed using gas chromatography.

Samples collected

At each station, six depths were sampled from the CTD. A complete list of all collected samples is presented in Table 7.1.

Incubations using $^{12}C/^{13}C$-labelled TEP

Objectives

The composition of phytoplankton blooms in the Arctic is changing. This has many implications, amongst others, different organic matter might be excreted, thus forming TEP with slightly different carbohydrate composition. This could result in differences in colonizing microbial communities, potentially affecting the degradation rate of the microgels. Thus, incubating different water masses with pre-produced,^{13}C-labelled TEP will highlight the response of TEP-degrading microbial communities. The use of different TEP originating from an Arctic diatom, an Atlantic diatom and a *Phaeocystis* species will allow predictions of the change in microbial TEP-colonising communities due to differing phytoplankton species dominating blooms in the Arctic Ocean.

Sampling strategy

At four stations water was sampled to start incubations. For each treatment, a total of 5x 3L incubations was started. Treatments for experiments 1 and 2 were: control, ^{12}C- and ^{13}C-labelled TEP derived from *Phaeocystis pouchetii* and ^{12}C- and ^{13}C-labelled TEP derived from *Thalassiosira weissflogii*. Treatments for experiment 3 were: control, ^{12}C- and ^{13}C- labelled TEP derived from *Thalassiosira weissflogii* and *Thalassiosira nordenskioeldii*. Treatments for experiment 4 were control and ^{12}C- and ^{13}C- labelled TEP derived from *Thalassiosira nordenskioeldii*. TEP was added at concentrations of 1.5x of the natural concentrations to allow for ^{13}C tracking in the DNA and PLFA of degrading microbes while not overly enriching samples in TEP. Samples for TEP abundance, TEP microbial community and DNA sequencing were taken after 24 hours incubation in the dark at *in situ* temperatures. After 48 hours, incubations were terminated and sampled for TEP abundance, TEP microbial community, DNA sequencing and PLFA.

Methods

Frozen samples will be transported back to the Marine Biological Association of the UK (MBA) analysed there (see sections above for more details on the individual methods).

Samples collected

During the cruise, a total of four incubation experiments were started (see Table 12.1 for locations and more details) at one depth just below the chlorophyll maximum for incubations with *Thalassiosira weissflogii* and *Phaeocystis pouchetii* at incubation 1 and 2, *Thalassiosira weissflogii* and *Thalassiosira nordenskioeldii* at incubation 3 and *Thalassiosira nordenskioeldii* at incubation 4.

13. Project CHASE (Chronobiology in Arctic Sea Ecosystems)

Jordan Grigor (SAMS). Jennifer Freer (BAS)

The CHASE project is interested in the life cycles and adaptations of zooplankton, and specifically how they differ in populations of copepods and krill between polar and temperate habitats. Diapause (the period of deep-water rest during winter, when algal food availability is reduced), is a key component of the life cycle of the abundant copepod species *C. finmarchicus* and is important in carbon flux and affecting food availability for marine predators. Important parameters of diapause, such as its timing and duration are likely to vary with latitude. We collected samples and data that will help us to determine if *C. finmarchicus* were in diapause in the Fram Strait and Greenland Sea in August 2019.

Genetics samples

Diapausing copepods can be expected to show differences in circadian clock gene expression compared to non-diapausing copepods. Community samples were collected for seasonal gene expression analysis where the cruise plan allowed for sampling two separate 36-hour stations. At stations F7 and D6, two genetics samples were collected approximately every four hours from the upper and lower levels of *Calanus finmarchicus* depth distribution. Most of the sampling was conducted using the Mammoth Multinet. At each station, half a teaspoon of zooplankton >500µm were fixed in RNA later under red lighting. Samples were kept for 24 hours at 2°C (in the JCR cold room), and then frozen at -80°C for long term storage. For timepoint one, eight nets were deployed to sample the entire water column between 50 m and 1000 m, to gauge the distribution of *C. finmarchicus*; all these samples were kept. Successful samples were collected during nine timepoints at F7, and ten timepoints at D6 (Table 13.1).

Table 13.1: Summary of samples taken for clock gene analysis. *Preserved in ethanol. Note that a further three MOCNESS deployments (event numbers 42-44) intended to cover timepoints 2-3 at station F7 failed.

NET DATE TIME IN (UTC)	EVENT NO	STATION	LAT	LON	GEAR	TIME POINT	DEPTH RANGE (M)	RNA SAMPLE	TIME IN RNA LATER (UTC)
07/08 12:33	2	Shakedown	69.52321	-2.92378	BONGO	1	0-200	1	-
12/08 15:15	40	F7	79.0043	3.33547	MOCNESS	1	994-876*	3	19:18
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	876-758*	4	19:15
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	758-640*	5	19:08
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	640-522*	6	19:05
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	522-404*	7	19:00
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	404-286*	8	18:56
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	286-168*	9	18:51
‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	‘‘’’	168-50*	10	18:47
12/08	41	F7	78.99855	3.32367	MOCNESS	2	520-400	12	21:58

19:30									
“”	“”	“”	“”	“”	“”	“”	170-50	11	21:45
13/08	45	F7	78.99991	3.33386	MAMMOTH	5	480-285	14	10:13
08:40									
“”	“”	“”	“”	“”	“”	“”	130-5	13	10:09
13/08	46	F7	78.99989	3.33381	MAMMOTH	6	480-400	16	13:52
11:23									
“”	“”	“”	“”	“”	“”	“”	130-5	15	13:56
13/08	47	F7	78.9999	3.33381	MAMMOTH	7	520-400	18	16:54
15:15									
“”	“”	“”	“”	“”	“”	“”	170-50	17	17:07
13/08	48	F7	78.99987	3.3337	MAMMOTH	8	520-400	19	21:45
20:05									
“”	“”	“”	“”	“”	“”	“”	170-50	20	21:51
14/08	52	F7	79.00002	3.33312	MAMMOTH	9	520-400	22	02:13
00:32									
“”	“”	“”	“”	“”	“”	“”	170-50	21	02:03
14/08	54	F7	79.00003	3.3331	MAMMOTH	10	520-400	24	07:02
05:24									
“”	“”	“”	“”	“”	“”	“”	170-50	23	06:57
14/08	56	F7	79	3.33309	MAMMOTH	11	520-400	25	12:02
10:31									
“”	“”	“”	“”	“”	“”	“”	170-50	26	12:08
20/08	115	D6	79.16657	6.60002	MAMMOTH	1	1000-875	27	01:59
23:08									
“”	“”	“”	“”	“”	“”	“”	875-750	48	02:04
“”	“”	“”	“”	“”	“”	“”	750-625	53	02:06
“”	“”	“”	“”	“”	“”	“”	625-500	49	02:09
“”	“”	“”	“”	“”	“”	“”	500-375	50	02:13
“”	“”	“”	“”	“”	“”	“”	375-250	51	02:18
“”	“”	“”	“”	“”	“”	“”	250-125	52	02:25
“”	“”	“”	“”	“”	“”	“”	125-5	28	02:22
21/08	116	D6	79.16659	6.60018	MAMMOTH	2	520-400	30	05:32
04:02									

“”	“”	“”	“”	“”	“”	“”	130-5	29	05:25
21/08	117	D6	79.16659	6.60004	MAMMOTH	3	520-400	31	09:21
08:00									
“”	“”	“”	“”	“”	“”	“”	130-5	32	09:26
21/08	118	D6	79.1666	6.60007	MAMMOTH	4	520-400	33	13:38
12:11									
“”	“”	“”	“”	“”	“”	“”	130-5	34	13:43
21/08	119	D6	79.16659	6.60007	MAMMOTH	5	520-400	35	17:34
16:04									
“”	“”	“”	“”	“”	“”	“”	130-5	36	17:40
21/08	120	D6	79.16659	6.59998	MAMMOTH	6	520-400	37	21:40
20:10									
“”	“”	“”	“”	“”	“”	“”	130-5	38	21:42
22/08	121	D6	79.16658	6.60008	MAMMOTH	7	520-400	39	01:33
00:07									
“”	“”	“”	“”	“”	“”	“”	130-5	40	01:38
22/08	122	D6	79.16659	6.60003	MAMMOTH	8	520-400	41	05:40
04:06									
“”	“”	“”	“”	“”	“”	“”	130-5	42	05:43
22/08	123	D6	79.16658	6.59998	MAMMOTH	9	520-400	43	09:28
08:00									
“”	“”	“”	“”	“”	“”	“”	130-5	44	09:30
22/08	124	D6	79.16661	6.59993	MAMMOTH	10	520-400	45	13:29
12:02									
“”	“”	“”	“”	“”	“”	“”	130-5	46	13:33

Calanus copepod swimming behaviour experiments

Diapausing copepods can also be expected to show differences in swimming behaviour and oxygen consumption compared to non-diapausing copepods. All measurements were made on individual copepods using Trikinetics Locomotor Activity Monitors (LAMS). Activity measurements using LAMs yield activity as a proxy for swimming, quantified as the number of beam breaks across the experimental chamber per specified unit of time. Experiments were carried out to investigate the behaviour of ~250 *Calanus* copepods from stations F7 and D6 in LAMs (Figure 1). Each monitor can hold up to 32 animals enclosed inside small acrylic tubes. All swimming behaviour experiments were conducted using stage CV *Calanus* sp. picked in the JCR cold room under red light and transferred to 0.2µm filtered seawater from 250m at each station (salinity = 34.9ppt).

All measurements were made on individual stage 5 copepods using eight LAMs (approx. 200 channels) inside a compressor incubator with no lighting. Each run contained copepods collected from the upper and lower levels of *Calanus finmarchicus* depth distribution. LAM light beams were positioned at the bottom of the tubes in six of

the LAMs and middle of the tubes in the remaining two (Figure 13.1). Temperature was controlled (2.8°C at F7 and 4°C at D6). Experimental runs are annotated in Table 13.2. After each run, each copepod was photographed for later measurement of prosome length and area (to be converted to dry weight) and lipid sac volume (where applicable), prior to freezing for genetic confirmation of species (*C. finmarchicus* or *C. glacialis*).

Top of incubator

3	1*
10	8
2*	9
7	4

Bottom of incubator

Figure 13.1: Positions of locomotor activity monitors inside the compressor incubator. *Beams positioned in the middle of the tubes rather than the bottom.

Table 13.2: Summary of *Calanus* swimming behaviour experiments (note all animals collected with 200µm Mammoth multinet sampler).

NET DATE TIME IN (UTC)	EVENT NO	STATION	LAT	LON	LAMs	DEPTH RANGE (M)	TIME POINT	START DATE TIME (UTC)	END DATE TIME (UTC)	TEMP.
13/08 08:40	45	F7	78.99991	3.33386	2, 4	480-285	5	13/08 22:50	20/08 06:25	2.8
13/08 11:23	46	F7	78.99989	3.33381	1, 7, 9, 10	130-5	6	14/08 01:00	20/08 06:25	2.8
13/08 15:15	47	F7	78.9999	3.33381	3, 8	520-400	7	13/08 19:28	20/08 06:25	2.8
20/08 23:08	115	D6	79.16657	6.60002	2, 3, 4, 8	500-375	1	21/08 04:00	27/08 07:33	4.0
20/08 23:08	115	D6	79.16657	6.60002	1, 7, 9, 10	125-5	1	21/08 04:22	27/08 07:33	4.0

Copepod respiration experiments

We conducted oxygen consumption experiments to provide a physiological correlate to rhythmic activity measurements made on individual *Calanus* copepods from stations F7, D1 and D6. All measurements were made on individual stage 5 copepods using a 24-well (1700µm) Loligo microplate respirometry system inside a compressor incubator with no lighting. Each run contained copepods collected from the upper and lower levels of *Calanus finmarchicus* depth distribution, picked in the JCR cold room under white light and transferred to 0.2µm filtered seawater from 250m at each station (salinity = 34-35ppt). Temperature was controlled (2.8°C at F7 and D1, 4°C at D6). Experimental runs are annotated in Table 13.3. After each run, each copepod was photographed

for later measurement of prosome length and area (to be converted to dry weight) and lipid sac volume (where applicable), prior to freezing for genetic confirmation of species (*C. finmarchicus* or *C. glacialis*). Later, oxygen consumption data will be processed to calculate respiration rates and critical partial pressures (Pcrit). These values will be compared among stations, species, depth, energetic status as measured by lipid reserves, and time of day to test whether respiration rates reflect periods of increased activity observed in the LAM experiments.

Table 13.3: Summary of respiration experiments. All experiments were performed at 4°C.

NET DATE TIME IN (UTC)	EVENT NO	STATION	LAT	LON	GEAR	DEPTH RANGE (M)	TIME POINT	START DATE TIME (UTC)	END DATE TIME (UTC)	TEMP.	NOTES
14/08 10:31	56	F7	79	3.33309	MAMMOTH	520-400	11	14/08 15:22	16:08 10:17	2.8	RUN 1
14/08 10:31	56	F7	79	3.33309	MAMMOTH	170-50	11	14/08 15:22	16/08 10:17	2.8	RUN 1
14/08 10:31	56	F7	79	3.33309	MAMMOTH	520-400	11	16/08 10:00	17/08 06:01	2.8	RUN 2
14/08 10:31	56	F7	79	3.33309	MAMMOTH	170-50	11	16/08 10:00	17/08 06:01	2.8	RUN 2
17/08 02:57	78	D1	78.32013	0.61235	MOCNESS	500-375	1	17/08 12:13	19/08 13:59	2.8	RUN 1
17/08 02:57	78	D1	78.32013	0.61235	MOCNESS	125-5	1	17/08 12:13	19/08 13:59	2.8	RUN 1
22/08 00:07	121	D6	79.16658	6.60008	MAMMOTH	520-400	7	22/08 03:11	23/08 16:46	4.0	RUN 1
22/08 00:07	121	D6	79.16658	6.60008	MAMMOTH	130-5	7	22/08 03:11	23/08 16:46	4.0	RUN 1

Krill swimming behaviour experiments

This cruise also gave us the opportunity to gather data on the swimming behaviour of krill *Meganyptiphus norvegica.* All measurements were made on individual krill, collected from two stations, using a larger Trikinetics

DATE TIME IN (UTC)	EVENT NO	STATION	LAT	LON	DEPTH RANGE (M)	START DATE TIME (UTC)	END DATE TIME (UTC)	NOTES
24/08 07:00	141	D7	79°15.650 N	2° 15.012 E	500-250	24/08 13:05	27/08 07:32	8 x *M. norvegica* stored at 5°C for ~2 hrs. before placing in LAM
25/08 05:46	149	D8	78° 19.483N	6° 48.780 E	375-125	25/08 11:05	27/08 07:32	4 x *M. norvegica* stored at 5°C for ~2 hrs. before placing in LAM

LAM using acrylic tubes with diameters of 5cm instead of 1cm. Individual krill were placed in the tubes containing 0.2um filtered seawater sourced from 250m at D6 . Experimental runs are annotated in Table 4. Experiments were performed inside a dark Zarges box fixed down on the aft deck of the ship.

Table 13.4: Summary of krill swimming behaviour experiments (note all animals collected with MOCNESS sampler).

14. AME Mechanical report

Science Equipment

MOCNESS

Setup

A small quantity of oil had leaked from the motor in transit, although enough was present under the membrane to deploy without further action.

One of the sensor mounts was flipped to allow the altimeter to be mounted in the correct orientation. Although the LabVIEW pitch readings didn't appear to be correct throughout the cruise – data showing the net was often at only 20° to the horizonal.

It would be a nice improvement to have dedicated sensor mounts made.

Only the pressure sensor was calibrated, and the scientists have been cross-referencing CTD data for net deployments, the DWNM instruments are only used as an 'indication'. All instruments should probably be calibrated in future. The flowmeter is not designed for any off-axis measurements and should be mounted on a gimbal with a fin to ensure it is parallel to the flow and providing accurate data.

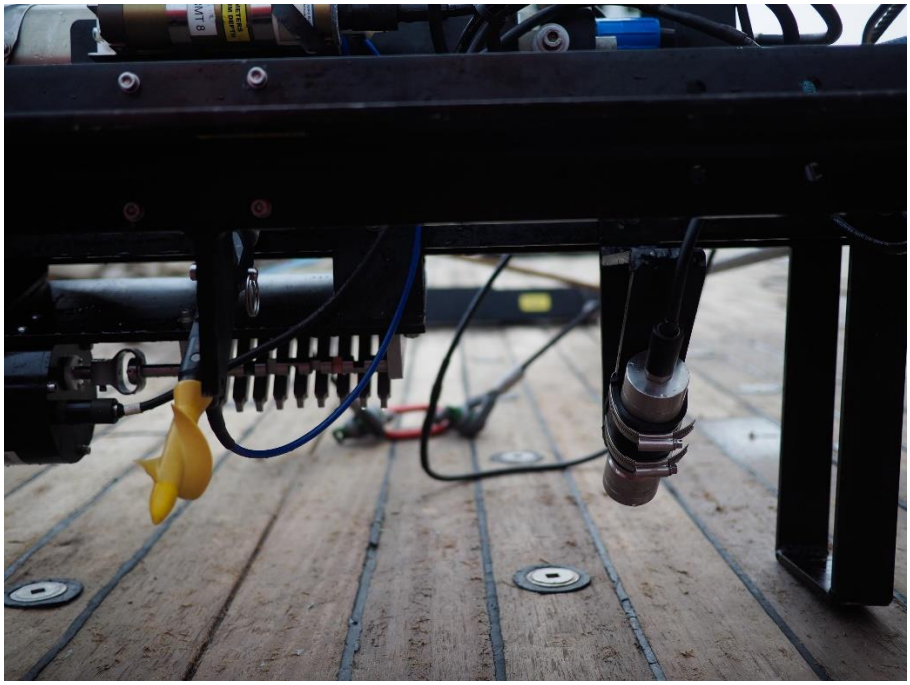


Figure 1 - Flowmeter and altimeter orientation

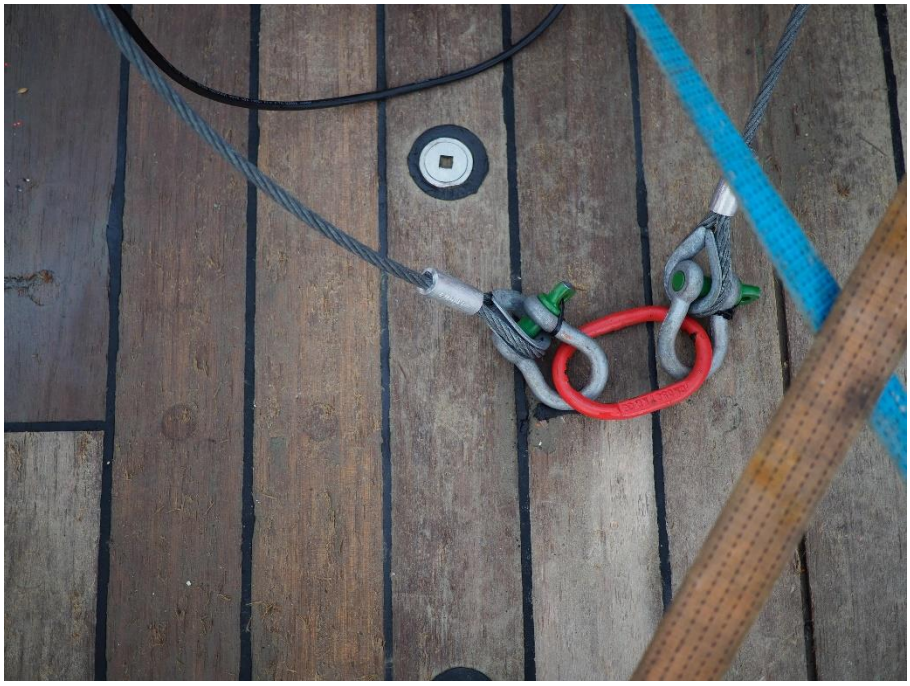


Figure 2 - MOCNESS rigging arrangement

Test Station

Temperature, salinity, and altimeter data was incorrect on the test deployment. The first two were because of incorrect cabling. The altimeter cable was found to have flooded and a new one was made.

The depth reading was intermittent at the start of the deployment but then stabilised, so no further action was taken.

Netmonitor data-logging wasn't working which was traced to the COM port on LabVIEW being incorrect.

Stations

The bar nuts had worked loose after a couple of deployments and were tightened.

The altimeter didn't work with the new cable. A hard-copy of a wiring guide (written by Carson McAfee) was found which detailed the correct pin-outs, which are contrary to the DWNM technical manual. The document isn't on the AME Mechanical Drive and needs adding. The altimeter then worked.

Two failed deployments, one partial (two nets fired) and on complete failure. The release unit was swapped for the spare but that also failed.

The biowire was Megger tested and was reading 130 MΩ, much lower than ideal (4000 MΩ is the maximum on the tester) but the wire wasn't immediately re-terminated as it was needed for the Mammoth.

The spare release has a history of not working and therefore wasn't considered a good indicator of where the fault may lie. Both units were inspected.

The primary release was drained of oil and inspected inside and out. No faults were apparent.

The live wire on the spare release was found crushed to the casing. The wire was repaired, and the unit reassembled. Unfortunately, we didn't get another opportunity to test this release.

Data was pulled from SCS which showed a lower voltage during firing than had been seen previously (Figure 3). No mechanical issues were found so the battery was replaced with one from another fish (we didn't have spares). The replacement appeared to hold a more consistent voltage during testing.

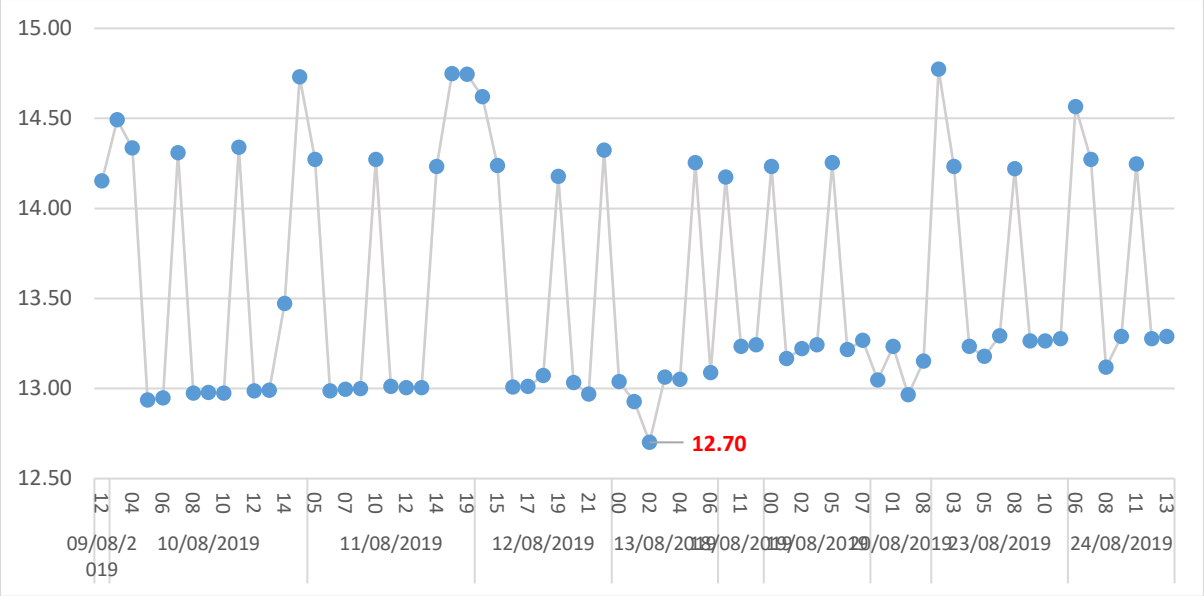


Figure 3 - Unprecedented low voltage on second failed deployment, higher minimum voltages apparent after battery replaced

At this point the ship was in ice, so we were unable to carry out a full test deployment. Instead, the nets were removed, and the frame was deployed vertically to 500m. The motor was fired at 50m intervals on the way up and, on recovery, all releases had operated.

Due to the ice, the biowire wasn't required for some time so the decision was made to re-terminate it, see *Biowire* section for details.

On the next two deployments, the pressure sensor stopped reading at 992m. It was cleaned with de-ionised water in accordance with the manufacturer's instructions and re-mounted but did the same again on the next deployment and was replaced by another unit. The fault remained with the new unit, but the decision was made not to investigate further due to the risk of introducing a fault as the fish would have to be dismounted and opened again.

Several changes have been made to the MOCNESS LabVIEW:

- The Firing Control bar now shows the current open net
- Items were resized so everything was visible on the screen
- The altimeter now reads 'NaN' for anything above 85m (i.e. out of range)
- Plus, several minor aesthetic changes

post-cruise tasks

1. Replace fish batteries
2. Inspect nets
3. Investigate pitch sensor

4. Make instrument mounts
5. Calibrate sensors

Mammoth

Setup

The Mammoth is already 'built' so the only task required for setup was to make a sea cable to the biowire. This was functionally tested before use.

Test Station

The Mammoth was not deployed at the test station.

Sites

The Mammoth was used extensively after the failure of the MOCNESS and proved very reliable.

It had to be used in pre-programmed mode as it didn't connect via the biowire, despite the successful test earlier. The deck box 'sees' the Mammoth but reads the top line of the display only, with no further data or control:

MULTI PLANKTON SAMPLER 9nets /3000m

The 30m cable was ran out to the unit and it worked fine, leaving only the biowire and the new sea cable as possible sources of the fault. The new cable was tested using a multimeter but couldn't be tested fully without making another cable, which we didn't have the pigtails for.

The baud rate on the Mammoth seems much higher than that of the DWNM (4800 vs 600). This is adjustable in *OceanLab* but it's not clear whether the carries over to the deck box and the Mammoth itself. A lower baud rate might make the Mammoth more tolerant of a poorer connection and this is something to ask the manufacturer.

The fault remained after the biowire re-termination and Hydro-Bios have been contacted for advice.

It took a few attempts to get the deployment and recovery up-to-speed. The Mammoth and carousel have been colour-coded to show the correct locations of the wires. Both have also been marked with the directions they should face and it's important to maintain these whenever either are lifted off the deck: not doing so can cause the nets to twist.

Videos of deployment and recovery have been made and are on the AME shared drive.

A lot of sea creatures were getting caught in the nets. The basket cables were measured against some older ones and found to be significantly shorter, allowing bights to form. The manufacturer's manual specifies a length of 5.5m. No suitable wire rope was on board, so the two 'old' wires were fitted, and two ropes made up to the same length (measured at 5.36m). The catches improved significantly after this.

On analysis of the Mammoth data, the flowmeter has not been working correctly and this needs rectifying.

Post-Cruise Tasks

- Rectify control fault
- Replace basket wires
- Inspect nets
- Rectify flow meter
- Clean & remove corrosion
- Replace missing top panel
- Re-align bar on Net 9
- Write setup guide

O/C Bongo

Setup

The studding on the cod end support needs to be replaced by bolts as it's currently awkward to assemble.

One whale-spectacle bolt was missing, and we didn't have a spare of the correct size.

The plates for the cod-end latches weren't fitted initially but were found and installed. There are no spares.

The swaging on the MCU wire was re-done as the first one wasn't satisfactory (the tail was inside the ferrule after swaging). It's also not clear which size ferrule should be used (Intal and Talurit guides have different numbers) and this need establishing and documenting in the Bongo manual, along with the correct swaged dimensions. This is especially important given that there is no means of load testing the termination. On this occasion, a size 5 ferrule and dies were used.

The swager itself probably hasn't been serviced for several years and this seems worth doing – the JCR's swager has been unreliable and would have to be dismounted to enable terminating the Bongo. It is also significantly larger than our portable swager so this would not be an easy undertaking.

The control cable was run up to the UIC to make programming easier, although it is not intended for outdoor use and a ruggedised version should be made. There are also no blanks for the Seacon end and no back shell.

Test Station

The Bongo was successfully deployed at the test station.

Sites

The Bongo was primarily used in 'dumb' mode. It was noted that an external valve position indicator would be a nice modification, if possible.

Safety pins were fitted to the cod ends to secure them during deployment. They appear to be plated, not stainless. They were secured with string, but some came loose: crimped lanyards would be an improvement.

During one pressure-programmed deployment, the scientists reported that one cod-end was empty. On inspection, the valves were in the correct place and the mechanism fired correctly several times. No fault found.

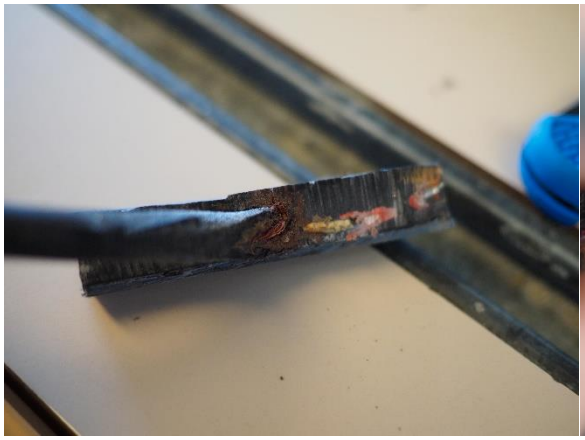
The bongo was also deployed once with the valves closed, after changing from a pressure-programmed to a dumb deployment. This gives further support to the idea of an external visual indicator.

Biowire

As detailed in the MOCNESS section, the biowire was Megger tested and the resistance found to be much lower than ideal.

During a suitable operational window, the biowire was re-terminated.

The previous termination was inspected, and the cause of failure appeared to be water ingress where the wire exits the potting. Water was present inside the pot and corrosion apparent on the wires.



When re-terminated, the cable outer was roughed-up to help the potting adhere. Some flexible marine sealant was also applied at this point to create a secondary seal.

There is only one potting cone for the biowire, and there was no more tubing so one had to be turned from nylon bar.

On completion, the wire was load-tested to 3T, then Megger tested, this time reading the meter's maximum 4000 MΩ.

The wire was Megger tested again and the end of the cruise and was reading low again. It will need re-terminating before next use.

Workshop

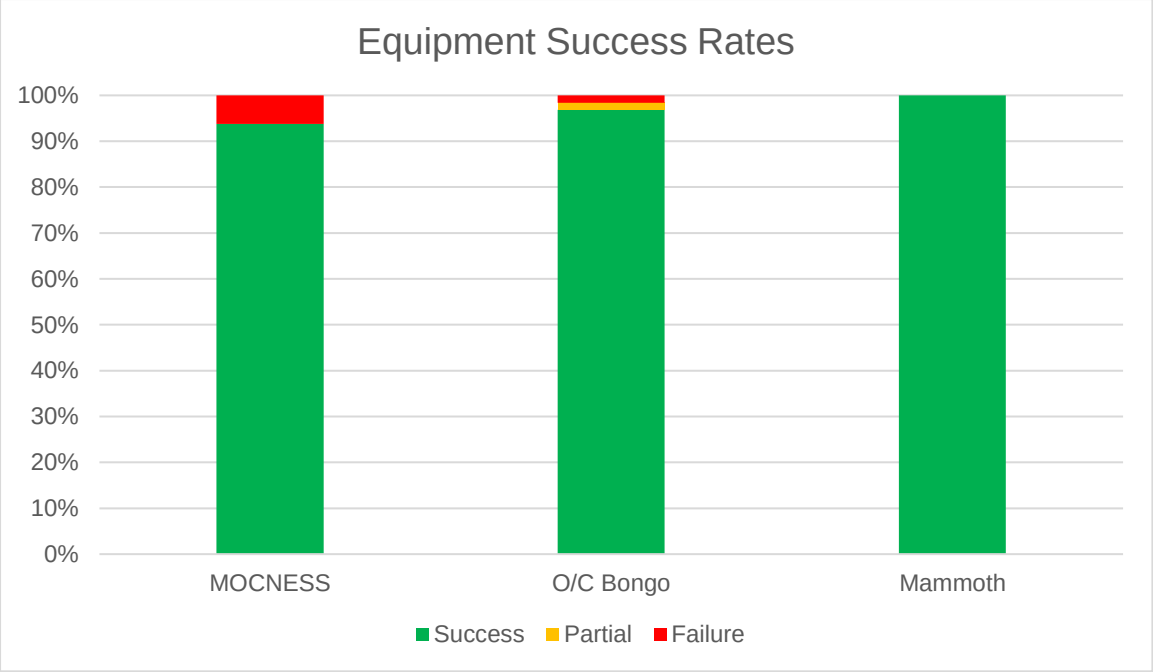
Consumables

The following consumables are needed:

- ABS tube for wire termination
- Potting compound
- Grease for potting moulds
- Cable ties, 120, 220, 280mm
- Pens
- Notepads
- Oil for MOCNESS motor
- Rubber gloves
- Needle file (round)
- Sandpaper (roll)
- Rope, 10mm polypropylene
- Electrical tape
- Scotchbrite

Equipment

- 110V heater for the workshop
- Crab shifter
- Potting cone for biowire
- Nylon potting mould spacers (the supplied ones aren’t very good)


Equipment Success Rates
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MOCNESS
O/C Bongo
Mammoth
Success
Partial
Failure

Other

The OneDrive documentation worked well but we need to ensure everything is available there in electronic versions. We are carrying a lot of old paper documents which should be either updated or eliminated.

15. AME Department Notes

Priority needs and Notices

Pre-cruise tasks

Task	Status
Download AME_Eng/Platform_Specific/JCR	Y
Check cruise planning meeting notes	Y
Number of hours hand over with previous ships AME Engineer	18H

Daily & weekly tasks

Task	Frequency	Status
Sanity check the Oceanlogger data	Daily	Y
Check the Following Fans: Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween)	Monthly	Y
Mega test CTD cable	Weekly	Y

End of cruise checks

Task	Status
XBT left in cage, in a suitable state	Y
The salinity bottles have been cleaned, if used	Y
CTD left in suitable state - Ducts cleaned with Triton and deionised water, blanking plugs installed and system washed with water	Y
CTD Slip Ring have been cleaned	Y
Office is tidy, with manuals and files returned and items stowed for sea	Y
Clean the following fans: Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween)	Y
Scintillation Counter test Precedure	Y

16. IT Cruise Report

O5 August 2019

- Started Cruise leg.
- Changed permissions for users on the Legwork sub-folders to 'Create & Delete'.
- Cannot access Legwork and data has stopped logging to JRLB
    - JRLB rebooted but stuck on 're-booting' Legdata and Legwork parent folders accessible but legwork sup-folders are not.
    - JRLB still has a Veeam snapshot. Checked Veeam, no jobs are running for JRLB and so JRLB was shut down and the snapshot removed.
    - Snapshot progressed to 99% after about 1 hr but still at 99% at 11pm.
    - ESX0 Health checked in iDRAC, all physical disk are shown as on-line and healthy.

06 August 2019

- ESX0 restarted JRLB auto-started and all legwork folders are accessible. Re-synced SCS with JRLB
- DWNM & UDB9400 PCs displays blank. They were both windows XP. Booted them into safe mode an un-installed the graphics drivers and the displays were restored.

08 August 2019

- Netmonitor data not being updated on Legdata. Attempted re-sync of SCS with JRLB but lost sync of all updates to JRLB
- Restarted JRLB - but stooped with the following error "*Checking Configuration Files for slapd:'… Unclean shutdown detected… recovery skipped in read-only mode. Run manual recovery if errors are encountered".*
- Booted JRLB into single user mode ran the following commands to repair the LDAP database JRLB rebooted successfully

    cd /sysadmin/packages/openldap/current/
    ../sbin/slaptest
    ../sbin/slapcat
    ../bin/db_recover -v -h ../var/openldap-data/

- Still could not sync SCS with JRLB so restarted SCS once ship was off station.
- Netmonitor still not writing to raw log on SCS. Further investigation by AME revealed that that the SCS serial lead was connected to the wrong COM port on the netmonitor PC.

09 August 2019

- Replaced 'BAS Intranet' and 'Who's Who' links on JCR web page with links to the BAS Digital Workspace.

11 August 2019

- Email from Crone Daemon.
  "mount: it seems /lvm/uservol/users/jcrdata/picarro is mounted multiple times"
- Logged onto JRLB as root and ran *"mount |grep |wc -l"* which showed 80 mounts.
- Ran "*for i in {1..80}; do umount /lvm/uservol/users/jcrdata/topas; done;"* to clear the mounts.

12 August 2019

- Received further emails reporting
  "/lvm/uservol/users/jcrdata/picarro is mounted multiple times"
- Re-ran "*mount |grep |wc -l"* which showed multiple mounts so cleared the mounts and restarted both Picarro PCs.

13 August 2019

- JCR Amanda Daily Backup Failed

- Aeng logged onto to JCR remotely and rebooted AMANDA. Amanda daily backups working again.
- EM122 was restarted for Aeng to investigate EM122 mount issue, em122asvp looks like it was due to some stuck process waiting for the em122 to come back.

14 August 2019

- Still getting multiple Picarro mounts, which I have been clearing manually. Reluctant to re-start JLRLB until the end of the cruise.

29 August 2019

- Ended leg, however after logging into jrw-veeam-s1 noticed the last 2 replication back-ups had failed, as they could not connect to JRLB, JRLB manual replication also failed.
    - Restarted jrw-veeam-s1 and JRLB manual replication completed successfully. The snapshot removal was a lot quicker about 1 1/2 hrs. (Daily replications 30 August were successful).

17. Event log

TYPE	SITE	EVENT #	Start time	Start Lat	Start Lon	Time at bottom	Lat at bottom	Lon at bottom	End time	End Lat	End Lon	Wdepth	Responsible	Comments
CTD001		1	07/08/2019 11:20	69.52319	-2.9238	07/08/2019 11:28	69.5232	-2.92377	07/08/2019 11:54	69.5232	-2.92379	3570	Jo	Shakedown cast, samples collected for NOCS
Bongo001		2	07/08/2019 12:33	69.52321	-2.92378	07/08/2019 12:38	69.52321	-2.92384	07/08/2019 12:58	69.52322	-2.92381		Dan	Deployed to 200m for NOCS
CTD002		3	07/08/2019 13:27	69.52321	-2.92385				07/08/2019 13:53	69.52319	-2.92375	3571	Jo	Samples for PETRA
Mocness001		4	07/08/2019 14:21	69.52495	-2.91791				07/08/2019 14:57	69.53373	-2.86773		Geraint/Gabi	
CTD003	NT11	5	08/08/2019 21:02	75.33563	-5.46446	08/08/2019 21:06	75.33563	-5.46447	08/08/2019 21:22	75.33562	-5.46444	3570	Jo	Samples collected for NOCS. Deployed to 50m
Bongo002	NT11	6	08/08/2019 21:44	75.33563	-5.46438	08/08/2019 21:50	75.33562	-5.46441	08/08/2019 22:15	75.33564	-5.46413	3570	Dan	Deployed to 200m for NOCS
Bongo003	NT11	7	08/08/2019 22:25	75.33558	-5.46417	08/08/2019 22:30	75.33559	-5.46416	08/08/2019 22:54	75.33557	-5.46422	3570	Dan	Deployed to 200m for NOCS
Bongo004	NT11	8	08/08/2019 23:01	75.33557	-5.46425	08/08/2019 23:06	75.33557	-5.46421	08/08/2019 23:24	75.33556	-5.46422	3570	Dan	Deployed to 200m for NOCS
Bongo005	NT11	9	08/08/2019 23:29	75.33555	-5.46423	08/08/2019 23:37	75.33555	-5.46423	08/08/2019 23:56	75.33556	-5.46423	3570	Dan	Deployed to 200m for NOCS
CTD004	NT11	10	09/08/2019 00:43	75.33557	-5.46415	09/08/2019 01:46	75.33557	-5.46424	09/08/2019 03:16	75.33555	-5.46428	3570	Jo	Physics
Mocness002	NT11	11	09/08/2019 04:08	75.33206	-5.45555	09/08/2019 05:10	75.303	-5.38494	09/08/2019 07:07	75.244	-5.24422		Geraint/Gabi	Deployed to 1815
Bongo006	NT11	12	09/08/2019 08:28	75.33618	-5.46366	09/08/2019 08:34	75.33618	-5.46365	09/08/2019 08:44	75.43796	-5.86886	3570	David	Deployed to 200m. Samples for Stirling
Mocness003	NT11	13	09/08/2019 09:16	75.43796	-5.86886	09/08/2019 10:23	75.43796	-5.86886	09/08/2019 12:13	75.43796	-5.86886		Geraint/Gabi	Deployed to 1408
CTD005	NT9	14	09/08/2019 14:30	75.64241	-6.62673	09/08/2019 14:37	75.64242	-6.62673	09/08/2019 16:30	75.64241	-6.62669	3282	Jo	Physics
CTD006	NT8	15	09/08/2019 21:09	75.79555	-7.21911	09/08/2019 21:15	75.79554	-7.21915	09/08/2019 21:31	75.79555	-7.21911	2695	Jo	Samples for NOCS
Bongo007	NT8	16	09/08/2019 21:53	75.79554	-7.21905	09/08/2019 21:58	75.79555	-7.21908	09/08/2019 22:19	75.79556	-7.21912	2695	Dan	Deployed to 200m. Samples for NOCS
Bongo008	NT8	17	09/08/2019 22:24	75.79556	-7.21911	09/08/2019 22:29	75.79558	-7.21913	09/08/2019 22:47	75.79557	-7.21912	2695	Dan	Deployed to 200m. Samples for NOCS

Bongo009	NT8	18	09/08/2019 22:52	75.79557	-7.21913	09/08/2019 22:57	75.79557	-7.2191	09/08/2019 23:18	75.79555	-7.21914	2695	Dan	Deployed to 200m. Samples for NOCS
Bongo010	NT8	19	09/08/2019 23:23	75.79554	-7.21911	09/08/2019 23:28	75.79554	-7.21918	09/08/2019 23:57	75.79556	-7.21911	2695	Dan	Deployed to 200m. Samples for NOCS
Bongo011	NT8	20	10/08/2019 00:00	75.79556	-7.21909	10/08/2019 00:04	75.79556	-7.21909	10/08/2019 00:21	75.79558	-7.21914	2695	Dan	Deployed to 200m. Samples for NOCS
Bongo012	NT8	21	10/08/2019 00:26	75.79558	-7.21921	10/08/2019 00:31	75.79558	-7.21918	10/08/2019 00:48	75.79558	-7.21921	2695	Dan	Deployed to 200m. Samples for NOCS
CTD007	NT8	22	10/08/2019 01:31	75.79556	-7.21916	10/08/2019 02:12	75.79556	-7.21913	10/08/2019 03:30	75.79558	-7.21915	2694	Jo	Physics
Mocness004	NT8	23	10/08/2019 04:06	75.79981	-7.20808	10/08/2019 05:16	75.83163	-7.11014	10/08/2019 06:57	75.88149	-6.96634		Geraint/Gabi	Deployed to 2022m
Mocness005	NT8	24	10/08/2019 07:54	75.80602	-7.19883	10/08/2019 08:57	75.83041	-7.30614	10/08/2019 10:34	75.87096	-7.4659		Geraint/Gabi	Deployed to 1918m
Mocness006	NT8	25	10/08/2019 11:13	75.88643	-7.53255	10/08/2019 12:13	75.90812	-7.62704	10/08/2019 13:50	75.95797	-7.59695		Geraint/Gabi	Deployed to 1784m
CTD008	NT7	26	10/08/2019 14:39	75.94947	-7.81646	10/08/2019 15:20	75.94945	-7.81647	10/08/2019 16:02	75.94945	-7.81637	2037	Jo	Physics
CTD009	NT6a	27	10/08/2019 21:07	76.03862	-8.09524	10/08/2019 21:13	76.03861	-8.0952	10/08/2019 21:32	76.03862	-8.09518	1636	Jo	Deployed to 50m. Samples for NOCS
Bongo013	NT6a	28	10/08/2019 21:57	76.03864	-8.09517	10/08/2019 22:07	76.03829	-8.09874	10/08/2019 22:23	76.03755	-8.10711	1636	Dan	Deployed to 200m. Samples for NOCS
Bongo014	NT6a	29	10/08/2019 22:28	76.03754	-8.10742	10/08/2019 22:33	76.03742	-8.10959	10/08/2019 22:50	76.03699	-8.11741	1636	Dan	Deployed to 200m. Samples for NOCS
Bongo015	NT6a	30	10/08/2019 22:57	76.03693	-8.11866	10/08/2019 23:02	76.03679	-8.12084	10/08/2019 23:18	76.0364	-8.12775	1636	Dan	Deployed to 200m. Samples for NOCS
Bongo016	NT6a	31	10/08/2019 23:23	76.03634	-8.12838	10/08/2019 23:28	76.03623	-8.13058	10/08/2019 23:42	76.03591	-8.13684	1636	Dan	Deployed to 200m. Samples for NOCS
Bongo017	NT6a	32	10/08/2019 23:58	76.03591	-8.13696				11/08/2019 00:20	76.03591	-8.1369	1636	Dan	Deployed to 200m. Samples for NOCS
CTD010	NT6a	33	11/08/2019 00:20	76.03591	-8.1369	11/08/2019 00:52	76.03558	-8.14282	11/08/2019 01:50	76.03518	-8.1502	1572	Jo	Physics
CTD011	NT6a	34	11/08/2019 03:07	76.0352	-8.15024	11/08/2019 03:15	76.03517	-8.15033	11/08/2019 03:41	76.03516	-8.15053	1572	Jo	Deployed to 100m. Samples for PETRA
CTD012	NT6a	35	11/08/2019 04:52	76.03515	-8.15045	11/08/2019 05:00	76.03514	-8.15055	11/08/2019 05:23	76.03496	-8.15298	1572	Jo	Deployed to 75m. Samples for PETRA
Mocness007	NT6a	36	11/08/2019 05:44	76.03418	-8.12997	11/08/2019 07:00	76.03264	-7.94904	11/08/2019 08:46	76.02596	-7.69827		Geraint/Gabi	Deployed to 2200m.
Bongo018	NT6a	37	11/08/2019 09:45	76.03436	-8.15184	11/08/2019 09:56	76.03418	-8.15439	11/08/2019 10:09	76.03336	-8.16336		David	Deployed to 200m. Samples for Stirling
Mocness008	NT6a	38	11/08/2019 10:28	76.03397	-8.15309	11/08/2019 11:39	76.04087	-8.00531	11/08/2019 13:27	76.05416	-7.77078		Geraint/Gabi	Deployed to 2090m
CTD013	F7	39	12/08/2019 14:21	79.00021	3.33068	12/08/2019 14:32	79.0002	3.33083	12/08/2019 14:52	79.0002	3.33079	3022	Jo	Deployed to 250m. Samples for CHASE

Mocness009	F7	40	12/08/2019 15:15	79.0043	3.33547	12/08/2019 16:24	79.04161	3.39113	12/08/2019 18:35	79.11272	3.50832		Jordan	Deployed to 2060m. Samples for CHASE
Mocness010	F7	41	12/08/2019 19:30	78.99855	3.32367	12/08/2019 20:10	79.02103	3.35722	12/08/2019 21:32	79.06337	3.46085		Jordan	Deployed to 1030 m. Samples for CHASE
Mocness011	F7	42	12/08/2019 23:57	79.01465	3.3395	13/08/2019 00:08	79.02088	3.34429	13/08/2019 01:21	79.06378	3.37694		Jordan	Deployed to 943m. Samples for CHASE. Nets didn't close properly
Mocness012	F7	43	13/08/2019 03:10	79.00152	3.32775	13/08/2019 03:44	79.02061	3.3194	13/08/2019 04:55	79.05978	3.34245		Jordan	Deployed to 963m. Samples for CHASE. Nets didn't close properly
Mammoth001	F7	44	13/08/2019 08:10						13/08/2019 08:15	78.99989	3.33383		Jordan	Nets tangled. Deployment aborted
Mammoth002	F7	45	13/08/2019 08:40	78.99991	3.33386	13/08/2019 09:00	78.99991	3.3339	13/08/2019 10:03	78.99989	3.33383		Jordan	Deployed to 600m. Samples for CHASE
Mammoth003	F7	46	13/08/2019 11:23	78.99989	3.33381	13/08/2019 11:51	78.9999	3.33381	13/08/2019 13:47	78.99989	3.33383		Jordan	Deployed to 600m. Samples for CHASE
Mammoth004	F7	47	13/08/2019 15:15	78.9999	3.33381	13/08/2019 15:41	78.99987	3.33389	13/08/2019 16:43	78.9999	3.33382		Jordan	Deployed to 601m. Samples for CHASE
Mammoth005	F7	48	13/08/2019 20:05	78.99987	3.3337	13/08/2019 20:35	78.99985	3.33357	13/08/2019 21:37	78.99985	3.33382		Jordan	Deployed to 600m. Samples for CHASE
CTD014	F7	49	13/08/2019 22:24	78.99987	3.33376	13/08/2019 22:29	78.99988	3.33379	13/08/2019 22:47	78.99987	3.33381	3023	Jo	Deployed to 50m. Samples for NOCS
Bongo019	F7	50	13/08/2019 23:10	78.99988	3.33373	13/08/2019 23:15	78.99987	3.33401	13/08/2019 23:30	78.99985	3.33395		Dan	Deployed to 200m. Samples for NOCS
Bongo020	F7	51	13/08/2019 23:33	78.99989	3.33385	13/08/2019 23:38	78.99995	3.33339	13/08/2019 23:52	78.99999	3.33301		Dan	Deployed to 200m. Samples for NOCS
Mammoth006	F7	52	14/08/2019 00:32	79.00002	3.33312	14/08/2019 01:03	79.00001	3.33313	14/08/2019 02:01	79	3.33318		Jordan	Deployed to 595. Samples for CHASE
CTD015	F7	53	14/08/2019 02:39	79.00002	3.33316	14/08/2019 03:35	79.00003	3.33318	14/08/2019 05:04	79.00002	3.3331	3021	Jo	Physics
Mammoth007	F7	54	14/08/2019 05:24	79.00003	3.3331	14/08/2019 05:48	79.00001	3.33315	14/08/2019 06:50	79.00001	3.33308		Jordan	Deployed to 600m. Samples for CHASE
Mammoth008	F7	55	14/08/2019 10:31	79	3.33309	14/08/2019 10:55	79	3.33305	14/08/2019 11:56	79.00003	3.33316		Jordan	Deployed to 600m. Samples for CHASE
Mammoth009	F7	56	14/08/2019 10:31	79	3.33309	14/08/2019 10:55	79	3.33305	14/08/2019 11:56	79.00003	3.33316		Jordan	Deployed to 600m. Samples for CHASE
Bongo021	F7	57	14/08/2019 12:08	79.00003	3.3331	14/08/2019 12:15	79.00003	3.33309	14/08/2019 12:25	79.00001	3.33305		Dan	Deployed to 200m. Samples for NOCS
Mammoth010	F7	58	14/08/2019 12:44	79.00001	3.33294	14/08/2019 13:26	79.00001	3.333	14/08/2019 15:21	79.00001	3.33311		David	Deployed to 1200m. Samples for Stirling
CTD016	Ice Station 1	59	14/08/2019 21:11	78.91531	-0.28817	14/08/2019 21:21	78.91434	-0.28986	14/08/2019 21:37	78.91229	-0.29398	2527	Jo	Deployed to 55m. Samples for NOCS

Bongo022	Ice Station 1	60	14/08/2019 22:03	78.90328	-0.30872	14/08/2019 22:08	78.90254	-0.30931					Dan	Deployed to 200m. Samples for NOCS
Bongo023	Ice Station 1	61	14/08/2019 22:38	78.89649	-0.32121	14/08/2019 22:43	78.89486	-0.32427	14/08/2019 22:56	78.89304	-0.32685		Dan	Deployed to 200m. Samples for NOCS
CTD017	Ice Station 1	62	14/08/2019 23:50	78.87103	-0.31714	15/08/2019 00:43	78.8592	-0.33083	15/08/2019 01:37	78.844	-0.35682	2657	Jo	Physics. Samples for salinity at depth only
Mocness013	Ice Station 1	63	15/08/2019 02:39	78.81082	-0.38722	15/08/2019 02:54	78.81082	-0.38733	15/08/2019 03:06	78.81083	-0.3874		Geraint/Gabi	Test
CTD018	Ice Station 1	64	15/08/2019 03:58	78.78386	-0.48256	15/08/2019 04:10	78.78047	-0.49071	15/08/2019 04:34	78.77402	-0.50622	2526	Jo	Deployed to 200m. Physics
CTD019	Ice Station 2	65	15/08/2019 21:06	78.36376	-4.64363	15/08/2019 21:16	78.36076	-4.65254	15/08/2019 21:30	78.35681	-4.66174	837	Jo	Deployed to 200m. Samples for NOCS
Bongo024	Ice Station 2	66	15/08/2019 22:02	78.349	-4.6838				15/08/2019 22:19	78.34492	-4.69515		Dan	Deployed to 200m. Samples for NOCS
Bongo025	Ice Station 2	67	15/08/2019 22:26	78.34273	-4.70126	15/08/2019 22:31	78.3413	-4.70407	15/08/2019 22:44	78.33832	-4.71006		Dan	Deployed to 200m. Samples for NOCS
CTD020	Ice Station 2	68	15/08/2019 23:19	78.33007	-4.72773	15/08/2019 23:35	78.3266	-4.73436	16/08/2019 00:10	78.31976	-4.75201	672	Jo	Deployed to 658m. Physics
CTD021	Ice Station 2	69	16/08/2019 01:38	78.30135	-4.78202	16/08/2019 01:48	78.29947	-4.78459	16/08/2019 02:15	78.29441	-4.79097	608	Jo	Deployed to 200m. Samples for PETRA
CTD022	Ice Station 2	70	16/08/2019 03:55	78.27185	-4.80775	16/08/2019 04:08	78.26896	-4.80924	16/08/2019 04:27	78.26511	-4.81674	586	Jo	Deployed to 100m. Samples for PETRA
Bongo026	Ice Station 2	71	16/08/2019 04:39	78.26279	-4.82311	16/08/2019 05:00	78.25908	-4.83677					Claudia	Deployed to 200m. Samples for Claudia
Bongo027	Ice Station 2	72	16/08/2019 05:04	78.2584	-4.83958	16/08/2019 05:12	78.25704	-4.84513	16/08/2019 05:23	78.25517	-4.85272		Claudia	Deployed to 200m. Samples for Claudia
Bongo028	Ice Station 2	73	16/08/2019 05:27	78.25449	-4.85551	16/08/2019 05:36	78.25294	-4.86158	16/08/2019 06:00	78.24874	-4.87764		David	Deployed to 200m. Samples for Stirling
CTD023	D1	74	16/08/2019 21:06	78.31705	0.61618	16/08/2019 21:12	78.31705	0.61623	16/08/2019 21:28	78.31706	0.61615	2962	Jo	Deployed to 50m. Samples for NOCS

Bongo029	D1	75	16/08/2019 21:53	78.31706	0.61616	16/08/2019 21:58	78.31707	0.61611	16/08/2019 22:15	78.31708	0.61616		Dan	Deplyed to 200m. Samples for NOCS
Bongo030	D1	76	16/08/2019 22:18	78.31707	0.61617	16/08/2019 22:23	78.31707	0.61612	16/08/2019 22:42	78.31706	0.61611		Dan	Deplyed to 200m. Samples for NOCS
CTD024	D1	77	16/08/2019 23:40	78.31706	0.61605	17/08/2019 00:35	78.31706	0.61607	17/08/2019 02:10	78.31705	0.61615	2962	Jo	Physics
Mocness014	D1	78	17/08/2019 02:57	78.32013	0.61235	17/08/2019 04:05	78.35506	0.52888	17/08/2019 05:44	78.40373	0.38493		Geraint/Gabi	Deployed to 1992
Bongo031	D1	79	17/08/2019 06:52	78.31662	0.61537	17/08/2019 07:03	78.31662	0.61534	17/08/2019 07:14	78.31663	0.61537		Claudia	Deployed to 200m. Samples for Claudia
Mocness015	D1	80	17/08/2019 07:38	78.32037	0.60463	17/08/2019 08:51	78.35475	0.49839	17/08/2019 10:39	78.40645	0.33037		Geraint/Gabi	Deployed to 2135m
CTD025	D2	81	17/08/2019 21:06	79.33322	5.16727	17/08/2019 21:14	79.33322	5.16729	17/08/2019 21:35	79.33325	5.16721	2125	Jo	Deployed to 200m. Samples for NOCS
Bongo032	D2	82	17/08/2019 21:56	79.33323	5.16721	17/08/2019 22:01	79.33324	5.1672	17/08/2019 22:19	79.33323	5.16723	2125	Dan	Deployed to 200m. Samples for NOCS
Bongo033	D2	83	17/08/2019 22:22	79.33323	5.16721	17/08/2019 22:28	79.33323	5.16718	17/08/2019 22:47	79.33325	5.16713	2125	Dan	Deployed to 200m. Samples for NOCS
Bongo034	D2	84	17/08/2019 22:54	79.33324	5.16719	17/08/2019 22:59	79.33322	5.16719	17/08/2019 23:15	79.33323	5.16719	2125	Dan	Deployed to 200m. Samples for NOCS
CTD026	D2	85	18/08/2019 00:02	79.33321	5.16726	18/08/2019 00:45	79.33323	5.16719	18/08/2019 02:12	79.33321	5.16734	2125	Jo	Physics
Mocness016	D2	86	18/08/2019 02:42	79.3353	5.15611	18/08/2019 03:46	79.36017	5.02644	18/08/2019 05:16	79.38143	4.78718		Geraint/Gabi	Deployed to 1812m
Bongo035	D2	87	18/08/2019 06:00	79.33279	5.16543	18/08/2019 06:15	79.33279	5.16547	18/08/2019 06:28	79.33281	5.16554	2125	Claudia	Deployed to 200m. Samples for Claudia
Mocness017	D2	88	18/08/2019 06:47	79.33547	5.14713	18/08/2019 07:53	79.35811	4.98471	18/08/2019 09:30	79.37698	4.70783		Geraint/Gabi	Deployed to 1942m
Mocness018	D2	89	18/08/2019 10:25	79.33755	5.15391	18/08/2019 11:04	79.35095	5.06365	18/08/2019 12:19	79.36923	4.84487		Geraint/Gabi	Deployed to 1166m
CTD027	D2	90	18/08/2019 12:34	79.36926	4.84121	18/08/2019 12:48	79.36927	4.84123	18/08/2019 13:22	79.36927	4.8413	2418	Jo	Deployed to 575m. Samples for NOCS
CTD028	D3	91	18/08/2019 21:08	79.59994	7.33298	18/08/2019 21:12	79.59993	7.33298	18/08/2019 21:30	79.59995	7.33296	881	Jo	Deployed to 60m. Samples for NOCS
Bongo036	D3	92	18/08/2019 21:50	79.59995	7.33297	18/08/2019 21:55	79.59993	7.3328	18/08/2019 22:12	79.59989	7.33263	881	Dan	Deployed to 200m. Samples for NOCS
Bongo037	D3	93	18/08/2019 22:14	79.59989	7.33267				18/08/2019 22:36	79.59989	7.32748	881	Dan	Deployed to 200m. Samples for NOCS
CTD029	D3	94	18/08/2019 23:12	79.59994	7.33224	18/08/2019 23:32	79.59994	7.33219	19/08/2019 00:10	79.59993	7.33226	881	Jo	Physics
Mocness019	D3	95	19/08/2019 00:54	79.59003	7.31407	19/08/2019 01:48	79.55932	7.25787	19/08/2019 03:14	79.51358	7.20299		Geraint/Gabi	Deployed to 1568m
Bongo038	D3	96	19/08/2019 04:09	79.60018	7.33062	19/08/2019 04:12	79.60019	7.33063	19/08/2019 04:18	79.60019	7.33058	881	David	Deployed to 30m. Samples for Stirling

Bongo039	D3	97	19/08/2019 05:02	79.60021	7.33052	19/08/2019 05:09	79.60021	7.33055	19/08/2019 05:28	79.60019	7.3306	881	David	Deployed to 200m. Samples for Sttirling
Mocness020	D3	98	19/08/2019 05:54	79.59622	7.32069	19/08/2019 06:38	79.57611	7.23864	19/08/2019 07:48	79.54669	7.12382		Geraint/Gabi	Deployed to 1306m
Mammoth011		99	19/08/2019 09:42	79.46921	5.99545	19/08/2019 10:40	79.46921	5.99536	19/08/2019 13:18	79.46921	5.99541		Geraint/Gabi	Deployed to 1500m
CTD030	D4	100	19/08/2019 21:06	79.66659	9.39961	19/08/2019 21:11	79.66657	9.3996	19/08/2019 21:30	79.6666	9.39959	341	Jo	Deployed to 50m. Samples for NOCS
Bongo040	D4	101	19/08/2019 21:49	79.66661	9.39951	19/08/2019 21:54	79.6666	9.39954	19/08/2019 22:09	79.66659	9.39957	341	Dan	Deployed to 200m. Samples for NOCS
Bongo041	D4	102	19/08/2019 22:11	79.66658	9.39967	19/08/2019 22:16	79.66658	9.39964	19/08/2019 22:38	79.66658	9.39963	341	Dan	Deployed to 200m. Samples for NOCS
CTD031	D4	103	19/08/2019 23:14	79.66658	9.39954	19/08/2019 23:25	79.6666	9.39959	19/08/2019 23:53	79.66661	9.39961	341	Jo	Physics
Mocness021	D4	104	20/08/2019 00:30	79.66963	9.35947	20/08/2019 00:45	79.6735	9.31712	20/08/2019 01:18	79.68412	9.22334		Geraint/Gabi	Deployed to 460m
Bongo042	D4	105	20/08/2019 06:06	79.66695	9.40021	20/08/2019 06:07	79.66695	9.40021	20/08/2019 06:14	79.66697	9.40023	341	David	Deployed to 30m. Samples for Stirling
Bongo043	D4	106	20/08/2019 06:21	79.66696	9.40027	20/08/2019 06:27	79.66694	9.40027	20/08/2019 06:45	79.66694	9.4002	341	David	Deployed to 200m. Samples for Stirling
Mocness022	D4	107	20/08/2019 07:27	79.63366	9.21709	20/08/2019 07:42	79.63885	9.25191	20/08/2019 08:30	79.65653	9.36274		Geraint/Gabi	Deployed to 460m
CTD032	D5	108	20/08/2019 12:30	79.90432	8.88788	20/08/2019 12:32	79.90444	8.88424	20/08/2019 12:42	79.90458	8.85881	469	Jo	Deployed to 50m. Samples for Birthe
CTD033	D5	109	20/08/2019 13:33	79.9211	8.8522	20/08/2019 13:40	79.92162	8.83883	20/08/2019 14:06	79.92325	8.78759	474	Jo	Deployed to 100m. Samples for PETRA
Bongo044	D5	110	20/08/2019 14:21	79.92407	8.76106	20/08/2019 14:27	79.92453	8.74982	20/08/2019 14:47	79.9257	8.7187	474	Claudia	Deployed to 200m. Samples for Claudia
Bongo045	D5	111	20/08/2019 15:07	79.92691	8.69558	20/08/2019 15:13	79.92735	8.69208	20/08/2019 15:31	79.92867	8.66643	474	David	Deployed to 200m. Samples for Stirling
Bongo046	D5	112	20/08/2019 15:35	79.92909	8.66141	20/08/2019 15:41	79.92955	8.6552	20/08/2019 16:00	79.93125	8.63505	474	David	Deployed to 200m. Samples for Stirling
CTD034	D5	113	20/08/2019 16:25	79.93454	8.61978	20/08/2019 16:38	79.93543	8.61364	20/08/2019 16:58	79.9372	8.59846	485	Jo	Deployed to 75m. Samples for PETRA
CTD035	D6	114	20/08/2019 22:07	79.1666	6.59987	20/08/2019 22:16	79.16657	6.59995	20/08/2019 22:32	79.16659	6.60002	1491	Jo	Deployed to 250m. Samples for CHASE
Mammoth012	D6	115	20/08/2019 23:08	79.16657	6.60002	20/08/2019 23:49	79.16658	6.60024	21/08/2019 01:50	79.16659	6.60007	1491	Jordan	Deployed to 1200m. Samples for CHASE
Mammoth013	D6	116	21/08/2019 04:02	79.16659	6.60018	21/08/2019 04:26	79.16657	6.60003	21/08/2019 05:21	79.16658	6.60006	1491	Jordan	Deployed to 550m. Samples for CHASE
Mammoth014	D6	117	21/08/2019 08:00	79.16659	6.60004	21/08/2019 08:20	79.16658	6.60006	21/08/2019 09:15	79.16658	6.60013	1491	Jordan	Deployed to 550m. Samples for CHASE
Mammoth015	D6	118	21/08/2019 12:11	79.1666	6.60007	21/08/2019 12:31	79.1666	6.59996				1491	Jordan	Deployed to 600m. Samples for CHASE

Mammoth016	D6	119	21/08/2019 16:04	79.16659	6.60007	21/08/2019 16:28	79.16658	6.59998	21/08/2019 17:30	79.16658	6.60016	1491	Jordan	Deployed to 580m. Samples for CHASE
Mammoth017	D6	120	21/08/2019 20:10	79.16659	6.59998	21/08/2019 20:30	79.16658	6.59994	21/08/2019 21:30	79.16659	6.60008	1491	Jordan	Deployed to 580m. Samples for CHASE
Mammoth018	D6	121	22/08/2019 00:07	79.16658	6.60008	22/08/2019 00:28	79.16659	6.59997	22/08/2019 01:27	79.16657	6.6001	1491	Jordan	Deployed to 580m. Samples for CHASE
Mammoth019	D6	122	22/08/2019 04:06	79.16659	6.60003	22/08/2019 04:30	79.16659	6.59997	22/08/2019 05:30	79.16658	6.60003	1491	Jordan	Deployed to 580m. Samples for CHASE
Mammoth020	D6	123	22/08/2019 08:00	79.16658	6.59998	22/08/2019 08:23	79.16658	6.60002	22/08/2019 09:22	79.16658	6.59999	1491	Jordan	Deployed to 550m. Samples for CHASE
Mammoth021	D6	124	22/08/2019 12:02	79.16661	6.59993	22/08/2019 12:22	79.1666	6.59992	22/08/2019 13:21	79.16658	6.59997	1491	Jordan	Deployed to 580m. Samples for CHASE
Bongo047	D6	125	22/08/2019 13:55	79.16658	6.60005				22/08/2019 14:05	79.16659	6.59998	1491		
Bongo048	D6	126	22/08/2019 14:08	79.16659	6.60006	22/08/2019 14:10	79.16659	6.60002	22/08/2019 14:15	79.16658	6.60005	1491		Deployed to 30m
Bongo049	D6	127	22/08/2019 14:24	79.16657	6.6001	22/08/2019 14:29	79.16658	6.60003	22/08/2019 14:49	79.16657	6.60001	1491		Deployed to 200m
CTD036	D6	128	22/08/2019 21:05	79.16651	6.59987	22/08/2019 21:13	79.1665	6.59987	22/08/2019 21:36	79.16649	6.59984	1491	Jo	Deployed to 50m. Samples for NOCS
Bongo050	D6	129	22/08/2019 21:55	79.1665	6.59977	22/08/2019 22:00	79.1665	6.59974	22/08/2019 22:17	79.1665	6.5997	1491	Dan	Deployed to 200m. Samples for NOCS
Bongo051	D6	130	22/08/2019 22:20	79.16651	6.59974	22/08/2019 22:26	79.16651	6.59968	22/08/2019 22:45	79.16652	6.59981	1491	Dan	Deployed to 200m. Samples for NOCS
CTD037	D6	131	22/08/2019 23:29	79.16656	6.59985	23/08/2019 00:10	79.16656	6.59978	23/08/2019 01:04	79.16655	6.59981	1491	Jo	Physics
Mocness023	D6	132	23/08/2019 03:15	79.16692	6.61233	23/08/2019 04:30	79.1733	6.83305	23/08/2019 06:18	79.18097	7.15839		Geraint/Gabi	Deployed to 2237m
Bongo052	D6	133	23/08/2019 07:36	79.16679	6.59656	23/08/2019 07:40	79.16681	6.59659	23/08/2019 08:05	79.16684	6.59672	1491	Claudia	Deployed to 200m. Samples for Claudia
Mocness024	D6	134	23/08/2019 08:25	79.16652	6.61851	23/08/2019 09:42	79.16309	6.8456	23/08/2019 11:33	79.15985	7.17363		Geraint/Gabi	Deployed to 2258m
CTD038	D7	135	23/08/2019 21:08	79.31692	2.64929	23/08/2019 21:14	79.31692	2.64927	23/08/2019 21:32	79.31693	2.64924	3235	Jo	Deployed to 50m. Samples for NOCS
Bongo053	D7	136	23/08/2019 21:54	79.31692	2.64932	23/08/2019 21:58	79.31692	2.64934	23/08/2019 22:11	79.31692	2.64939	3235	Dan	Deployed to 200m. Samples for NOCS
Bongo054	D7	137	23/08/2019 22:15	79.31691	2.64938	23/08/2019 22:19	79.31691	2.64935	23/08/2019 22:34	79.31691	2.64938	3235	Dan	Deployed to 200m. Samples for NOCS
CTD039	D7	138	23/08/2019 23:13	79.31693	2.64927	24/08/2019 00:17	79.31693	2.64929	24/08/2019 02:49	79.31697	2.64902	3235	Jo	Physics
CTD040	D7	139	24/08/2019 03:58	79.31695	2.6491	24/08/2019 04:09	79.31695	2.64906	24/08/2019 04:41	79.31695	2.64904	3235	Jo	Deployed to 200m. Samples for PETRA
CTD041	D7	140	24/08/2019 06:12	79.31695	2.64918	24/08/2019 06:22	79.31693	2.64915	24/08/2019 06:40	79.31693	2.64917	3235	Jo	Deployed to 100m. Samples for PETRA

Mocness025	D7	141	24/08/2019 07:00	79.31199	2.62098	24/08/2019 08:04	79.28943	2.48902	24/08/2019 09:38	79.26016	2.244		Geraint/Gabi	Deployed to 1886m
Bongo055	D7	142	24/08/2019 10:38	79.31661	2.64985	24/08/2019 10:44	79.31661	2.64983	24/08/2019 11:00	79.31662	2.64982	3235	Claudia	Deployed to 200m. Samples for Claudia
Mocness026	D7	143	24/08/2019 11:20	79.31263	2.64699	24/08/2019 12:23	79.2785	2.60359	24/08/2019 13:55	79.22978	2.5351		Geraint/Gabi	Deployed to 1865m
Mammoth022	D7	144	24/08/2019 14:40	79.31789	2.65245	24/08/2019 16:13	79.31676	2.65029	24/08/2019 18:25	79.31675	2.65058		Geraint/Gabi	Deployed to 2700m
CTD042	D8	145	25/08/2019 00:33	78.41663	6.99986	25/08/2019 00:38	78.41664	6.99984	25/08/2019 00:55	78.4166	6.99984	3362	Jo	Deployed to 50m. Samples for NOCS
Bongo056	D8	146	25/08/2019 01:19	78.41659	6.99994	25/08/2019 01:23	78.4166	6.99994	25/08/2019 01:39	78.4166	7.00003	3362	Dan	Deployed to 200m. Samples for NOCS
Bongo057	D8	147	25/08/2019 01:43	78.41659	7	25/08/2019 01:48	78.4166	7.00001	25/08/2019 02:05	78.41661	6.99995	3362	Dan	Deployed to 200m. Samples for NOCS
CTD043	D8	148	25/08/2019 02:48	78.41662	6.99995	25/08/2019 03:51	78.41663	6.99995	25/08/2019 05:26	78.41661	6.99999	3362	Jo	Physics
Mocness027	D8	149	25/08/2019 05:43	78.41261	6.98566	25/08/2019 06:50	78.37767	6.90161	25/08/2019 08:24	78.32231	6.80932		Geraint/Gabi	Deployed to 1886m
Bongo058	D8	150	25/08/2019 09:27	78.41667	7.00041	25/08/2019 09:32	78.41667	7.00038	25/08/2019 09:54	78.41666	7.00044	3362	Claudia	Deployed to 200m. Samples for Claudia
Mocness028	D8	151	25/08/2019 10:11	78.4137	6.99313	25/08/2019 11:22	78.38058	6.88534	25/08/2019 13:02	78.31403	6.76789		Geraint/Gabi	Deployed to 2052m
Mammoth023	D8	152	25/08/2019 13:57	78.41694	7.00002	25/08/2019 15:27	78.41696	7.00003	25/08/2019 17:43	78.41693	6.99997		Geraint/Gabi	Deployed to 2700m
CTD044	D9	153	25/08/2019 21:32	77.71672	7.58313	25/08/2019 21:37	77.71672	7.58307	25/08/2019 21:54	77.71671	7.58305	3539	Jo	Deployed to 50m. Samples for NOCS
Bongo059	D9	154	25/08/2019 22:19	77.71673	7.58312	25/08/2019 22:24	77.71671	7.58311	25/08/2019 22:41	77.71671	7.58309	3539	Dan	Deployed to 200m. Samples for NOCS
Bongo060	D9	155	25/08/2019 22:45	77.71672	7.58305	25/08/2019 22:50	77.71671	7.58308	25/08/2019 23:06	77.71672	7.58315	3539	Dan	Deployed to 200m. Samples for NOCS
CTD045	D9	156	25/08/2019 23:45	77.71672	7.58316	26/08/2019 00:50	77.71672	7.58305	26/08/2019 03:10	77.71671	7.58312	3539	Jo	Physics
Mocness029	D9	157	26/08/2019 03:35	77.71381	7.57116	26/08/2019 04:43	77.68269	7.46505	26/08/2019 06:20	77.63372	7.3538		Geraint/Gabi	Deployed to 1944m
Mocness030	D9	158	26/08/2019 07:08	77.71312	7.56619	26/08/2019 08:20	77.67884	7.41825	26/08/2019 10:07	77.62452	7.22797		Geraint/Gabi	Deployed to 2158m
Mammoth024	D9	159	26/08/2019 11:09	77.71703	7.58192	26/08/2019 12:45	77.71662	7.58338	26/08/2019 14:56	77.7166	7.58338		Geraint/Gabi	Deployed to 2700m
CTD046	D10	160	26/08/2019 21:23	77.46681	13.49352	26/08/2019 21:26	77.46682	13.49351	26/08/2019 21:49	77.46682	13.49353	211	Jo	Physics
Bongo061	D10	161	26/08/2019 22:08	77.4668	13.49348	26/08/2019 22:13	77.46679	13.49343	26/08/2019 22:23	77.4668	13.49348	211	Dan	Deployed to 150. Samples for NOCS
Bongo062	D10	162	26/08/2019 22:27	77.4668	13.4935	26/08/2019 22:32	77.46678	13.49348	26/08/2019 22:43	77.4668	13.49347	211	Dan	Deployed to 150. Samples for NOCS

CTD047	D10	163	26/08/2019 23:15	77.4668	13.4936	26/08/2019 23:22	77.46681	13.4936	26/08/2019 23:45	77.46683	13.49358	211	Jo	Deployed to 200m. Samples for PETRA
CTD048	D10	164	27/08/2019 01:04	77.46681	13.49359	27/08/2019 01:13	77.46678	13.49359	27/08/2019 01:33	77.46681	13.49362	211	Jo	Deployed to 100m. Samples for PETRA

19. Cruise summary report

CRUISE SUMMARY REPORT	FOR COLLATING CENTRE USE **Centre: BODC Ref. No.:** Is data exchange ☐ ☐ ☐ restricted Yes In part No

SHIP enter the full name and international radio call sign of the ship from which the data were collected, and indicate the type of ship, for

example, research ship; ship of opportunity, naval survey vessel; etc.

Name: RRS James Clark Ross **Call Sign: ZDPL**

Type of ship: Research

enter the unique number, name or acronym assigned to the cruise (or cruise leg, if appropriate).

CRUISE NO. / NAME JR18007

CRUISE PERIOD start 04 /08/ 2019 to / / 2019 end

(set sail) **day/ month/ year** **day/ month/ year** **(return to port)**

PORT OF DEPARTURE (enter name and country) **Aberdeen, United Kingdom**

PORT OF RETURN (enter name and country) **Aberdeen, United Kingdom**

RESPONSIBLE LABORATORY enter name and address of the laboratory responsible for coordinating the scientific planning of

the cruise

Name: David Pond

Address: Stirling University

Country: United Kingdom

CHIEF SCIENTIST(S) enter name and laboratory of the person(s) in charge of the scientific work (chief of mission) during the cruise.

David Pond, Stirling University

OBJECTIVES AND BRIEF NARRATIVE OF CRUISE enter sufficient information about the purpose and nature of the cruise so as to provide the context in which the report data were collected.

DIAPOD: examining how the biomass dominant marine zooplankton taxon *Calanus* will be affected by future climate change in the Arctic through synthesising past datasets of *Calanus* in the Arctic alongside satellite-derived data on primary production to examine whether smaller, more temperate species have been increasingly colonising of Arctic. Furthermore, it will consider how the timing of life-cycle events may have changed over past decades and between different Arctic regions.

The focus of JR18007 was the Fram Strait, where deep basins coincide with seasonal sea-ice generating ideal conditions for *Calanus* to accumulate large fat stores and enter diapause in deep ocean layers. At each station, there was a series of activities to address the objectives of DIAPOD. Specifically, a series of nets (including Bongo, MOCNESS, Hydrobios opening and closing nets and ring nets) were deployed to different depth horizons to study the depth distribution of *Calanus* and collect specimens. Furthermore, physiological experiments were carried out to assess rates of ingestion, turn-over and respiration. Chl-a and phytoplankton samples were collected to ground-truth corresponding satellite images of surface productivity. *Calanus* samples were also collected to assess body condition and feeding history through stable isotope analysis

PETRA: investigating the impact of three stressors (temperature, ocean acidification and elevated irradiation) on the production and consumption of the climatically active gases nitrous oxide (N_2O), methane (CH_4), dimethyl sulphide (DMS) and carbon monoxide (CO) in the marine environment.

As part of JR18007, PETRA carried out six incubation experiments, at selected locations ranging from Atlantic to Arctic waters with contrasting sea ice conditions. To characterize each station over down to (~100m), discrete samples of CO, DMS, N_2O, CH_4, pH, CDOM (colored dissolved organic matter), pigments and DNA (functional genes for DMS and N cycling) were taken

Micro-ARC: focussing on understanding of how short-term (e.g. seasonal) and long-term (e.g. climate-driven) changes in the physical environment of the Arctic Ocean are impacting pelagic microbial ecosystems and how these affect current and future organic matter (OM) biogeochemistry.

As part of JR18007, Micro-ARC carried out sampling and protocols (1) to determine the abundance and size distribution of microgels; (2) to extract DNA and RNA of the water column and on microgels; (3) to sample for fungi cultivation in the water column; (4) to sample for phospholipid fatty acid (PLFA); and (5) to incubate $^{12}C/^{13}C$-labelled TEP.

CHASE: investigating the behaviour, physiology and genetic responses of copepods and krill to their natural and new photoperiodic environments, with a focus on the circadian biological clock, central in day-length measurement and in orchestrating key seasonal life-cycle events.

For JR18007, CHASE collected community samples seasonal gene expression analysis over two separate 36-hour stations; carried out *Calanus* copepod swimming behaviour experiments using Trikinetics Locomotor Activity Monitors (LAMS); conducted copepod respiration experiments to provide a physiological correlate to rhythmic activity measurements made on individual *Calanus* copepods; and performed northern krill swimming behaviour experiments.

PROJECT (IF APPLICABLE) if the cruise is designated as part of a larger scale cooperative project (or expedition), then enter the name of the project, and of organisation responsible for co-ordinating the project.

Project name: DIAPOD

Coordinating body: Stirling University

PRINCIPAL INVESTIGATORS: Enter the **name**, **organisational affiliation** and **email address** of the Principal Investigators responsible for the data collected on the cruise and who may be contacted for further information about the data. (The letter assigned below against each Principal Investigator is used on pages 2 and 3, under the column heading 'PI', to identify the data sets for which they are responsible)

David Pond (Stirling Uni)

Anna Belcher (BAS)

Patrick Downes (PML)

Andy Rees, PML

Jo Dixon, PML

Zara Botterel, PML

Claudia Catellani, PML

Tim Brand, SAMS

Birthe Zaencker, MBA

Hanna Campen, GEOMAR

Holly Jenkins, Univerisity of Southampton

Florence Atherton, Univerisity of Southampton

Jordan Grigor, SAMS

Joana Beja, BODC

Gabriele Stowasser, BAS

Geraint Tarling, BAS

Dan Mayor, NOC

MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS

This section should be used for reporting moorings, bottom mounted gear and drifting systems (both surface and deep) deployed and/or recovered during the cruise. Separate entries should be made for each location (only deployment positions need be given for drifting systems). This section

may also be used to report data collected at fixed locations which are returned to routinely in order to construct 'long time series'.

PI	APPROXIMATE POSITION						DATA TYPE	DESCRIPTION
	LATITUDE			LONGITUDE				Identify, as appropriate, the nature of the instrumentation the parameters (to be) measured, the number of instruments and their depths, whether deployed and/or recovered, dates of deployments and/or recovery, and any identifiers given to the site.
See top of page.	deg	min	N/S	deg	min	E/W	enter code(s) from list on last page.	
								Please continue on separate sheet if necessary

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

Except for the data already described on page 2 under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the cruise, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls).

Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) BT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc.

Each data set entry should start on a new line – it's description may extend over several lines if necessary.

NO, UNITS : for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

PI see page 2	NO see above	UNITS see above	DATA TYPE Enter code(s) from list on last page	DESCRIPTION Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
A	18	stations	B03, B72	CTD water samples for fatty acids, pigments and lugols
A	29	Hauls	B09	Net hauls for zooplankton and grazing data, species composition
B	16	stations	B10	CTD water samples for chlorophyll determination at 2 depths in the water column (chl maximum and surface)
C	6	stations	B01, B07, B90, H24, H25, H26, H76,	CTD water samples for primary productivity, bacterial productivity, extracellular enzyma activity, and nutrients
D	6	stations	H27, H90, B90, B02, B71	CTD water samples for Alkalinity, carbonate system, DNA, pigments, DOC determination, trace gases
F	6	stations	B09, P13	CTD water samples for zooplankton community compositon and microplastics

E	6	stations	H33, B90	CTD water samples for DMS and molecular DNA
G	8	Net hauls	B09	Net hauls for zooplankton experiments
H	15	stations	H24, H25, H26, H76	CTD water samples for macronutrient determination
I	13	stations	B07, B72	CTD water samples for Biogenic gels and microbial community
J	6	stations	H33, B06, B02, B90	CTD water samples for CO, DMS, CDOM, DNA, pigments
K	21	stations	B03	CTD water samples for copepod grazing incubations
K	5	Net hauls	B09	Net hauls for copepod grazing incubations
L	21	Net hauls	B13	Net hauls for egg production determination
L	5	stations	B09	CTD water samples for TLC (Tauring lipids)
M	21	Net hauls	B09	Net hauls for circadian rythm experiments
N	34	days	H71, M90	Navigation, bathymetry, meteorological and surface hydrography continuous measurements
N	48	stations	H10	48 CTD casts: pressure, temperaturem salinitym conductivity, PAR, fluorometry, beam transmission, beam attenuation
O	9	stations	H32	CTD water samples for stable isotope analysis
O	8	Net hauls	B09	Net hauls for zooplankton
P	11	Net hauls	B09	Net hauls for biomass dominance of calanus species through different depth stratta, lipid sac volumes
Q	20	Net hauls	B72	Net hauls for metabolomics
				Please continue on separate sheet if necessary

TRACK CHART: You are strongly encouraged to submit, with the completed report, an annotated track chart illustrating the route followed	Insert a tick(✔) in	☐

and the points where measurements were taken.	**this box if a track chart is supplied**	

GENERAL OCEAN AREA(S): Enter the names of the oceans and/or seas in which data were collected during the cruise – please use commonly recognised names (see, for example, International Hydrographic Bureau Special Publication No. 23, 'Limits of Oceans and Seas').

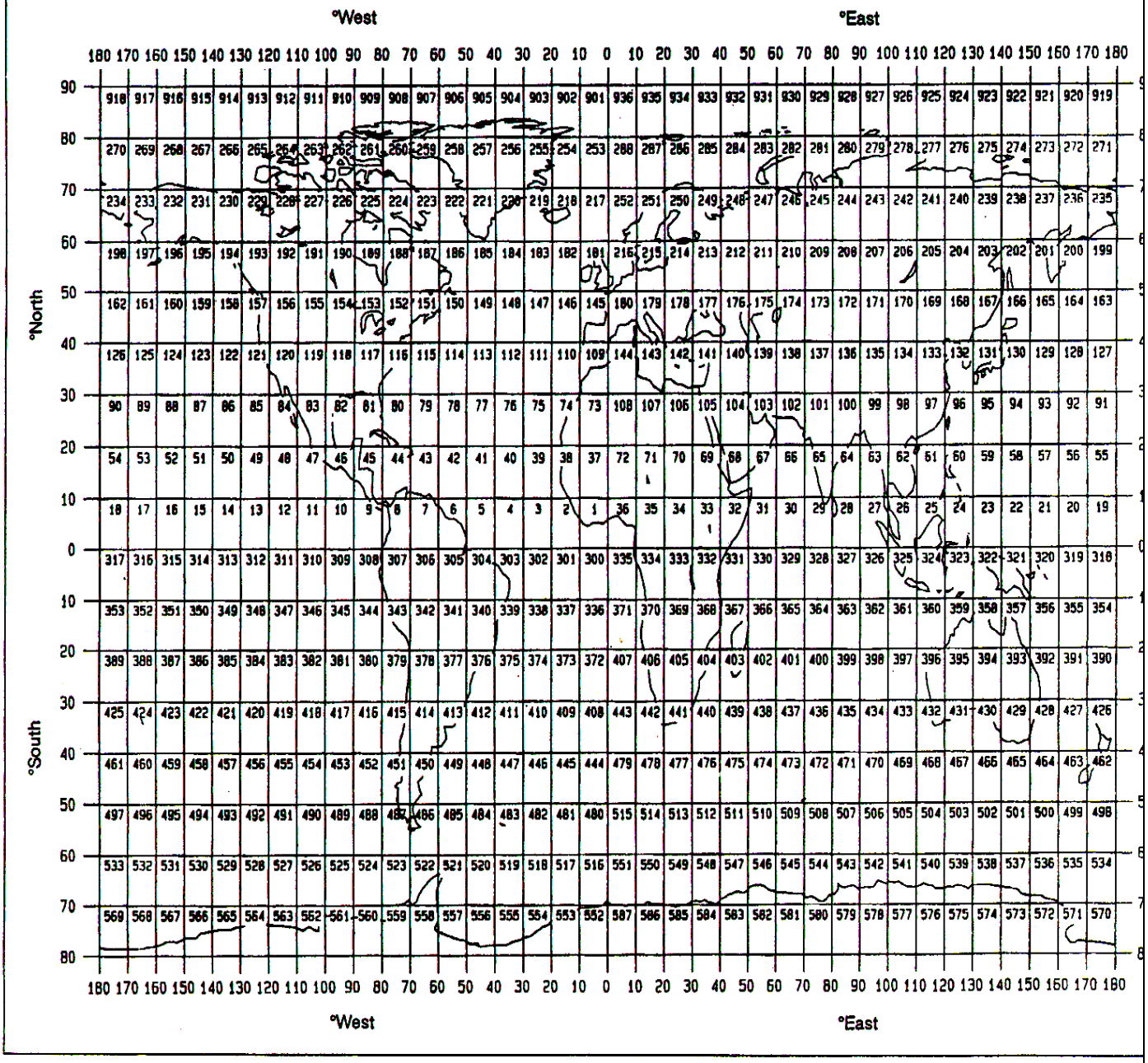
SPECIFIC AREAS: If the cruise activities were concentrated in a specific area(s) of an ocean or sea, then enter a description of the area(s). Such descriptions may include references to local geographic areas, to sea floor features, or to geographic coordinates.

Please insert here the number of each square in which data were collected from the below given chart

Fram Strait (253, 254, 288)

see above

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED



PARAMETER CODES

METEOROLOGY

M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

PHYSICAL OCEANOGRAPHY

H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

CHEMICAL OCEANOGRAPHY

H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

MARINE CONTAMINANTS/POLLUTION

P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

MARINE BIOLOGY/FISHERIES

B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

MARINE GEOLOGY/GEOPHYSICS

G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements