JR15002 Cruise Report

Western Core Box Survey

6th November 2015 – 15th December 2015

British Antarctic Survey Cruise Report

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

1. Introduction

Gabriele Stowasser

1.1 Rationale

JR15002 is a combined science and logistics leg of the 2015-16 voyage of the RRS James Clark Ross to the Antarctic. As part of the logistics element, the ship undertook base reliefs at Signy (South Orkneys), Bird Island (South Georgia) and King Edward Point (South Georgia). During the science part of the cruise we undertook the Western Core Box survey to determine the distribution and biomass of krill and other plankton to the northwest of South Georgia, refurbished 2 biological moorings in the South Georgia region, undertook a series of time stations across the Scotia Sea which provided a focus for collaborative studies with scientists from the UK and the USA. Included in this cruise were 2 activities funded under the Collaborative Gearing Scheme (CGS). Unlike many previous combined science and logistic legs, JR15002 mixed science and logistics throughout to minimize the revisiting of locations and hence minimize time and total mileage steamed. Thus after leaving Stanley (Falkland Islands) the ship undertook the following main blocks of work:

1. Test station en route to Signy
2. Signy base relief
3. CTDs at three stations en route to Bird Island (section 7)
4. Mooring recovery at P2 Southern Mooring Station en route to Bird Island (section 4)
5. Bird Island base relief
6. King Edward Point base relief
7. Stromness Acoustic Calibration (section 3)
8. Mooring recovery at P3 Northern Mooring Station and time station sampling (sections 4 and 6)
9. Bird Island base relief (remainder of work)
10. Time station and mooring refurbishment at P2 Southern Mooring Station (sections 4 and 6)
11. Western Core Box Survey (section 5)
12. Time station and mooring refurbishment at P3 Northern Mooring Station (sections 4 and 6)
13. Time station at Upwelling Station (NW of South Georgia)(section 6)

1.2 Western Core Box Summary

Since 1981 BAS have undertaken cruises to determine krill biomass as part of the ongoing assessment of the status of the marine ecosystem in the region of South Georgia. This unique time series, known as the Western Core Box, is part of the Ecosystems Programme contribution to BAS national capability. It comprises an acoustic grid survey of 8 transects each of 80 km in length, together with associated net and oceanographic sampling and the calibration of acoustic instrumentation. In addition to the acoustic survey, which covers a wide area but has limited temporal coverage, there are two moorings (In deep water to the southwest and northwest of South Georgia) to provide a temporal, year-round set of observations. These moorings are recovered during the cruise, refurbished and data downloaded, and then re-deployed later in the cruise.

1.3 Time Station Summary

This year a series of 3 time stations to investigate diel changes in distribution and production of the lower trophic levels of the pelagic food-web were planned and provided a focus for much of the collaborative work being undertaken on this cruise. For each station the overall structure of the sampling was based around a set of 4 oblique zooplankton net hauls centred on the cardinal times of midday, midnight, morning and evening (MOCNESS and MAMMOTH, all with respect to local noon) and 2 zooplankton hauls set above and below the thermocline at sunrise and sunset (Net traps). Other activities such as CTDs, water sampling and vertical netting (Bongos, WP2) were interspersed between the oblique netting. In addition at stations P2 and P3, the time station incorporated refurbishment of the deep water moorings.

1.4 Collaborative Gearing Scheme (CGS) Summary

Two CGS projects have been incorporated into cruise JR15002:

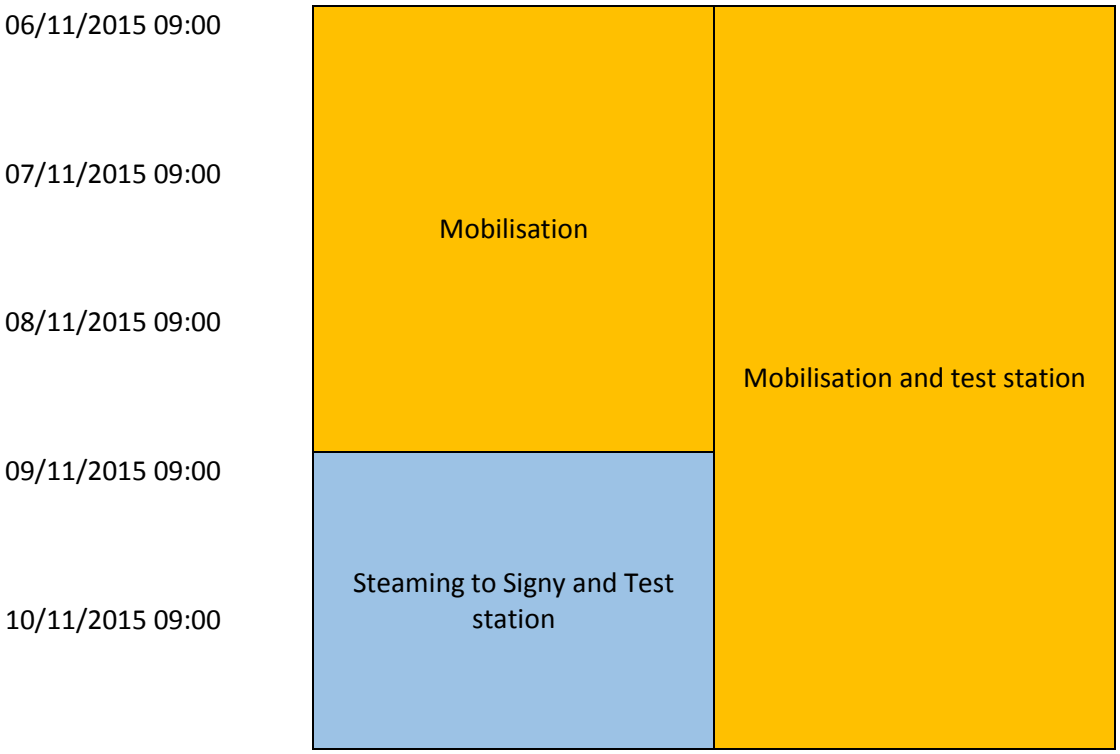
• Characterising the modern distribution of oceanographic properties and marine microbiota north-west of South Georgia, and reconstructing recent (ca. 200 yrs) climatic and environmental changes in the same region (CGS 112; section 8)

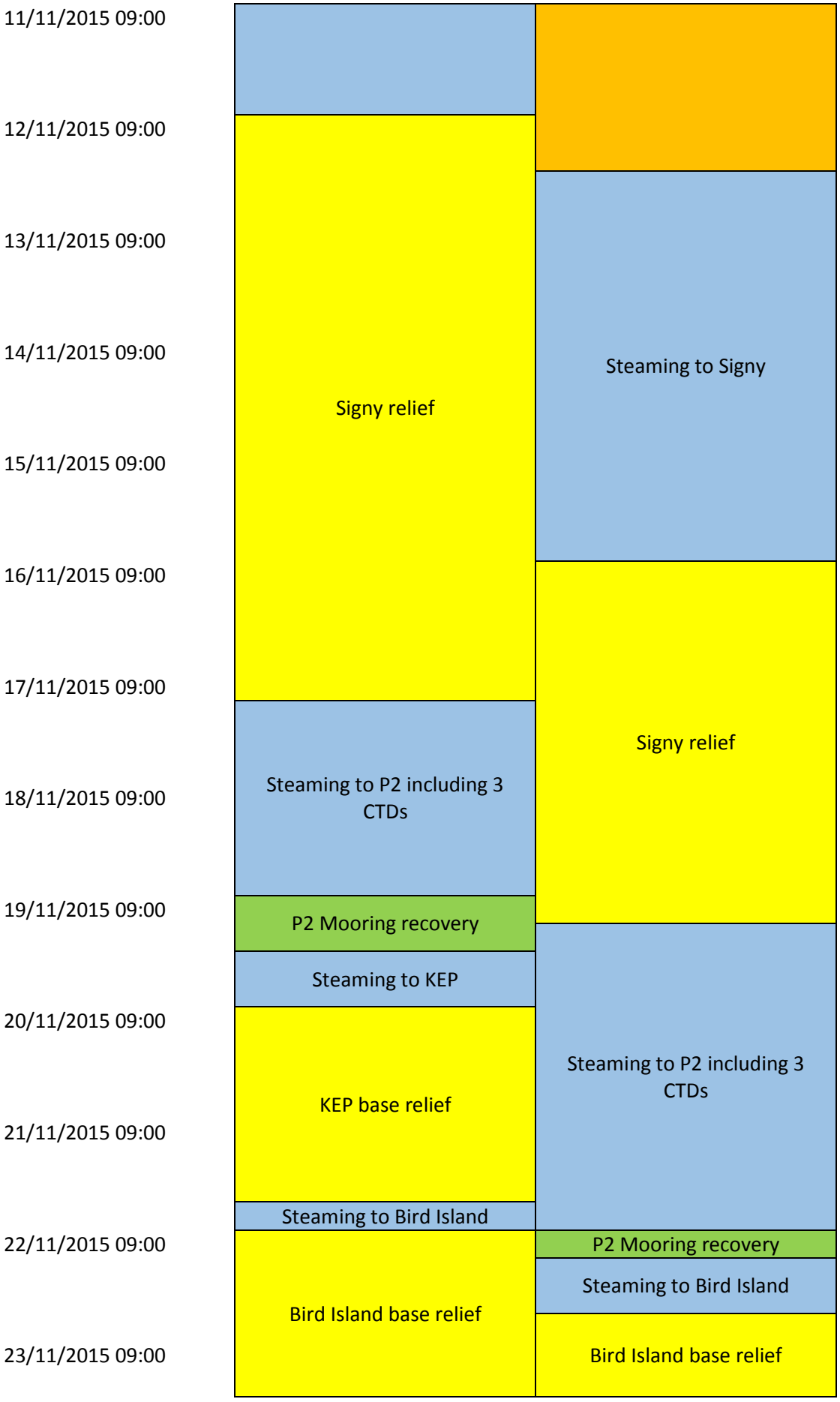
• Intertidal algae and Infauna. A functional group approach to ecosystem services (CGS 119; section 8)

1.5 Cruise Timings Planned vs Actual

In relation to the ship's original itinerary the ship was delayed in sailing by 3 days due to personnel issues that required a new member of crew to be flown out from the UK. There were also delays in re-fuelling at Mare Harbour. To compensate an additional 2 days of time were added during the cruise to the overall itinerary. Once at sea, a combination of weather and work required at Bird Island meant that effectively 3 days were used compared with 2 days allocated on the original itinerary. However, relief work went well in Signy and this together with the allocation of 2 extra days from Cambridge meant that overall we lost 1 day of science to logistics. While the science element will always be at risk of logistic overruns in these combined cruises it should be appreciated that by combining these two elements re-organizing and interleaving of the science and logistics can be continually re-assessed during the cruise to make the most efficient overall use of time.

Table 1.1: Breakdown of planned and actual activity times and organisation during cruise JR15002

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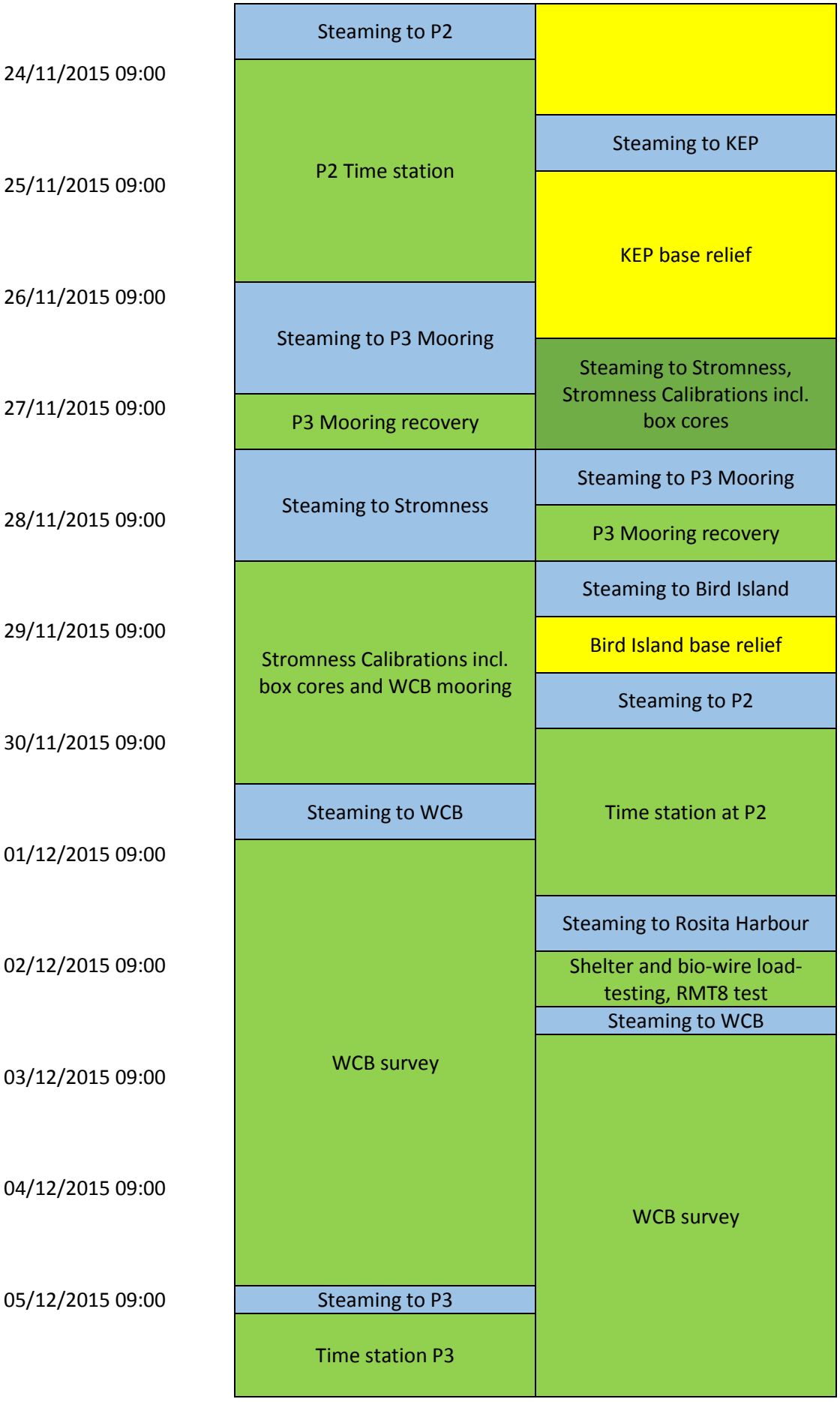
Signy relief
Steaming to P2 including 3 CTDs
P2 Mooring recovery
Steaming to KEP
KEP base relief
Steaming to Bird Island
Bird Island base relief
Steaming to Signy
Signy relief
Steaming to P2 including 3 CTDs
P2 Mooring recovery
Steaming to Bird Island
Bird Island base relief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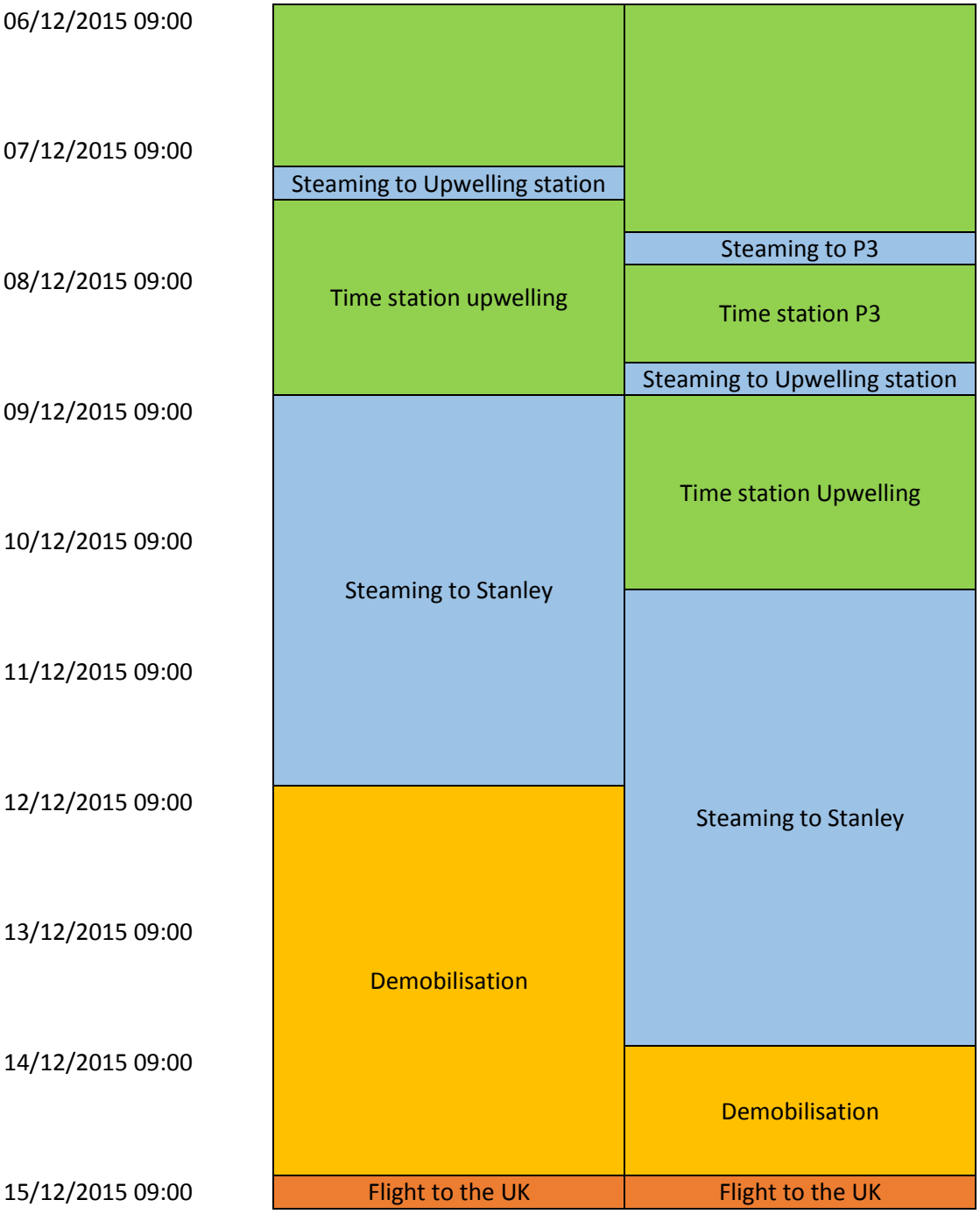
05/12/2015 09:00
Steaming to P2
P2 Time station
Steaming to P3 Mooring
P3 Mooring recovery
Steaming to Stromness
Stromness Calibrations incl. box cores and WCB mooring
Steaming to WCB
WCB survey
Steaming to P3
Time station P3
Steaming to KEP
KEP base relief
Steaming to Stromness, Stromness Calibrations incl. box cores
Steaming to P3 Mooring
P3 Mooring recovery
Steaming to Bird Island
Bird Island base relief
Steaming to P2
Time station at P2
Steaming to Rosita Harbour
Shelter and bio-wire load-testing, RMT8 test
Steaming to WCB
WCB survey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13/12/2015 09:00
14/12/2015 09:00
15/12/2015 09:00
Steaming to Upwelling station
Time station upwelling
Steaming to Stanley
Demobilisation
Flight to the UK
Steaming to P3
Time station P3
Steaming to Upwelling station
Time station Upwelling
Steaming to Stanley
Demobilisation
Flight to the UK

1.6 Cruise Narrative JR15002 (all times given are local)

05. November 2015 (Thursday)

A small science party (6 staff) left Brize Norton at 08:00 to fly to the Falkland Islands. We arrived at Midnight local time on the 6th and were transferred to our overnight accommodation.

6. November 2015 (Friday)

Our science party joined the ship at 14:00 to start mobilisation of JR15002. The PSO inspected the Lab spaces and found boxes from the AMT cruise in the cold room (+4C) occupying space that will be needed for experiments conducted during our cruise. The PSO of the AMT cruise was contacted and the issue is under investigation.

07. November 2015 (Saturday)

Both containers were lifted on board at 08:00 and the science party started unpacking and assemble scientific gear. At the end of the working day one container, holding gear for cruise JR15004 and empty boxes was lifted off to be stored at FIPASS until our return. The remaining container will stay on board to house mooring equipment needed on this cruise. All boxes were transferred to appropriate Labs to be emptied the following day. The remainder of the science party and base personnel did arrive in the afternoon.

08. November 2015 (Sunday)

Mobilisation of scientific gear and laboratory spaces continued and was almost finished at the end of the day. Samples collected on the AMT cruise could, for the duration of our cruise, be stored in one of the Chemical lockers thus freeing up space needed for conducting incubation experiments. The PSO did an inspection and handover of laboratory spaces with the Chief Officer.

09. November 2015 (Monday)

The re-packing of the container was finished at lunchtime. The ship set sail at 19:00 to commence re-fuelling at Mare Harbour in the morning. The PSO was informed that due to a crew member being declared unfit for duty by BASMU on the 9th we would have to wait for the incoming MOD flight on Thursday 12th to replace said crew member.

10. November 2015 (Tuesday)

The ship came alongside at 09:00 at Mare Harbour but could not commence fuelling before 13:30 due to fuelling problems of the Pharos. Fuelling finished for the day atl 20:00. The science party prepared scientific gear for a trial station planned for the 11. November.

11. November (Wednesday)

Fuelling commenced again at 08:00 and finished at 12:30. We set sail at 13:30 and made our way out to the 50m contour, where we conducted our test station. The CTD was tested first. The communication of the CTD with the deck unit did not work and we moved on to successfully test the MAMMOTH net.

12. November (Thursday)

We re-started our test station at 08:00 and tested the CTD, WP2 zooplankton net and the downward and upward-facing net traps. All systems worked well and the test station was concluded at 11:00. We then made our way back to Stanley and went alongside at FIPASS to wait for an additional crew member to join us in the evening. We set sail at 21:00 to make our way to Signy.

13. November (Friday)

Passage to Signy.

14. November (Saturday)

Passage to Signy

15. November (Sunday)

We reached the sea ice margin early afternoon and made slow progress through thick sea-ice for the remainder of the day.

16. November (Monday)

Arrival at Signy early afternoon. The Bay was clear of ice but the cove was still covered in fast ice. The Signy crew went to explore the options of carrying out base relief along the coast.

17. November (Tuesday)

Base relief started early in the morning and continued all day. All cargo apart from food and bond could be delivered to the station.

18. November (Wednesday)

Due to strong northerly winds overnight ice was blown into the bay and no relief work could be carried out.

19. November (Thursday)

The remainder of cargo could be delivered early in the morning and all technical support from people off the JCR was finished by 14:00. JCR set sail at 16:00 heading for our first science station (C2) to the north of Coronation Island.

20. November (Friday)

The first science station (C2) was reached at 11:00. We carried out one CTD to 1000m. All systems worked fine. Breaking through ice the whole day we reached our second science station (C3) 33 nM from C2 at 22:00. We carried out 1 CTD to 1000m, 3 Bongo nets and 1 WP2 net. The CTDs and the Bongos worked fine, the WP2 net was deployed to 400m and recovery was difficult due to wire length and drum size incompatibilities. The crew will try to resolve this issue before the next deployment.

21. November (Saturday)

We arrived at the science station (C4) at 10:00. We carried out a CTD (1000m) and 3 Bongos. All systems worked fine. We moved off station at 12:00 to continue to P2 for mooring recovery.

22. November (Sunday)

We arrived at station P2 at 07:00 and started mooring recovery in good weather, low sea state at 08:00. The recovery of the mooring worked well and was finished at 11:00. Several mooring instruments were found to be heavily damaged by pressure. Analysis of ADCP data showed that the strong current present at this station in May submerged the buoy to below 1000m. After recovery a full depth CTD (~3200m) and 3 Bongos were carried out. We moved off station at 15:00 en route to Bird Island.

23. November (Monday)

We arrived at Bird Island at 05:00. The wind was too strong to do any relief work and we were forced to seek shelter off South Georgia.

24. November (Tuesday)

The Bird Island personnel plus two FIDs (Joe Meddle and Rod Strachan) were dropped off on Bird Island by humber early in the morning. Relief work started after lunch and continued until the onset of darkness. Rod Strachan re-joined the ship and we then left for KEP.

25. November (Wednesday)

Relief work at KEP started at 11:00 and we finished for the day at 18:00.

26. November (Thursday)

Relief work started at 8am and finished at 19:00. We set sail at 20:00 to Stromness for calibration work. Work started with a brief swath survey at the entrance to Stromness Harbour. Calibration work started at 22:00 and was continued through the night to 03:00.

27. November (Friday)

We finished work in Stromness Harbour at 16:00. We set sail to carry out several box cores on our way to station P3 to recover the deep water mooring.

28. November (Saturday)

Mooring recovery at P3 started at 08:00 and was finished by 11:00. We carried out several Bongo and WP2 hauls and set sail to Bird Island at 18:00 in order to finish relief work.

29. November (Sunday)

We started relief work at 7:00 and finished at 19:00. We proceeded to station P2 to start our first 36 hour process station.

30. November (Monday)

Station work at P2 started at 10:00 and continued throughout the night. Most instruments worked well and we were able to stay within our time plan. Some WP2 hauls had to be repeated due to issues with the net.

01. December (Tuesday)

Station work at P2 continued until 21:00 and all planned work could be carried out. We moved off to the start of the Western Core Box at 6am the next morning.

02. December (Wednesday)

We started the first leg of the Western Core Box at 6am this morning but had to break off due to bad weather conditions. We sought shelter in Rosita Harbour in order to carry out load-testing on the bio-wire. We carried out a test deployment of the RMT8 in the Bay of Islands in order to familiarise the nightshift crew and scientists with the instrument. We left the Bay of Islands at 19:00 to carry out a CTD and Bongo at box core station 2. The mid-ships gantry developed problems and we had to call off any station work at 21:00.

03. December (Thursday)

The first acoustic transect W 1.2S was started at 6am in very calm conditions. Fishing commenced at 18:00 with an oblique haul at the Southern end of the transect. Target fishing was unsuccessful during the night due to a lack of targets.

04. December (Friday)

The acoustic transect started at 6:30. Weather conditions worsened during the day to winds up to 30kn. Both CTDs were carried out but the swell and wind were too strong to do any RMT nets.

05. December (Saturday)

The weather was still too marginal to do any fishing. The acoustic transects as well as the CTDs were carried out.

06. December (Sunday)

Acoustic transects were carried out during the day and target fishing for krill during the night.

07. December (Monday)

The weather improved considerably and we were able to carry out 3 of the oblique hauls cancelled on previous days. The rest of the night was spent on target fishing for krill. Break-off was midnight and we set sail for station P3 to deploy our deep-water mooring and start our 36 hour station work.

08. December (Tuesday)

We started at 10:00 with station work at P3. The mooring was deployed successfully and we continued with netting throughout the night.

09. December (Wednesday)

Early in the morning on the 9th Dec. the main winch running the bio-wire unravelled and we could not deploy any further gear off the aft deck. This meant that the daylight oblique zooplankton hauls (MOCNESS, Mammoth) had to be cancelled. We broke off station work at P3 at 05:00 and set sail to the Upwelling Station where we started work at 8:00 with a full depth CTD to 3680m. We continued station work from the side gantry (Bongos, WP2, Net trap) until the early afternoon when we had to stop due to bad weather. We came off DP at 20:00 to go hove-to to the weather until early next morning.

10. December (Thursday)

Science started at 08:00 when a weather window opened up and continued until 15:00 when the wind became too strong to do any more netting. Another weather window opened up at in the early evening and we continued work. Science for cruise JR15002 finished at 21:00 and we started our journey back to Stanley with ETA set at 07:00 on the

14th December.

11. December – 13. December (Friday to Sunday)

These passage days were spent with finishing experiments, packing samples and boxes and preparing documentation for submission at the end of the cruise (post-cruise assessment (BAS), cruise summary report (BDOC) and cruise report (BAS))

14. December (Monday)

We went alongside FIPASS at 08:00 and started demob at 09:00. Although the weather was rough on the journey home we managed to pack up most of our boxes. The opportunity to store a variety of instruments in their assembled state in the Science hold aft for our next cruise in January (JR15004) made it possible to finish demob at 17:00. Otherwise the time for demob would have been too short.

1.7 Cruise Track

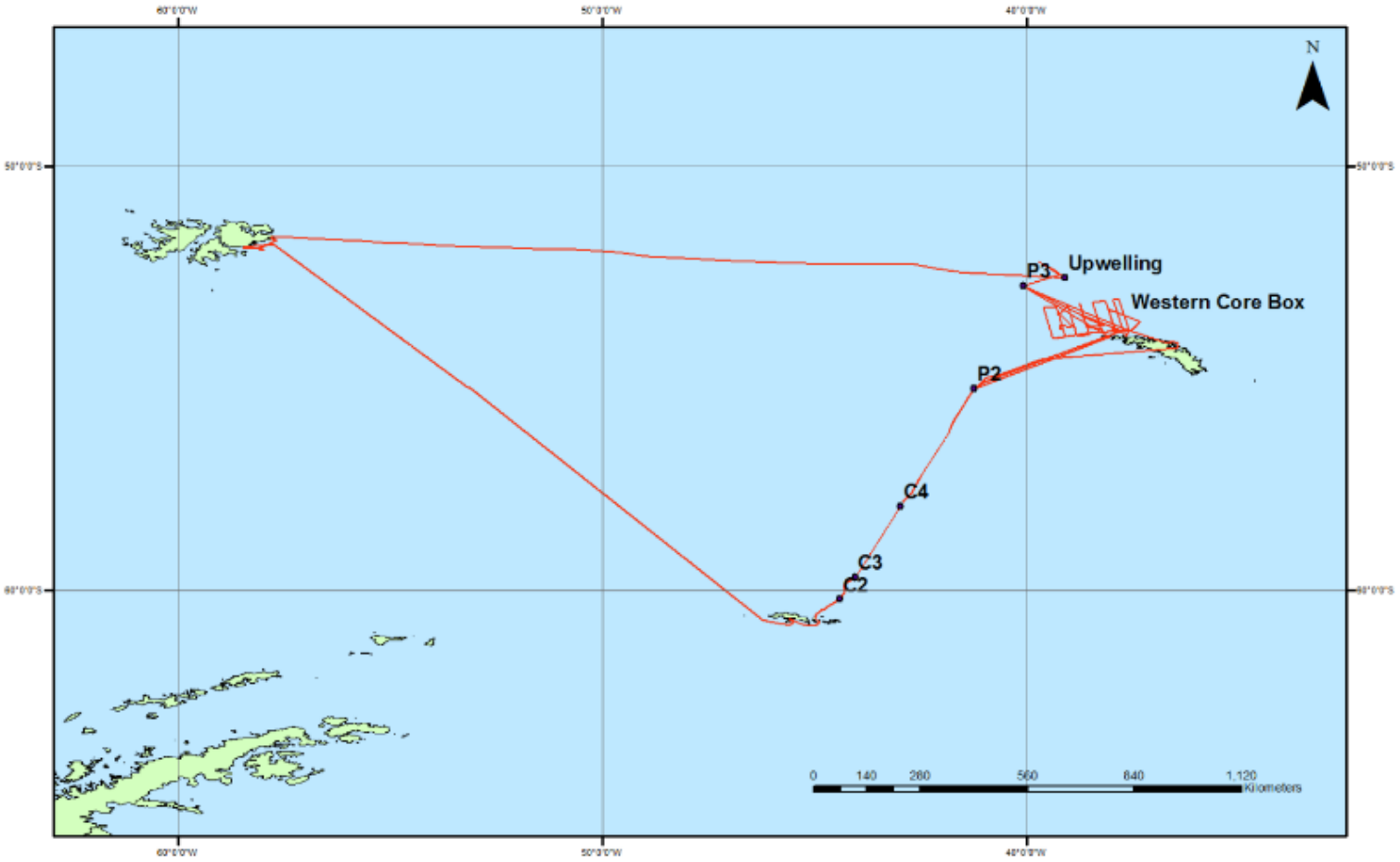


Fig. 1.1 Cruise track of JR15002

1.8 Cruise Event Summary

Table 1.2: Summary of station work on JR15002. Events are listed with dates according to GMT (Bridge event log)

Dates	Events	Station	Activities	Comments
11.11-12.11.2015	1-9	Test station	CTD, MAMMOTH, Net traps, WP2s, Bongos	Test station
20.11.2015	10	C2	CTD	On transect Signy to P2 Southern Mooring Station
21.11.2015	11-18	C3, C4	CTDs, Bongos, WP2s	On transect Signy to P2 Southern Mooring Station
22.11.2015	20-24	P2	CTD, Mooring recovery, Bongos	P2 Southern Mooring station
26.11-27.11.2015	25-26	Stromness Harbour	Swath survey, Acoustic calibration, CTD	
27.11-28.11.2015	27-30		Box corer	Transect SG to P3 Northern Mooring Station
28.11.2015	31-39	P3	CTD, Mooring recovery, Bongos, WP2s	P3 Northern Mooring Station
30.11-01.12.2015	40-70	P2	Mooring deployment, CTD, net traps, MOCNESS, MAMMOTH, WP2s, Bongos	Time station work at P2 Southern Mooring Station
02.12.2015	71	Rosita Harbour	Test deployment RMT8	
03.12-08.12.2015	72-113	WCB	XBTs, CTDs, RMT8s	Western Core Box survey
08.12-09.12.2015	114-135	P3	Mooring deployment, CTD, Bongos, MAMMOTH, WP2s	Time station work at P3 Northern Mooring Station
09.12-10.12.2015	136-161	Upwelling	CTD, WP2s, Bongos, Net traps	Upwelling station north-east of P3

1.9 Personnel

Table 1.3: JR15002 Scientific and in-transit personnel

JR15002 cruise personnel		
Gabriele Stowasser	BAS	PSO/ Marine Ecologist
Sarah Chapman	BAS	Data Manager
Rowan Dejardin	University of Nottingham	PhD student
Peter Enderlein	BAS	Equipment Engineer
Sophie Fielding	BAS	Acoustician
Jennifer Freer	University of Bristol	PhD student
Jessie Gardner	University of East Anglia	PhD student
Cecilia Liszka	University of East Anglia	PhD student
Clara Manno	BAS	Marine Ecologist
Paul Morgan	BAS	AME, Electrical Engineer
Rosie Oakes	Penn State University, USA	PhD student
Meltem Ok	BAS	Marine Ecologist
Victoria Peck	BAS	Paleo-Oceanographer
Elisabeth C. Pindar	University of Hull	PhD student
Scott Polfrey	BAS	AME, Mechanical Engineer
Jeremy Robst	BAS	IT
Geraint Tarling	BAS	Marine Ecologist
Jonathan Watkins	BAS	Acoustician
Non JR15002 staff on-board		
Hugh Marsden	BAT	BAT postal clerk
Signy staff in transit		
Stacy Adlard	BAS	Zoological field assistant
Stefan Bokhorst	BAS	Visiting scientist CGS
Paul Cousens	BAS	Building services
Inge de Vries	BAS	Visiting scientist CGS
Michael Dunn	BAS	Penguin biologist
Matt Jobson	BAS	Signy station leader
Owen Pihama	BAS	Electrical services technician
Alexander Taylor	BAS	Field assistant
Bird Island staff in transit		
Jeremy Gillham	BAS	Bird Island station leader
Timothy Morley	BAS	Zoological field assistant
James Robbins	BAS	Zoological field assistant
Robbie Scott (BI to Stanley)	BAS	Electrical services technician
David Storey	BAS	Electrical services technician
KEP staff in transit	BAS	
Joe Meddle	BAS	Building services
Rodney Strachan	BAS	Station Operations Manager
Rebecca Taylor	BAS	Doctor

Table 1.4: JR 15002 officers and crew

JCR officers and crew	
Graham Chapman	Master
Simon Wallace	Chief Officer
Christopher Hipsey	2nd Officer
Georgina Delph	3rd Officer
Harry Taylor	3rd Officer
Charles Waddicor	ETO (Coms)
Luke Parnell	Chief Engineer
Edel Trearty	2nd Engineer
Stephen Gardiner	3rd Engineer
Steven Eadie	4th Engineer
Simon Wright	Deck Engineer
Julian Klepacki	ETO (Eng)
James Gibson	Purser
Timothy Osborne	Doctor
George Stewart	Bosun SciOps
Clifford Mullaney	Bosun
John O'Duffy	Bosun's Mate
Kevin Campbell	SG1
Kenneth Phelps	SG1
Colin Leslie	SG1
Lasse Pedersen	SG1
Martyn Dyer	SG1
Stephen Pictor	MG1
Kristian Bates	MG1
Padraig Molloy	Cook
Brian Roberstson	2nd Cook
James Newall	Steward
Derek Lee	Senior Steward
Thomas Patterson	Steward
Roger Route	Steward

1.10 Acknowledgements

This cruise is the 20th year that the Western Core Box Survey has been undertaken and so maintaining this time series has required a major investment of effort over the years; to a large extent this commitment has fallen on a small core of dedicated scientists within the current Ecosystems programme who carry out this cruise year in and year out. The core staff are supported and joined by a willing and enthusiastic group of support staff and collaborators from other polar and marine groups both within the UK and internationally. To all of you thanks for your enthusiasm and hard work which have enabled the cruise objectives to be completed once again.

The cruise also provides logistic support to the bases, all scientists and support staff together with ship staff and base staff worked tirelessly moving cargo and helping across a range of tasks to complete the base reliefs as effectively as possible during the often short suitable weather windows. We are also grateful to the base staff travelling on the ship, particularly those going to Bird Island, for the patience shown as we undertook science both en route to Bird Island which extended the time that they had to spend on the ship prior to getting in to start their field-studies.

The whole ship's complement from Master and Officers through to deck crew, catering staff and engineers are enthusiastic and interested in the science being undertaken. We are very grateful for all the help and support that they provide.

2. Physical Oceanography

2.1 CTD Operation

Paul Morgan, Sophie Fielding, Sarah Chapman

2.1.1 Introduction

A Conductivity-Temperature-Depth (CTD) unit was used to vertically profile the water column. A total of 18 CTD deployments, 17 of which were successful, were carried out, as part of the 36-hour time stations at the P2 and P3 mooring stations, Discovery 2010 CTD sites C2, C3 and C4 and as part of the Western Core Box survey. The CTD was operated by Paul Morgan, assisted by Sarah Chapman and processed by Sophie Fielding.

2.1.2 CTD Instrumentation and Deployment

An SBE32 carousel water sampler, holding 24 12-litre Niskin bottles, an SBE9Plus CTD and an SBE11Plus deck unit were used. The SBE9Plus unit held dual SBE3Plus temperature and SBE4 conductivity sensors and a *Paroscientific* pressure sensor. An SBE35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired, and time, bottle position and temperature are stored, allowing comparison of the SBE35 readings with the CTD and bottle data. Additional sensors included an altimeter, a fluorometer, two oxygen sensors, a photosynthetically active radiation (PAR) sensor and a transmissometer. The altimeter returns real time accurate measurements of height off the seabed within approximately 100m of the bottom. This allows more accurate determination of the position of the CTD with respect to the seabed than is possible with the Simrad EA600 system, which sometimes loses the bottom and, in deep water, often returns depths that are several tens of metres deeper than the true bottom location.

A fin attached to the CTD frame reduced rotation of the package underwater. The CTD package was deployed from the mid-ships gantry on a cable connected to the CTD through a conducting swivel.

CTD data were collected at 24Hz and logged via the deck unit to a PC running Seasave, version 7.22.3 (Sea-Bird Electronics, Inc.), which allows real-time viewing of the data. The procedure was to start data logging, deploy the CTD, then stop the instrument at 10m wire out, where the CTD package was left for at least two minutes to allow the seawater-

activated pumps to switch on and the sensors to equilibrate with ambient conditions. The pumps are typically expected to switch on 60 seconds after the instrument is deployed.

After the 10m soak, the CTD was raised to as close to the surface as wave and swell condition allowed and then lowered to within 10m of the seabed. Bottles were fired on the up cast, where the procedure was to stop the CTD winch, hold the package *in situ* for a few seconds to allow sensors to equilibrate, and then fire a bottle. The sensor averages these readings to produce one value for each bottle fire. When firing multiple bottles at the same depth approximately 30 seconds is given between each bottle to avoid loss of SBE35 readings. Bottle firing depths were determined by sampling requirements for Scientists onboard (see Table 2.2).

2.1.3 Data Acquisition and Processing

The CTD data were recorded using Seasave, version 7.22.3, and run through the SVP script which created four files:

JR15002_[NNN].hex binary data file

JR15002_[NNN].XMLCON ascii configuration file with calibration information

JR15002_[NNN].hdr ascii header file containing sensor information

JR15002_[NNN].bl ascii file containing bottle fire information

where NNN is the CTD event number (see Table 2.1). Please note all raw data files are held on the BAS central storage system and can be found at /data/cruise/jcr/20151105/ctd.

The *.hex* file was then converted from binary to ascii using the SBE Data Processing software *Data Conversion* module. The output was a file named *jr15002ctd[NNN].cnv*. The *Data Conversion* module calculates parameters using the coefficients detailed in Appendix B as follows:

Pressure:

$$P = C\left(1-\frac{T_0^2}{T^2}\right)\left(1-D\left(1-\frac{T_0^2}{T^2}\right)\right)$$

where *P* is the pressure (dbar), *T* is the pressure period in (µsec) $D=D_1+D_2U$, $C=C_1+C_2U+C_3U$ and $T_0= T_1+T_2U+T_3U_2+T_4U_3+T_5U_4$ are calculated from the coefficients detailed in Appendix B, where *U* is the temperature in ˚C.

Conductivity: $cond = \frac{(g + hf^2 + if^3 + if)^4}{10(1 + \delta t + \varepsilon p)}$

where *cond* is the conductivity in Sm-1, *p* is pressure, *t* is temperature, δ = CTcor and ε = CPcor. All coefficients are included in Appendix B.

Temperature*: temp(ITS90)* $$\frac{1}{\left\{g + h\left[\ln(f_0 / f)\right] + i\left[\ln^2(f_0 / f)\right] + j\left[\ln^3(f_0 / f)\right]\right\}} - 273.15$$

Where the temperature, *temp*, is measured in ˚C, *g*, *h*, *i* and *j* are coefficients detailed in Appendix H and *f* is the frequency output by the sensor.

Oxygen: $\boldsymbol{oxy = \left(Soc(V + Voffset)\right)e^{Tcor|T}\, Oxsat(T,S)\, e^{Pcor\,p}}$

where *oxy* is dissolved oxygen in ml/l, *V* is the voltage output from the SBE43 sensor, *Oxsat* is oxygen saturation (ml/l), a function of temperature, *T*, salinity, *S*, and pressure, *P*, and the remaining coefficients are detailed in Appendix B.

PAR: $$PAR = \left(\frac{multiplier.10^9.10^{(V-B)/M}}{C}\right) + offset$$

where *V*, *B*, *M*, *offset*, *multiplier* and *C*, the calibration constant, can be found in Appendix H.

Fluorescence: $$flsc = \frac{slope(10e^{(V/slope\,factor)} - 10e^{VB})}{10e^{V1} - 10e^{Vacetone}} + offset$$

Where *flsc* is measured in µg/l, *V* is the fluorometer output voltage and the remaining coefficients can be found in Appendix B.

The SVP script also sends the CTD data output to the Met Office (as of November 2014, following a note from Tim Smyth (PML) – PSO on JR303).

Transmission: $$Light\,transmission = M.output\,voltage + B$$

Where light transmission is measured in % and *M* and *B* are derived from measured voltages through air and water in light and darkness.

The SBE Data Processing *Align CTD* module was then used to align parameter data in time, relative to pressure. This ensures that calculations of salinity, dissolved oxygen concentration, and other parameters are made using measurements from the same parcel of water.

The SBE Data Processing *Wild Edit* module was then used to mark wild points in the data by replacing the data value with *badflag*. The *badflag* value is documented in the input .cnv header. Wild Edit's algorithm requires two passes through the data: the first pass obtains an accurate estimate of the data's true standard deviation, while the second pass replaces the appropriate data with *badflag*.

The SBE Data Processing *Cell thermal mass* module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This reads in the *jr15002ctd[NNN].cnv* file and re-derives the pressure and conductivity, taking into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output is another ascii file, named as *jr15002ctd[NNN]_ctm.cnv*. The correction applied to the CTD data is detailed below:

Corrected conductivity = conductivity + ctm

Where:

$$ctm = -1 \times \left(\frac{1 - 5\alpha}{2s\beta + 4} \right) \times ctm_0 + \frac{2\alpha}{s\beta + 2} \times 0.1(1 + 0.006[T - 20]) \times \Delta T$$

and *s* is the sample interval, *T* is temperature, *ctm0* is the uncorrected cell thermal mass, $\alpha = 0.03$ and $\beta = 7.0$.

The following matlab scripts were then used to process the CTD files.

ctdread.m Reads in JR15002CTDnnn_awctm.cnv to matlab. Outputs JR15002ctdnnn.cal

editctd.m Reads in JR15002ctdnnn.cal. Manual edit of CTD file to remove start and end data when CTD out of water and any spikes. Outputs file JR15002ctdnnn.edt

Interpol.m	Reads in JR15002ctdnnn.edt. Interpolate any missing data. Output JR15002ctdnnn.int
Salcalapp.m	Reads in JR15002ctdnnn.int. Calculates density (sig0, sig2 sig4). Output JR15002ctdnnn.var
Splitcast.m	Reads in JR204ctdnnn.var. Splits up cast and down cast. Output JR15002ctdnnn.var.up and JR15002ctdnnn.var.dn.
Fallrate.m	Reads in JR15002ctdnnn.var.dn. Removes data from periods where CTD above a pressure it has already sampled. Output JR15002ctdnnn.var.dn
Gridctd.m	Reads in JR15002ctdnnn.var.dn. Grids data into 2dB depth intervals. Output JR15002ctdnnn.2db.mat. Note a 1dB file was also created on request from Richard Lampitt
Fill-to-surf.m	Reads in JR15002ctdnnn.2db.mat. Fills in surface values if CTD doesn't reach surface, user input to determine which ones. Output file JR15002ctdnnn.2db.mat
Ctdplot.m	Reads in JR15002ctdnnn.2db.mat files and creates overview plots saved in /images folder
Makebot	Reads in JR15002ctdnnn.2db.mat. Extracts median and standard deviation of variables at the depth/time of each bottle firing. Output file JR15002botnnn.1st

All processed files are stored on the BAS Central Storage system see /data/cruise/jcr/20151105/scientific_work_areas/CTD and will be deposited with the British Oceanographic Data Centre (BODC).

2.1.4 CTD Casts and Water Sampling Summary

17 CTD casts were undertaken plus 1 failed CTD (Event no.1) where no data file was created.
Table 2.1: CTD casts

Time (GMT)	Event no.	Station	Latitude	Longitude	Event Depth (m)	Bottles Fired	Action
11/11/2015 20:53	1	Test Station	-51.62435	-57.60112	n/a	0	Time in water
12/11/2015 11:20	5	Test Station	-51.62435	-57.60111	60	24	At bottom
20/11/2015 15:20	10	C2	-60.20816	-44.40772	1000	9	At bottom
21/11/2015 01:30	11	C3	-59.68867	-44.05425	1000	21	At bottom
21/11/2015 13:28	16	C4	-58.02285	-42.98422	1000	23	At bottom
22/11/2015 14:58	21	P2	-55.24256	-41.25757	3340	23	At bottom
27/11/2015 00:47	26	Stromness	-54.159	-36.69499	50	2	At bottom
28/11/2015 13:24	31	P3	-52.8052	-40.08624	3742	24	At bottom
30/11/2015 13:29	40	P2	-55.24276	-41.25753	1000	16	At bottom
01/12/2015 11:26	62	P2	-55.23498	-41.2746	200	4	At bottom
03/12/2015 20:39	77	W1.2S	-53.84607	-39.14367	200	3	At bottom
04/12/2015 07:30	81	W1.2N	-53.49297	-39.25085	1000	5	At bottom
04/12/2015 22:30	87	W2.2N	-53.43244	-38.6949	1000	17	At bottom
05/12/2015 06:14	88	W2.2S	-53.78491	-38.58402	200	0	At bottom
05/12/2015 20:43	94	W3.2S	-53.71383	-37.96637	130	9	At bottom
06/12/2015 00:03	95	W3.2N	-53.36107	-38.0831	1000	5	At bottom
08/12/2015 13:06	114	P3	-52.81172	-40.11164	1000	10	At bottom
09/12/2015 12:12	136	Upwelling	-52.62716	-39.11516	3685	24	At bottom

Water samples were collected at each site except the test station and cast number 13.

Table 2.2: Water samples collected from CTD bottles. *Note the initials are of those scientists collecting water samples – Jennifer Freer (JF), Jessie Gardner (JG), Gabi Stowasser (GS), Meltem Ok (MO), Cecilia Liszka (CL), Will Goodall-Copestake (WG) samples were collected by JF for WG and Clara Manno (CM).

Event no.	CTD Cast	eDNA (JF)	TA & DIC (JG)	Nutrients (JG)	Incubation (JG)	POM (GS)	PIC (MO)	Oxygen Isotopes (MO)	Incubation (CL)	Genetics (WG)	Sediment Trap (CM)
5	1	X			X						
10	2	X	X	X	X	X			X	X	
11	3	X	X	X	X	X			X	X	
16	4	X	X	X	X	X			X	X	
21	5	X	X	X	X				X	X	
26	6								X		
31	7	X	X	X	X		X	X	X	X	X
40	8				X	X	X	X	X		
62	9				X						
77	10				X						
81	11				X				X		
87	12	X			X	X			X		
88	13										
94	14	X			X	X					
95	15				X				X		
114	16				X	X			X		
136	17	X	X	X	X	X	X	X		X	

2.2 Vessel Mounted Acoustic Doppler Current Profiler (ADCP)

Sophie Fielding

The ADCP collected data on water currents throughout the cruise on an opportunistic basis. The ADCP was synchronised with other instruments using the k-sync and standard settings (8 m bins, water column only, collected to a depth of 800 m). The data have not been processed on this cruise.

2.3 Underway

Sophie Fielding

2.3.1 Underway Navigation

A number of data streams are recorded throughout the cruise, collecting navigational, meteorological data and information on deployments.

2.3.2 Underway sampling

Surface ocean and meteorological data were logged continuously throughout the cruise. Ocean data were collected from the ship's uncontaminated seawater supply, whilst the meteorological data were measured by instruments on the forward mast. Instruments were as follows:

- Chelsea Technologies 10-AU 005 Fluorometer 31
- Litre meter F112P Flow meter
- Photosynthetically Active Radiation (PAR) 1, Parlite Quanum Sensor, Kipp & Zonen
- Photosynthetically Active Radiation (PAR) 2, Parlite Quanum Sensor, Kipp & Zonen – not working
- Wetlabs C-star Transmissometer
- Kipp & Zonen SPLite2 (TIR 1)
- Kipp & Zonen SPLite2 (TIR 2)
- Air temperature/humidity 1, Rotronic MP402H-050300
- Air temperature/humidity 2, Rotronic MP402H-050300 19
- Barometer 1
- Barometer 2
- SeaBird Electronics SBE38 seawater temperature 1
- SeaBird Electronics SBE38 seawater temperature 2
- SeaBird Electronics SBE45 thermosalinograph

2.4 Expendable bathythermographs - XBTs

Jeremy Robst, Sarah Chapman

2.4.1 Introduction

Expendable bathythermographs (XBTs) were used to vertically profile the temperature through the water column on transects in the Western Core Box. The XBT launcher was operated by Jeremy Robst and Sarah Chapman. There were 26 deployments (1 test, 25 on the WCB), of which 4 failed see Table 2.3. These failures attributed to firing too early and a technical issue with water seeping into the electrics. On each occasion, the probe was launched at a pre-defined location which has been done on previous surveys in the Western Core Box.

2.4.2. Instrumentation and Operation

The following details have been summarised from the Equipment Guide held on board the JCR (http://wiki.jcr.nerc-bas.ac.uk/Data_and_Instrumentation/XBT). Each deployment was made using a launcher in which the expendable probe was mounted before deployment. When the probe was locked in position, an electrical connection was made between the probe and recorder. An operator then confirmed that the ship-based recording programme was ready for launch. Following the launch of the probe, copper wire de-reeled from inside the launch canister as well as inside the probe to compensate for ship movement. As the probe descended through the water column, depth and temperature data were recorded and displayed in real time (the design of the probe with precision weighting and spin-stabilisation allows a predictable rate of descent and therefore a depth accuracy of 2%). When the probe reached the sea floor (if shallower than the length of the wire), the wire was cut. In deeper water the wire de-reeled to its full length, then dropped into the water column or was cut.

Deployments made were with Lockheed Martin Sippicon T5 probes which have a wire length of 1830 m and need to be operated at a ship speed of 6 knots or less. On several occasions Lockheed Martin Sippicon T7 probes were used which can be operated at 10 knots, but were still deployed at 6 knots in this case. T7 probes also have a shorter wire length of 760 m.

2.4.3 Data Recording

Data were recorded and displayed real-time using Sea-Air Systems software:

- WinMK21 v3.0.5
- MIK21COEF v3.0.5
- MK21AL v3.0.5

Before launch, metadata were entered into the software and K9 was set running to ensure the PC time was synced to ship time. Data were recorded straight into /data/cruise/jcr/current/xbt. .EDF (ASCII output of profile data and launch metadata in the header) and .RDF files exist for each deployment.

Table 2.3: XBT deployment information.

Time	Station	Event no.	Filename	Comment
01/12/2015 19:16	Test	66	T7_00001	Test – aborted when system shown to be working.
03/12/2015 09:07	WCB 1.1	72	T5_00002	
03/12/2015 10:06	WCB 1.2	73	T5_00003	
03/12/2015 11:13	WCB 1.3	74	T5_00004	
03/12/2015 12:21	WCB 1.4	75	T5_00005	
03/12/2015 13:30	WCB 1.5	76	T5_00006	
04/12/2015 09:30	WCB 2.1	82		Failed. No file created
04/12/2015 10:43	WCB 2.2	83	T5_00007	Failed. Technical fault.
04/12/2015 11:51	WCB 2.3	84	T5_00008	
04/12/2015 12:59	WCB2.4	85	T7_00009	
04/12/2015 14:07	WCB 2.5	86	T7_00010	
05/12/2015 09:06	WCB 3.1	89	T5_00011	
05/12/2015 10:11	WCB 3.2	90	T5_00012	
05/12/2015 11:20	WCB 3.3	91	T5_00013	
05/12/2015 12:27	WCB 3.4	92	T5_00014	
05/12/2015 13:30	WCB 3.5	93		Failed. No file created.
06/12/2015 09:10	WCB 4.1	96	T5_00015	
06/12/2015 10:15	WCB 4.2	97	T5_00016	
06/12/2015 11:20	WCB 4.3	98	T5_00017	
06/12/2015 12:26	WCB 4.4	99	T5_00018_4_4	No.RDF file.
06/12/2015 13:40	WCB 4.5	100	T5_00018	File naming out of sync due to previous failed XBT. No T5_00019 file exists.
06/12/2015 14:25	WCB 4.6	101	T5_00020	
06/12/2015 15:35	WCB 4.7	102	T5_00021	
06/12/2015 16:44	WCB 4.8	103	T5_00022	
06/12/2015 17:52	WCB 4.9	104	T5_00023	
06/12/2015 18:59	WCB 4.10	105	T5_00024	

All XBT data were backed up and stored on BAS central storage system in Cambridge /data/cruise/jcr/20151105/xbt.

3. Acoustics EK60

Sophie Fielding, Peter Enderlein, Jon Watkins

3.1 Acoustic instrumentation

3.1.1 Introduction

The EK60 was run throughout JR15002 to collect information on the horizontal and vertical distribution of krill and to derive estimates of krill biomass for the Western Core Box and to contribute data from transects from the Falklands to South Georgia. An EK80 recently fitted to the JCR (August 2015) was run periodically but several concerns with data quality were realised and so it was only a brief period.

3.1.2 Aim

Collection of acoustic data to accompany all transects, acoustic surveys, and net tows during the South Georgia survey.

Backup and process the acoustic data

3.1.3 Methods/System specification

EK60

The EK60 was operated using software Simrad ER60 v. 2.4.3 from the 1A computer was used to run the EK60. The .raw data files were logged to the Linux server JRLB, using a Samba connection, which is backed up at regular intervals. Raw data were collected to 1100 m during the long transects and at all other times. The EK60 GPTs were moved in August from within the gravity meter room to a space near the sub bottom profiler transceivers. This involved some recabling. In addition a new 120 kHz transducer was fitted to the hull of the JCR.

File locations

All raw data were saved in a general folder JRLB/EK60. All files were prefixed with JR15002. Calibration data were additionally saved to the calibration folder.

EK60 (ER60) settings

The EK60 was run using the settings from refit until calibration on the following settings (Table default settings). Calibration (27/11/2015) parameters were uploaded to the EK60 and used as the settings post calibration.

Table 3.1: Default settings

Variable	38 kHz	70 kHz	120 kHz	200 kHz
Sound velocity (m/s)	1472	1472	1472	1472
Mode	Active	Active	Active	Active
Transducer type	ES38	ES70-C	ES120-7	ES200-7
Transceiver Serial no.	009072033fa5	0090720770eb	00907203422d	009072033f91
Transducer depth (m)	0	0	0	0
Absorption coef. (dB/km)	9.8	19.9	29.9	42.9
Pulse length (ms)	1.024	1.024	1.024	1.024
Max Power (W)	1000	750	250	300
2-way beam angle (dB)	-20.70	-20.60	-20.40	-19.70
Transducer gain (dB)	25.60	26.25	24.00	20.66
Sa correction (dB)	-0.54	-0.38	0	-0.27
Angle sensitivity along	22	23	21	23
Angle sensitivity athwart	22	23	21	23
3 dB Beam along	7.10	7.10	7.20	7.90
3 dB Beam athwart	7.00	7.20	7.20	8.00
Along offset	0	0	0	0
Athwart offset	0	0	0	0

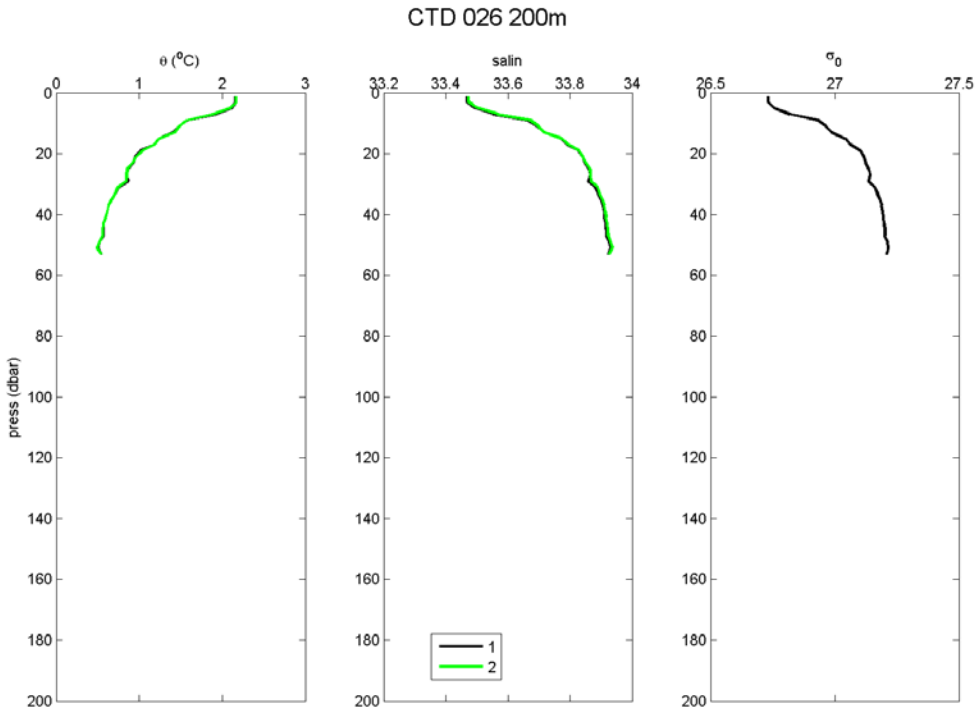
The EK60 was controlled through the k-sync using variable settings depending on whether the swath was being run opportunistically. A new setting on the k-sync (swath+bio) was used to ping the EK60 as much as possible (on a 2 second ping rate) whilst the swath was pinging once, and then to let the EK60 ping twice on its own. . In this scenario the **swath is not allowed to be master**. This enables the interference from the swath to be removed from the EK60 data using a spike filter. At other times (when the swath wasn't used) the k-sync was used to synchronise the EA600, ADCP and EK60 all triggering on a 2 second ping rate, with the ADCP and EA600 triggering slower when required. Due to the k-sync switching the EK60 into standby several times after 3 triggers without reply, the reply function was disconnected – which solved the problem.

3.2 EK60 Calibration

An acoustic calibration was carried out in Stromness Harbour, South Georgia on 27/11/2015. The ship was anchored, its movement balanced by minimal DP usage, and all over the side water deposits stopped. The EK60 was triggered through the k-sync, the EA600 was still running and ADCP was switched off. Each transducer was calibrated in turn, although all transducers were operating at the time. Standard ER60 calibration procedures were used as documented for previous cruises (the relevant copper sphere was moved through all quadrants of each transducer). In addition the sphere was held on-axis for extra periods of time to enable calibration variables to be determined in Echoview. The calibration of the EK60 was also checked using a tungsten carbide sphere for future calibrations.

A CTD (Event 26) was undertaken on the morning of the calibration. Temperature and salinity were averaged from the surface to 30 m (depth of the calibration sphere) and were 1.06 °C and 33.79 PSU resulting in a speed of sound constant of 1456 m/s (Kongsberg software calculation).

Fig. 3.1: Calibration CTD



om the ER60 lobes calibration were updated onto the ER60 software (Table 3.2 calibrated settings).

Table 3.2: Acoustics_ EK60 Calibration

Date (dd/mm/yyyy)	27/11/2015	27/11/2015	27/11/2015	27/11/2015
Location	Stromness	Stromness	Stromness	Stromness
Time (GMT)				
Frequency (kHz)	38	70	120	200
GPT serial no	009072033fa5	0090720770eb2	00907203422d	9072033191
Comments	EA600 on	EA600 on	EA600 on	EA600 on
Water temperature (°C)	1.4	1.4	1.4	1.4
Salinity (PSU)	33.7	33.7	33.7	33.7
Sound velocity (m/s)	1456	1456	1456	1456
Absorption coeff (dB/km)	10.00	18.11	26.29	39.75
Ping rate (sec^{-1})	1	1	1	1
Transmit Power (W)	2000	750	500	300
Pulse length (ms)	1.024	1.024	1.024	1.024
Bandwidth (kHz)	2.43	2.86	3.03	3.09

Sample Interval (m)	0.186	0.186	0.186	0.186
Original gain (dB)	25.60	26.25	24.00	20.66
Original Sa correction (dB)	-0.54	-0.38	0	-0.27
Theoretical TS of sphere (dB)	-33.70	-39.15	-40.24	-44.87
New gain (dB)	25.66	26.23	23.38	22.82
New Sa correction (dB)	-0.55	-0.36	-0.29	-0.24

3.3 Data coverage

3.3.1 Acoustic transects

An attempt to run the WCB was made on the 02/12/2015 at 09:00 but after 45 minutes the attempt was aborted due to poor weather. Ultimately the WCB was run in a west to east direction starting at the Northern end and commenced on the 03/12/2015. Fishing over night was not feasible on the 2nd and 3rd night as a result of poor weather. These net stations were undertaken on the 07/12/2015, as well as a large focus on target fishing.

Table 3.3: Acoustics_5 Transect times, directions and speeds.

Transect	Date	Start time (GMT)	End time (GMT)	Comments
WCB1.1	03/12/2015	08:54	13:26	North to South
WCB1.2	03/12/2015	14:45	19:04	
WCB2.1	04/12/2015	09:30	14:08	
WCB2.2	04/12/2015	15:10	19:30	
WCB3.1	05/12/2015	09:00	13:30	
WCB3.2	05/12/2015	15:08	19:12	
WCB4.1	06/12/2015	09:00	13:40	
WCB4.2	06/12/2015	14:20	18:54	

3.3.2 Problems encountered

Interference from other acoustic instruments was at a minimum with respect to the other scientific instruments. The k-sync issue of putting instruments into standby if it doesn't receive confirmation from an instrument has created problems by stopping instruments when there is no need to. As a result we disabled the feedback into the k-sync so that it wouldn't trip out. Occasionally the EK60 would stop being triggered by the k-sync. In the end during the WCB the EK60 was triggered from the USB port on the computer. This actually resulted in a very small delay between triggers on other instruments and the EK60

which results in some noise. It isn't clear what the source of noise or the source of issues with synchronisation were – but they cleared in JR15004 without any significant alteration to anything.

4. Moorings

Peter Enderlein, Scott Polfrey, Gabriele Stowasser, Sophie Fielding, Clara Manno & Geraint Tarling

General:

During JR15002 the P2 and P3 deep sediment trap moorings where successfully recovered and redeployed. No new equipment was added, but the layout of the mooring had to change, due to the P2 mooring had been dragged below 1000 m, destroying some instruments. Also the SAMI pH sensor, the Oceanus CO2 sensor and the Aquamonitor Water sampler could not be redeployed due to calibration, corrosion and malfunction issues.

4.1 3200m sediment trap mooring @ P2

4.1.1 Recovery

The recovery took place on the 22nd of November 2015. The acoustic releases responded straight away and after ranging the mooring successfully a few time, the mooring was released and was within 5min at the surface. The mooring was hooked mid ships and the mooring winch rope attached. The whole rig was recovered by using the mooring winch and a stopper rope on a cleat. This worked very well again and despite the length of the rig, it was a speedy recovery taking just a little bit over 2 hours.

4.1.2 Performance

The **CTD** (SN 4852) operated from 30th November 2014 to 4th September 2015. During this time it highlighted that on the 31st May 2015 the mooring had been knocked down below 1000 m (and in fact depth reading capability of the CTD) and it was this period that likely resulted in the implosion of several of the instruments.

ADCP – The ADCP (SN 7522) collected acoustic data from 21:00 30/11/2015 until 05:00 08/11/2015. The data were not analysed at sea.

Sediment trap – On recovery 1 of the 21 bottles (position 10) was missing. All the remaining 20 sample bottles fitted to the sediment trap were successfully recovered. All bottles were packed into vermiculate boxes for storage at +4°C for analysis in Cambridge. The pH of the solution in each bottle was measured and was ranging between 8.00-8.01. This pH values confirmed that the buffer solution was working well and the samples will be suitable for further Ocean Acidification studies. This was the first deployment, where the bottles have been preserved with formalin instead of mercuric chloride (MgCl2). The buffer was a mixture of salt (NaCl) and BORAX. We noticed that bottles corresponding to the high production periods (i.e. from 15th December-end of February) were almost empty, while bottle 1 (covering the period 1 to 15th December) was completely full. We performed a sediment trap trial and we discovered the motor rotating the bottles was not responding well to the electronic input. In fact bottles were not aligned after we gave the ”turn” command. We hypothesise that the first 3 months of sediment flux were collected just in the first bottle. This sediment sample will be suitable for qualitative analysis and measurement of annual carbon export but not suitable for the investigation of flux seasonality. In order to not lose some bottles during deployment or recovery, we substituted the original plastic bottles provided by McLane with light marine graded aluminium bottles (more resistant to stress than the previous ones), designed at BAS by P. Enderlein. To avoid any contamination with chemicals, the bottles have been coated on the inside with plastic. We equipped the bottom sediment traps with new bottles for re-deployment and also added a shallow sediment trap to the mooring line.

SAMI-pH sensor – imploded due to exceeding its depth limits – The pressure housing was missing and the content (controller board, batteries and optics) totally destroyed. Inside the reagent housing, the reagent bags were imploded and all the chemicals missing. Unfortunately it was impossible to recover data from the instrument. We did not re-deploy the instrument.

Pro-Oceanus-CO2 sensor– Battery housing with massive corrosion, fuse blown, battery pack fine 13.04V. The sensor collected data only for 4 months (from Dec to March) and then stopped working. We did not re-deploy the instrument.

Aquamonitor-Water sampler – massive corrosion to connectors on SS plate and main battery pack, damage to internal cable showing bare wires, most likely causing current on housing, thereby responsible for most of the corrosion. This was the manufactures fault as we received the battery pack in the housing and did not open it until its recovery. The battery pack was fine 12.2 V, but the fuse was blown. Bags did not collect properly and of the 47 bags only 14 contained water samples. However due to the valves not sealing properly in cold water the sample volumes in the bags may not be correct and may not have been collected at the recorded time. Samples are not suitable for further analysis. We did not re-deploy the instrument.

Seaguard current meter with O2 sensor – The current meter and the O2 sensor were successfully recovered. They were both working properly and it was possible to recover the full deployment dataset. We did not re-deploy this instrument on this (P2) mooring but moved it on to the P3 mooring.

Aquadopp current meter – imploded due to exceeding its depth limitations - It was impossible to recover data. We moved the Aquadopp previously deployed on mooring P3 to the P2 mooring.

4.1.3 Re-deployment

The mooring was redeployed on the 1st of December 2015. The deployment started at 13:30 GMT, buoy first. Due to the problem with some of the instruments on both moorings, the mooring was deployed in the reconfigured layout as per drawing below. The weight was finally released at **15:29 at 55 14.64S 041 16.19W**. After given the mooring time to settle, it was triangulated to calculate it actual position in the water: **55 14.92S 41 15.73W**

Work carried out:

Acoustic releases: 290 + 1219

- ☒ new batteries
- ☒ tested
- ☒ new linking bar

Irmasat Iridium beacon: 12098770

- ☒ new batteries
- ☒ tested

NOVATEC Combo beacon: CO2-058

Imploded, not redeployed

CTD 37 SMP 43742: 4852 *on main buoy*

- ☒ download data, **file**: L drive: CTD 4852
- ☒ new batteries
- ☒ new O-rings

- ☒ set-up instrument for re-deployment
  - set real time clock to PC clock (p. 28)
  - check instruments is ok and clock is set properly by using "DS"command (p. 27)
  - set-up instrument for "Autonomous Sampling" following the instructions on page 24
  - samplenum=0 automatically makes entire memory available for recording
  - sample interval: 900 sec

CTD 37 SMP 43742: 4855 <u>not deployed</u>

- ☒ new batteries

☒ set-up instrument for re-deployment

ADCP WHS300 – I – UG26: 7522

☒ download data, **file: L drive: DP_P2000.000**

☒ new batteries

ADCP 7522 not redeployed due to broken connector, replaced with ADCP 155548

☒ set-up instrument for re-deployment

- erase data (p.16 WinSC)
- start WinSC for set up instrument
- set-up instrument
  - Number of bins: 30 (1-128)
  - Bin size (m): 8 (0.2-16)
  - Pings per Ensemble: 10
  - Interval: 15 min
  - Duration: 550 days
  - Transducer depth: 200 m
- save deployment settings
- start time:
- set up ADCP real time clock to PC clock
- don't verify the compass (needless on a ship)
- run pre-deployment tests to check instrument

Sediment trap deep: Parflux No: ML11966-11

☒ new batteries (14x C – Cells + 2x AAA battery)

- **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ **Set up sediment trap with the new Aluminum cups**

Unit ML11966-11 was replaced with unit: ML13136-02

PS2 DEEP Sediment Trap Deployment November 2015 JR15002

Schedule Verification:

Event 1 of 22 = 12-15-15
Event 2 of 22 = 01-01-16
Event 3 of 22 = 01-15-16
Event 4 of 22 = 02-01-16
Event 5 of 22 = 02-15-16
Event 6 of 22 = 03-01-16
Event 7 of 22 = 04-01-16
Event 8 of 22 = 05-01-16
Event 9 of 22 = 06-01-16
Event 10 of 22 = 07-01-16
Event 11 of 22 = 08-01-16
Event 12 of 22 = 09-01-16
Event 13 of 22 = 10-01-16
Event 14 of 22 = 11-01-16
Event 15 of 22 = 12-01-16
Event 16 of 22 = 12-15-16
Event 17 of 22 = 01-01-17
Event 18 of 22 = 01-15-17
Event 19 of 22 = 02-01-17
Event 20 of 22 = 02-15-17
Event 21 of 22 = 03-01-17
Event 22 of 22 = 04-01-17

Sediment trap shallow: Parflux No: MC13136-01

☒ new batteries (14x C – Cells + 1x 9V Block battery)

- **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ **Set up sediment trap with the new Aluminum cups**

PS2 SHALLOW Sediment Trap Deployment November 2015 JR15002

PS3 Sediment Trap Deployment

Schedule Verification

Event 1 of 22 = 12-15-15
Event 2 of 22 = 01-01-16
Event 3 of 22 = 01-15-16
Event 4 of 22 = 02-01-16
Event 5 of 22 = 02-15-16
Event 6 of 22 = 03-01-16
Event 7 of 22 = 04-01-16
Event 8 of 22 = 05-01-16
Event 9 of 22 = 06-01-16
Event 10 of 22 = 07-01-16
Event 11 of 22 = 08-01-16
Event 12 of 22 = 09-01-16
Event 13 of 22 = 10-01-16
Event 14 of 22 = 11-01-16
Event 15 of 22 = 12-01-16
Event 16 of 22 = 12-15-16
Event 17 of 22 = 01-01-17
Event 18 of 22 = 01-15-17
Event 19 of 22 = 02-01-17
Event 20 of 22 = 02-15-17
Event 21 of 22 = 03-01-17
Event 22 of 22 = 04-01-17

Current meter: Aquadopp No A2L – 1793

Imploded due to exceeding its depth limits, therefore it was replaced with the Aquadopp from the P3 mooring:

Aquadopp No AQD-2018

- ☒ new batteries

deployment settings:

L drive: Aquadop_P2.dep and Aquadop_P2.log

pH sensor SAMI: PO 128

imploded due to exceeding its depth limitations

CO2 Sensor Oceanus: 33-191-75

- ☒ Remember the battery needs charging for 24 hours before deployment
- ☒ data downloaded, **file**: L drive: PCO2_20151122.pdf and ….txt

as battery housing showed massive corrosion, the unit was not redeployed

Water sampler:

as the Connector of the Water sampler battery housing as well as he main distribution body showed massive corrosion, the unit was not redeployed

Seaguard current meter with O_2 sensor: 1309

Seaguard current meter serial number: 1309

Current meter sensor: 851

Optode: 1561

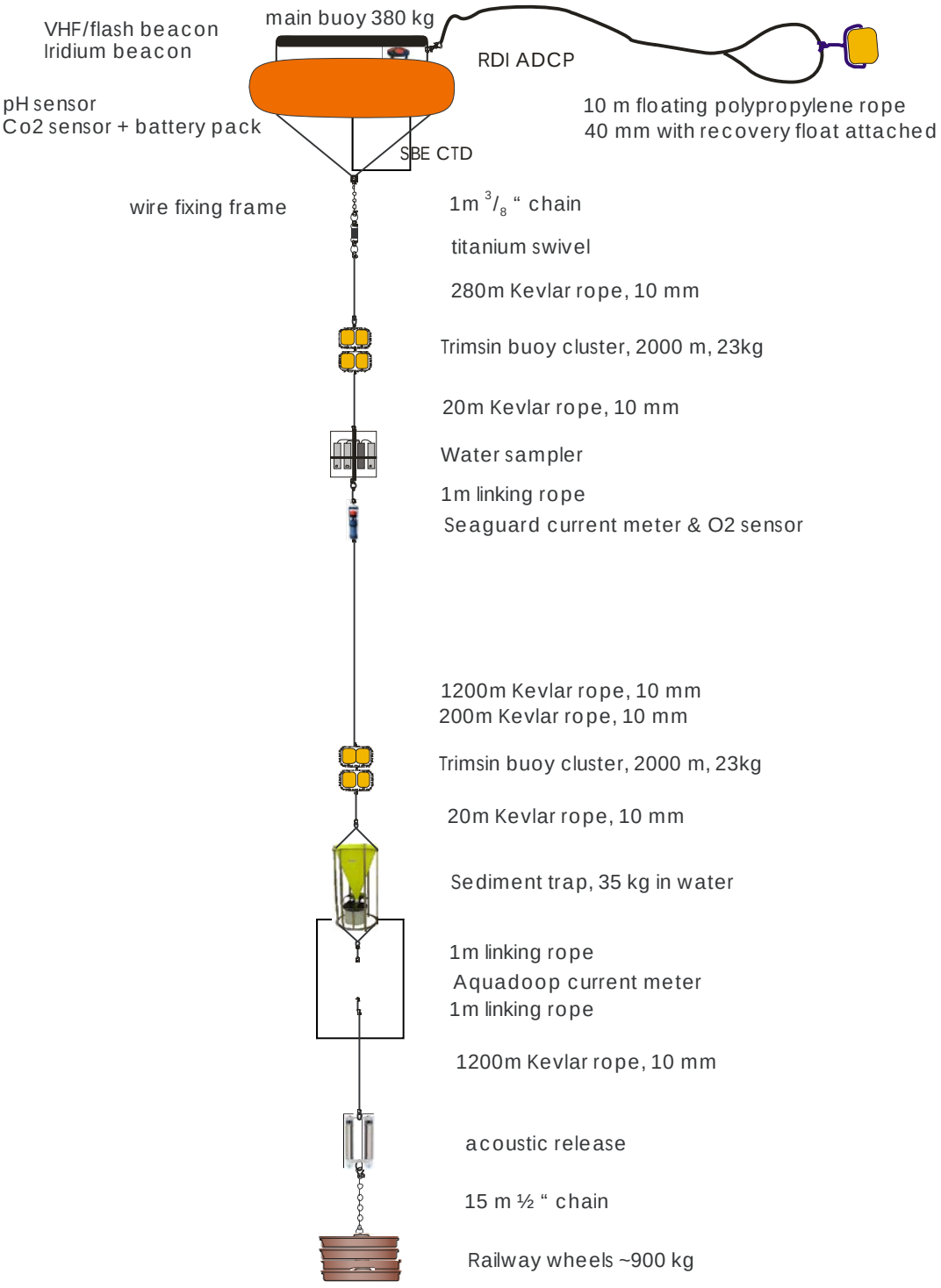
The seaguard current meter with O_2 sensor does not output a setup file.

- ☒ data downloaded, **file**: L drive: RCN_1307_20141130_2100
- ☒ new batteries

Unit was not redeployed on P2, instead put on P3

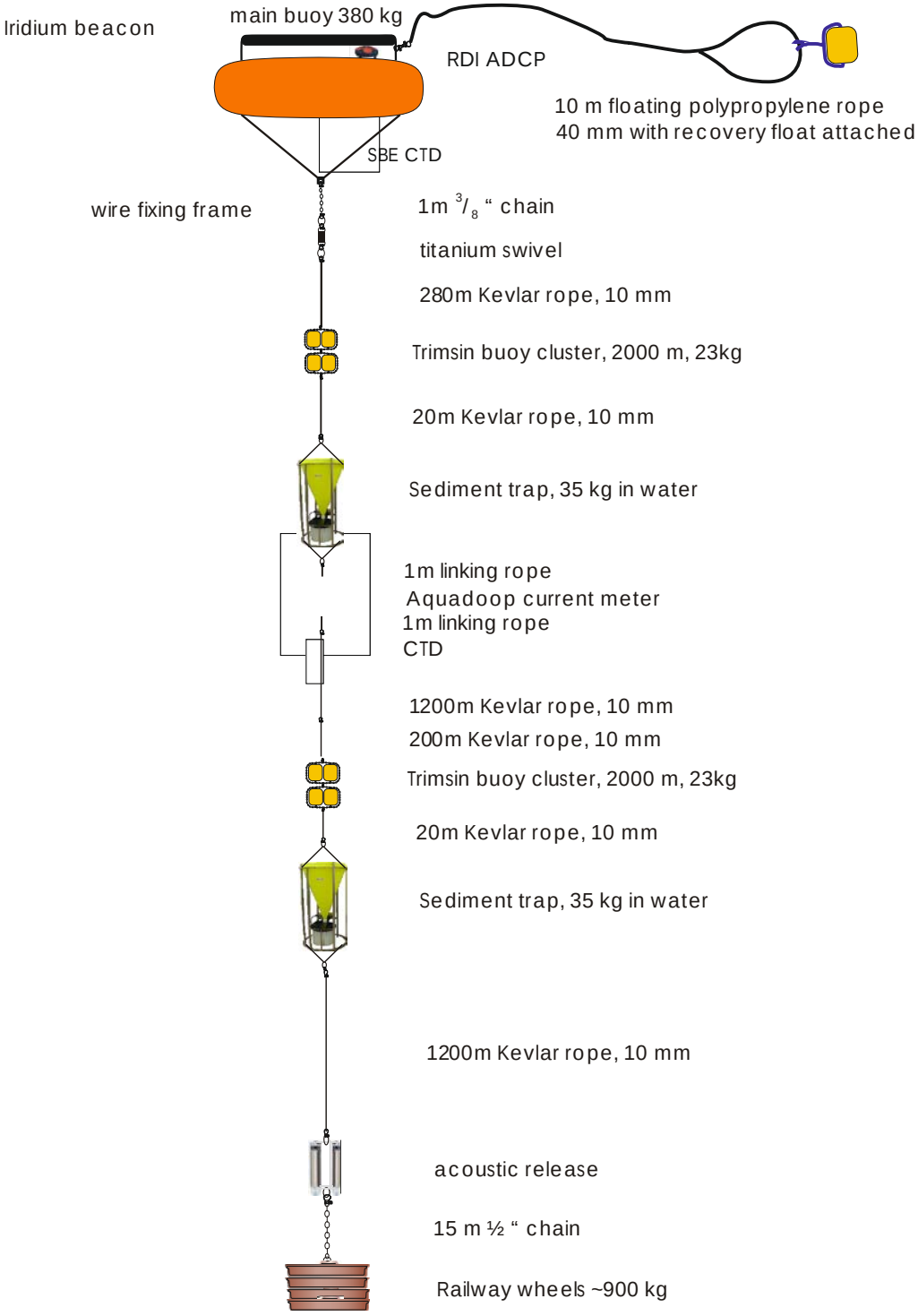
Mooring rig recovered:

P2 Sediment trap mooring (3200m water depth)



Mooring rig redeployed:

P2 Sediment trap mooring (3200m water depth)



4.2 3700m sediment trap mooring @ P3

4.2.1 Recovery

The recovery took place on 28 of November 2015. The acoustic releases responded straight away and after ranging the mooring successfully a few time, the mooring was released and was within 5min at the surface. The mooring was hooked mid ships and the mooring winch rope attached. The whole rig was recovered by using the mooring winch and a stopper rope on a cleat. This worked very well again and despite the length of the rig, it was a speedy recovery taking 2 hours.

4.2.2 Performance

The CTD (SN 2462) operated from 13th December 2014 to 29th November 2015. The CTD was mounted on the buoy and showed that the buoy sat around 150 m water depth for most of the deployment. There was one period where the buoy was knocked down to 350 m on the 10th February 2015.

The CTD (SN 4584) only recorded temperature and conductivity information and did not record water depth. It operated from the 13th December 2014 to 29th November 2015.

ADCP – The ADCP (SN 2967) collected acoustic data from 00:01 12/12/2015 until 15:15 29/11/2015. The data were not analysed at sea.

Sediment trap (shallow and deep) – All bottles were successfully recovered on both sediment traps. Bottles were packed into vermiculate boxes for storage at +4°C for analysis in Cambridge. The pH of the solution in each bottles was measured and was ranging between 8.00-8.01. This pH values confirmed that the buffer solution was working well and the samples will be suitable for further Ocean Acidification studies.

This was the first deployment where the bottles have been preserved with formalin instead mercuric chloride (MgCl2). The buffer was a mix of salt (NaCl) and BORAX. McLane bottles were substituted with aluminium bottles as for P2. Both sediment traps were re-deployed.

SAMI-pH sensor- The sensor did not present any signs of corrosion and/or damage. The battery was fine and the instrument recorded data throughout the deployment. However the instrument did not respond well to the calibration procedure (i.e. the value of standard pH was not corresponding to the reading of the sensor) and there was a systematic offset in the data collected. We tried to fix the problem by opening the pressure housing and adjust the signal of the wavelengths of light as it was very close to saturation. This operation did not solve the problem and we did not re-deploy the sensor.

Pro-Oceanus CO2 sensor – Battery housing with corrosion, fuse fine, battery pack drained to 3.66V. The battery charge dropped heavily because the recording clock was set to recording every 6h instead of every 24h. Data were recorded only until April. As for P2 we did not re-deploy the instrument because of the housing corrosion.

Aquamonitor-Water sampler –corrosion to connectors –The battery pack was fine 12.2 V. The bags did not collect properly and of the 47 bags only 20 contained water samples. However due to the valves not sealing properly in cold water the sample volumes in the bags may not be correct and may not have been collected at the recorded time. Samples will be not suitable for further analysis. We did not re-deploy the instrument.

Seaguard current meter with O2 sensor - The instrument was successfully recovered and it collected data throughout the period of deployment. No sign of corrosion and/or damage was detected. After downloading the data we re-deployed the instrument on P3.

Aquadopp current meter – The instrument was successfully recovered and it collected data throughout the period of deployment. No sign of corrosion and/or damage was detected. We decided to re-organise the mooring configurations and we moved the Aquadopp from P3 onto P2.

4.2.3 Re-deployment

The mooring was re-deployed on the 8st of December 2015. The deployment started at 17:27 GMT, buoy first. Due to the problem with some of the instruments on both moorings, the mooring was deployed in the reconfigured layout as per drawing below. The weight was finally released at **19:28 at 52 48.63S 040 07.30W**. After given the mooring time to settle, it was triangulated to calculate it actual position in the water: **52 48.696S 40 07.086W**

Work carried out:

Acoustic releases: 93 + 573

- ☒ new batteries
- ☒ tested
- ☒ new linking bar

Irmasat Iridium beacon: 13901110

- ☒ new batteries
- ☒ tested

Argos beacon: SN 280, ID: 60210

- ☒ new batteries
- ☒ tested

NOVATEC Combo beacon: R090-020

- ☒ new batteries
- ☒ tested

CTD 37 SMP 43742: 2462 *on main buoy*

- ☒ download data, **file**: L drive: CTD_2462

☒ new batteries

☒ new O-rings

☒ set-up instrument for re-deployment

- set real time clock to PC clock (p. 28)
- check instruments is ok and clock is set properly by using “DS”command (p. 27)
- set-up instrument for “Autonomous Sampling” following the instructions on page 24
- samplenum=0 automatically makes entire memory available for recording
- sample interval: 900 sec

CTD 37 SMP 43742: 4584 *below Water sampler*

☒ download data, **file**: L drive: CTD_4584

☒ new batteries

☒ set-up instrument for re-deployment

ADCP WHS300 – I – UG26: 2967

☒ download data, **file: L drive: P3_14000.000**

☒ new batteries

☒ set-up instrument for re-deployment

- erase data (p.16 WinSC)
- start WinSC for set up instrument
- set-up instrument
  - Number of bins: 30 (1-128)
  - Bin size (m): 8 (0.2-16)
  - Pings per Ensemble: 10
  - Interval: 15 min

    - Duration: 550 days
    - Transducer depth: 200 m
- save deployment settings
- start time:
- set up ADCP real time clock to PC clock
- don't verify the compass (needless on a ship)
- run pre-deployment tests to check instrument

Sediment trap shallow: Parflux No: 11966-01 top one

☒ new batteries (14x C – Cells + 1x 9V Block battery)

- **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ **Set up sediment trap with the new Aluminum cups**

PS2 SHALLOW Sediment Trap Deployment November 2015 JR15002

Schedule Verification:

Event 1 of 22 = 12-15-15
Event 2 of 22 = 01-01-16
Event 3 of 22 = 01-15-16
Event 4 of 22 = 02-01-16
Event 5 of 22 = 02-15-16
Event 6 of 22 = 03-01-16
Event 7 of 22 = 04-01-16
Event 8 of 22 = 05-01-16
Event 9 of 22 = 06-01-16

Event 10 of 22 = 07-01-16
Event 11 of 22 = 08-01-16
Event 12 of 22 = 09-01-16
Event 13 of 22 = 10-01-16
Event 14 of 22 = 11-01-16
Event 15 of 22 = 12-01-16
Event 16 of 22 = 12-15-16
Event 17 of 22 = 01-01-17
Event 18 of 22 = 01-15-17
Event 19 of 22 = 02-01-17
Event 20 of 22 = 02-15-17
Event 21 of 22 = 03-01-17
Event 22 of 22 = 04-01-17

Sediment trap deep: Parflux No: 13176-01 bottom one

☒ new batteries (14x C – Cells + 2* AAA batteries)

- **do not remove both batteries at the same time!**

- **Always disconnect the cable on the Sediment trap first, before unplugging the Computer end!!**

☒ **Set up sediment trap with the new Aluminum cups**

PS2 DEEP Sediment Trap Deployment November 2015 JR15002

Schedule Verification:

Event 1 of 22 = 12-15-15
Event 2 of 22 = 01-01-16
Event 3 of 22 = 01-15-16
Event 4 of 22 = 02-01-16
Event 5 of 22 = 02-15-16
Event 6 of 22 = 03-01-16
Event 7 of 22 = 04-01-16

Event 8 of 22 = 05-01-16
Event 9 of 22 = 06-01-16
Event 10 of 22 = 07-01-16
Event 11 of 22 = 08-01-16
Event 12 of 22 = 09-01-16
Event 13 of 22 = 10-01-16
Event 14 of 22 = 11-01-16
Event 15 of 22 = 12-01-16
Event 16 of 22 = 12-15-16
Event 17 of 22 = 01-01-17
Event 18 of 22 = 01-15-17
Event 19 of 22 = 02-01-17
Event 20 of 22 = 02-15-17
Event 21 of 22 = 03-01-17
Event 22 of 22 = 04-01-17

Current meter: Aquadopp No A2L - 1793

☒ data downloaded, **file**: L drive: P3_30401.aqd

redeployed on P2 mooring

pH sensor SAMI: PO 129

☒ data downloaded, **file**: L drive: SAMI_PO129_291015.txt

NOT redeployed

CO2 Sensor Oceanus: 33-192-75

- Remember the battery needs charging for 24 hours before deployment

☒ data downloaded, **file**: L drive: CO2_P3.txt and .pdf

NOT redeployed

Water sampler:

NOT redeployed

Seaguard current meter with O_2 sensor: 1307

Seaguard current meter serial number: 1307

Current meter sensor: 851

Optode: 1561

The seaguard current meter with O_2 sensor does not output a setup file.

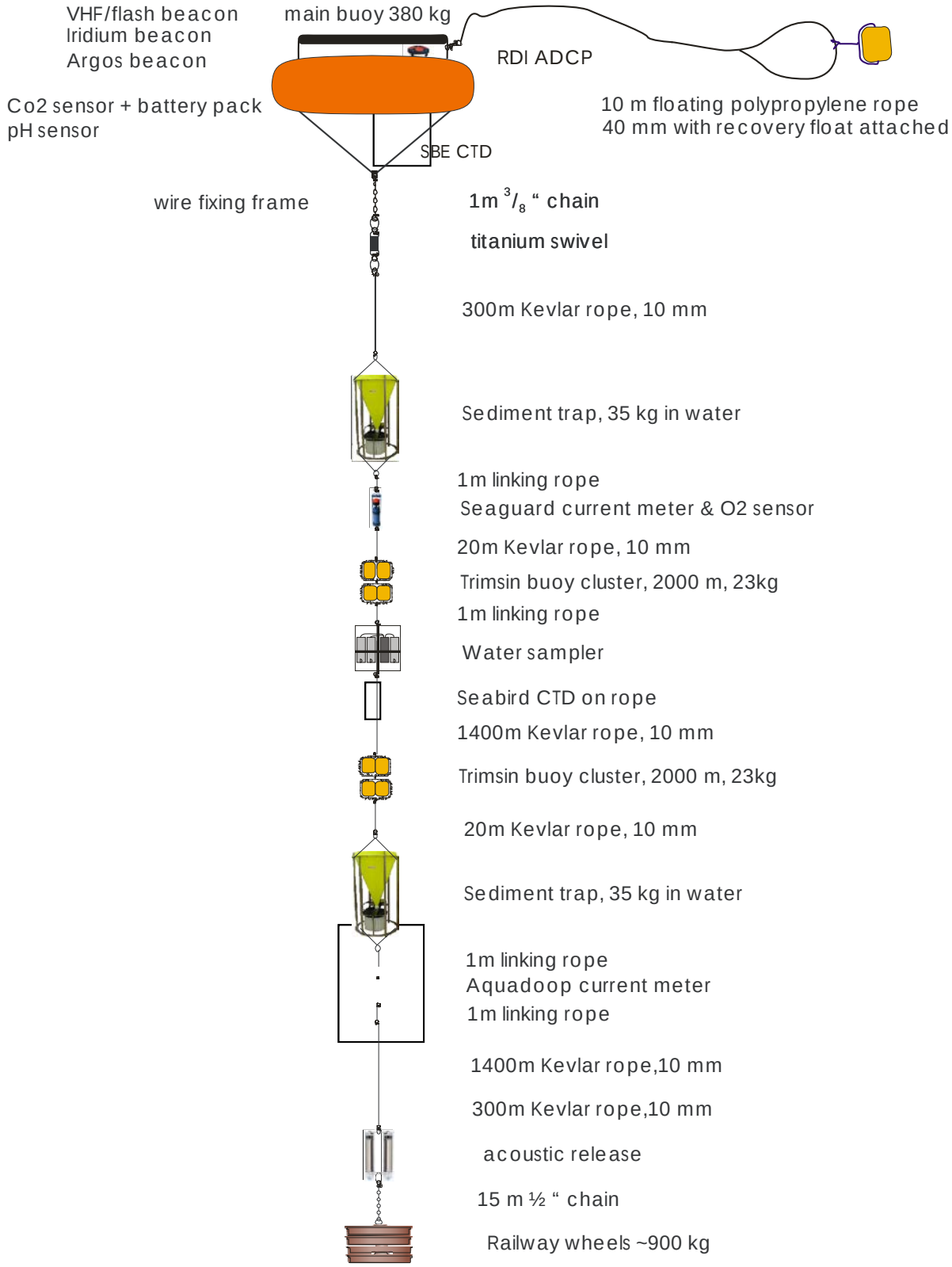
Deployment settings:

The sampling interval was set to 2 hrs, as this resulted in a deployment time of 560 days. All other settings were left at the manufacturers settings. It was checked that the current meter was set in burst mode (optimal for long term battery use). It is assumed a deployment file will be logged on the memory card for download on retrieval.

- ☒ data downloaded, **file**: L drive: 6 files, Data: DT000000.txt
- ☒ new batteries

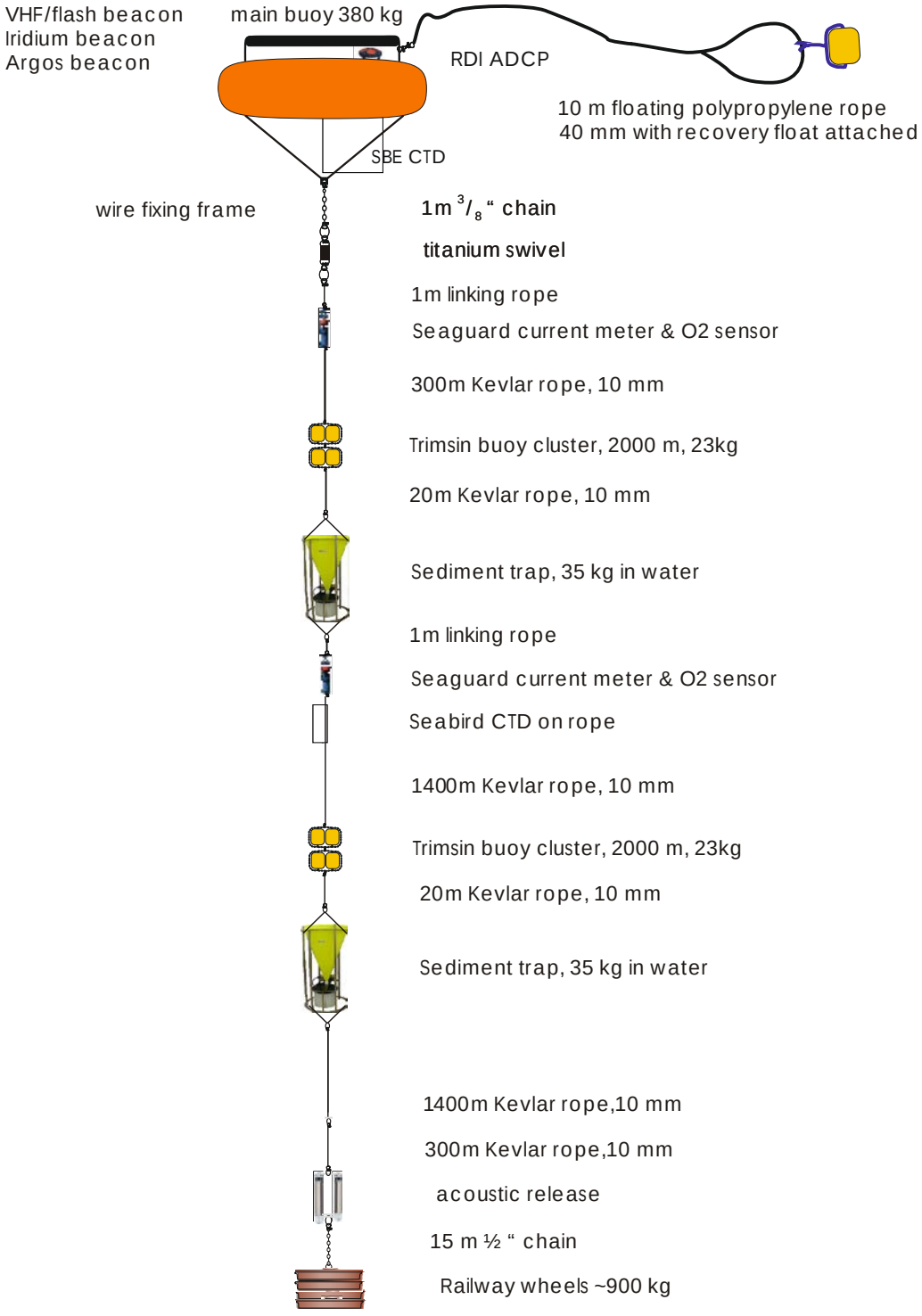
Mooring rig recovered:

P3 Sediment trap mooring (3700m water depth)



Mooring rig redeployed:

P3 Sediment trap mooring (3700m water depth)



5. Western Core Box

5.1 Introduction and Event Summary

Jon Watkins

The twentieth running of the annual WCB survey, following the standard previously well-described track and plan, started at 06:00 on Wednesday 2 December 2015, however the wind and sea state were such that after just 40 min of steaming the transect was abandoned. The restart of transect pair 1.1 and 1.2 took place on Thursday 3 December 2015 without hitch followed by the CTD and RMT8 sampling at stations WCB1.2N and WCB1.2S with successful target fishing for krill between the two stations.

On the 4th and 5th December acoustic transect pairs 2.1 and 2.2, and 3.1 and 3.2 were undertaken but the wind was not suitable for netting and so only the CTD's at the 4 stations were undertaken. The final transect pair, 4.1 and 4.2, was undertaken on 6 December and then overnight three RMT8's were target fished in the region of the shelf break.

During the day on 7 December the double oblique station tows with the RMT8 were undertaken at stations WCB3.2N, WCB2.2N and WCB2.2S. So that the only station not fully sampled was WCB3.2S. Finally target fishing with the RMT8 was carried out to obtain two good catches of krill before heading off at midnight to steam to the P2 mooring site.

5.2 Macrozooplankton

Gabriele Stowasser, Sophie Fielding, Peter Enderlein, Scott Polfrey, Geraint Tarling, Clara Manno, Cecilia Liszka and Jon Watkins

5.2.1 Gear

The RMT8 was used to characterise the macrozooplankton community in the Western Corebox in 200m oblique trawls and target trawls (Table 5.1 – RMT net events). Target trawls were undertaken on krill swarms identified from the EK60. In oblique trawls net 1 was opened at the surface and the net deployed to 200m (where water depth was sufficient) before closing and net 2 opened at 200m depth and closed at the surface. The choice of deployment type depended on the task. Target hauls were made to supply the WCB team with krill for length frequency measurements and Cecilia Liszka (PhD student at BAS) with *Euphausia superba* (Antarctic krill) for faecal pellet studies. Krill was furthermore sampled for individual weight measurements (Sophie Fielding, BAS), preservation for

genetic studies (Will Goodall-Copestake, BAS) and the development of ageing techniques (Christian Reiss, NOAA). Oblique trawls were only undertaken at the Western Core Box CTD positions. All preserved samples are listed in Table 5.2.

5.2.2 Catch Sorting and Processing

Oblique hauls

For the oblique hauls the total catch of net 2 (200m – surface) was sorted and quantified. Numbers caught and total weight was obtained for each species. For some groups specific identification was not possible and identification will be verified through re-examination in the laboratory. All material collected in net 1 (surface – 200m) was preserved in 4% formalin. Specimens of fish and various invertebrate species (including krill) were collected for a microplastics study on the food web in the Scotia Sea (Claire Waluda, BAS) and preserved at -80°C. All amphipod specimens were collected for phylogenetic analyses (Hyperiidea and Lysianassoidea) and population genetic studies (*Themisto gaudichaudii*) and preserved in 96% Ethanol, in collaboration with Charlotte Havermans (Alfred Wegener Institut, Germany). All data were recorded in an Excel database.

Targeted hauls

The catch of targeted hauls was sorted and quantified. Where live *E. superba* were caught samples were taken for individual weight measurements (Sophie Fielding, BAS). In hauls, where sufficient numbers of *E. superba* were caught, length-frequency data was collected (see chapter on krill length frequency). Krill total length was measured on 100 fresh krill, using the standard BAS measurement from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest mm (Morris et al. 1988). Maturity stage was assessed using the scale of Makarov and Denys with the nomenclature described my Morris et al. (1988).

Table 5.1: RMT8 hauls carried out on cruise JR15002.

Event No	Time and Date (GMT)	Net depth (m)	latitude	longitude	Action	Comment
78	03/12/2015 21:11	8.9	53° 50.73'S	39° 08.93'W	Net 1 opened	Oblique
78	03/12/2015 21:40	199.4	53° 50.58'S	39° 10.60'W	Net 1 closed	
78	03/12/2015 21:40	207.2	53° 50.36'S	39° 12.60'W	Net 2 opened	
78	03/12/2015 22:13	12.4	53° 50.36'S	39° 12.60'W	Net 2 closed	
79	04/12/2015 02:10	34.7	53° 46.87'S	38° 53.85'W	Net 1 opened	Target
79	04/12/2015 02:13	15.3	53° 46.86'S	38° 53.97'W	Net 1 closed	
79	04/12/2015 02:14	15.6	53° 46.86'S	38° 54.01'W	Net 2 opened	
79	04/12/2015 02:17	16.1	53° 46.84'S	38° 54.13'W	Net 2 closed	
80	04/12/2015 05:13	19.9	53° 29.54'S	39° 16.26'W	Net 1 opened	Oblique
80	04/12/2015 05:44	200.2	53° 29.60'S	39° 14.32'W	Net 1 closed	
80	04/12/2015 05:44	203.4	53° 29.60'S	39° 14.36'W	Net 2 opened	
80	04/12/2015 06:18	19.9	53° 29.54'S	39° 16.26'W	Net 2 closed	
106	06/12/2015 23:57	18	53° 49.97'S	37° 52.76'W	Net 1 opened	Target
106	07/12/2015 00:03	21	53° 50.00'S	37° 53.05'W	Net 1 closed	
106	07/12/2015 00:03	22.1	53° 50.01'S	37° 53.07'W	Net 2 opened	
106	07/12/2015 00:09	14.3	53° 50.02'S	37° 53.30'W	Net 2 closed	
107	07/12/2015 01:20	25	53° 49.85'S	37° 51.88'W	Net 1 opened	Target
107	07/12/2015 01:24	18	53° 49.85'S	37° 52.06'W	Net 1 closed	
107	07/12/2015 01:24	20.7	53° 49.85'S	37° 52.10'W	Net 2 opened	
107	07/12/2015 01:27	18.3	53° 49.86'S	37° 52.19'W	Net 2 closed	
109	07/12/2015 13:09	0.6	53° 25.97'S	38° 39.33'W	Net 1 opened	Oblique
109	07/12/2015 13:35	198	53° 21.63'S	38° 04.04'W	Net 1 closed	
109	07/12/2015 13:36	202.6	53° 21.63'S	38° 04.09'W	Net 2 opened	
109	07/12/2015 14:04	16.7	53° 21.68'S	38° 05.63'W	Net 2 closed	
110	07/12/2015 16:30	14	53° 25.98'S	38° 39.45'W	Net 1 opened	Oblique
110	07/12/2015 17:00	200.4	53° 25.95'S	38° 41.06'W	Net 1 closed	
110	07/12/2015 17:01	207.4	53° 25.94'S	38° 41.12'W	Net 2 opened	
110	07/12/2015 17:30	11.8	53° 25.96'S	38° 42.60'W	Net 2 closed	
111	07/12/2015 19:56	17.2	53° 47.60'S	38° 33.03'W	Net 1 opened	Oblique
111	07/12/2015 20:27	179	53° 47.07'S	38° 34.90'W	Net 1 closed	
111	07/12/2015 20:27	180.8	53° 47.06'S	38° 34.93'W	Net 2 opened	
111	07/12/2015 20:56	10.8	53° 46.48'S	38° 36.35'W	Net 2 closed	
112	07/12/2015 23:02	154.5	53° 45.74'S	38° 17.18'W	Net 1 opened	Target
112	07/12/2015 23:35	0.6	53° 45.60'S	38° 19.09'W	Net recovered	
113	08/12/2015 01:01	51.3	53° 44.46'S	38° 12.36'W	Net 1 opened	Target
113	08/12/2015 01:04	36.6	53° 44.48'S	38° 12.50'W	Net 1 closed	
113	08/12/2015 01:04	37.9	53° 44.48'S	38° 12.53'W	Net 2 opened	
113	08/12/2015 01:07	40.3	53° 44.49'S	38° 12.65'W	Net 2 closed	

Table 5.2: Invertebrate and fish species sampled and preserved from RMT8 hauls in the Western Core Box area during cruise JR15002

Project	Species	Event-Net	Number sampled	Storage
Krill genetics (Will Goodall-Copestake)	*Euphausia superba*	107-2	50	-80°C
	Euphausia superba	112-1	50	-80°C
	Euphausia superba	113-1	50	-80°C
Amphipod genetics (Charlotte Haverman)	Hyperiidea	78-1	2	Ethanol
	Hyperiidea	79-1	16	Ethanol
	Hyperiidea	79-2	9	Ethanol
	Hyperiidea	80-2	10	Ethanol
	Hyperiidea	106-2	1	Ethanol
	Lysianassoidea	107-1	1	Ethanol
	Lysianassoidea	107-2	1	Ethanol
	Hyperiidea	109-1	8	Ethanol
	Hyperiidea	109-2	10	Ethanol
	Hyperiidea	110-1	1	Ethanol
	Hyperiidea	110-2	6	Ethanol
	Hyperiidea	112-1	40	Ethanol
Microplastics (Claire Waluda)	Fish and invertebrates	78-2	1;107	-80°C
	Fish	80-1	13	-80°C
	Fish	80-2	14	-80°C
	Fish and invertebrates	107-1	4;10	-80°C
	Fish	107-2	2	-80°C
	Fish	109-1	1	-80°C
	Fish and invertebrates	109-2	4;1	-80°C
	Fish	110-1	4	-80°C
	Invertebrates	110-2	20	-80°C
	Invertebrates	111-2	15	-80°C
	Invertebrates	112-1	10	-80°C
Ageing techniques (Christian Reiss)	*E. superba* male and female	78-1	20	-80°C
	E. superba male and female	106-1	16	-80°C
	E. superba male and female	112-1	40	-80°C
	E. superba male and female	113-2	20	-80°C

5.3 Krill Length-Frequency and Photography

Jon Watkins

5.3.1 Introduction

Antarctic krill (*Euphausia superba*) were sampled to determine the variation in the structure of the population around South Georgia and to provide parameters required in the target strength model for krill biomass estimation.

5.3.2 Methods

Krill samples were taken from RMT8 samples where there were sufficient numbers of krill to select 100 decent state specimens for length frequency, maturity and krill shape photographs. Krill were laid out on blue plastic boards (in pre-drilled grooves) and photographed using a Nikon D810 fitted with an AF-S Micro Nikkor 60 mm f/2.8 G ED lens mounted on a copy stand (Fig. 5.1). Light was provided by two obliquely mounted Metz SCA 300 System flash guns. Two photographs of each set of krill were taken; one with krill in dorsal aspect and one with krill in lateral aspect. The same krill were then measured for length and staged. Krill total length was measured, using the standard BAS measurement from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest millimetre (Morris et al. 1988). Maturity stage was assessed using the scale of Makarov and Denys with the nomenclature described by Morris et al. (1988).

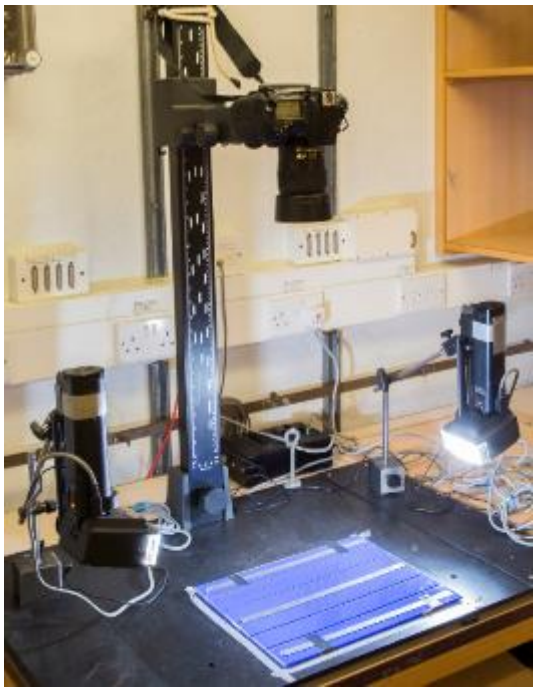


Figure 5.1. Krill photography set-up showing relative positions of flashes and camera to sample board

Camera Setup

Figure 5.1. Nikon D810 showing location of major controls used in setting up camera for krill photography

The following setup was used with the Nikon D810. Focus was set to **auto** by firstly ensuring that the focus switch on the lens was set to **M/A** (located at A on Fig. 5.2) and then adjusting the camera focus mode to **automatic zone** (by pressing centre of button B and then rotating forward control wheel E until **Auto** appears in the top LCD window). Camera mode was set to **Manual** (by pressing MODE button G and then rotating rear control wheel F until **M** appears in top left corner of top LCD window). Shutter drive was set to **S** (single shot, set by rotating collar to S as shown at D in Fig. 5.2). Exposure was set with aperture f/22 (by rotating forward control wheel E) and shutter speed 1/250 sec (by rotating rear control wheel F). Manual ISO 100 was set using ISO button and forward control wheel **E** to ensure changed from auto ISO to manual ISO and then using ISO button and rear control wheel **F** to set ISO 100. File size was set at high resolution TIFF using by holding QUAL button and rotating forward control wheel **E** to get L and TIFF on the left side of the top LCD display. Finally the flash sync cord was inserted into the socket **C** and flashes were set with control dial on **M1/4**.

A Nikon DR5 right angle viewing attachment was available but was not used because it was not possible to remove the standard eye cup.

5.3.3 Results

Krill length frequency data were input into a spreadsheet on the L drive "JR15002_krill_length_frequencies.xls. The Net event numbers from which krill were measured and whether they were photographed is identified in Table 5.1 with the mean length of those events. A full list of all photographs taken is provided in Table 5.2.

Table 5.1: Krill length frequency mean length per station

Event Number	Photo	Mean length (mm)
79_1	Y	28.23
79_2	Y	29.05
106_1	Y	30.73
106_2	Y	28.85
107_1	Y	29.37
107_2	Y	29.39
112_1	Y	50.00
113_1	Y	51.36
113_2	Y	51.36

The krill length frequency pdf for the whole cruise are shown in Figure 5.3.

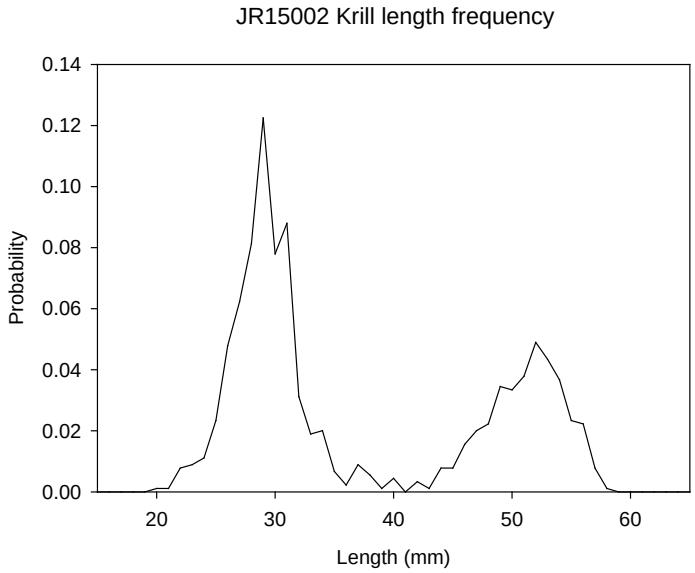


Figure 5.3 Krill length frequency for JR15002

Table 5.2: Listing of krill length photographs taken and saved on L: drive during JR15002

Filename	Event Number	Net Number	Plate/Tray No.	View
DSC_0060.TIFF	079	2	1	Lateral
DSC_0061.TIFF	079	2	1	Dorsal
DSC_0062.TIFF	079	1	1	Lateral
DSC_0063.TIFF	079	1	1	Dorsal
DSC_0064.TIFF	079	1	2	Lateral
DSC_0065.TIFF	079	1	2	Dorsal
DSC_0066.TIFF	079	2	2	Lateral
DSC_0067.TIFF	079	2	2	Lateral
DSC_0068.TIFF	079	2	2	Dorsal
DSC_0069.TIFF	079	2	2	Dorsal
DSC_0070.TIFF	079	2	3	Lateral
DSC_0071.TIFF	079	2	3	Dorsal
DSC_0072.TIFF	079	2	3	Dorsal
DSC_0073.TIFF	079	1	3	Lateral
DSC_0074.TIFF	079	1	3	Lateral
DSC_0075.TIFF	079	1	3	Dorsal
DSC_0076.TIFF	079	1	3	Dorsal
DSC_0077.TIFF	106	1	1	Lateral
DSC_0078.TIFF	106	1	2	Lateral
DSC_0079.TIFF	106	1	3	Lateral
DSC_0080.TIFF	106	1	1	Dorsal
DSC_0081.TIFF	106	1	2	Dorsal
DSC_0082.TIFF	106	1	3	Dorsal
DSC_0083.TIFF	106	2	1	Lateral
DSC_0084.TIFF	106	2	2	Lateral
DSC_0085.TIFF	106	2	1	Dorsal
DSC_0086.TIFF	106	2	2	Dorsal
DSC_0087.TIFF	106	2	3	Lateral
DSC_0088.TIFF	106	2	3	Dorsal
DSC_0089.TIFF	107	1	2	Dorsal
DSC_0090.TIFF	107	1	1	Dorsal
DSC_0091.TIFF	107	1	3	Dorsal
DSC_0092.TIFF	107	1	3	Lateral
DSC_0093.TIFF	107	1	1	Lateral
DSC_0094.TIFF	107	1	2	Lateral
DSC_0095.TIFF	107	2	3	Dorsal
DSC_0096.TIFF	107	2	3	Lateral
DSC_0097.TIFF	107	2	1	Dorsal
DSC_0098.TIFF	107	2	1	Lateral
DSC_0099.TIFF	107	2	2	Dorsal
DSC_0100.TIFF	107	2	2	Lateral
DSC_0101.TIFF	112	1	3	Dorsal
DSC_0102.TIFF	112	1	2	Dorsal
DSC_0103.TIFF	112	1	1	Dorsal

DSC_0104.TIFF	112	1	2	Lateral
DSC_0105.TIFF	112	1	3	Lateral
DSC_0106.TIFF	112	1	1	Lateral
DSC_0107.TIFF	112	1	4	Dorsal
DSC_0108.TIFF	112	1	4	Lateral
DSC_0109.TIFF	112	1	5	Dorsal
DSC_0110.TIFF	112	1	5	Lateral
DSC_0111.TIFF	113	1	1	Dorsal
DSC_0112.TIFF	113	1	1	Lateral
DSC_0113.TIFF	113	1	1	Lateral
DSC_0114.TIFF	113	1	3	Dorsal
DSC_0115.TIFF	113	1	5	Dorsal
DSC_0116.TIFF	113	1	4	Dorsal
DSC_0117.TIFF	113	1	4	Dorsal
DSC_0118.TIFF	113	1	3	Lateral
DSC_0119.TIFF	113	1	5	Lateral
DSC_0120.TIFF	113	1	4	Lateral
DSC_0121.TIFF	113	1	2	Dorsal
DSC_0122.TIFF	113	1	2	Lateral
DSC_0123.TIFF	113	2	3	Dorsal
DSC_0124.TIFF	113	2	3	Lateral
DSC_0125.TIFF	113	2	4	Dorsal
DSC_0126.TIFF	113	2	4	Lateral
DSC_0127.TIFF	113	2	5	Dorsal
DSC_0128.TIFF	113	2	2	Dorsal
DSC_0129.TIFF	113	2	5	Lateral
DSC_0130.TIFF	113	2	2	Lateral
DSC_0131.TIFF	113	2	1	Dorsal
DSC_0132.TIFF	113	2	1	Lateral

5.4 Krill Weigh Bridge

Sophie Fielding

5.4.1 Methods

The weight and density of krill was measured during JR15002 using the krill weigh bridge designed and built by Sevi Afanasyev. Krill were kept in the cold room and used when weather conditions permitted. Prior to each set of weight measurements the krill weigh bridge was set up and left connected to the battery for a minimum of an hour with the reference weight and an 80g calibration weight to establish the baseline measurements made by the load cells. After each measurement the krill was put into a single eppendorf tube and frozen at -80 °C.

Measurement protocol: The process requires an accurate measurement (on land) of the reference weight, the density bottle (and lid) and the volume of water the bottle can hold. In this case bottle "old 2" was used as this allowed the scales the largest range within poor weather conditions. The volume has been estimated from the table 5.3 below (and the known volume of bottle 3 used from cruise JR291 of 52.595 ml)

Table 5.3 Bottle measurements and estimated volumes

Bottle ID	Bottle num	Bottle wt (g)	Lid wt (g)	Both wt (g)	Both + water (g)
K67	1	26.63	5.17	31.80	83.99
K68	2	27.2318	5.2069	32.4338	84.6291
K58	3	26.9584	5.1882	32.1462	84.4319
K57	4	27.2745	5.1808	32.4552	84.5491
Old	1	28.9882	7.8093	36.7976	77.4895
Old	2	28.4704	8.5621	37.0323	76.5787

The following constants are required before use (with weights measured on land):

W_{rw} Weight of the reference weight (g) = 80 g

W_b Weight of empty bottle and lid (hereafter just referred to as bottle) (g) = 37.0323 g

V_b Volume of bottle (ml) = 39.5464 ml

Step by step procedure

1. Fill bottle to brim with water and weigh (W_1)
2. Remove ~2ml of water using a syringe and weigh (W_2)
3. Add krill to bottle and weigh (W_3)
4. Fill bottle to brim with water (same water and temperature as during 1) and weigh (W_4)

Specific gravity of the water (σ_w) used is calculated as:

$$\sigma_w = \frac{(W_1 - W_b)}{V_b}$$

Weight of krill (W_k) is calculated as:

$$W_k = W_3 - W_2$$

Weight of liquid (W_l) added is calculated as:

$$W_l = W_4 - W_k - W_b$$

Volume of liquid (V_l) in bottle is calculated as:

$$V_l = \frac{W_l}{\sigma_w}$$

Volume of krill (V_k) is calculated as:

$$V_k = V_b - V_l$$

Specific gravity of krill (σ_k) is calculated as:

$$\sigma_k = \frac{W_k}{V_k}$$

Prior to measuring krill a series of measurements were undertaken to zero the instrument and match both gain and inertia (data contained within folder “Zeroing balance”).

Checking gain

Reference weight on channel B, 50, 20 and 10 g weight on channel A

File: bln-20151202-182038.csv

Balance A has a mean of: 601.8206 and a standard deviation of: 10.8603

Balance B has a mean of: 611.5847 and a standard deviation of: 10.8968

The mean difference is: -9.7641 and a standard deviation of: 3.8709

Total number of samples used is: 1293 out of 1294

Reference weight on channel B, 50, 20, 10 and 5 g weight on channel A

File: bln-20151202-182659.csv

Balance A has a mean of: 816.5877 and a standard deviation of: 8.1036

Balance B has a mean of: 612.705 and a standard deviation of: 7.7313

The mean difference is: 203.8828 and a standard deviation of: 3.7675

Total number of samples used is: 1288 out of 1288

Reference weight and 5 g on channel B, 50, 20, and 10 g weight on channel A

File: bln-20151202-182851.csv

Balance A has a mean of: 602.3667 and a standard deviation of: 10.9509

Balance B has a mean of: 826.72 and a standard deviation of: 11.4973

The mean difference is: -224.3532 and a standard deviation of: 4.1118

Total number of samples used is: 1257 out of 1257

Obviously need to balance the offset. So zeroed the offset.

File: bln-20151202-185422.csv

Balance A has a mean of: 608.7503 and a standard deviation of: 9.5545

Balance B has a mean of: 608.6633 and a standard deviation of: 8.8861

The mean difference is: 0.087008 and a standard deviation of: 4.4607

Total number of samples used is: 1678 out of 1685

Checking inertia

Reference weight on channel B, 50, 20, 10 and 5 g weight on channel A

File: bln-20151202-185846.csv

Balance A has a mean of: 822.266 and a standard deviation of: 13.4672

Balance B has a mean of: 608.419 and a standard deviation of: 12.7579

The mean difference is: 213.847 and a standard deviation of: 5.6406

Total number of samples used is: 1222 out of 1227

Reference weight and 5 g on channel B, 50, 20, and 10 g weight on channel A

File: bln-20151202-190004.csv

Balance A has a mean of: 609.2072 and a standard deviation of: 7.487

Balance B has a mean of: 823.4595 and a standard deviation of: 6.7058

The mean difference is: -214.2523 and a standard deviation of: 4.3368

Total number of samples used is: 1086 out of 1094

File: bln-20151202-190440.csv

Balance A has a mean of: 609.0568 and a standard deviation of: 10.5007

Balance B has a mean of: 608.5971 and a standard deviation of: 10.1067

The mean difference is: 0.45971 and a standard deviation of: 4.2701

Total number of samples used is: 3624 out of 3640

To ensure lack of inertia

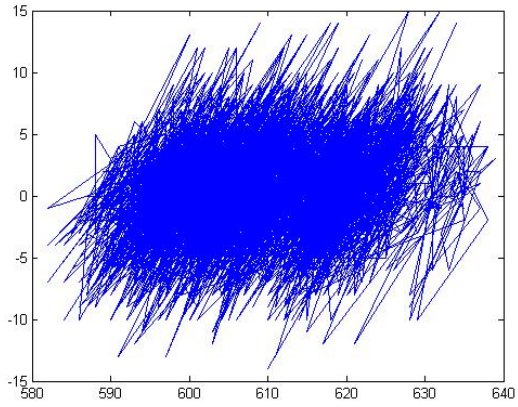


Figure 5.4

5.4.2 Krill Measurement Results

A total of 15 krill were measured, collected from events 107 (small krill) and 113 (large krill). Table Krill weights contains all the measurements of krill and their relevant files saved within the legwork folder. The relationship between krill length and weight are given in Figure 5.5.

Table 5.6 Krill weights

Krill number	Balance A (g)	Balance B	Filename	Temperature	Salinity	Length	Stage	Weight	Comments
Blank	80	Ref weight	20151207-191758	2.047	33.868				
1	78	Bottle full water	20151207-192619	2.047	33.868	40	MS1		
1	76.02	Bottle - 2ml	20151207-193129	2.047	33.868	40	MS1		
1	76.7	Bottle + krill	20151207-194010	2.047	33.868	40	MS1	0.68	
1	77.95	Bottle + krill + water	20151207-194521	2.047	33.868	40	MS1		
2	78	Bottle full water	20151207-195122	2.047	33.868	28	J		
2	75.35	Bottle - 2ml	20151207-195653	2.047	33.868	28	J		
2	75.5	Bottle + krill	20151207-195913	2.047	33.868	28	J	0.15	
2	78	Bottle + krill + water	20151207-200126	2.047	33.868	28	J		
3	78.03	Bottle full water	20151207-201432	2.047	33.868	55	FA3		
3	75.54	Bottle - 2ml	20151207-201732	2.047	33.868	55	FA3		
3	77.58	Bottle + krill	20151207-202017	2.047	33.868	55	FA3	2.04	
3	78.27	Bottle + krill + water	20151207-202316	2.047	33.868	55	FA3		
4	78.01	Bottle full	20151207-	2.047	33.868	27	J		

		water	203110					
4	75.3	Bottle - 2ml	20151207-203326	2.047	33.868	27	J	
4	75.46	Bottle + krill	20151207-203518	2.047	33.868	27	J	0.16
4	78	Bottle + krill + water	20151207-203737	2.047	33.868	27	J	
Blank	80	Ref weight	20151207-213048	2.047	33.868			
5	78.05	Bottle full water	20151207-213352	2.047	33.868	44	MA2	
5	75.15	Bottle - 2ml	20151207-214040	2.047	33.868	44	MA2	
5	75.85	Bottle + krill	20151207-214336	2.047	33.868	44	MA2	0.7
5	78.04	Bottle + krill + water	20151207-214752	2.047	33.868	44	MA2	
6	78.02	Bottle full water	20151207-215350	2.047	33.868	30	J	
6	76.14	Bottle - 2ml	20151207-215645	2.047	33.868	30	J	
6	76.33	Bottle + krill	20151207-215933	2.047	33.868	30	J	0.19
6	78	Bottle + krill + water	20151207-220155	2.047	33.868	30	J	
7	78.05	Bottle full water	20151207-220738	2.047	33.868	51	MA2	
7	76.65	Bottle - 2ml	20151207-220925	2.047	33.868	51	MA2	
7	77.83	Bottle + krill	20151207-221228	2.047	33.868	51	MA2	1.18
7	78.13	Bottle + krill	Not	2.047	33.868	51	MA2	

		+ water	recorded						
8	78.07	Bottle full water	20151207-221944	2.047	33.868	28	J		
8	76.39	Bottle - 2ml	20151207-222205	2.047	33.868	28	J		
8	76.55	Bottle + krill	20151207-222417	2.047	33.868	28	J	0.16	
8	78.04	Bottle + krill + water	20151207-222829	2.047	33.868	28	J		
Blank	80	Ref weight	20151209-165151	2.426	33.89				
9	78	Bottle full water	20151209-165713	2.426	33.89	32	J		
9	75.73	Bottle - 2ml	20151209-170213	2.426	33.89	32	J		
9	75.99	Bottle + krill	20151209-170454	2.426	33.89	32	J	0.26	
9	77.97	Bottle + krill + water	20151209-171535	2.426	33.89	32	J		Need to check file name
10	77.97	Bottle full water	20151209-174621	2.426	33.89	27	J		Need to check length of krill
10	76.75	Bottle - 2ml	20151209-174913	2.426	33.89	27	J		
10	76.92	Bottle + krill	20151209-175335	2.426	33.89	27	J	0.17	
10	77.95	Bottle + krill + water	20151209-175638	2.426	33.89	27	J		
11	78	Bottle full water	20151209-190312	2.426	33.89	36	FS1		
11	76.23	Bottle - 2ml	20151209-	2.426	33.89	36	FS1		

			191045					
11	76.63	Bottle + krill	20151209-191442	2.426	33.89	36	FS1	0.4
11	77.97	Bottle + krill + water	20151209-192214	2.426	33.89	36	FS1	
12	78	Bottle full water	20151209-192818	2.426	33.89	46	MA1	
12	76.04	Bottle - 2ml	20151209-193030	2.426	33.89	46	MA1	
12	76.85	Bottle + krill	20151209-193429	2.426	33.89	46	MA1	0.81
12	78.02	Bottle + krill + water	20151209-193702	2.426	33.89	46	MA1	
13	77.95	Bottle full water	20151209-000000	2.426	33.89	31	J	
13	76.27	Bottle - 2ml	20151209-000000	2.426	33.89	31	J	
13	76.51	Bottle + krill	20151209-000000	2.426	33.89	31	J	0.24
13	77.94	Bottle + krill + water	20151209-000000	2.426	33.89	31	J	
14	77.98	Bottle full water	20151209-000000	2.426	33.89	28	J	
14	76.14	Bottle - 2ml	20151209-000000	2.426	33.89	28	J	
14	76.35	Bottle + krill	20151209-000000	2.426	33.89	28	J	0.21
14	77.97	Bottle + krill + water	20151209-000000	2.426	33.89	28	J	
15	78	Bottle full water	20151209-000000	2.426	33.89	37	FS1	
15	76.3	Bottle - 2ml	20151209-	2.426	33.89	37	FS1	

			000000					
15	76.75	Bottle + krill	20151209-000000	2.426	33.89	37	FS1	0.45
15	77.98	Bottle + krill + water	20151209-000000	2.426	33.89	37	FS1	

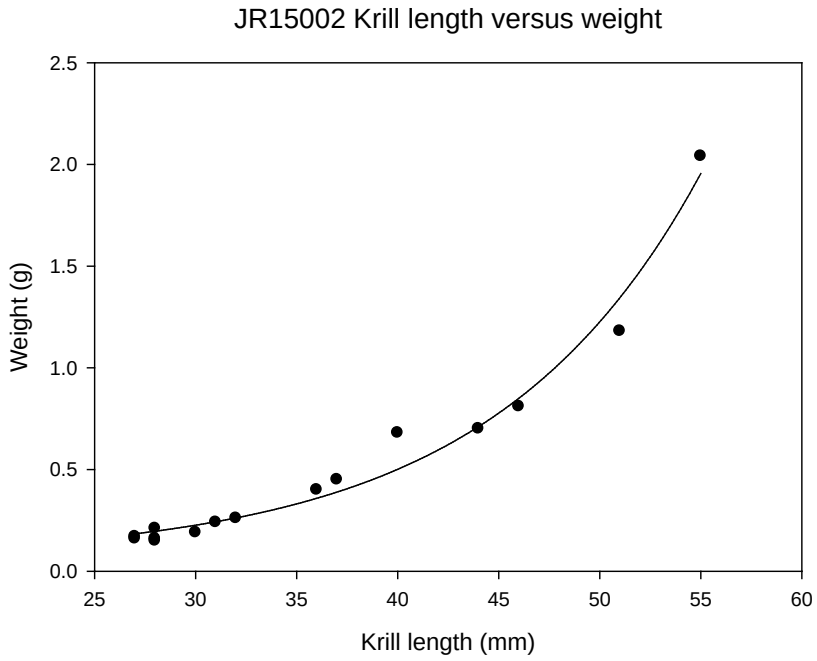


Figure 5.5 Relationship between krill length and weight.

6. Time Series Stations

6.1 Net Sampling

6.1.1 MOCNESS

Geraint Tarling

The MOCNESS has been refitted with the down-wire net monitor system, including flow-meter and temperature sensor. A signal is given to the cogging mechanism via the Labview software, which controls all communications with the net during the deployment. The original feedback mechanism has been removed given its unreliability and the deployment is run without any feedback on cogging and the incrementing of nets. The net was deployed twice during this cruise, both times at P2 – night-time (Event 54, 30/11) and daytime (Event 61, 1/12). Sampling depths were as listed in table 6.1 below. All samples were preserved in 70% buffered ethanol.

Table 6.1: Timings and sampling depths for MAMMOTH deployments on JR15002

Time (GMT)	Bridge Event no.	Net no.	Latitude	Longitude	Water Depth (m)	Net Open Depth (m)	Net Close Depth (m)
30/11/2015 20:45	52		-55.2544	-41.2402	3350.27	net deployed	
30/11/2015 21:40	52	1	-55.2819	-41.2014	3300.65	0	1000
30/11/2015 21:46	52	2	-55.2269	-41.2198	3233.27	1000	875
30/11/2015 21:56	52	3	-55.2269	-41.2198	3233.27	875	750
30/11/2015 22:04	52	4	-55.2282	-41.2228	3242.44	750	625
30/11/2015 22:10	52	5	-55.2315	-41.2316	3268.63	625	500
30/11/2015 22:23	52	6	-55.2337	-41.2353	3289.77	500	375
30/11/2015 22:34	52	7	-55.2369	-41.2417	3313.86	375	250
30/11/2015 22:43	52	8	-55.2386	-41.2459	3324.63	250	125
30/11/2015 22:52	52	9	-55.2402	-41.2492	3334.22	125	5
30/11/2015 22:58	52		-55.2418	-41.2525	3345.55	net recovered	
01/12/2015 08:30	61		-55.2819	-41.2014	3300.65	net deployed	
01/12/2015 09:36	61	1	-55.2571	-41.2369	3344.61	0	1000
01/12/2015 09:44	61	2	-55.2544	-41.2402	3350.27	998	875
01/12/2015 09:50	61	3	-55.2519	-41.2434	3352.83	875	750
01/12/2015 09:55	61	4	-55.2495	-41.2467	3354.00	750	625
01/12/2015 10:02	61	5	-55.2470	-41.2510	3355.87	625	500
01/12/2015 10:09	61	6	-55.2447	-41.2569	3360.91	500	375
01/12/2015 10:17	61	7	-55.2417	-41.2634	3364.20	375	250
01/12/2015 10:28	61	8	-55.2379	-41.2702	3367.64	250	125
01/12/2015 10:35	61	9	-55.2379	-41.2702	3367.64	125	5
01/12/2015 10:38	61		-55.2351	-41.2761	3369.95	net recovered	

The following specimens were removed from the catches prior to preservation

Event 61, net number 9 – 71 adult pteropods, Ev 61, net number 8 - 98 adult pteropods

6.1.2 MAMMOTH

Geraint Tarling

The Mammoth net (Fig. 6.1) is a multi-net sampler that can be deployed either in a vertical mode or hauled and deployed obliquely. The frame has a mouth opening of $1m^2$ and it is equipped with 9 nets that are opened and closed in sequence via spring-loaded dropping bars. The net can be deployed without any single net being open, so 9 nets can be opened and closed during its upward trajectory. We equipped the net with 300 µm mesh nets. Deployments were made in vertical mode over the stern using the bio-wire. The cod-ends were held in a purpose-built frame. Communication was maintained with the net throughout deployments (it is also possible to programme the instrument in advance and not require communication during deployment).

This was the first use of the Mammoth multi-net since its purchase in summer 2015. Test deployments were made in Falkland Island waters (events 2, 3 and 4) to practise deployment and recovery methods and check instruments were working and the firing mechanism was functional. Tests went according to plan and a deployment protocol using the side wires on the gantry was determined.

Science deployments were as follows: P2 daytime deployment (Event 45, 30/11), P2 night time (Event 55, 1/12), P3 daytime (Event 131, 9/12) – see Table 6.2 below. The net was paid out at 40 m/min and hauled in at 40 m/min until 250 m, when the hauling speed was reduced to 10 m/min. Set depths (m) were: 1000-700, 700-400, 400-300, 300-250, 250-200, 200-150, 150-100, 100-50, 50-5. This division of depths was to maximise resolution in the surface layers.

There was a malfunction before P2 night due to a hot plugging incident and a new fuse was required. The temperature sensor from then on was not functional, but all other functions were as normal. There were no issues in firing and the net performed as expected in all three deployments.

All samples were preserved in 70% buffered ethanol, mainly 250 ml bottles, with sample 9 sometimes being subsampled and placed in 500 ml bottles

Table 6.2: Mammoth net deployments during JR15002

Time (GMT)	Event no.	Net no.	Lat	Long	Water depth (m)	Open (m)	Close (m)
11/11/2015 21:24	2		-51.85852	-57.86733	66.81		
11/11/2015 21:29	2		-51.85854	-57.86732	66.84		
11/11/2015 21:39	3		-51.85854	-57.86732	66.84		
11/11/2015 21:58	3		-51.85852	-57.86737	66.82		
11/11/2015 22:02	4		-51.85855	-57.86732	66.62		
11/11/2015 22:11	4		-51.85854	-57.86732	66.82		
30/11/2015 15:59	45		-55.24282	-41.2572	3356.91	deployed	
30/11/2015 16:24	45	1	-55.24281	-41.25721	3357.01	1000	700
30/11/2015 16:34	45	2	-55.24278	-41.25718	3354.62	700	400
30/11/2015 16:42	45	3	-55.24282	-41.2572	3356.91	400	300
30/11/2015 16:49	45	4	-55.24282	-41.2572	3356.91	300	250
30/11/2015 16:54	45	5	-55.24283	-41.2572	3356.99	250	200
30/11/2015 17:00	45	6	-55.24282	-41.25721	3357.34	200	150
30/11/2015 17:05	45	7	-55.2428	-41.25721	3356.63	150	100
30/11/2015 17:10	45	8	-55.24281	-41.25723	3357.1	100	50
30/11/2015 17:16	45	9	-55.24281	-41.2572	3356.83	50	5
30/11/2015 17:21	45	9	-55.24283	-41.25721	3357.13	50	5
30/11/2015 17:25	45		-52.81185	-40.0869	3785.7	recovered	
01/12/2015 01:20	55		-55.24332	-41.25956	3362.13	deployed	
01/12/2015 01:50	55	1	-55.24327	-41.25954	3361.34	1000	700
01/12/2015 01:58	55	2	-55.24328	-41.25954	3361.83	700	400
01/12/2015 02:05	55	3	-55.24328	-41.25954	3361.92	400	300
01/12/2015 02:12	55	4	-55.24328	-41.25955	3361.97	300	250
01/12/2015 02:16	55	5	-55.24329	-41.25956	3361.91	250	200
01/12/2015 02:20	55	6	-55.2433	-41.25956	3361.62	200	150
01/12/2015 02:24	55	7	-55.24331	-41.25955	3362.27	150	100
01/12/2015 02:28	55	8	-55.24331	-41.25956	3362.22	100	50
01/12/2015 02:32	55	9	-55.24331	-41.25957	3361.89	50	5
01/12/2015 02:37	55	9	-55.24332	-41.25956	3362.08	50	5
01/12/2015 02:54	55		-55.24332	-41.25956	3362.13	recovered	
09/12/2015 02:12	131		-52.81185	-40.0869	3785.7	deployed	
09/12/2015 02:45	131	1	-52.81184	-40.08687	3795.92	1000	700
09/12/2015 02:56	131	2	-52.81184	-40.0869	3785.8	700	400
09/12/2015 03:07	131	3	-52.81186	-40.08687	3786.31	400	300
09/12/2015 03:14	131	4	-52.81185	-40.08685	3786.1	300	250
09/12/2015 03:18	131	5	-52.81185	-40.08685	3786.29	250	200
09/12/2015 03:22	131	6	-52.81184	-40.08685	3786.18	200	150
09/12/2015 03:26	131	7	-52.81183	-40.08685	3786.11	150	100
09/12/2015 03:31	131	8	-52.81182	-40.08685	3796.17	100	50
09/12/2015 03:35	131	9	-52.81182	-40.08686	3794.98	50	5
09/12/2015 03:39	131	9	-52.81182	-40.08686	3794.98	50	5
09/12/2015 03:51	131		-52.81182	-40.08684	3794.82	recovered	

The following specimens were removed from the samples before preservation

Event 55 net 9 - 73 adult Pterepods

Fig. 6.1: Mammoth net

6.1.3 Bongo Nets

Geraint Tarling

The cod-end buckets on the Bongo nets were modified such that they could be unclasped at the end of every haul. This modification was to enable the catch to be taken off the net in its entirety and then processed in ways that were sympathetic to delicate organisms (e.g. shelled pteropods). 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 often a backlog of sample within the net (resulting from phytoplankton clogging). Therefore, none of the preserved samples represent a quantitative estimate of the total catch (between 5 and 20% of each catch was spilled).

The Bongo net was deployed opportunistically at CTD stations, Process stations and other sites where there was sufficient time for their deployment. The net was fitted with 100µm and 200µm meshes. The majority of deployments were to a maximum depth of 200 m, with one to 100 m. The main purpose of the nets was for catching shelled pteropods. The majority of net samples were then discarded, with a small number being preserved either in formalin or buffered 70% ethanol.

The net performed as expected throughout the cruise. Modifications will be required to minimise the amount of spillage on future cruises.

Table 6.3: Bongo net deployments on JR15002

Time in (GMT)	Time out (GMT)	Lat	Long	Max depth (m)	Water depth (m)	Event no.	Fate
21/11/2015 02:28	21/11/2015 02:52	-59.68864	-44.05425	200	4155.96	12	Formalin (100um, 200um)
21/11/2015 02:53	21/11/2015 03:11	-59.68868	-44.05425	200	4157.12	13	Formalin (100um, 200um)
21/11/2015 03:14	21/11/2015 03:23	-59.68868	-44.05422	100	4152.82	14	Formalin (100um, 200um)
21/11/2015 14:16	21/11/2015 14:36	-58.02195	-42.9829	200	2847.17	17	Formalin (100um, 200um)
21/11/2015 14:38	21/11/2015 14:56	-58.0183	-42.99111	200	2848.7	18	Formalin (100um, 200um)
22/11/2015 16:24	22/11/2015 16:36	-55.24265	-41.25756	200	3357.43	22	Formalin (100um, 200um)

22/11/2015 16:38	22/11/2015 16:53	-55.2427	-41.25785	200	3358.03	23	Formalin (100um, 200um)
22/11/2015 16:56	22/11/2015 17:14	-55.24293	-41.25864	200	3359.78	24	Formalin (100um, 200um)
28/11/2015 17:56	28/11/2015 18:15	-55.24671	-41.25465	200	3360.86	33	Not retained
28/11/2015 18:17	28/11/2015 18:35	-52.81187	-40.11325	200	NA	34	Not retained
30/11/2015 15:00	30/11/2015 15:15	-55.24298	-41.25681	200	3356.64	43	Not retained
30/11/2015 15:15	30/11/2015 15:35	-55.24298	-41.25681	200	3357.07	44	Not retained
30/11/2015 23:43	01/12/2015 00:10	-55.24334	-41.25954	200	3362.07	53	Not retained
01/12/2015 00:11	01/12/2015 00:35	-55.24426	-41.25777	200	3361.3	54	Not retained
01/12/2015 04:00	01/12/2015 04:15	-55.24388	-41.2584	200	3360.92	56	Not retained
01/12/2015 04:18	01/12/2015 04:32	-55.24352	-41.25929	200	3361.9	57	Not retained
01/12/2015 07:11	01/12/2015 07:26	-55.24577	-41.25569	200	3360.2	59	Not retained
01/12/2015 07:31	01/12/2015 07:47	-55.24577	-41.25569	200	3360.2	60	Not retained
08/12/2015 16:17	08/12/2015 16:30	-52.81174	-40.11167	200	3785.66	122	Not retained
08/12/2015 20:53	08/12/2015 21:11	-52.82042	-40.11401	200	3650.11	124	Ethanol (1 sample only)
08/12/2015 21:14	08/12/2015 21:35	-52.8204	-40.11389	200	3348.1	125	Not retained
09/12/2015 01:50	09/12/2015 01:50	-52.81181	-40.08688	200	3786.08	130	Not retained
09/12/2015 14:01	09/12/2015 14:20	-52.62719	-39.11511	200	3740.24	137	Ethanol (100um, 200um)
09/12/2015 14:38	09/12/2015 14:24	-52.62721	-39.11512	200	3740.24	138	Not retained
09/12/2015 14:39	09/12/2015 14:56	-52.62713	-39.11566	200	3740.24	139	Not retained
10/12/2015 11:16	10/12/2015 11:33	-52.62626	-39.11401	200	3740.24	143	Not retained
10/12/2015 11:35	10/12/2015 11:48	-52.62708	-39.11492	200	3732.11	144	Not retained
10/12/2015 11:50	10/12/2015 12:01	-52.6272	-39.11513	200	3731.62	145	Not retained

6.1.4 Open-Closing Net WP2

Geraint Tarling

This is a 50 cm diameter ring net, attached to a brass jaw mechanism which releases firstly the net ring and then the net bridle on impact of two consecutive messengers. The first messenger opens the net for sampling, the second, closes it through strangling the mid-section of the net with a rope with which the net is finally recovered. The net was equipped with either a 200 µm or 53 µm mesh net, the former for zooplankton community incubations (Liszka), the latter for formanifera (Ok). Deployments were made vertically to a maximum of 400 m. The first messenger was sent on reaching the maximum haul depth and, after the messenger impact was felt, the net hauled up to a second depth (usually 50 to 100 m above the deepest depth), where the second messenger was sent. The net was recovered to the surface after the impact of the second messenger. In so doing, a discrete depth layer was sampled.

Successful tests were made in Falkland Island waters (Events 6 and 7). The net proved to be very difficult to operate in open ocean conditions, particularly at sea states above 4. Entanglement of one or more ropes was common, and by the end of the cruise, the wire became twisted to the extent that it started to knot during deployments. Probably the most difficult part of the deployment was during the initial submergence at the surface where the jaw mechanism would overtake the net and entanglements would be common. Also, the 53 µm net was difficult to submerge since air was often entrapped, creating a balloon that floated on the surface.

Failures to open and close were common, with the rate of failure increasing towards the end of the cruise, being a combination of twisting memory in the wire and sea state. Nevertheless, adequate sets of samples were obtained to facilitate active flux incubations at P3 and the upwelling station (200 µm mesh deployments), and in obtaining foraminifera samples (53 µm deployments).

It is not recommended that this net be deployed in future unless in the very calmest of conditions.

Table 6.4: Opening-closing WP2 deployments on JR15002

Time (GMT)	Lat	Long	Event	Net Open Depth (m)	Net Close Depth (m)	Mesh Size (µ)	Net catch fate
21/11/2015 03:40	-59.6887	-44.0542	15	400	300	200	
28/11/2015 18:48	-52.8121	-40.1129	35	150	100	200	
28/11/2015 19:03	-52.8121	-40.1128	36	200	150	200	discarded
28/11/2015 19:27	-52.8121	-40.1129	37	200	150	200	discarded
28/11/2015 20:05	-52.8121	-40.1128	38	200	150	200	used for incubations
28/11/2015 20:25	-52.8122	-40.1126	39	250	0	200	picked for Pterepods (RO) - rest discarded
30/11/2015 14:12	-55.2428	-41.2575	41	200			
30/11/2015 14:38	-55.2428	-41.2575	42	100			
30/11/2015 17:57	-55.2428	-41.2572	46	50	0	53	preserved in buffered formaldehyde
30/11/2015 18:10	-55.2428	-41.2572	47	100	50	53	
30/11/2015 18:16	-55.2428	-41.2572	48	100	50	53	
30/11/2015 18:22	-55.2428	-41.2572	49	100	50	53	preserved in buffered formaldehyde
30/11/2015 18:44	-55.2428	-41.2572	50	200	100	53	preserved in buffered formaldehyde
30/11/2015 19:22	-55.243	-41.257	51	400	200	53	preserved in buffered formaldehyde
01/12/2015 22:07	-55.2435	-41.2573	67	200	150	200	Discarded as net failed
01/12/2015 22:35	-55.2435	-41.2573	68	100	50	200	None as didn't work
01/12/2015 22:55	-55.2435	-41.2573	69	100	50	200	None as didn't open
01/12/2015 23:21	-55.2435	-41.2573	70	100	50	200	Used for incubations
08/12/2015 13:42	-52.8118	-40.1117	115	150	100	200	Failed
08/12/2015 14:12	-52.8118	-40.1117	116	150	100	200	Used for incubations
08/12/2015 14:32	-52.8118	-40.1117	117	200	150	200	Used for incubations
08/12/2015 14:58	-52.8117	-40.1117	118	150	100	200	Used for incubations
08/12/2015 15:13	-52.8117	-40.1116	119	200	150	200	Used for incubations
08/12/2015 15:34	-52.8117	-40.1117	120	150	100	200	Used for incubations
08/12/2015 15:52	-52.8117	-40.1116	121	200	150	200	Used for incubations
08/12/2015 21:47	-52.8204	-40.1139	126	50	0	53	preserved in formaldehyde
08/12/2015 22:03	-52.8204	-40.1139	127	100	50	53	Preserved in buffered formaldehyde
08/12/2015 22:29	-52.8204	-40.1139	128	200	100	53	Preserved in buffered formaldehyde
08/12/2015 23:08	-52.8204	-40.1139	129	400	200	53	Preserved in buffered formaldehyde
09/12/2015 04:55	-52.8118	-40.0869	132	150	100	200	Used for incubations
09/12/2015 05:32	-52.8119	-40.0868	133	200	150	200	Used for incubations
09/12/2015 06:05	-52.8118	-40.0869	134	150	100	200	Used for incubations
09/12/2015 06:31	-52.8118	-40.0869	135	200	150	200	Used for incubations
10/12/2015 12:10	-52.6272	-39.1151	146	100	50	200	
10/12/2015 12:40	-52.6272	-39.1151	147	150	100	200	

10/12/2015 12:48	-52.6272	-39.1152	148			200	net failed
10/12/2015 13:04	-52.6272	-39.1152	149			200	net failed
10/12/2015 13:21	-52.6272	-39.1152	150			200	net failed
10/12/2015 13:36	-52.6271	-39.1153	151			200	net failed
10/12/2015 13:48	-52.6271	-39.1152	152			200	net failed
10/12/2015 14:32	-52.6272	-39.1152	153	50	0	53	preserved in buffered formaldehyde
10/12/2015 14:41	-52.6272	-39.1152	154	100	50	53	Preserved in buffered formaldehyde
10/12/2015 14:58	-52.6271	-39.1153	155	200	100	53	discarded
10/12/2015 16:04	-52.6272	-39.1152	156	200	100	53	preserved in buffered formaldehyde
10/12/2015 16:54	-52.6272	-39.1154	157	400	200	53	discarded
10/12/2015 21:14	-52.6269	-39.1158	158	150	100	200	Incubations for Cecelia
10/12/2015 21:47	-55.2435	-41.2573	159	100	0	200	Net failed to close at 50 m so hauled open to surface - catch still valid for incubations
10/12/2015 22:18	-52.6293	-39.1158	160	150	100	200	Net failed - Pterepods taken then discarded
10/12/2015 23:01	-52.6306	-39.1164	161	150	100	200	Net failed

6.1.5 Net Traps

Geraint Tarling

This is a pair of nets that are deployed simultaneously, one facing upwards, the other facing downwards. They are sent to the same depth, where they are opened. They sample through plankton either swimming downwards or upwards respectively into the nets. After a period of time, the nets are closed again and recovered to the surface. The upward looking net has two conjoined rings (a bongo net) while the downward looking net is a single net with lead weights on the (downward looking) net-ring. The respective nets are connected to a brass jawed-mechanism which sequentially opens and closes the nets through brass messengers sent down the wires. The upward looking net was deployed from the mid-ships gantry; downward looking net from the starboard aft mooring winch, via a block from the deck and a second one held by the Effer crane. Both sets of nets were equipped with 200 µm mesh nets.

The nets were used successfully at dawn and then late afternoon at station P2 on the 1st December. On descending to a depth of 100 m, the nets were opened with the first messenger and left for 15 minutes before being closed by the second messenger and then

recovered to the surface. The samples were filtered through a 200 µm mesh and the loaded mesh frozen in its entirety at -80°C.

In future deployments, it is advisable that operations are underway for deploying the net from the starboard aft winch in advance of the mid-ships gantry since the former takes longer to deploy. There are some concerns of contamination during the descent and a means of covering the net openings to prevent sampling is advisable.

Note that the downward looking net was used at the upwelling station in an attempt to obtain stratified net samples in heavy swell. The attempts were not successful, mainly due to jamming in the jaw mechanism.

Table 6.5: Net trap deployments during cruise

Time (GMT)	Lat	Long	Net depth (m)	Event	Trap type	Action
01/12/2015 06:33	-55.2437	-41.2588	100	58	Upward	Net deployed
01/12/2015 06:33	-55.2437	-41.2588	100	58	Downward	Net deployed
01/12/2015 06:46	-55.2442	-41.2578	100	58	Upward	Net recovered
01/12/2015 06:46	-55.2442	-41.2578	100	58	Downward	Net recovered
01/12/2015 17:15	-55.2438	-41.2551	100	64	Upward	Rigging error
01/12/2015 17:34	-55.2435	-41.2578	100	64	Upward	Rigging error
01/12/2015 17:50	-55.2436	-41.2571	100	65	Upward	Net deployed
01/12/2015 17:50	-55.2436	-41.2571	100	65	Downward	Net deployed
01/12/2015 18:08	-55.2437	-41.2556	100	65	Upward	Net recovered
01/12/2015 18:13	-52.6273	-39.1157	100	65	Downward	Net recovered

6.2 Pteropod Observation and Incubation: Responses to Ocean Acidification

6.2.1 Incubation of Pteropods to Observe Calcification and Physiological Responses to Ocean Acidification

Jessie Gardner

6.2.1.1 Introduction

Pteropods are free-floating holoplanktonic gastropods that are ubiquitous and abundant within the world's oceans. Fewer pteropods have adapted to the Southern Ocean including the shelled thecosome *Limacina helicina Antarctica* and *Limacina retroversa.* Both species are characterised by their delicate shells made of aragonite, a polymorph of calcium carbonate with lower stability that may be particularly susceptible to forecasted changes in sea water carbonate chemistry. The shells have been indicated as major contributors to carbonate flux and organic carbon flux and carbon sequestration within the Southern Ocean (Manno *et al.*, 2010). Both species can dominate zooplankton communities, for example *Limacina retroversa* abundance has been reported as over 67,800 individuals per 1000 m^3 around sub-Antarctic Patagonia (Dadon, 1990) while *Limacina helicina* accounted for 63 % of total zooplankton in the Ross Sea (Hunt *et al.,* 2008). Ecosystem studies have indicated that pteropods are key components of high latitude pelagic food webs (Armstrong *et al.*, 2005).

The ecological and biogeochemical significance of pteropods coupled with susceptibility to ocean acidification has increased their suitability as key environmental indicators of oceanic health (Orr *et al.*, 2005). This has initiated numerous studies into the response and vulnerability of these polar species to projected changes, yielding results of shell dissolution, reduced generation time and reductions in growth (Bednarsek *et al.,* 2012; Manno *et al.*, 2012). Despite this, key knowledge gaps remain. This includes pteropod response during specific stages of life cycles considered most vulnerable, such as early developmental and reproductive stages (Byrne, 2011; Guo *et al.*, 2015). Additionally, whether interspecific differences between the tolerance, life history and physiology of polar species such as *Limacina helicina antarctica* and *Limacina retroversa* remains unknown. Such differences might cause shifts in southern communities, population dynamics and oceanic range.

This project has three major themes that will be addressed by the following objectives:

1. Identify physiological responses of *Limacina helicina Antarctica* and *Limacina retroversa* to projected oceanic acidification and temperatures within the Scotia Sea
2. Determine variation in spatial distribution of *Limacina helicina Antarctica* and *Limacina retroversa* in response to oceanic change in the Southern Ocean in current and projected oceanic acidification and temperature regimes.
3. Determination of the life-history of *Limacina helicina Antarctica* and *Limacina retroversa* and assessment of the implications of current and projected oceanic acidification and temperature regimes.

6.2.1.2 Methods

Pteropod collection

A paired motion-compensated Bongo net (60 cm diameter aperture) with mesh sizes of 100 µm and 200 µm and 5-1 solid cod-ends was mainly adopted (Figure 6.2). Nets were vertically deployed to a depth of 200 m. Occasionally pteropods were also captured within the MOCNESS net. This is 1 m^3 and equipped with nine nets made of 333 µm mesh. Nets are remotely fired enabling depth discrete sampling. Sample depths reached a maximum of 10 m with samples taken every 200 m and then 100-50 m on ascent to the surface. A single net remains open during the entirety of the trawl and around eight other depths are sampled.

Figure 6.2. Bongo net

The motion compensation of the Bongo net means that the fragile shells of pteropods remain relatively intact and experience less stress in comparison to the MOCNESS.

Cod ends were emptied into white, non-marked buckets. Samples that were thick with phytoplankton were diluted with seawater collected from the underway water supply to

ensure proficient oxygen content. Pteropods were able to be separated using a mixture of dilution, stirring and settling techniques due to high sinking rates causing them to fractionate from the rest of the sample. Pteropods were transferred using a wide mouthed Pasteur pipette into 500 ml containers of filtered underway water and immediately examined under a light microscope (Olympus SZX16 fitted with a Cannon EOS 60D). Adults and large juveniles were isolated immediately into a separate 500ml contained and placed into a 4˚C cold room to allow for acclimatisation. Smaller individuals were often amongst diatoms, ostracods, foraminifera and other similar sized phytoplankton and so were separated using a Doncaster sorting dish into a 500 ml container of filtered seawater. Once separated these were also placed within the 4˚C cold room for acclimatisation. Care was taken not to cause additional thermal stress by continuously monitoring container temperatures using a thermometer and placing these on ice or within the cold room where temperatures approached 4˚C. Were possible entire samples were sorted through and counted however if large quantities of pteropods were captured only and estimate was given (Table 6.6).

Table 6.6. Number of pteropods collected from each bongo net.

Time	Bridge event number	Net mesh size (µm)	Taxa picked	Number picked
21/11/2015 06:00	12	100	Pteropods	3
21/11/2015 20:02	13	200	Pteropods	2
21/11/2015 06:00	13	200	Pteropods	2
21/11/2015 20:02	14	100	Pteropods	1
21/11/2015 06:00	14	100	Pteropods	1
21/11/2015 14:36	17	100	*L. helicina*	20
21/11/2015 14:36	17	200	*L. helicina*	10
21/11/2015 14:56	18	100	*L. helicina*	4
21/11/2015 14:56	18	200	*L. helicina*	45
28/11/2015 18:15	33	200	Pteropods	56
28/11/2015 18:15	33	100	Pteropods	4
28/11/2015 18:35	34	200	Pteropods	26
28/11/2015 18:35	34	100	Pteropods	10

30/11/2015 15:15	43	200	*L. helicina*	405
30/11/2015 15:15	43	100	*L. helicina*	309
30/11/2015 15:35	44	100	*L. helicina*	254
30/11/2015 15:35	44	200	*L. helicina*	231
01/12/2015 00:10	53	200	*L. helicina*	> 111
01/12/2015 00:10	53	100	Pteropods	19
01/12/2015 00:10	53	100	*L. helicina*	93
01/12/2015 00:35	54	100	*L. helicina*	(114?)
01/12/2015 00:35	54	200	*L. helicina*	> 110
01/12/2015 07:26	59	100	*L. helicina*	> 205
01/12/2015 07:26	59	200	*L. helicina*	> 408
01/12/2015 07:47	60	100	*L. helicina*	> 210
01/12/2015 07:47	60	200	*L. helicina*	> 306
08/12/2015 16:15	122	200	Pteropods	10 Juveniles 2 Adults >50 veligers
08/12/2015 16:15	122	100	Pteropods	21 Juveniles 4 Adults >30 veligers
08/12/2015 20:55	124	200	Pteropods	32 Juveniles 10 Adults >50 veligers
08/12/2015 20:55	124	100	Pteropods	23 Juveniles 8 Adults >50 veligers
08/12/2015 21:25	125	100	Pteropods	36 Juveniles 11 Adults >50 veligers
08/12/2015 21:25	125	200	Pteropods	12 Juveniles 3 Adults >50 veligers
09/12/2015 01:30	130	100	Pteropods	4 Juveniles 1 Adults >50 veligers
09/12/2015 01:30	130	200	Pteropods	8 Juveniles >80 veligers
09/12/2015 14:20	137	200	Pteropods	16 Juveniles 6 Adults >80 veligers 2 Pyramidata
09/12/2015 14:20	137	100	Pteropods	16 Juveniles 6 Adults >80 veligers 2 Pyramidata
09/12/2015 14:30	138	200	Pteropods	>20 Juveniles 4 Adults >50 veligers 1 Pyramidata
09/12/2015 14:30	138	100	Pteropods	>20 Juveniles 7 Adults >50 veligers 1 Pyramidata
09/12/2015 14:55	139	200	Pteropods	>20 Juveniles 7 Adults >50 veligers
09/12/2015 14:55	139	100	Pteropods	>20 Juveniles 2 Adults >20 veligers
10/12/2015 11:35	143	200	Pteropods	>20 Juveniles 5 Adults >50 veligers
10/12/2015 11:35	143	100	Pteropods	>20 Juveniles 7 Adults >50 veligers
10/12/2015 11:40	144	200	Pteropods	>20 Juveniles 1 Adults >20 veligers
10/12/2015 11:40	144	100	Pteropods	>20 Juveniles 3 Adults >20 veligers
10/12/2015 11:52	145	200	Pteropods	>10 Juveniles 5 Adults >30 veligers

10/12/2015 11:52	145	100	Pteropods	>20 Juveniles 2 Adults >20 veligers

Actively swimming individuals with no signs of damage (shell and body) were isolated into unfiltered, ambient seawater for two hours allowing for acclimatisation. Afterwards, pteropods were photographed in as much detail as conditions allowed, although some were too active to obtain a focused image. Those that were not actively swimming during either examination were removed and washed with de-ionised water prior to air drying and storage on a specimen slide. It was assumed that these were healthy individuals that suffered during capture. For comparison two active individuals were also preserved in this way. Once dry, specimens were photographed again in case of damage during transport (Figure 6.3). Shell characteristics of these individuals will be considered as a control representing natural pteropod state.

Figure 6.3. Pteropod after air drying and rising with deionised water on specimen slides.

6.2.1.3 Experimental Setup

Exp. 1 Experimental investigation into calcein staining of pteropods to indicate calcification rate

Individuals were transferred into clear, non-pyrogenic polystyrene incubation bottles (65 ml, corning®) spiked with calcein in the following conditions:

A. No calcein staining, incubation while dead
B. No calcein staining, incubation while alive
C. 50 mg/l concentration of calcein, alive and stained for 2 hours
D. 50 mg/l concentration of calcein, alive and stained for 6 hours
E. 100 mg/l concentration of calcein, alive and stained for 2 hours
F. 100 mg/l concentration of calcein, alive and stained for 2 hours
G. 50 mg/l concentration of calcein, dead and stained for 2 hours
H. 50 mg/l concentration of calcein, dead and stained for 6 hours

Calcein is a non-toxic fluorescent dye that binds to calcium allowing fluorescent visualisation (Figure 6.4).

Figure 6.4. Pteropods in the process of being dyed with calcein

After these treatments pteropods were incubated in clear, non-pyrogenic polystyrene incubation bottles (65 ml, corning®) in filtered (0.22 µm) underway water for 48 hours. Care was taken not to introduce or trap any air bubbles. Incubators were maintained at 1.5˚C, in darkness and gently inverted every 4 hours for 30 seconds. Measurements of oxygen (µmol/l) and temperature (˚C) using an oxygen sensor and fibre optic oxygen, temperature (Fibox 4, PreSans) (see 'oxygen and temperature' measurements), behaviour, activity, condition and records of extracellular material were made every six hours. Specimens were retrieved using a wide mouthed Pasteur pipette and observed within a deep petri-dish. Mortality and general condition were recorded under a dissection microscope (Olympus SZX16 fitted with a Cannon EOS 60D). Specimens were thoroughly rinsed with de-ionised, buffered water.

Exp. 2 Maternal effects of pteropods

Parental exposure to ocean acidification or warming may have an impact on fecundity and survival or morphology of offspring. Therefore 8 adult *Limicina helicina* were transferred into clear, non-pyrogenic polystyrene incubation bottle (65 ml, corning®) filled with filtered (0.22 µm) seawater collected at 200m. Seawater was manipulated to simulate predicted conditions in 2100 with atmospheric pCO_2 1100 µatm. Target pCO_2 conditions were achieved via calculating additions of $NaHCO_3$ and HCL. using CO2SYS . Parameters were based on ambient sample salinity, pH and carbonate chemistry using CTD profiles (see section 7.1, carbonate chemistry)

Exp. 3 Recovery of pteropods after short term exposure to ocean acidification

Juvenile *Limacina helicina* were incubated in clear, non-pyrogenic polystyrene incubation bottles (65 ml, corning®) in filtered (0.22 µm) water collected from a CTD at 200m. Care was taken not to introduce or trap any air bubbles. Seawater was manipulated to simulate predicted conditions in 2100 with atmospheric pCO_2 1100 µatm. Target pCO_2 conditions were achieved via calculating additions of $NaHCO_3$ and HCL. using CO2SYS . Parameters were based on ambient sample salinity, pH and carbonate chemistry using CTD profiles (see section 7.1, carbonate chemistry). Incubators were maintained at 1.5˚C via thermocirculators. Measurements of oxygen (µmol/l) and temperature (˚C) using an oxygen sensor and fibre optic oxygen, temperature (Fibox 4, PreSans) (see 'oxygen and temperature' measurements), behaviour, activity, condition and records of extracellular material were made throughout. After 1 week a small sample of juveniles was collected and the remaining juveniles placed in either ambient or future pH conditions. The same measurements were taken as above for another week (Figure 6.5). After all pteropods were preserved on 75% buffered ethanol.

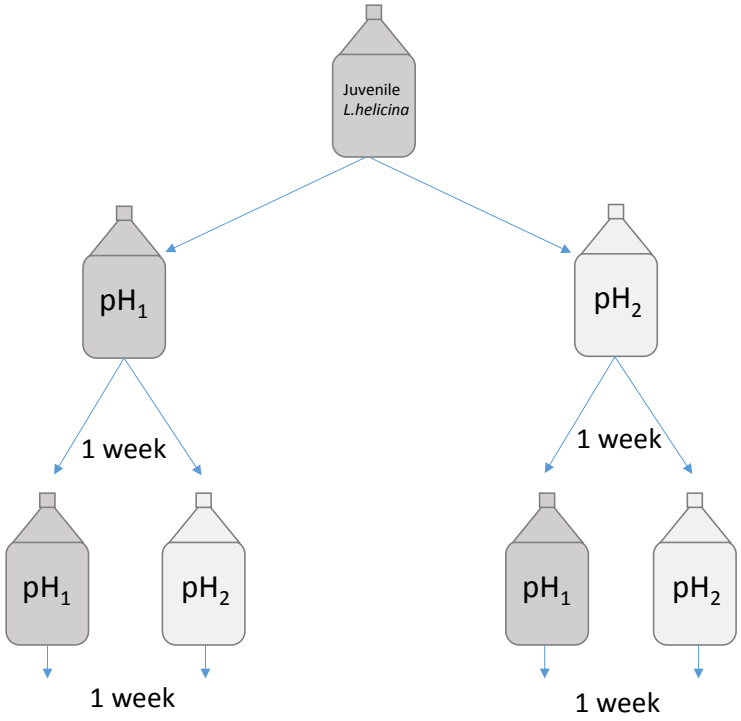


Figure 6.5. Schematic detailing the experimental set up to investigate recovery of pteropods under short term exposure to lower pH conditions where pH_1 represents current conditions and pH_2 conditions expected in 2100.

Exp. 4 Recovery of pteropods after short term exposure to ocean acidification and warming

Juvenile *Limacina helicina* were incubated in clear, non-pyrogenic polystyrene incubation bottles (65 ml, corning®) in filtered (0.22 µm) water collected from a CTD at 200m. Care was taken not to introduce or trap any air bubbles. Seawater was manipulated to simulate predicted conditions in 2100 with atmospheric pCO_2 1100 µatm. Target pCO_2 conditions were achieved via calculating additions of $NaHCO_3$ and HCL.using CO2SYS. Parameters were based on ambient sample salinity, pH and carbonate chemistry using CTD profiles (see section 7.1, carbonate chemistry). Incubators were maintained at 1.5˚C and 4˚C via thermocirculators. Measurements of oxygen (µmol/l) and temperature (˚C) using an oxygen sensor and fibre optic oxygen, temperature (Fibox 4, PreSans) (see 'oxygen and temperature' measurements), behaviour, activity, condition and records of extracellular material were made throughout. After 1 week a small sample of juveniles was collected and the remaining juveniles placed in either ambient or future pH conditions. The same measurements were taken as above for another week (Figure 6.6). After all pteropods were preserved on 75% buffered ethanol.

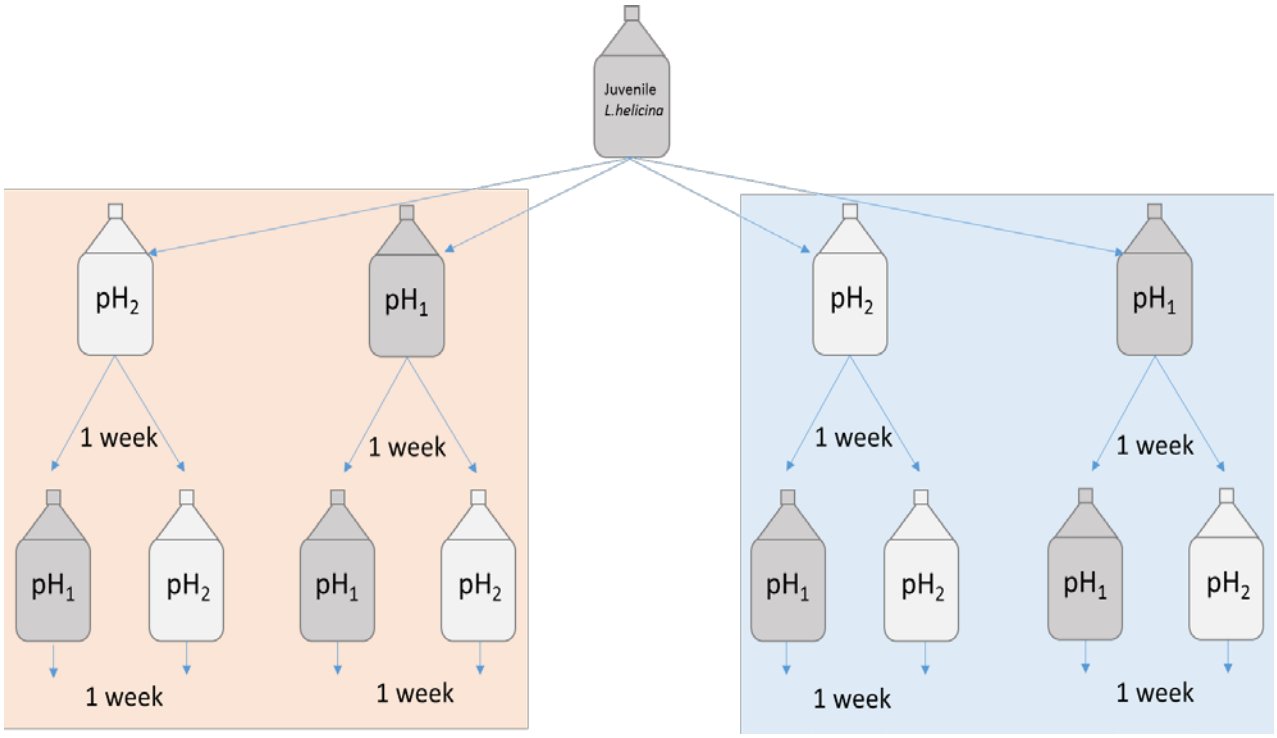


Figure 6.6. Schematic detailing the experimental set up to investigate recovery of pteropods under short term exposure to lower pH and higher temperature conditions where pH_1 represents current conditions and pH_2 conditions expected in 2100. Red box surrounds samples incubated at 4.5˚C predicted in 2100 while the blue box surrounds current conditions of 1.5˚C.

Exp. 5 Does food availabiity reduce the impact of ocean acidifcation on pteropods

Juvenile *Limacina helicina* were incubated in clear, non-pyrogenic polystyrene incubation bottles (65 ml, corning®) in filtered (0.22 µm) water collected from a CTD at 200m. Care was taken not to introduce or trap any air bubbles. Seawater was manipulated to simulate predicted conditions in 2100 with atmospheric pCO_2 1100 µatm. Target pCO_2 conditions were achieved via calculating additions of $NaHCO_3$ and HCL.using CO2SYS. Parameters were based on ambient sample salinity, pH and carbonate chemistry using CTD profiles (see section 7.1, carbonate chemistry). Food was added to some bottles while other pteropods were starved (Figure 6.7). Behaviour, activity, condition and records of extracellular material were made throughout. After, all pteropods were preserved on 75% buffered ethanol.

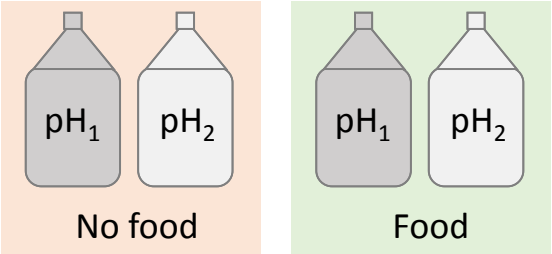


Figure 6.7 Schematic detailing the experimental set up to investigate the impact of starvation under lower pH conditions where pH_1 represents current conditions and pH_2 conditions expected in 2100.

Exp. 6 What is the impact of increased temperature and pCO_2 to the survival and physiology of adult *Limacina helicina*

Adult *Limacina helicina* were incubated in clear, non-pyrogenic polystyrene incubation bottles (500 ml, corning®) in filtered (0.22 µm) water collected from a CTD at 200m. Care was taken not to introduce or trap any air bubbles. Seawater was manipulated to simulate predicted conditions in 2100 with atmospheric pCO_2 1100 µatm and increased temperatures. Incubations achieved two temperatures (1.5 and 4˚C) and two pCO_2 values (400 and 1100 µatm) (Figure 6.8).Target pCO_2 conditions were achieved via calculating additions of $NaHCO_3$ and HCL using CO2SYS. Parameters were based on ambient sample salinity, pH and carbonate chemistry using CTD profiles (see section 7.1, carbonate chemistry. Measurements of oxygen (µmol/l) and temperature (˚C) using an oxygen sensor and fibre optic oxygen, temperature (Fibox 4, PreSans) (see 'oxygen and temperature' measurements),behaviour, activity, condition and records of extracellular material were made throughout. Some pteropods were preserved on 75% buffered ethanol while 24 were preserved by placing pteropods into Eppendorf's using Pasteur pipettes and immediately

immersing these into ethanol cooled to -80˚C. These specimens will be further analysed using metabolomics.

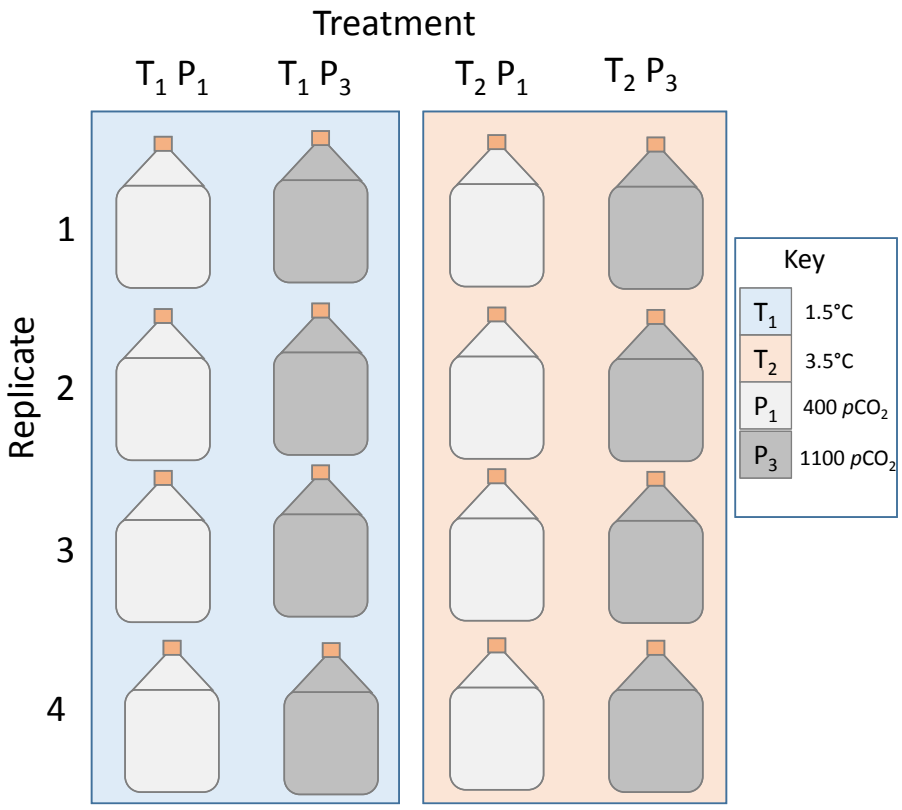


Figure 6.8. Schematic detailing the experimental set up to investigate the impact ocean acidification and oceanic warming on adult *Limacina helicina*

Exp. 7 Oxygen and temperature measurements

A fibre optic sensor (PreSans) was held over a non-invasive oxygen sensor patch glued (Silicone rubber compound, R S components) to the inside of each incubation bottle. During measurements it was ensured that incubation bottles were immersed in the water bath 2 cm. The sensor was placed in the centre of the sensor spots and held vertically for 30 seconds. A temperature sensor was place next to the incubation bottle (Figure 6.9).

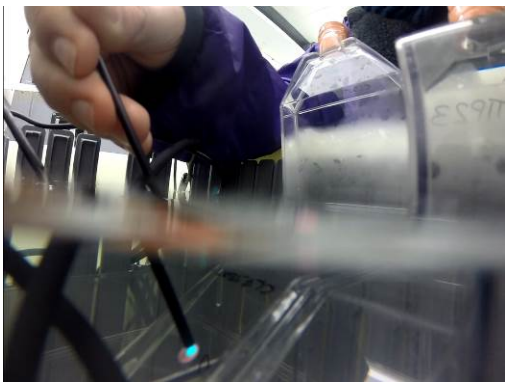


Figure 6.9. Fibox 4 (PreSans) attached with a fibre optic oxygen transmitter and temperature probe

6.2.2 Pteropod 3D Recording and Behavioural Experiment

Clara Manno

Pteropods swim by means of paired muscular wings that extend upwards out of the shell aperture. Upward motion of the pteropods is a result of downward strokes of the wings.
We investigated if, under OA (Ocean Acidification) stress, the extra energy cost necessary to this organism to maintain some physiological activities could affect the energy budget devoted to swimming.

Adults of *Limacina helicina* and *Clione limacina* were incubated under controlled temperatures and 2 different pH (corresponding to the present day and 1100 ppm $CO2_{atm}$). The changes in sea water chemistry were induced by a predetermined addition of a combination of Sodium Carbonate (Na_2CO_3) and strong hydrochloric acid (HCl) to change dissolved inorganic carbon concentrations (DIC) and to restore total alkalinity (TA). Pteropods were sorted and cleaned with 0.2 µm filtered sea water before being carefully transferred with a pipette to a 500 ml closed aquarium without head space to limit CO_2 exchange with atmosphere.

For behavioural responses, pteropod specimens were filmed for at least 10 minutes every day in order to capture 10-15 upward vertical migrations. Two mirrors were used to reflect

two orthogonal views of the square incubation bottles into the lens of a single video camera, thus creating distortion-free, three-dimensional images (setup see Figure 6.10). Software analysis of these videos will be performed post-cruise.

Parameters such as angle of movement, ascent speed and wing beat frequency will be measured. At the termination of each experiment animals were immediately stored at -80°C for post cruise analysis.

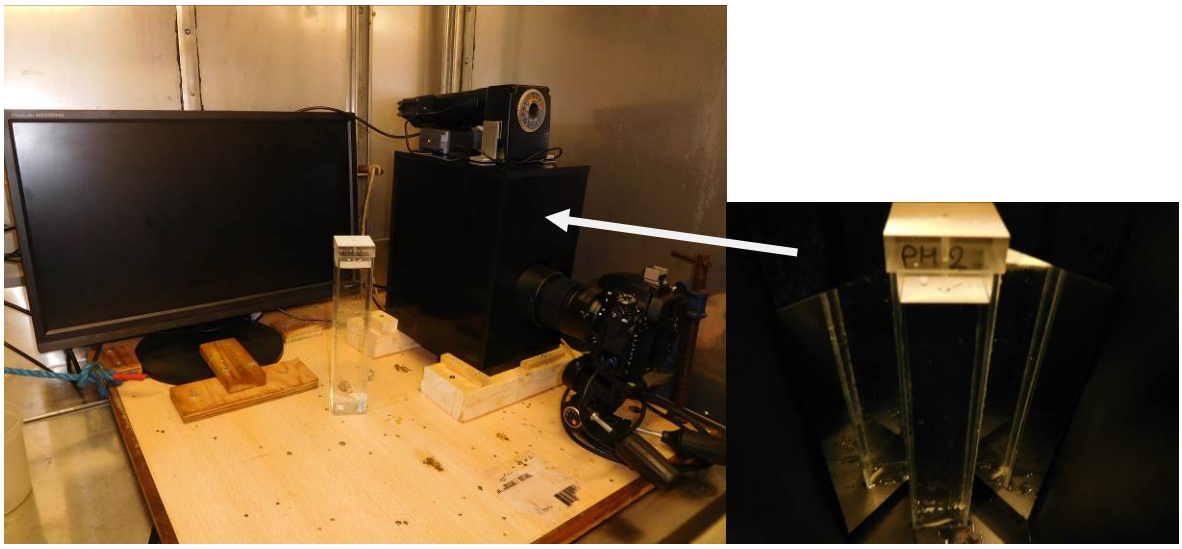


Figure 6.10: Experimental setup for behavioural experiments on pteropods

6.2.3 Assessing the Variability of Pteropod Shells using Micro-CT Scanning

Rosie Oakes

6.2.3.1 Introduction

Thecosome pteropods are a group of nektonic molluscs which reach their highest abundances in polar oceans (Bednaršek et al., 2012). Pteropod shells are formed from aragonite, the more soluble form of calcium carbonate (Mucci, 1983). The combination of their mineralogy, and the fact that they are found in polar oceans where carbon dioxide is more soluble, makes these organisms at high risk from ocean acidification.

Pteropod shells are affected by dissolution. Traditionally, this dissolution has been assessed using a light or scanning electron microscope (e.g. Gerhardt et al., 2000; Gerhardt and Henrich, 2001; Bednaršek, Tarling, et al., 2012). Shells are ranked on qualitative scales

moving from a glassy, pristine shell to a highly dissolved mottled, milky shell. Although these techniques have been useful to assess major changes in pteropod shell state, we expect that shell changes linked to future climate changes will be more minor.

Advances in micro-CT (computed tomography) scanning technology mean that it is now possible to image pteropods in three dimensions. This enables quantitative measurements of shell properties, such as shell thickness and volume, to be made. This method, once fully established, could be used as a tool to monitor pteropod response to ocean acidification.

6.2.3.2 Aim

Pteropod shell thickness may be affected by many parameters such as the carbonate content of the water, growth rate, and the pH of the seawater. The aim of this study is to compare pteropods collected at three sites to assess the variability of pteropod shell thickness in the Scotia Sea. The three sites are: P2, a low iron site; P3, a high iron site; and R3, an upwelling site. It will be particularly interesting to see how the pteropods vary between upwelling and non-upwelling locations. Upwelling waters have a lower pH and lower carbonate content as the products of organic matter breakdown have accumulated in these waters over time. I therefore expect that pteropod shells from R3 will be thinner and show more signs of dissolution than those at P2 and P3.

6.2.3.3 Methods

Samples (see Table 6.7) were collected at the three sites using a motion compensated bongo net. The net was deployed from the starboard side gantry and hauled vertically through the water column from 200 – 0 m. Pteropods were picked from both the 100 µm and 200 µm nets.

The contents of the cod catchers were transferred into large white buckets in small portions. The contents of the bucket were swirled, causing the pteropods to move to the centre of the bucket where they were removed using a plastic pipette.

The isolated pteropods were identified under the microscope and washed with underway seawater to remove any other planktonic organisms, such as diatoms. The pteropods were then rinsed three times with milliQ water. This killed the pteropods and removed any excess

salt crystals from the shells. Excess water was removed using a pipette and a paper towel. Pteropods were then transferred into a picking slide and dried in the oven at 40°C for 24 hours.

Once back at Penn State University, pteropods will be scanned using a *GE phoenix v|tome|x m* industrial CT scanner. The samples require no further preparation prior to scanning.

Table 6.7: Pteropods sampled on JR15002 for CT scanning

Site	Number of pteropods	Species	Sample name
P2 – low iron	10	*L. helicina*	JR15002 RO Ev. 33 Bongo
P2 – low iron	10	*L. helicina* (juveniles)	JR15002 RO Ev. 44 Bongo
P3 – high iron	15	*L. retroversa*	JR15002 RO Ev. 122 Bongo
R3 – upwelling	10	*L. retroversa*	JR15002 RO Ev. 137 Bongo
R3 – upwelling	8	6 x *L. helicina* 2 x *L. retroversa*	JR15002 RO Ev. 143 Bongo

6.2.3.4 References

Bednaršek N., Možina J., Vogt M., O'Brien C. and Tarling G. A. (2012) The global distribution of pteropods and their contribution to carbonate and carbon biomass in the modern ocean. *Earth Syst. Sci. Data* **5**, 167–186.

Bednaršek N., Tarling G. A., Bakker D. C. E., Fielding S., Jones E. M., Venables H. J., Ward P., Kuzirian A., Lézé B., Feely R. A. and Murphy E. J. (2012) Extensive dissolution of live pteropods in the Southern Ocean. *Nat. Geosci.* **5**, 1–5. Available at: http://www.nature.com/doifinder/10.1038/ngeo1635 [Accessed November 26, 2012].

Gerhardt S., Groth H., Rühlemann C. and Henrich R. (2000) Aragonite preservation in late Quaternary sediment cores on the Brazilian Continental Slope: implications for intermediate water circulation. *Int. J. Earth Sci.* **88**, 607–618.

Gerhardt S. and Henrich R. (2001) Shell preservation of Limacina inflata (Pteropoda) in surface sediments from the Central and South Atlantic Ocean : a new proxy to determine the aragonite saturation state of water masses. *Deep. Res. I* **48**, 2051–2071.

Mucci A. (1983) The solubility of calcite and aragonite in seawater at various salinities, temperatures, and one atmosphere total pressure. *Am. J. Sci.* **283**, 780–799.

6.2.4 Re-evaluating Methods of Pteropod Preservation

Rosie Oakes

6.2.4.1 Introduction

Pteropods are predicted to be at high risk from future ocean acidification (Orr et al., 2005; Fabry et al., 2008; Doney et al., 2009). Lower carbonate concentrations and lower pH will make it more energetically costly for pteropods to form their shells. Pteropods form their shells from aragonite, the more soluble form of calcium carbonate (Mucci, 1983), which makes them more susceptible to these changes than other calcifiers. Because of this, pteropods have been termed the 'canary in the coal mine' for ocean acidification and could be used as an indicator for ocean acidification.

There are many different ways to collect pteropods, each with its own set of pros and cons. Collection using nets takes a snapshot sample of the water column at the time you samples it. Live pteropods are collected but they can be damaged as the net hauls up through the water column. Sediment traps take a time averaged view of the water column in one spot and can take samples year round, which is not feasible using nets. However, pteropods in the sediment traps are often dead having fallen through the water column to reach the sediment trap.

Once collected, pteropods are preserved in a range of different ways. These different methods likely stem from the fact that pteropod researchers come from a wide range of different fields. A review of the literature revealed that there are some clear favourites: 70% ethanol (e.g. Bednaršek et al., 2012), 4% buffered formalin (Bathmann, Ulrich et al., 1991), and air dried (e.g. Li et al., 2015). In addition to these we tested 70% buffered ethanol to account for the decreased pH of ethanol, mercuric chloride solution ($MgCl_2$) and salt buffered formalin as these are used in sediment traps.

6.2.4.2 Aims

If an organism is to be used as an indicator of ocean chemistry, it is essential that we are measuring a primary ocean signal and not secondary alterations. The aim of this study is to assess the effect that different preservation techniques, and different collection methods, have on pteropod shells. The different preservation techniques are: 70% ethanol; 70%

buffered ethanol; 4% buffered formalin; NaCl and formalin; mercuric chloride solution; and air dried. Two collection methods were simulated: net collection; and sediment trap collection.

The overall goal of this study is to find a 'best practice' which can be used when studying pteropod shell condition. This means that spatial and temporal comparisons of pteropod shell condition can be more accurately made without having to account for secondary alterations to the shell.

6.2.4.3 Methods

All the specimens for this study were collected at P3 (52.81176°S, 40.11169°W) using a motion compensated bongo net. Both the 100 µm and the 200 µm nets were picked for pteropods. There were 12 experimental setups in total and we had enough pteropods for 12 specimens per experiment. Initially, the total sample was split into two; half was used for the live sample, simulating preservation of pteropods caught in nets, the other half was used for the dead samples, simulating the condition pteropods would be in by the time they reached the sediment trap.

All specimens were imaged using an Olympus SZX 16. The image magnification was calibrated with a 125µm mesh.

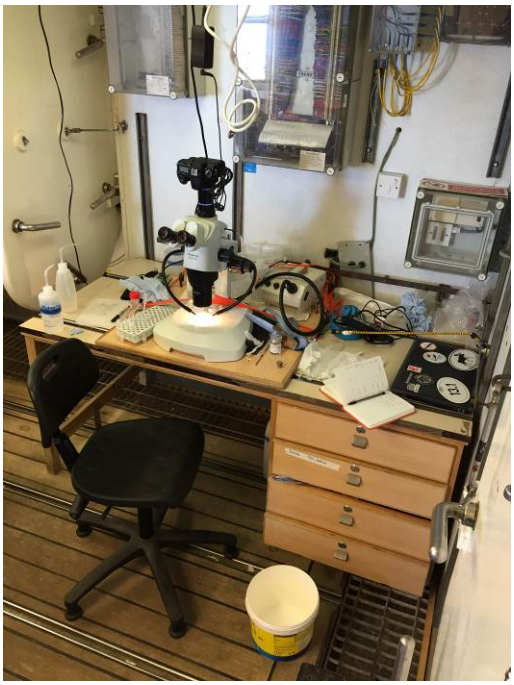


Figure 6.11: The microscope set up on board – Olympus SZX 16 (left) and working on the microscope (right) (*Photo credit: J. Freer*)

Live samples

The live sample was rinsed with underway seawater to remove any excess plankton so only the pteropods remained. The sample was then rinsed three times with MilliQ water to kill the pteropods and remove and salt crystals from the shell which can cause it to crack. The samples were then immediately transferred to their relevant preservation conditions outlined below.

70% ethanol

- Solution of 70 ml of 96% ethanol + 25 ml of MilliQ water → 70% ethanol
- Fill 1.5 ml Eppendorf tube to 1 ml with 70 % ethanol
- Image 4 rinsed pteropods while still submerged in water to record initial shell condition
- Transfer 4 pteropods with a pipette to the Eppendorf tube
- Fill to top with ethanol to ensure there is no air in the Eppendorf tube
- Repeat twice more to give a total of 12 pteropods preserved in 70 % ethanol

70% buffered ethanol

- Solution of 70 ml of 96% ammonium hydroxide buffered ethanol + 25 ml of Milli Q water → 70% buffered ethanol
- Fill 1.5 ml Eppendorf tube to 1 ml with 70 % buffered ethanol
- Image 4 rinsed pteropods while still submerged in water to record initial shell condition
- Transfer 4 pteropods with a pipette to the Eppendorf tube
- Fill to top with buffered ethanol to ensure there is no air in the Eppendorf tube
- Repeat twice more to give a total of 12 pteropods preserved in 70 % buffered ethanol

Buffered formalin

- Fill 1.5 ml Eppendorf tube to 1 ml with borax buffered formalin
- Image 4 rinsed pteropods while still submerged in water to record initial shell condition
- Transfer 4 pteropods with a pipette to the Eppendorf tube
- Fill to top with buffered formalin to ensure there is no air in the Eppendorf tube

- Repeat twice more to give a total of 12 pteropods preserved in buffered formalin

NaCl and formalin

- Weigh 5 g of pure salt into a Nalgene. Measure 2.7 ml of 36% formalin into cylinder and bring up to 100 ml using underway seawater. Shake until all the salt has dissolved.
- Fill 1.5 ml Eppendorf tube to 1 ml with NaCl and formalin
- Image 4 rinsed pteropods while still submerged in water to record initial shell condition
- Transfer 4 pteropods with a pipette to the Eppendorf tube
- Fill to top with NaCl and formalin to ensure there is no air in the Eppendorf tube
- Repeat twice more to give a total of 12 pteropods preserved in NaCl and formalin

$HgCl_2$ solution

- Add 20 µl of $HgCl_2$ added to 100 ml of Milli Q water (*wear gloves when handling)
- Fill 1.5 ml Eppendorf tube to 1 ml with $HgCl_2$ solution
- Image 4 rinsed pteropods while still submerged in water to record initial shell condition
- Transfer 4 pteropods with a pipette to the Eppendorf tube
- Fill to top with $HgCl_2$ solution to ensure no air in the Eppendorf tube
- Repeat twice more to give a total of 12 pteropods preserved in $HgCl_2$ solution

Air dried

- Image 12 rinsed pteropods while still submerged in water to record initial shell condition
- Remove all the excess water using a pipette and a paper towel
- Transfer the pteropods into a picking tray using a paint brush
- Image the pteropods again once in the picking tray to document shell condition
- Dry pteropods in an over at 40°C for 24 hours

Dead samples

The second half of the sample was used for the 'dead' study. Pteropods were collected at P3 and killed by rinsing them in MilliQ water. The pteropods were then transferred back into underway seawater collected at P3. The container was sealed and filled to the top with

seawater to ensure no exchange with the atmosphere. The container was left in the cold room (at 4°C) for three days to simulate the length of time it takes for a pteropod to reach a sediment trap after it dies. This is a highly simplified view of a sediment trap as only pteropods were preserved in the seawater and all other organic material was removed.

The specimens were imaged on day 1 after they were killed, before being transferred back into the seawater. Specimens were imaged again on day 3 before they were preserved. The same preservation conditions were used for the dead samples as for the live samples.

Analysis

All samples will be analysed in 6 months to see how the shells have been changed by the different preservation conditions. Samples will be imaged on a light microscope and a scanning electron microscope to see if microscale changes can be observed.

Table 6.8:

	70% ethanol	70% buffered ethanol	Buffered formalin	NaCl and formalin	$HgCl_2$ solution	Dried
Live	12	12	12	12	12	12
Dead	12	12	12	12	12	12

6.2.4.4 References

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6.3 The Role of Planktonic Foraminifera as Drivers of Carbonate Export

Meltem Ok, Clara Manno

The amount of carbon dioxide transferred to the deep ocean is regulated by the carbon (promoting CO_2 sink through photosynthesis) and carbonate (providing CO_2 source through calcification) pump. Planktonic foraminifera (carbonate producers), contribute up to 50 % of the total carbonate export in the ocean, and in the Southern Ocean can represent a dominant component of carbonate flux. Therefore the understanding of foraminifera population dynamics and their response to the anthropogenic stressors (i.e. Ocean Acidification) is a critical issue.

The objective of this study is to investigate the vertical distribution of foraminifera and their contribution to the carbonate export by combining samples collected through sediment trap and WP2 nets during JR15002. Water samples (see Table 6.9) were also collected from the Niskin bottles for PIC (particulate inorganic carbon), Carbon and Oxygen isotopic analysis (please see section 7.1 for the further details).

Table 6.9 List of water samples collected from the Niskin Bottles during CTD deployments.

Time	Sta.	Event no	Depth	Sample For	Volume
09/12/15	Upwelling	136	53.7	PIC , Oxygen & Carbon isotopes	1L, 0.5L
09/12/15		136	102.7	PIC , Oxygen & Carbon isotopes	2L, 0.5L
09/12/15		136	203.4	PIC , Oxygen & Carbon isotopes	3L, 0.5L
09/12/15		136	302.6	PIC , Oxygen & Carbon isotopes	4L,0.5L
09/12/15		136	403.1	PIC , Oxygen & Carbon isotopes	4L,0.5L
09/12/15		136	600	PIC , Oxygen & Carbon isotopes	6.5L, 0.5L
09/12/15		136	800	PIC , Oxygen & Carbon isotopes	5L, 0.5L
09/12/15		136	1000	PIC , Oxygen & Carbon isotopes	6L, 0.5L
30/11/15	P2	40	5	PIC , Oxygen & Carbon isotopes	1L, 0.5L
30/11/15		40	50	PIC , Oxygen & Carbon isotopes	2L, 0.5L
30/11/15		40	100	PIC , Oxygen & Carbon isotopes	2L, 0.5L
30/11/15		40	200	PIC , Oxygen & Carbon isotopes	3L, 0.5L
30/11/15		40	400	PIC , Oxygen & Carbon isotopes	4L, 0.5L
30/11/15		40	600	PIC , Oxygen & Carbon isotopes	6L, 0.5L
30/11/15		40	800	PIC , Oxygen & Carbon isotopes	5L, 0.5L
30/11/15		40	1000	PIC , Oxygen & Carbon isotopes	6.5L, 0.5L
28/11/15	P3	31	5	PIC , Oxygen & Carbon isotopes	1L, 0.5L
28/11/15		31	10	PIC , Oxygen & Carbon isotopes	2L, 0.5L
28/11/15		31	50	PIC , Oxygen & Carbon isotopes	2L, 0.5L
28/11/15		31	100	PIC , Oxygen & Carbon isotopes	2L, 0.5L
28/11/15		31	200	PIC , Oxygen & Carbon isotopes	3L, 0.5L
28/11/15		31	400	PIC , Oxygen & Carbon isotopes	4L, 0.5L
28/11/15		31	1000	PIC , Oxygen & Carbon isotopes	6.5L, 0.5L

Planktonic foraminifera samples were collected by using WP-2 net (53 µm mesh size). At each station, four depth intervals were sampled from the sea surface down to 400 m (see Table 6.10).

Table 6.10 Station details and comments on fate of catch for WP2 net deployments for planktonic foraminifers.

Time	Sta	Net Open Depth	Net Close Depth	Bridge Event no	Fate of the samples
10/12/15 17:25	Upwelling	400	200	157	discarded due to failure
10/12/15 16:17		200	100	156	preserved
10/12/15 15:25		200	100	155	discarded due to failure
10/12/15 14:54		100	50	154	preserved
10/12/15 14:36		50	0	153	preserved
09/12/15 00:33	P3	400	200	129	preserved
08/12/15 23:02		200	100	128	preserved
08/12/15 22:22		100	50	127	preserved

08/12/15 21:57		50	0	126	preserved
30/11/15 19:54		400	200	51	preserved
30/11/15 19:16		200	100	50	preserved
30/11/15 18:35	P2	100	50	49	preserved
30/11/15 18:19		100	50	48	discarded due to failure
30/11/15 18:12		100	50	47	discarded due to failure
30/11/15 18:02		50	0	46	preserved

In addition, planktonic foraminifera samples (see Table 6.11) were collected from bongo net deployments through opportunistic sampling in order to calculate sinking rate of planktonic foraminifers in 3 different size fractions (>150 µm, 150-250 µm, >250 µm). The sinking rate calculations were carried out in the cold room of RRS JCR.

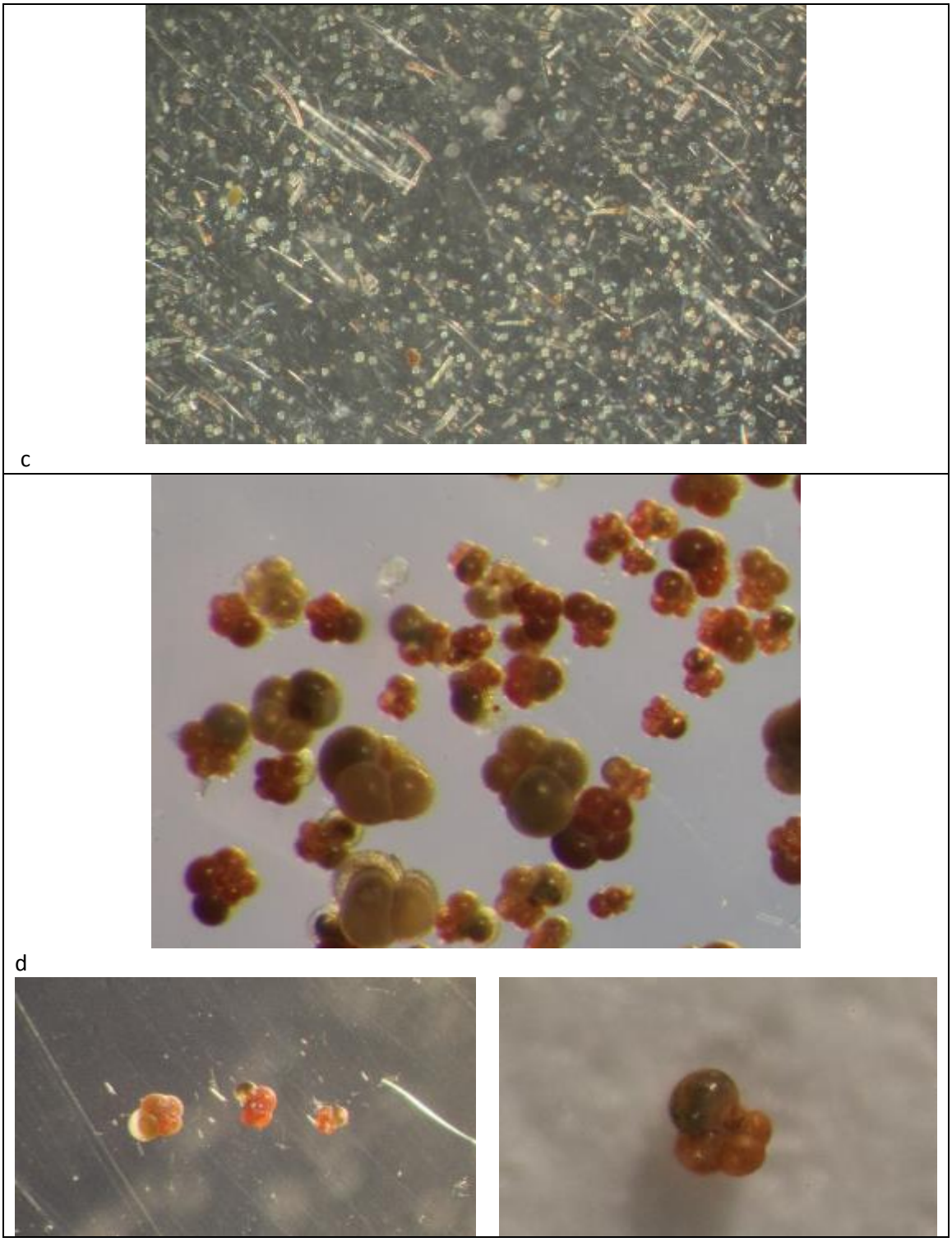
Table 6.11. Bongo net station that planktonic forams collected.

Time	**Event number**	**Fate of sample**
22/11/15 16:56	24	≈50 air dried and stored
22/11/15 16:38	23	≈50 air dried and stored
22/11/15 16:24	22	≈50 air dried and stored
21/11/15 02:52	12	≈150 air dried and stored

Before preserving the catch 3 subsample replicates (50 ml) were taken by stempel pipette for planktonic foraminifera examination on board. The rest of the samples were sieved with a sieve of 53 mm mesh size and preserved in buffered formaldehyde in 250 ml plastic bottles. The foraminifera were wet picked by a pipette, sized and counted. The counting and dividing into size classes (>150 µ, 150-250 µ, >250 µ) (Figure 6.11 a-c) were done using a stereo-microscope (Olympus SZX 16). The photos of each series of samples were taken by Canon camera attached to the microscope. Then all the specimens collected were transferred to a micro-slides and dried in the oven at 40 °C for about 12 hours. In total more than 2000 specimen were sized, counted and majority of them transferred to the micro-slides. Further analyses (ie. Scanning Electron Microscope examinations) will be performed in Cambridge.

a

b



c

d

Figure 6.12a-d: Microscope set up in the laboratory of RRS JCR (a), subsample preparation (b) sample preservation (c), general view of samples collected at station P2.

6.4 Vertical Migration of Zooplankton as means of Active Flux of Carbon and Nitrogen

Cecilia Liszka

6.4.1 Introduction

Samples were collected on board the RRS James Clark Ross (JCR) on cruise JR15002 in the austral spring/ summer of 2015 to contribute to my PhD investigating the active flux of carbon in the Southern Ocean as mediated by the vertical migration of zooplankton (Primary Supervisor: Geraint Tarling, Secondary Supervisors: Clara Manno, Gabi Stowasser and Carol Robinson). Samples of mixed zooplankton for gut pigment analysis were obtained from upward/ downward net trap deployments, and shipboard incubation experiments with live mixed zooplankton communities, individual *Euphausia triacantha* and euphausiid faecal pellets were carried out using samples obtained from WP2 and RMT8 net deployments.

The purpose of samples collected and experiments undertaken during the cruise was to gather data on the community metabolism of mixed zooplankton samples at different times of day/ night and both within and below the mixed layer; to gather additional data on the metabolism of *Euphausia triacantha*; to investigate the degradation of euphausiid faecal pellets over time within the water column; and to gather samples for gut pigment analysis. The following sections describe the experiments undertaken, samples collected and the equipment used to obtain samples.

6.4.2 Aims

1. To obtain mixed zooplankton samples from within and below the mixed layer from a series of stations approximately 12 hours apart (day and night) for incubation under two different temperatures, to determine metabolic activity (O_2 consumption and NH_4 excretion), thus giving an estimation of the active flux component that can be attributed to migratory zooplankton
2. To determine the respiration rate and excretion of *Euphausia triacantha*
3. To qualitatively and quantitatively assess the degradation of euphuasiid faecal pellets in different water masses over time

6.4.3 Methods

6.4.3.1 Mixed Zooplankton Respiration Experiments

Initially, both full gut experiments (using animals incubated immediately after retrieval) and empty gut experiments (using animals from the same net hauls but incubated in filtered seawater for a minimum of 6 hours to allow gut evacuation to take place) were planned and were carried out for early experiments. However, due to large amounts of phytoplankton present at the stations, requiring catches to settle out prior to incubations being set up, only empty gut experiments were carried out for the later incubation using animals ~6 hours after net retrieval.

In addition, early experiments involved two size classes of animal (200 – 1,000 um and 1,000 – 5,000 um) to separate out smaller copepods and larger, more biomass dominant, zooplankters. However, small samples meant that insufficient animals could be obtained to allow this to be carried out effectively and the majority of experiments were thus carried out on a single size class >200 um.

6.4.3.2 Incubator Set-up[1]

Incubation experiments were conducted in two tanks set to different temperatures designed to approximate different depths in the water column. The temperatures selected were 4 C and 1 C. Temperatures were maintained with a water bath set-up comprised of a chiller unit (Julabo FL300 chiller) and two thermostatic stirrer units with cooling coil (ED Heating Immersion Circulator and Julabo Cooling Coil) inside a large plastic Allibert box used as a tank. The system was kept in the Cool Specimen (Cool Spec) room, the temperature of which was set to 4 °C. To insulate the 1 C tank against the temperature of the room, the box was covered on the outside with a layer of bubble wrap and a second layer of closed cell foam on all sides and bottom of the tank. To achieve the desired temperature, the chiller unit was filled with approximately 5 L of ethylene-glycol anti-freeze which was circulated through tubing sequentially connected to the cooling coils fitted to each chiller unit (see

[1] I would like to thank Deck Engineer, Simon Wright, and Electronics Engineer, Paul Morgan, for their help in waterproofing the units. I would also like to acknowledge the very generous assistance provided by Electrical Officer, Julian Klepacki, in investigating and explaining the technical problems encountered at all times, even when off-duty, and helping to maintain the set-up as much as possible during incubations. His help was much appreciated.

Figure 6.13). One length of tubing connected the outlet pipe of the chiller unit to the inlet of the first circulator; a second length connected the outlet of the first circulator to the inlet of the second; a final length connected the outlet of the second stirrer back to the chiller unit. The chiller unit was set to -10 °C and the thermostatic stirrer units were set to 4 °C or 1 °C respectively, achieved by the heating element of the stirrer unit sitting inside the cooling coil.

Figure 6.13: Photograph showing the incubator set-up and insulation of the 1 C tank (with the chiller unit sitting to the left hand side of the left hand tank)

Each stirrer unit was fixed to a hard plastic bracket, cut to the correct height to keep the cooling coil and automatic cut-off float submerged just below the surface of the water. The brackets were placed in the top right and left hand corners of the 4 °C and 1 °C tanks, respectively, so that stirrers and cooling coils could be easily connected to one another. To reduce the likelihood of water splashing or entering the units during times of rough weather, the units were encased in Tupperware boxes cut to shape and large gaps padded out with foam. Small gaps were closed up with electrical tape. A flexible plastic 'skirt' was attached to the bottom of the unit to sit on the water and limit splash-back. Figure 6.14 shows how the units were encased.

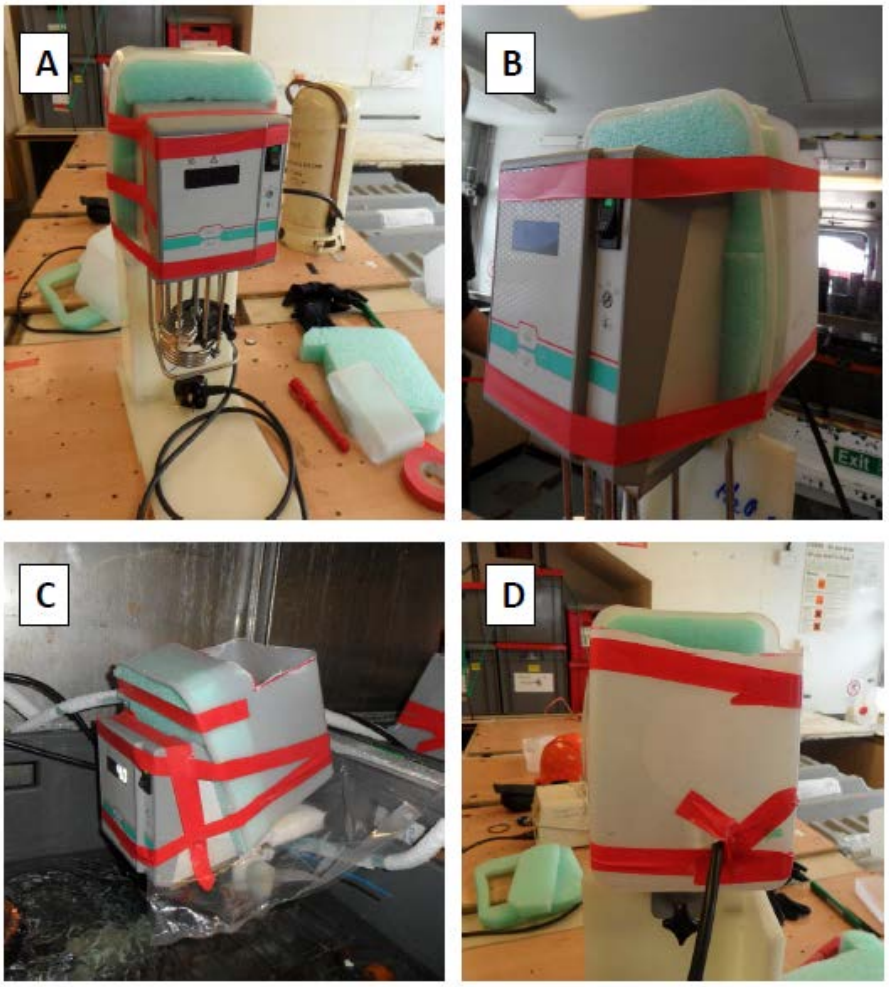


Figure 6.14: Photographs showing how the thermostatic stirrer was stabilised and protected by A) being affixed to a hard plastic bracket; B) the front view showing the Tupperware container and foam padding enclosing the unit; C) the plastic skirt attached to the bottom of the unit; and D) the back view showing smaller holes taped up to prevent water ingress

Despite this, due to the high level of humidity in the Cool Spec room, water still entered the backs of the stirrer units and this led to some technical problems that occurred as the cruise progressed. In particular, an inbuilt system error (Error 14), designed to cut the unit off if the water inside the tank reached a certain temperature, malfunctioned about two thirds of the way through the cruise and was activated when the water inside the tank was at 1 °C. It is thought that this was a fault with the electronics of the circuitry caused by condensation on the circuit board (see Figure 6.15).

This error was periodically reset by turning the system off and on at the unit, the socket, and fuse box but on occasions it took some time for the error to reset during which time the tank would have had no temperature control. Towards the end of the cruise, the error

appeared too frequently to rely on the circulator and it was replaced by the remaining functioning circulator from a second (identical) incubator set-up in which the first had also broken. In addition, occasionally the units short-circuited, causing the system to turn off and have a short period with no temperature control. Again, this was most likely due to moisture ingress.

In general, the ambient room temperature and insulation on the 1 °C tank maintained the temperature of tanks close enough to the target temperature that when the errors were reset, the tanks quickly returned to temperature with minimal effect on incubations. All oxygen measurements were taken alongside a temperature probe reading inside the tank so that corrections can be made where necessary. NB the temperature recorded by the PreSens temperature probe was approximately 0.4 – 0.6 °C higher than the temperature sensed by the inbuilt thermocirculator thermostat.

Finally, during the final incubations of the cruise (Upwelling Station), the chiller unit suffered an electrical breakdown, again likely related to moisture. This caused the cooling controlling the temperature of the tanks to fail and temperatures of both tanks slowly rose during incubations. Unfortunately, the error could not be repaired in the time available, nor due to the logistics of draining the units of anti-freeze and maintaining the incubation. The temperature of the thermostatic stirrer was instead lowered to try to achieve 4 °C. However, this approach was necessarily trial and error, so took some time to arrive at temperature; furthermore this was a less accurate and stable method of temperature control. Following the failure of the other chiller unit/ thermocirculator incubator system, the second chiller unit had ethylene-glycol antifreeze mix circulated through tubing connected solely to the chiller unit and coiled around both tanks sequentially.

The temperature set-point of the chiller unit had to be adjusted by trial and error to achieve 1 °C (see Table 2). Maintaining a stable temperature was difficult and as a result the temperature of the planned 1 °C tank in the final incubations fluctuated between -0.58 and -0.84.

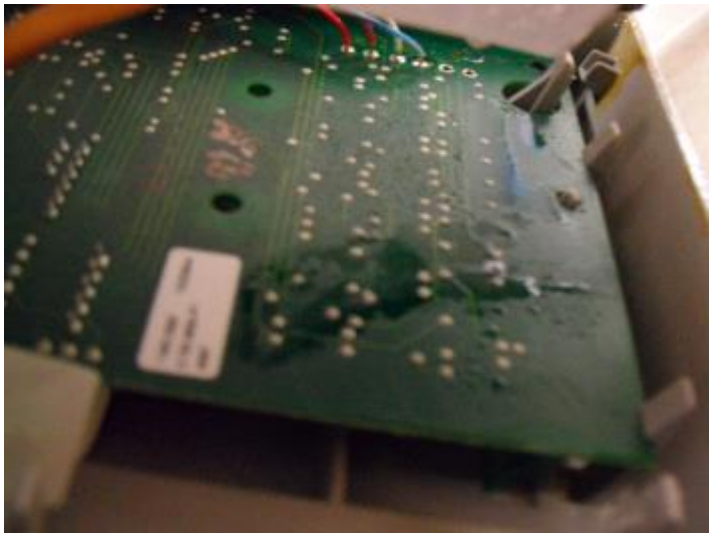


Figure 6.15: Photograph showing the condensation on the internal circuit board of one of the thermocirculators immediately after being removed from its internal casing in the Cool Spec room (condensation is shown by where a finger has been drawn across the board)

6.4.3.3 Oxygen Measurements and Bottle Calibration

Oxygen readings were taken using a PreSens Fibox 4 fiber optic oxygen transmitter with temperature sensor Pt100 and PSt3 sensor spots (PreSens, Precision Sensing GmbH, Germany). The device is based on the principle of dynamic luminescence quenching following the Stern-Volmer equation (e.g. Demas et al., 1999, Klimant et al., 1997) by molecular oxygen, whereby a chemical complex fixed in an oxygen-permeable matrix (the sensor spot) is excited by a blue light that responds to the level of oxygen present in the medium, returning an oxygen-quenched red luminescence (Tengberg et al., 2006). The more oxygen present, the greater the luminescence quenching, and the lower the level of luminescence returned by the indicator molecule.

A number of experiments[2] were carried out prior to JR15002 to determine the length of time required to get a reliable reading, the repeatability of readings and the variability of readings between bottles. Results showed that stable readings of O_2 as umol/ l were obtained within 30 repeat measurements at 1 second intervals; that the mean of groups of readings taken 10 minutes apart varied between 0.2 umol/ l and 1 umol/l[3]; and that readings did vary between bottles. Calibrations were therefore carried out on every bottle (as described below) and an additional experiment was carried out on a subsample of

[2] Detailed here: ..\PreSens\Incubation bottle testing & calibration\Optode testing pre JR15002\Optode tests analysis 131015v2.docx

[3] ..\PreSens\Incubation bottle testing & calibration\Optode testing pre JR15002\CAL_1210_131015_CL_additional analysis for cruise report 050116.xlsx

bottles to compare the difference in values obtained from pre-calibrated and post-calibrated bottles.

Although all spots from the same supply batch were calibrated to the same manufacturers values, all sensor spots were nonetheless individually re-calibrated to 100% saturated seawater and 0% saturated seawater, according to the manufacturer's instructions[4], prior to departing for JR15002. This was due to variation a) between bottles, b) where the spot was adhered to on the bottle, and c) the amount of adhesive used, affecting the luminescence reaching the spot and being reflected back. On cruise JR15002 the 100% saturation calibrations were repeated, as per the manufacturer's recommendation. Water was prepared as described in the footnote, with the exception being that underway seawater was filtered through a three-step filtration pump (smallest pore size 0.22 um).

6.4.3.4 Animal Capture

Samples were obtained from the WP2 net (50 cm diameter, 200 um mesh size) to get depth discrete samples from layers identified by the depth of the thermocline based on the CTD profile from corresponding stations. The closed net was deployed to the bottom of the first depth layer and a messenger sent down to open the net. The net was then hauled up, paused at the top of the respective depth layer and a second messenger sent down to close the net. The net was then hauled back to the surface. Animals brought up in the cod end were decanted into a bucket and the cod end was rinsed with seawater to catch any remaining sample. The bucket was labelled and immediately transferred to the Cool Spec room.

For later experiments, multiple nets were deployed (where weather conditions allowed) for each to depth increase the number of animals available for incubations.

NB: We had a number of problems with the WP2 net over the course of the cruise, whereby the net either didn't open, didn't close, where the wire came out of the release mechanism

[4] 0% oxygen water was produced first by filtering seawater through a 0.22 um filter (500 ml bottle top filter, Ultra Cruz) into a laboratory bottle and then by adding a sodium sulphite and cobalt nitrate mixture (1 g Na_2SO_3 and 50 ul $Co(NO_3)_2$ per 100 ml seawater). 100% oxygen saturated water was produced by filtering seawater as before into a laboratory bottle, filling to three quarters of the way, and leaving the bottle to equilibrate with the air overnight at the calibration temperature. Calibration bottles were filled from these bottles.

preventing the messengers from operating correctly, or where the net got wrapped around the wire due to strong currents dragging the net up during its descent. Many of the problems described above occurred as a result of the net being too light to withstand poor weather and strong currents.

6.4.4 Experiments

6.4.4.1 Test Experiments: Stanley, C3, P2 and P3 (1st stop for mooring recovery)

Test experiments were run at a test station in Falkland Island waters, shortly after departure from Port Stanley, and again at C3. The following section describes the methodology employed and amendments made.

Nets were deployed as described above. Once the net was retrieved to deck and sample had been transferred to the Cool Spec room, the contents of the bucket was gently poured through a series of stacked sieves to separate out size classes. The sieves comprised a 5,000 um mesh to filter out the largest size fraction e.g. salps, large krill and jellyfish; a 1,000 um mesh to obtain the larger size fraction; a 200 um mesh to obtain the smaller size fraction; and a 100 um mesh to obtain an animal free control sample. Each sieve was sequentially transferred to another bucket with a small amount of filtered seawater (FSW) to keep animals submerged and in good condition.

From each bucket containing animals from the first depth (200 – 1,000 um and 1,000 – 5,000 um respectively) a subsample was taken and preserved with buffered formalin to later identify the animals present in the sample, one 50 ml Stempel pipette of sample was pipetted into four experimental bottles that had been acclimated to temperature in the 4 C tank, and four experimental bottles acclimated to temperature in the 1 C tank. From the bucket containing the >100 um sample one 50 ml Stempel pipette was transferred to two control bottles from each temperature.

The remainder of the sample was transferred to a gut evacuation (pre-incubation) bottle (one for each size fraction) comprising an outer glass bottle partially filled with FSW and containing a hard plastic tube with 100 um mesh fixed to the bottom to allow faecal material to pass out whilst retaining the animals (see Figure 6.16). These bottles were also

acclimated to the temperature of the respective tanks. Bottles were raised above the level of the water of the tank using foam to prevent water from the tank entering the bottle as a result of the motion of the ship. In practice, it took trial and error to get the right height and stability as the motion of the ship was gauged.

Figure 6.16: Internal plastic tube of gut evacuation bottles with mesh affixed to bottom to allow faecal material to pass out whilst retaining zooplankton

Bottles were topped up with FSW that had also been acclimated in the tanks to their respective temperatures, gently tapped and tipped from side to side to remove air bubbles, and stopped with rubber bungs. Bottles were inverted to check for any trapped air and, if bubbles were found, the bung was removed and the process repeated until no air remained. Bottles were replaced in the tanks, incubated for up to four hours and measured approximately every hour with the PreSens Fibox4 non-invasive oxygen sensor, as described earlier. The same was done for the samples from the second depth, totalling 24 bottles between the two tanks.

First measurements were taken approximately 15 - 30 minutes after replacing bottles in the incubator to allow animals to settle after being transferred. Bottles were stabilised in the tank using separators and when measurements were taken, bottles were placed on a stable platform under water such that the probe was less liable to slip and there was no change to the temperature inside or around the bottle. The temperature probe was placed beside the bottles being measured. Oxygen was measured in two units: % air saturation and µmol O_2 per litre (see Figure 6.17). Approximately 10 readings of % air saturation and at least 40

readings of µmol/ l O_2 were taken. Measurements were taken approximately every hour and experiments were terminated after four or five readings. Immediately after the final measurements, experiments were terminated by a) decanting 40 ml sample water through a 53 µm mesh filter into a 50 ml vial and freezing at -80 °C for later analysis of NH4, rinsing anything caught on the mesh back into the bottle, and b) filtering the remaining contents of the bottle onto a pre-ashed GF/F filter for analysis of carbon content via CHN analysis.

Figure 6.17: Taking O_2 readings from bottles submerged on a stable platform in the incubator
Following this, a second incubation was set up with the contents of the gut evacuation bottles. The same procedure was followed as described above, with controls taken from the remaining sample water passed through a 100 um mesh sieve.

6.4.4.2 P2 Test Incubation

At P2, bongo nets were deployed and significant amounts of phytoplankton comprising chain forming diatoms were encountered, prompting a test of the sieving methodology to minimise phytoplankton contamination of the samples. Subsamples from the bucket were gently sieved through a series of sieves of different mesh sizes, from 200 um to 1,000 um, gently moving the sieve from side to side to encourage the phytoplankton to fall through the mesh. However, since the phytoplankton had clumped together so significantly, it was impossible to filter it through even the largest mesh size, at which point there was the additional likelihood of losing a large quantity of animals.

An incubation was carried out with a 50 ml aliquot sample that had as many zooplankters as possible removed by hand under the microscope, so as to test whether the phytoplankton would produce a significant O_2 signal should it be impossible to remove from samples at future stations, although the methodology was subsequently modified to reduce the phytoplankton concentration (see below).

6.4.4.3 P2 and P3 (2nd stops) and Upwelling Station Modifications

Two changes were made to the methodology for the second P2 and P3 and Upwelling stations. Firstly, due to significant phytoplankton present at all stations, the contents of buckets were decanted to tall measuring cylinders and secured in the Cool Spec room for approximately six hours to allow phytoplankton and dead zooplankton to settle out. The contents of the cylinders were then siphoned off into separate containers, from which incubations were then set up (see Figure 6.18).

Figure 6.18 Siphoning zooplankton from the cylinder to a second container using a small silicone tube taped to a ruler as a weight and to enable deeper submersion in the cylinder

Secondly, since earlier experiments indicated that insufficient animals were present in the incubation bottles to give a clear signal relative to the controls, it was decided to increase the number of net deployments, thus increasing the number of available animals, and to reduce the number of bottles per incubation, whilst retaining enough for statistical comparison.

6.4.4.4 RMT 8 Net Samples for Faecal Pellet and *E. triacantha* Incubation

Samples were taken from RMT 8 net deployments during the Western Core Box (WCB) survey to:

1. To collect *E. superba* faecal pellets for incubation and degradation over time experiments; and
2. To collect *E. triacantha* specimens for respiration incubations.

6.4.4.5 Faecal Pellet Degradation Experiments

At stations where incubations were likely to be set up, water from 300 m and 1,000 m was collected from the CTD in sterile Nalgene bottles (with the exception of the first experiment where water was collected from 150 m and 1,000 m). Bottles were kept in the Cool Spec room until faecal pellets had been collected.

To collect sufficient faecal pellets for incubation, subsamples of healthy krill caught in RMT8 net hauls were kept in buckets for a period of some hours; long enough to collect sufficient pellets but not so long that significant degradation may already be occurring. Faecal pellets were then gently pipetted using a disposable transfer pipette and transferred into 15 ml test tubes. For each experiment, 12 test tubes for water from each depth were prepared: five to be fixed with 1 ml of 10 % formalin for scanning electron microscope (SEM) analysis over consecutive days; five to be filtered onto ashed GF/F filters for carbon analysis; and two filtered onto GF/Fs for photographing under the microscope on Day One and Five for qualitative analysis to compare with the formalin-preserved SEM images e.g. Figure 6.19.

Figure 6.19 Example of a faecal pellet sample on filter paper photographed under an Olympus SZX16 microscope with Canon EOS 60D camera and EF Bayonet 1.6 x projective

Once FPs had settled to the bottom of the test tube, as much water as possible was pipetted off, trying to leave FPs untouched and as stationary as possible. ~13 ml of water from each depth was gently pipetted into the test tube. Day One samples were fixed/ filtered immediately and the rest were placed in the Cool Spec room. To limit mechanical degradation from movement, test tubes were wedged in racks with foam and kept on a secure shelf. Formalin fixation and filtration for the remaining samples was carried out at approximately the same time each day.

Formalin fixed samples were stored in a box packed with vermiculite and filters were stored in the -80 °C freezer. Filters for photographing were transported back to Cambridge and stored at 4 °C.

6.4.4.6 Respiration Incubations

Incubations were carried out in the tanks using the same set-up as described in the earlier mixed zooplankton section. Oxygen readings were taken using the PreSens Fibox 4 fiber optic oxygen transmitter with temperature sensor Pt100 and PSt3 sensor spots (PreSens, Precision Sensing GmbH, Germany), set-up and calibrated as described in the earlier mixed zooplankton section. When taking O_2 readings, approximately 10 repeat O_2 % saturation were taken followed by at least 40 repeat µmol/ l readings. Readings were taken approximately every hour, in general for a minimum of three readings.

To set up the incubations, the contents of buckets brought up from the RMT8 net hauls were examined for healthy individuals and the healthiest individuals were transferred to a smaller container of 0.22 µm FSW. They were then transferred a second time to rinse them as well as possible whilst causing minimal stress, before transferring them to 250 ml incubation bottles.

Healthy looking individuals were transferred to bottles of 0.22 µm FSW that had been acclimated to the temperature of the incubation tank. For the first experiment, 5 individuals were put in each 250 ml bottle see Figure 6.20. For the second, 4 individuals were put in each 250 ml bottle. Two control bottles for each set of three experimental bottles were set up with an amount of water, similar to that added with the *E. triacantha* individuals, added from the *E. triacantha* container. Bottles were topped up with 0.22 µm FSW that had also been sitting at the respective temperature. They were then gently tapped and tipped from side to side to rid the bottle of any air bubbles, and bungs were inserted. Bottles were gently inverted to test for any trapped air bubbles. If any were present, the bung was removed and the same process was repeated until no air bubbles remained. Once all bottles were set up, bottles were left for 15-30 minutes to allow animals to settle prior to taking the first reading. Whilst taking readings, the animals were inspected for general activity and health. If any were showing signs of dying, the bottle was terminated immediately. Bottles

containing a full set of healthy animals were terminated at the same time, after at least three readings.

Figure 6.20 Setting up *E. triacantha* incubations

To terminate experiments, firstly a 40 ml aliquot of water from the incubation bottle was filtered through a 53 µm mesh into a 50 ml test tube for ammonia analysis. The mesh was backwashed into the incubation bottle so any material caught on the mesh was not lost. The remaining contents of the bottle was then filtered onto a GF/F filter. Towards the end, the water was passed through a slotted spoon to catch the animals which were individually placed in Eppendorf tubes. Eppendorfs were numbered so that any notes corresponding to a particular animal could be noted. Finally, the incubation bottle and spoon were rinsed with FSW to ensure all material was retained on the filter. Filters were then transferred, using clean forceps, into a labelled sterile filter case. Parafilm was wrapped around the lids of all test tubes and filter cases, and all samples including the Eppendorfs were stored in labelled boxes in the -80 °C freezer.

6.4.4.7 Upward/ Downward Net Traps

When conditions were favourable, upward/ downward net traps were deployed as close to dawn and dusk as possible. The contents of nets were filtered immediately onto 200 um meshes through an interlocking sieve. Filters were immediately folded up, stapled and placed into labelled bags. Samples were frozen at -80 °C for later gut fluorescence analysis.

6.4.4.8 Tables

A complete list of incubation experiments undertaken on JR15002, with the corresponding date and station, is provided in Table 6.13.

Table 6.13 Log of incubation experiments and stations

Experiment stations and dates			
Experiment #	**Date**	**Station**	**Description**
1	12/11/2015	TEST	Departing Port Stanley
2	21/11/2015	C3	Ice station - first full test
3	22/11/2015	P2	Phytoplankton production experiment and testing how to deal with phytoplankton
4	28/11/2015	P3 (1st stop)	Evening experiment only Full gut
5	29/11/2015	P3 (1st stop)	Evening experiment only Empty gut
6	30/11/2015	P2 Day	Day, full gut
7	01/12/2015	P2 Day	Day, empty gut
8	02/12/2015	P2 Night	Night, full gut only
9	04/12/2015	WCB	*E. triacantha* 1
10	07/12/2015	WCB	*E. triacantha* 2
11	09/12/2015	P3 (2nd stop)	Day
12	09/12/2015	P3 (2nd stop)	Night
13	10/12/2015	Upwelling	Day
14	11/12/2015	Upwelling	Evening

Table 6.14 Log of incubator tank and chiller temperatures. The temperature given is that of incubator tanks and chiller unit when cooled through tubing alone (no thermocirculators attached)

Date	Time	Temp			Notes
		Far incubator	Near incubator	Chiller set point	
06/12/2015	15:00	4.2	4.5	1.0	
	15:30	4.1	4.3		
	16:00	4.1	4.2		Chiller reached 1.0
	16:30	4.1	4.2	-1.0	
	17:00	4.3	4.6		Chilled reached -1.0
	17:30	4.3	4.5		Insulating lids put on
	18:00	4.0	3.9		
	18:30	4.1	3.8	-2.5	
	19:45	4.0	3.7	-3.0	
	21:00	3.8	3.2		
07/12/2015	02:00	2.9	2.5		
	09:00	2.4	1.5	-3.5	
	11:00	2.1	2.4	-7.0	
	13:00	2.1	2.3		
	15:00	1.3	1.1		
	20:00	1.2	1.1		
08/12/2015	10:00	1.0	0.9		

6.4.4.9 References

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7. CTD Water Sampling

7.1 Carbonate Chemistry, Nutrients, $\delta^{13}C$, $\delta^{18}O$ Isotopes and PIC sampling

Clara Manno

7.1.1 Carbonate Chemistry

A full depth CTD was collected to investigate the total alkalinity (TA), Total Dissolved Inorganic Carbon (DIC) and nutrients to determine the carbonate saturation level of the water column. Water samples were decanted through Tygon tubing into acid washed (1 % hydrochloric acid) borosilicate bottles (250 ml). Seawater was collected immediately and care was taken to avoid trapping bubbles to minimise gaseous exchange. Samples were poisoned with 50 µl saturated Mercuric Chloride solution ($HgCl_2$) to prevent biological alteration, homogenised and sealed with apiezon grease. Bottles were then stored in darkness at 4 ˚C for future analysis. The concentration of [CO_3^{2-}] was indirectly determined from the measured carbonate parameters using the free computer program CO_2SYS and the saturation of calcite or aragonite calculated by the ratio:

$$\Omega = [Ca^{2+}]\ [CO_3^{2-}] / K'_{sp}$$

i.e. The ion product of the concentrations of calcium and carbonate ions, at the in situ temperature, salinity and pressure, divided by the stoichiometric solubility product at the same conditions. K'_{sp} is the value of the carbonate dissociation constants. Ca^{2+} can be estimated from salinity. $\Omega > 1$ indicates supersaturation with respect to calcite or aragonite, while $\Omega < 1$ denotes undersaturation with respect to the carbonate phase. In order to correct the CO2SYS calculation, nutrients samples (Silicate and Phosphate) were collected in Nalgene bottles and stored at -20 °C to be analyses post cruise.

Carbonate chemistry data will be used for pteropod studies (see Section 6.2)

Table 7.1. CTD water samples taken for water chemistry analysis where TA/DIC (Total Alkalinity and Dissolved inorganic carbon) and nutrient samples will be further analysed to determine the carbonate chemistry over a range of depths per station. Incubation water was collected to incubate live pteropods captured in proximate spatiotemporal conditions to allow accurate understanding of carbonate chemistry and allow chemical manipulation.

Time	Bridge Event number	Bottle number	Wire Out (m)	Bottle Depth (m)	TA/DIC	Nutrients	Incubation
09/12/2015 13:37	136	24	5	5	x	x	
09/12/2015 13:36	136	23	39	42.9	x	x	
09/12/2015 13:33	136	20	100	102.7	x	x	
09/12/2015 13:31	136	19	200	203.4	x	x	
09/12/2015 13:30	136	18	200	203.7			x
09/12/2015 13:30	136	17	200	204			x
09/12/2015 13:27	136	15	300	302.6	x	x	
09/12/2015 13:25	136	14	400	403.1	x	x	
09/12/2015 13:20	136	11	600	600	x	x	
09/12/2015 13:16	136	10	800	800	x	x	
09/12/2015 12:58	136	7	1200	1201.9	x	x	
09/12/2015 12:51	136	6	1200	1600	x	x	
09/12/2015 12:43	136	5	2000	2002.9	x	x	
09/12/2015 12:35	136	4	2400	2402.6	x	x	
09/12/2015 12:28	136	3	2800	2807.1	x	x	
09/12/2015 12:21	136	2	3200	3200.9	x	x	
09/12/2015 12:12	136	1	3685	3687.1	x	x	
08/12/2015 13:22	114	6	200	201.5			x
08/12/2015 13:22	114	5	200	201.6			x
08/12/2015 13:21	114	4	200	201.4			x
06/12/2015 00:20	95	5	200	203.6			x
06/12/2015 00:19	95	4	200	204.1			x
06/12/2015 00:19	95	3	200	203.6			x
05/12/2015 20:45	94	4	120	123.9			x
05/12/2015 20:45	94	3	120	123.4			x
05/12/2015 20:44	94	2	120	123.4			x
04/12/2015 22:51	87	11	200	205.5			x
04/12/2015 22:51	87	10	200	204.3			x
04/12/2015 22:50	87	9	200	206.4			x
04/12/2015 22:50	87	8	200	206.3			x
04/12/2015 07:47	81	4	200	200			x
04/12/2015 07:46	81	3	200	200			x
04/12/2015 07:46	81	2	200	200			x
03/12/2015 20:42	77	3	200	199.8			x
03/12/2015 20:41	77	2	200	199.9			x
03/12/2015 20:41	77	1	200	199.8			x
01/12/2015 11:28	62	4	200	202.4			x
01/12/2015 11:27	62	3	200	202.4			x
01/12/2015 11:27	62	2	200	202.4			x

01/12/2015 11:26	62	1	200	202.4			x
30/11/2015 13:47	40	9	200	200			x
30/11/2015 13:47	40	8	200	200			x
28/11/2015 14:41	31	22	10	10	x	x	
28/11/2015 14:39	31	21	50	50	x	x	
28/11/2015 14:38	31	20	100	100	x	x	
28/11/2015 14:38	31	20	100	100	x	x	
28/11/2015 14:35	31	18	200	200			x
28/11/2015 14:32	31	16	300	300	x	x	
28/11/2015 14:30	31	15	400	400	x	x	
28/11/2015 14:25	31	13	600	600	x	x	
28/11/2015 14:14	31	5	1000	1000	x	x	
28/11/2015 14:07	31	4	1400	1400	x	x	
28/11/2015 13:56	31	3	2000	2000	x	x	
28/11/2015 13:39	31	2	3000	3000	x	x	
28/11/2015 13:25	31	1	3735	3735	x	x	
22/11/2015 16:11	21	21	50	50	x	x	
22/11/2015 16:10	21	20	56	56	x	x	
22/11/2015 16:09	21	19	100	100	x	x	
22/11/2015 16:06	21	17	200	200			x
22/11/2015 16:06	21	16	200	200	x	x	
22/11/2015 16:04	21	15	300	300	x	x	
22/11/2015 16:01	21	12	400	400	x	x	
22/11/2015 15:56	21	10	600	600	x	x	
22/11/2015 15:52	21	9	800	800	x	x	
22/11/2015 15:48	21	6	1000	1000	x	x	
22/11/2015 15:40	21	5	1400	1400	x	x	
22/11/2015 15:35	21	4	1700	1700	x	x	
22/11/2015 15:26	21	3	2000	2000	x	x	
22/11/2015 15:16	21	2	2600	2600	x	x	
22/11/2015 15:05	21	1	3000	3000	x	x	
21/11/2015 14:01	16	20	10	10	x	x	
21/11/2015 13:53	16	16	100	100	x	x	
21/11/2015 13:50	16	14	200	200	x	x	
21/11/2015 13:50	16	13	200	200			x
21/11/2015 13:47	16	11	300	300	x	x	
21/11/2015 13:44	16	8	400	400	x	x	
21/11/2015 13:41	16	6	500	500	x	x	
21/11/2015 13:38	16	4	600	600	x	x	
21/11/2015 13:34	16	3	800	800	x	x	
21/11/2015 02:05	11	19	11	11	x	x	
21/11/2015 02:02	11	16	100	100	x	x	
21/11/2015 01:59	11	13	150	150	x	x	
21/11/2015 01:57	11	12	200	200			x
21/11/2015 01:57	11	11	200	200			x
21/11/2015 01:54	11	8	300	300	x	x	
21/11/2015 01:51	11	7	400	400	x	x	

21/11/2015 01:49	11	6	500	500	x	x	
21/11/2015 01:45	11	4	600	600	x	x	
21/11/2015 01:41	11	3	800	800	x	x	
21/11/2015 01:36	11	1	1000	1000	x	x	

7.1.2 $\delta^{13}C$, $\delta^{18}O$ Isotopes and Particulate Inorganic Carbon (PIC)

Water samples for stable isotope analyses were taken from the rosette sampler. Samples for ^{13}C analysis (250 mL) were drafted carefully into glass bottles without sputtering and thus avoiding bubbles. Samples were immediately poisoned with sutured $HgCl_2$ solution (50 µl) to stop biochemical reactions, which may alter the carbon isotopic composition of CO2. Water samples for ^{18}O analysis (250 mL) were filled into glass bottles and sealed by plastic screw-on caps. The oxygen and carbon isotope mass ratios of the water samples will be measured post cruise by mass spectrometer.

Water samples for Particulate Organic Carbon (PIC) was filtered on board by a vacuum pump filtration system on 47mm GFF filters and then dried at 60 °C for 24h before being stored. PIC samples will be analysed post cruise by HCN auto-analyzer.

Table 7.2: $\delta^{13}C$, $\delta^{18}O$ Isotopes and PIC data will be used for foraminifera study (see Section 6.3)

Time	St.	Event no		Depth	Sample For	Volume
09/12/15	Upwelling	136	22	53.7	PIC, $\delta^{13}C$, $\delta^{18}O$	1L, 0.5L
09/12/15		136	20	102.7	PIC, $\delta^{13}C$, $\delta^{18}O$	2L, 0.5L
09/12/15		136	19	203.4	PIC, $\delta^{13}C$, $\delta^{18}O$	3L, 0.5L
09/12/15		136	15	302.6	PIC, $\delta^{13}C$, $\delta^{18}O$	4L,0.5L
09/12/15		136	14	403.1	PIC, $\delta^{13}C$, $\delta^{18}O$	4L,0.5L
09/12/15		136	11	600	PIC, $\delta^{13}C$, $\delta^{18}O$	6.5L, 0.5L
09/12/15		136	10	800	PIC, $\delta^{13}C$, $\delta^{18}O$	5L, 0.5L
09/12/15		136	8	1000	PIC, $\delta^{13}C$, $\delta^{18}O$	6L, 0.5L
30/11/15	P2	40	16	5	PIC, $\delta^{13}C$, $\delta^{18}O$	1L, 0.5L
30/11/15		40	14	50	PIC, $\delta^{16}C$, $\delta^{18}O$	2L, 0.5L
30/11/15		40	12	100	PIC, $\delta^{13}C$, $\delta^{18}O$	2L, 0.5L
30/11/15		40	11	200	PIC, $\delta^{13}C$, $\delta^{18}O$	3L, 0.5L
30/11/15		40	6	400	PIC, $\delta^{13}C$, $\delta^{18}O$	4L, 0.5L
30/11/15		40	4	600	PIC, $\delta^{13}C$, $\delta^{18}O$	6L, 0.5L
30/11/15		40	3	800	PIC, $\delta^{13}C$, $\delta^{18}O$	5L, 0.5L
30/11/15		40	2	1000	PIC, $\delta^{13}C$, $\delta^{18}O$	6.5L, 0.5L
28/11/15	P3	31	23	5	PIC, $\delta^{13}C$, $\delta^{18}O$	1L, 0.5L
28/11/15		31	22	10	PIC, $\delta^{13}C$, $\delta^{18}O$	2L, 0.5L

28/11/15		31	21	50	PIC, $\delta^{13}C$, $\delta^{18}O$	2L, 0.5L
28/11/15		31	20	100	PIC, $\delta^{13}C$, $\delta^{18}O$	2L, 0.5L
28/11/15		31	19	200	PIC, $\delta^{13}C$, $\delta^{18}O$	3L, 0.5L
28/11/15		31	15	400	PIC, $\delta^{13}C$, $\delta^{18}O$	4L, 0.5L
28/11/15		31	5	1000	PIC, $\delta^{13}C$, $\delta^{18}O$	6.5L, 0.5L

7.2 POM sampling – Highly Branched isoprenoids (HBIs)

Gabriele Stowasser, Simon Belt

7.2.1 Background

Southern Ocean sea ice is critical to Earth's climate regulation because sea ice forms a physical barrier, which reduces sea-air communication of gases and heat, and influences ocean dynamics, such as Antarctic bottom water and current formation[1,2]. However, we know little about the long-term dynamics of sea ice (especially summer sea ice) because there are no effective tools to investigate its historical variability. Sea ice also provides a habitat for various microflora, especially diatoms, which bloom during the spring and provide a key component within polar ecosystems. The impact of reduced sea ice cover on sea ice algal productivity and the impacts that this may have on higher trophic levels is poorly understood and in particular, whether organisms that currently rely on sea ice organic carbon are able to adapt to pelagic sources, even if available. Once again, such investigations require the development of methods that target specific carbon sources in order for our understanding to develop.

Certain diatoms produce unique lipids in extreme environments, such as sea ice, and these lipids can be used as environmental proxies. For example, highly branched isoprenoid (HBI) alkenes are unusual lipids made by known common diatom genera including *Haslea*, *Navicula*, *Pleurosigma*, *Rhizosolenia* and *Berkeleya*[3-8]. One HBI (IP_{25}: Ice Proxy with 25 carbon atoms[9]), is produced selectively by certain diatoms residing in Arctic sea ice and its presence in underlying sediments is a powerful proxy for the past occurrence of Arctic spring sea ice[9]. IP_{25} has also emerged as a suitable tracer of sea ice-derived organic carbon source within Arctic food webs[10-12]. IP_{25} has not been reported in Antarctic sea-ice diatoms, sediments or heterotrophic consumers, but a structural analogue (an HBI diene) has been[13-

[20]. Since this HBI diene is co-produced with IP_{25} by Arctic sea-ice diatoms (and can therefore also be used as a proxy for Arctic sea ice) and has an isotopic ($\delta^{13}C$) signature characteristic of a sea-ice origin when detected in Antarctica[18], it has the potential to provide the basis for palaeo sea-ice reconstruction and food web studies for the Southern Ocean. Indeed, a small number of studies based on the HBI diene have begun to appear[13-20]. A further HBI (an HBI triene) has been reported in Antarctica, but appears not to be made by diatoms living in sea ice. The significantly lighter isotopic composition ($\delta^{13}C$) of the HBI triene compared to the HBI diene[18], indicates an origin in the pelagic phytoplankton, possibly from species that thrive within the marginal ice zone or retreating ice margin. Measurement of the HBI diene and triene has the potential to provide key proxy data for both palaeo sea ice and for tracing organic carbon in Southern Ocean ecosystems. However, the development of HBIs as proxies for Antarctic sea ice is much less advanced than that of IP_{25} for the Arctic[9] and has relied almost entirely on their analysis in sediments and a few higher trophic level organisms, rather than within their source environments. Further, the specific diatoms responsible for HBI production in the Southern Ocean are not known, but the species found in Antarctic winter sea ice have already been eliminated as HBI producers.

In order to create a baseline for HBI production across the Scotia Sea we aim to collect phytoplankton samples along a transect from the South Orkneys to the Polar Front.

7.2.2 Methods

Phytoplankton samples were obtained from a combination of filtering from the ship's intake line (underway water supply) of near surface waters and Niskin bottles deployed via a CTD rosette with water being collected from various depths at each station (see Table 7.3). All water samples collected from Niskin bottles were processed on-board. 5 litres of seawater per depth were filtered onto 47mm GF/F filters and the filters stored frozen at -80°C. Underway sampling was carried out by placing a phytoplankton net (20µm cod-end mesh size) under the outflow of the underway water supply. Keeping a constant flow rate (2l/min), sampling was then conducted during the time the ship remained on station (For times filtered see Table 7.3). Accumulated particulate organic matter (POM) was washed from the filter into 50ml vials using filtered seawater and samples stored at -80°C. All samples will subsequently be analysed for HBIs at Plymouth University.

Table 7.3: POM samples collected for HBI analysis.

Station	CTD event	sample depths	water depth (m)	latitude	longitude	comment
C2	10	Chlmax (46m), 100m, 200m, 500m, underway	5457	-60.2082	-44.4077	US*: litr. filtered 98
C3	11	Chlmax (11m), 50m, 100m, 200m, 500m, underway	4152	-59.6887	-44.0543	US: litr. filtered 328
C4	16	Chlmax (23m), 2nd Chl peak (4m), 50m, 100m, 200m, 500m, underway	2847	-58.0229	-42.9842	4m+Chlmax+ 50m two filters each in separate petri dishes US: litr. filtered 141
P2	40	Chlmax (48m), 100m, 200m, 500m, underway	3358	-55.2428	-41.2575	Chlmax two filters in separate petri dishes US: litr. filtered 923
WCB 2.2N	87	Chlmax (12m), 50m, 100m, 200m, 500m, underway	3494	-53.4325	-38.6950	Chlmax, 50m two filters each in separate petri dishes US: litr. filtered 118
WCB 3.2S	94	Chlmax (37m), 50m, 100m	132	-53.7138	-37.9664	Chlmax, two filters in separate petri dishes; no underway
P3	114	Chlmax (28m), 50m, 100m, 200m, 500m, underway	3785	-52.8117	-40.1116	Chlmax, two filters in separate petri dishes US: litr. filtered 422
Upwelling	136	Chlmax (39m), 50m, 100m, 200m, 500m, underway	3730	-52.6272	-39.1152	Chlmax, 50m two filters each in separate petri dishes US: litr. filtered 418

*US = Underway Sampling. All times are given in GMT

7.2.3 References

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7.3 Environmental DNA sampling

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7.3.1 Detecting Myctophidae using e-DNA

7.3.1.1 Introduction

Environmental DNA (eDNA) can be defined as genetic material obtained directly from environmental samples (soil, sediment, water, etc.) without any obvious signs of biological source material (Thomsen and Willerslev, 2015). Due to it being efficient, cost effective and sensitive, eDNA is becoming an ever popular method for detecting and monitoring freshwater species, especially for those that are rare, elusive or of ecological importance (Thomsen and Willerslev, 2015, Kelly et al., 2014, Sigsgaard et al., 2015, Thomsen et al., 2012b, Bohmann et al., 2014, Dejean et al., 2012, Rees et al., 2014, Ficetola et al., 2008). Few studies have tested the use of eDNA in marine environments however Thomsen et al. (2012a) detected a wide range of coastal fish species with results that were more accurate than other sampling techniques. They also found that eDNA degraded beyond detection after 1-6 days, limiting the possibility of long distance transport of DNA.

Lanternfish of the family Myctophidae are the dominant mesopelagic fish species in many oceans, occupying depths between 200 and 1000m but also extend to epipelagic (<200m) and bathypelagic (>1000m) zones. They are thought to comprise at least 20% of all oceanic ichthyofauna biomass (Catul et al., 2011) and have an important role in the ecosystem functioning. They have high centrality in pelagic food webs, consuming zooplankton and transferring energy to higher trophic levels (Barrera-Oro, 2002). As adults, myctophids are a major component of the diurnal vertical migration (DVM) which constitutes the biggest

animal migration on earth in terms of biomass (Hays, 2003) and has a key role in the vertical transport of carbon in the oceans (Steinberg et al., 2000, Longhurst et al., 1990).

Yet the deep pelagic ocean is the least well sampled of all marine environments (Webb et al., 2010, Ramirez-Llodra et al., 2010). Inaccessible locations, net avoidance behaviour, and the need for taxonomic expertise remain major challenges in accurately detecting myctophid species and other pelagic fauna. Thus, eDNA offers new hope for effective biodiversity assessment and monitoring in pelagic and deep ocean environments.

7.3.1.2 Aims

The aim of this study was to collect and filter water samples from multiple depths in order to investigate a) the potential application of eDNA sampling for the detection of deep pelagic fish species with a particular focus on myctophids, and b) how the quality and quantity of eDNA is affected by different environmental conditions.

7.3.1.3 Methods

Laboratory set up is shown in Figure 7.1. All sampling and filtering equipment were rinsed in 10% bleach solution for at least 30 min before and after use.

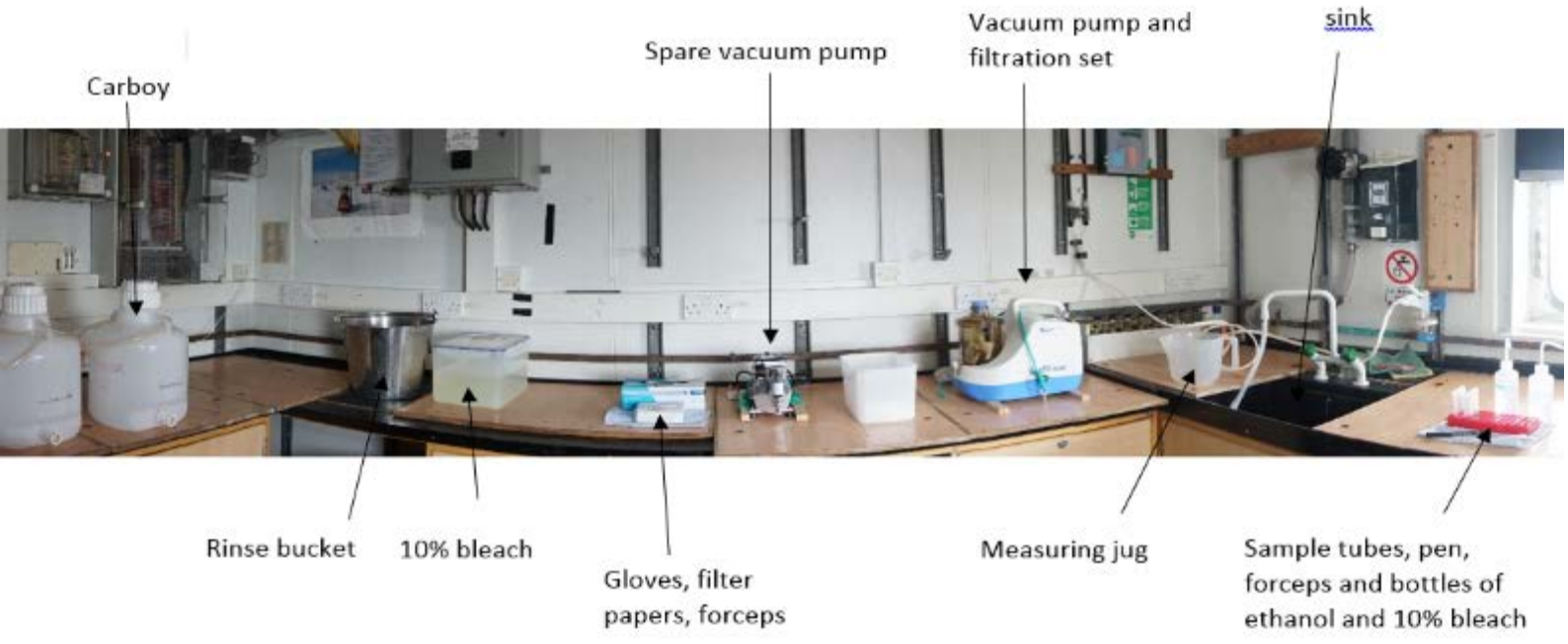

Figure 7.1: Labelled panorama of Environmental DNA laboratory

Water sampling took place during CTD deployments (Table 7.4). Samples were collected in 12 litre Niskin bottles which were fired at the pre-determined depths of 5m, 100m, 300m,

550m and 850m. These depths were chosen based on previous stratified net sampling depths (Collins et al., 2012) in order for a comparison between net and eDNA results.

From each sample, three replicates of two litres of seawater were vacuum-filtered using a Lafil-400 filtration system (Figure 7.2; Rocker Scientific, Taiwan) onto 47 mm diameter Cellulose nitrate filters (nominal pore size, 1.0 µm; Whatman, Maidstone, UK). For each depth, two litres of Milli-Q water was also filtered to be used as a negative control and treated identically to the seawater. The following measures were also carried out to minimize possible contamination between depths: separate water containers were used for each depth, filtration sets were rinsed in 10% bleach, work benches were cleaned and gloves changed after each depth had been filtered

Each filter was stored in 95% ethanol for subsequent DNA extraction which will take place at University of Bristol.

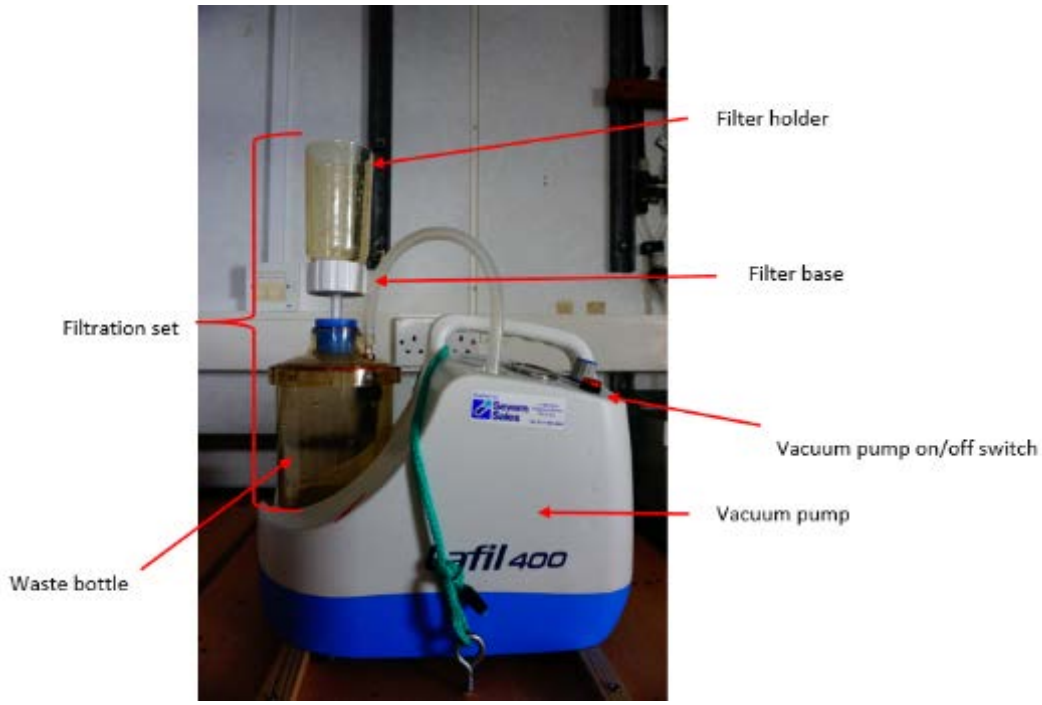

Figure 7.2: Labelled photograph of the Rocker 400 Lafil filtration set used during eDNA filtering

7.3.2 Detecting Antarctic Krill, *Euphausia superba*, using eDNA

7.3.2.1 Aims

The aim of this study is to test the potential application of eDNA for the detection of Antarctic krill, *Euphausia superba*, and their predators. Samples were collected for Will Goodall-Copestake (BAS) and collaborators.

7.3.2.2 Methods

At each CTD station (Table 7.4), seawater from a target depth of 5m was sampled. Three replicates of 1 litre of seawater were vacuum-filtered on to 47mm diameter filters (pore size 0.45µm) using the same equipment and techniques as described in section 7.2.1. Similarly, filters were stored in 95% ethanol for subsequent DNA extraction. In addition, two 3 litre bags of seawater from each station were frozen at -20°C.

Table 7.4: List of eDNA seawater samples collected from CTD deployments and the fate of each sample. JF = Jennifer Freer, WG = Will Goodall-Copestake.

Time	Event Number	Station ID	CTD bottle number	CTD bottle depth (metres)	Volume sampled (Litres)	Sample Fate
09/12/2015 13:37	136	upwelling	24	5	6	Myctophids (JF)
09/12/2015 13:33	136	upwelling	21	100	6	Myctophids (JF)
09/12/2015 13:27	136	upwelling	15	300	6	Myctophids (JF)
09/12/2015 13:21	136	upwelling	12	550	6	Myctophids (JF)
09/12/2015 13:15	136	upwelling	9	850	6	Myctophids (JF)
05/12/2015 20:50	94	W3.2	9	5	6	Myctophids (JF)
05/12/2015 20:50	94	W3.2	8	5	9	Krill (WG)
04/12/2015 22:58	87	W2.2	17	5	9	Krill (WG)
04/12/2015 22:57	87	W2.2	16	5	6	Myctophids (JF)
04/12/2015 22:54	87	W2.2	12	100	6	Myctophids (JF)
04/12/2015 22:46	87	W2.2	6	300	6	Myctophids (JF)
04/12/2015 22:40	87	W2.2	3	550	6	Myctophids (JF)
04/12/2015 22:34	87	W2.2	2	850	6	Myctophids (JF)
28/11/2015 14:43	31	P3	24	5	9	Krill (WG)
28/11/2015 14:42	31	P3	23	5	6	Myctophids (JF)
28/11/2015 14:38	31	P3	20	100	6	Myctophids (JF)
28/11/2015 14:33	31	P3	17	300	3	Myctophids (JF)
28/11/2015 14:27	31	P3	14	550	6	Myctophids (JF)
28/11/2015 14:17	31	P3	6	850	6	Myctophids (JF)

22/11/2015 16:13	21	P2	23	5	9	Krill (WG)
22/11/2015 16:12	21	P2	22	5	6	Myctophids (JF)
22/11/2015 16:08	21	P2	18	100	6	Myctophids (JF)
22/11/2015 16:03	21	P2	13	300	6	Myctophids (JF)
22/11/2015 15:58	21	P2	11	550	6	Myctophids (JF)
22/11/2015 15:51	21	P2	8	850	6	Myctophids (JF)
22/11/2015 15:05	21	P2	1	3000	6	Myctophids (JF)
21/11/2015 14:02	16	C4	22	5	9	Krill (WG)
21/11/2015 14:02	16	C4	21	5	6	Myctophids (JF)
21/11/2015 13:52	16	C4	15	100	6	Myctophids (JF)
21/11/2015 13:47	16	C4	10	300	6	Myctophids (JF)
21/11/2015 13:40	16	C4	5	550	6	Myctophids (JF)
21/11/2015 13:32	16	C4	2	850	6	Myctophids (JF)
21/11/2015 02:06	11	C3	21	5	9	Krill (WG)
21/11/2015 02:06	11	C3	20	5	6	Myctophids (JF)
21/11/2015 02:00	11	C3	14	100	6	Myctophids (JF)
21/11/2015 01:54	11	C3	9	300	6	Myctophids (JF)
21/11/2015 01:47	11	C3	5	550	6	Myctophids (JF)
21/11/2015 01:40	11	C3	2	850	6	Myctophids (JF)
20/11/2015 15:42	10	C2	9	5	0	Did not fire
20/11/2015 15:39	10	C2	6	100	6	Myctophids (JF)
20/11/2015 15:34	10	C2	4	300	6	Myctophids (JF)
20/11/2015 15:29	10	C2	2	550	6	Myctophids (JF)
20/11/2015 15:23	10	C2	1	850	6	Myctophids (JF)
12/11/2015 11:26	5	Test -North PF	7	10	6	Myctophids (JF)
12/11/2015 11:25	5	Test -North PF	5	20	6	Myctophids (JF)
12/11/2015 11:24	5	Test -North PF	4	30	6	Myctophids (JF)
12/11/2015 11:23	5	Test -North PF	3	40	6	Myctophids (JF)
12/11/2015 11:22	5	Test -North PF	2	50	6	Myctophids (JF)
12/11/2015 11:21	5	Test -North PF	1	60	6	Myctophids (JF)

7.3.2.3 References

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8. Collaborative Gearing Scheme (CGS)

8.1 Characterising the Modern Distribution of Oceanographic Properties and Marine Microbiota North-west of South Georgia, and Reconstructing Recent (ca. 200 yrs) Climatic and Environmental Changes in the same Region – CGS 112

Vicky Peck (BAS) and Rowan Déjardin (University of Nottingham)

A CGS grant was awarded to Rowan Déjardin to collect surface sediment samples from the South Georgia shelf on JR15002. The objective of this study is to analyse the sediment composition, biomarkers and the microfossil assemblage (diatoms and benthic and planktonic foraminifera and their stable isotopic composition) to better calibrate paleoceanographic proxies in this region and aid the interpretation of a number of BAS

gravity cores on the South Georgia shelf. In addition, if enough calcareous foraminifera are collected, a radiocarbon marine reservoir correction for this region will be calculated. On 27.11.15 the BAS box corer (see Figure 8.1) was used to collect surface sediment samples from two trough systems on the South Georgia shelf, off Antarctic Bay-Possession Bay, BC737 and Bay of Isles, BC738 (see Table 8.1). From each box core six surface samples (top 1-2 cm) were collected, two of which were frozen, three retained in the cold store, and one immediately washed through a 63 µm sieve and dyed with Rose Bengal to identify live and recently dead foraminifera. Four sub-cores were also taken, 15 cm in length from BC737 and 20 cm in length from BC738. Two of these sub-cores were frozen, with one being cut into 1 cm slices that were then wrapped in aluminium foil to prevent plastic contamination that can adversely affect biomarker analysis. The remaining two sub-cores were retained in the cold store (+4 ˚C), one being cut into 1 cm samples which were then washed through a 63 µm sieve and the top 7 samples dyed with Rose Bengal.

Time limitations prevented the collection of a water-column profile, water samples or a plankton sample at the time that the box cores were collected. An opportunity to revisit the site of BC738 arose on 02.12.15 but a fault with the mid-ships gantry prevented deployment of the CTD or bongo net. Ocean-logger data will be used to calibrate relevant proxies to sea surface conditions and more remote CTD data will be studied to assess benthic conditions on the South Georgia shelf.

Figure 8.1: Box corer recovery and sample. Sides of box corer measure 50 cm.

Table 8.1: Details of box cores undertaken, Events 28 & 30, BC737 and BC738.

Date	Time at sea floor (GMT)	Lat.	Long.	Water depth (m)	Sub-core recovered (cm)	Bagged surface sample
27.11.15	20:51:52	-53.99709	-36.82012	260	15 x2 (frozen) x2 (cold store)	x2 (frozen) x3 (cold store) x1 (washed
28.11.15	00:18:00	-53.85504	-37.65095	287	20 x2 (frozen) x2 (cold store)	x2 (frozen) x3 (cold store) x1 (washed

8.2 Intertidal Algae and Infauna. A Functional Group Approach to Ecosystem Services CGS 119 *EC Pindar (University of Hull)*

8.2.1 Aims

The project aims to investigate the roles different invertebrate species play in communities living in association with intertidal seaweeds and compare these with similar communities elsewhere. Functional groups of macroalgae and infauna will be used create a model which could determine intertidal community robustness with applications for future environmental change.

8.2.2 Methods

- Sampling: Macroalgae and infauna

Sampling was undertaken in at low water at seven different sites, as shown in Table 8.2 The complete macroalgae, including holdfast, was sampled. Where available, five replicates were taken of each species and carefully placed in a zip-lock bag to ensure retention of invertebrate infauna. Photographs of the sites are shown in Figure 8.2

Table 8.2: Sampling sites

Sampling Event	Site	Location	Position (S)	Position (W)	Date	Individuals sampled	Sample Reference	Comments
1	Surf Bay	East Falkland	51°39.73	57°40.56	09/11/2015	69	SB1 - SB16	To south of bay
2	Mare Sound	East Falkland	51°54.06	58°26.88	10/11/2015	30	MS17 - MS22	From rib
3	Mare Harbour	East Falkland	51°54.65	58°26.88	10/11/2015	34	MH23 - MH29	At the bunkerage
4	Port Stanley	East Falkland	51°41.50	57°49.45	12/11/2015	15	PS30 - PS32	Outside the Narrows
5	Bernsten Point	Signy	60°42.50	45°35.49	19/11/2015	20	BP33 - BP36	No shoreline due to sea ice
6	King Edward Cove	South Georgia	54°16.99	36°29.78	25/11/2015	64	SG37 - SG50	
7	Iceberg Point	Bird Island	54°00.60	38°03.15	29/11/2015	56	BI51 - BI65	Access limited by fur seal population

- Sampling: sediments

Intertidal sediment samples were taken at the King Edward Cove site. Other sites were rocky shores.

Three replicates of sediment were taken in 100ml sample pots.

- Sampling: Macroalgae associated invertebrates

Invertebrates associated with the intertidal macroalgal communities were sampled at King Edward Cove and Iceberg Point.

8.2a Surf Bay

8.2b Mare Sound

8.2c Mare Harbour

8.2d Port Stanley

8.2e Bernsten Point, Signy

8.2f King Edward Cove, South Georgia

8.2g Iceberg Point, Bird Island

Figure 8.2: Sampling sites

- Laboratory: Macroalgae

On return to the James Clark Ross (JCR) all samples were catalogued & frozen at -20°C. Where available, replicates 4/5 and 5/5 were subsequently defrosted during the cruise. All defrosted samples were carefully washed to remove infauna and sediment. The wash water was passed through a 250µ sieve and the fractions preserved in 70% ethanol. Replicate 4/5 was then photographed for later digital analysis and refrozen for disposal in the UK. Example photographs are shown in figure 8.3 Replicate 5/5 was placed in a biological press to create a reference collection.

Figure 8.3: Example macroalgal images

A 1cm piece of each macroalgal sample was preserved in 96% ethanol for genetic analysis, as required.

- Laboratory: sediments

All sediment samples were preserved in 70% ethanol for analysis in the UK.

- Laboratory: Associated invertebrates

All associated invertebrates were preserved in 70% ethanol for identification in the UK.

- Long term storage for transit to UK

Invertebrates, sediments and macroalgal sub-samples were packed in vermiculite for long term storage. Whole macroalgal samples were packed in the -20°C freezer. All to remain on the JCR until her return to the UK at the end of the Antarctic season.

9. AME Report

Cruise: JR15002 Start date: 7 Nov 2015 Finish date: 15 Dec 2015

Name of AME engineer: Paul Morgan

Name of principle scientist (PSO): Gabriele Stowasser

9.1 LAB Instruments

Instrument	S/N Used	Comments
AutoSal	63360	
Scintillation counter	Y	
Magnetometer STCM1	N	
XBT	Y	

9.2 Acoustics

Instrument	S/N Used	Comments
ADCP	N	
PES	N	
EM120	N	
TOPAS	N	
EK60	Y	
EK80	Y	EK80 was installed successfully
SSU	Y	
USBL	N	
10kHz IOS pinger	N	
Benthos 12kHz pinger S/N 1316 + bracket	N	
Benthos 12kHz pinger S/N 1317 + bracket	N	
MORS 10kHz transponder	N	

9.3 Oceanlogger

Instrument	S/N Used	Comments
Barometer1(UIC)	5002	
Barometer1(UIC)	5003	
Foremast Sensors		
Air humidity & temp1	3898	

Air humidity & temp2	3896	
TIR1 sensor (pyranometer)	2993	Not working
TIR2 sensor (pyranometer)	2992	Not working
PAR1 sensor	0127	
PAR2 sensor	0126	
prep lab		
Thermosalinograph SBE45	0016	
Transmissometer	396	
Fluorometer	1100243	
Flow meter	811950	
Seawater temp 1 SBE38	0601	
Seawater temp 2 SBE38	0599	

9.4 CTD

(all kept in cage/ science hold when not in use)

Instrument	**S/N Used**	**Comments**
Deck unit 1 SBE11plus	0458	
Underwater unit SBE9plus	0707	
Temp1 sensor SBE3plus	2075	
Temp2 sensor SBE3plus	5766	
Cond1 sensor SBE 4C	2248	
Cond2 sensor SBE 4C	4471	
Pump1 SBE5T	1807	
Pump2 SBE5T	7606	
Standards Thermometer SBE35	0024	
Transmissometer C-Star	846	
Oxygen sensor SBE43	0676	
PAR sensor	7274	
Fluorometer Aquatracka	008-249	
Altimeter PA200	163162	
LADCP	15060	
CTD swivel linkage		
Pylon SBE32	0636	
Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc		All lanyards were replaced at the start of the cruise.

9.5 AME Unsupported Instruments but Logged

Instrument	Working?	Comments
EA600	Y	
Anemometer	Y	
Gyro	Y	
DopplerLog	Y	
EMLog	y	

9.6 End of Cruise Procedure

At the end of the cruise, please ensure that:

- The XBT is left in a suitable state (store in cage if not to be used for a while – do not leave on deck or in UIC as it will get kicked around). Remove all deck cables at end of cruise prior to refit.
- The salinity sample bottles have been washed out and left with deionised water in – please check this otherwise the bottles will build up crud and have to be replaced.
- The CTD is left in a suitable state (washed (including all peripherals), triton + deionised water washed through TC duct, empty syringes put on T duct inlets to keep dust out and stored appropriately). Be careful about freezing before next use – this will damage the C sensors (run through with used standard seawater to reduce the chance of freezing before the next use). Remove all the connector locking sleeves and wash with fresh water. Blank off all unconnected connectors. See the CTD wisdom file for more information. If the CTD is not going to be used for a few weeks, at the end of your cruise please clean all connectors and attach dummy plugs or fit the connectors back after cleaning if they are not corroded.
- The CTD winch slip rings are cleaned if the CTD has been used – this prevents failure through accumulated dirt.
- The SVP is left in a suitable state (washed and stowed). Do not leave this on deck without a cover for any length of time as it rusts. Stow inside at end of cruise.
- All manuals have been returned to the designated drawers and cupboards.
- You need to clean all the fans listed below every cruise or every month, whichever is the longer.

Please clean the intake fans on the following machines:

Instrument	Cleaned?
Oceanlogger	Y
EM120, TOPAS, NEPTUNE UPSs	Y
Seatex Seapath	Y
EM120 Tween Deck	Y
TOPAS Tween Deck	Y

9.7 Additional notes and recommendations for change / future work

Ocean logger

The new updated version of the ocean logger started to show a glitch, the fluorometer showed NaN and the temperature sensors were not around the values expected. The 2013 version of ocean logger was implemented and the issues disappeared. The 2013 version will continue to run until the issue is investigated.

CTD

All lanyards were replaced at the start of the cruise subject to Seth's recommendations. Only one bottle did not fire properly. This occurred on the first deployment and since then the trigger mechanism was removed in between each CTD cast and left to soak in warm fresh water to remove any leftover salt residue. The top clamp which holds the fin to the CTD frame snapped. This was replaced and the original part fixed which is now kept in the spares box.

CLAM

During cruise JR298 the CLAM PC failed. As part of the solution an XP windows PC was put in place to run the aging Labview software. During this cruise it was notice the biological wire was not recording tension properly, as the Bio-wire was never tested until the requirements of this cruise. A load meter was connected to the deck and showed two tonnes of tension whereas the CLAM PC read that as ~11 tonnes. The route cause was never found, it was quicker to install the MOXA cards onto the AME PC which has Windows7 and upgrade the CLAM software from Labview V5.1 to 2012. This solved the issue.

Signy Ice Camera

During the Signy Island relief Mike Dunn, Scott and I went up to perform routine maintenance and a modification to the diode board within the battery box. The modifications went through without any issues although it was noticed that no LEDs were lighting up as the camera was turned on. There was power being proved to the camera system and with little other options, Mike was asked if he gets the chance to have a look later in the season if the camera is actually taking pictures.

Mike Dunn checked the camera two weeks later and the SD card showed the camera taking photos every six days in December 2014 through to March 2015. The card was swapped and the camera worked as it should, taking two pictures a day. Unfortunately, when the card was swapped back at the start of this season the same problem arose. I believed the problem lies with the SD card, as this is where the camera is told when to take pictures.

Bio-wire

An electrical check was performed on the Bio-wire after it was untangled, which it passed. The Bio-wire will be electrically tested again after its mechanical check on the next cruise.

Mammoth

A fuse blew and used up the only spare with the kit. As they are unusual size a 100 have been ordered and are to be kept in the AME electronics office.

Support Engineer: Paul Morgan Date: 11th December 2015

10. Gear Report

Peter Enderlein and Scott Polfrey

10.1 Down Wire Net Monitor system (DWNM)

The DWNM was used with the Biological Wire and had a new mechanical and electrical termination at the very beginning of the cruise. It was tested to 3.5 tonne. Initially the load cell on the Bio Wire was not working properly and maxed out during the first load test. This was rectified and thereafter the load cell was working with an offset of about 0.4 to at 3.5 to. On the 09.12.15 after the successful recovery of the Mammoth, the Bio Winch started turning on its own for about 10 min. This left the cable in an absolute mess and we had to unspool about 2300 m of cable before we could spool it back on. It seems that the cable suffered little damage and the initial electrical test suggest the cable is in working order. At least one further off spooling under low tension (~500kg) and re spooling, followed by a further electrical test, is required, before the cable can be used again with any equipment.

Two of the four DWNM units were used this time with various sensors attached to them. There was one on the RMT8 and a modified unit for the MOCNESS, both worked as expected.

10.2 Mooring Winch

The winch worked fine throughout the 2 moorings. A new stainless steel housing has been fitted to replace the plastic one holding the breaker unit.

10.3 Bongo Net

This net was used 21 times. Some new fixings and fixtures were made and replaced for the net over the summer which seems to have made it easier to assemble. New detachable cod ends were made which seems to work well. A few modifications to the new cod ends for next season are needed. Also the project to have an open and closing system on the Bongo net is well under way, the UW unit is selected and the technical drawings are made.

10.4 MOCNESS Net

The MOCNESS was deployed 2 times during the cruise. The net worked as expected with the new integration cables. There is some damage to net 1 which needs some repair work. Some modifications to the cod ends are needed for next season along with some new spares.

10.5 RMT 8

The RMT 8 worked perfectly apart from on recovery of the last deployment. Release wire 3 was caught on the top towing bar and sustained some damage. This will need to be replaced for the next cruise (15004). It was deployed 12 times throughout the cruise.

10.6 Net Traps

The net traps were used 8 times and worked well when being used in good weather conditions.

10.7 WP2 Net

This net was deployed 47 times over the cruise. There are some issues with getting it to sink as its very light and suffers greatly to gather a proper sample when being operated in poor conditions. The release needs some small modifications.

10.8 Giant Box Corer

The box corer was deployed 4 times in total at 2 locations. There were some issues with it firing to begin with due to some tight tolerances after being galvanised in refit. A replacement cable was fitted as it had some very minor damage to it after the second deployment along with a new release bungee. The corer was serviced and greased.

10.9 Mammoth

This was the first time the Mammoth was used by BAS on JCR. It was deployed a total of 6 times over the cruise. In the beginning a method to deploy the Mammoth with its Cod End frame had to be established. Using the auxiliary winches to lift the Cod End frame, while lifting the main frame with the towing wire, seem to work very well. This means the side wires need swapping over during deployment/recovery, like with the RMT nets. This method worked very well and all deployment went fine. There were a couple of issues,

when the fuse in the underwater unit was blown due to the bio-wire being plugged into the unit whist under power. The fuse was then replaced and spares have been ordered. Afterwards the temperature sensor did not work properly and gave false readings. Some modifications to the cod ends are needed for next season along with some spares and a dedicated Aluminium box.

11. JR15002 ICT Engineer's Report

Jeremy Robst

11.1 Data Logging / SCS

The SCS server and data logging systems worked well throughout the cruise, with very few logging events occurring.

Time & Date (GMT)	**Event**
2015/11/05 15:23	ACQ restarted, newleg run (**Cruise: 20151105**)
2015/11/13 22:15	Until now some Oceanlogger sensors not working – switch to Oceanlogger2013
2015/11/16 16:00	Modified Anemometer Raw to ACO conversion to add wind_speed_ms and to calculate knots for wind_speed.
2015/11/26 11:13	SCS failed to write to JRLB disk at 01:17. ACQ restarted and Compress streams rebuilt
2015/12/14 ??:??	ACQ restarted, newleg run

11.2 Oceanlogger

The Oceanlogger labview software was modified by Seth Thomas on the AMT cruise, and this version was running from 5th November. However on the 13th It was discovered to not be reading some sensors correctly (e.g sea temp, fluor). We stopped this version and started the Oceanlogger2013 version, and this gave correct readings, apart from the TIR sensors which are broken.

11.3 Anemometer

During refit 2015 the anemometers were replaced and configured to output wind speed as m/s instead of knots as the previous anemometers did. To prevent confusion I modified the RAW to ACO conversion program to do the m/s to knots conversion; this is output as the

wind_speed variable as previous years. An additional variable wind_speed_ms is output to the ACO file containing the raw data from the anemometer.

11.4 Seatex

We noticed the seatex-gga stream was outputting less records than the furuno-gga stream. We did not find a reason for this. As of 12/11/2015 there are approximately 20000 records less in the seatex-gga stream than the furuno-gga stream.

11.5 CTDs

CTD event 94 accidentally got entered as CTD 96, the files have been renamed but not editied so they may refer to the wrong data files internally.

11.6 EK80 / EK60

The new gigabyte Brix PCs were used to run the EK60/EK80 software. PU1 was used throughout the cruise. Paul Morgan (AME) made a serial port cable from the Ksync to sync the EK80 via the PC – the EK80 cannot be synced from the transceivers as the EK60 can. Initially we ran the EK60 with the GPT sync from the Ksync, however this generated lots of warnings. We tried changing network switches to no avail, and eventually setup the EK60 to sync via the serial port (using the EK80 settings in the Ksync), which significantly reduced (though not eliminated) the warnings. We also saw partial data loss in the EK60 pings; again changing network switches or PCs did not appear to make any difference to this. In the end we believe this is a problem between the transducer and the transceiver, with further investigation and assistance from Simrad necessary to identify and resolve the issue.

The EK80 software was run briefly at the start of the cruise, it appears to generate a significant amount of data – logging to 200m resulted in around 100MB/min. If this scaled when logging to 1100m (the normal depth for EK60 logging) this would be around 700GB / day – much more than the current JCR storage system can cope with.

11.7 Other systems

The other systems on board – the JRLB unix fileserver, SABRIS systems and ESX server all worked without any serious issues. Occasionally the VEEAM backups (around once a month) will fail and the VEEAM server needs to be restarted.

12. Data Management Cruise Report

Sarah Chapman

12.1 Introduction

The 2015/1016 season is the first year of the new cruise numbering system, where by the cruise number is known as the cruise leg JR15002. All data from the K: drive and L: drive are saved under the start date of the cruise 20151105 on the BAS central storage system.

12.2 Cruise Metadata

All cruise metadata entered into the digital event logs during JR15002 can be downloaded as .csv files from the JCR Intranet (http://eventlog.jcr.nerc-bas.ac.uk/eventlog/analyst/view_logs). Copies have also been saved to the work folder in L: /data management/event logs. Event logs were created for the CTD, Bongo, WP2, Net Traps, MOCNESS, Mammoth, Underway, Box Core, EK60, EM122, ADCP, XBT, RMT8 and TOPAS. A test log was created by Jeremy Robst to read bottle information from .bl and CTD files automatically after each CTD deployment. This proved useful for PhD students who needed data readings for incubation experiments.

12.3 Cruise Data

Data from the K: drive and L: drive are backed up by ICT and archived back in Cambridge. For cruise participants that are internal to BAS, the data has been saved on the UNIX drive under /data/cruise/jcr/20151105. Cruise participants external to BAS or any other external party, who would like any copies of data from the cruise please contact the Polar Data Centre polardatacentre@bas.ac.uk.

12.4 Data Requests

During the cruise the following data requests were completed on-board:

- Cruise track at various points throughout the cruise
- ArcGIS assistance to PhD student to map Box Core sites
- CTD profile data for specific casts
- Data Management guest blog
- Summary of data to be collected on JR15002 (see Table 12.1)

Table 12: Summary of data types collected on JR15002

Data Type	Samples/Data	Responsible Scientist	Sample/Data Fate
EK60	n/a	Sophie Fielding	Raw data collected. Processed back in Cambridge.
EM122	n/a	Sophie Fielding	Raw data collected. Processed back in Cambridge.
ADCP	n/a	Sophie Fielding	Raw data collected. No processing on-board.
EA600	n/a	Sophie Fielding	Raw data collected. No processing on-board.
SCS	n/a	Jeremy Robst	Raw data collected. No processing on-board.
TOPAS	n/a	Rob Larter	Raw TOPAS data collected on Rob Larter's behalf.
P2 Mooring	ADCP, CO2 Sensor, CTD, Sediment Trap, Current Meter 02 sensor	Peter Enderlein/Sophie Fielding/Clara Manno	Raw data saved on L: drive. Backed up and put on BAS servers in Cambridge
P3 Mooring	ADCP, CO2 Sensor, CTD x2, Sediment Trap, Current Meter, PH sensor, 02 sensor, Sediment Trap	Peter Enderlein/Sophie Fielding/Clara Manno	Raw data saved on L: drive. Backed up and put on BAS servers in Cambridge
CTD Profile Data		Polar Data Centre/Sophie Fielding	Data stored on K: drive. Backed up in Cambridge and placed on BAS servers.
CTD Water Samples	EDNA	Jennifer Freer	Processed on-board and preserved.
	TA & DIC, Nutrients, Incubation	Jessie Gardner	Processed on-board and preserved.
	POM	Gabi Stowasser	Processed on-board and preserved.
	Incubation	Cecilia Liszka	Processed on-board for incubation experiment.
	PIC, Oxygen Isotopes, Carbon	Meltem Ok	Processed on-board and preserved.
	Genetics	Will Goodall-Copestake	Processed on-board and preserved.

	Sediment Trap Cleaning	Clara Manno	n/a
Bongo			
Bongo Samples	Zooplankton	Cecilia Liszka	Processed on-board for incubation. Preservation of faecal samples.
	Pteropods	Clara Manno	Processed on-board for behavioural experiment.
	Pteropods	Jessie Gardner	Processed on-board for incubation experiment.
	Pteropods	Rosie Oakes	Preserved.
	Planktonic foraminifera	Meltem Ok	Processed and preserved.
WP2			
WP2 Samples	Zooplankton	Cecilia Liszka	Processed on-board for incubation. Preservation of faecal samples.
	Planktonic foraminifera	Meltem Ok	Preserved and processed on-board.
Net Traps			
Net Traps Samples	Zooplankton	Cecilia Liszka	Processed on-board for incubation. Preservation of faecal samples.
	Pteropods	Clara Manno	Opportunistic sampling for behavioural experiment.
	Pteropods	Jessie Gardner	Opportunistic sampling for incubation.
	Pteropods	Rosie Oakes	Opportunistic sampling. Preserved.
RMT8			
RMT8 Samples	Macro-zooplankton	Gabi Stowasser/WCB Team	Processed on-board and preserved.
	Zooplankton	Cecilia Liszka	Processed on-board and preserved.
	Amphipods	Charlotte Havermans	Preserved to be sent to AWI.
	Genetic Krill Samples	Will Goodall-Copestake	Preserved for BAS.
	Pteropods	Clara Manno	Processed on-board for behavioural experiment.
	Pteropods	Jessie Gardner	Processed on-board and preserved.
	Pteropods	Rosie Oakes	Opportunistic sampling for preservation.

MOCNESS			
MOCNESS samples	Zooplankton	Cecilia Liszka	Processed on-board for incubation. Preservation of faecal samples.
	Amphipods	Charlotte Havermans	Preserved to be sent to AWI.
	Pteropods	Clara Manno	Processed on-board for behavioural experiment.
	Pteropods	Jessie Gardner	Processed on-board for incubation experiment.
Mammoth			
Mammoth Samples	Zooplankton	Cecilia Liszka	Processed on-board and preserved.
	Amphipods	Charlotte Havermans	Preserved to be sent to AWI.
	Pteropods	Clara Manno	Processed on-board for behavioural experiment.
	Pteropods	Jessie Gardner	Processed on-board for incubation experiment.
Underway			
Underway_samples	E-DNA	Geraint Tarling/Sophie Fielding	Processed on-board and preserved.
	POM	Gabi Stowasser	Processed on-board and preserved for Plymouth Marine Laboratory for HBI analysis.
	$\delta^{18}0$	Rowan Dejardin	Preserved.
Intertidal Samples (CGS)	Seaweed samples	Caroline Pindar	Preserved.
Box Cores (CGS)	Sediment cores	Rowan Dejardin	Preserved.

Appendix A. Bridge Event Log

Time	Event	Lat	Lon	Comment
11/11/2015 20:36		-51.85844	-57.86725	VSL on DP
11/11/2015 20:50	1	-51.85853	-57.86733	Commence deploying CTD
11/11/2015 20:53	1	-51.85853	-57.86734	CTD in the water
11/11/2015 20:57	1	-51.85852	-57.86734	Recovering CTD to deck - technical fault
11/11/2015 20:58	1	-51.85851	-57.86733	CTD recovered to deck
11/11/2015 21:16	2	-51.85849	-57.86734	Commence deploying Mammoth
11/11/2015 21:25	2	-51.85853	-57.86733	Mammoth in the water
11/11/2015 21:26	2	-51.85853	-57.86733	Commence recovery of Mammoth
11/11/2015 21:29	2	-51.85854	-57.86732	Mammoth recovered to deck
11/11/2015 21:35	3	-51.85853	-57.86732	Commence deploying Mammoth
11/11/2015 21:39	3	-51.85854	-57.86733	Mammoth in the water
11/11/2015 21:40	3	-51.85854	-57.86733	Mammoth stopped at 30m
11/11/2015 21:44	3	-51.85855	-57.86736	Commence hauling Mammoth
11/11/2015 21:58	3	-51.85852	-57.86737	Mammoth recovered to deck
11/11/2015 22:02	4	-51.85855	-57.86732	Commence deploying Mammoth
11/11/2015 22:05	4	-51.85854	-57.86732	Mammoth in the water
11/11/2015 22:06	4	-51.85854	-57.86732	Mammoth stopped at 10m
11/11/2015 22:11	4	-51.85854	-57.86732	Mammoth recovered to deck
11/11/2015 23:00		-51.85896	-57.86756	VSL off DP
12/11/2015 11:06		-51.62443	-57.60113	VSL on DP
12/11/2015 11:12	5	-51.62443	-57.60113	CTD Deployed
12/11/2015 11:14	5	-51.62435	-57.60112	CTD in water
12/11/2015 11:16	5	-51.62435	-57.60113	CTD stopped at 10m
12/11/2015 11:18	5	-51.62436	-57.60112	CTD Hauled to surface
12/11/2015 11:19	5	-51.62435	-57.60111	CTD veering to 60m
12/11/2015 11:22	5	-51.62438	-57.60114	Commenced hauling CTD
12/11/2015 11:36	5	-51.62438	-57.60114	CTD recovered to deck
12/11/2015 11:50	6	-51.62437	-57.60113	WP2 Deployed

12/11/2015 11:52	6	-51.62435	-57.60113	WP2 in Water
12/11/2015 11:54	6	-51.62436	-57.60112	WP2 Veered to 30m
12/11/2015 11:56	6	-51.62436	-57.60113	WP2 commenced hauling
12/11/2015 11:58	6	-51.62436	-57.60112	WP2 recovered to deck
12/11/2015 12:00	7	-51.62436	-57.60112	WP2 Deployed
12/11/2015 12:02	7	-51.62436	-57.60112	WP2 In water veering to 30m
12/11/2015 12:08	7	-51.62436	-57.60111	WP2 Hauling
12/11/2015 12:10	7	-51.62436	-57.60113	WP2 recovered to deck
12/11/2015 12:20	8	-51.62435	-57.60114	Net trap deployed
12/11/2015 12:22	8	-51.62435	-57.60115	Net trap in water
12/11/2015 12:26	8	-51.62434	-57.60114	Net Trap 'Soaking' at 30m
12/11/2015 12:32	8	-51.62434	-57.60113	Commence hauling
12/11/2015 12:36	8	-51.62433	-57.60112	Net Trap recovered to deck
12/11/2015 12:49	9	-51.62436	-57.60113	Net Trap deployed
12/11/2015 12:52	9	-51.62436	-57.60112	Net Trap veering to 30m
12/11/2015 12:54	9	-51.62436	-57.60112	Net Trap 'soaking' at 30m
12/11/2015 13:00	9	-51.62436	-57.60113	Commence Hauling Net Trap
12/11/2015 13:02	9	-51.62437	-57.60113	Net Trap recovered to deck
12/11/2015 13:42		-51.62436	-57.60112	Vessel off DP
13/11/2015 13:00		-53.45612	-55.44589	Commence SWATH Survey
20/11/2015 14:54		-60.20839	-44.41033	On DP
20/11/2015 15:00	10	-60.20837	-44.41027	CTD in water
20/11/2015 15:02	10	-60.20837	-44.41021	Veering CTD to 1000m
20/11/2015 15:20	10	-60.20816	-44.40773	CTD stopped at 1000m
20/11/2015 15:44	10	-60.20818	-44.40773	CTD recovered to deck
20/11/2015 15:54	10	-60.20819	-44.40773	Off DP
21/11/2015 01:00		-59.68929	-44.051	Vessel on DP
21/11/2015 01:14	11	-59.68879	-44.05435	CTD Deployed
21/11/2015 01:15	11	-59.68874	-44.05431	CTD in Water
21/11/2015 01:17	11	-59.68867	-44.05424	CTD Soaking

21/11/2015 01:19	11	-59.68868	-44.05425	CTD Veering to 1000m
21/11/2015 01:36	11	-59.68868	-44.05425	CTD at depth - 1000m
21/11/2015 01:38	11	-59.68867	-44.05426	CTD Hauling
21/11/2015 02:09	11	-59.68866	-44.05426	CTD Recovered
21/11/2015 02:28	12	-59.68864	-44.05425	Bongo net Deployed
21/11/2015 02:32	12	-59.68864	-44.05426	Bongo Veering to 200m
21/11/2015 02:52	12	-59.68867	-44.05426	Bongo recovered to deck
21/11/2015 02:53	13	-59.68867	-44.05426	Bongo Net launched
21/11/2015 03:12	13	-59.68867	-44.05424	Bongo recovered
21/11/2015 03:15	14	-59.68868	-44.05422	Bongo deployed
21/11/2015 03:18	14	-59.68867	-44.05422	Bongo at 100m
21/11/2015 03:24	14	-59.68867	-44.05425	Bongo recovered
21/11/2015 03:40	15	-59.68865	-44.05422	WP2 deployed
21/11/2015 03:50	15	-59.68867	-44.05424	WP2 at 400m
21/11/2015 04:14	15	-59.68866	-44.0542	WP2 at 300m
21/11/2015 04:41	15	-59.68864	-44.05418	WP2 recovered
21/11/2015 04:48		-59.68864	-44.05421	Off DP
21/11/2015 13:06		-58.02281	-42.9835	Vessel on DP
21/11/2015 13:08	16	-58.02281	-42.98361	CTD deployed
21/11/2015 13:10	16	-58.02281	-42.98367	CTD Veering to 1000m
21/11/2015 13:28	16	-58.02285	-42.98422	CTD at 1000m
21/11/2015 13:30	16	-58.02286	-42.98423	CTD Hauling
21/11/2015 14:04	16	-58.02197	-42.9829	CTD Recovered
21/11/2015 14:16	17	-58.02145	-42.984	Bongo net deployed
21/11/2015 14:18	17	-58.02195	-42.9829	Bongo net veering
21/11/2015 14:36	17	-58.02088	-42.98533	bongo net recovered
21/11/2015 14:38	18	-58.01808	-42.99161	Bongo net deployed
21/11/2015 14:40	18	-58.0171	-42.99379	Bongo net veering
21/11/2015 14:56	18	-58.01474	-42.99917	Bongo recovered
21/11/2015 15:06		-58.0129	-43.00325	Off DP

22/11/2015 03:00	19	-56.00509	-41.71816	APEX 7517 deployed
22/11/2015 10:18		-55.24986	-41.25008	Vsl stopped on DP
22/11/2015 11:12	20	-55.24908	-41.24825	P2 sediment trap signal sent
22/11/2015 11:16	20	-55.24897	-41.24803	P2 mooring released
22/11/2015 11:20	20	-55.24879	-41.24774	P2 Mooring sighted 3 points to Starboard
22/11/2015 12:02	20	-55.24101	-41.25278	P2 Mooring recovery line attached
22/11/2015 12:06	20	-55.24097	-41.25268	Commence recovery of P2 Sediment trap mooring
22/11/2015 12:10	20	-55.2401	-41.25365	RDI ADCP Recovered to Deck
22/11/2015 12:25	20	-55.23877	-41.25489	Trimsin Buoy Cluster 1 - water sampler / seagaurd current meter - recovered to deck
22/11/2015 13:06	20	-55.23657	-41.25782	Trimsin buoy cluster 2 - Sediment trap / Aquadoop current meter - Recovered to deck
22/11/2015 13:24	20	-55.23659	-41.25782	P2 Acoustic release recovered to deck
22/11/2015 13:55	21	-55.23967	-41.25746	CTD Deployed
22/11/2015 13:59	21	-55.23968	-41.25747	CTD Veering to 3340m
22/11/2015 14:58	21	-55.24256	-41.25757	CTD stopped at 3300m
22/11/2015 16:14	21	-55.24266	-41.25756	CTD recovered
22/11/2015 16:24	22	-55.24265	-41.25756	Bongo deployed
22/11/2015 16:28	22	-55.24266	-41.25758	Bongo at 200m
22/11/2015 16:36	22	-55.2427	-41.25788	Bongo recovered
22/11/2015 16:38	23	-55.2427	-41.25785	Bongo deployed
22/11/2015 16:44	23	-55.24273	-41.25797	Bongo at 200m
22/11/2015 16:53	23	-55.24287	-41.2585	Bongo recovered
22/11/2015 16:56	24	-55.24293	-41.25864	Bongo deployed
22/11/2015 17:03	24	-55.24306	-41.25891	Bongo at 200m
22/11/2015 17:14	24	-55.24331	-41.25944	Bongo recovered
22/11/2015 17:30		-55.24218	-41.26127	Off DP
26/11/2015 23:14	25	-54.13922	-36.62567	Start of SWATHE survey (passing through position)
26/11/2015 23:26	25	-54.14218	-36.63047	A/C 100 (Deg true) Commence second leg of survey
26/11/2015 23:33	25	-54.14323	-36.61939	End of survey

27/11/2015 00:06		-54.15901	-36.69698	Vessel on DP
27/11/2015 00:42	26	-54.15911	-36.69485	CTD Deployed
27/11/2015 00:46	26	-54.15902	-36.69498	CTD Veering 50m
27/11/2015 00:48	26	-54.15901	-36.695	CTD at 50m
27/11/2015 00:48	26	-54.15301	-36.65546	CTD at surface
27/11/2015 00:58	26	-54.15896	-36.68796	CTD recovered
27/11/2015 19:54		-53.99718	-36.81982	VSL on DP
27/11/2015 20:08	27	-53.99709	-36.8201	Commence deploying box corer
27/11/2015 20:11	27	-53.9971	-36.82012	Box Corer in the water
27/11/2015 20:20	27	-53.9971	-36.82012	Box Corer on the sea bed
27/11/2015 20:22	27	-53.9971	-36.82012	Box Corer clear of the sea bed
27/11/2015 20:29	27	-53.99711	-36.82012	Box Corer at the surface - spade not dropped
27/11/2015 20:31	27	-53.99711	-36.82011	Box Corer recovered to deck
27/11/2015 20:40	28	-53.9971	-36.82013	Commence redeploying Box Corer
27/11/2015 20:42	28	-53.99708	-36.82012	Box Corer in the water
27/11/2015 20:52	28	-53.99709	-36.82012	Box Corer on the sea bed
27/11/2015 20:53	28	-53.9971	-36.82013	Box Corer clear of the sea bed
27/11/2015 21:01	28	-53.99712	-36.82014	Box Corer recovered to deck
27/11/2015 21:12		-53.99712	-36.82012	Vsl off DP
27/11/2015 23:36		-53.85503	-37.65096	Vessel on DP
27/11/2015 23:38	29	-53.85501	-37.65092	Box Core Deployed
27/11/2015 23:48	29	-53.85503	-37.65096	Box Core on the seabed
27/11/2015 23:50	29	-53.85504	-37.65096	Box core off Seabed
27/11/2015 23:59	29	-53.85504	-37.65095	Box Core on surface failed to deploy
28/11/2015 00:00	29	-53.85504	-37.65095	Box Core recovered to deck
28/11/2015 00:06	30	-53.85503	-37.65093	Box Core deployed
28/11/2015 00:09	30	-53.85504	-37.65096	Box core on surface
28/11/2015 00:17	30	-53.85504	-37.65095	Box Core on the seabed
28/11/2015 00:18	30	-53.85504	-37.65095	Box core off the seabed
28/11/2015 00:41	30	-53.85501	-37.65095	Box core recovered to deck

28/11/2015 01:00		-53.85499	-37.65094	Vessel off DP
28/11/2015 12:00		-52.80531	-40.08568	Vessel On DP
28/11/2015 12:17	31	-52.80522	-40.08625	CTD Deployed
28/11/2015 12:19	31	-52.80521	-40.08626	CTD In water - at surface
28/11/2015 12:21	31	-52.80521	-40.08625	CTD Veering to 3780m
28/11/2015 13:26	31	-52.80521	-40.08626	CTD at Depth 3735m
28/11/2015 13:26	31	-52.80521	-40.08626	CTD Hauling
28/11/2015 14:44	31	-52.80522	-40.08623	CTD at Surface
28/11/2015 14:46	31	-52.80524	-40.08622	CTD Recovered
28/11/2015 15:00		-52.80571	-40.08736	Vessel Off DP
28/11/2015 15:12		-52.80965	-40.10392	On DP
28/11/2015 15:18	32	-52.80982	-40.10459	Mooring ranged at 780m
28/11/2015 15:36	32	-52.80962	-40.10415	Mooring released
28/11/2015 15:42	32	-52.80977	-40.10453	Mooring sighted
28/11/2015 15:51	32	-52.81346	-40.11414	Vessel manoeuvring onto mooring
28/11/2015 15:54	32	-52.81398	-40.11607	Mooring grappled
28/11/2015 15:56	32	-52.81395	-40.11617	Recoverey line attached
28/11/2015 16:02	32	-52.81514	-40.11699	Top buoy recovered
28/11/2015 16:20	32	-52.81596	-40.11795	First sediment trap and current meter & O2 sensor recovered
28/11/2015 16:26	32	-52.81626	-40.11832	1st buoy cluster
28/11/2015 17:00	32	-52.81781	-40.12012	2nd buoy cluster recovered
28/11/2015 17:05	32	-52.81803	-40.12039	Second sediment trap and Aquadoop currentmeter recovered
28/11/2015 17:36	32	-52.81887	-40.1214	Release recovered
28/11/2015 17:56	33	-52.81189	-40.11325	Bongo deployed
28/11/2015 18:03	33	-52.81187	-40.1132	Hauling bongo
28/11/2015 18:17	33	-52.81187	-40.11325	Bongo recovered
28/11/2015 18:18	34	-52.81188	-40.11323	Bongo deployed
28/11/2015 18:22	34	-52.81187	-40.11323	Hauling bongo
28/11/2015 18:35	34	-52.81195	-40.11309	Bongo recovered
28/11/2015 18:48	35	-52.81209	-40.11285	WP2 deployed

28/11/2015 18:52	35	-52.81208	-40.11286	WP2 triggered at 150m
28/11/2015 18:55	35	-52.81208	-40.11286	WP2 triggered at 100m
28/11/2015 18:58	35	-52.8121	-40.11285	WP2 recovered
28/11/2015 19:03	36	-52.8121	-40.11284	Commence deploying WP2
28/11/2015 19:05	36	-52.81209	-40.11285	WP2 in the water
28/11/2015 19:07	36	-52.81209	-40.11284	WP2 triggered at 200m
28/11/2015 19:12	36	-52.8121	-40.11287	WP2 triggered at 150m
28/11/2015 19:16	36	-52.81208	-40.11287	WP2 recovered
28/11/2015 19:27	37	-52.81207	-40.11287	Deploying WP2
28/11/2015 19:28	37	-52.81207	-40.11286	WP2 in the water
28/11/2015 19:32	37	-52.81208	-40.11287	WP2 triggered at 200m
28/11/2015 19:36	37	-52.81206	-40.11284	WP2 triggered at 150m
28/11/2015 19:42	37	-52.81207	-40.11282	WP2 recovered to deck
28/11/2015 20:05	38	-52.81206	-40.11282	Commence deploying WP2
28/11/2015 20:07	38	-52.81207	-40.11283	WP2 in the water
28/11/2015 20:13	38	-52.81208	-40.11282	WP2 triggered at 200m
28/11/2015 20:16	38	-52.81208	-40.11282	WP2 triggered at 150m
28/11/2015 20:21	38	-52.8122	-40.11263	WP2 recovered to deck
28/11/2015 20:25	39	-52.81223	-40.11262	Commence deploying WP2
28/11/2015 20:26	39	-52.81223	-40.11262	WP2 in the water
28/11/2015 20:32	39	-52.81223	-40.11262	WP2 triggered at 250m
28/11/2015 20:36	39	-52.81222	-40.11263	WP2 triggered at 200m
28/11/2015 20:44	39	-52.81225	-40.11255	WP2 recovered to deck
28/11/2015 21:00		-52.81231	-40.11252	Vessel off DP proceeding towards Bird Island
30/11/2015 13:00		-55.24286	-41.25823	Vessel on DP
30/11/2015 13:02	40	-55.24276	-41.25747	CTD deployed
30/11/2015 13:12	40	-55.24274	-41.25736	CTD Veering to 1000m
30/11/2015 13:29	40	-55.24277	-41.25749	CTD at depth of 1000m
30/11/2015 13:54	40	-55.24274	-41.25754	CTD at Surface
30/11/2015 13:58	40	-55.24278	-41.25751	CTD Recovered

30/11/2015 14:12	41	-55.24277	-41.25752	WP2 Deployed
30/11/2015 14:14	41	-55.24277	-41.2575	WP2 Veering to 200m
30/11/2015 14:21	41	-55.24278	-41.25751	WP2 at 200m
30/11/2015 14:33	41	-55.24279	-41.25749	WP2 Recovered to deck
30/11/2015 14:38	42	-55.24279	-41.2575	WP2 Deployed
30/11/2015 14:39	42	-55.24279	-41.25749	WP2 Veering to 100m
30/11/2015 14:44	42	-55.24279	-41.2575	WP2 at 100m
30/11/2015 14:46	42	-55.24279	-41.25749	WP2 Recovered to deck
30/11/2015 15:02	43	-55.24279	-41.25749	Bongo deployed
30/11/2015 15:06	43	-55.2428	-41.25749	Bongo at 200m
30/11/2015 15:18	43	-55.24306	-41.25649	Bongo recovered
30/11/2015 15:20	44	-55.24304	-41.2566	Bongo deployed
30/11/2015 15:26	44	-55.24295	-41.25688	Bongo at 200m
30/11/2015 15:38	44	-55.24298	-41.25672	Bongo recovered
30/11/2015 15:58	45	-55.24279	-41.25718	Mammoth deployed
30/11/2015 16:24	45	-55.24281	-41.25717	Mammoth stopped at 957m
30/11/2015 17:24	45	-55.24282	-41.25721	Mammoth recovered
30/11/2015 17:57	46	-55.24282	-41.2572	WP2 net deployed
30/11/2015 17:59	46	-55.24283	-41.25723	WP2 Triggered
30/11/2015 18:02	46	-55.24282	-41.25722	WP2 recovered
30/11/2015 18:10	47	-55.24282	-41.2572	WP2 deployed
30/11/2015 18:12	47	-55.24282	-41.25719	WP2 launch aboured due to failure to sink
30/11/2015 18:16	48	-55.24283	-41.2572	WP2 deployed
30/11/2015 18:19	48	-55.24283	-41.2572	WP2 launch aboured due to failure to sink
30/11/2015 18:22	49	-55.24283	-41.25719	WP2 deployed
30/11/2015 18:23	49	-55.24283	-41.25721	WP2 sunk
30/11/2015 18:25	49	-55.24283	-41.25719	WP2 triggered at 100m
30/11/2015 18:33	49	-55.24283	-41.25717	WP2 triggered at 50m
30/11/2015 18:35	49	-55.24284	-41.2572	WP2 recovered
30/11/2015 18:44	50	-55.24283	-41.25722	WP2 deployed

30/11/2015 18:51	50	-55.24283	-41.25721	WP2 triggered at 200m
30/11/2015 19:00	50	-55.24283	-41.25722	Net not triggered
30/11/2015 19:02	50	-55.24283	-41.25723	Lowering net back to 200m
30/11/2015 19:05	50	-55.24283	-41.25724	WP2 retriggered at 200m
30/11/2015 19:16	50	-55.24284	-41.25719	WP2 recovered to deck
30/11/2015 19:22	51	-55.24297	-41.25701	Commence deploying WP2
30/11/2015 19:23	51	-55.24296	-41.25699	WP2 in the water
30/11/2015 19:30	51	-55.24295	-41.257	WP2 triggered at 400m
30/11/2015 19:45	51	-55.24293	-41.257	WP2 triggered at 200m
30/11/2015 19:54	51	-55.24296	-41.25696	WP2 recovered to deck
30/11/2015 20:06		-55.24324	-41.2566	Vsl off DP
30/11/2015 20:28	52	-55.21232	-41.18577	Turning to run up wind for MOCNESS deployment
30/11/2015 20:37	52	-55.21152	-41.1895	Commence deploying MOCNESS
30/11/2015 20:45	52	-55.21364	-41.19264	MOCNESS in the water
30/11/2015 21:40	52	-55.22694	-41.21975	MOCNESS stopped at 1200m wire out
30/11/2015 22:58	52	-55.24388	-41.25616	MOCNESS recovered to deck
30/11/2015 23:06		-55.24387	-41.25602	Vsl on DP
30/11/2015 23:43	53	-55.24334	-41.25954	Bongo Deployed
30/11/2015 23:48	53	-55.24332	-41.25954	Bongo veering to 200m
01/12/2015 00:08	53	-55.24405	-41.2582	Bongo net recovered
01/12/2015 00:09	54	-55.24408	-41.25813	Bongo net deployed
01/12/2015 00:10	54	-55.24416	-41.25799	Bongo net veering to 200m
01/12/2015 01:09	55	-55.24328	-41.25953	Bulwark door open
01/12/2015 01:20	55	-55.24329	-41.25953	Mammoth deployed
01/12/2015 01:21	55	-55.24329	-41.25954	Bulwark door closed
01/12/2015 01:22	55	-55.24329	-41.25953	Mamoth veering to 1000m
01/12/2015 01:50	55	-55.24327	-41.25954	Mammoth at 1000m
01/12/2015 02:37	55	-55.24332	-41.25956	Bulwark door open
01/12/2015 02:50	55	-55.24331	-41.25955	Mamoth recovered to deck
01/12/2015 04:00	56	-55.24329	-41.25952	Bongo deployed

01/12/2015 04:06	56	-55.24329	-41.25951	Bongo at 200m
01/12/2015 04:15	56	-55.24352	-41.25931	Bongo recovered
01/12/2015 04:18	57	-55.24352	-41.25929	Bongo deployed
01/12/2015 04:23	57	-55.24352	-41.25928	Bongo at 200m
01/12/2015 04:32	57	-55.24388	-41.2584	Bongo recovered
01/12/2015 06:20	58	-55.24333	-41.25964	Aft net trap deployed
01/12/2015 06:27	58	-55.24334	-41.25958	Aft net trap at 100m
01/12/2015 06:27	58	-55.24334	-41.25958	Midships next trap deployed
01/12/2015 06:32	58	-55.24361	-41.25891	Midships net trap at 100m
01/12/2015 06:49	58	-55.24435	-41.25754	Commence heaving aft net trap
01/12/2015 06:49	58	-55.24435	-41.25754	Commence heaving midships net trap
01/12/2015 06:53	58	-55.24453	-41.25716	Midships net trap recovered
01/12/2015 06:59	58	-55.24485	-41.25658	Aft net trap recovered
01/12/2015 07:09	59	-55.24455	-41.25714	Commence deploying bongo nets
01/12/2015 07:11	59	-55.24453	-41.25717	Bongo Net in the water
01/12/2015 07:17	59	-55.24483	-41.2568	Bongo nets at 200m
01/12/2015 07:26	59	-55.24553	-41.25591	Bongo nets recovered to deck
01/12/2015 07:30	60	-55.24577	-41.25567	Commence deploying bongo net
01/12/2015 07:31	60	-55.24577	-41.25569	Bongo net in the water
01/12/2015 07:37	60	-55.24615	-41.25525	Bongo nets at 200m
01/12/2015 07:47	60	-55.24671	-41.25465	Bongo nets recovered to deck
01/12/2015 07:54		-55.24685	-41.25459	Vsl off DP
01/12/2015 08:18	61	-55.28286	-41.20668	Turning to run up wind / current for MOCNESS deployment
01/12/2015 08:26	61	-55.28263	-41.20038	Commence deploying MOCNESS
01/12/2015 08:30	61	-55.28193	-41.20141	MOCNESS in the water
01/12/2015 09:36	61	-55.24629	-41.25268	MOCNESS stopped at 1767m wire out
01/12/2015 10:40	61	-55.23476	-41.27668	MOCNESS recovered to deck and stern door closed
01/12/2015 10:48		-55.23496	-41.27485	Vsl on DP
01/12/2015 11:16	62	-55.23498	-41.27458	CTD Deployed
01/12/2015 11:22	62	-55.23498	-41.27456	CTD veering to 200m

01/12/2015 11:26	62	-55.23498	-41.2746	CTD at 200m
01/12/2015 11:34	62	-55.23497	-41.27461	CTD Recovered
01/12/2015 11:36		-55.23496	-41.2746	Vessel off DP
01/12/2015 12:24		-55.27909	-41.26805	Vessel On DP
01/12/2015 13:30	63	-55.27903	-41.26804	P2 Sediment trap Mooring Main buoy Deployed - Commence deployment
01/12/2015 13:42		-55.27665	-41.26811	Trimsin Buoy Cluster deployed
01/12/2015 13:48	63	-55.27583	-41.26812	Sediment Trap Deployed
01/12/2015 13:50		-55.27547	-41.26809	Aquadopp current meter Deployed
01/12/2015 13:53		-55.27512	-41.26808	CTD Deployed
01/12/2015 14:27	63	-55.26411	-41.26804	Trimsin Buoy Cluster Deployed
01/12/2015 14:28		-55.26392	-41.26806	Sediment Trap Deployed
01/12/2015 15:27		-55.24419	-41.26971	Releases in the water
01/12/2015 15:29		-55.24397	-41.26987	Weight released
01/12/2015 15:48		-55.23837	-41.27047	Vessel on DP 1000m from mooring deployment position awaiting first range
01/12/2015 16:08		-55.23831	-41.27053	Depth 3368 at first ranging site
01/12/2015 16:11		-55.2383	-41.27052	Mooring ranged at 3587m
01/12/2015 16:12		-55.23831	-41.27053	Off DP
01/12/2015 16:36		-55.25571	-41.27503	On DP
01/12/2015 16:38		-55.25545	-41.27456	Depth 3383m at second ping site
01/12/2015 16:41		-55.25544	-41.27451	Mooring ranged at 3530m
01/12/2015 16:42		-55.25542	-41.27451	Off DP
01/12/2015 16:54		-55.25087	-41.25281	On DP
01/12/2015 16:59		-55.25001	-41.2529	Depth 3692m at third ranging site
01/12/2015 17:00		-55.25001	-41.25293	Off DP
01/12/2015 17:00		-55.25001	-41.25293	Mooring ranged at 3418m. P2 mooring calculated at 55 14.92S 041 15.73W
01/12/2015 17:12		-55.24309	-41.2592	On DP
01/12/2015 17:15	64	-55.24308	-41.25914	Midships Net trap deployed
01/12/2015 17:19	64	-55.24309	-41.25907	Midships Net trap at 100m
01/12/2015 17:32	64	-55.24345	-41.25798	Commence hauling midships net tray
01/12/2015 17:35	65	-55.24353	-41.25774	Midships net trap recovered

01/12/2015 17:41	65	-55.24359	-41.25754	Net traps deployed Midships and aft
01/12/2015 17:44	65	-55.24359	-41.25752	Midships net trap at 100m
01/12/2015 17:53	65	-55.24368	-41.25664	Aft Net trap at 100m
01/12/2015 18:02	65	-55.24364	-41.25567	Commence hauling midships net trap
01/12/2015 18:05	65	-55.24364	-41.25566	Commence hauling aft net trap
01/12/2015 18:08	65	-55.24368	-41.25555	Midships net trap recovered
01/12/2015 18:15	65	-55.24377	-41.25516	Aft net trap recovered
01/12/2015 19:16	66	-55.24353	-41.25727	XBT deployed
01/12/2015 22:07	67	-55.24353	-41.25728	Commence deploying WP2
01/12/2015 22:08	67	-55.24353	-41.25728	WP2 in the water
01/12/2015 22:19	67	-55.24353	-41.25728	WP2 triggered at 200m
01/12/2015 22:24	67	-55.2435	-41.25725	WP2 triggered at 150m
01/12/2015 22:29	67	-55.2435	-41.25727	WP2 recovered to deck
01/12/2015 22:35	68	-55.24352	-41.25725	Commence deploying WP2
01/12/2015 22:36	68	-55.24351	-41.25726	WP2 in the water
01/12/2015 22:41	68	-55.24349	-41.25727	WP2 triggered at 100m
01/12/2015 22:46	68	-55.2435	-41.25726	WP2 triggered at 50m
01/12/2015 22:50	68	-55.24349	-41.25727	WP2 recovered to deck - failed redeploying
01/12/2015 22:55	69	-55.2435	-41.25726	Commence deploying WP2
01/12/2015 22:56	69	-55.24352	-41.25727	WP2 in the water
01/12/2015 23:02	69	-55.24349	-41.2573	WP2 triggered at 100m
01/12/2015 23:07	69	-55.24352	-41.25727	WP2 triggered at 50m
01/12/2015 23:11	69	-55.24355	-41.25728	WP2 recovered to deck
01/12/2015 23:21	70	-55.24354	-41.25728	Commence deploying WP2
01/12/2015 23:22	70	-55.24353	-41.25728	WP2 in the water
01/12/2015 23:31	70	-55.24353	-41.25729	WP2 at 100m
01/12/2015 23:34	70	-55.24353	-41.25728	WP2 Recovered
01/12/2015 23:42		-55.24353	-41.25729	Off DP
02/12/2015 09:02		-54.05461	-39.39108	WCB1.1 survey start of transect
02/12/2015 09:44		-53.94016	-39.42601	WCB1.1 aborted due to weather conditions

02/12/2015 17:12		-54.01732	-37.43979	On DP in Rosita Harbour for CLAM and Box corer repairs
02/12/2015 20:18		-54.01713	-37.44006	Vsl off DP repairs completed
02/12/2015 20:48		-54.00727	-37.35996	Vsl on DP
02/12/2015 21:06		-54.00787	-37.36083	Vsl off DP
02/12/2015 21:11	71	-54.00857	-37.36218	Commence deploying RMT 8
02/12/2015 21:14	71	-54.00935	-37.36342	RMT 8 in the water
02/12/2015 21:30	71	-54.01471	-37.37211	Commence hauling RMT 8 - wire out 23m
02/12/2015 21:40	71	-54.01827	-37.37774	RMT 8 recovered to deck and stern door closed
02/12/2015 21:42		-54.01879	-37.3786	Vsl on DP
02/12/2015 21:54		-54.01897	-37.37879	Vsl off DP
02/12/2015 23:30		-53.85327	-37.65083	Vessel on DP
03/12/2015 00:54		-53.85418	-37.65167	Vessel off DP
03/12/2015 08:54		-54.05542	-39.391	Commence WCB Transect 1.1
03/12/2015 09:00	72	-54.03983	-39.39653	XBT 1 Deployed
03/12/2015 10:01	73	-53.87862	-39.44423	XBT 2 Deployed
03/12/2015 11:09	74	-53.70064	-39.49808	XBT 3 Deployed
03/12/2015 12:16	75	-53.52523	-39.54969	XBT 4 Deployed
03/12/2015 13:26	76	-53.34667	-39.60218	XBT 5 Deployed
03/12/2015 14:45		-53.31971	-39.30185	Start of Southbound Transect 1.2
03/12/2015 19:04		-54.0261	-39.08854	End of Transect 1.2
03/12/2015 20:18		-53.84605	-39.1437	Vsl on DP
03/12/2015 20:27	77	-53.84608	-39.1437	Commence deploying CTD
03/12/2015 20:30	77	-53.84607	-39.1437	CTD in the water
03/12/2015 20:32	77	-53.8461	-39.14371	CTD veering to approx 280m
03/12/2015 20:39	77	-53.84607	-39.14367	CTD stopped at 279m
03/12/2015 20:49	77	-53.84608	-39.14373	CTD recovered to deck
03/12/2015 21:06		-53.84599	-39.14461	Vsl off DP
03/12/2015 21:07	78	-53.8459	-39.14548	Commence deploying RMT 8
03/12/2015 21:08	78	-53.84582	-39.14631	RMT 8 in the water
03/12/2015 21:41	78	-53.84284	-39.17769	RMT 8 stopped at 362m

03/12/2015 22:24	78	-53.83814	-39.21846	RMT 8 recovered to deck and stern door closed
04/12/2015 01:50	79	-53.78234	-38.88372	RMT8 Net Deployed
04/12/2015 01:58	79	-53.78183	-38.88921	RMT8 veered to 66m
04/12/2015 02:24	79	-53.78032	-38.90718	RMT8 Recovered to Deck
04/12/2015 05:06	80	-53.49357	-39.20367	Vessel at 2 knots head to wind for RMT deployment
04/12/2015 05:10	80	-53.49349	-39.20686	RMT net deployed
04/12/2015 05:45	80	-53.49337	-39.23958	Commence hauling wire
04/12/2015 06:28	80	-53.49178	-39.28134	RMT recovered
04/12/2015 06:54		-53.49217	-39.24896	Vsl on DP
04/12/2015 07:06	81	-53.49294	-39.25085	Commence deploying CTD
04/12/2015 07:10	81	-53.49297	-39.25087	CTD in the water
04/12/2015 07:13	81	-53.49298	-39.25091	CTD veering to 1000m
04/12/2015 07:31	81	-53.49296	-39.25087	CTD stopped at 1000m
04/12/2015 07:55	81	-53.49294	-39.25091	CTD recovered to deck
04/12/2015 08:06		-53.49297	-39.25088	Vsl off DP
04/12/2015 09:30		-53.28387	-39.03992	Commence WCB transect 2.1
04/12/2015 09:31	82	-53.28552	-39.03856	XBT 6 Deployed
04/12/2015 10:38	83	-53.46411	-38.98371	XBT 7 Deployed
04/12/2015 11:48	84	-53.64157	-38.92851	XBT 8 Deployed
04/12/2015 12:58	85	-53.81891	-38.87317	XBT 9 Deployed
04/12/2015 14:08	86	-53.99895	-38.8167	XBT 10 Deployed
04/12/2015 15:10		-53.96065	-38.52709	start W2.2 transect
04/12/2015 19:30		-53.25272	-38.75124	Complete Transect 2.2
04/12/2015 21:36		-53.43313	-38.69321	Vsl on DP
04/12/2015 22:05	87	-53.43247	-38.69495	Commence deploying CTD
04/12/2015 22:11	87	-53.43243	-38.69493	CTD in the water
04/12/2015 22:13	87	-53.43245	-38.69494	CTD veering to 1000m
04/12/2015 22:32	87	-53.43245	-38.69495	CTD stopped at 1000m
04/12/2015 23:04	87	-53.43249	-38.69488	CTD Recovered to Deck
04/12/2015 23:18		-53.4325	-38.69486	Vessel Off DP

05/12/2015 05:06		-53.78548	-38.58692	On DP to assess conditions
05/12/2015 06:09	88	-53.78493	-38.58399	CTD deployed
05/12/2015 06:11	88	-53.78494	-38.58396	Veering CTD to 192m
05/12/2015 06:15	88	-53.78492	-38.58399	CTD stopped at 185m
05/12/2015 06:21	88	-53.7849	-38.58402	CTD recovered
05/12/2015 06:42		-53.78616	-38.58712	Off DP
05/12/2015 09:00		-53.92633	-38.21863	Commence transect 3.1
05/12/2015 09:01	89	-53.92491	-38.21885	XBT 11 Deployed
05/12/2015 10:06	90	-53.75169	-38.27826	XBT 12 Deployed
05/12/2015 11:16	91	-53.57202	-38.3368	XBT 13 Deployed
05/12/2015 12:24	92	-53.39562	-38.39299	XBT 14 Deployed
05/12/2015 13:30	93	-53.22438	-38.44785	XBT 15 Deployed
05/12/2015 15:08		-53.2362	-38.12335	Commence Transect 3.2
05/12/2015 19:12		-53.89001	-37.90677	Transect 3.2 completed
05/12/2015 20:30		-53.71376	-37.96569	Vsl on DP
05/12/2015 20:36	94	-53.71385	-37.96637	Commence deploying CTD
05/12/2015 20:40	94	-53.71385	-37.96633	CTD in the water
05/12/2015 20:41	94	-53.71383	-37.96633	CTD veering to 120m
05/12/2015 20:44	94	-53.71382	-37.96638	CTD stopped at 120m
05/12/2015 20:52	94	-53.71382	-37.96633	CTD recovered to deck
05/12/2015 21:06		-53.71385	-37.96642	Vsl off DP
05/12/2015 23:30		-53.36034	-38.08271	Vessel on DP
05/12/2015 23:44	95	-53.36107	-38.08308	CTD Deployed
05/12/2015 23:46	95	-53.36107	-38.08305	CTD Veering to 1000m
06/12/2015 00:04	95	-53.36107	-38.08311	CTD at 1000m
06/12/2015 00:27	95	-53.36108	-38.08308	CTD Recovered to Deck
06/12/2015 00:46		-53.36108	-38.08309	Vessel Off DP
06/12/2015 09:00		-53.86977	-37.72696	Commence transect 4.1
06/12/2015 09:05	96	-53.86219	-37.72966	XBT 16 deployed
06/12/2015 10:10	97	-53.6925	-37.78747	XBT 17 Deployed

06/12/2015 11:16	98	-53.51611	-37.84676	XBT 18 Deployed
06/12/2015 12:26	99	-53.33535	-37.9045	XBT 19 Deployed
06/12/2015 13:40	100	-53.1513	-37.96741	XBT 20 Deployed
06/12/2015 14:20	101	-53.14855	-37.83148	XBT 21 Deployed
06/12/2015 15:31	102	-53.32469	-37.77298	XBT 22 deployed
06/12/2015 16:39	103	-53.50013	-37.71354	XBT 23 deployed
06/12/2015 17:47	104	-53.67579	-37.65428	XBT 24 deployed
06/12/2015 18:54	105	-53.85218	-37.5939	XBT 25 deployed. Transect 4.2 completed
06/12/2015 23:00		-53.84435	-38.0047	Turning to run downwind for target fishing
06/12/2015 23:48	106	-53.833	-37.87359	RMT 8 Net Deployed
07/12/2015 00:24	106	-53.83475	-37.89899	RMT 8 Net Recovered
07/12/2015 00:50	107	-53.83158	-37.84748	RMT 8 Net Deployed
07/12/2015 01:36	107	-53.83098	-37.87714	RMT 8 Net Recovered
07/12/2015 02:44	108	-53.82732	-37.76971	RMT 8 Net Deployed
07/12/2015 03:13	108	-53.82723	-37.7916	RMT 8 Net recovered
07/12/2015 04:10		-53.81877	-37.65686	Target fishing complete vessel proceeding towards morning station
07/12/2015 13:00		-53.36086	-38.04072	Vessel On DP
07/12/2015 13:06		-53.36051	-38.04314	Vessel Off DP
07/12/2015 13:08	109	-53.36036	-38.04486	RMT 8 Net Deployed
07/12/2015 13:36	109	-53.36056	-38.06821	RMT 8 Net veered to 280m
07/12/2015 14:12	109	-53.36144	-38.10164	RMT 8 Net Recovered
07/12/2015 16:24	110	-53.43284	-38.6522	Vessel at 2 knots head to wind
07/12/2015 16:28	110	-53.43291	-38.6555	RMT deployed
07/12/2015 16:59	110	-53.43249	-38.68351	All stopped at 320m
07/12/2015 17:12	110	-53.43199	-38.69451	Vessel passes through station 2.2N
07/12/2015 17:37	110	-53.43282	-38.71698	RMT net recovered
07/12/2015 19:47		-53.79615	-38.5417	Vsl head to wind at 2 knts ready for deployment
07/12/2015 19:48	111	-53.79579	-38.54238	Commence deploying RMT 8
07/12/2015 19:52	111	-53.79453	-38.54605	RMT 8 in the water
07/12/2015 20:27	111	-53.78451	-38.58159	RMT 8 stopped at 336m wire out

07/12/2015 21:03	111	-53.77269	-38.61283	RMT 8 recovered to deck and stern door closed.
07/12/2015 22:33	112	-53.7609	-38.26807	Krill swarm identified
07/12/2015 22:41	112	-53.76387	-38.26617	Turning to head in to wind for RMT 8 deployment
07/12/2015 22:42	112	-53.76378	-38.26714	Commence deploying RMT 8
07/12/2015 22:44	112	-53.76356	-38.26886	RMT 8 in the water
07/12/2015 23:06	112	-53.76208	-38.28987	RMT 8 Veered to 225m
07/12/2015 23:36	112	-53.75982	-38.31907	RMT 8 Recovered to Deck
08/12/2015 00:48	113	-53.74024	-38.19551	RMT 8 Net Deployed
08/12/2015 00:56	113	-53.74062	-38.20187	RMT 8 Net Veered to 61m
08/12/2015 01:20	113	-53.74164	-38.22188	RMT 8 Net Recovered
08/12/2015 12:36		-52.81206	-40.11165	Vessel On DP
08/12/2015 12:46	114	-52.81173	-40.11161	CTD Deployed
08/12/2015 12:48	114	-52.81173	-40.11164	CTD Veering to 1000m
08/12/2015 13:06	114	-52.81172	-40.11164	CTD at 1000m
08/12/2015 13:31	114	-52.81174	-40.11167	CTD Recovered to Deck
08/12/2015 13:42	115	-52.81175	-40.11167	WP2 Deployed
08/12/2015 13:44	115	-52.81174	-40.11168	WP2 Veering to 150m
08/12/2015 14:00	115	-52.81176	-40.11166	WP2 Recovered
08/12/2015 14:11	116	-52.81176	-40.11166	WP2 Deployed
08/12/2015 14:12	116	-52.81175	-40.11167	WP2 Veering to 150m
08/12/2015 14:26	116	-52.81175	-40.11166	WP2 Recovered
08/12/2015 14:32	117	-52.81175	-40.11166	WP2 Deployed
08/12/2015 14:34	117	-52.81175	-40.11167	WP2 Veering to 200m
08/12/2015 14:53	117	-52.81176	-40.11164	WP2 Recovered
08/12/2015 14:58	118	-52.81174	-40.11165	WP2 Deployed
08/12/2015 15:05	118	-52.81173	-40.11163	WP2 triggered at 150m
08/12/2015 15:08	118	-52.81174	-40.11167	WP2 recovered
08/12/2015 15:13	119	-52.81172	-40.11164	WP2 deployed
08/12/2015 15:18	119	-52.81175	-40.11167	WP2 triggered at 200m
08/12/2015 15:21	119	-52.81175	-40.11167	Second trigger dropped

08/12/2015 15:28	119	-52.81174	-40.11164	WP2 recovered
08/12/2015 15:34	120	-52.81173	-40.11166	WP2 deployed
08/12/2015 15:37	120	-52.81175	-40.11169	WP2 triggered at 150m
08/12/2015 15:44	120	-52.81174	-40.11165	Second trigger dropped
08/12/2015 15:46	120	-52.81174	-40.11167	WP2 recovered
08/12/2015 15:52	121	-52.81174	-40.11164	WP2 deployed
08/12/2015 15:59	121	-52.81173	-40.11164	WP2 triggered at 200m
08/12/2015 16:02	121	-52.81173	-40.11167	Second trigger dropped
08/12/2015 16:07	121	-52.81175	-40.11169	WP2 recovered
08/12/2015 16:17	122	-52.81174	-40.11167	Bongo deployed
08/12/2015 16:20	122	-52.81177	-40.11169	Bongo at 200m
08/12/2015 16:30	122	-52.8118	-40.11172	Bongo recovered
08/12/2015 16:54		-52.81173	-40.1117	Off DP
08/12/2015 17:18	123	-52.81726	-40.06085	On DP for mooring deployment
08/12/2015 17:27	123	-52.81733	-40.06156	Commence mooring deployment with top buoy in the water
08/12/2015 17:40	123	-52.81675	-40.0668	First buoy cluster deployed
08/12/2015 17:46	123	-52.81654	-40.06859	Sediment trap and current meter deployed
08/12/2015 17:49	123	-52.81646	-40.06943	CTD deployed
08/12/2015 18:40	123	-52.81345	-40.09619	Second buoy cluster deployed
08/12/2015 18:45	123	-52.81338	-40.09678	Second sediment trap deployed
08/12/2015 19:12	123	-52.81112	-40.11681	1400m section of rope completed
08/12/2015 19:23	123	-52.81059	-40.12054	Final 300m lenght of rope deployed
08/12/2015 19:27	123	-52.81052	-40.12136	Acoustic release deployed
08/12/2015 19:28	123	-52.81047	-40.12166	Anchor weight deployed
08/12/2015 20:00	123	-52.80982	-40.1267	Mooring ranged at 3796m
08/12/2015 20:20	123	-52.80342	-40.1039	Mooring ranged at 3968m
08/12/2015 20:36		-52.82035	-40.11327	Vsl on DP
08/12/2015 20:41	123	-52.82043	-40.11401	Mooring ranged at 3884m
08/12/2015 20:51	124	-52.82041	-40.11402	Commence deploying bongo nets
08/12/2015 20:53	124	-52.82042	-40.11401	Bongo nets in the water

08/12/2015 20:59	124	-52.82043	-40.11399	Bongo nets at 200m
08/12/2015 21:11	124	-52.82046	-40.11399	Bongo nets recovered to deck
08/12/2015 21:13	125	-52.82045	-40.11405	Commence deploying bongo nets
08/12/2015 21:14	125	-52.82045	-40.11402	Bongo nets in the water
08/12/2015 21:21	125	-52.8204	-40.11389	Bongo nets at 200m
08/12/2015 21:35	125	-52.82039	-40.11392	Bongo nets recovered to deck
08/12/2015 21:47	126	-52.82038	-40.11388	WP2 in the water
08/12/2015 21:51	126	-52.82037	-40.1139	WP2 triggered at 50m
08/12/2015 21:57	126	-52.82037	-40.1139	WP2 recovered to deck
08/12/2015 22:03	127	-52.82036	-40.1139	WP2 in the water
08/12/2015 22:13	127	-52.82035	-40.11387	WP2 triggered at 100m
08/12/2015 22:18	127	-52.82036	-40.11391	WP2 triggered at 50m
08/12/2015 22:22	127	-52.82037	-40.1139	WP2 recovered to deck
08/12/2015 22:29	128	-52.82035	-40.1139	WP2 in the water
08/12/2015 22:45	128	-52.82039	-40.11391	WP2 triggered at 200m
08/12/2015 22:56	128	-52.8204	-40.1139	WP2 triggered at 100m
08/12/2015 23:02	128	-52.8204	-40.11389	WP2 Recovered
08/12/2015 23:08	129	-52.82038	-40.11393	WP2 Deployed
08/12/2015 23:10	129	-52.82037	-40.11391	WP2 Veering to 400m
08/12/2015 23:47	129	-52.82037	-40.11387	WP2 Triggered 400m
09/12/2015 00:33	129	-52.8204	-40.11392	WP2 Recovered
09/12/2015 00:48		-52.81724	-40.11135	Vessel Off DP
09/12/2015 01:12		-52.8118	-40.08685	Vessel On DP
09/12/2015 01:32	130	-52.81181	-40.08688	Bongo Net Deployed
09/12/2015 01:50	130	-52.81182	-40.08686	Bongo Net Recovered
09/12/2015 02:12	131	-52.81185	-40.0869	Mammoth Deployed
09/12/2015 02:45	131	-52.81185	-40.08687	Mammoth at 1000m
09/12/2015 03:51	131	-52.81182	-40.08684	Mammoth recovered
09/12/2015 04:55	132	-52.81185	-40.08685	WP2 deployed
09/12/2015 05:10	132	-52.81183	-40.08685	WP2 triggered at 150m

09/12/2015 05:15	132	-52.81182	-40.08686	Second trigger dropped
09/12/2015 05:21	132	-52.81185	-40.08686	WP2 recovered
09/12/2015 05:32	133	-52.81185	-40.08684	WP2 deployed
09/12/2015 05:49	133	-52.81186	-40.08685	WP2 triggered at 200m
09/12/2015 05:54	133	-52.81187	-40.08686	Second trigger dropped
09/12/2015 06:00	133	-52.81187	-40.08689	WP2 recovered
09/12/2015 06:05	134	-52.81183	-40.08686	WP2 deployed
09/12/2015 06:17	134	-52.81185	-40.08686	WP2 triggered at 150m
09/12/2015 06:22	134	-52.81184	-40.08684	Second trigger dropped
09/12/2015 06:26	134	-52.81183	-40.08686	WP2 recovered
09/12/2015 06:31	135	-52.81183	-40.08686	WP2 deployed
09/12/2015 06:50	135	-52.81183	-40.08686	WP2 triggered at 200m
09/12/2015 06:53	135	-52.81183	-40.08687	Second trigger dropped
09/12/2015 07:00	135	-52.81184	-40.08687	WP2 recovered to deck
09/12/2015 07:12		-52.81185	-40.08686	Vsl off DP
09/12/2015 10:54		-52.62782	-39.11385	Vsl on DP
09/12/2015 11:03	136	-52.62643	-39.11443	Commence deploying CTD
09/12/2015 11:05	136	-52.62644	-39.11441	CTD in the water
09/12/2015 11:08	136	-52.62648	-39.11449	CTD Veering to 3720m
09/12/2015 12:12	136	-52.62716	-39.11516	CTD at 3685m
09/12/2015 13:41	136	-52.62718	-39.11516	CTD Recovered to Deck
09/12/2015 13:58	137	-52.62721	-39.11508	Bongo Net Deployed
09/12/2015 14:01	137	-52.62721	-39.1151	Bongo Net veering to 200m
09/12/2015 14:20	137	-52.62719	-39.11511	Bongo Net Recovered
09/12/2015 14:24	138	-52.6272	-39.11516	Bongo net deployed veering to 200m
09/12/2015 14:38	138	-52.62721	-39.11512	Bongo Net Recovered
09/12/2015 14:39	139	-52.62719	-39.11514	Bongo Net Deployed
09/12/2015 14:56	139	-52.62713	-39.11566	Bongo Net Recovered
09/12/2015 15:57	140	-52.62729	-39.1152	Net trap deployed from midships gantry
09/12/2015 16:00	140	-52.62725	-39.11534	Net trap triggered at 50m

09/12/2015 16:04	140	-52.62728	-39.1155	Net trap recovered
09/12/2015 16:10	141	-52.62726	-39.11543	Net trap deployed from midships gantry
09/12/2015 16:12	141	-52.62732	-39.11541	Net trap triggered at 50m
09/12/2015 16:15	141	-52.62732	-39.11549	Net trap recovered
09/12/2015 16:20	142	-52.62728	-39.1157	Net trap deployed
09/12/2015 16:22	142	-52.6273	-39.11569	Net trap triggered at 50m
09/12/2015 16:26	142	-52.62727	-39.11589	Net trap recovered
09/12/2015 23:30		-52.62046	-39.11389	Vessel Off DP
10/12/2015 10:48		-52.62623	-39.11399	Vessel on DP
10/12/2015 11:16	143	-52.62626	-39.11401	Bongo Net Deployed
10/12/2015 11:17	143	-52.62627	-39.11406	Bongo Net Veering to 200m
10/12/2015 11:34	143	-52.62705	-39.11494	Bongo Net Recovered
10/12/2015 11:35	144	-52.62709	-39.11495	Bongo Net deployed veering to 200m
10/12/2015 11:48	144	-52.62721	-39.11518	Bongo Net Recovered
10/12/2015 11:49	145	-52.62722	-39.11512	Bongo Net Deployed
10/12/2015 11:50	145	-52.62723	-39.11513	Veering to 200m
10/12/2015 12:02	145	-52.62717	-39.11512	Bongo Net Recovered
10/12/2015 12:11	146	-52.62722	-39.11516	WP2 Deployed
10/12/2015 12:14	146	-52.62719	-39.11514	WP2 Triggered
10/12/2015 12:18	146	-52.62721	-39.11511	WP2 Recovered
10/12/2015 12:25	147	-52.6272	-39.11518	WP2 Deployed
10/12/2015 12:26	147	-52.62718	-39.11511	WP2 veering to 150m
10/12/2015 12:39	147	-52.62721	-39.11515	WP2 Recovered
10/12/2015 12:47	148	-52.6272	-39.11515	WP2 Deployed
10/12/2015 12:48	148	-52.62718	-39.11518	WP2 Veering to 150m
10/12/2015 12:59	148	-52.62719	-39.11517	WP2 Recovered
10/12/2015 13:04	149	-52.62717	-39.11517	WP2 Deployed
10/12/2015 13:05	149	-52.62714	-39.11518	WP2 Veering to 150m
10/12/2015 13:17	149	-52.62714	-39.11519	WP2 Recovered
10/12/2015 13:21	150	-52.62717	-39.1152	WP2 Deployed

10/12/2015 13:21	150	-52.62717	-39.1152	WP2 Verring to 150m
10/12/2015 13:30	150	-52.62718	-39.11519	WP2 Recovered
10/12/2015 13:36	151	-52.62714	-39.11525	WP2 Deployed
10/12/2015 13:46	151	-52.62717	-39.1153	WP2 Recovered
10/12/2015 13:48	152	-52.62714	-39.11524	WP2 Deployed
10/12/2015 13:48	152	-52.62714	-39.11524	WP2 Triggered
10/12/2015 14:00	152	-52.62718	-39.11531	WP2 Recovered
10/12/2015 14:32	153	-52.62713	-39.11524	WP2 Deployed
10/12/2015 14:36	153	-52.62716	-39.11519	WP2 Recovered
10/12/2015 14:41	154	-52.62715	-39.11522	WP2 Deployed
10/12/2015 14:54	154	-52.62712	-39.11529	WP2 Recovered
10/12/2015 14:58	155	-52.62712	-39.11534	WP2 Deployed
10/12/2015 15:07	155	-52.62717	-39.11516	WP2 triggered at 200m
10/12/2015 15:09	155	-52.62716	-39.1152	WP2 recovered
10/12/2015 16:04	156	-52.62719	-39.11521	WP2 deployed
10/12/2015 16:08	156	-52.6272	-39.11525	WP2 triggered at 200m
10/12/2015 16:14	156	-52.6272	-39.11523	Second trigger dropped
10/12/2015 16:17	156	-52.62718	-39.11528	WP2 recovered
10/12/2015 16:54	157	-52.62714	-39.11543	WP2 deployed
10/12/2015 16:57	157	-52.62716	-39.11541	WP2 sunk
10/12/2015 17:05	157	-52.62717	-39.11543	WP2 triggered at 400m
10/12/2015 17:25	157	-52.62714	-39.11542	WP2 recovered
10/12/2015 21:14	158	-52.62687	-39.11576	WP2 in the water
10/12/2015 21:30	158	-52.62745	-39.11578	WP2 triggered at 150m
10/12/2015 21:34	158	-52.62779	-39.11577	WP2 triggered at 100m
10/12/2015 21:44	158	-52.62835	-39.11578	Recovered to deck
10/12/2015 21:47	159	-52.62826	-39.11568	WP2 in the water
10/12/2015 22:00	159	-52.62867	-39.11579	WP2 triggered at 100m
10/12/2015 22:04	159	-52.62902	-39.11577	WP2 triggered at 50m
10/12/2015 22:08	159	-52.62925	-39.11578	WP2 recovered to deck

10/12/2015 22:18	160	-52.62933	-39.11581	WP2 in the water
10/12/2015 22:34	160	-52.6298	-39.1158	WP2 triggered at 150m
10/12/2015 22:40	160	-52.63025	-39.11575	WP2 triggered at 100m
10/12/2015 22:47	160	-52.63077	-39.11586	WP2 recovered to deck
10/12/2015 23:01	161	-52.63063	-39.11642	WP2 in the water
10/12/2015 23:03	161	-52.63063	-39.11637	WP2 Veering to 150m
10/12/2015 23:24	161	-52.63114	-39.11663	WP2 Triggered at 100m
10/12/2015 23:35	161	-52.63144	-39.11695	WP2 Recovered
10/12/2015 23:54				Vessel Off DP

Appendix B. Alcohol Samples

Ev 45	Mammoth	Net 1	250 ml
P2		Net 2	250 ml
		Net 3	250 ml
		Net 4	250 ml
		Net 5	250 ml
		Net 6	250 ml
		Net 7	250 ml
		Net 8	250 ml
		Net 9	500 ml
Ev 52	MOCNESS	Net 2	500 ml
P2		Net 3	250 ml
		Net 4	500 ml
		Net 5	250 ml
		Net 6	250 ml
		Net 7	250 ml
		Net 8	250 ml
		Net 9	250 ml
Ev 55	Mammoth	Net 1	250 ml
P2		Net 2	250 ml
		Net 3	250 ml
		Net 4	250 ml
		Net 5	250 ml
		Net 6	250 ml
		Net 7	250 ml
		Net 8	250 ml
		Net 9	500 ml
Ev 61	MOCNESS	Net 2	250 ml
P2		Net 3	250 ml
		Net 4	250 ml
		Net 5	250 ml
		Net 6	250 ml
		Net 7	250 ml
		Net 8	500 ml
		Net 9	500 ml
Ev 124	Bongo		500 ml
Ev 131	Mammoth	Net 1	250 ml
P3		Net 2	250 ml
		Net 3	250 ml
		Net 4	250 ml
		Net 5	250 ml
		Net 6	250 ml
		Net 7	250 ml
		Net 8	250 ml
		Net 9	250 ml
Ev 137	Bongo	100 um	500 ml
		200 um	500 ml
Other			
Misc pteropods in alcohol (1 bag), Rosie Oakes			
eDNA samples in alcohol (2 boxes and 1 bag), Jennifer Freer			
Amphipods in alcohol (1 box), Charlotte Havermann			

Appendix C. Formalin Samples

EV 12	Bongo	100um	500 ml
		200um	500 ml
Ev 13	Bongo	100um	500 ml
		200um	500 ml
Ev 14	Bongo	100um	500 ml
		200um	500 ml
Ev 17	Bongo	100um	500 ml
		200um	500 ml
Ev 18	Bongo	100um	500 ml
		200um	500 ml
Ev 22	Bongo	100um	500 ml
		200um	500 ml
Ev 23	Bongo	100um	500 ml
		200um	500 ml
Ev 24	Bongo	100um	500 ml
		200um	500 ml
Ev 78	RMT8		I L
Ev 80	RMT8		I L
Ev 109	RMT8		I L
Ev 110	RMT8		I L
Ev 111	RMT8		I L
Ev 48	WP2	53 um	250 ml
Ev 49	WP2	53 um	250 ml
Ev 50	WP2	53 um	250 ml
Ev 51	WP2	53 um	250 ml
Ev 126	WP2	53 um	250 ml
Ev 127	WP2	53 um	250 ml
Ev 128	WP2	53 um	250 ml
Ev 129	WP2	53 um	250 ml
Ev 153	WP2	53 um	250 ml
Ev 154	WP2	53 um	250 ml
Ev 155	WP2	53 um	250 ml
Miscellaneous samples in plastic box			Cecelia Liszka
Miscallaneous samples in bag (1.5 ml vials)			Rosie Oakes