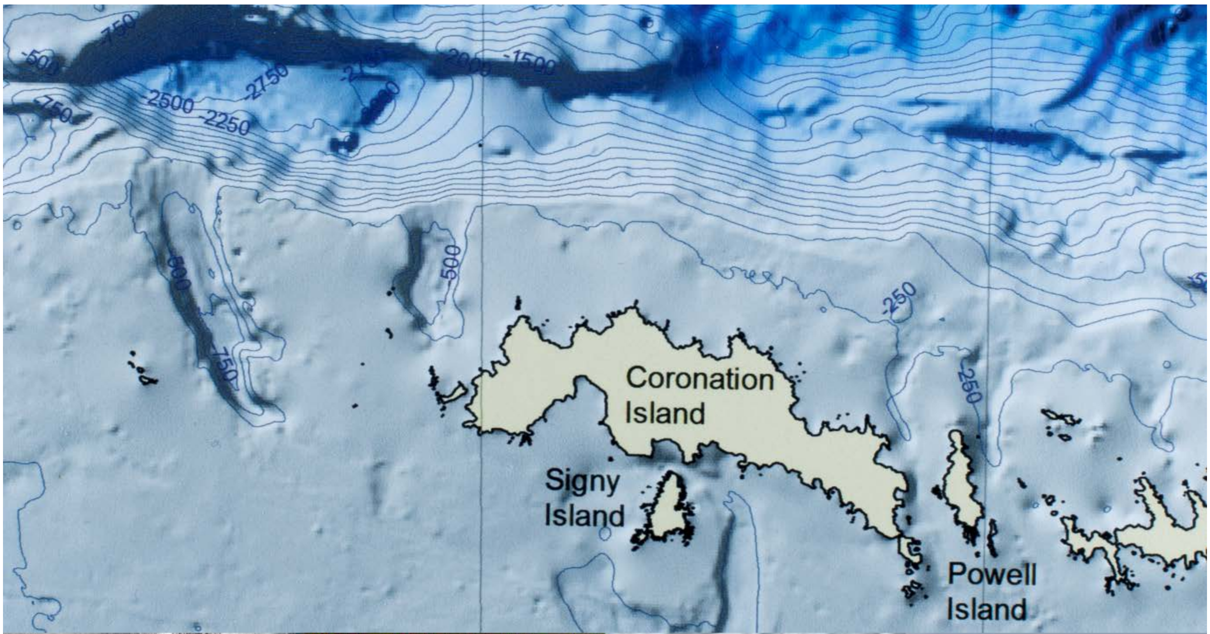
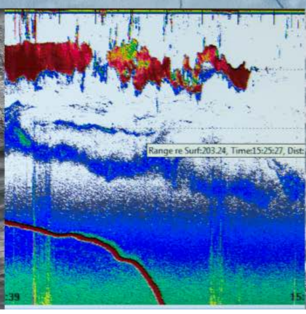
JR15004 Cruise Report
South Orkney Ecosystem Studies
15 January – 23 February 2016





1 Contents

2 Introduction

2.1 Rationale

The South Orkney Island region of the Scotia Sea is a major focus for the commercial Antarctic krill fishery, it is also a key region in the ecology of Antarctic krill, an area where interactions between sea-ice and water currents from the Western Antarctic Peninsula and Weddell Sea create conditions that promote krill reproduction, growth and subsequent dispersal towards South Georgia. Understanding the relationship between distribution of predators, pelagic resource and the commercial fishery is vital in deriving ecosystem based management plans for the fishery. The SOES cruise examined what factors determine the distribution patterns of krill and other pelagic organisms such as mesopelagic fish and zooplankton across a range of time and space scales from the movement of individual krill swarms up to the longer term flux of krill into and out of the hotspots that occur in the canyons on the northern South Orkney shelf.

The work was carried out to analyse spatial and temporal variability at different spatial scales that correspond to the major organisational scales of krill distribution centred on the intermediate scale of major predator –prey - fishery interactions (krill patches, km to 10s km). The work involved coordinated studies from RRS James Clark Ross utilizing underway instrumentation (particularly multi-frequency acoustics), net sampling, water sampling and predator observations. It was augmented by the deployment of autonomous samplers (moorings) for the duration of the cruise. These research vessel activities link with concurrent observations from commercial fishing vessels operating in the region, together with a regional 5 day krill survey undertaken by Norwegian fishing vessel FV Saga Sea. The ship-based activities are also tightly linked to predator tracking studies being undertaken from key penguin and fur seal colonies in the South Orkney region.

2.2 Cruise structure

JR15004 consisted of a series of science modules operating at different spatial scales. The overall plan for the different modules in shown in Figure 2-1. The individual modules with goals and design are then shown in the following sections working through in order of decreasing spatial scales below:

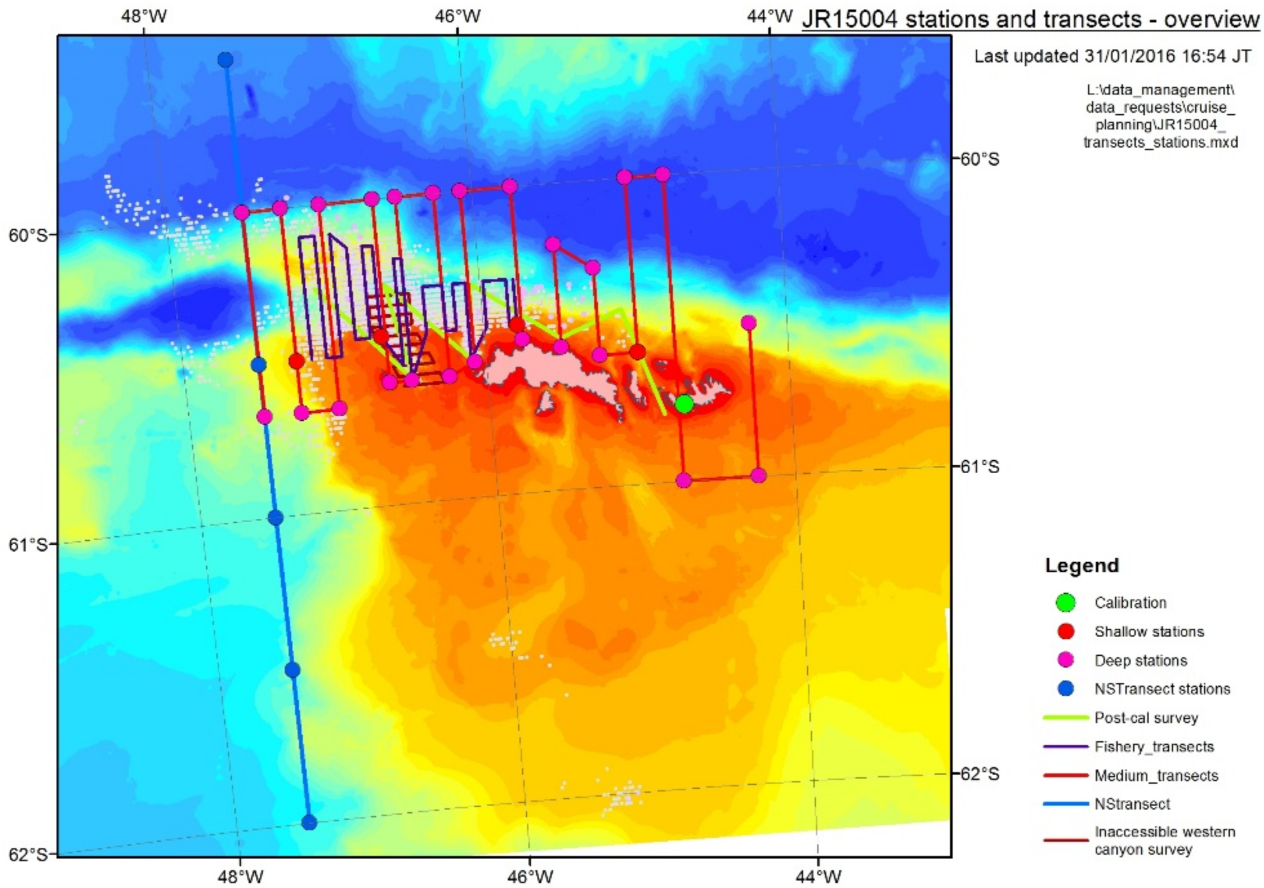


Figure 2-1: Planned transects and stations for the different modules of JR15004

2.2.1 North/South transect.

Goal: to characterize physical and biological environment on a latitudinal transect upstream of the South Orkney region. To complement acoustic and biological sampling undertaken as part of the RV Saga Sea regional scale survey.

Module design: Regular stations to undertake vertical MAMMOTH net hauls and CTD casts to 1000 m. Underway acoustic sampling between stations with EK60 and ADCP (Figure 2-2).

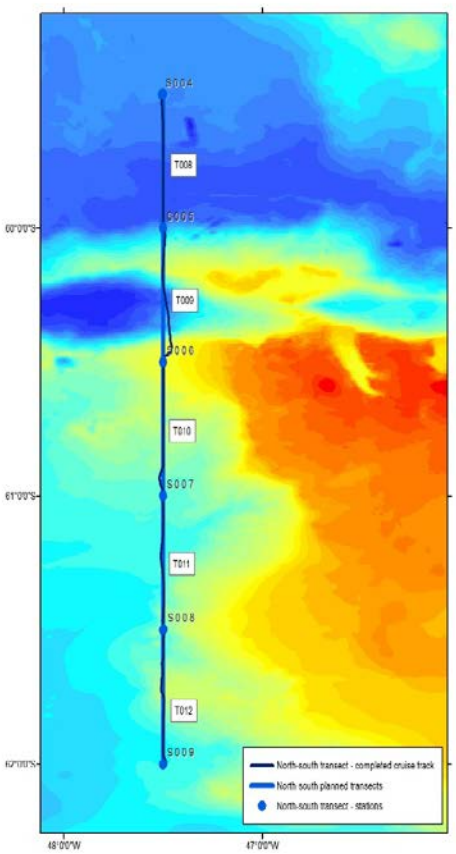


Figure 2-2: North/South transect showing planned and actual track and stations

2.2.2 Medium scale survey

Goal: To characterize the physical and biological environment of the northern shelf and shelf break region of the South Orkney Islands.

Module design: Day time acoustic transects interleaved with night time net haul stations. Night time stations comprise CTD and RMT25 stratified sampling down to 1000 m. Additional CTD stations added to provide more complete spatial coverage (Figure 2-3).

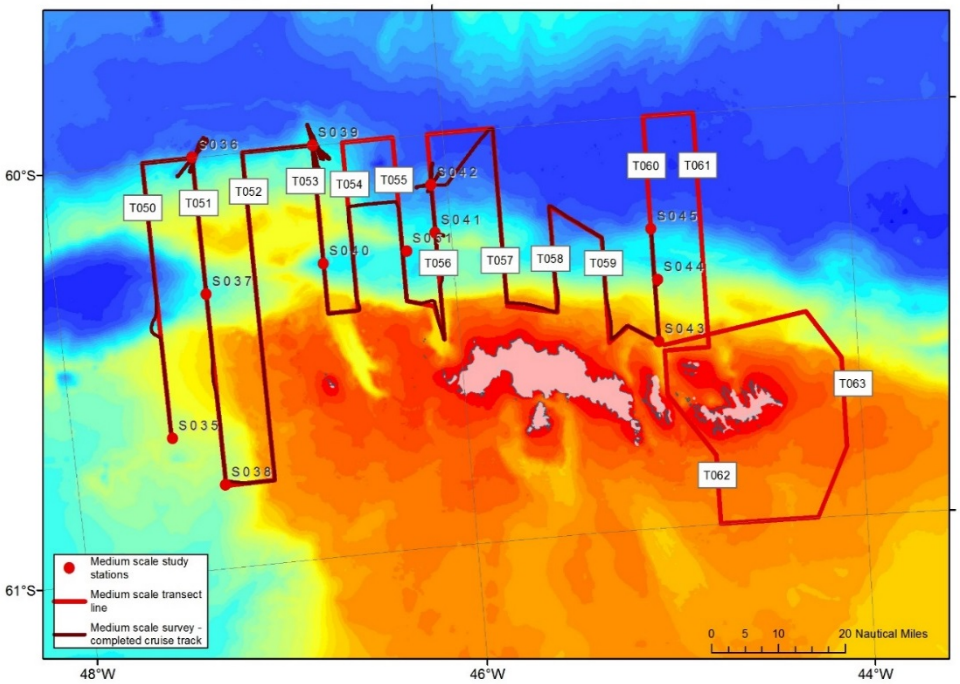


Figure 2-3: Medium scale survey showing the planned and actual track together with transect and station numbers

2.2.3 Fine scale fishing survey

Goal: Determine the fine scale distribution of krill across the most heavily fished area of the north coast of the South Orkney Islands

Module design: In 2014 as part of the Norwegian fishing vessel survey, a 2 day fine scale survey was undertaken that covered the shelf break and canyons where the fishery was located. This scale of survey is slightly smaller and more detailed than the medium scale survey above. The transect lines were modified slightly due to bathymetric constraints but still provide a perfect coverage of the key fishing area (Figure 2-4).

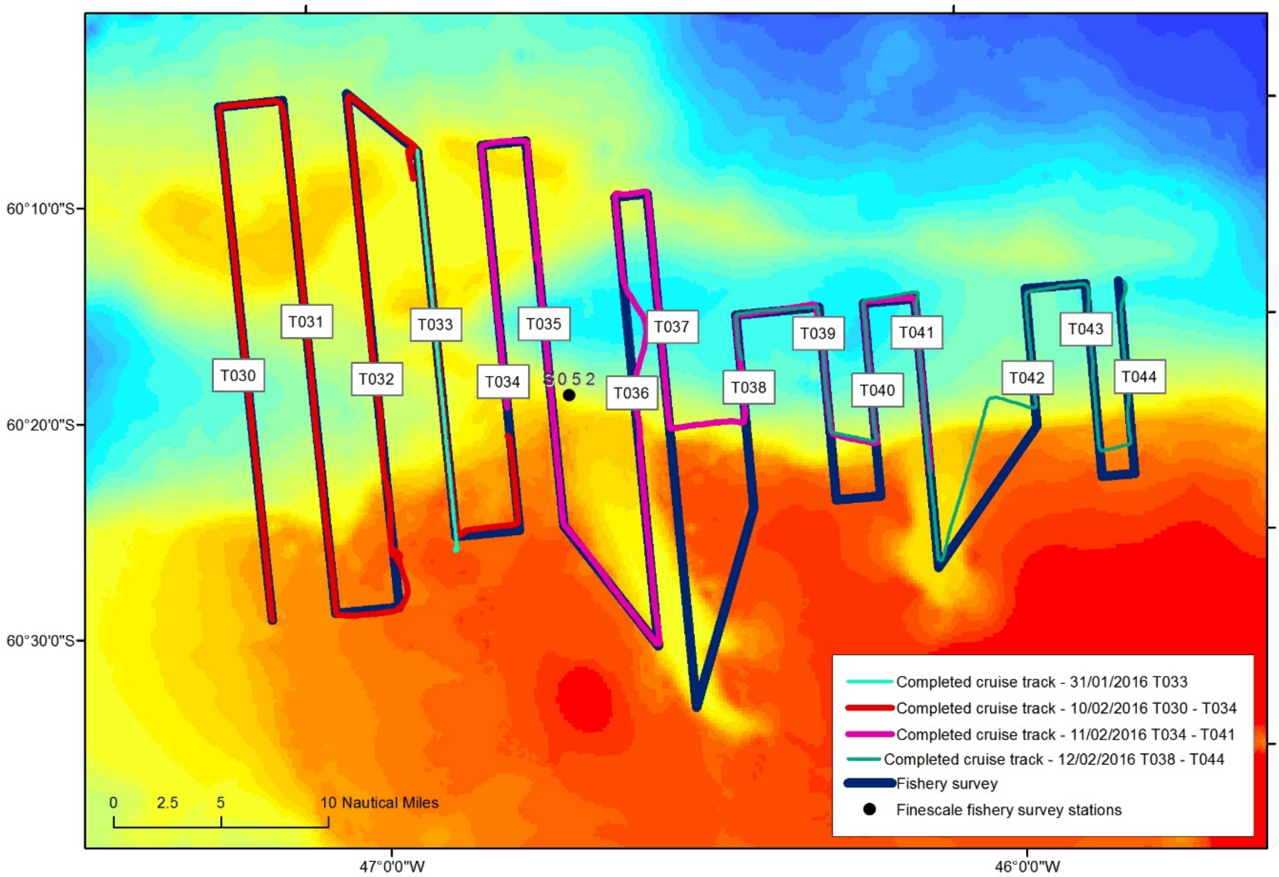


Figure 2-4: Fine scale fishing survey showing the planned and actual track together with transect numbers

2.2.4 Western canyon study

Goal: to understand physical-biological drivers at the small scale of the Western Canyon.

Module design: Canyon scale grid survey consisting of 10 short transects across the Canyon. Linked with the deployment of moorings within the canyon and CTD transects across the canyon. Net sampling with RMT8 to assess krill population structure and validate acoustics (Figure 2-5).

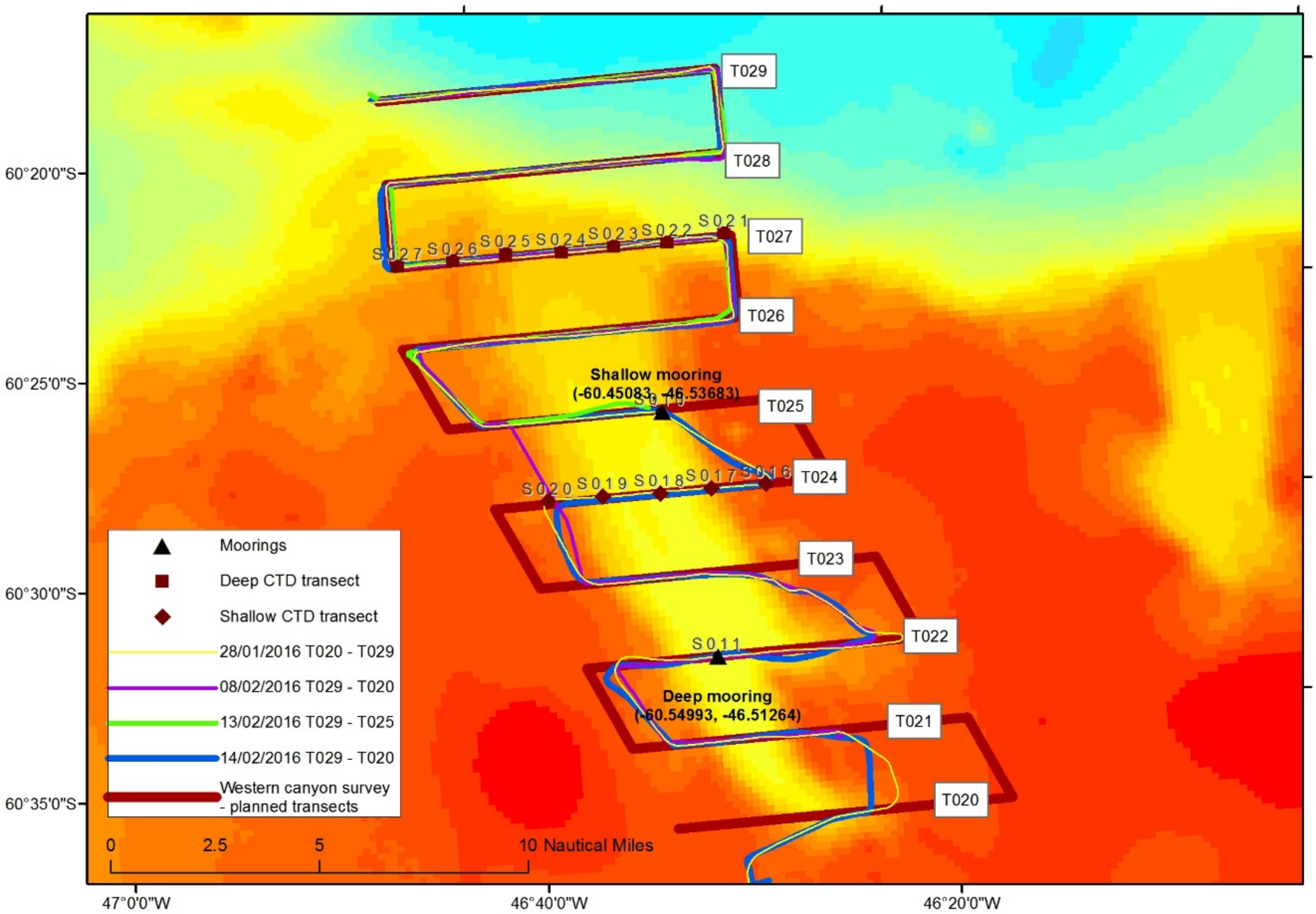


Figure 2-5: West canyon study showing the planned and actual track together with transect numbers. The positions of the mooring deployments and the CTD transects are also shown.

2.2.5 Large krill aggregation study

Goal: to map distribution and biomass of krill and predators in large krill aggregation detected on shelfbreak of Coronation Island.

Module design: Acoustic transects running north/south across aggregation, separation 0.5 nm (Figure 2-6).

2.2.6 Behavioural studies

Goal: to understand physical-biological drivers of behaviour in krill aggregations.

Module design: deployment of WBAT on CTDs within krill swarms, UW stereo camera drops. Linked to Western Canyon Study.

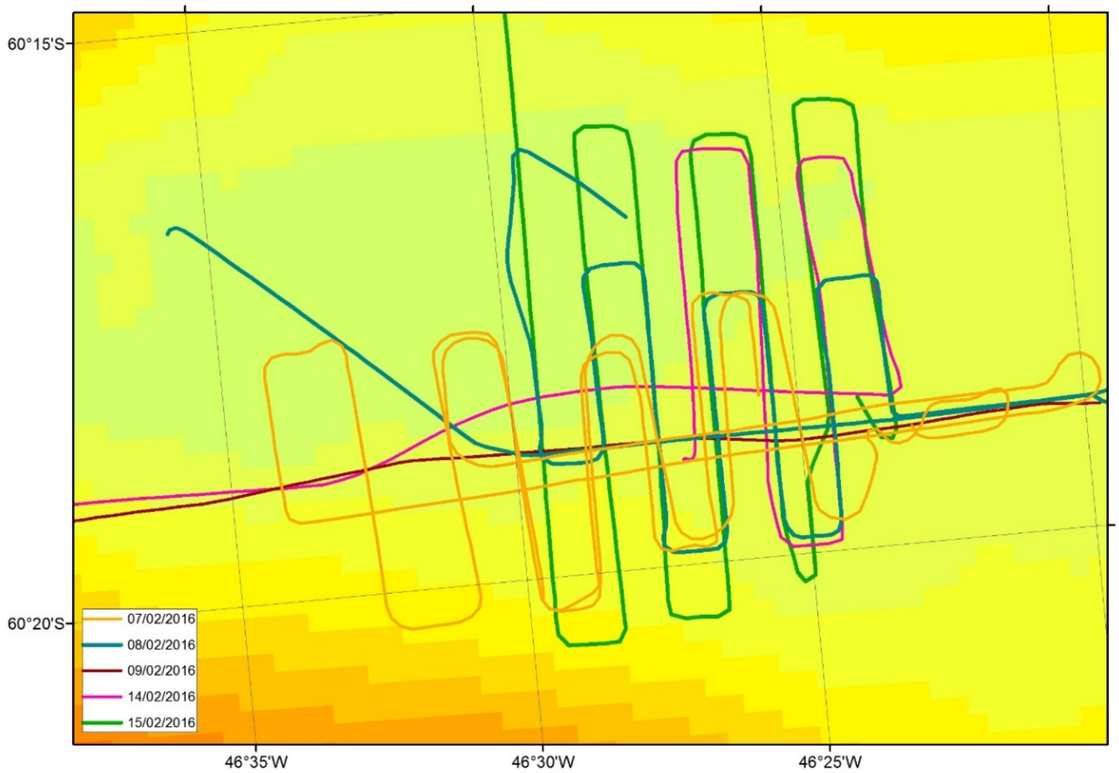


Figure 2-6: Large krill aggregation study showing the actual tracks on the different dates the aggregation was surveyed

2.2.7 Calibration:

Goal: calibrate EK60 and EK80 systems on JCR. WBAT standalone system for moorings and CTD. RDI ship-mounted ADCP.

Module design: Echo sounder calibrations undertaken at Scotia Bay on Laurie Island. ADCP calibrations undertaken during steaming.

2.3 Station Positions

The location of stations sampled during the cruise can be found in the JR15004 Event Log (section 15.1). Maps showing the station positions are shown below (Figure 2-7 and Figure 2-8).

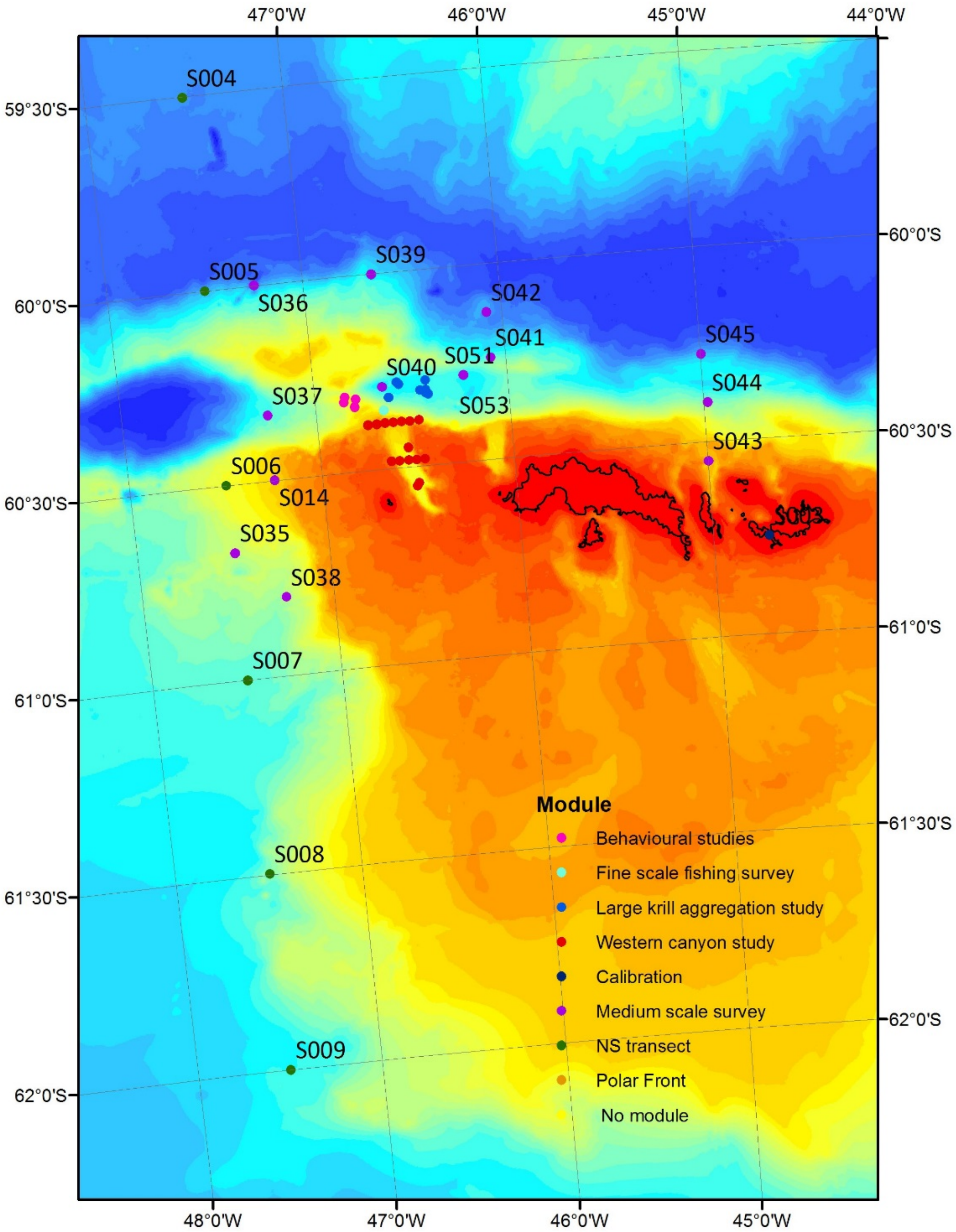


Figure 2-7: Position of stations undertaken in the different science modules of JR15004. Station numbers shown for Calibration, Medium scale survey and NS transect. Station numbers for the other modules shown in Figure 2-8. Note that stations undertaken at the Polar Front near the end of the cruise are not shown on these maps

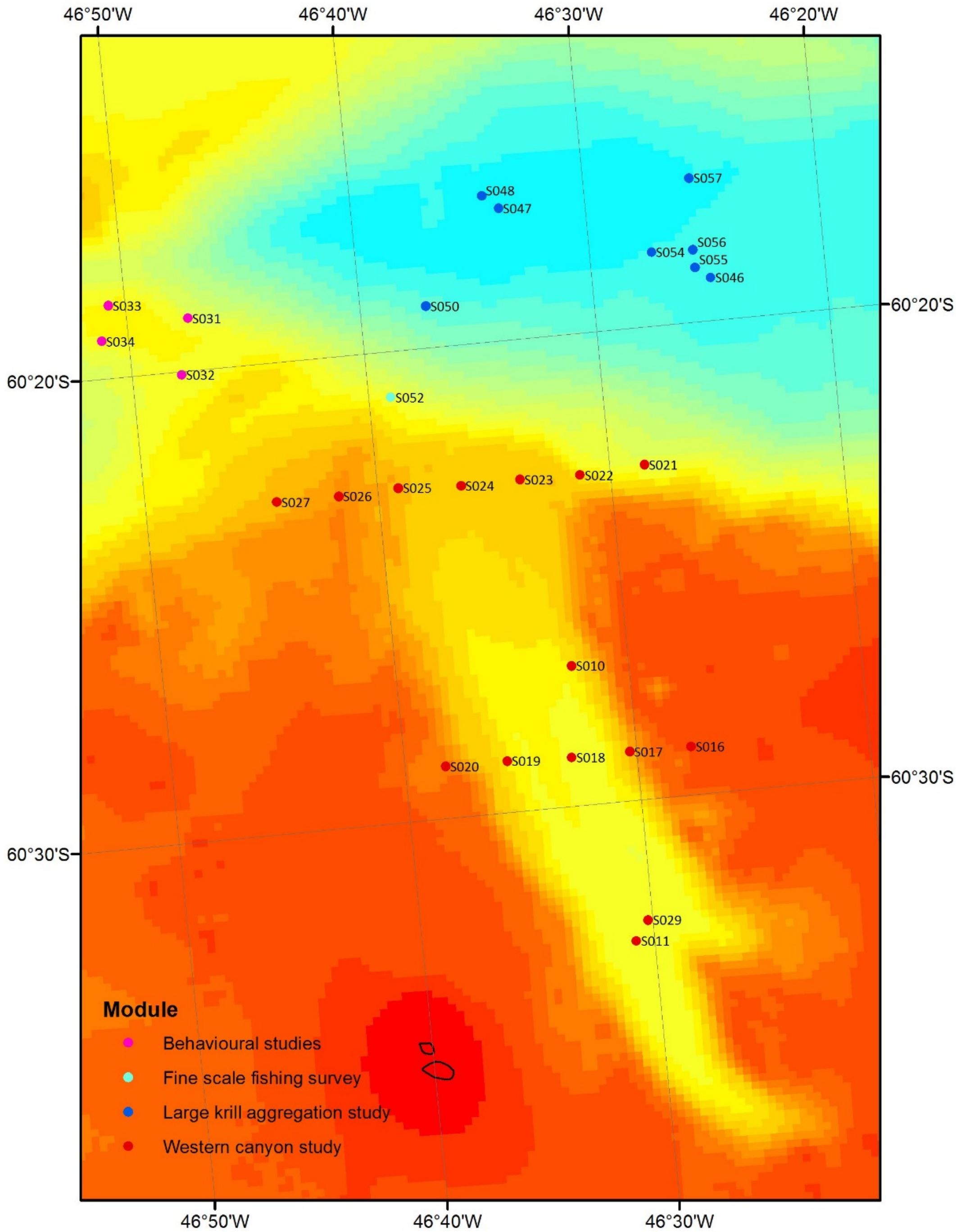


Figure 2-8: Location of stations undertaken in the small scale modules - Behavioural studies, Fine scale fishing survey, Large krill aggregation study and Western Canyon study

2.4 Cruise track

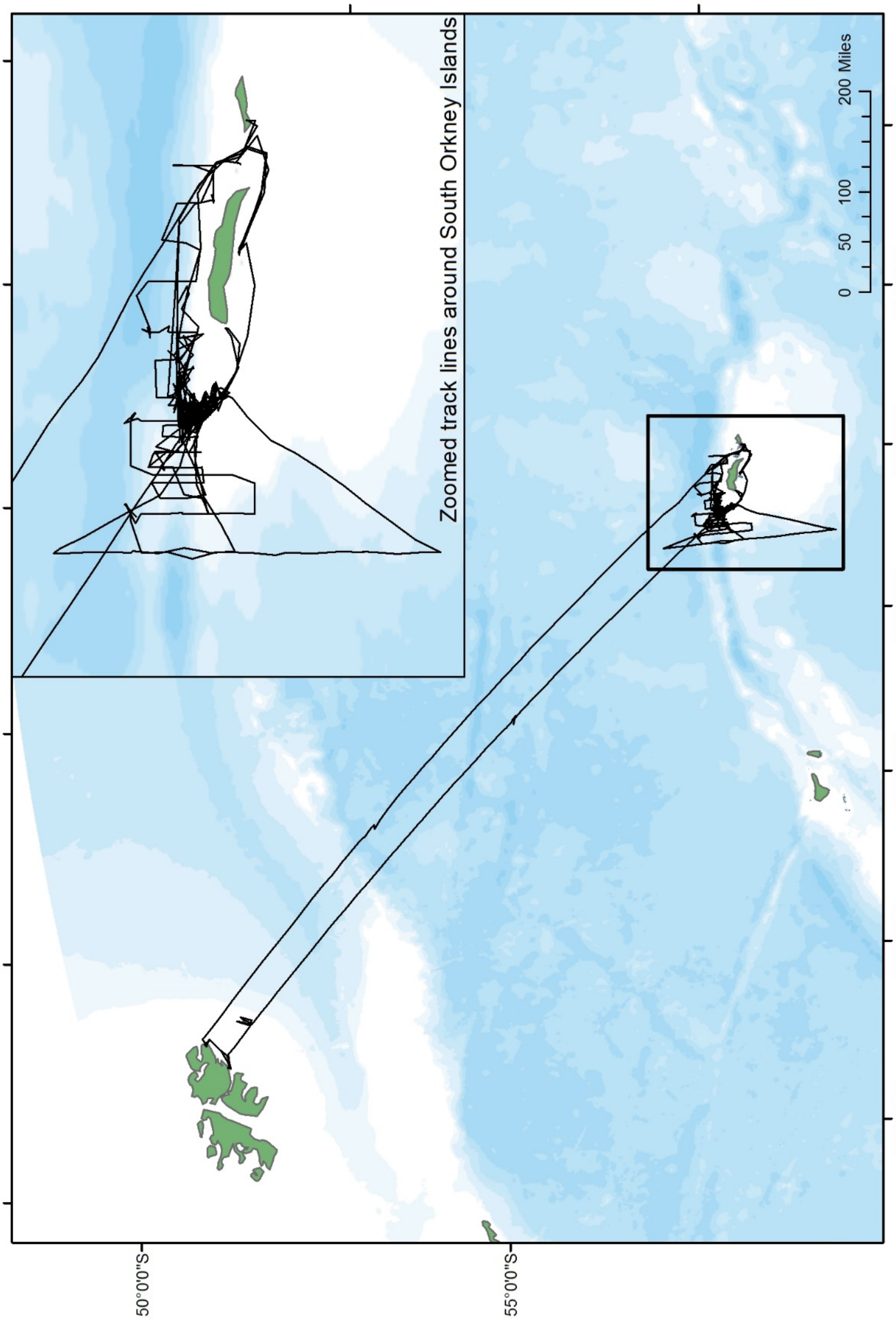


Figure 2-9: Cruise track for JR15004, leg 20160113

2.5 Cruise Narrative

10 Jan 2016: Advance science party leaves Cambridge along with JCR crew to fly to Falklands

11 Jan 2016: Advance science party arrive and distributed around Stanley hotels and guest houses.

13 Jan 2016: JCR arrives Stanley at 08:00. Main science party leave from UK.

14 Jan 2016: Main science party arrive in Stanley and board ship.

15-18 Jan 2016: Ship mobilizing while engineers work on repairs to engines.

19 Jan 2016: 51° 40'S 57° 48'W, 2 Nm, F4 WSW, sea Slight, air 9.0°C, sea 10.0°C, 1009 mb rising. Left Stanley at 11:00 to sail around to Mare Harbour to refuel.

20 Jan 2016: 51° 54'S 58° 27'W, 55 Nm, F4 SW, sea Slight, air 11.0°C, sea 10.0°C, 1011 mb steady. Started to test the EM2040 on the cargo tender. The RMT25 rigged and net modifications undertaken. EM2040 trials cut short as fuel quality issues required return to Stanley. Arrived in Stanley in evening and refuelling takes place.

21 Jan 2016: 51° 40'S 57° 49'W, 49 Nm, F4 SW, sea Slight, air 14.0°C, sea 11.0°C, 1007 mb steady. Ship sails from Stanley at 11:00. Boat drills and safety briefs undertaken

22 Jan 2016: 54° 35'S 53° 50'W, 226 Nm, F3 W, sea Slight, air 6.0°C, sea 3.0°C, 1002 mb falling. First full day at sea. Respooling of RMT25 wire undertaken before lunch with 1150 m of the 17 m conducting wire veered over the side and then recovered. In the afternoon a trial station undertaken to test and demonstrate deployment of the CTD, RMT25 and mammoth net.

23 Jan 2016: 57° 47'S 46° 14'W, 479 Nm, F5 SW, sea Slight, air 3.0°C, sea 3.0°C, 992 mb steady. Ship continuing south towards Scotia Bay and calibration site. Discussions of acoustics and calibrations occurring.

24 Jan 2016: 60° 45'S 44° 42'W, 716 Nm, F2 W, sea Calm, air 1.0°C, sea 1.0°C, 993 mb steady. At 04:04:37 reached 60° 00'S. Arrived at Scotia Bay on the south side of Laurie Island at 12:30. Ship anchored for calibration and CTD deployed at 14:00. First calibration sphere in place under hull-mounted 120 kHz at 16:00. Those not working on calibration took opportunity to visit Orcadas base.

25 Jan 2016: 60° 45'S 44° 43'W, 717 Nm, F3 S, sea Calm, air 0.0°C, sea 1.0°C, 983 mb steady. Hull calibration continued until 02:15. Standalone WBAT calibrations re-commenced at immediately after breakfast and data collection continued until 13:15. Ship left to start acoustic runs across the northern shelf of Coronation to get an overview of krill distribution prior to starting the N/S transect tomorrow.

26 Jan 2016: 59° 30'S 47° 30'W, 916 Nm, F5 SE, sea Moderate, air 0.0°C, sea 0.0°C, 992 mb steady. The N/S transect started with CTD and mammoth net station at 10:30. Science event log records that over 40 whales were seen along the northern coast during the initial acoustic runs.

27 Jan 2016: 61° 30’S 47° 30’W, 1037 Nm, F5 NW, sea Calm, air 0.0°C, sea 1.0°C, 1000 mb steady. Second day of working the N/S transect. Transect finished at 20:00 and relocate overnight to southern end of large/Inaccessible canyon.

28 Jan 2016: 60° 23’S 46° 47’W, 1219 Nm, F5 NW, sea Calm, air 0.0°C, sea 1.0°C, 1000 mb steady. Start acoustic survey of Inaccessible Canyon shortly after dawn (04:30). Norwegian fishing vessels, Saga Sea and Antarctic Sea are fishing shelf break between Inaccessible and Monroe Canyons. Chinese fishing vessel Longda also sighted. Acoustic survey finished by 14:11 and ship investigates possible mooring sites using SUCS camera deployments. Two mooring sites chosen in canyon by end of the day.

29 Jan 2016: 60° 27’S 46° 32’W, 1370 Nm, F3 NW, sea Calm, air 1.0°C, sea 0.0°C, 1006 mb steady. Started mooring deployment preparations at 06:00 this morning. First mooring finally deployed in canyon at station S010 by 13:45. Repositioned to second canyon mooring site but eyesplice on mooring cable broke when main buoy lifted off deck. Fortunately no one was hurt and instruments were still functional. The second attempt to deploy mooring was thwarted when brake on mooring winch seized. Work on mooring stopped at 19:30 and after dark a triangular ADCP calibration survey was run overnight.

30 Jan 2016: 60° 33’S 46° 31’W, 1499 Nm, F6 NW, sea Moderate, air 2.0°C, sea 1.0°C, 1002 mb rising. ADCP calibration runs followed by repeat passes along T033 until mooring ready to go. Worked started again at 08:00 to deploy second mooring and mooring finally in water and released at station S011 at 12:16. Second mooring ranged and information on positions sent to CCAMLR and neighbouring fishing vessels. At 15:00 ship proceeded to start of Medium-Scale survey but weather too rough for more than a CTD.

31 Jan 2016: 60° 23’S 46° 29’W, 1615 Nm, F7 NW, sea Rough, air 1.0°C, sea 0.0°C, 995 mb steady. Ship returned to canyon to range shallow mooring at station S010. Micro-scale survey around deepwater (S011) survey undertaken during night. Set of 5 CTDs undertaken across canyon along T024 undertaken from 06:00. At midday second line of 7 CTDs undertaken along T027.

01 Feb 2016: 60° 24’S 46° 28’W, 1721 Nm, F7 W, sea Moderate, air 2.0°C, sea 0.0°C, 992 mb falling. Some stereo camera deployments undertaken at S029 in early hours of the morning. Then the canyon scale acoustic survey was repeated during daylight hours together with predator observations. However relatively few aggregations were detected in the canyon. The Norwegian fishing vessels and the presence of many whales on the shelf break west of the canyon was used to identify an aggregation capable of sampling with the stereo camera, SUCS camera, CTD-mounted WBAT and RMT8.

02 Feb 2016: 60° 40’S 47° 30’W, 1827 Nm, F5 SW, sea Moderate, air 0.0°C, sea 0.0°C, 1000 mb rising. Undertook some ad hoc acoustic runs through the high krill area NW of the canyon before arriving at the start point for the Medium Scale Survey at 1100. After CTD at S035 steam transect T050 before sampling at first deep RMT25 station (S036) with CTD at 17:30 followed by two RMT25 hauls.

03 Feb 2016: 60° 48’S 47° 04’W, 1965 Nm, F3 WNW, sea Slight, air 0.5°C, sea 0.0°C, 1007 mb falling. Started T051 at 03:38 with acoustics and bird/predator observations. Fog by 05:00 meant that speed

reduced to 6 knots. Ship stopped to undertake CTD cast at S037 at 06:00 with further CTD cast at S038. Transect T052 then run with predator obs and acoustics until 18:00 and the overnight station S039.

04 Feb 2016: 60° 19'S 46° 18'W, 2115 Nm, F3 E, sea Slight, air 0.5°C, sea 0.5°C, 992 mb falling. Overnight CTD and RMT25 sampling. Acoustic transect and predator obs started at 03:30. Fog again and length of T054/5 reduced to keep to schedule. In afternoon CTD at S041 aborted due to problem with conductivity cell which replaced and then tested. Also problem with RMT25 conducting cable meant that 500 m of wire spooled off to untwist wire at station. Transect T056 stopped at 18:30 for night time station sampling with CTD and RMT 25.

05 Feb 2016: 60° 27'S 46° 15'W, 2254 Nm, F8 WNW, sea Rough, air 1.0°C, sea 1.0°C, 981 mb steady. Ship finished station S042 at 02:30 and repositioned to start transect T057 at 04:20.Transects T057-T59 completed by 12:20 and then ship undertook CTD at S043. Transect T060 and CTDs at stations S044 and S045 completed by 19:15. However increasing wind and swell meant that ship sought shelter on north side of Coronation for night.

06 Feb 2016: 60° 32'S 46° 14'W, 2314 Nm, F9 SW, sea Rough, air 1.0°C, sea 1.0°C, 980 mb steady. Ship continued to shelter through day and night as gale prevented science work

07 Feb 2016: 60° 18'S 46° 31'W, 2381 Nm, F4 NW, sea Slight, air 0.0°C, sea 0.0°C, 1002 mb steady. After two nights sheltering in lee of South Orkneys and experiencing winds of up to >70 knots we left shelter this morning to return to work. Encountered large krill aggregation with many feeding penguins, fur seals and whales (fins and humpbacks). Organized small scale acoustic survey over aggregation. Continued to survey area until time to move to night time fishing area off the shelf break

08 Feb 2016: 60° 21'S 46° 28'W, 2486 Nm, F3 NNW, sea Slight, air 1.0°C, sea 1.0°C, 993 mb steady. Re ran large aggregation survey from dawn. Then moved to run canyon scale survey, however due to fog throughout day shortened canyon survey to finish at 1600 so that possible to relocate onto krill aggregation to undertake RMT8 net hauls and CTD with WBAT attached.

09 Feb 2016: 60° 19'S 46° 37'W, 2608 Nm, F1 variable, sea Slight, air 1.0°C, sea 0.5°C, 978 mb falling. Still foggy but successful fishing last night. Undertook CTD casts at central stations along T024 and T027. Acoustics over large aggregation carried out but aggregation appears as series of separate swarms rather than 1 large swarm. CTD conducted at station S050 prior to attempting rendezvous with Saga Sea to undertake 2 ship work. No obvious aggregations found and leave Saga Sea to allow her to find good swarms while we undertake RMT station overnight.

10 Feb 2016: 60° 17'S 46° 57'W, 2748 Nm, F3 SW, sea Slight, air 1.0°C, sea 0.5°C, 968 mb steady. Start Fine Scale Fishing Survey at dawn as Saga Sea has started Norwegian Large Scale Survey. In afternoon rendezvous with Saga Sea for transfer of mooring battery and then with Shackleton who were on way from Halley to Stanley. Overnight we attempt CTD and RMT25 station on shelf-break, however, deteriorating weather with winds > 40 knots means that we have to abandon the station after the CTD and ship goes onto DP to wait for the wind and swell to go down.

11 Feb 2016: 60° 23’S 46° 46’W, 2808 Nm, F7 SW, sea Rough, air 0.0°C, sea 0.5°C, 967 mb rising. JCR remains on DP until conditions improve enough after lunch to continue with the Fine Scale Fishing Survey. Continue with this survey through afternoon and night.

12 Feb 2016: 60° 24’S 46° 18’W, 2977 Nm, F3 SW, sea Moderate, air 1.0°C, sea 1.0°C, 971 mb falling. Break off fisheries fine scale survey prior to dawn to steam over to large canyon to recover moorings. Mooring at southeast end of canyon released just after 06:00 and all equipment onboard and secure by 07:15. Mooring at northeast end of canyon released at 08:14 and all onboard by 08:55. Norwegian mooring detected on EK60 at 10:50 and once released a boat lowered to lasso the buoy. Mooring on deck at 12:00 and ship relocates to survey fisheries fine scale transects T038-T044.

13 Feb 2016: 60° 36’S 46° 03’W, 3155 Nm, F4 W, sea Moderate, air 1.0°C, sea 0.5°C, 983 mb rising. Surveyed large canyon prior to preparing to go into Monroe to retrieve field party. Swell and wind dropping steadily and sun shines in a brilliant blue sky as we sit anchored with a view of grounded icebergs and but it isn’t until 17:00 that conditions are suitable for the Humbers to go in. Only 2 scientists required to help in boats so many people just watching and enjoying both views and the sunny weather. Uplift of Trathan and Thomas undertaken rapidly and ship steamed out of anchorage at 19:30. Relocated to shelf break just beyond large canyon to undertake an RMT25 haul.

14 Feb 2016: 60° 29’S 46° 35’W, 3293 Nm, F7 SE, sea Slight, air 0.0°C, sea 0.5°C, 973 falling. Repeated large canyon runs and shelf aggregation runs looking to identify aggregations suitable for daytime target fishing. Found the large aggregation again and undertaken some runs across so that ready to fish, deploy WBAT and stereo camera overnight.

15 Feb 2016: 60° 36’S 44° 58’W, 3441 Nm, F5 SW, sea Slight, air -2°C, sea 0.5°C, 981 mb steady. Aggregation survey started at 03:30 with predator observations starting when sufficient light (04:30). Departed aggregation for Powell island at 07:00, arrived at Powell at 13:00 with brilliant sunshine but cold wind. Cargo tender deployed to pick up Chevalier, Lowther and Staniland. All safely onboard by 16:30 and ship departs for Signy. Arrived off Signy at 20:00.,

16 Feb 2016: 60° 49’S 45° 29’W, 3495 Nm, F4 E, sea Slight, air 2°C, sea 0.5°C, 966 mb falling. Early start as cargo tender launched by 05:00 and 12 scientists on tender to help with cargo shoreside. Rendezvous with Saga Sea to transfer acoustic buoy to them. Cargo tender unloading hampered by building wind and 50 knot gusts when scientists reboarding required good boat handling and nimble hands and feet on the pilot ladder. Three from Signy now joined us (Ratcliffe, Scott and Lalung). Lull in weather around 11:00 tempted us to steam around and through Washington Strait to start a CTD transect at the most easterly canyon. However the weather out beyond the shelter of Coronation was already at the limit for CTD’s and the decision was made to return to shelter near Signy.

17 Feb 2016: 60° 43’S 45° 33’W, 3582 Nm, F6 W, sea Slight, air -1.0°C, sea 0.5°C, 977 mb rising. Peak wind overnight was 78 knots. Saga Sea and Antarctic Sea also sheltering close by this morning. Predicted winds for next week strong to very strong so decision made after lunch to forego any more fishing around Signy and to head straight for the Polar Front. Leave Signy at 18:30.

18 Feb 2016: 58° 39’S 49° 15’W, 3767 Nm, F6 WNW, sea Moderate, air 4.0°C, sea 2.0°C, 996 mb rising. Crossed out of Antarctic (60° S) at 03:21. Making good progress towards Polar Front, expected

ETA there around midnight tonight. Passed a warm water eddy in the afternoon but bright to sample with RMT8. Polar Front sampling started at 22:00 with RMT8s at an acoustic layer.

19 Feb 2016: 56° 38'S 52° 06'W, 3950 Nm, F3 N, sea Slight, air 2.0°C, sea 3.0°C, 1007 mb steady. Three RMT8's carried out overnight followed by WBAT on CTD in layer. Final overside event of the cruise was a CTD to determine the water mass structure at the front. Station finished at 08:00 and ship proceeded on transit to Mare Harbour. An ADCP calibration has been planned for the Falkland Shelf prior to entering Mare Harbour on Sunday afternoon.

20 Feb 2016: 53° 48'S 55° 51'W, 4164 Nm, F7 NNE, sea Moderate, air 8.0°C, sea 6.0°C, 987 mb steady. Fire and boat drill at 10:30. Science team writing and packing. Quiz night in evening in bar.

21 Feb 2016: 51° 58'S 58° 08'W, 4386 Nm, F7 NNE, sea Slight, air 15.0°C, sea 10.0°C, 997 mb rising. ADCP calibration runs over shelf during hours of darkness. Frantic packing ongoing to maximize use of fair weather which is due to end tomorrow. Ship enters Mare Harbour for 14:00 pilot pickup. Containers arrive just before cruise buffet dinner in evening.

22 Feb 2016: Mare Harbour. Containers loaded. Labs cleaned and handed over. Kitbags packed.

23 Feb 2016: 07:30 start for those travelling back to UK. Team arrive UK on 24 Feb.

2.6 Personnel

Table 2-1: Scientific personnel

Name	Job	Affiliation	Email
Jon Watkins	PSO, Krill Ecology	BAS	jlwa@bas.ac.uk
Daniel Ashurst	AME Support	BAS	danash@bas.ac.uk
Tracy Dornan	Acoustics/e-DNA	BAS	Tarna70@bas.ac.uk
Peter Enderlein	Gear Engineer	BAS	pend@bas.ac.uk
Sophie Fielding	Acoustics/Krill	BAS	sof@bas.ac.uk
Olav Rune Godø	Acoustics/Krill	Institute of Marine Research, Bergen	olav.rune.godoe@imr.no
John Horne	Acoustics	Univ. of Washington	jhorne@uw.edu
Rokas Kubilius	Research scientist	Institute of Marine Research/ METAS AS, Bergen	rokas.kubilius@imr.no/ rokask@metas.no
Carson Mcafee	AME Support	BAS	carmca@bas.ac.uk
Mark Preston	AME Support	BAS	mopr@bas.ac.uk
Christian Reiss	Oceanography and Krill Ecology	US AMLR, La Jolla	christian.reiss@noaa.gov
Jeremy Robst	ICT Support	BAS	jpro@bas.ac.uk
Ryan Saunders	Fish Ecology	BAS	ryaund@bas.ac.uk
Jose Seco	Predator Ecology	Univ. of Coimba, Portugal	joses.seco@gmail.com
Gabriele Stowasser	Marine Ecology	BAS	gsto@bas.ac.uk
Jenny Thomas	Data Manager	BAS	jenoma@bas.ac.uk
Claire Waluda	Predator Ecology	BAS	clwa@bas.ac.uk
Jose Xavier	Predator Ecology	Univ. of Coimba, Portugal	jxavier@zoo.uc.pt

Table 2-2: Personnel joining ship towards end of cruise

Name	Affiliation	Origin
Catrin Thomas	BAS	Munroe Island
Phil Trathan	BAS	Munroe Island
Gabriel Chevalier	BAS	Powell Island
Andy Lowther	National Polar Institute, Tromso	Powell Island
Iain Staniland	BAS	Powell Island
Japereng Lalung	Universiti Sains Malaysia	Signy
Norman Ratcliffe	BAS	Signy
James Scott	BAS	Signy

Table 2-3: Ship's personnel on JR15004

Name	Position
Ralph Stevens	Master
Timothy Page	Chief Officer
Carola Rackete	2nd Officer
Wave Crookes	3rd Officer
Huw Seddon	Extra 3rd Officer
Michael Glostein	ETO Comms
Neil MacDonald	Chief Engineer
Gert Behrmann	2nd Engineer
Christopher Mannion	3rd Engineer
Marc Laughlan	4th Engineer
Craig Thomas	Deck Engineer
Stephen Amner	ETO
Richard Turner	Purser
David Peck	Bosun/Sci Ops
Martin Bowen	Bosun
George Dale	Bosun's Mate
Samuel English	SG1A
Francisco Hernandez	SG1A
Alan Howard	SG1A
Sheldon Smith	SG1A
Graham Waylett	SG1A
Ian Herbert	MG1
Gareth Wale	MG1
John Pratt	Chief Cook
Brian Robertson	2nd Cook
Lee Jones	Snr Steward
Nicholas Greenwood	Steward
Graham Raworth	Steward
Rodney Morton	Steward

3 Physical oceanography

3.1 Vessel-mounted Acoustic Doppler Current Profiler (ADCP)

No ADCP data processing was accomplished during the cruise although raw speed and direction data were examined to ensure that high quality data were collected. Below the basic elements of the instrumentation and the data collection procedures are documented.

3.1.1 Instrumentation

The JCR is equipped with a hull mounted 75 kHz RD Instruments Ocean Surveyor (OS75) ADCP that is mounted in the sea chest. Accounting for the distance of the transducer from the polycarbonate window, and the thickness of the window, the hull depth of the ADCP transducers is estimated as 6,3m. In contrast to the RDI recommended alignment of the ADCP relative to the ships centre line, the OS75 is mounted at approximately 60 degrees, and this offset is recorded in the setup files for the ADCP.

Owing to the other acoustic instruments (EK 60, EA600; the SWATH) being concurrently run during this cruise, the ADCP ping rate was controlled by the SSU. For this cruise the EK60 was set as master through the SSU and both EA600 (a single beam echosounder) and OS75 were set as slaves, pinging in multiple ping rates of 2 seconds. On occasions when the swath was running during the cruise, the swath was pinged by the SSU in a separate group within the SSU, and the EK60/ADCP pinged multiple times in a different group. As usual, the Seapath GPS unit was used to provide a heading feed to the OS75, rather than the more traditional use of the gyrocompass with correction to GPS heading (from Ashtech).

3.1.2 Configuration

RDI VMDAS (V1.42) was used to control and monitor the OS75. Synchronization of the ADCP to the other acoustic instruments was accomplished through the SSU with a 2 second ping rate. When the ADCP is used in bottom track mode it is not synchronised through the SSU and so interference occurs in the EK60, and so the ADCP was run in this BT mode when other acoustic data was not required.

For most of the cruise the ADCP was run in narrow band mode, with 100, 8 meter bins, to 800 meters. The blanking distance was set to 8 meters. Salinity at the transducer was set to zero, and Beam 3 misalignment was set to 60.08 degrees (see above discussion). Full configuration files for each mode used are given at the end of this section.

3.1.3 Outputs

The ADCP writes files to a network drive that is samba-mounted from the Unix system. The raw data (.ENR and .N1R) are also written to the local PC hard drive. For use in the matlab scripts the raw data saved to the PC would have to be run through the VMDas software again to create the .ENX files. When the Unix system is accessed (via samba) from a separate networked PC, this enables post-processing of the data without the need to move files.

Output files are of the form JR15004_XXX_YYYYYY.ZZZ, where XXX increments each time the logging is stopped and restarted, and YYYYYY increments each time the present filesize exceeds 10 Mbyte. ZZZ are the filename extensions, and are of the form:

- .N1R (NMEA telegram + ADCP timestamp; ASCII)
- .ENR (Beam co-ordinate single-ping data; binary). These two are the raw data, saved to both disks
- .VMO (VmDas configuration; ASCII)
- .NMS (Navigation and attitude; binary)
- .ENS (Beam co-ordinate single-ping data + NMEA data; binary)
- .LOG (Log of ADCP communication and VmDas error; ASCII)
- .ENX (Earth co-ordinate single-ping data; binary). This is read by matlab processing
- .STA (Earth co-ordinate short-term averaged data; binary)
- .LTA (Earth co-ordinate long-term averaged data; binary).

Although calibration was attempted using water tracking and bottom tracking no good calibration was accomplished using the data collected during the survey. However, much data that could be useful for calibrating remains within the dataset, and more effort is required to properly calibrate the ADCP. Ensembles 33-36, 53-55, 63, and ensembles collected during the small scale slope survey would be the best to use for calibration. Matlab based calibration routines were provided by Hugh Venables (BAS).

3.2 Moored Acoustic Doppler Current Profiler (ADCP)

Owing to issues regarding the mounting positions of the moored Long Ranger ADCPs, no useful current data was collected. Please see Mooring Instrumentation section for details.

3.3 CTD

3.3.1 Introduction

A SBE Model 9+11 Conductivity-Temperature-Depth (CTD) unit was used to vertically profile the water column. 41 casts were carried out in total, over the course of the survey. Six stations were sampled to relate to the MAMMOTH Transects, and two transects were conducted across the large canyon to describe hydrographic conditions in that area. Two of these transect stations were resampled during the cruise to characterize the hydrographic variability following a moderate gale. The CTD was operated by Carson MaCafee and Mark Preston

3.3.2 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 SBE4C conductivity sensors and dual SBE5T submersible pumps. 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.

An altimeter attached to the CTD was used to indicate the instruments height off the seabed beginning 100m off the bottom. In general, the CTD was lowered to within 10m of the bottom or 1000m. The CTD was equipped with a fin to reduce rotation of the CTD package during deployment.

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.). The data were viewed in realtime in order to determine the depth of the fluorescence (chlorophyll-a) maximum, which was sampled for a variety of biological studies. The typical deployment of the CTD was to start data logging, deploy the CTD, then stop the instrument at 10m wireout, 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 upcast, 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

3.3.3 CTD sensor calibrations

Details of the calibrations of sensors on the CTD can be found in section 15.3. Importantly, however, approximately half way through the survey the primary conductivity unit was replaced owing to spurious data. The glass pump tube connection was found to have broken.

3.3.4 Data acquisition and processing

The CTD data were recorded using Seasave, version 7.22.3, and run through the SVP script. In addition to sending the data to the UK Meteorological Office (as of November 2014, following a note from Tim Smyth (PML) – PSO on JR303), it creates the following four files:

- *JR15004_NNN.hex* binary data file
- *JR15004_NNN.XMLCON* ascii configuration file with calibration information
- *JR15004_NNN.hdr* ascii header file containing sensor information
- *JR15004_NNN.bl* ascii file containing bottle fire information

where NNN is the 3-digit CTD event number. The *.hex* file was then converted from binary to ASCII using the SBE Data Processing software *Data Conversion* module. Three files are output:

- *JR15004_NNNmet.cnv* data file with header information
- *JR15004_NNNmet.ros* data file associated to bottle firing with header information
- *JR15004_NNNsvp.asc* ascii data file

The *Data Conversion* module calculates parameters using the coefficients detailed in the calibration documentation (section 15.3) and the raw XMLCON files (stored at the British Antarctic Survey in /data/cruise/jcr/20160113/ctd/JR15004) as follows. Data were processed using Seabird processing scripts in the following order:

- DATCNV – data conversions form binary to engineering units
- ALIGNCTD – Aligns instruments based on their response characteristics in order to eliminate salinity spiking
- FILTER --- filters data to reduce high frequency variability
- LOOPEDIT – removes looping that occurs from the motion of waves

- CELLTM - additional adjustment for the thermal mass of instruments
- DERIVE --- for dissolved oxygen only
- BINAVG – bin average data into 1m depth bins
- DERIVE-- Potential temperature, Salinity, Potential density, Sigma –theta
- SPLIT – Split and save upcast and downcast files.
- BOTSUM – Generate Summary data files for the bottles fired ar each depth

Bottles were tripped at 18 of the 46 stations. No water was collected for salinity calibrations, so no salinity drift was examined over the cruise period.

3.3.5 Code and files

The data were then run through a matlab script to generate datafiles for input into Ocean Data View for visualization, and into EXCEL files for distribution to other biological groups requiring data.

The processed data will be transferred to the British Oceanographic Data Centre along with the raw data and cruise report.

3.3.6 CTD casts

A total of forty six CTD casts were made over the cruise period. Water was collected for a variety of biological and chemical analyses at 18. One CTD cast was aborted owing to the broken tube connection (Table 3-1).

Table 3-1: List of CTD casts conducted during JR15004. Bottles were tripped at 850, 500, 200, 100, 30, 20, 5 meters and at the chlorophyll-a maximum as seen on the fluorescence trace

Station	Event Number	Time and Date In	Longitude	Latitude	Maximum Depth (m)	Water Depth (m)	Water Samples	Comment	Operator
S002	3	16:35:00 22/01/2016	-53.57	-54.76	1000	4222	Yes		MP
S003	8	16:52:00 24/01/2016	-44.71	-60.75		48	No		CM
S004	13	13:54:00 26/01/2016	-47.51	-59.50	850	3989	Yes		CM
S005	16	21:53:00 26/01/2016	-47.50	-60.00	1000	3536	Yes		CM
S006	18	03:09:00 27/01/2016	-47.50	-60.50	1000	823	Yes		CM
S007	20	08:33:00 27/01/2016	-47.50	-61.00	1000	2371	Yes		CM
S008	22	14:14:00 27/01/2016	-47.50	-61.50	1000	2552	Yes		MP
S009	25	20:53:00 27/01/2016	-47.50	-62.00	1000	2811	Yes		CM
S014	35	21:12:00 30/01/2016	-47.25	-60.50	479	494	No		CM
S016	37	09:07:46 31/01/2016	-46.46	-60.48	145	150	No		MP
S017	38	09:41:00 31/01/2016	-46.51	-60.48	360	376	No		CM
S018	39	10:22:00 31/01/2016	-46.55	-60.48	726	739	Yes		CM
S019	40	11:44:00 31/01/2016	-46.59	-60.48	560	570	No		CM
S020	41	12:43:00 31/01/2016	-46.64	-60.48	174.7	181	No		CM
S021	42	15:00:00 31/01/2016	-46.48	-60.38		769	No		CM
S022	43	16:15:00 31/01/2016	-46.52	-60.38	589	557	No		CM
S023	44	17:22:00 31/01/2016	-46.56	-60.38	412	432	No		CM
S024	45	18:22:00 31/01/2016	-46.61	-60.38	440	458	No		CM
S025	46	19:24:00 31/01/2016	-46.65	-60.38	358	372	Yes		CM
S026	47	20:13:00 31/01/2016	-46.70	-60.38	249	262	No		CM
S027	48	20:56:00 31/01/2016	-46.74	-60.38	363	380	No		CM
S028	49	02:53:00 01/02/2016	-47.49	-60.67		182	No	WBAT attached.	CM
S032	52	22:34:00 01/02/2016	-46.83	-60.30		712	Yes	WBAT attached.	CM
S035	58	14:16:00 02/02/2016	-47.49	-60.67	1000	1083	No		CM
S036	59	20:18:00 02/02/2016	-47.25	-60.00	1001.6	3312	Yes		CM
S037	62	09:09:00 03/02/2016	-47.25	-60.33	1002.1	2422	Yes		CM
S038	63	13:26:00 03/02/2016	-47.25	-60.80	1000.6	1609	Yes		CM
S039	64	21:03:00 03/02/2016	-46.65	-60.00	1000.6	3095	Yes		CM
S040	67	08:27:00 04/02/2016	-46.65	-60.29	1002.4	2891	Yes		CM
S041	68	18:22:00 04/02/2016	-46.08	-60.24		2246	No	**Cast cancelled. Problem with conductivity.**	CM

S041	70	19:54:00 04/02/2016	-46.04	-60.25	20		No	**Conductivity Sensor Replaced.**	CM
S042	71	21:37:00 04/02/2016	-46.08	-60.12	1102	3807	Yes		CM
S043	74	16:54:00 05/02/2016	-45.00	-60.55	379.8	402	No		CM
S044	75	19:11:00 05/02/2016	-45.00	-60.40	1003.4	1955	No		CM
S045	76	21:16:00 05/02/2016	-45.00	-60.27	1004	3367	Yes		CM
S046	78	21:18:00 07/02/2016	-46.42	-60.32	75	2694	No	WBAT attached.	CM
S047	80	00:16:00 08/02/2016	-46.56	-60.29	126.8	2896	No	WBAT attached.	CM
S018	87	08:09:00 09/02/2016	-46.55	-60.48		736	No		MP
S024	88	09:54:00 09/02/2016	-46.62	-60.38		448	No		MP
S050	89	14:58:00 09/02/2016	-46.62	-60.32	1000	2252	No		MP
S051	90	21:20:00 09/02/2016	-46.23	-60.28	999.4	2781	Yes		CM
S052	92	22:41:21 10/02/2016	-46.65	-60.35	812.5	815	Yes		CM
S054	98	21:37:00 14/02/2016	-46.46	-60.31	25	2796	Yes	WBAT attached.	MP
	100	00:10:00 15/02/2016	-46.43	-60.31	75.6	2720	Yes	WBAT attached.	CM
	107	08:16:00 19/02/2016	-51.35	-57.00	100	4156	No		CM
	108	09:57:00 19/02/2016	-51.36	-56.59	1500	4195	No		CM

3.4 Water sampling

3.4.1 Chlorophyll-*a*.

Chlorophyll-*a* samples were taken at 14 stations for calibration to the CTD fluorometer (Figure 3-1). 100ml water samples were filtered through 25mm Whatmann GFF glass fibre filters. Samples were taken at 200, 100, 50, the chlorophyll-*a* maximum and at 5m depth. At the first three stations, triplicate samples at each depth taken. At remaining stations a single chlorophyll-*a* determination at each depth was made. Filters were placed in 90% acetone, kept refrigerated (4°C) in the dark for 24 hours, then warmed to 20 °C, before determining the fluorescence using a TD-700 laboratory fluorometer. Owing to a laboratory error, about 30 samples were eliminated from the sample chain. A total of 60 samples were processed from 10 stations. Owing to the laboratory error determinations were not made at all stations.

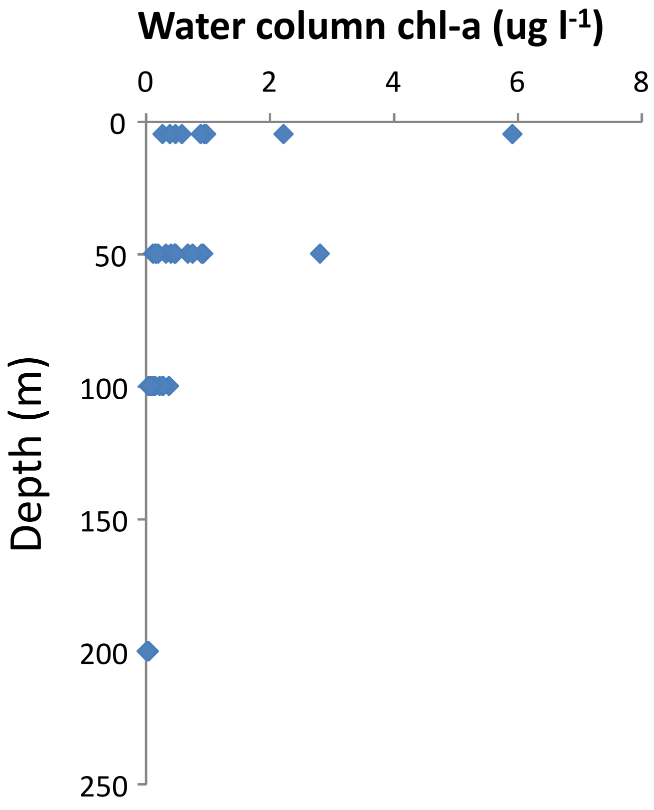


Figure 3-1: Chlorophyll-a concentration from water samples collected at standard depths (200, 100, 50, 5 meters) during cruise JR15004. Chlorophyll-a varied significantly across stations and sampled areas

4 Net sampling

4.1 Zooplankton sampling

4.1.1 Mammoth net

The mammoth net is a multinet 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. 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.

Deployments were conducted at 6 stations along a North-South transect to the West of the South Orkneys (Table 4-1). The net was paid out at 40 m/min and hauled in at 20 m/min. Set depths (m) were: 750-650, 650-550, 550-450, 450-350, 350-250, 250-150, 150-75, 75-25, 25-5. This division of depths was to maximise resolution in the surface layers and overlap with the depths chosen for POM sampling.

There were no issues in firing and the net performed as expected in all deployments. However the vertical deployment of the net does not allow for enough water to be filtered through the nets and therefore catches were very small. It is recommended in future to tow the net rather than deploy it vertically to allow for a bigger volume of water to be filtered and thus potentially increase the catch size.

Various zooplankton species were collected of the same depth layers POM samples were sampled from. Because sample sizes were small zooplankton species were also collected from RMT8 catches later on in the cruise (see section 4.1.2). All samples were frozen at -80°C for future HBI analysis in the laboratory in Plymouth. The remainder of catches was preserved in 4% buffered formalin.

Table 4-1: Zooplankton samples collected from Mammoth nets. Latitude and longitude are given in decimal degrees

Event	Latitude	Longitude	Species sampled
15	-59.5016	-47.50757	*Salpa thompsoni* *Themisto gaudichaudii* *Thysanoessa* sp. *Tomopteris* sp. Calyptopes larvae of *E. superba*
17	-59.9995	-47.50018	*Vibilia* sp. *Euphausia triacantha* *Thysanoessa* sp.
19	-60.5001	-47.50052	No samples taken
21	-60.9995	-47.50071	*Thysanoessa* sp. *Spongiobranchia* sp. *Primno macropa*
23	-61.4975	-47.49593	*Euphausia superba* *Salpa thompsoni*
26	-61.9999	-47.49969	No samples taken

4.1.2 RMT8

Gabriele Stowasser, Claire Waluda, Ryan Saunders, José Seco, José Xavier, Sophie Fielding, Tracey Dornan, John Horne, Peter Enderlein, Dan Ashurst

The RMT8 was used to characterise the krill (*Euphausia superba*) and macrozooplankton community in the South Orkney region (Table 4-2). Target trawls were undertaken on krill swarms and other layers of interest identified from the EK60/EK80. Target hauls were made to supply the fishing team with krill for length frequency measurements and krill and macrozooplankton for various studies within BAS and collaborating institutes. Krill was sampled for preservation for genetic studies (Will Goodall-Copestake, BAS), the development of ageing techniques (Christian Reiss, NOAA), microplastic studies (Claire Waluda, BAS), contaminant and trophic ecology studies (José Seco and José Xavier, University of Coimbra, University of Aveiro and University of St. Andrews) and HBI (Highly-branched isoprenoids) analysis (Gabriele Stowasser, BAS). Macrozooplankton species were also collected for microplastic (Claire Waluda, BAS), HBI (Gabriele Stowasser, BAS) and contaminant studies (José Seco and José Xavier). Amphipod specimens were collected for phylogenetic analyses (Hyperiidea) and population genetic studies (*Themisto gaudichaudii*) and preserved in 96% Ethanol, in collaboration with Charlotte Havermans (Alfred Wegener Institut, Germany).

4.1.2.1 RMT8 Catch sorting and processing

Each RMT8 catch was sorted and quantified. In hauls, where sufficient numbers of *E. superba* were caught, length-frequency data was collected (see section 4.2). 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 by Morris et al. (1988). In targeted layers other than krill swarms length-frequency data was also collected for smaller euphausiid species (*Thysanoessa* spp. and *Euphausia frigida*) in order to verify target strength. Krill and macrozooplankton species collected for various projects associated with this cruise are listed in Table 4-2 and Table 4-3.

Table 4-2: RMT8 hauls carried out on cruise JR15004

Event No	Start time (GMT)	End time (GMT)	Net	Start Latitude	Start Longitude	End Latitude	End Longitude	Mean Net depth	Mean water depth
54	02/02/2016 01:06	02/02/2016 01:07	Net 1	-60.3117	-46.8480	-60.3124	-46.8483	44	650
54	02/02/2016 01:09	02/02/2016 01:10	Net 2	-60.3131	-46.8488	-60.3141	-46.8495	30	648
56	02/02/2016 04:12	02/02/2016 04:14	Net 1	-60.2972	-46.8486	-60.2985	-46.8492	46	1031
56	02/02/2016 04:15	02/02/2016 04:16	Net 2	-60.2991	-46.8493	-60.3002	-46.8492	43	890
77	07/02/2016 20:30	07/02/2016 20:44	Net 1	-60.3278	-46.3915	-60.3239	-46.4008	104	2641
77	07/02/2016 20:46	07/02/2016 20:56	Net 2	-60.3235	-46.4020	-60.3210	-46.4087	102	2666
79	07/02/2016 23:44	07/02/2016 23:46	Net 1	-60.2925	-46.5481	-60.2920	-46.5496	56	2895
79	07/02/2016 23:47	07/02/2016 23:48	Net 2	-60.2917	-46.5501	-60.2912	-46.5514	49	2895
82	08/02/2016 03:46	08/02/2016 03:56	Net 1	-60.3158	-46.4933	-60.3133	-46.5003	63	2646
82	08/02/2016 04:00	08/02/2016 04:07	Net 2	-60.3120	-46.5027	-60.3094	-46.5084	16	2715
84	09/02/2016 00:05	09/02/2016 00:16	Net 1	-60.5800	-46.5229	-60.5745	-46.5331	64	331
84	09/02/2016 00:17	09/02/2016 00:28	Net 2	-60.5743	-46.5334	-60.5694	-46.5418	38	255
85	09/02/2016 01:56	09/02/2016 02:06	Net 1	-60.5451	-46.5735	-60.5386	-46.5779	49	193
85	09/02/2016 02:07	09/02/2016 02:17	Net 2	-60.5379	-46.5787	-60.5310	-46.5846	35	189
86	09/02/2016 03:24	09/02/2016 03:34	Net 1	-60.5377	-46.5385	-60.5335	-46.5449	50	773
86	09/02/2016 03:41	09/02/2016 03:52	Net 2	-60.5311	-46.5481	-60.5274	-46.5527	32	780
97	14/02/2016 20:39	14/02/2016 20:41	Net 1	-60.2920	-46.4525	-60.2927	-46.4522	45	2836
97	14/02/2016 20:44	14/02/2016 20:46	Net 2	-60.2936	-46.4523	-60.2945	-46.4515	26	2831
99	14/02/2016 23:44	14/02/2016 23:46	Net 1	-60.3090	-46.4245	-60.3097	-46.4247	52	2769
99	14/02/2016 23:48	14/02/2016 23:50	Net 2	-60.3106	-46.4248	-60.3111	-46.4247	28	2758
102	15/02/2016 03:18	15/02/2016 03:19	Net 1	-60.2950	-46.4337	-60.2956	-46.4344	46	2817
102	15/02/2016 03:22	15/02/2016 03:24	Net 2	-60.2967	-46.4353	-60.2974	-46.4358	25	2813
104	19/02/2016 01:37	19/02/2016 02:08	Net 1	-57.0289	-51.5825	-57.0251	-51.6189	262	4178
104	19/02/2016 02:13	19/02/2016 02:43	Net 2	-57.0244	-51.6242	-57.0170	-51.6620	208	4117
105	19/02/2016 04:28	19/02/2016 04:48	Net 1	-57.0464	-51.5082	-57.0363	-51.5303	257	3801
105	19/02/2016 04:53	19/02/2016 05:24	Net 2	-57.0338	-51.5358	-57.0179	-51.5701	209	3883
106	19/02/2016 06:36	19/02/2016 07:06	Net 1	-57.0488	-51.4983	-57.0323	-51.5295	224	3805
106	19/02/2016 07:07	19/02/2016 07:37	Net 2	-57.0319	-51.5304	-57.0161	-51.5598	201	3900

Table 4-3: Krill and macrozooplankton species sampled and preserved for various projects from RMT8 hauls during cruise JR15004

Project (PI)	Species	Event-Net	Number of specimens sampled	Storage
Krill and salp genetics (Will Goodall-Copestake)	*Euphausia superba*	54-2	50	-80°C
	Euphausia superba	79-2	50	-80°C
	Euphausia superba	97-1	50	-80°C
	Euphausia superba	99-1	50	-80°C
	Salpa spp.	104-1	23	-80°C
Krill ageing studies (Christian Reiss)	*Euphausia superba*	54-2	40	-80°C
	Euphausia superba	56-1	40	-80°C
	Euphausia superba	79-1	40	-80°C
	Euphausia superba	85-2	40	-80°C
	Euphausia superba	97-1	40	-80°C
	Euphausia superba	79-1	10	Ethanol
	Euphausia superba	84-1	10	Ethanol
	Euphausia superba	97-1	12	Ethanol
	Euphausia superba	99-1	10	Ethanol
Microplastics (Claire Waluda)	*Euphausia superba*	54-2	20	-80°C
	Euphausia superba	56-1	20	-80°C
	Euphausia superba	79-1	20	-80°C
	Euphausia superba	97-1	20	-80°C
	Euphausia superba	99-1	20	-80°C
	Var. zooplankton species	82-1	129	-80°C
	Var. zooplankton species	82-2	10	-80°C
	Var. zooplankton species	85-2	20	-80°C
	Var. zooplankton species	86-2	6	-80°C
	Var. zooplankton species	97-1	20	-80°C
	Var. zooplankton species	99-1	20	-80°C
	Icefish larvae	102-1	15	-80°C
HBI analysis (Gabriele Stowasser)	*Euphausia superba*	54-2	20	-80°C
	Euphausia superba	56-1	20	-80°C
	Euphausia superba	79-1	20	-80°C
	Euphausia superba	85-2	20	-80°C
	Euphausia superba	97-1	20	-80°C
	Euphausia superba	99-1	20	-80°C
	Salpa thompsoni	56-1	30	-80°C
	Thysanoessa spp.	77-1	20	-80°C
	Themisto gaudichaudii	84-1	9	-80°C
	Var. zooplankton species	86-2	30	-80°C
Contaminants (-20°C) and Physiology (-80°C) (José Seco and José Xavier)	*Euphausia superba*	54-2	30	-80°C
	Euphausia superba	54-2	50	-20°C
	Euphausia superba	56-1	15	-20°C
	Euphausia superba	77-2	20	-20°C
	Euphausia superba	79-1	70	-20°C

Contaminants (-20°C) and Physiology (-80°C) (José Seco and José Xavier)	*Euphausia superba*	79-2	20	-20°C
	Euphausia superba	85-2	100	-20°C
	Euphausia superba	86-2	17	-20°C
	Euphausia superba	97-1	85	-20°C
	Euphausia superba	99-1	90	-20°C
	Euphausia superba	102-2	25	-20°C
	Var. zooplankton species	56-1	81	-20°C
	Thysanoessa spp.	77-1	20	-20°C
	Euphausia frigida	84-1	15	-20°C
	Thysanoessa spp.	84-2	15	-20°C
	Themisto gaudichaudii	85-1	25	-20°C
	Themisto gaudichaudii	85-1	5	-80°C
	Themisto gaudichaudii	85-2	5	-20°C
	Var. zooplankton species	86-2	10	-80°C
	Galiteuthis glacialis	104-1	2	-80°C
	Var. zooplankton species	105-1	6	-80°C
	Metridia sp.	105-2	2	-80°C
	Var. zooplankton species	106-1	3	-80°C
Identification (Mark Belchier)	Various fish larvae	56-1	13	-20°C
	Various fish larvae	56-2	3	-20°C
Energetics (Ryan Saunders)	*C. gunnari* larvae	82-1	20	-80°C
	C. gunnari larvae	82-2	29	-80°C
	C. gunnari larvae	84-1	50	-80°C
	C. gunnari larvae	84-2	29	-80°C
	C. gunnari larvae	85-1	132	-80°C
	C. gunnari larvae	86-1	28	-80°C
	C. gunnari larvae	86-2	48	-80°C
Amphipod genetics (Charlotte Haverman)	Hyperiidea	85-2	20	Ethanol
	Hyperiidea	104-1	30	Ethanol
	Hyperiidea	104-2	7	Ethanol
	Hyperiidea	105-2	36	Ethanol

4.2 Krill sampling

Antarctic krill (*Euphausia superba*) were sampled to determine the krill length distribution from the swarms under study. RMT8 net trawls were targeted on krill swarms and krill length and maturity stage was determined from at least 100 krill where available. In addition the length of Antarctic krill was determined from other trawls targeted on non-krill targets (frequently termed the blue fuzzy layer). From these layers other krill species length distributions were also measured (both *Thysanoessa* sp and *Euphausia frigida*).

4.2.1 Methods

Krill samples were taken from RMT8 samples where there were sufficient numbers of krill to select 100 decent state specimens for length frequency and maturity. 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).

4.2.2 Data

Krill length frequency data were input into a spreadsheet now available at /data/cruise/jcr/20160113/work/scientific_work_areas/RMT8/JR15004_krill_length_frequency.xls. Krill mean lengths are summarized in Table 4-4.

Table 4-4: *Euphausia superba* length frequency from RMT8 nets with target type and mean length of krill in net

Event Number	Target type	Mean length (mm)
54_1	Krill swarm	47.41
54_2		47.43
56_1	Krill swarm	40.65
56_2		39.42
77_1	Blue layer	36.49
77_2		35.00
79_1	Krill swarm	44.17
79_2		48.15
82_2	Blue layer	35.42
84_1	Grey layer	42.58
85_1	Grey layer	43.90
85_2	Krill swarm	44.53
86_1	Blue layer	42.82
86_2		43.89
97_1	Krill swarm	52.07
99_1	Krill swarm	49.00
99_2		46.10
102_1	Krill swarm	47.12
102_2		46.15

The length frequency of *E. superba* was examined between krill found in swarms and those found in nets targeted on "blue" layers in the echosounder (Figure 4-1). Smaller krill were found in the layers compared with the krill swarms.

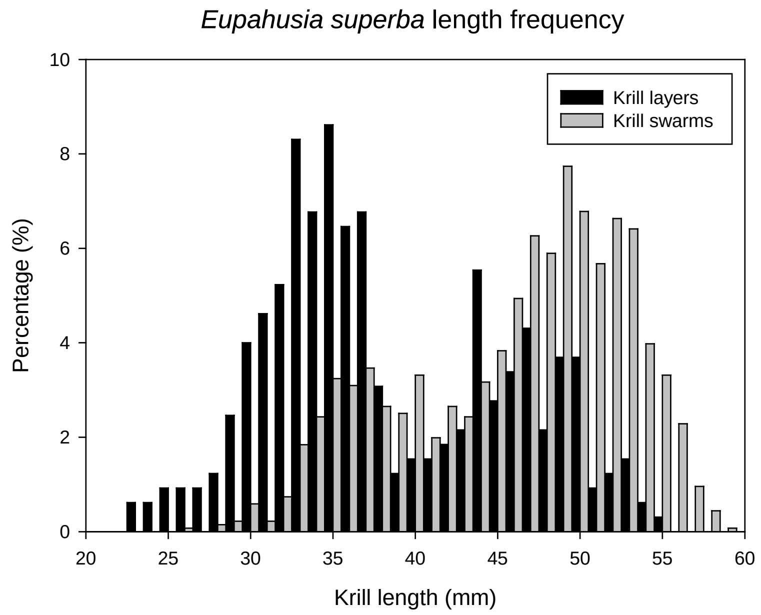


Figure 4-1: *Euphausia superba* length frequency for krill swarms and krill found in layers

A suggestion was made that there were different sizes of krill at different depths. This was examined by fishing at different depths within the same krill swarm. Figure 4-2 shows that there is no significant difference in krill length frequency.

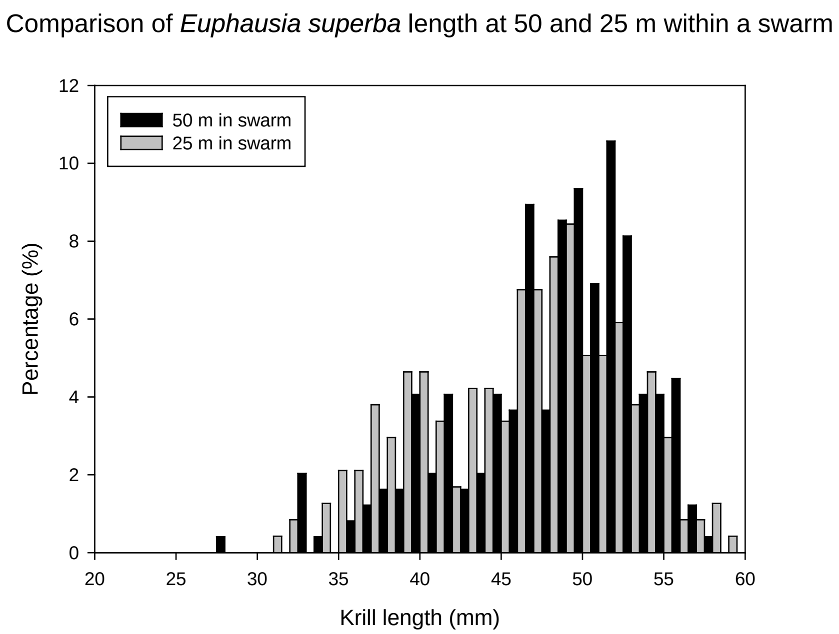


Figure 4-2: Length frequency from events 99 and 102

Finally the length frequency of *Thysanoessa* sp and *Euphausia frigida* was undertaken on all samples targeted on "blue" layers (Figure 4-3 and Figure 4-4)

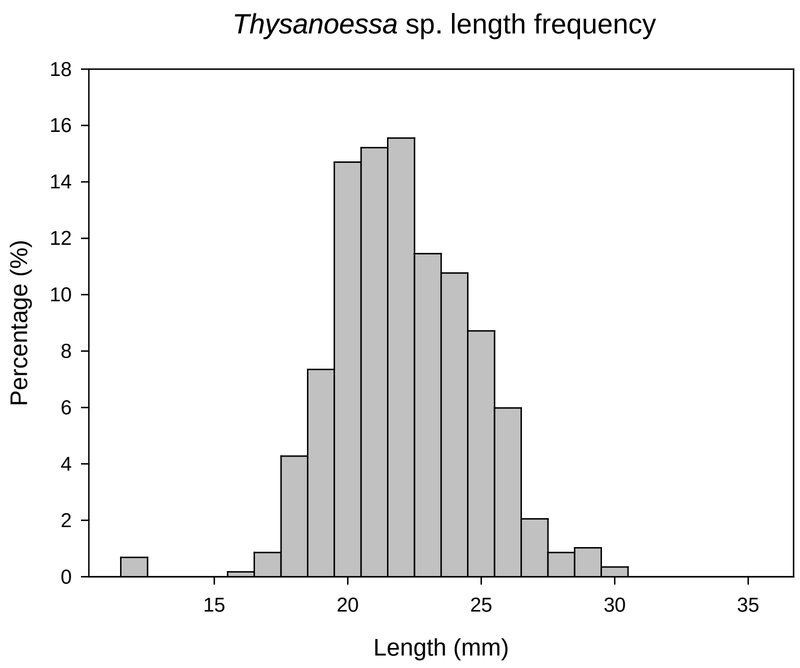


Figure 4-3: Length frequency of *Thysanoessa* sp sampled in RMT8 hauls

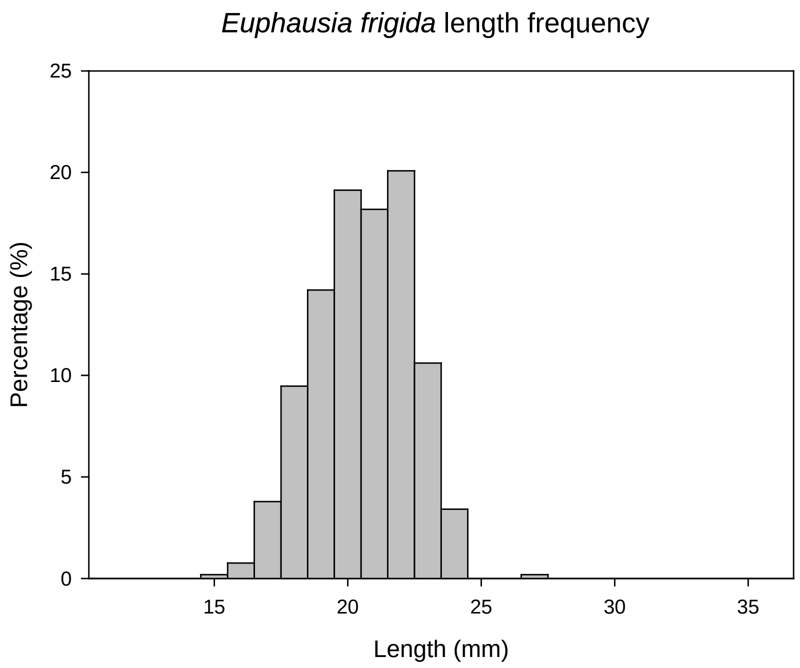


Figure 4-4: Length frequency of *Euphausia frigida* sampled in RMT8 hauls

4.3 Fish and macrozooplankton

Ryan Saunders, Gabriele Stowasser, Claire Waluda, José Xavier, José Seco and Tracey Dornan

4.3.1 Introduction

Mesopelagic fish and macrozooplankton are important components of the Southern Ocean ecosystem. Myctophids are the dominant mesopelagic fish of the Southern Ocean in terms of both biomass and diversity, and they play a vital role in the transfer of energy through the Southern Ocean food web. During JR15004, the mesopelagic fish community around the South Orkneys was sampled to:

- Investigate spatial and vertical patterns in community structure in oceanic and shelf-break waters between 0-1000 m, linking patterns to the underlying oceanographic conditions in the region.
- Investigate diet and population dynamics of key mesopelagic fish species around the South Orkneys.
- Investigate trace metal accumulation in key myctophid fish species and examine their role as vectors of heavy metal contaminants through the Southern Ocean food web.
- Quantify the abundance/biomass of myctophid fish targeted by land-based predators in key foraging areas to assess spatial patterns in predator/prey interactions.
- Quantify the carbon content/energy budget of the deep-dwelling mesopelagic fish community.
- Examine the swimbladder structure of key mesopelagic fish using x-rays to facilitate acoustic target strength modelling.

4.3.2 Gear

An RMT25 net was used to sample the mesopelagic fish and macrozooplankton community during the survey. Depth-discrete samples were collected in both shelf-break and off-shelf waters between 0-1000 m. In oceanic waters, the following depths zones were sampled: 1000-700, 700-400, 400-200 and 200-0 m. Only depths between 400-200 and 200-0 m were sampled in shelf-break waters where bottom depths were mostly around 500 m. All RMT25 hauls were deployed in hours of darkness (nautical sunset to nautical sunrise), with the uppermost depth strata sampled at times of maximum darkness. The RMT25 was operated via a down-wire net monitor and was equipped with a flow meter, and temperature and salinity sensors. Each depth strata was sampled for approximately 45 mins (Table 4-5).

4.3.3 Sample processing

The total weight of each RMT25 net haul was recorded. All fish specimens were first identified to species level, where possible, and then enumerated and measured using Standard Length (SL). The composite weight of each fish species (when >1 g) was recorded, and sex/maturity status was also determined using external features where possible. A random sub-sample of 10 fish per species was x-rayed and photographed for swimbladder and morphometric analysis. Also, 10 males and 10 females of key myctophid species were selected at random from off-shelf and shelf-break regions for trace metal analysis. All myctophid fish samples were frozen whole at -20 °C, whilst most deep-dwelling non-myctophid (e.g. bathylagids) fish were frozen whole at -80 °C for subsequent biochemical analysis.

Macrozooplankton samples were sub-sampled where necessary, and specimens were identified to the highest taxonomic level possible, then counted and weighed. Key species were sampled for further biochemical analyses, but the remainder was not retained.

4.3.4 Preliminary results

A total of 16 net hauls were deployed during the survey, with 12 in oceanic waters and 4 along the shelf-break (Table 4-5). The RMT25 work package was impacted substantially by weather conditions and ship winch/gantry problems, however, a sizable collection of mesopelagic fish samples was obtained for various biochemical studies. Details of the species caught during the survey are given in Table 4-6. In total, 721 fish were caught belonging to at least 15 species, with catches dominated by the myctophids *Electrona antarctica* and *Gymnoscopelus braueri* and the bathylagids *Bathylagidae* spp. The myctophid *Gymnoscopelus nicholsi* was also caught in waters along the shelf-break. It was not possible to differentiate between species for the bathylagid fish based on external morphology, and samples were retained for genetic-based studies.

Length-frequency distributions of the 3 most abundant species are illustrated in Figure 4-5. The *E. antarctica* population was predominantly unimodal (mode: ~80 mm) throughout the survey, whilst the *G. braueri* population was possibly bimodal (modes: ~90 and 115 mm). Both these species were spread throughout the water column (0-1000 m) in oceanic waters. *G. nicholsi* was caught between 0-200 m and specimens were mostly around 150 mm in size based on the available data. Consistent with previous surveys in the region (e.g. JR177), specimens less than 40 mm in size were absent from the populations of these three myctophid species. The overall size range of *Bathylagidae* spp. was between 45 and 190 mm. However, it was not possible to examine patterns in population structure due difficulties with species identification. These fish were most abundant at depths below 400 m.

The macrozooplankton component of the RMT25 net catches was mostly dominated by the salp *Salpa thompsoni*, particularly in the upper water column (0-200 m). The euphausiids *Thysanoessa macrura* and *Euphausia frigida*, the siphonore *Diphyes* spp. and chaetognaths (presumably *Sagitta maxima*) were also relatively abundant in the net catches. Small numbers of amphipods, such as *Themisto gaudichaudii* and *Cyphocaris richardi* were also found in several net catches.

Table 4-5: Summary of the RMT25 deployment details during JR15004 (see Appendix for further details from the bridge log)

Event	Date	Start time (GMT)	Start Lat	Start long	Station	Location	Net 1 depth (m)	Net 2 depth (m)
60	02/02/16	21:49	-59.9641	-47.1774	S036	Oceanic	1000-700	700-400
61	03/02/16	02:05	-59.9615	-47.1882	S036	Oceanic	400-200	200-0
65	03/02/16	22:35	-60.0345	-46.5806	S039	Oceanic	1000-700	700-400
66	04/02/16	02:14	-60.0328	-46.6157	S039	Oceanic	400-200	200-0
72	04/02/16	23:05	-60.0737	-46.0612	S042	Oceanic	1000-700	700-400
73	05/02/16	02:38	-60.1027	-46.0406	S042	Oceanic	400-200	200-0
91	09/02/16	22:45	-60.2326	-46.1921	S051	Shelf-break	1000-700	700-400
96	14/02/16	02:44	-60.3073	-46.7017		Shelf-break	400-200	200-0

Table 4-6: Summary of fish caught in RMT25 net hauls during JR15004

Species	Number	Weight (g)
Bathylagus spp.	104	1332
Benthalbella elongata	4	259
Champsocephalus aceratus	1	126
Champsocephalus aceratus larvae	2	0
Champsocephalus gunnari larvae	37	4
Cryodraco antarcticus larvae	1	0
Cyclothone spp.	28	8
Cynomacrurus piriei	1	30
Electrona antarctica	332	2042
Gymnoscopelus braueri	156	1662
Gymnoscopelus nicholsi	22	716
Gymnoscopelus opisthopterus	2	59
Notolepis annulata	4	0
Notolepis annulata larvae	3	0
Notolepis coatsi	15	16
Notolepis coatsi larvae	4	0
Paradiplospinus gracilis	3	296
Protomyctophum bolini	2	2
Total	721	6552

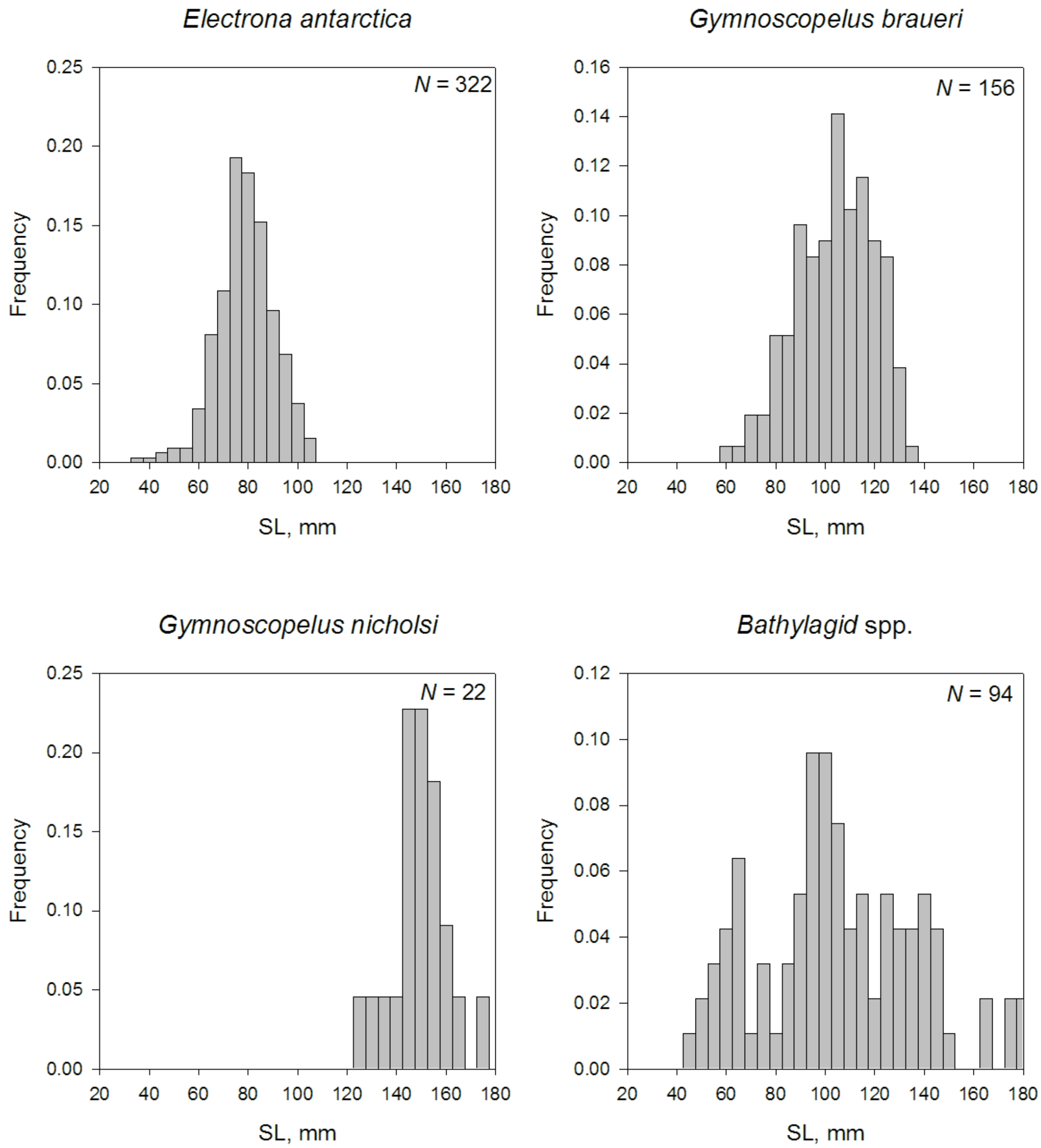


Figure 4-5: Length-frequency distributions of the most abundant mesopelagic fish caught during JR15004.

4.4 Morphometric analysis of mesopelagic fish fauna

Tracey Dornan, John Horne

4.4.1 Introduction

Fish with gas-filled swim bladders produce a stronger acoustic signal than those with lipid filled or fish without swim bladders, due to the higher acoustic impedance difference between sea water and gas. It is known that a number of mesopelagic fish species have gas-filled swim bladders, which either regress or become lipid filled with age. Other species retain gas filled bladders throughout their life history. Given the morphological diversity in mesopelagic fish, it is important to identify gas bearing mesopelagic species and to quantify the natural variability within and among species. Once the intra- and interspecific diversity is known, acoustic characteristics of the Southern Ocean mesopelagic community can be modelled to increase understanding of deep scattering layers.

4.4.2 Aims

The aim of this study was to image mesopelagic fish bodies and swim bladders using optics and radiographs to facilitate acoustic backscatter modelling and subsequent characterisation of acoustic deep scattering layers.

4.4.3 Methods

A combination of radiography and digital photography were used to image mesopelagic fish swimbladders and bodies. Fish were primarily sampled from RMT 25 stratified hauls, but were also sampled from RMT 8 stratified and targeted Polar Front hauls to include the widest number of species possible in the sample.

Initial training and x-ray procedure advice, was given to three members of the science team by the ship's doctor. The JCR surgery was then set up for fish radiography (Figure 4-6) with all work surfaces covered with disposable wipe clean sheeting. The surgery bathroom was used as a darkroom for the loading and development of film. The radiography unit used was an Ultrapower 100 from vetxrays.co.uk,positioned approximately 88cm above the film cassette cartridge. Exposure time and kVp were set for each exposure. Columnation of the exposure area was limited to one half of a 24 x 30 cm cassette. Typically 5 fish were radiographed as a group on each film. A lateral image was taken on the upper half and a dorsal image was taken on the lower half of the film.

An initial trial of the exposure and development process was conducted by John Horne and Tracey Dornan using stored frozen samples of a *Electrona antarctica* and a *Protomyctophum bolini*. These were visually inspected for edge contrast on developed film. Results indicated that a range of exposure power and time settings would produce useable images depending on the thickness of the animals being imaged. Exposure power and timing were set depending on the approximate size of the animals, with the smallest individuals exposed at 44 kVP for 0.08 seconds and the larger *Gymnoscopelus nicholsi* at 50 kVp for 0.09s.

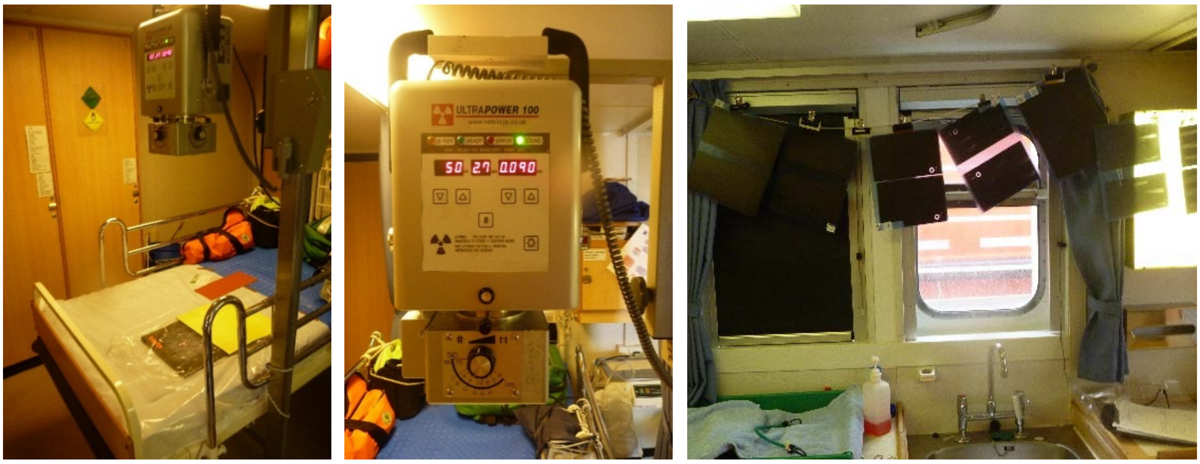


Figure 4-6: The JCR surgery was set up with work surfaces covered with disposable wipe clean sheeting and x-ray cartridge covered with zip lock bag. Radiograph unit shows setting of 50kVp and exposure time of 0.09s. Radiographs were processed in the ships darkroom during calm weather and then hung to dry over the sink

Radiograph workflow was organised as follows:

- Insert film into cassette in surgery in safelight conditions prior to fish being brought on deck. Seal filled cassette inside a plastic zip lock bag to prevent animals and water contaminating cassette.
- Prepare support wedges for dorsal exposures. Use chunks of rolled, wet paper towelling. The length and diameter of the chunks depend on fish size. Fish were propped up using paper towel chunks on opposite sides of the body.
- Prepare a numbering system: Cruise, Event, Net and X-ray number, x-rays were numbered sequentially from 1-16 on data recording sheets.
- Decide how many fish to expose on a single plate. The number of fish depends on the size of the cassette relative to the size of the fish. Lateral and dorsal exposures were taken on the same plate using lead blockers to cover unexposed area. All previously exposed areas were blocked in subsequent exposures.

4.4.3.1 Radiograph procedure:

- Fish were transferred to the surgery and placed on the cassette at the earliest opportunity after landing.
- Record all animal information and event details on a summary sheet.
- Adjust settings on x-ray machine as indicated by trial exposure. Setting of kVp and exposure time were recorded on data sheet.
- Block cassettes to cover unused or exposed sections of film. If radiographing more than one fish on a plate, make sure that EACH fish is clearly identified and that the fish order is the SAME on lateral and dorsal radiographs. To ensure that images where consistent all fish were orientated 'swimming' to the left (Figure 4-7).
- Photograph fish on cassette for later reference and identification purposes.
- Lateral exposure was completed on the top half of cassettes followed by dorsal on lower half, making sure that fish were straight and upright, with the exception of cassette 14 which was split into quadrants.

- Radiographing fish followed all H&S and standard procedures, as outlined in relevant COSHH, RA and SOP.
- Freeze fish for further analysis as required asap.
- Film was stored in a spare cassette in the darkroom for development during calm seas, with most recent film at the top. Each film was marked with an identification number and date using a sticky label on the corner of the film.
- Film was developed as soon as (i) a sufficient number were taken to minimise use of chemicals and (ii) weather permitted safe use of chemicals.

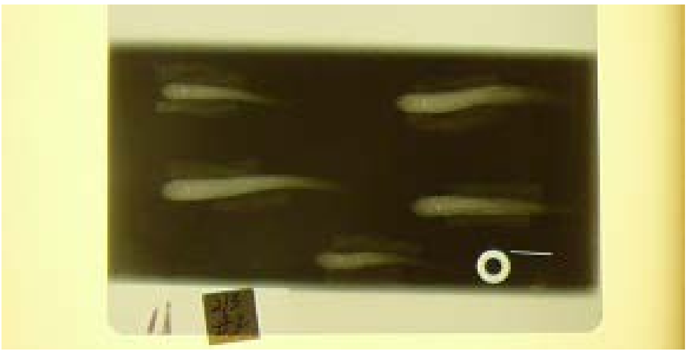


Figure 4-7: Developed dorsal x-ray of Electrona antarctica, note fish orientation head left and held in dorsal up position using damp rolled tissue. Solid white markers in bottom right corner are size reference markers, bar is 20mm

4.4.3.2 Development procedure

All solutions were prepared as per SOP. In safelight, exposed film to be processed was clipped into tweezers and:

- Submerged in 'G150 x-ray manual developer/replenisher' diluted 1:5 with warm tap water for 2 minutes 30 seconds.
- Stopped development in warm tap water filled tray for 30 seconds.
- Fixed by submerging in 'G354 x-ray manual photographic fixing concentrate' diluted 1:3 with warm tap water for 5 minutes.
- Rinsed in tap water filled tray for 30 seconds.
- Pinned up to dry.

4.4.3.3 Development dates

- Plates 1-4 02.02.2016
- Plates 5-12 17.02.2016
- Plates 13-16 22.02.2016

Table 4-7 summarizes the total numbers of fish by species, and lists the radiography settings used for each fish. Table 4-8 summarizes the 248 photographed fish for morphometric analysis.

Table 4-7: Summary of radiogrpahed fish by event, net and species

X-ray no.	Event no.	Net no.	*Electrona antarctica* n	*Electrona carlsbergi* n	*Gymnoscopelus braueri* n	*Gymnoscopelus nicholsi* n	*Protomyctophum bolini* n	Exposure	
								kV p	Time (s)
1	60	1	5					46	0.09
2	60	2	5					46	0.09
3	60	2			5			46	0.09
4	61	1			5			46	0.09
5	65	1	5					46	0.08
6	65	1	5					46	0.08
7	72	2	5					46	0.08
8	73	2	2		2		1	46	0.08
9	91	1	5					44	0.08
10	96	2				3		50	0.09
11	96	2				3		50	0.09
12	96	2	3			3		50	0.09
13	104	1					13	44	0.08
14U	104	1		2				44	0.08
14L	105	2		3				46	0.08
15	105	1		2			3	44	0.08
16	106	2	2	7			1	44	0.08
	Total n		**37**	**14**	**12**	**9**	**18**		

4.4.3.4 Digital Photography

Because initial radiographs did not contain evidence of swimbladder presence, Initial results from x-rays 1-4 showed that the majority of fish did not show obvious inclusions of gas filled swimbladders. Additional lateral and dorsal body images were obtained to aid in backscatter modelling and potential use for morphometric analysis (Figure 4-8). Measuring boards were numbered and a paper identifier was placed onto a visible portion of the board with Plate, Event and Net numbers. The resultant images were saved to a hard drive. Table 4-8 summarizes photographs by species.

Table 4-8: Photographed fish for morphometric modelling by species and event

Plate no.	Event no.	Net no.	Bathylagus spp.	Electrona antarctica	Electrona carlsbergi	Gymnoscopelus braueri	Gymnoscopelus nicholsi	Gymnoscopelus opisthopterus	Protomyctophum bolini
1	65	2				6			
2	65	2		10					
3	66	1		10					
4	66	1				5			
5	66	2				10			
6	66	2				10			
7	66	2		15					
8	72	2	10						
9	72	1	6						
10	72	1		11					
11	82	1		4					
12	91	1		5					
13	91	1		13					
14	91	1						1	
15	91	2		15					
16	91	2				1			
17	96	2					5		
18	96	2		3			4		
19	96	1				10			
20	96	1				10			
21	96	1		10					
22	96	1		10					
23	96	1		10					
24	104	1							13
25	104	1			2				
26	105	2	3	1	3	3			
27	105	1			2	2			3
28	106	2		4	7	3			1
29	106	1		2	1	3			1
Total n			**19**	**123**	**15**	**63**	**9**	**1**	**18**

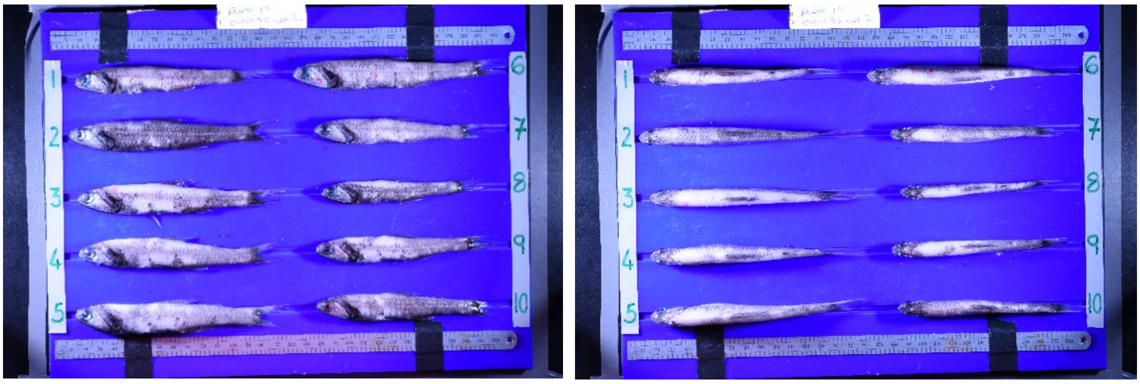


Figure 4-8: Example of *Gymnoscopelus braueri* lateral and dorsal digital images to be used for backscatter modelling

4.4.3.5 Recommendations

Fish condition deteriorates quickly after capture. Whilst fish were generally held either in cold seawater or on ice until being transferred to the surgery. Improved communications about x-ray requirements prior to fish landing regarding how fish were to be logged and managed may havereduced the time between capture and imaging. A designated ice-pack tray for x-ray bound fish would have helped maintain their condition. an ice pack prepared in a zip lock bag formed in a tray for transfer would be an effective way to maximize the cooling of fish during transport to and from surgery.

During morphometric photography some batches of images were compromised due to the movement of flash guns which resulted in shadowing; and/or changes to the settings on the camera resulting in loss of autofocus leading to blurred images. These poor quality images were not noticedue to the camera being positioned at a height which limited viewing of the viewfinder/screen. This could have been avoided if the system was set up and then not moved during the photography sessions, or if all settings were checked before each image was taken.

5 Acoustics

Sophie Fielding, John Horne, Rokas Kubilius, Peter Enderlein

5.1 Introduction

The JCR is equipped with a four frequency Simrad EK60 scientific echosounders operating at 38, 70, 120 and 200 kHz. All transducers are mounted on the hull enabling data collection through the water column while underway at speeds up to 10 knots. In September 2015, additional transceivers, Simrad EK80 WBTs, were installed in the JCR. The WBTs are the next generation echosounders, which operate in both continuous wave (CW) and/or frequency modulated (FM; i.e. wideband) transmission modes. The existing 70 and 120 kHz transducers are capable of receiving transmission pulses in both modes. With mechanical switching of transducer connections, either the EK60, the EK80, or a combination of the two types of transceiver can be used at any time.

During cruise JR15004, the EK60 and/or EK80 echosounders were operated continuously to collect information on the horizontal and vertical distribution of krill and micronekton (i.e small pelagic fish). Depending on the objective, different combinations of systems and settings were used to measure reflected energy (i.e. backscatter) from the water column. At all times, transmission rates and intervals of all actively transmitting acoustic instruments were synchronised using the K-Sync to reduce interference. EK60 transceivers were used during transits from the Falkland Islands to the South Orkney Islands. Once in the survey area, both sets of transducers were calibrated at Scotia Bay 24-25/01/2016. After calibration, the EK60 was used to map distributions and measure densities of krill following CCAMLR protocols. The EK80 transceivers were used during WBAT profiling deployments (see WBAT section for detail), and during transects or portions of transects that were repeated to collect data that will be used to compare CW to wideband data. Wideband data are expected to better resolve individual krill, which will provide measurements of acoustic size (i.e. target strengths) that are used to estimate abundance of krill aggregations.

5.2 EK60

The EK60 was operated using Simrad ER60 v. 2.4.3 software, predominantly from the PU1 PC (except when it was run in tandem with the EK80, where the old EK60 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 a range of 1100 m during transits to and from the Orkney Islands . During the meso- and fine-scale krill survey grids, data recording depths were shallower and more variable. When data collection ranges were reduced pulse transmission rates (i.e. ping rates) of the echosounders could be increased to maximize horizontal resolution of the data.

5.2.1 File locations

All raw data collected were saved in a general folder JRLB/EK60. All files were prefixed with JR15004. Calibration data were saved to a separate calibration folder on the linux server that stays on the vessel.

5.2.2 EK60 (ER60) parameter settings

The EK60 collected data during the transect south (Falklands to South Orkneys) using parameter settings from JR15002 (post-calibration), and then after calibration on the 25/01/2016 it was operated using parameter settings listed in Table 5-1.

Table 5-1: EK60 default settings

Variable	38 kHz	70 kHz	120 kHz	200 kHz
Sound velocity (m/s)	1448	1448	1448	1448
Mode	Active	Active	Active	Active
Transducer type	ES38	ES70-7C	ES120-7C	ES200-7
Transceiver Serial no.	009072033fa5	0090720770eb	00907203422d	009072033f91
Transducer depth (m)	0	0	0	0
Absorption coef. (dB/km)	9.8	17.0	24.6	38.8
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	-20.70	-20.40	-19.70
Transducer gain (dB)	25.92	26.39	23.72	22.59
Sa correction (dB)	-0.49	-0.37	-0.24	-0.36
Angle sensitivity along	22	23	21	23
Angle sensitivity athwart	22	23	21	23
3 dB Beam along	7.03	6.49	6.37	6.20
3 dB Beam athwart	6.98	6.57	6.36	6.24
Along offset	-0.07	-0.05	-0.08	-0.06
Athwart offset	-0.04	0.05	-0.08	-0.07

Pulse transmission (i.e. ping) rates of the EK60 were controlled through the k-sync using variable settings depending on whether the swath multibeam sonar (EM122) was being operated at the same time. During these periods, the k-sync (swath+bio) setting was used to maximize the number of samples from the EK60:le a 2 second ping rate whilst the swath was pinging once, and then the EK60 would transmit twice on its own. In this scenario the multibeam sonar **was not allowed to determine the transmission priority or rate (i.e. be the master)**. This sample mode allows transmission interference (i.e. cross talk) from the multibeam sonar to be removed from the EK60 data using a spike filter. When the swath wasn't used, the k-sync was used to synchronise the EA600, ADCP, and EK60 by typically triggering all instruments on a 2 second ping rate, with the ADCP and EA600 triggering slower (by factors of 2)when data was collected at depths exceeding _1500m.

5.2.3 EK60 echosounder calibration

An acoustic calibration was carried out in Scotia Bay, South Orkneys on 24-25/01/2016. The ship was anchored, its movement balanced by minimal DP usage, and all over-the-side water deposits were stopped. Transmission of the EK60 was triggered through the k-sync, and the EA600 and ADCP were switched off. Each transducer was calibrated in turn, with all transducers transmitting though the entire calibration. Standard ER60 calibration procedures were used as documented for previous cruises, with the exception that a 38.1 mm tungsten carbide sphere was used for all frequencies, suspended from a swivel. TS gains were similar (within 0.2 dB) to values obtained in November during JR15004. The calibration sphere was also positioned on the acoustic axis for extra periods of time to enable calibration variables to be estimated using Echoview software.

A CTD (Event 8) was undertaken on the morning of the calibration (Figure 5-1). Temperature and salinity were averaged from the surface to 30 m (depth of the calibration sphere) and were -0.7 °C and 33.79 PSU, resulting in a speed of sound constant of 1448 m/s (Kongsberg software calculation).

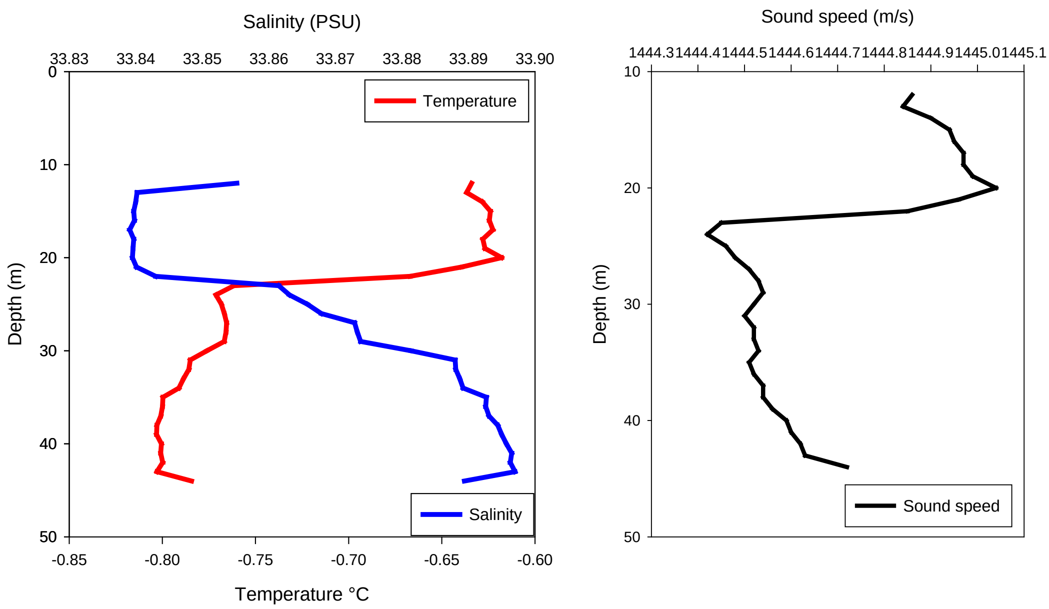


Figure 5-1: Salinity, temperature and sound speed profiles from calibration CTD in Scotia Bay

Each transducer was calibrated at the environmental settings measured with the CTD cast and used throughout the cruise. Parameters from the ER60 lobes calibration were updated onto the ER60 software.

5.3 EK80

The EK80 was operated using Simrad ER80 v. 1.8.2 software from the PU1 PC. 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 different depths depending on the target animal (fish or krill). The resulting volume of data differs among deployments and is much larger (~ order of magnitude) when the EK80 operates in FM pulse transmission mode.

5.3.1 File locations

All raw data were saved in a general folder JRLB/EK80. All files were prefixed with JR15004. Calibration data were saved to the folder appended with a description (e.g. 70_CW_1ms_20mmWC) of the calibration being undertaken.

5.3.2 EK80 settings

The EK80 was operated during sections or all of repeated transects, during some fishing operations, and typically when the stereo camera was deployed through krill swarms. Environmental parameters from the calibration were input into the software, but the EK80 software is unable to accept a temperature value below 0 when calculating sound speed. Environment parameter settings were 0°C and 33.8 PSU, with the sound speed 1448 m/s input manually.

5.3.3 EK80 calibration

The EK80 was calibrated in Scotia Bay, 24/01/2016. A CTD (Event 8) pre-empted the calibration (see above). A 20.001 mm sphere was used as it had a relatively flat response across the three frequencies to be calibrated (38, 120, 200 kHz)(Figure 5-2).

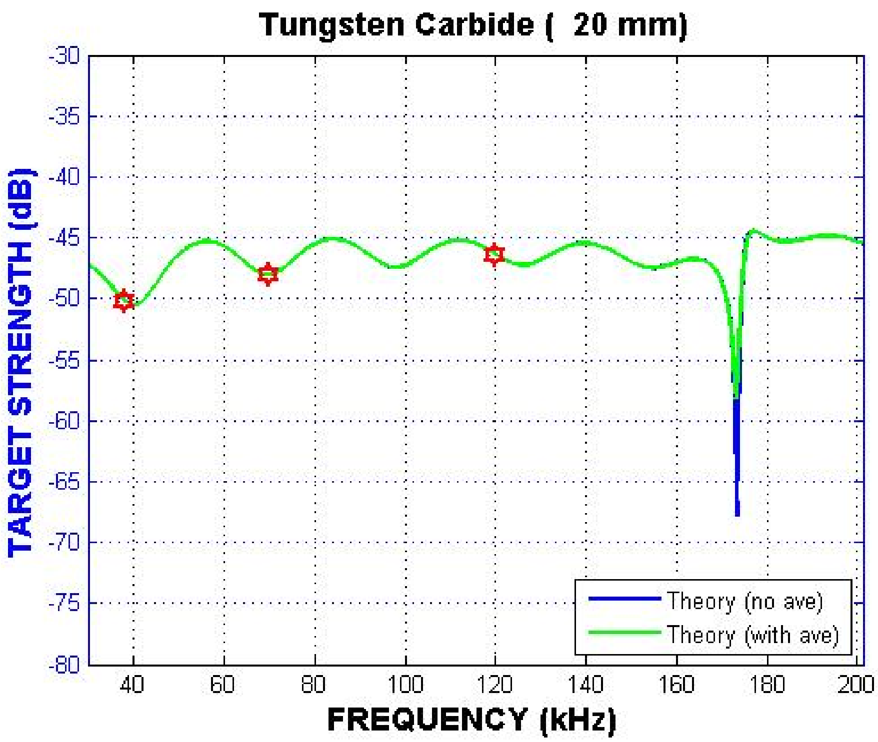


Figure 5-2: Frequency response curve of 20.001 mm tungsten carbide sphere

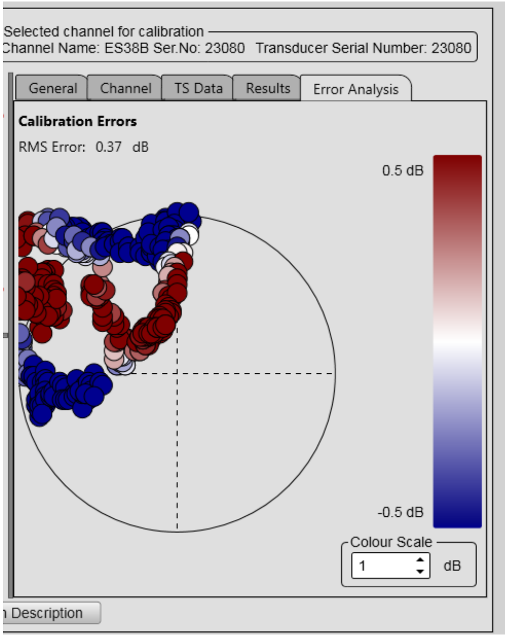


Figure 5-3: Distribution of calibration errors at 38 kHz CW

The calibration of the 70 kHz and 120 kHz transducers in both CW and FM mode went smoothly, and calibration parameters were uploaded to the program. These values are saved to the data folder in XMl files. The 38 kHz was not capable of being calibrated. It was not possible for the calibration sphere to be detected in the starboard quadrants of the 38 kHz transducer, no matter what settings were used to collect the single targets with. Examination of the calibration data for CW mode also identified patterns in the distribution of calibration error – which normally should be randomly distributed (Figure 5-3).

As a result it was decided not to use the 38 kHz with the EK80 so all measurements during the cruise only use the 70 and 120 kHz transducers.

5.3.4 EK80 data files

The EK80 was run sporadically throughout the cruise due to the large data volumes it creates (Table 5-2). When it was operated, it was operated through the K-sync in a group on its own (so no other instruments pinged at the same time as it), sequentially to other instruments. Typically the other instruments (in a group together) were the EK60 38 and 200 kHz, ADCP and EA600. The reason for separation is that the EK80 receives its trigger through a serial port, whereas all other instruments receive it at the GPT (or equivalent). As a result the EK80 trigger is slightly mis-timed with the other instruments, and therefore requires separation from them.

Table 5-2: EK80 activities and times run

Start date/time	End date/time	Comment
24/01/2016 17:10	24/01/2016 19:10	Setting up for calibration
24/1/2016 19:17	25/01/2016	Calibration 120-CW, 70-CW, 70-FM, 38-CW, 120-FM, 38,70,120 FM
01/02/2016 01:23	02/02/2016 07:05	CTD, survey, stereo camera
03/02/2016 04:08	03/02/2016 06:06	Run through Event 61 net haul line
04/02/3016 06:02	04/02/2016 06:33	Run through Event 66 net haul line
05/02/2016 05:22	05/02/2016 06:18	Run through Event 73 net haul line
08/02/2016 23:49	09/02/2016 05:17	RMT8 Events 84, 85, 86
14/02/2016 17:59	15/02/2016 05:47	RMT8 Events 97, 98, 99, 100, 101, 102 and 103

5.4 WBAT

The Simrad WideBand Autonomous Transceiver (WBAT) is a low-power, scientific echosounder (Figure 5-4) that can be used to observe distributions of zooplankton and micronekton . It operates in continuous wave (CW) or frequency modulated (FM) wideband modes. Using a transducer centred at 120 kHz, CW echoes are received at 120 kHz, or echoes from FM transmitted pulses are received from over a frequency band extending from 95 to 160 kHz. A sample range from 100 to 300 m can be selected, although this influences the rate at which measurements can be obtained.

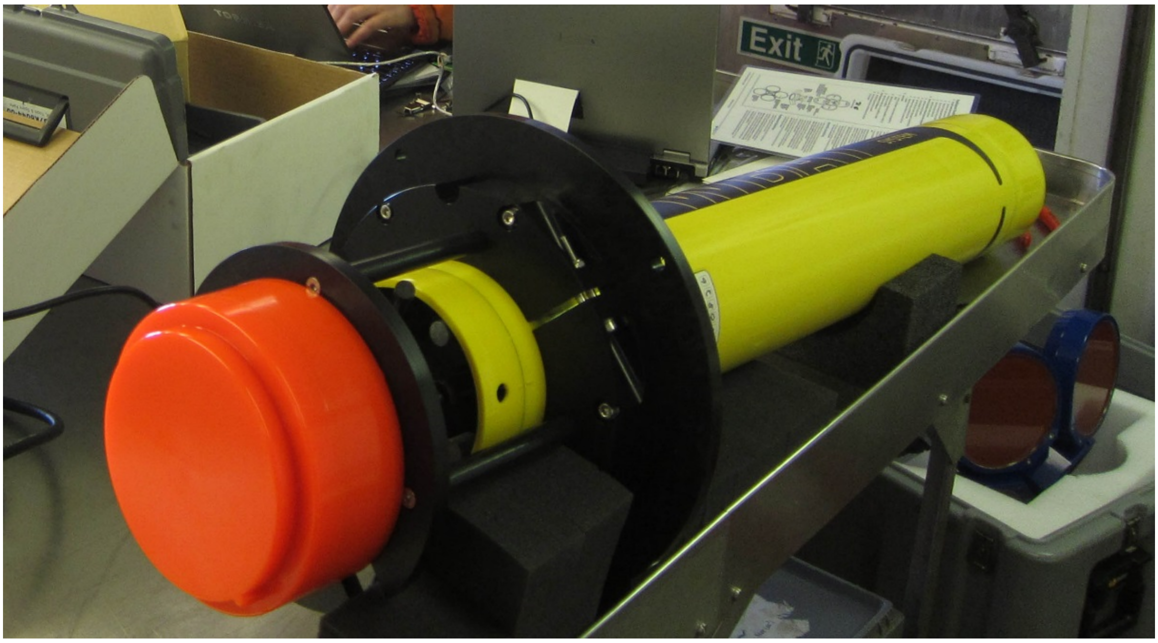


Figure 5-4: The WBAT (yellow) and 120 kHz transducer(orange) assembled for installation on mooring (photo courtesy of Rokas Kubilius)

Two WBATs were purchased to deploy on two moorings as part of a capital augmentation bid (BAS-POEMS). The WBATs (S/N 240826 and S/N 240809) and two 120 kHz transducers (S/N 126 and 127) were sea-freighted from Cambridge after the JCR had left the UK due to delivery after the packing deadline. On unpacking, it was apparent that one of the transducers (S/N 126) had been damaged at the termination of the cable at the transducer, most likely in transit due to poor packing (Figure 5-5). The cable was re-terminated using the potting complex used in the trawl wire terminations (Figure 5-6). The impact of this damage is recognition that the cable termination is now a weak point on the transducer, and may not withstand deep deployment depths or mechanical manhandling during mooring deployments. At this point the decision was made to only deploy one WBAT on a mooring, and to use the other repaired system as a

Figure 5-5: Broken termination of cable entering WBAT transducer

profiling system, attached to the CTD frame and deployed to relatively shallow (<150 m) depths.

Figure 5-6: Re-terminated potting of cable and transducer

5.4.1 Calibration

As per standard operating procedures for all scientific echosounders, an attempt was made to calibrate the WBATs using standard sphere techniques (Foote et al. 1987). The BAS ES853/glider calibration rig was re-jigged as a WBAT platform and deployed from the aft 20T crane during a period (events 9 to 12) at anchor in Scotia Bay from the 24/01/2016 – 25/01/2016 (Figure 5-7). Calibration of the WBATs occurred during the calibration of the ships echosounders (both EK60 and EK80), ensuring that the 120 kHz transceiver on the ship remained in passive mode when the WBATs were in the water.

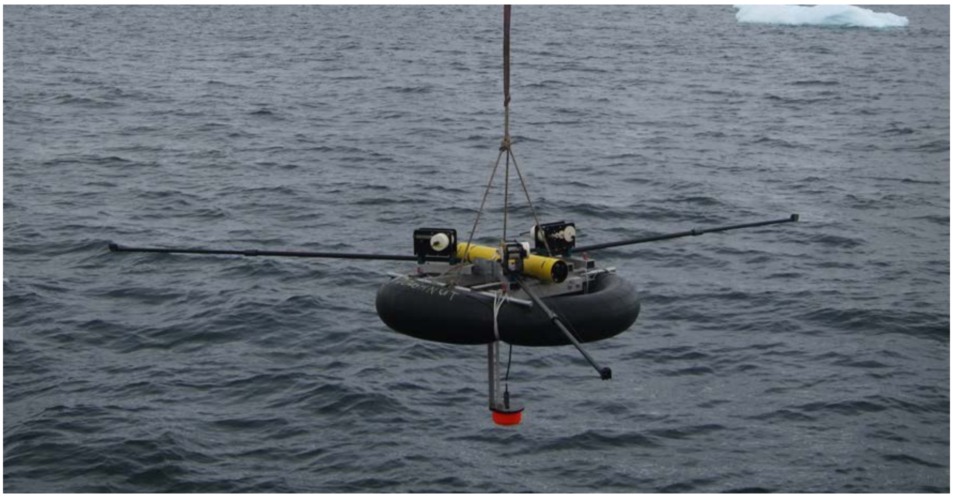


Figure 5-7: The ES853/glider/WBAT calibration rig (photo courtesy of Rokas Kubilius)

A 20.001 mm tungsten carbide sphere was used for calibration as it has relatively stable target strength (TS) values across the 120 kHz wideband range of frequencies (95 – 160 kHz). The expected TS of the sphere at 120 kHz was -46.48 dB, at a water temperature of -0.7 (°C) and salinity of 33.8 (PSU) calculated using environmental data from 10 m to 35 m from CTD event 008. TS as a function of frequency is plotted in Figure 5-8.

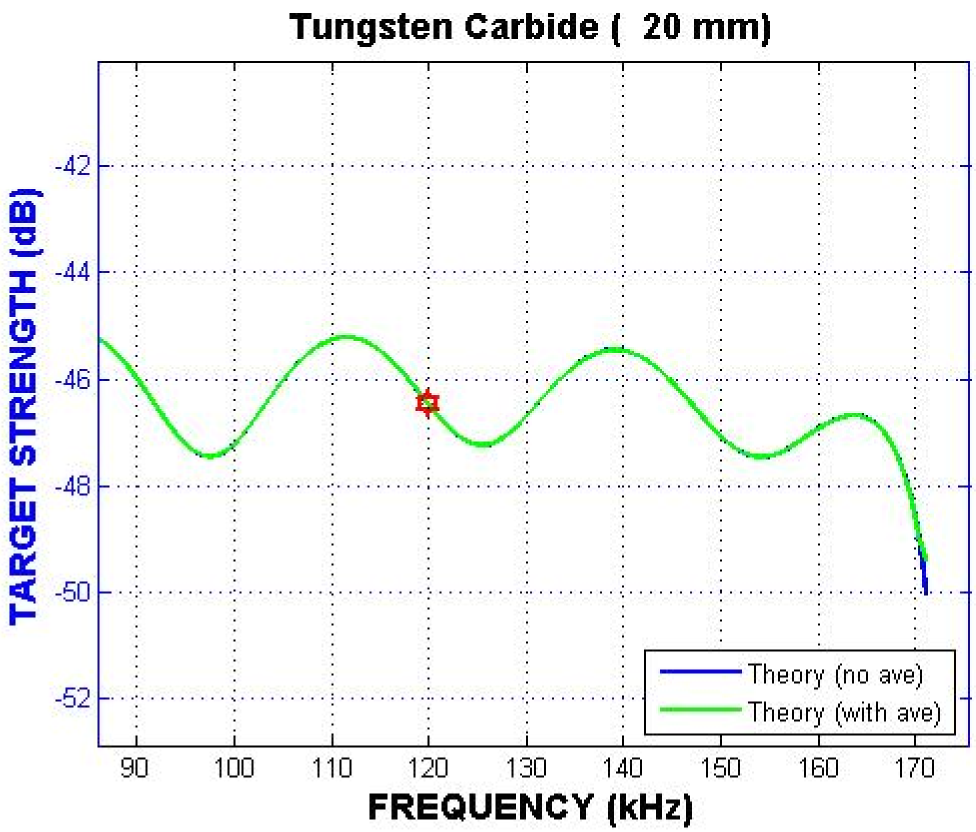


Figure 5-8: Target strength of 20 mm calibration sphere across range of frequencies of the WBAT and 120 kHz transducer

Because the WBATs record data internally and there is no live display, the only way of knowing whether a calibration sphere is located within the beam of the echosounder is after the event. Two attempts were undertaken to calibrate each transducer, but TS values of the sphere were not measured in all 4 quadrants and on the acoustic axis, which are needed to obtain a good calibration (Figure 5-9). Using observed data, Table 5-3 summarizes the calibration coefficients for CW mode for each WBAT/transducer pairing, although both calibrations had high RMS (>0.5).

Table 5-3: Summary of calibration coefficients for CW mode for each WBAT/transducer pair

	SN 240809/SN 126	SN 240846/SN 127
Resulting gain (dB)	26.85	26.54
Gain adjust (dB)	-0.15	-0.46
Beamwidth (along, deg)	7.35	7.47
Beamwidth (athwart, deg)	7.07	6.63
Offset (along, deg)	-0.16	-0.28
Offset (athwart, deg)	0.02	0.38
Sa correction	0.01	0

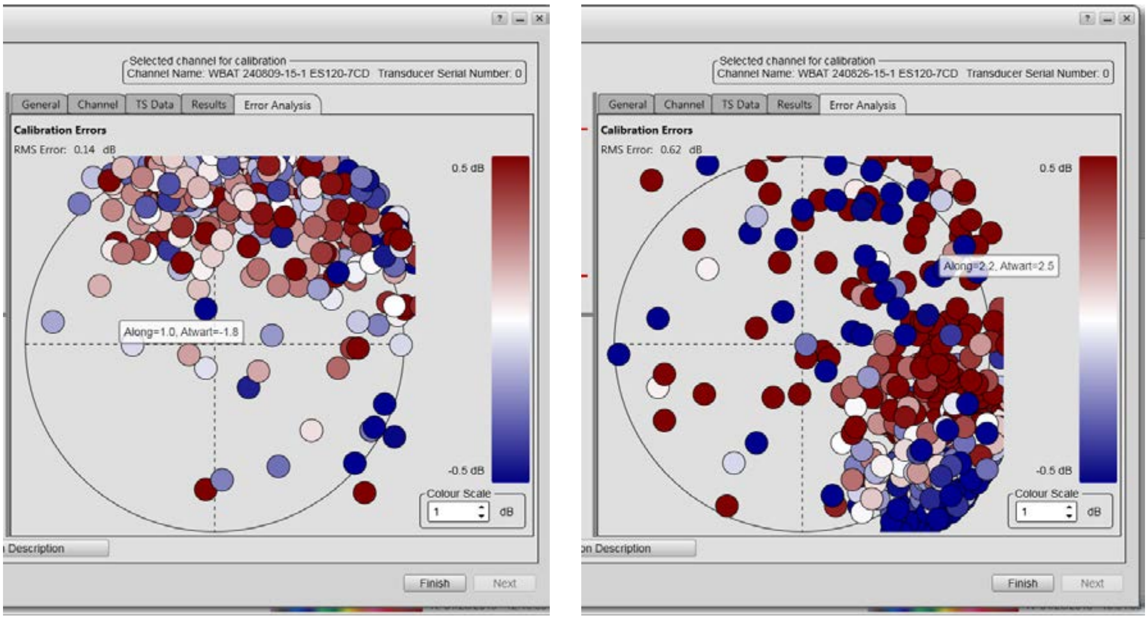


Figure 5-9: Distribution of targets measured during calibration for Transducer SN126 (left) and SN127 (right) in CW mode

5.4.2 Data Collection Deployments

During all deployments both CW and FM data were collected. Mission plans summarizing sample designs are logged on the data drive L:\Scientific_work_areas\WBAT\mission plans. Both sets (WBAT+1 transducer) of instruments were deployed twice for calibration. One WBAT was then deployed on the Signy South Mooring for a period of 12 days (Figure 5-10). The second WBAT was deployed 6 times near krill aggregations while mounted on the CTD frame (Figure 5-11). All deployments are summarised in Table 5-4.

Table 5-4: WBAT deployments during JR15004

Start-Time	Stop-Time	WBAT SN	Transducer SN	Mission Name
24/01/2016 20:20	24/01/2016 21:15	240826	127	20160124-Calibration profile1
24/01/2016 22:10	24/01/2016 23:15	240809	126	20160124-Calibration profile2
25/01/2016 11:55	25/01/2016 12:50	240809	126	20160124-Calibration profile3
25/01/2016 13:30	25/01/2016 14:25	240826	127	20160124-Calibration profile4
30/01/2016 21:00	11/02/2016 12:00	240826	127	20160130-Signy mooring v3
01/02/2016 03:10	01/02/2016 04:20	240809	126	20160201-Event 49_CTD_deployment
01/02/2016 22:30	01/02/2016 23:45	240809	126	20160201-Event 52 mega krill swarm2

07/02/2016 21:25	07/02/2016 22:10	240809	126	20160207-Event 78 blue layer
08/02/2016 00:20	08/02/2016 01:11	240809	126	20160208-Event 80 krill swarm
14/02/2016 21:40	14/02/2016 22:31	240809	126	20160214-Event 98 krill swarm
15/02/2016 00:15	15/02/2016 00:46	240809	126	20160215-Event 100 krill swarm

The Signy mooring deployment generated 137 Gb of data and used 55.74 Amp hours of battery (approximately 44% of battery capacity). Preliminary inspection of the data indicates a successful deployment, collecting data throughout the deployment period as scheduled. The lowered WBAT system also worked successfully, although initial sampling designs did not operate as expected. This was eventually determined to result from confusion of the manufacturer's term "Time between events." This period refers to the interval between start times, and not the period between one end time and the succeeding start time. As a result, initial deployments did not have time between event times that were long enough for the instrument to complete its mission. As a result, the first two CTD deployments only have FM data collected throughout the deployment, rather than a combination of CW and FM transmission mode data.

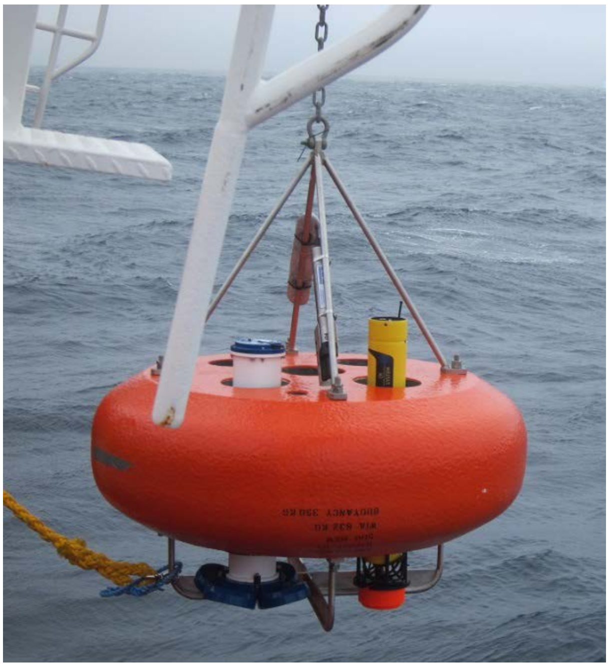


Figure 5-10: The WBAT on the Signy mooring (photo courtesy of Rokas Kubilius)

Figure 5-11: The WBAT on the CTD frame (photo courtesy of John Horne)

5.4.3 Operational hints

Use Tera Term to connect to the WBAT using the communication cable. Set correct serial port and serial communication baud rate to 38400. "Enter" will wake the WBAT (assuming the correct firmware is installed). The communication allows the user to observe the WBAT entering its sleep phase, as well as recording ping rates during a test mission. Type “HELP” for a list of commands at the prompt.

When installing the USB stick into the WBAT be careful that it is properly seated (can try to move sideways – if possible – then USB not seated correctly). Advised to lubricate (e.g. Vaseline) the outside of the rubber cup that protects the USB stick. This will reduce the likelihood of the protective rubber cap trying to rotate the USB stick. A 24 mm rachet is required to open and close the USB data stick cap on the communications end of the WBAT.

The lithium battery packs have a nominal life of 128 amphours per battery (estimated for 4°C *in situ* water temperature).

Time between events is time between the starts of succeeding events. This should not be left to 0 (the system will remain permanently awake). In addition this time should be set greater than the time it takes to complete a sequence of pings, to allow the WBAT to go to sleep after it completes the event (if not, the WBAT will remain on and the battery will be drained).

Do not remove the memory stick whilst data is being written. This will corrupt the USB stick and it will not be readable. In an emergency, the Linux/UNIX utility fsck may be used to attempt to make the stick readable. If required, remove battery to cease the current mission plan.

5.4.4 Future tasks

5.4.4.1 To purchase

- New O-rings for the main chassis and the memory stick port.
- A dedicated 24 mm ratchet/spanner
- Zarges box and appropriate foam to store transducers and mounting plates/screws
- Fairy liquid
- New calibration spheres
- Small floats

5.4.4.2 To compile (on a usb stick):

- Latest firmware from Kongsberg
- CDM RS234 communication protocol (for communication and control laptop)
- File extension Ext2Fsd utility for reading USB stick files (for communication and control laptop)
- WBAT setup notes from IVAR

5.5 EM122 Swath bathymetry

The EM122 multibeam echo sounder was used to measure the depth of the sea floor both to aid the ship with navigation, in particular in areas surrounding the field party locations. A large area of the waters around the South Orkneys are unchartered and therefore this was very useful data for the team on the bridge. In addition, it was used to better survey the western canyon region in order to decide on locations for placing the moorings.

The EM122 was run through the K-Sync system in order to maximise the use of all echo sounders on board.

5.5.1 Data storage

Data were stored in one folder for the whole set of surveys on the cruise: JR15004_a.

5.5.2 Data coverage

Swath surveys conducted during the cruise are shown in Table 5-5.

Table 5-5: Swath surveys conducted during JR15004

Swath survey mooring	Western canyon study	28/01/16	21:15	28/01/16	22:00	cruise_track_seatex gll_swath_survey_2 0160128
Swath survey mooring	Western canyon study	28/01/16	23:10	29/01/16	00:14	cruise_track_seatex gll_swath_survey_2 0160129
Swath survey		02/02/16	07:30	02/02/16	14:00	cruise_track_seatex gll_swath_survey_2 0160202

As mentioned previously, additional data were also collected but for the purposes of navigation. These data will be useful for the next cruise on board the JCR and the coverage of the data was requested by Alex Tate (PDC, BAS) for planning purposes. It is likely these data will be processed on this upcoming cruise.

5.5.3 Data processing

A small proportion of the data were cleaned using MB System.

6 Moorings

Peter Enderlein, Dan Ashurst, Sophie Fielding, Christian Reiss, Claire Waluda & Olav Rune Godø

6.1 Introduction

During JR15004 two newly designed and purchased moorings were successfully deployed and recovered. The deployment period was for 14 days. Both moorings contained an SBE CTD, an RDI 150 kHz ADCP and a Sono.Vault acoustic listening device. The deep mooring also had a Kongsberg WBAT mounted. Also during the cruise the request was made to recover a Norwegian Nortek Signature 55 mooring.

6.2 Shallow Signy mooring:

6.2.1 Shallow Signy mooring deployment

The mooring was deployed on the 29th of January 2016 in good weather conditions (Figure 6-1). The deployment started at 15:35 GMT, buoy first. The weight was released at 16:44 at 60°27.03S 046°32.406W. EA600 depth 554m. After giving the mooring time to settle, it was triangulated and its calculated position was 60 27.05°S 46 32.32°W.

6.2.2 Shallow Signy mooring recovery

The recovery took place on 12th of February 2016. The acoustic releases responded straight away and after ranging the mooring successfully a few times, the mooring was released at 11:14 and was at the surface within 4min. The mooring was hooked mid ships and the ships mooring winch rope attached. The whole rig was recovered by using the ships mooring winch and a stopper rope on a cleat. This worked very well again and the recovery was finished by 11:50.

6.2.3 Shallow Signy mooring performance

6.2.3.1 CTD

The new SBE CTDs Microcat 37 did not function with the old software. Unfortunately due to unfamiliarity with the new software, the CTD did not work. This mistake was spotted after the deployment of the shallow mooring, when it was too late, but in time for the deep mooring CTD. It was found to be very important to use the “startlater” command in the new software, otherwise the CTD will not go to sleep.

6.2.3.2 ADCP

see comments in the “Deep Signy mooring” section

6.2.3.3 Sono.Vault

The Sono.Vault was programmed to begin collecting passive acoustic data 4 hours after the battery was connected. The unit successfully collected data as anticipated in the mission plan, this was 320 GB in total. Only 3 of the 4 memory cards were filled with data as the length of deployment was shorter than the anticipated maximum deployment length of 28 days for the current deployment.

6.2.4 Shallow Signy mooring instrumentation and work carried out

- **NOVATEC beacon**: DO7-017, RF700 C1, Ch C, 160.725 MHz
- **Argos beacon:** 784

- **Iridium beacon:** MO15U5, IMEI: 300434060651120

Acoustic Releases: 2007 and 2061

Codes:

Release No: 2007

- ARM, Ranging: 0B20
- Release code: ARM + 0B55
- Diagnostic: ARM + 0B49

Release No: 2061

- ARM, Ranging: 0B76
- Release code: ARM + 0B55
- Diagnostic: ARM + 0B49

Acoustic releases:

- tested

Irmasat beacon:

- tested

ARGOS beacon:

- new batteries
- tested

VHF Combo beacon:

- new batteries
- tested

CTD 37 SMP: 37-13720

- new batteries
- set-up:
    - set real time clock to PC clock
    - check instruments is ok and clock is set properly by using “DS”command
    - set-up instrument for “Autonomous Sampling”
    - samplenum=0 automatically makes entire memory available for recording
    - sample interval: 60 sec
    - start time was set to start in 3 hours’ time, but due to unfamiliarity with the new software, the final command “start later” was not send to the unit, so it never started sampling.

ADCP: 231

- batteries connected
- set-up instrument for deployment:
    - ;Signy mooring north JR15004
    - ;29/01/2016
    - CR1

- CQ255
- CF11101
- EA0
- EB0
- ED3000
- ES34
- EX11111
- EZ1111101
- WA50
- WB1
- WD111100000
- WF704
- WN99
- WP50
- WS400
- WV175
- TE00:05:00.00
- TP00:06.00
- CK
- CS
- ;
- ;Instrument = Workhorse Long Ranger
- ;Frequency = 76800
- ;Water Profile = YES
- ;Bottom Track = NO
- ;High Res. Modes = NO
- ;High Rate Pinging = NO
- ;Shallow Bottom Mode= NO
- ;Wave Gauge = NO
- ;Lowered ADCP = NO
- ;Ice Track = NO
- ;Surface Track = NO
- ;Beam angle = 20
- ;Temperature = 1.00
- ;Deployment hours = 432.00
- ;Battery packs = 2
- ;Automatic TP = YES
- ;Memory size [MB] = 256
- ;Saved Screen = 2
- ;
- ;Consequences generated by PlanADCP version 2.06:
- ;First cell range = 12.71 m

- ;Last cell range = 404.71 m
- ;Max range = 607.18 m
- ;Standard deviation = 4.10 cm/s
- ;Ensemble size = 2134 bytes
- ;Storage required = 10.55 MB (11062656 bytes)
- ;Power usage = 805.86 Wh
- ;Battery usage = 1.8
- ;
- ; WARNINGS AND CAUTIONS:
- ; There are no warnings or cautions present.
- run pre-deployment tests to check instrument

- data downloaded

Sono.Vault Acoustic listening device: 15366, Hydrophone TC4037-3 S/N 0815002

Configuration file:

<?xml version="1.0" encoding="UTF-8"?>

<Device><System><Type>Sono.Vault</Type><Rev><Hardware>0x400</Hardware><Software>0x400</Software></Rev><Compatibility>0x001</Compatibility><User><StartupMessage>Yes</StartupMessage><LogFlush>No</LogFlush><LogLevel>Info</LogLevel></User></System><Sampling><ADC24Freq>96000</ADC24Freq><ADC16Freq>0</ADC16Freq><ADC24LPMode>No</ADC24LPMode><Gain>4</Gain><Autostart>No</Autostart><ExtStart>Yes</ExtStart><DirFiles>300</DirFiles><FileDuration>1800</FileDuration><WAVID>96k-Gain4</WAVID></Sampling><Ports><Com_0><Baudrate>9600</Baudrate><Handshake>None</Handshake><Parity>None</Parity><Transceiver>232</Transceiver><Mode>Command</Mode><Sleep>Yes</Sleep></Com_0></Ports><Clock><UTCOffset>0</UTCOffset><TCVCXO>16384000</TCVCXO><BaseCalib>44230</BaseCalib><Crystal>19200000</Crystal></Clock><Scheduler><Event_0>

<!--Start_Sampling_4hrs_After_Startup-->

<Time>+14400000</Time><Repeat>1</Repeat><Type>StartSampling</Type><ADC24Freq>96000</ADC24Freq><ADC16Freq>0</ADC16Freq><Gain>4</Gain><FileDuration>1800</FileDuration><WAVID>96k-Gain4</WAVID></Event_0><Event_1>

<!--Sample_Digital_Pressure_Once_Per_Minute-->

<Interval>60000</Interval><Repeat>0xffff</Repeat><Type>PressureSensor</Type><SensorType>Digital</SensorType></Event_1></Scheduler></Device>

- Software configured for deployment 15/08/2015 in Cambridge
- Battery connected 29/01/ 2016 at 12:04.
- Power up 29/01/2016 at 16:04 (configured for 4 hour delay)
- Battery disconnected 12/02/2016 at 11:53
- Data downloaded 12/02/2016 to the scientific work area (moorings/Sig N)

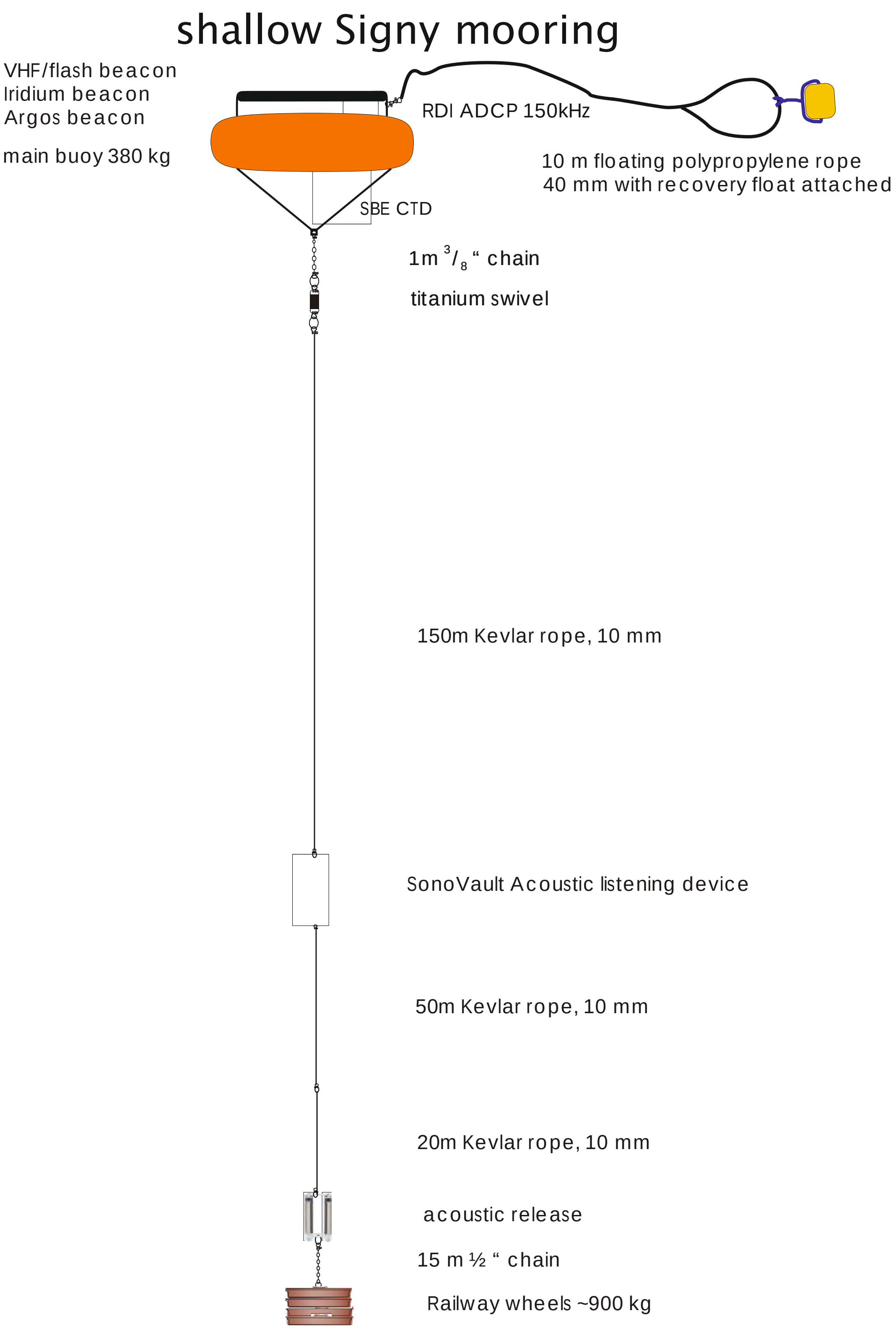


Figure 6-1: Shallow Signy mooring arrangement

6.3 Deep Signy mooring:

6.3.1 Deep Signy mooring deployment

The mooring was initially being deployed on the 29th of January 2016 (Figure 6-3). The deployment started at 19:13 GMT, but at 19:17 when the main buoy was lifted off the deck, the splice in the mooring line came apart and the main mooring buoy dropped on the deck from about 30cm. The deployment was abandoned straight away for a full investigation into the incident. It became clear that it was a dodgy splice by the rope manufacturer and that the inner Kevlar rope just slipped out of the splice. Luckily nobody was hurt or injured as well as no equipment damaged (Accident ref JCR\34\i\3407).

After testing the new rope, unfortunately the mooring winch stopped operating, so we had to revert back to the old method, using the ship's mooring winch. Once all mooring line was transferred onto the ship's mooring winch, a second attempt was made to deploy the mooring.

The deployment started on the 30th of January at 12:54 GMT, buoy first. Half way through the deployment it was noticed that none of the recovery instruments had been switched on. The decision was made to recover the mooring back on deck to switch these beacons on. The mooring was back on deck at 14:03 and was re-deployed at 14:40 and finally released at 15:16 GMT at 60°33.0063°S 046°30'.8008°W. EA600 depth 802m.

After giving the mooring time to settle, it was triangulated and its calculated position was 60°32'.9958°N 046°30'.7583°W.

6.3.2 Deep Signy mooring recovery

The recovery took place on the 12th of February 2016. The acoustic releases responded straight away and after ranging the mooring successfully a few times, the mooring was released at 09:11 GMT and was at the surface within 4min. The mooring was hooked midships and the ship's mooring winch rope attached. The whole rig was recovered by using the ship's mooring winch and a stopper rope on a cleat. This worked very well again and the recovery took 54 min, having everything recovered on deck at 10:04.

6.3.3 Deep Signy mooring performance

6.3.3.1 CTD

The SBE37, Microcat CTD attached to the deep (northern) Signy Island Mooring, performed well. All data were recovered from the instrument. No issues with the data are noted.

6.3.3.2 ADCP

The two Long Ranger ADCPS did not provide useful current data. Although data were recorded on each of the four transducers, placement of the ADCPS in the buoys was problematic. The Cross-brace on the moorings interfered with three of the transducers (see Figure 6-2). In future, the Long Ranger ADCPS must be placed in a configuration on the moorings where the wide-beams of the ADCP transducers are well away from any potential sources of interference. Alternatively a different buoy, with different configurations could be provided.

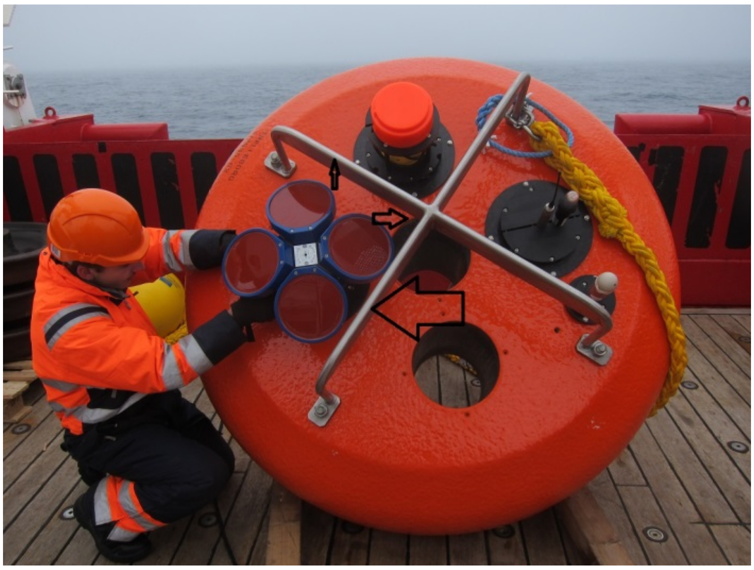


Figure 6-2: Mooring buoy with Long Ranger ADCP in mooring receptacle. Note the protective cross bracing (arrows) that caused interference with three of the four transducer faces

6.3.3.3 Sono.Vault

On initially connecting the battery, the main unit did not respond correctly. This was investigated and a faulty connection between the battery and cable was found and quickly repaired by AME. Once deployed, the Sono.Vault was programmed to begin collecting passive acoustic data 4 hours after the battery was connected. The unit successfully collected data as anticipated in the mission plan, this was 297 GB in total. Only 3 of the 4 memory cards were filled with data as the length of deployment was shorter than the anticipated maximum deployment length of 28 days for the current deployment.

6.3.3.4 WBAT

The WBAT collected data as per the designed mission plan, and should be acknowledged as a successful deployment. The one consideration for future deployments is to separate the transducer from the WBAT control cylinder. It is noted that the transducer is close to being exposed and knocked when the buoy is deployed or recovered. There should be enough transducer cable to connect the transducer to one of the buoy holes, separately from the control cylinder.

6.3.4 Deep Signy mooring instrumentation and work carried out:

- **NOVATEC beacon**: DO7-017, RF700 C1, Ch C, 160.725 MHz
- **Argos beacon:** 783
- **Iridium beacon:** MO1169H, IMEI: 300434060655100

Acoustic Releases: 2006 and 2062

Codes:

Release No: 2006

- ARM, Ranging: 0B19
- Release code: ARM + 0B55
- Diagnostic: ARM + 0B49

Release No: 2062

- ARM, Ranging: 0B77
- Release code: ARM + 0B55
- Diagnostic: ARM + 0B49

Acoustic releases:

- tested

Inmarsat beacon:

- tested

ARGOS beacon:

- new batteries
- tested

VHF Combo beacon:

- new batteries
- tested

CTD 37 SMP: 37-13719

- new batteries
- set-up:
  - set real time clock to PC clock
  - check instruments is ok and clock is set properly by using “DS”command
  - set-up instrument for “Autonomous Sampling”
  - samplenum=0 automatically makes entire memory available for recording
  - sample interval: 60 sec
  - remember “start later” command, followed by ds to check
- Data downloaded

ADCP: serial number?

- batteries connected
- set-up instrument for deployment:
  - ;Signy mooring south JR15004
  - ;29/01/2016
  - CR1
  - CQ255
  - CF11101
  - EA0
  - EB0
  - ED3000
  - ES34
  - EX11111
  - EZ1111101
  - WA50

- WB1
- WD111100000
- WF704
- WN99
- WP50
- WS400
- WV175
- TE00:05:00.00
- TP00:06.00
- CK
- CS
- ;
- ;Instrument = Workhorse Long Ranger
- ;Frequency = 76800
- ;Water Profile = YES
- ;Bottom Track = NO
- ;High Res. Modes = NO
- ;High Rate Pinging = NO
- ;Shallow Bottom Mode= NO
- ;Wave Gauge = NO
- ;Lowered ADCP = NO
- ;Ice Track = NO
- ;Surface Track = NO
- ;Beam angle = 20
- ;Temperature = 1.00
- ;Deployment hours = 336.00
- ;Battery packs = 2
- ;Automatic TP = YES
- ;Memory size [MB] = 256
- ;Saved Screen = 2
- ;
- ;Consequences generated by PlanADCP version 2.06:
- ;First cell range = 12.71 m
- ;Last cell range = 404.71 m
- ;Max range = 607.18 m
- ;Standard deviation = 4.10 cm/s
- ;Ensemble size = 2134 bytes
- ;Storage required = 8.21 MB (8604288 bytes)
- ;Power usage = 626.78 Wh
- ;Battery usage = 1.4
- ;
- ; WARNINGS AND CAUTIONS:

- ; There are no warnings or cautions present.
- run pre-deployment tests to check instrument
- data downloaded

Sono.Vault Acoustic listening device: 15366, Hydrophone TC4037-3 S/N 0815009

Configuration file:

<?xml version="1.0" encoding="UTF-8"?>

<Device><System><Type>Sono.Vault</Type><Rev><Hardware>0x400</Hardware><Software>0x400</Software></Rev><Compatibility>0x001</Compatibility><User><StartupMessage>Yes</StartupMessage><LogFlush>No</LogFlush><LogLevel>Info</LogLevel></User></System><Sampling><ADC24Freq>96000</ADC24Freq><ADC16Freq>0</ADC16Freq><ADC24LPMode>No</ADC24LPMode><Gain>4</Gain><Autostart>No</Autostart><ExtStart>Yes</ExtStart><DirFiles>300</DirFiles><FileDuration>1800</FileDuration><WAVID>96k-Gain4</WAVID></Sampling><Ports><Com_0><Baudrate>9600</Baudrate><Handshake>None</Handshake><Parity>None</Parity><Transceiver>232</Transceiver><Mode>Command</Mode><Sleep>Yes</Sleep></Com_0></Ports><Clock><UTCOffset>0</UTCOffset><TCVCXO>16384000</TCVCXO><BaseCalib>43940</BaseCalib><Crystal>19200000</Crystal></Clock><Scheduler><Event_0>

<!--Start_Sampling_4hrs_After_Startup-->

<Time>+14400000</Time><Repeat>1</Repeat><Type>StartSampling</Type><ADC24Freq>96000</ADC24Freq><ADC16Freq>0</ADC16Freq><Gain>4</Gain><FileDuration>1800</FileDuration><WAVID>96k-Gain4</WAVID></Event_0><Event_1>

<!--Sample_Digital_Pressure_Once_Per_Minute-->

<Interval>60000</Interval><Repeat>0xffff</Repeat><Type>PressureSensor</Type><SensorType>Digital</SensorType></Event_1></Scheduler></Device>

- Software configured for deployment 15/08/2015 in Cambridge
- Battery connected 30/01/ 2016 at 11:21.
- Power up 15:21 30/01/ 2016 (configured for 4 hour delay)
- Battery disconnected 12/02/2016 at 11:39

- Data downloaded 12/02/2016 to the scientific work area (moorings/Sig S)

Kongsberg WBAT: S/N Z460826, Transducer 127

- battery connected
- set up instrument for deployment: should there be some info of setup here?
- Data downloaded

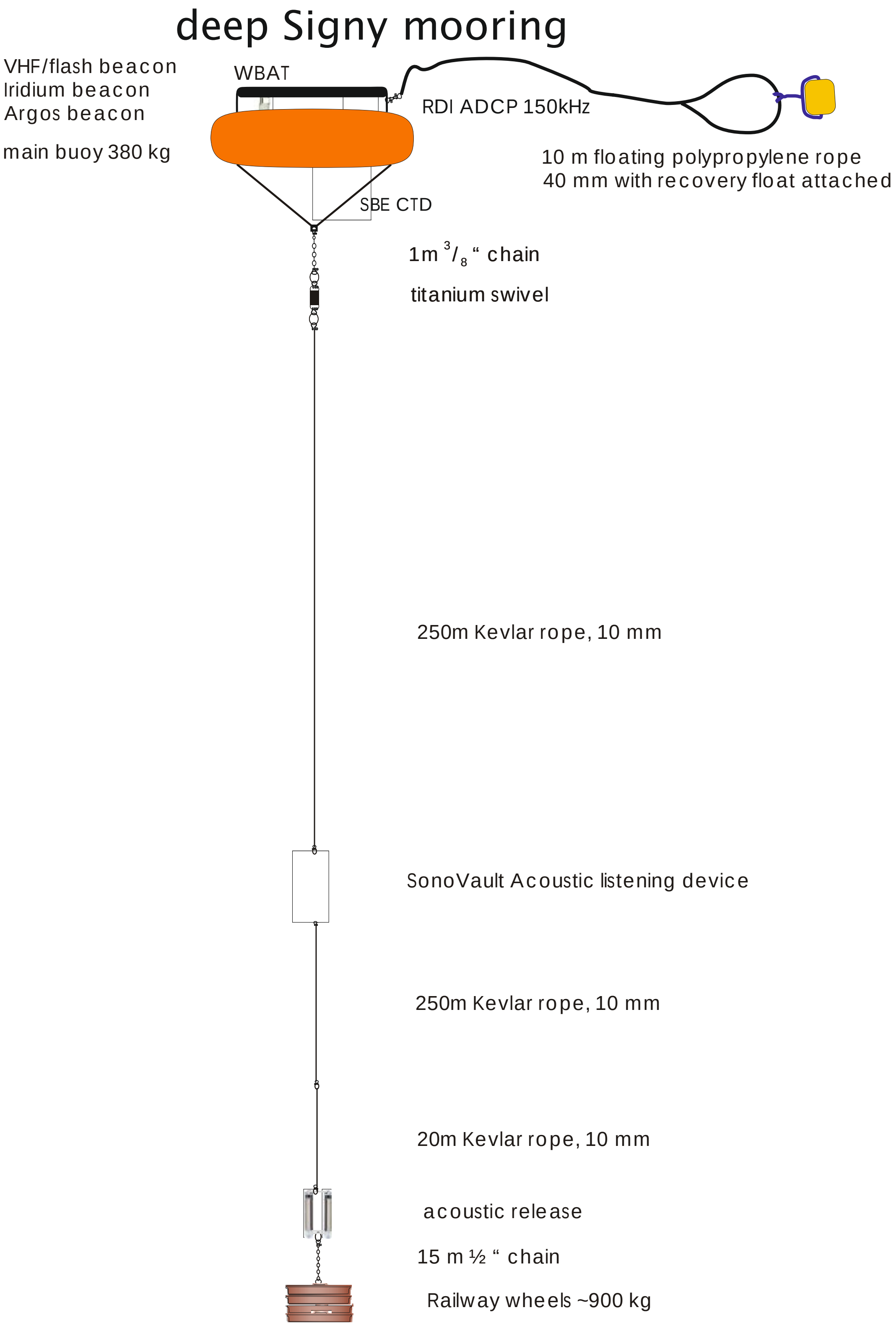


Figure 6-3: Deep Signy mooring arrangement

6.4 Norwegian Nortek Signature 55 mooring:

6.4.1 Norwegian mooring deployment

The mooring with the Signature 55 instrumentation was launched by FV Saga Sea on February 9 and recovered by JCR on February 12. The bottom depth on the launch site was 1000m and 500m rope left the instruments at 500m with the ADCP and the echosounder facing upwards (Figure 6-4: Norwegian Nortek Signature 55 mooring).

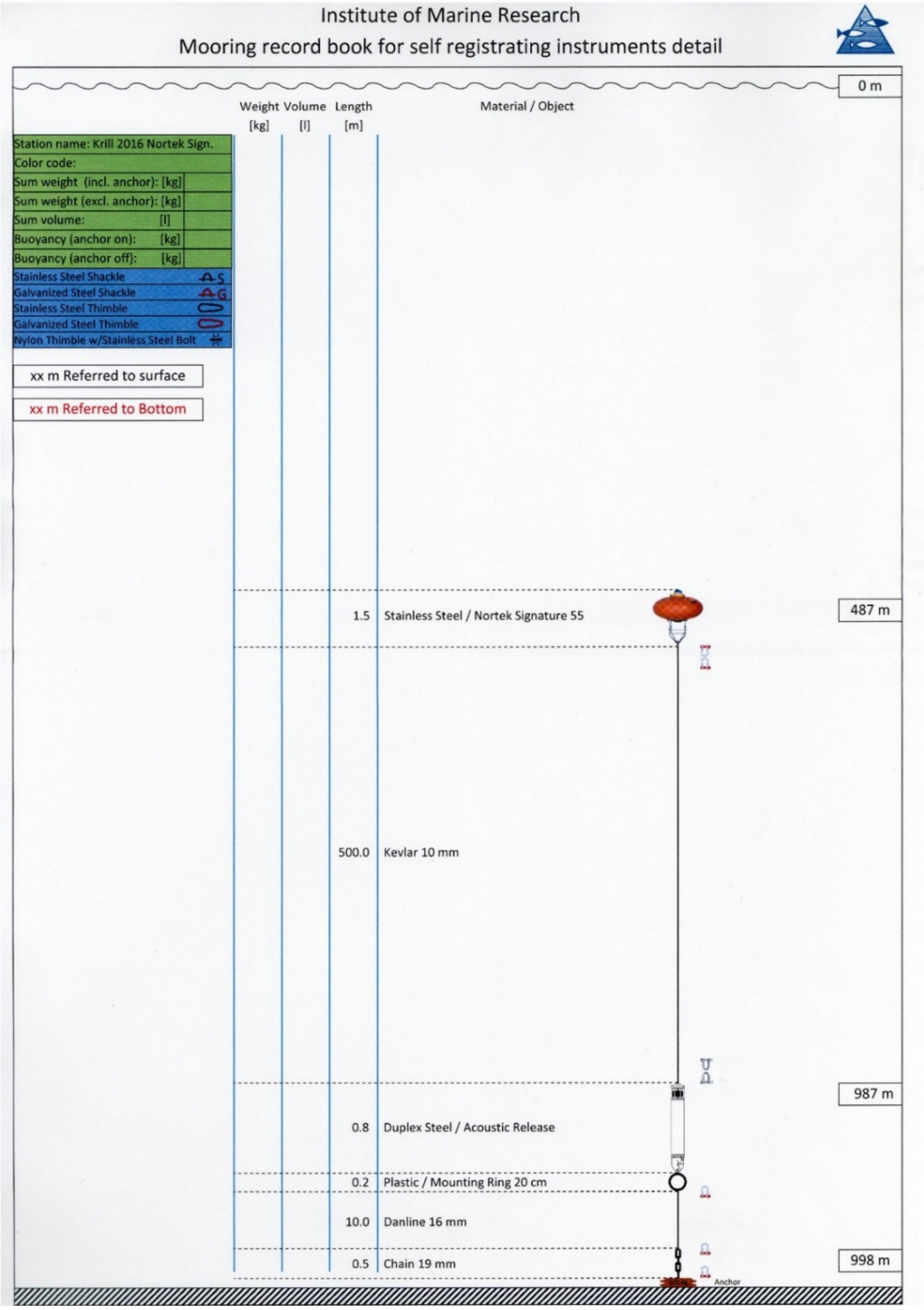


Figure 6-4: Norwegian Nortek Signature 55 mooring

6.4.2 Norwegian mooring recovery:

During the cruise the request was made to recover a mooring which was deployed just a few days earlier, to check if the instrument on it was working. According to the drawings and information received (120cm diameter, 360kg weight in air, no upper steel work, just underneath), it became obvious that there would be no recovery line or any other means of hooking-on on the top of the mooring buoy. Therefore the only way of hooking up the buoy was by sending a boat in to hook it up. This depended on good weather to be able to launch and recover a rib.

On the 12th of Feb. in less than ideal weather condition, the mooring was released at 14:13 GMT and the buoy was sighted 7 min later at 14:20. After getting closer to the buoy the Fast Rescue Craft (FRC) was launched to have a look at the mooring and to hook it up. Due to the weather condition and the narrow steel frame underneath the buoy there was no chance to connect a shackle with a line to the steel frame underneath the buoy. Also it was impossible to flip the buoy over to get access to the steel frame. Therefore the only chance to get the buoy out of the water was to lasso it with a rope around. Having now a little bit more control over the mooring, the ship and the FRC met, a line was passed down and attached to the lasso line. By pulling hard the crew managed to turn the buoy upside down and to secure the line on a cleat. Then a second line (the recovery line from the mooring winch) was passed down and the buoy was hooked up on the main metal frame using a snap hook, as due to the weather condition it was impossible to attach a shackle to it. The mooring was then walked aft and secured on another cleat while the FRC was recovered. Once recovered the mooring buoy was hauled onboard, but could not immediately landed on deck, as the transducer heads of the instrument had no protection and the buoy could not be flipped over easily. Therefore a wooden tower was erected and the buoy safely landed on there. As there was no link underneath the main buoy and just two shackles, it was not easy to transfer the load and to take the main buoy off. Luckily a shackle – ring – shackle combination was just long enough to transfer the load safely. Once transferred the rest of the 500m of Kevlar rope was recovered with the single release at the end.

On the 16th of Feb. the Fishing Vessel Saga Sea came to Signy and picked up the mooring buoy and the Kevlar rope. The release was not picked up and will be left at BAS agent in Stanley for delivery to Saga Sea (through MS LaManche) in late March.

6.4.3 Norwegian mooring performance

6.4.3.1 Operational experience:

The Signature system is untested in realistic field conditions and the following operational experience requires considerations:

The transducers on are unprotected during launch and recovery and this create difficulties in handling the buoy on deck, particularly under rough weather conditions.

The fact that the buoy floats to the surface with the transducers facing up while the natural floating orientation of the buoy without the weight of the acoustic release is with the transducers down. The lack of an attachment on the transducer side creates large problem during retrieval as the buoy need to be turned for attaching the winch wire.

Suggestion: To solve the difficulties under 1 and 2 a steel ring mounted on the transducer side could simultaneously protect the transducers and serve recovery purposes. Operation of the mooring would be substantially safer and easier with such a protection – recovery ring permanently mounted on the transducer side.

6.4.3.2 Scientific/technical experience:

ADCP: The data was downloaded and converted to Matlab code and studied by matlab scripts. Due to confusing outcome of these tests, raw data files were sent to Nortek. They concluded that there was a malfunction of the ADCP which has taken place after the instrument left Nortek. It was decided to send the instrument back to Nortek for repair.

Echosounder: The echosounder produced data that were not range compensated and thus the performance is becoming weaker with distance from the transducer. The data are remarkably clean and show swarms of krill close to surface with diving top predators between surface and swarm. Mesopelagic fishes close to the transducer are traced in detailed, particularly on the broadband echograms (Figure 6-5).

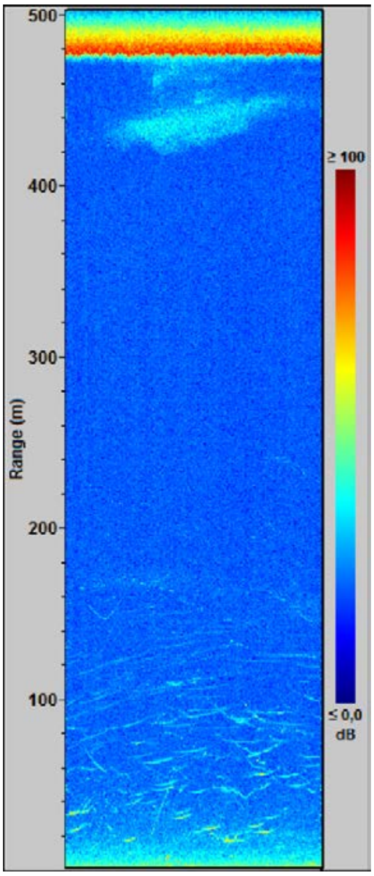


Figure 6-5: . Echogram example from Signature echosounder with a krill swarm and diving top predators

6.4.4 Norwegian mooring Instrumentation and work carried out:

Signature55 is a new series of acoustic current profilers developed by Nortek AS. A center slot is open to various purposes like transducer for measuring ice thickness or as our case a broadband transducer for marine life detection and quantification.

Signature55 ADCP:

- Uses 55 kHz and 75 kHz frequency
- Range of 1000m in the open ocean.

Signature55 Echosounder:

- Operate at 70 and 120 kHz CW pulses and 90 kHz broadband (chirp) pulses.
- The 90 kHz broadband system produces outputs in 9 bins of bandwidth between 70 and 120 kHz.

Battery: Stand alone, double lithium 3600Wh, 19V.

Temperature: The ADCP has a built in temperature sensor.

Acoustic release IXSEA ARX61:

Serial no: 1251

Range code: 08B8

Release code: 0855

This was the first deployment of the Signature55 system with broadband echosounder. Therefore, the mooring was deployed for few days with the objectives of retrieving and testing its performance. If the test demonstrated performance in accordance with specification, the plan included a re-launch for 12 months period.

7 Stereo camera. Cruise report jr15004

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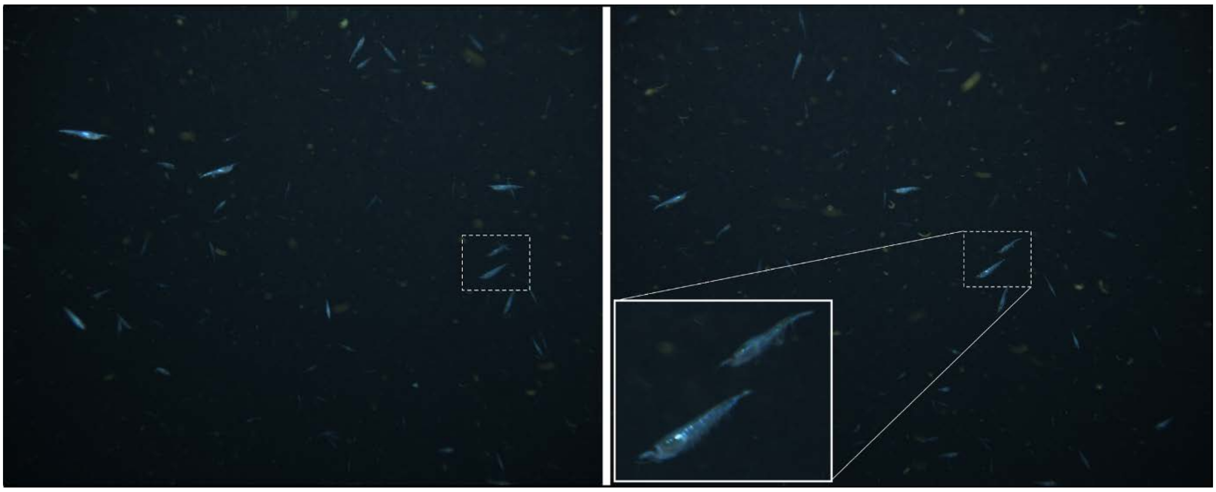


Figure 7-1: Stereo image pair example with multitude of Antarctic krill visible. Dotted-line squares mark two animals as simultaneously observed by left and right cameras of the stereo camera unit. Images were taken at 31m depth within a krill swarm

7.1 Summary

A tailored stereo photo camera for underwater estimation of size and orientation of marine organisms was used at multiple stations during the cruise (Figure 7-1). The objectives were to remotely observe and measure Antarctic krill size and orientation to support evaluation of acoustic target strength. Camera was deployed on a winch cable into krill swarms that also were sampled with other gears like broad band acoustics and RMT nets. When possible, the swarms were profiled to uncover potential swarm structure. Natural body orientation of krill is crucial for understanding variability in the acoustic backscattering from these animals and thus for estimating their abundance. Up to one hour-long camera deployments took place primarily during the hours of darkness with deployment depths varying between 10-80m. Four successful deployments yielded varying numbers of krill measurements per deployment (~100-1000). Large krill body angle variability was observed (SD ~ 20-40°) with initial indications for possible vertical segregation by size and tilt angle.

7.2 Equipment

The camera is a METAS underwater stereo camera (Figure 7-2) produced by METAS AS, Norway (www.metas.no). It consisted of two Manta G-609 cameras enclosed in two separate underwater camera housings (depth rating 1500m) and connected to a single flash unit located in its own separate underwater housing (depth rating 500m). The three above units were connected, powered and controlled via the interface unit also hosting a computer, pitch/roll/heading sensor, and two laptop batteries (taken from HP EliteBook 8530p). A pressure and temperature sensor (AANDERAA, Pressure Sensor 4117E) was attached to the interface unit, which then was mounted on the stereo camera frame. Camera frame consisted of specially designed camera base enabling precise between-camera distance and camera convergence angle adjustments within limits 150-6500mm and 3-9° respectively. METAS Stereo Streamer software was installed on interface computer. Stereo Streamer enabled both on-demand image capture as well as autonomous operation with pre-set image acquisition frequency. A 100m Ethernet communication cable was used for live-view of the acquired images and for monitoring the water depth reading. Image acquisition was set to fixed 20sec time lapse.

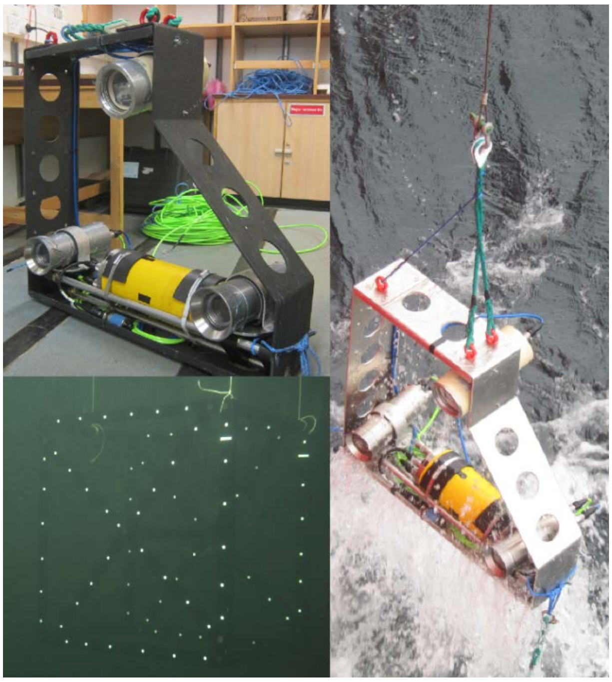
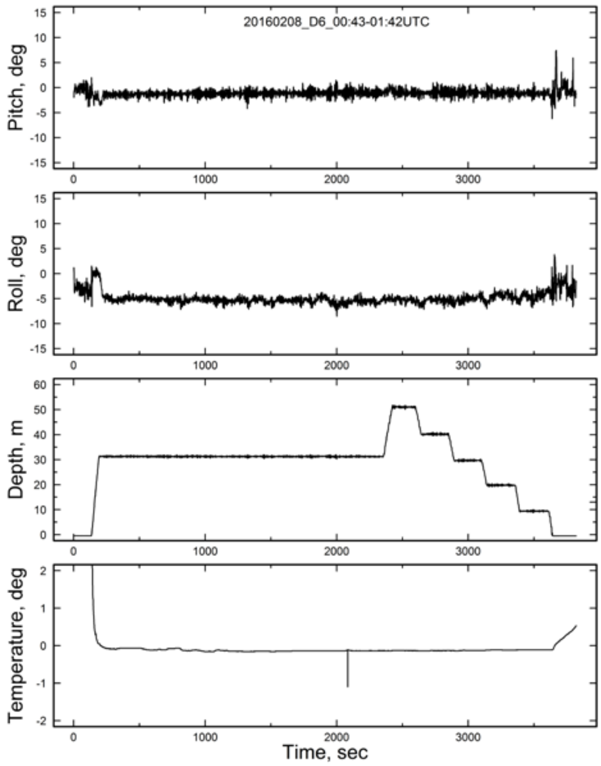


Figure 7-2: Stereo camera during test deployment (right) and prepared for data acquisition (tp-left). Example camera calibration image with calibration cube is also shown

Stereo camera calibration was performed using purpose-build SeaGis calibration cube (500x500x300mm) and software CAL (version 2.20). Stereo image data analysis was/will be done using EventMeasure software (version 4.31). Camera calibration was performed prior to the start of the survey, in Mare harbour (Falkland Islands) at 3m depth.



7.3 Deployment and data

Suitable krill swarms were located using ship echosounders. Stereo camera was deployed from mid-ship, CTD hangar using available winch and 6mm diameter steel cable. Three camera deployments included data acquisition with unit deployed to the middle of the krill swarm and kept still for periods of 30-60min. Similarly, three deployments included krill swarm profiling vertically with 5 or 10m depth steps and time allowance for 10 or 20 stereo image pairs per depth step. Studied krill swarms were 30-100m thick with top of the swarm at 10-20m depth.

Each stereo camera deployment lasted for 30-60min and about 100-200 stereo image pairs were collected per deployment. Occurrence and number of observed animals varied greatly between deployments, from no krill observed (missed the targeted swarm) to several thousands. Data from four successful deployments potentially contain from 100 to >1000 krill measurements per dataset. Example sensor log data is shown in Figure 7-3. Stereo camera deployment details are listed in Table 7-1.

Figure 7-3: Example sensor log from stereo camera deployment into a krill swarm (event 081). Stereo camera was suspended in the middle of the swarm for 30min then swarm was profiled vertically from top to bottom boundaries of the aggregation with 10m depth steps

Results

Four successful deployments yielded varying numbers of krill measurements per deployment (~100-1000). Large krill body angle variability was observed (SD ~ 20-40°) with initial indications for possible vertical segregation by size and tilt angle.

Table 7-1: Stereo camera deployment list and details

Date, Time in water (UTC)	Event No.	Location (Lat./Lon.)	Camera/ bottom depth, m	Wind speed, knots	Stereo pair count (N)	Comment
27/01/2016 16:37-17:15	024	-61.49757/ -47.49608	12-24/ 2558	19.5	116	Stereo camera test deployment. Depth - 20min at 24m, 10min at 12m. No krill.
01/02/2016 05:21-06:08	050	-60.52795/ -46.54382	40-80/ 779	21.7	142	Depth steps: 40, 60, 80m. Missed the targeted swarm, record in a thin plankton layer with few krill.
01/02/2016 19:35-20:25	051	-60.31498/ -46.79171	60-80/ 850	23.5	99	Daytime deployment into swarm. Depth steps: 60, 75, 95, 80m. 100-150 krill observed, up to 50 measurable.
02/02/2016 01:52-02:34	055	-60.31801/ -46.85170	20-40/ 691	20.8	120	Deployment into swarm. Depth steps: 20, 30, 40m. Several hundreds of krill observed. Up to 100 krill measurable.
02/02/2016 06:13-07:04	057	-60.27017/ -46.84281	45-85/ 369	26.2	146	Deployment into swarm. Depth steps: 45, 75, 85m. About 100 krill observed, up to 50 measurable. Significant camera avoidance due to rapidly increasing ambient light level (swarm found and deployed into at sunrise).
08/02/2016 00:43-01:42	081	-60.28689/ -46.56153	10-51/ 2896	21.2	175	Deployment into swarm. Depth steps: 30min at 31m depth. 3min at depth steps 51, 40, 30, 20, 10m. Several thousands of krill recorded. Up to 1000 measurable.

08/02/2016 05:02-06:10	083	-60.27924/ -46.59461	32-42/ 2898	21.2	204	Deployment into swarm. Depth steps: 32, 42m. Low-density swarm. Hundreds of krill recorded. About 200 measurable.
15/02/2016 01:04-02:01	101	-60.30801/ -46.42635	10-50/ 2777	32.1	173	Deployment into swarm. Depth steps: 10, 20, 30, 40, 50m. Thousands of krill recorded. 500-1000 measurable.
15/02/2016 05:04-05:42	103	-60.28267/ -46.42432	10-35/ 2819	25.5	114	Deployment into swarm. Depth steps: 10, 15, 20, 25, 30, 35m. Hundreds of krill recorded. Up to 400 measurable. Drifted out of swarm prematurely.

7.4 Operational experience

Krill avoidance is a commonly experienced problem in doing detailed krill observations. To minimize the camera impact from the light reflecting aluminium frame and steel cameras (Figure 7-2 right) we camouflaged the unit by painting it black and used tape on the cameras to reduce reflections (Figure 7-2, top left). Also, we minimized onboard deck lightening which gave an immediate positive impact on the observation conditions of krill.

This was the first deployment of the Metas Stereo Camera unit. Overall, the experience is very positive. Some adjustments according to the above operational experience might be useful, e.g. cover the unit with a shell that ensure camouflaged deployment and avoid unnecessary turbulence around the unit.

8 Predator observations

8.1 At-sea observations

8.1.1 Introduction

As a complement to the other scientific work being carried out during JR15004, and predator tracking data being collected from several locations around the South Orkney Islands during the same period, visual observations of higher-predators were undertaken from the ship. With a focus on ship-based active acoustic data collection on these surveys during daylight, there was an emphasis on recording feeding diving predators. Having said that, all flying birds were also recorded during all but one survey.

8.1.2 Aims

The main aim of this study was to record air-breathing predators on each survey to obtain an overview of possible foraging areas, relative abundance and predator aggregations across the main survey areas. Assemblages of predators will be analysed for spatial cross correlation with acoustically-detected prey aggregations from ship-based transducers.

8.1.3 Methods

8.1.3.1 Transect observations.

Standard seabirds at sea methodology (Camphuysen et al. 2004) was used to carry out observations of flying birds, penguins and marine mammals (hereafter known collectively as predators unless there is the need to distinguish otherwise). All observations were made from one side of the bridge; initially this was dependent upon weather and glare, but it soon became apparent that the starboard side was preferable (the heating element made it very difficult to see out of the furthermost port window with binoculars). Scanning for predators was done with the naked eye in the forward starboard quadrant (Figure 8-1). Each individual or group of predators was identified, counted and recorded in one of the five distance bands (A: 0 – 50 m; B: 50 – 100 m; C: 100 – 200 m; D: 200 – 300 m; E > 300 m) which ran parallel to the ship track and were measured from the side of the ship (Figure 8-1). Cetaceans in particular, but occasionally groups of penguins and pinnipeds as well, were recorded when spotted on the port side as well, but were noted as being outside of the observed transect and this area was not actively scanned and priority was given to recording predators within the survey area. The time (in GMT) of each observation was recorded to the nearest minute, when the predator was abeam the ship. Initially, callipers and an estimate of bearing were used to get an accurate measure of

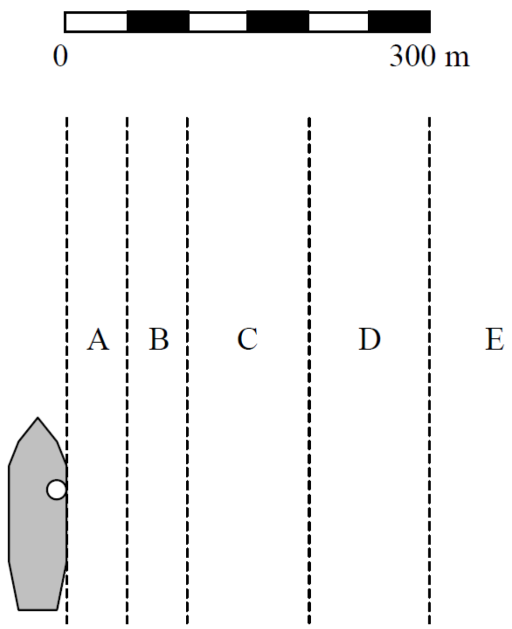


Figure 8-1: Distance bands as measured from the side of the ship for all predator observations

distance from the side of the ship (Heinemann 1981), but it was found to be easier for the observer to stand in the same location and have a reference point for each distance band on the side of the ship. An estimate of distance to predators, in particular cetaceans, was made by eye when they were outside the 300 m transect.

All observations were made by the naked eye by Jenny Thomas and where necessary, identified using a pair of 8 x 40 Olympus binoculars. Identification was made to species level or where there was doubt, to genus or a lower taxonomic level. Jon Watkins assisted with counting, identification of cetaceans (using a pair of 8 x 42 Opticron binoculars) and data entry. A simple spreadsheet was used on a laptop to directly record the observations that were called out by the observer. This was found to be the simplest way to cope with the large concentration of predators that were sometimes encountered. Vessels and floating matter such as animal remains, were also recorded.

Behaviour of the predators was recorded according to the codes in Table 8-1. These codes are much simplified from those in the JNCC seabirds at sea methodology which would have been very difficult to follow, particularly when encountering large aggregations. Similar definitions have been applied to the codes to make them applicable to penguins, pinnipeds and cetaceans. Finally, where no particular behaviour was noted or commented on, this was recorded as "N". No assumptions were made of avoidance or attraction to the ship, so "actively swimming" could encompass all of these possibilities: it is a code that distinguishes the behaviour from simply "resting" in the water. In addition to behaviour, a description was noted where animals were associated with other predators or items in the water; codes from Table 8-2 were used for this. For both the behaviour and association codes, equivalent JNCC codes (Camphuysen et al 2004) are provided in Table 8-1 and Table 8-2 respectively, so that these can be used in comparison with other data sets if necessary.

The direction of movement of the predators was recorded in some circumstances, particularly for the diving predators when they could have been passing underneath the ship, in order that their movement could be compared to the traces on acoustic observations.

Table 8-1: Behaviour codes used with equivalent codes from JNCC seabirds at sea methodology

Type of predator	Code	Equivalent JNCC code (Camphuysen et al 2004)	Description
Flying birds	A		Flying
	B		Sitting on water
	C		Actively foraging
	D	37	Pattering on water
Penguins	D	60 / 79	Resting / preening on surface
	E		Actively swimming
	F		On iceberg
Pinnipeds	G	60 / 79	Resting on surface
	H		Actively swimming
	I		On iceberg
Cetaceans	J		Actively feeding
	K		Actively swimming
All predators	N		Not recorded

Table 8-2: Association codes used with equivalent codes from JNCC seabirds at sea methodology

Code	Equivalent JNCC code (Camphuysen et al 2004)	Description
0		Associated with carrion
11	11	Associated with cetaceans
27	27	Associated with or on sea ice

Basic weather conditions (cloud cover, sun glare, sea ice, precipitation and visibility) were estimated visually by the observer at the start of each observation period. If these changed drastically during the observation period, this was noted. The time of each observation period will allow the meteorological observation data recorded by the bridge Officers to be assimilated with the data set. Wind speed and direction, and vessel speed recorded by the ship's underway system (data feeds from anemometer-wind-speed, anemometer-wind-dir and emlog-vhw-velocity-f/a respectively) were matched with the data set.

Observations were made even when visibility was less than 300 m and sea state conditions were not ideal, however once it was considered that light was poor at dawn or dusk, observations ceased.

Ship-following animals (notably some species of flying birds) were not routinely excluded from the recorded observations, although care was taken to avoid double-counting when possible. Ship observations were not undertaken when the ship was stationary, although there may be cases when the ship was moving at a slower speed due to reduced visibility.

Each survey undertaken was a set of transects. Predators were observed along each transect but not in-between transects (although notable aggregations of predators were recorded but noted as being outside of the observation period). This allowed the observers to have a short break in order to remain alert. Additionally on some long transects (over an hour), the observers took short recorded 10-minute breaks.

8.1.3.2 Surveys

Observations were undertaken on all study modules (Table 8-3). The North-south transect was just used for practising the methods, so these observations should not be used in analyses. During some surveys there were times when the survey was started before dawn or completed after dusk, in which case predator observations were not undertaken on these transects.

It should be noted that on 15/02/2016, Phil Trathan acted as cetacean observer whilst Jenny Thomas recorded all flying birds, penguins and pinnipeds. Jon Watkins had the unenviable task of trying to keep up with the data entry!

The Large Krill Aggregation Survey observations undertaken on 07/02/2016 were done with a slightly different focus and therefore the observations were made in a slightly different manner. Flying birds were not recorded to allow the observers to focus on diving predators; due to the high density of diving predators it would have been difficult to maintain accurate observations of everything. Observations were still focussed on the starboard side and survey area, but an effort was made to record all diving predators that were near to the vessel on both sides, as well as details of their movement, so that they could be identified in the acoustic observations if possible. Observations were made by both observers on this occasion. The side on which the observers were located on the ship was still considered as the primary location and therefore everything on this side was counted as within the transect (given an observation id). As well as recording along transects, records were also made during the turns, because they were very short (normally 5 mins or less in duration).

8.1.3.3 Stationary observations

Observations were made from the monkey island (highest accessible part of the ship) which has a good all-round view when the vessel was stationary. It was not possible to obtain an instantaneous count of all of the predators around the ship because it is not possible to see the areas closest to the ship from one point on the monkey island. For these reasons, the same methodology was used as that in JR161: the observer (Jenny Thomas) familiarised herself with the predators in a 300 m-radius circle around the ship for a few minutes then made instantaneous counts from the port then starboard extremities of the ship, counting everything in a 180 degree arc (see figure 2). These observations were made in quick succession and every effort was made to avoid double-counting. Predators were not noted outside of the 300 m-band. No distinction was made between predators that were moving by or attracted to the ship, but observations were not made within the first half an hour of stopping on station.

Each individual was identified and number in assemblages were counted. Activity of the predator was noted using the same behaviour and associations codes as for the transect observations (Table 8-1 and Table 8-2 respectively). The location of the predator in relation to the ship was recorded, where 0 degrees was towards the bow and 180 degrees was towards the stern of the ship.

Some observations were made whilst the vessel was not moving at stations where the vessel had stopped to perform deployments of scientific equipment. These observations were trialled at stations on the north-south transect. Whilst the methods are detailed here, the observations were not carried out on other surveys for two reasons: one reason being that a large proportion of the stations were carried out at night and the second was that the observer was not satisfied with the methods being used. Ideally it would have been better to carry out observations for the front and rear 180 degree arcs, rather than port and starboard, so that it would be easier to tell if predators were attracted to the vessel, but from the monkey island there is not a sufficient view point to make this possible.

8.1.4 Summary of transect observations

8.1.4.1 Metadata

A summary of each observation period was recorded with start and end date and time, the name of the transect being run, brief weather observations and the names of the observers. Each observation period was assigned a unique observation id which was a sequential number beginning at 1. Each individual record of a sighting was then assigned against an observation id so it can be linked to the metadata record.

8.1.4.2 Data set

The data set has been checked to ensure records are complete, species names are consistent and all columns contain valid values. The comments field contains a variety of information from information about the individual animals to the distance to those outside of the distance bands.

Records that were noted when official observing was not taking place (during breaks or whilst not on transect) can be identified by NOT having an observation id and also having "y" in the out_of_transect field.

All records that were on the opposite side of the ship to the observers were noted as being outside of the transect by having "y" in the out_of_transect field. However if they were recorded during official observing periods, they do have an observation id.

Records where predators were in band E (> 300m) were still recorded as in the transect and have a null value in out_of_transect. These should still be used in analyses but their exact distance is not always known.

The distinction between these different types of records will allow them to be used for different means in the analysis.

Table 8-3: Observation periods and survey coverage

Day of year	Start time (GMT)	End time (GMT)	Observation duration (h)	Transect ID	Survey name
26	18:45:00	19:45:00	01:00:00	T008	North-south transect
27	12:10:00	13:20:00	01:10:00	T010	
27	18:42:00	19:57:00	01:15:00	T011	
32	09:41:00	10:09:00	00:28:00	T021	Western canyon study
32	10:25:00	11:01:00	00:36:00	T022	
32	11:24:00	12:03:00	00:39:00	T023	
32	12:14:00	12:50:00	00:36:00	T024	
32	13:20:00	13:54:00	00:34:00	T025	
32	14:12:00	14:56:00	00:44:00	T026	
32	15:10:00	16:15:00	01:05:00	T027	
32	16:30:00	17:15:00	00:45:00	T028	
32	17:30:00	18:33:00	01:03:00	T029	
33	15:16:00	16:36:00	01:20:00	T050	Medium scale study
33	16:47:00	18:07:00	01:20:00	T050	
33	18:23:00	19:22:00	00:59:00	T050	
34	06:38:00	08:59:00	02:21:00	T051	
34	10:06:00	11:31:00	01:25:00	T051	
34	11:41:00	12:44:00	01:03:00	T051	
34	15:09:00	17:29:00	02:20:00	T052	
34	17:38:00	19:48:00	02:10:00	T052	
35	06:36:00	08:11:00	01:35:00	T053	
35	09:27:00	10:33:00	01:06:00	T053	
35	11:14:00	13:01:00	01:47:00	T054	

35	14:01:00	15:24:00	01:23:00	T055	
35	16:32:00	18:00:00	01:28:00	T056	
35	20:33:00	21:25:00	00:52:00	T056	
36	07:21:00	08:15:00	00:54:00	T057	
36	08:26:00	10:01:00	01:35:00	T057	
36	11:14:00	12:55:00	01:41:00	T058	
36	13:56:00	15:28:00	01:32:00	T059	
36	17:36:00	18:30:00	00:54:00	T060	
36	20:09:00	20:55:00	00:46:00	T060	
38	13:22:00	19:57:00	06:35:00	T070_07-T080_07	Large krill aggregation study
39	13:42:00	14:56:00	01:14:00	T029	Western canyon study
39	15:18:00	16:25:00	01:07:00	T028	
39	16:42:00	17:47:00	01:05:00	T027	
39	18:06:00	19:14:00	01:08:00	T026	
39	19:35:00	19:40:00	00:05:00	T025	
39	20:13:00	20:44:00	00:31:00	T023	
39	21:15:00	22:17:00	01:02:00	T022	
39	22:41:00	23:16:00	00:35:00	T021	
41	09:51:00	10:50:00	00:59:00	T031	Finescale fishery study
41	11:03:00	12:10:00	01:07:00	T031	
41	12:30:00	12:47:00	00:17:00	T032	
41	13:59:00	15:02:00	01:03:00	T032	
41	15:18:00	16:04:00	00:46:00	T032	
41	16:31:00	16:35:00	00:04:00	T033	
41	18:35:00	19:24:00	00:49:00	T033	
41	19:27:00	20:25:00	00:58:00	T033	
42	17:05:00	18:19:00	01:14:00	T034	
42	18:34:00	19:12:00	00:38:00	T035	
42	20:07:00	21:24:00	01:17:00	T035	
42	22:08:00	23:05:00	00:57:00	T036	
43	16:40:00	16:52:00	00:12:00	T038	
43	17:16:00	17:54:00	00:38:00	T039	
43	18:08:00	18:46:00	00:38:00	T040	
43	19:05:00	20:32:00	01:27:00	T041	
43	21:38:00	22:08:00	00:30:00	T042	
43	22:27:00	23:20:00	00:53:00	T043	
46	07:25:00	07:49:00	00:24:00	T077_15	Large krill aggregation study
46	07:53:00	08:17:00	00:24:00	T076_15	
46	08:22:00	08:47:00	00:25:00	T075_15	
46	08:52:00	09:18:00	00:26:00	T074_15	
46	09:23:00	09:57:00	00:34:00	T073_15	

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8.1.5 Preliminary results.

Just over 68 hours of observing was carried out over 68 periods on four different sets of transect surveys. Four sets of instantaneous observations were made at stations but these data will be excluded from analyses.

8.2 Tracking tagged predators

Claire Waluda

8.2.1 Introduction

Throughout the duration of the cruise field parties based at several of the South Orkney Islands tagged birds and seals using a variety of tracking devices. Field parties were based at Monroe Island (to the West of Coronation Island), Powell Island and at the BAS base on Signy Island (Figure 8-2). The purpose of this work (along with the work on at sea observations, see Section 8.1) was to inform the ship as to the areas where predators were most likely to be foraging for krill and fish.

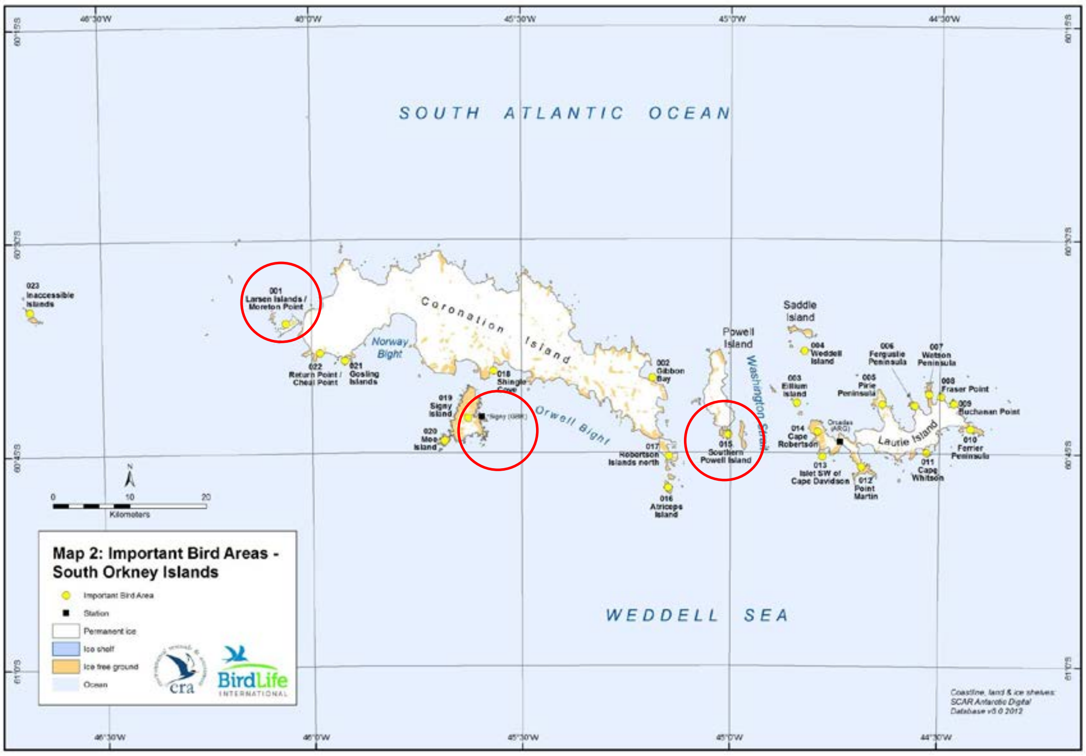

Figure 8-2: location of field parties based at Monroe, Signy and Powell Islands, South Orkneys. Adapted from Harris et al. 2015

Table 8-4: Tagging activities at the South Orkney Islands including number of tracks obtained during the period of the cruise

Location	Species	Type of tag	Number deployed (or tracks obtained) during cruise period
Monroe Island	Chinstrap penguins	GPS, TDR	44
Powell Island	Chinstrap penguins	PTT, TDR	6
	Antarctic fur seals	PTT, TDR	9
Signy Island	Chinstrap penguins	GPS, TDR	13

Both chinstrap penguins *Pygoscelis antarctica* and Antarctic fur seals *Arctocephalus gazella* were tagged using a variety of devices including Platform Transmitter Terminal (PTT), Geographic Positioning System (GPS) and Time Depth Recorder (TDR) devices (**Table 8-4**). Daily updates of PTT data were received from Andy Wood in BAS HQ, Cambridge via an automated account, with GPS data emailed directly to the ship from the field parties at Monroe Island and Signy Island. Personnel tagging predators were Phil Trathan and Catrin Thomas at Monroe Island, Iain Staniland, Andrew Lowther and Gabriel Chevalier at Powell Island, and Norman Ratcliffe and Harriet Clewlow at Signy Island.

8.2.2 Seal diet analysis

60 Fur seal scats were collected by Iain Staniland at Powell Island and processed to examine the diet variability and length frequency of key prey items (krill, squid and fish).

8.2.3 Results

In total 63 penguin tracks and 9 seal tracks were obtained during the period of the cruise (**Table 8-4**). Chinstrap penguins tracked from Monroe Island foraged in the area close to the area surveyed during JR15004, with many birds travelling to the shelf edge just beyond the eastern canyon (Figure 8-3). The majority of penguins tracked from Signy Island travelled south, with the exception of one bird which spent part of its time in the western canyon (Figure 8-5). Fur seals tracked from Powell Island generally travelled south, although foraging within the survey area was evident in some of the tracked animals (Figure 8-4).

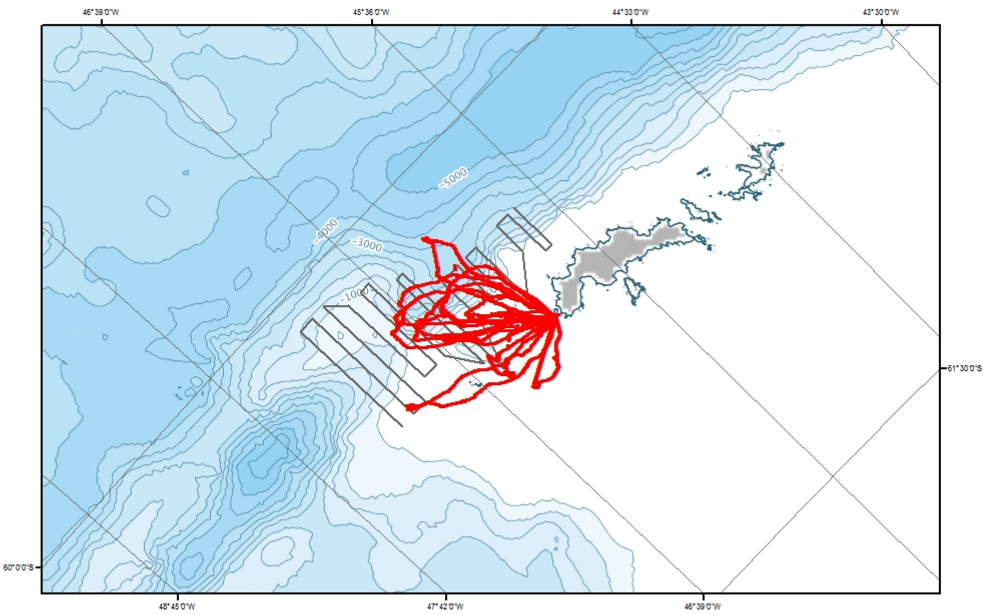

Figure 8-3: Chinstrap penguins tracked from Monroe Island using GPS (red). Location of fine scale fishery survey shown in black

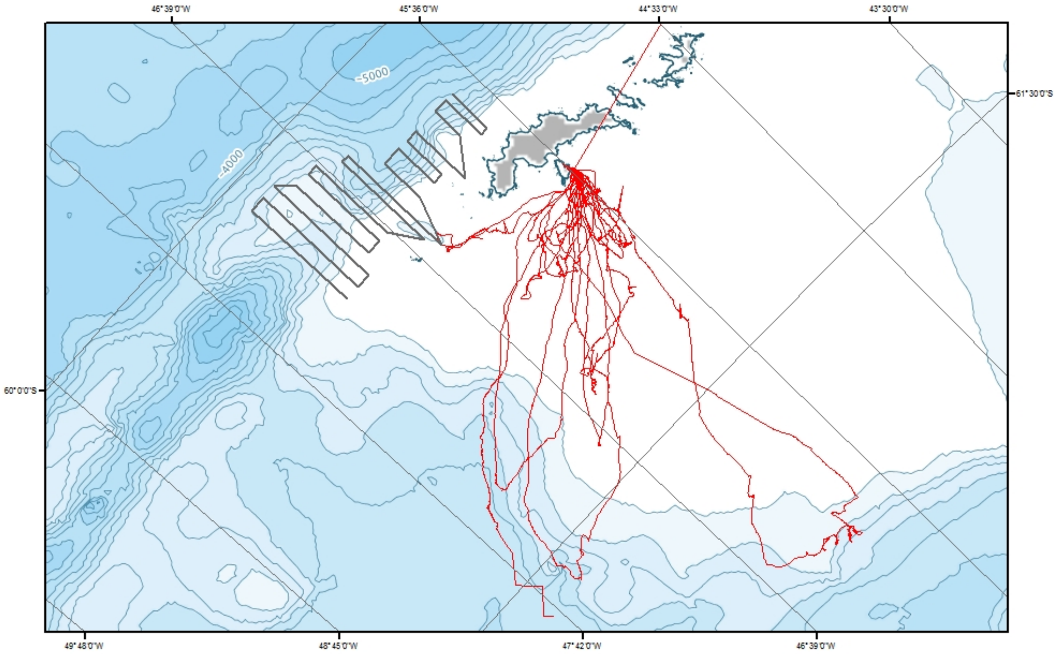

Figure 8-5: Chinstrap penguins tracked from Signy Island using GPS (red). Location of fine scale fishery survey shown in black

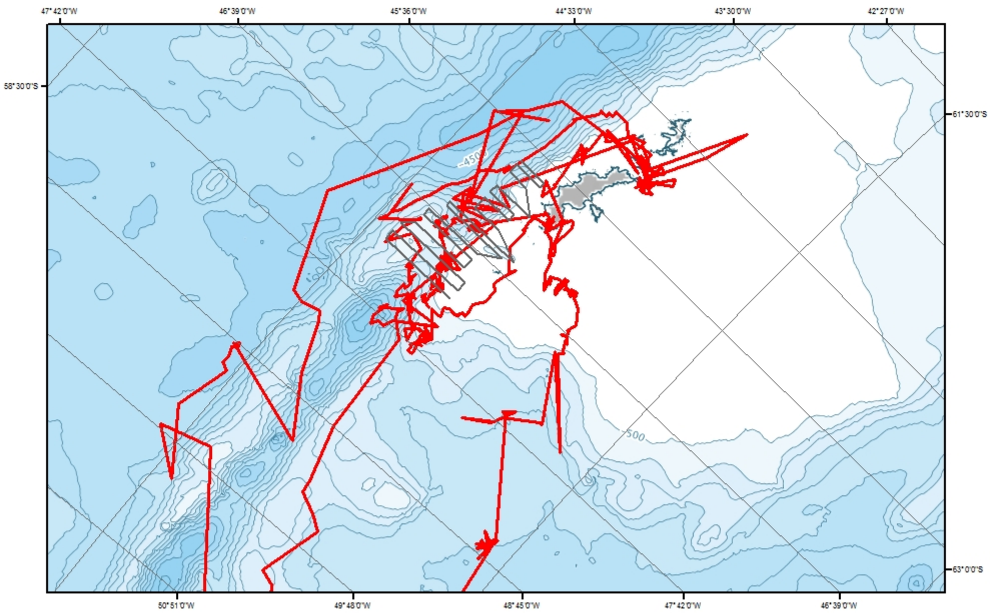

Figure 8-4: Antarctic fur seals tracked from Powell Island using PTT (red). Location of fine scale fishery survey shown in black

Seal diet analysis

A total of 60 Antarctic fur seal scats were processed, with krill found in 58 samples (97 %), fish in 27 samples (45 %) and squid in 4 samples (7%)(Table 8-5). Length frequencies were recorded for

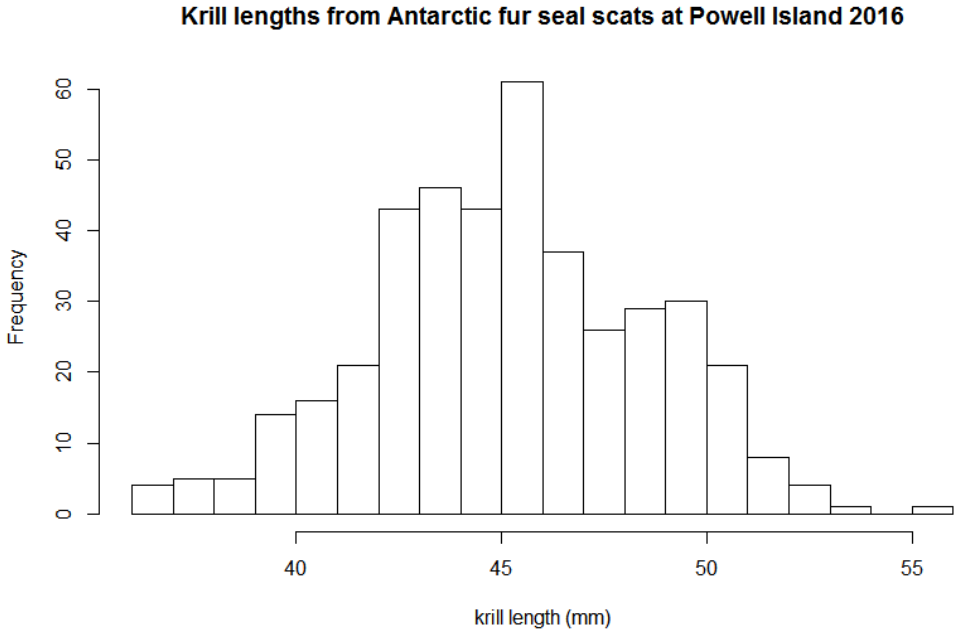

Figure 8-6: Length frequency of E. superba from fur seal scat samples (n = 415 krill)

Euphausia superba (Figure 8-6) *Gymnoscopelus nicholsi* (Figure 8-7) *Champsocephalus gunnari* (Figure 8-8) and *Lepidonotothen larseni* (Figure 8-9). Length frequencies were comparable with those taken in net samples (see section 4 – check with Ryan).

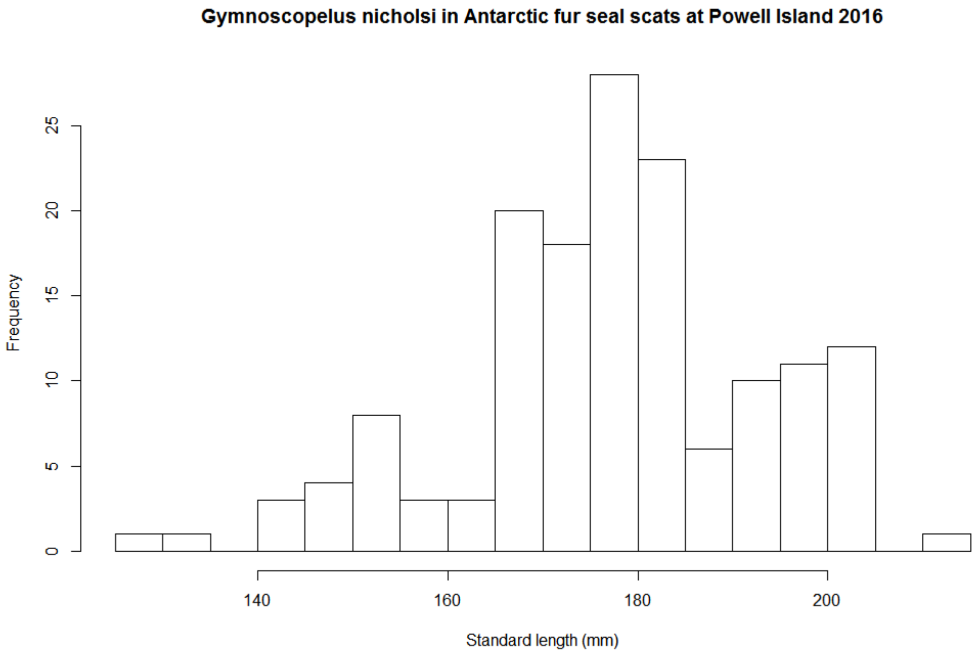

Figure 8-7: Length frequency of G. nicholsi from fur seal scat samples (n = * fish)

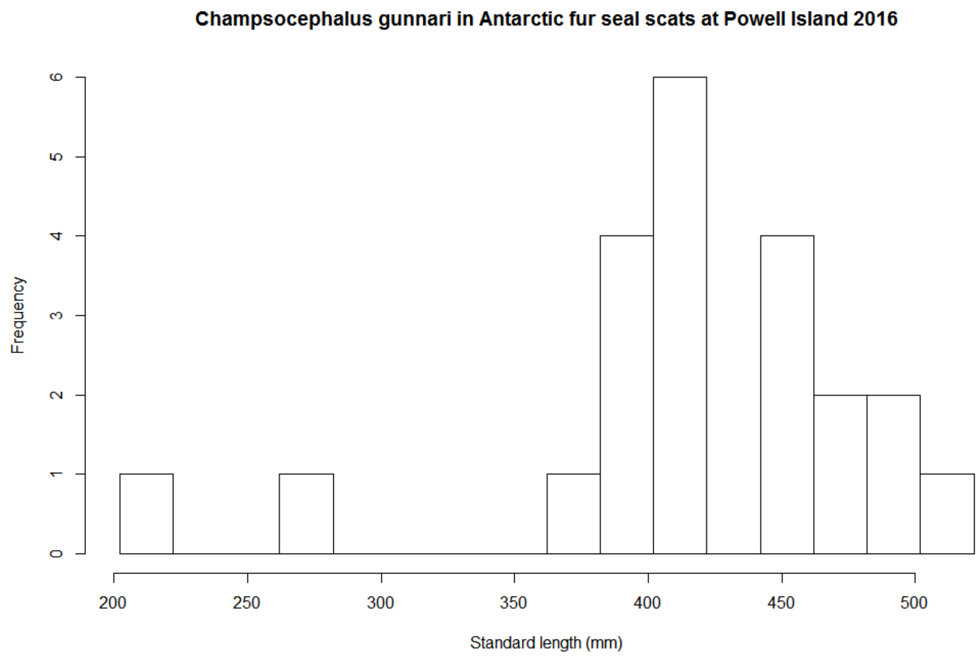

Figure 8-8: Length frequency of C. gunnari from fur seal scat samples (n = * fish)

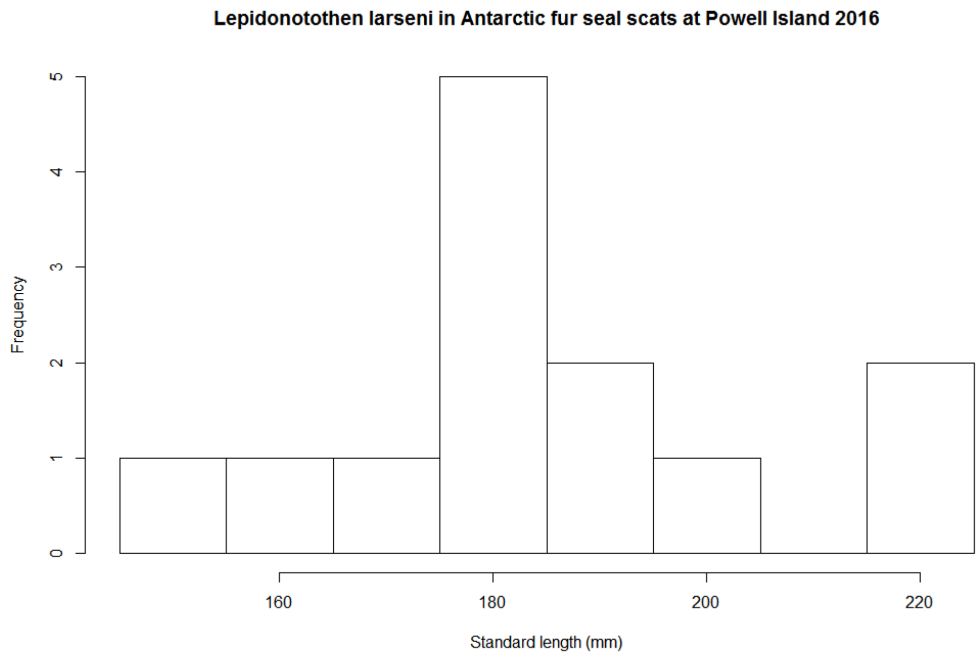

Figure 8-9: Length frequency of L. larseni from fur seal scat samples (n = * fish)

Table 8-5: Species found in diet samples (N = 60). Number of individuals derived from otoliths (fish), carapaces (krill) and beaks (squid)

Species	freq. (%) occurrence	N. individuals
Chaenocephalus aceratus	1 (1.7)	1
Champsocephalus gunnari	6 (10)	22
Gymnoscopelus braueri	1 (1.7)	1
Gymnoscopelus nicholsi	6 (10)	152
Lepidonotothen larseni	5 (8.3)	13
Slosarczykovia circumantarctica	1 (1.7)	2
Euphausia superba	58 (96.7)	413

8.2.4 Discussion and Recommendations

Links between the ship and field parties were maintained throughout the cruise with some good data relevant to the cruise obtained for further analysis, including a comparison of predator and krill distributions, at sea predator observations and data from net hauls.

8.3 References

Harris et al. Important bird areas in Antarctica 2015.

9 Environmental DNA sampling

9.1 Detecting Myctophidae using Environmental DNA

Sophie Fielding, Tracey Dornan

9.1.1 Introduction

[from JR15002 introduction by Jen Freer]

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. Few studies have tested the use of eDNA in marine environments however Thomsen et al. (2012) 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 and have an important role in the ecosystem functioning. Yet the deep pelagic ocean is the least well sampled of all marine environments (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.

9.1.2 Aims

The aim of this study was to collect and filter water samples from multiple depths that coincided with RMT25 fishing depths on myctophids. This independent validation of the eDNA is available for comparison with JR15002 samples that were spatially diverse in order to investigate how the quality and quantity of eDNA is affected by different environmental conditions.

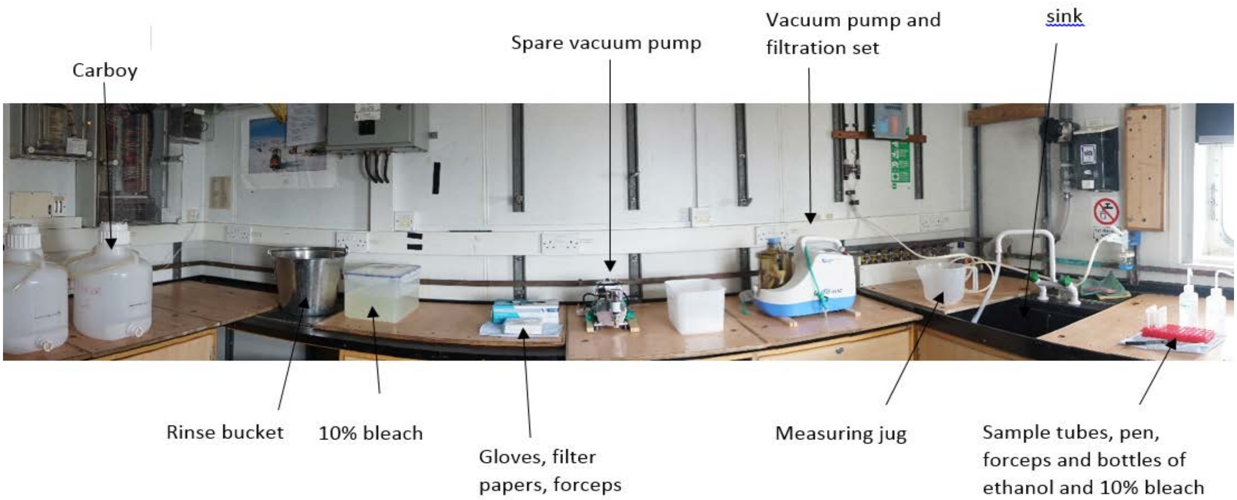

Figure 9-1: Labelled panorama of Environmental DNA laboratory

9.1.3 Methods

Laboratory set up is shown in Figure 9-1. All sampling and filtering equipment were rinsed in 10% bleach solution for at least 30 min before and after use.

Water sampling took place during CTD deployments (Table 9-1). 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 stratified net sampling depths (RMT25 report) 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 9-2; 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.

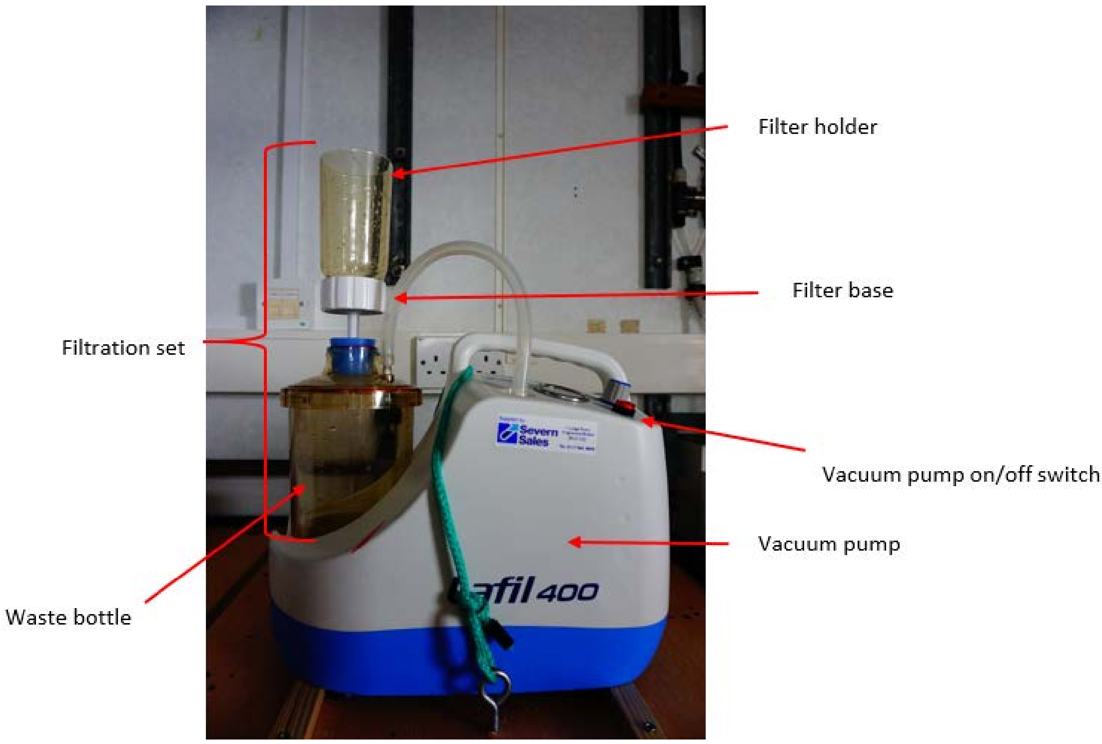

Figure 9-2: Labelled photograph of the Rocker 400 Lafil filtration set used during eDNA filtering

Table 9-1: : List of eDNA seawater samples collected from CTD deployments

Time	Event Number	CTD bottle number	CTD bottle depth (metres)	Volume sampled (Litres)	Sample Fate
02/02/2016	59	2	850	6	Ethanol
02/02/2016	59	4	550	6	Ethanol
02/02/2016	59	6	300	6	Ethanol
02/02/2016	59	10	100	6	Ethanol
02/02/2016	59	16	5	6	Ethanol
03/02/3016	64	1	850	6	Ethanol
03/02/3016	64	3	550	6	Ethanol
03/02/3016	64	6	300	6	Ethanol
03/02/3016	64	9	100	6	Ethanol
03/02/3016	64	15	5	6	Ethanol
04/02/2016	71	1	850	6	Ethanol
04/02/2016	71	2	550	6	Ethanol
04/02/2016	71	5	300	6	Ethanol
04/02/2016	71	8	100	6	Ethanol
04/02/2016	71	18	5	6	Ethanol
09/02/2016	90	1	850	6	Ethanol
09/02/2016	90	2	550	6	Ethanol
09/02/2016	90	5	300	6	Ethanol

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THOMSEN, P. F., KIELGAST, J., IVERSEN, L. L., MOLLER, P. R., RASMUSSEN, M. & WILLERSLEV, E. 2012a. Detection of a Diverse Marine Fish Fauna Using Environmental DNA from Seawater Samples. *Plos One,* 7.

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9.2 eDNA from predators

Claire Waluda, Tracey Dornan

Using the techniques described in 9.1.3 we sampled the water column for eDNA from higher predators with an aim to (1) test for the presence and abundance of air-breathing predator species at the south Orkneys and (2) corroborate data from sono.vault passive acoustic devices attached to the moorings (see moorings 6.2.3.3) and at sea observations (8.1).

Water sampling took place during CTD deployments. Samples were collected in 12 litre Niskin bottles which were fired at the pre-determined depths of 100m and 550m (Table 9-1).

From each sample, three replicates of two litres of seawater were vacuum-filtered using a Lafil-400 filtration system (Figure 9-2; Rocker Scientific, Taiwan) onto 47 mm diameter *** 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.

Table X: eDNA seawater samples collected from CTD deployments

10 CGS – Highly branched isoprenoids (HBIs)

Gabriele Stowasser, Simon Belt

10.1 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.

To explore their potential as sea-ice proxies further we recently conducted a pilot study focused on the natural surface water distribution of the HBI diene and triene. Transects from the Antarctic coast to Australia provided evidence for a sea-ice origin of the former and enhanced formation of the latter in the seasonal ice zone (Figure 10-1).

For the current project, we aim to use these pilot data to inform a complementary study of HBI distribution for a similar transect within the vicinity of the South Orkney Islands. The outcomes from our pilot study will also ensure that sampling is better distributed between different sea ice regimes. Specifically, we will collect phytoplankton samples that:

Will be analysed for HBI lipids by a PhD student at the University of Plymouth.

Represent a similar range of ice cover scenarios (current/recent season) as shown in Figure 10-1.

Will represent variable HBI production within different oceanographic settings – surface (underway), sub-surface (chl a max, 50m, 100m, 200m and 500m) water

In order to investigate the propagation of HBIs through the Antarctic food web we will also collect primary grazers of algal material (i.e. zooplankton) from each phytoplankton sampling location, where possible.

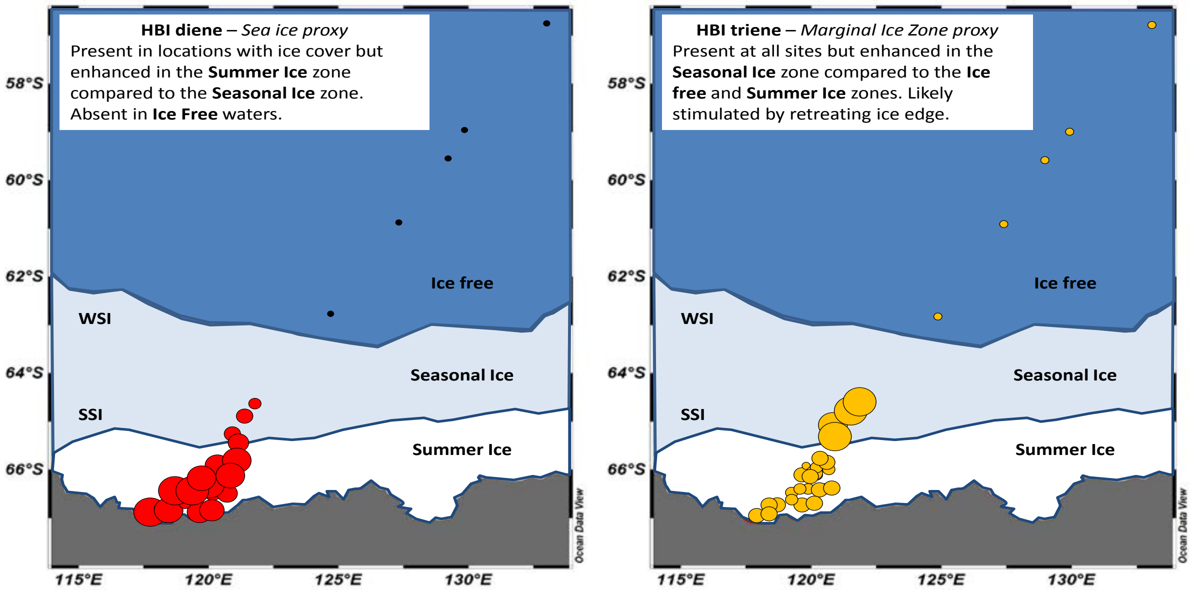

Figure 10-1: . Sampling locations from which HBI lipids have been analysed as part of a pilot study carried out in East Antarctica in 2014. WSI: modern winter sea-ice limit; SSI: modern summer sea-ice limit. (Belt, unpublished)

10.2 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 10-1). 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 (1l/min), sampling was then conducted during the time the ship remained on station (For times filtered Table 10-1). 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 10-1: POM samples collected for HBI analysis. Latitude and longitude are given in decimal degrees

Station	CTD event	sample depths	water depth (m)	latitude	longitude	comment
S004	13	Chlmax (35m), 50, 100m, 200m, 500m, underway	3989	-59.5015	-47.5075	US*: litr. filtered 294
S005	16	Chlmax (15m)	3532	-59.9998	-47.5011	
S006	18	Chlmax (20m), 50m, 100m, 200m, 500m, underway	823	-60.4999	-47.5001	US: litr. filtered 90
S007	20	Chlmax (40m)	2373	-60.9998	-47.5004	
S008	22	Chlmax (15m), 50m, 100m, 200m, 500m, underway	2558	-61.4976	-47.4960	US: litr. filtered 133
S009	25	Chlmax (25m)	2811	-61.9998	-47.4993	Labelled as Event 24
S018	39	Chlmax (20m), 50m, 100m, 200m, 500m, underway	736	-60.4824	-46.5487	US: litr. filtered 344 RMT25 station deep
S042	71	Chlmax (50m), 100m, 200m, 500m, underway	3807	-60.1244	-46.0770	US: litr. filtered 64
S051	90	Chlmax (20m), 100m, 200m, 500m	????	-60.2790	-46.2267	RMT25 station shelf-break
*US = Underway Sampling. All times are given in GMT						

10.3 References

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11 Outreach

11.1 Web-based projects

The cruise has been supported on the BAS website, with a project page at www.bas.ac.uk/project/krill_hotspots. During the cruise daily updates have been sent out via twitter @clairewaluda which have been retweeted by @BAS_News. As part of the website there are links to other projects related to the cruise including including blogs (Propolar.org, cientistapolar.jxavier.blogspot.pt) blog (section 11.5), the BBC micro:bit project (section 11.2) and Mike Gloistein's daily update page (www.gm0hcq.com/jcr_update.htm).

11.2 BBC Micro:bit

A BBC Micro:bit was given to Jenny Thomas to take part in the Micro:bit World Tour (https://microworldtour.github.io/microbit/macaroni.html). The BBC Micro:bit is a micro-processor due to be given to school children across the UK in 2016, by the BBC. It will be used to teach children how to program using a variety of programming languages, but in this case it was python (in fact micropython) that was being used.

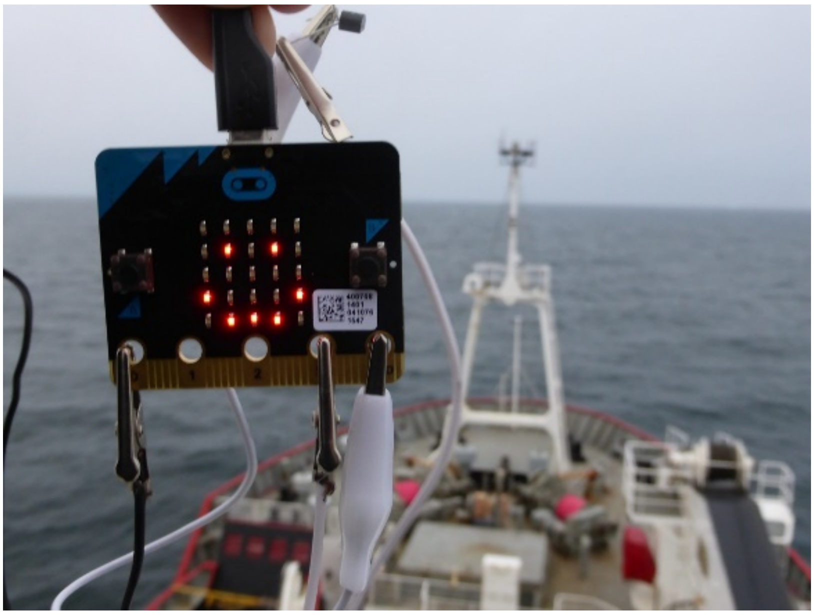

Figure 11-1: Macaroni the BBC Micro:bit measures the temperature at the southernmost point of the cruise (62° S). Photo courtesy Jenny Thomas

Several times during the cruise, the Micro:bit (named 'Macaroni' after the Macaroni penguin) was used to measure the temperature or to help out with experiments. The python code used, photographs and a brief description of what it was used for, were posted on the World Tour website, with the aim that the code and "stories" can be re-used by teachers, children or others using the Micro:bits.

Macaroni is the furthest-travelled of the BBC Micro:bit so far and its use in Antarctica will hopefully inspire children to want to use it and learn how to code. Further outreach may be done with this upon return to the UK.

11.3 Outreach to Brighton Elementary School in Washington.

Two Grade 3 classes (age 8-9) at Brighton Elementary School in Mountlake Terrace, Washington USA were included in an outreach effort undertaken by John Horne for the cruise. An initial presentation outlining the Antarctic ecosystem, cruise objectives, sampling gear, and the scientific method was posed as a set of question and answers with the classes on January 5th. Throughout the cruise, updates on activities were sent to one of the teachers that included short descriptions of events and wildlife, accompanied with photographs. On February 11th, an attempt was made to have a Skype call with the classes. Photographs of different areas of the James Clark Ross were sent before the call to stimulate a discussion on life aboard a research vessel. Unfortunately, the internet connection was not cooperating and, after a delay, we were limited to a question and answer period using the instant messaging function in Skype. The call was well received and was followed up with a message thanking the class and including additional photographs of wildlife that had been spotted over the previous two days. A post-cruise visit to the school is planned for late April or early May. A presentation of photographs, video, and a Styrofoam cup with the school logo that has been to 1000m is planned for the visit.

Figure 11-2: John Horne with Brighton School card in front of icebergs and Coronation Island

11.4 Antarctica Day Flags Outreach

December 1st marked the internationally recognized 'Antarctica Day', which celebrates the signing of the Antarctic treaty in 1959 and its importance throughout history. To promote the day the UKPN teamed up with Our Spaces charity, and Dr Julie Hambrook Berkmann, director of Our Spaces, to organize an 'Antarctic Flags' engagement activity. This international event was celebrated across the globe, with pupils' aged 4 to 16 designing flags with their schools. 38 schools from Britain, Ireland, Spain, Egypt, USA, Australia and more sent in a total of 284 flags. The flags were carried south by volunteer flag-bearers, who were already travelling to the pristine continent for science, heritage, exploration or research purposes. The flags of two schools were taken aboard the JCR by Tracey Dornan and photographs of their 'flying' in the Antarctic will be sent to participants along with a certificate stating the final destination.

Figure 11-3: Tracey Dornan, Jenny Thomas, John Horne, Dan Ashurst and Ryan Saunders holding Antarctica Day 'flags' on the ship with South Orkney Islands in the background

11.5 Education and outreach – Contribution by José Xavier and José Seco

Numerous education and outreach activities were carried related to the JR15004, prior, during and planned for after the cruise. We focused our report at 2 levels: World Wide Web (blog, facebook and website) and contact with schools. People from more than 10 countries viewed the outputs during the cruise

11.5.1 World Wide Web

The bi-lingual blog of José Xavier was created for the International Polar Year (www.cientistapolarjxavier.blogspot.com), and was already used on the previous cruise (JR177 (2008) and JR200 (2009)). The objective of the blog was to provide, on a regular basis in English and Portuguese, interesting information on the science and the living onboard of the James Clark Ross during the JR15004 cruise. The great majority of the scientists and crew participated on the blog, either by accepting to be photographed or interviewed, or providing photographs or input in writing. During the duration of the cruise, more than 3500 hits from more than 10 countries worldwide were recorded. These top 10 countries visiting the blog were: UK, Portugal, USA, France, Brazil, Spain, Belgium, Malaysia, Ireland and Australia. The website of the Portuguese Polar Programme PROPOLAR (www.propolar.org/), was also updated, with news from the cruise. Finally, regular updates of the cruise were carried out at the personal facebook pages of José Xavier and José Seco, which resulted in 52 posts, 116 shares and 3588 likes. Blog, facebook and website are part of the Portugal´s polar education and outreach initiatives on promoting polar science. A report to the SCAR life sciences program SCAR-AnTERA will be also produced informing about the overall goals of the cruise.

11.5.2 Contact with schools

Prior to the cruise, oral presentations about the expeditions took place on more than 10 schools and educational institutions in Portugal (involving ~ 1 000 students, teachers and educators directly). The flags of these schools and councils were brought with José Xavier and José Seco, in which photographs were taken during the cruise, on the ship and on land.

Figure 11-5: Jose X and Jose S undertaking a school Skype call from the winch room on the RRS James Clark Ross

During the cruise, José Xavier and José Seco participated in various projects with schools from Portugal and Mozambique. The interactions ranged from skype interviews (n=5) while onboard, email questions from students about the cruise and participation on school projects related to polar research. José Xavier and José Seco have done various interviews of scientists and crew to produce another education and outreach film to educate the younger generations the basic information about polar research, particularly the marine disciplines. Finally, we also awarded each school with a cup (we put the names of each school, signed by scientists and with drawings for various marine animals) that was in various depths (that was attached to the CTD) to illustrate the pressure that which different marine live (while providing a *souvenir* to each school). After the cruise, José Xavier and José will return to the schools to return their flags and give an overview of the research cruise.

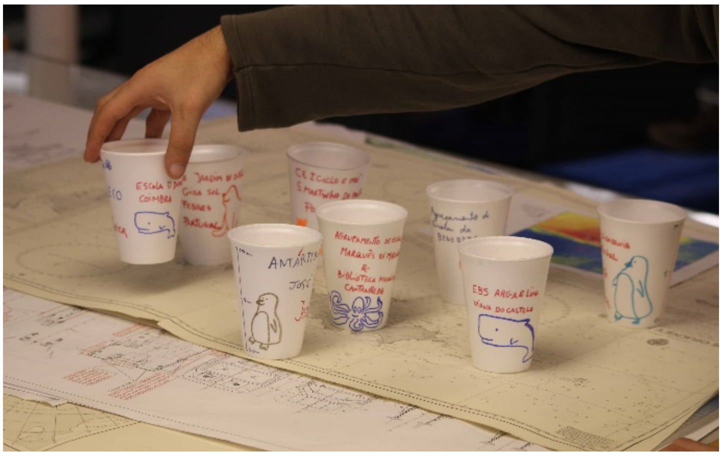

Figure 11-4 Polystrene cups being prepared prior to being sent down to 1500 m on the final CTD cast of the trip

All of these initiatives were carried out in collaboration of the Association of Polar Early Career Scientists (APECS) and Polar Educators International (PEI), the Portuguese Polar Programme PROPOLAR and SCAR AnTERA research program.

Figure 11-6: School flags in the South Orkneys and Falkland Islands

12 Scientific equipment report JR15004

Peter Enderlein & Dan Ashurst

12.1 Down Wire Net Monitor System (DWNM)

Two DWNM systems were used, one for the RMT8 (unit x) and one for the RMT25 (unit y). The system worked well and we encountered no issues with either the deck unit or the UW units.

The RMT25 used the 17.4mm coax wire, which needed terminating at the start of the cruise. This was load tested to 3.5 tonnes. The 17.4mm winch was not turning at the start of the cruise. The problem was solved by swapping out a circuit card in the winch controller. The wire had not been spooled correctly so a few layers on the drum had to be let out and spooled back on correctly. To do this the ship stopped and 1151m of cable where paid out over the stern, with approx. 200kg of RMT25 weights attached. The cable for the flow meter on the RMT25 DWNM failed and had to be replaced and the shaft of the flow meter needed to be realigned. A new bracket was made to attach the flow meter to the Cross at the start of the cruise. All other sensors worked as expected. The 30 tonne traction winch was put out of action due to a failed seal on one of the hydraulic pumps. This made the RMT25 unable to deploy.

The DWNM for the RMT8 worked well and all sensors were functioning. The Biowire already had been terminated and load tested prior to the cruise.

12.2 Mooring Winch

At the start of the cruise the mooring winch was working correctly. However, during the deployment of the second mooring – just after load testing a new line – the mooring winch stopped working. This was caused by a failing PLC. Spares have been ordered and are to arrive in Stanley. All subsequent deployments and recoveries of moorings used the ship's mooring winch.

12.3 EM2040

The EM2040 was assembled in Stanley, including the setup of the transducer and the container. A new generator with a voltage regulator was purchased in Stanley. The rig was put onto the cargo tender at Mare Harbour and tested, but we did not get it working, as the test had to be abandoned. The setup was tested back on deck and by swapping a cable into another port. This got the system working. The EM2040 was not deployed during the cruise due to time constraints.

12.4 RMT8

The RMT8 worked as expected and performed well throughout the cruise, with 14 successful deployments. Nothing was damaged or needs replacing.

12.5 RMT25

The RMT25 worked well and was deployed successfully 10 times. Because the new nets are considerably heavier than the old once, a new method of retrieving the cod ends was used for this cruise: The Gilson winch was clipped onto lines that attached to the cod ends. This then took the majority of the load while the team on deck hauled in the excess net. This new system was very effective and worked well. Nothing was damaged during the deployments, however new end pins for the toggle latches are needed. The grub screw holes on the side-wire rollers should be retapped.

12.6 SUCS

The SUCS was only deployed a couple of times throughout the cruise. The system was set up in Stanley and worked fine for all the deployments. An update to the software allowing Hi-Res display feed and video recording was working well. The SUCS winch developed some start up issues, the cause of which are still unknown. The sun shield for the outdoor monitor was very effective. Two GoPro cameras were also attached to the frame during deployments – one downward facing and one horizontal. While the downward facing camera worked well, the outward camera did not have enough light to capture much useful video.

12.7 Mammoth Net

The mammoth was deployed 8 times. During these deployments two nets were ripped as they caught on the cod end frame where a cod end was not attached. A zip on one of the nets was also broken as well as a couple of cod ends, which broke at the mounting bracket. All the bolts in the cod ends were replaced with longer ones, which helped prevent more from breaking. The deployment and recovery method established on cruise JR15002 worked successfully. Vertical deployment, with a haul rate of 20metres/min produced small sample sizes as each net was only open for around five minutes. A slower haul rate may produce better results. Deploying the net horizontally may also be beneficial. The number of lines to the cod end frame needs to be reduced. The temperature sensor was not working since having the fuse replaced. This needs to be taken up with the manufacturer.

13 Data Management

Jenny Thomas, Polar Data Centre, BAS

13.1 Data storage

All data recorded by instrumentation linked to the ship's network were recorded directly to respective folders within /data/cruise/jcr/current and additional folders were created within /data/cruise/jcr/current/work/scientific_work_areas to allow the scientists to back-up their work. When the data are transferred to the Storage Area Network (SAN) at BAS, the "current" folder will be re-named 20160113 as designated by ICT.

13.2 Event logs

In addition to the bridge event log (thanks to the Officers on watch for doing such a good job maintaining this), a number of digital logs were maintained to record deployments and sampling (Table 13-1).

Table 13-1: Digital logs maintained during cruise JR15004

CTD deployments	eDNA	RMT25
CTD sampling	Data Management	RMT8
CTD bottles	EK60	Mammoth

The officers were asked to record when equipment deployments began and ended and a guidance document was provided at the beginning of the cruise in addition to explanations. As all of the watch officers were new, this was very valuable to them.

13.3 Event numbers

Event numbers were assigned to equipment deployments by the officers on watch and were assigned sequentially when completing the event log. Event numbers were always three-digits, eg. 001. Some event numbers were assigned to activities rather than deployments of equipment: some examples of this were the calibration of the hull-mounted ADCP, wire tests and a deep-water micro survey. These are all listed in the event log (see section 15.1). A total of 109 separate events were recorded and comprise the following activities ().

Table 13-2: Deployment numbers for the equipment / activities recorded in the JR15004 event log

Equipment / activity	Nos deployments/times	Comments
CTD	45	
RMT8	14	
RMT25	10	
Mammoth net	8	
Stereo camera	9	
SUCS	4	
Mooring	8	For 3 different moorings
EM2040	1	
RV Doughnut	4	
ADCP (calibration)	2	
Deep-water micro survey	1	
Wire test	2	

13.4 Station numbers

Each location at which more than one event occurred, was given a station number. This was a three-digit number prefixed by 'S', eg. S001. Although events were carried out at 52 stations, numbers up to S058 were used. These were initially assigned by the officers on watch unless advised otherwise by the PSO or Data Manager. Station numbers were more or less assigned sequentially but this is not always the case. When revisiting a station, the same station number was assigned. Errors in assigning station numbers or assigning new ones when stations were revisited has led to some numbers ultimately not being used (stations S012, S013, S015, S028, S030, S049 do not exist). Locations of stations can be seen in Figure 2-7 and Figure 2-8

13.5 Data sets and their use

Table 13-3: EK60 data details and usage

Instrument	EK60		
Data	Raw	.raw, .bot, .inf files	/data/cruise/jcr/current/ek60
	Processed	Underwent some processing and analysis by Olav Rune Godo, Rokas Kubilius, John Horne.	
Paper logs	None		
Digital logs	EK60		
Calibration	JR15004 24/01/2016, Scotia Bay		
Long term data management	Data will be stored on the SAN at BAS and managed by the Polar Data Centre.		
Other users of the data	Olav Rune Godo (processed and has copies of raw data) Rokas Kubiliius (processed and has copies of raw data) John Horne will be using the data – will be based at BAS following the cruise so will access it from there.		

Table 13-4: EK80 data details and usage

Instrument	**EK80**		
Data	Raw	.raw files	/data/cruise/jcr/current/ek80
	Processed	John Horne	
Paper logs	None		
Digital logs	None		
Calibration	JR15004 24/01/2016		
Long term data management	Data will be stored on the SAN at BAS and managed by the Polar Data Centre		
Other users of the data	John Horne will be using the data – will be based at BAS following the cruise so will access it from there.		

Table 13-5: EM122 data details and usage

Instrument	**EM122**		
Data	Raw	.raw	/data/cruise/jcr/current/em122

	Processed	Data collected on 28/01/2016 underwent some processing and analysis by Jenny Thomas. Processed data in /data/cruise/jcr/current/work/scientific_work_areas/em122/mb/jr15004_a/processing See EM122 section of this report for the details of the processing.
Paper logs	None	
Digital logs	None	
Calibration		
Long term data management	Data will be stored on the SAN at BAS and managed by the Polar Data Centre.	
Other users of the data	The coverage of the data will be very useful for the next cruise on board the JCR (due to depart last week in Feb 2016).	

Table 13-6: ADCP data details and usage

Instrument	**ADCP**		
Data	Raw	/data/cruise/jcr/current/adcp	
	Processed	Data processed by Christian Reiss	/data/cruise/jcr/current/work/scientific_work_areas/adcp/ADCP_processing_reiss
Paper logs	None		
Digital logs	None		
Calibration	Event 031 on 31/01/2016 was unsuccessful because of shelf-break.		
Long term data management	Data will be stored on the SAN at BAS and managed by the Polar Data Centre		

Table 13-7: EA600 data details and usage

Instrument	**EA600**		
Data	Raw	.raw files	/data/cruise/jcr/current/ea600
	Processed	Data collected on 28/01/2016 underwent some processing and analysis by Jenny Thomas. Processed data in /data/cruise/jcr/current/work/scientific_work_areas/em122/mb/jr15004_a/processing	
Paper logs	None		
Digital logs	None		
Calibration	No information		
Long term data management	Data will be stored on the SAN at BAS and managed by the Polar Data Centre		

Table 13-8: ES853 data details and usage

Instrument	**ES853 (to be launched on glider)**	
Data	Raw	
	Processed	
Paper logs	None	
Digital logs	None	
Calibration	24/01/2016 from RV Doughnut deployment	

Table 13-9: EM2040 data details and usage

Instrument	**EM2040 launched from cargo tender**	
Data	Raw	No raw data collected: the instrument didn't collect any data.
Paper logs	None	
Digital logs	None	

Table 13-10: WBAT data details and usage

Instrument	**WBAT (deployed on CTD)**		
Data	Raw	.raw	/data/cruise/jcr/current/work/scientific_work_areas/WBAT/Event_XX
	Processed	.EV, .mpl, .evwx	/data/cruise/jcr/current/work/scientific_work_areas/WBAT/Event_XX
Paper logs	None		
Digital logs	None, but recorded in CTD_deployments when it was attached.		
Calibration	24/01/2016 from RV Doughnut deployment		
Long term data management	Data will be stored on the SAN at BAS.		

Table 13-11: CTD data details and usage

Instrument	**CTD**		
Data	Raw	.asc, .cnv, .ros	/data/cruise/jcr/current/ctd
	Processed	.btl, .cnv, and Matlab scripts	/data/cruise/jcr/current/work/scientific_work_areas/CTD, /data/cruise/jcr/current/work/scientific_work_areas/CTD/JCR15004_CTD.Data, /data/cruise/jcr/current/work/scientific_work_areas/EK60_EK80/ctd_lines Processing scripts in /data/cruise/jcr/current/work/scientific_work_areas/CTD/Christian_CTD_MATLAB
Paper logs	/data/cruise/jcr/current/work/data_management/log_sheets/scanned_logs/ctd.pdf		

Digital logs	CTD_deployments, CTD_sampling, CTD Bottles (produced by a script which reads from .btl files; note that this contains unprocessed values from the sensors).
Calibration	Various sensors on the CTD were calibrated. Calibration documents can be found in the cruise report appendix.
Long term data management	Raw and processed data will be stored on the SAN at BAS.
Other users of the data	Gabi Stowasser, BAS Jennifer Freer, BAS and University of Bristol Claire Waluda, BAS Sophie Fielding, BAS Jose Xavier, University of Coimbra, University of Aveiro Jose Seco, University of Coimbra, University of Aveiro, University of St Andrews Christian Reiss, NOAA Andy Lowther, IMR Rokas Kubilius, IMR Olav Rune Godo, IMR

Table 13-12: RMT8 data details and usage

Instrument	**RMT8**
Samples	Details of sampling done on board can be found in the RMT8 section of this report and in /data/cruise/jcr/current/work/scientific_work_areas/RMT8.
	Further work will be done on samples once they have been returned to BAS or other institution. Analysis of the samples will be done by colleagues within BAS and at other institutions.
Paper logs	None
Digital logs	RMT8
Long term data management	Some samples will be stored at BAS. Others will be sent to collaborators (see list below).
Other users of the data	Will Goodall-Copestake, BAS Claire Waluda, BAS Gabriele Stowasser, BAS Ryan Saunders, BAS Sophie Fielding, BAS Mark Belchier, BAS Tracey Dornan, BAS John Horne, University of Washington Charlotte Haverman, Alfred-Wegner Institute Christian Reiss, NOAA José Seco, University of Coimbra, University of Aveiro and University of St. Andrews José Xavier, BAS, University of Coimbra, University of Aveiro Olav Rune Godø, Institute of Marine Research Rokas Kubilius, Institute of Marine Research

Table 13-13: RMT25 data details and usage

Instrument	**RMT25**
Samples	Details of sampling done on board can be found in the RMT25 section of this report and in /data/cruise/jcr/current/work/scientific_work_areas/RMT25.
	Further work will be done on samples once they have been returned to BAS or other institution. Analysis of the samples will be done by colleagues within BAS and at other institutions.
Paper logs	/data/cruise/jcr/current/work/data_management/log_sheets/scanned_log s/rmt25.pdf
Digital logs	RMT25
Long term data management	Some samples will be stored at BAS. Others will be sent to collaborators (see list below).
Other users of the data	Will Goodall-Copestake, BAS Claire Waluda, BAS Gabriele Stowasser, BAS Ryan Saunders, BAS Sophie Fielding, BAS Mark Belchier, BAS Tracey Dornan, BAS John Horne, University of Washington Charlotte Haverman, Alfred-Wegner Institute Christian Reiss, NOAA José Seco, University of Coimbra, University of Aveiro and University of St. Andrews José Xavier, BAS, University of Coimbra, University of Aveiro Rokas Kubilius, Institute of Marine Research

Table 13-14: Mammoth net data details and usage

Instrument	**Mammoth net**
Samples	Details of sampling done on board can be found in the net sampling section of this report and in /data/cruise/jcr/current/work/scientific_work_areas/Mammoth.
	Further work will be done on samples once they have been returned to BAS or other institution. Analysis of the samples will be done by colleagues within BAS and at other institutions.
Paper logs	/data/cruise/jcr/current/work/data_management/log_sheets/scanned_log s/mammoth.pdf
Digital logs	Mammoth
Long term data management	Some samples will be stored at BAS. Others will be sent to collaborators (see list below).
Other users of the data	Will Goodall-Copestake, BAS Claire Waluda, BAS Gabriele Stowasser, BAS Ryan Saunders, BAS

	Sophie Fielding, BAS Mark Belchier, BAS Tracey Dornan, BAS John Horne, University of Washington Charlotte Haverman, XXX Christian Reiss, NOAA José Seco, University of Coimbra, University of Aveiro and University of St. Andrews José Xavier, BAS, University of Coimbra, University of Aveiro Rokas Kubilius, Institute of Marine Research

Table 13-15: SUCS camera data details and usage

Instrument	**SUCS**		
Data	Raw	.raw	/data/cruise/jcr/current/sucs
Use of data during cruise	Data was used to determine a safe anchor point at station 3, as well as to look at the sea floor before deploying both of the Signy moorings.		
Paper logs	None		
Digital logs	None. Recorded in bridge event log.		
Long term data management	Data will be stored on the SAN at BAS.		

Table 13-16: Stereo camera data details and usage

Instrument	**Stereo camera**	
Data	Raw	/data/cruise/jcr/current/work/scientific_work_areas/Stereo_Camera/YYYYMMDD_Deployment_X_event_XXX
Paper logs	None	
Digital logs	Stereo_camera	
Calibration	Test deployments were done when the JCR was still moored in Stanley and Mare Harbour before the cruise began.	
Long term data management	Data will be stored on the SAN at BAS.	
Other users of the data	Rokas Kubilius, Institute of Marine Research Olav Rune Godo, Institute of Marine Research	

Table 13-17: Mooring data details and usage

Instrument	**Moorings: Signy deep (southern), Signy shallow (northern) and IMR mooring**	
Data (Signy moorings only)	Set-up	Software and configuration details can be found in the Moorings section of this report as well as in the subfolders of /data/cruise/jcr/current/work/scientific_work_areas/Moorings/Sig_S and Sig_N

	Output data	Sub-folders within /data/cruise/jcr/current/work/scientific_work_areas/Moorings/Sig_S and Sig_N
Long term data management	Data will be stored on the SAN at BAS for the Signy moorings.	
Other users of the data	Olav Rune Godo, Institute of Marine Research – will be passing the WBAT data to Gavin Macaulay at Institute of Marine Research to investigate the data. Nothing will be done with these data before consultation with BAS.	

Table 13-18: SCS Underway data details and usage

Instrument	**SCS Underway**	
Data	Raw	/data/cruise/jcr/current/scs
Long term data management	Data will be stored on the SAN at BAS.	
Other users of the data	Christian Reiss, NOAA	

Table 13-19: At sea predator observations data details and usage

Instrument	**Predator observations**	
Data	Raw	/data/cruise/jcr/current/work/scientific_work_areas/predators/observations/observations_data_20160215.xslx
	Processed	/data/cruise/jcr/current/work/scientific_work_areas/predators/observations/observations_data_cleaned.xls has undergone some checking
Long term data management	Data will be stored on the SAN at BAS and will be combined with observation data collected in 2013 from the Saga Sea and Juvel fishing vessels, as well as possibly some Soviet whaling data.	
Other users of the data	Phil Trathan, BAS Claire Waluda, BAS Jenny Thomas, BAS Jon Watkins, BAS	

Table 13-20: Predator tracking data details and usage

Instrument	**Predator tracking – not collected during JR15004 but supplementary data that will be involved when doing the analysis for this investigation.**
Data	Raw data are held by field parties. Information about the Sono.Vault data collected on the moorings deployed on this cruise are noted in the Moorings section of this part of this report.
Those involved in data collection	Phil Trathan and Catrin Thomas (BAS) – Chinstrap Penguins, Monroe Island Iain Staniland (BAS), Gabriel Chevalier and Andy Lowther (IMR) – Fur Seals and Chinstrap Penguins, Powell Island

	Norman Ratcliffe (BAS) – Chinstrap Penguins, Gentoo Penguins, Signy Island. Predator tracking data and ship operations were coordinated on board by Claire Waluda (BAS).

Table 13-21: Underway water flow sampling data details and usage

Instrument	**Underway water flow sampling**
Samples	Taken by Gabi Stowasser (when she took bottle samples from the CTD). Details in /data/cruise/jcr/current/work/scientific_work_areas/Underway/POM sample JR15004.xls
Long term data management	This data will be stored on the SAN at BAS.

13.5.1 PML Satellite Data

Following a request from O.R. Godø prior to the cruise, satellite data was requested from Plymouth Marine Laboratory (PML). Initially contact was made through Andrew Fleming, then liaison was done with Ben Taylor. To begin with, the data manager was given access to the region "PH" (Falkland Islands, south to 65°S and east to South Georgia) through the NEODAAS portal (https://www.neodaas.ac.uk/multiview/) which provided weekly composite images of sea-surface temperature (sst) and chlorophyll-a (chl-a).
Data in: respective folders within /data/cruise/jcr/current/work/scientific_work_areas/satellite_data

From the beginning of February, the data were then made available on a daily basis via FTP site. These data were downloaded every few hours by Jeremy Robst and the data stored.

Data in: .png (image) files as well as data and metadata files are in /data/cruise/jcr/current/work/PML_Satellite_Images

The next cruise on board the JCR requested that these data streams continue to be pulled onto the ship for the use of the on-board scientists, and the future use of this service will be discussed with the Marine Data Manager within the Polar Data Centre following JR15004.

13.5.2 Data requests

A number of data requests were worked on during the cruise. The majority of these related to creating maps of the cruise track, stations and events and pulling data from various underway data streams.

Table 13-22: Data requests undertaken during JR15004

Date	Request	Output (in /data/cruise/jcr/current/work/data_management/data_requests)
18/02/2016	Predator track maps – mapping of tracking data from islands	2016-01-18_predator_tracks_map

26/01/2016	Map of planned surveys and stations	2016-01-26_cruise_planning
26/01/2016	Transect and station numbering for NS transect	2016-01-26_station_numbers_ns_transect
26/01/2016	Transect numbers for post calibration survey and other surveys	2016-01-26_transect_numbering
28/01/2016	Cruise track for western canyon survey (swath survey)	2016-01-28_west_canyon_survey_track
29/01/2016	GPS stream comparison	2016-01-29_test_gps_streams
05/02/2016	Extraction of data from netmonitor stream	2016-02-05_rokas_netmonitor_data
12/02/2016	Coverage of swath bathymetry data collected (in preparation for upcoming JCR cruise)	2016-02-12_tate_bathymetry
Throughout cruise	Maps of cruise tracks, stations, transects, events	cruise_planning
Prior to cruise	Bathymetry of canyons (western canyon) around South Orkneys	s_orkney_bathymetry
Transect start and end points	Start and end times of transects in cruise	transects

13.6 Recommendations, notes and concerns

13.6.1 Event logs

Whilst the event log system in its current form is essential to keep track of deployments during the cruise, it would be very useful to have a system which is much more integrated into other aspects. In order to consider how this could work and suit all involved parties, a discussion follows about several aspects that could, in theory, be incorporated.

Firstly, a system where the PSO was able to plan the waypoints, then send them directly to the bridge would avoid the PSO having to do this in one system and pass them hand-written to the bridge. Additionally, it could be possible to number transects, stations and surveys within the software so that this does not have to be done manually. It would also help to ensure that repeated stations are named the same. Having the facility to be able to export the exact locations as well as the start and end times and positions of stations and transects would help to avoid a lot of manual joining together of different bits of information from different sources.

A couple of simple(?) modifications to the current event logging system would help to alleviate simple errors and make life easier for the officers on watch. The first one would be to have a drop-down list of event numbers (so that the officers on watch can just select the next one, rather than having to look back in the log). The second would be to be able to load a list of the equipment to be used during the cruise (using a controlled vocabulary – BODC equipment list?) and have this available as a drop-down menu in the bridge event log. This latter point would serve two obvious purposes: firstly it would mean the officer would not have to type the name of the equipment each time (avoiding the use of different names/spellings by different people) and secondly it would allow the bridge log (when exported) to be easily searchable by the piece of equipment. This feeds nicely into being able to extract information for entering events into the tables for the marine database event log as well as to be able to use the information more easily with the dps package (set up by Jeremy Robst, ICT; available in /data/packages/current/samples – very useful!) which allows the joining of data sets.

Following on from drop-down lists for the bridge officers, it would also be really useful if the scientists could choose from a drop-down list of already-created events when entering their data. Ideally this list could contain the event number and the assigned piece of equipment, eg. 003 CTD.

13.6.2 Scripts for populating event information for MARINE database (for marine metadata portal)

There was some concern that some of the data sources used for populating the MARINE database events table are not fully understood. For instance, the EA600 source for water depth is unprocessed and this is not necessarily clear when entering the data source. Additionally, if the stream of EA600 data is pulled directly into the digital event log and used for populating the database, it may not be noticed when the echo sounder gives erroneous readings (happened fairly frequent on JR15004).

A lot of the data entry is fairly manual and is taken from readings by humans (read time for example, when the CTD is entering the water). The dps package (allows the joining of data sets and extraction of information from data files – see /data/packages/current/samples, created by Jeremy Robst, ICT) would be very useful in extracting some of this information such as has been done for the CTD bottles (set up on JR15002) and is done for the net opening and closing data (set up for Sophie Fielding on a previous cruise). This would take away a lot of repeated data entry by the data manager (avoiding typos) as well extracting information directly from the data files. This is not to say that the paper logs (and even digital event logs) are not a useful backup for if there were errors with the computer system, but they could be used to make the data entry much more efficient and less prone to errors.

14 JR15004 ICT Engineer's Report

Jeremy Robst, BAS

14.1 Data Logging / SCS

The SCS server and data logging systems worked well throughout the cruise. Table 14-1 describes the data logging events.

Table 14-1: Data logging events during JR15004

Time & Date (GMT)	Event
2016/01/13 15:33	ACQ restarted, newleg run (**Cruise: 20160113**)
2016/01/19 16:50	Power failue, approx. 10 mins. ACQ restarted at 17:10
2016/01/29 00:54	Oceanlogger stopped logging until 01:10
2016/02/02 16:59	ESX servers turned themselves off. Restarted 17:11, ACQ restarted 17:27
2016/02/02 21:50	Oceanlogger stopped logging. Had to reboot PC to restart logging at 22:07
2016/02/03 06:52	VEEAM backup caused Samba issue on JRLB. ACQ restart 07:00
2016/02/10 00:10	Oceanlogger didn't log between 00:10 and 00:51. Rebooted 03:25
2016/02/10 01:57	VEEAM backup caused Samba issue on JRLB. ACQ restart 02:34 and 02:35.
2016/02/15 01:57	VEEAM backup caused Samba issue on JRLB. ACQ restart 02:05
2016/02/16 17:07	ESX servers turned themselves off. Restart 17:11. ACQ restart 17:20
2016/02/23 00:00	ACQ restarted, newleg run

14.2 Oceanlogger

The Oceanlogger software would occasionally stop logging or reduce the logging frequency from every 5s to every 15-20s. On 10th Feb 2016 Mark Preston (AME) rebooted the flowmeter, this appeared to help the situation.

14.3 Seatex

We noticed the seatex-gga stream was outputting less records than the furuno-gga stream. We did not find a reason for this.

14.4 Other systems

The VEEAM backup system would fail and required the VEEAM servers to be rebooted around 1/week. Twice the ESX servers turned themselves off, for no apparent reason. One PSU from each ESX server has now been plugged into the wall supply, in case the issue is with the UPS.

JRLB has been removed from the nightly VEEAM backup as this was causing problems with the Samba service resulting in logging of various instruments stopping.

15 Appendices

15.1 JR15004 Event Log

Table 15-1: Event log for JR15004 showing start and end times with positions for each event. Station numbers can be found on XXX and Module names are described in Section YYY

Event	Start Time	Start lat	Start lon	End Time	End lat	End lon	Equipment	Station number	Module name
109	21/02/2016 01:15	-52.3776	-57.6281	21/02/2016 10:48	-52.3123	-57.7139	ADCP		Calibration
108	19/02/2016 09:57	-56.9944	-51.5990	19/02/2016 10:53	-56.9864	-51.6109	CTD	S058	Polar Front
107	19/02/2016 08:17	-57.0043	-51.5813	19/02/2016 09:23	-56.9984	-51.5931	CTD	S058	Polar Front
106	19/02/2016 06:23	-57.0556	-51.4871	19/02/2016 07:55	-57.0063	-51.5783	RMT8		Polar Front
105	19/02/2016 04:08	-57.0567	-51.4865	19/02/2016 05:42	-57.0098	-51.5865	RMT8		Polar Front
104	19/02/2016 01:24	-57.0309	-51.5667	19/02/2016 02:57	-57.0123	-51.6775	RMT8		Polar Front
103	15/02/2016 05:03	-60.2827	-46.4244	15/02/2016 05:44	-60.2826	-46.4243	Stereo Camera	S057	Large krill aggregation study
102	15/02/2016 03:13	-60.2932	-46.4322	15/02/2016 03:30	-60.2994	-46.4372	RMT8		Large krill aggregation study
101	15/02/2016 01:04	-60.3080	-46.4263	15/02/2016 02:05	-60.3062	-46.4264	Stereo Camera	S056	Large krill aggregation study
100	15/02/2016 00:12	-60.3143	-46.4261	15/02/2016 00:52	-60.3080	-46.4263	CTD	S055	Large krill aggregation study
99	14/02/2016 23:38	-60.3065	-46.4246	14/02/2016 23:57	-60.3145	-46.4249	RMT8		Large krill aggregation study
98	14/02/2016 21:37	-60.3076	-46.4557	14/02/2016 22:34	-60.3076	-46.4557	CTD	S054	Large krill aggregation study
97	14/02/2016 20:37	-60.2911	-46.4534	14/02/2016 20:50	-60.2957	-46.4508	RMT8		Large krill aggregation study
96	14/02/2016 02:44	-60.3073	-46.7017	14/02/2016 04:43	-60.3492	-46.6496	RMT25		Medium scale survey
95	12/02/2016 14:13	-60.4011	-46.2906	12/02/2016 14:52	-60.4050	-46.3003	Mooring	S053	
94	12/02/2016 11:14	-60.4475	-46.5322	12/02/2016 11:50	-60.4507	-46.5431	Mooring	S010	Western canyon study
93	12/02/2016 09:11	-60.5500	-46.5019	12/02/2016 10:04	-60.5459	-46.5190	Mooring	S011	Western canyon study
92	10/02/2016 22:42	-60.3499	-46.6511	10/02/2016 23:24	-60.3500	-46.6511	CTD	S052	Fine scale fishing survey

91	09/02/2016 22:51	-60.2378	-46.1964	10/02/2016 01:20	-60.2888	-46.2422	RMT25	S051	Medium scale survey
90	09/02/2016 21:20	-60.2790	-46.2267	09/02/2016 22:08	-60.2790	-46.2267	CTD	S051	Medium scale survey
89	09/02/2016 15:04	-60.3189	-46.6200	09/02/2016 15:44	-60.3190	-46.6200	CTD	S050	Large krill aggregation study
88	09/02/2016 09:58	-60.3838	-46.6177	09/02/2016 10:19	-60.3837	-46.6177	CTD	S024	Western canyon study
87	09/02/2016 08:10	-60.4820	-46.5490	09/02/2016 08:41	-60.4820	-46.5491	CTD	S018	Western canyon study
86	09/02/2016 03:19	-60.5399	-46.5345	09/02/2016 04:07	-60.5257	-46.5685	RMT8		Western canyon study
85	09/02/2016 01:55	-60.5458	-46.5726	09/02/2016 02:26	-60.5266	-46.5878	RMT8		Western canyon study
84	09/02/2016 00:01	-60.5825	-46.5198	09/02/2016 00:38	-60.5638	-46.5498	RMT8		Western canyon study
83	08/02/2016 05:02	-60.2792	-46.5946	08/02/2016 06:11	-60.2792	-46.5946	Stereo Camera	S047	Large krill aggregation study
82	08/02/2016 03:38	-60.3177	-46.4916	08/02/2016 04:15	-60.3063	-46.5152	RMT8	S048	Large krill aggregation study
81	08/02/2016 01:43	-60.2811	-46.5744	08/02/2016 02:45	-60.2811	-46.5744	Stereo Camera	S047	Large krill aggregation study
80	08/02/2016 00:16	-60.2869	-46.5615	08/02/2016 01:16	-60.2869	-46.5615	CTD	S047	Large krill aggregation study
79	07/02/2016 23:26	-60.2990	-46.5297	07/02/2016 23:58	-60.2876	-46.5599	RMT8	S047	Large krill aggregation study
78	07/02/2016 21:19	-60.3182	-46.4157	07/02/2016 22:20	-60.3182	-46.4157	CTD	S046	Large krill aggregation study
77	07/02/2016 20:26	-60.3293	-46.3888	07/02/2016 21:06	-60.3186	-46.4151	RMT8	S046	Large krill aggregation study
76	05/02/2016 21:17	-60.2749	-44.9987	05/02/2016 21:59	-60.2752	-44.9998	CTD	S045	Medium scale survey
75	05/02/2016 19:11	-60.3975	-44.9995	05/02/2016 19:50	-60.3975	-44.9996	CTD	S044	Medium scale survey
74	05/02/2016 16:54	-60.5501	-45.0005	05/02/2016 17:15	-60.5501	-45.0006	CTD	S043	Medium scale survey
73	05/02/2016 02:40	-60.1027	-46.0406	05/02/2016 04:40	-60.1220	-46.0965	RMT25	S042	Medium scale survey
72	04/02/2016 23:10	-60.0749	-46.0629	05/02/2016 01:45	-60.1343	-46.0896	RMT25	S042	Medium scale survey
71	04/02/2016 21:35	-60.1243	-46.0772	04/02/2016 22:25	-60.1244	-46.0771	CTD	S042	Medium scale survey
70	04/02/2016 19:56	-60.2491	-46.0377	04/02/2016 20:02	-60.2491	-46.0378	CTD	S041	Medium scale survey
69	04/02/2016 18:50	-60.2405	-46.0774	04/02/2016 19:32	-60.2473	-46.0410	Wire test	S041	Medium scale survey
68	04/02/2016 18:22	-60.2404	-46.0773	04/02/2016 18:30	-60.2405	-46.0774	CTD	S041	Medium scale survey
67	04/02/2016 08:26	-60.2897	-46.6489	04/02/2016 09:13	-60.2897	-46.6490	CTD	S040	Medium scale survey
66	04/02/2016 02:19	-60.0311	-46.6163	04/02/2016 04:28	-59.9802	-46.6412	RMT25	S039	Medium scale survey
65	03/02/2016 22:48	-60.0307	-46.5882	04/02/2016 01:15	-59.9860	-46.6373	RMT25	S039	Medium scale survey

64	03/02/2016 21:03	-59.9999	-46.6492	03/02/2016 21:51	-60.0001	-46.6499	CTD	S039	Medium scale survey
63	03/02/2016 13:22	-60.7991	-47.2509	03/02/2016 14:09	-60.7991	-47.2510	CTD	S038	Medium scale survey
62	03/02/2016 09:10	-60.3335	-47.2493	03/02/2016 09:57	-60.3335	-47.2494	CTD	S037	Medium scale survey
61	03/02/2016 02:05	-59.9615	-47.1882	03/02/2016 03:45	-59.9983	-47.2339	RMT25	S036	Medium scale survey
60	02/02/2016 21:59	-59.9668	-47.1836	03/02/2016 00:48	-60.0236	-47.2574	RMT25	S036	Medium scale survey
59	02/02/2016 20:19	-59.9996	-47.2503	02/02/2016 21:08	-59.9996	-47.2503	CTD	S036	Medium scale survey
58	02/02/2016 14:15	-60.6734	-47.4938	02/02/2016 14:54	-60.6734	-47.4938	CTD	S035	Medium scale survey
57	02/02/2016 06:16	-60.2702	-46.8428	02/02/2016 07:06	-60.2702	-46.8428	Stereo Camera	S034	Behavioural studies
56	02/02/2016 03:54	-60.2867	-46.8457	02/02/2016 04:27	-60.3064	-46.8508	RMT8	S034	Behavioural studies
55	02/02/2016 01:52	-60.3180	-46.8517	02/02/2016 02:35	-60.3154	-46.8522	Stereo Camera	S034	Behavioural studies
54	02/02/2016 01:01	-60.3094	-46.8466	02/02/2016 01:21	-60.3191	-46.8522	RMT8	S033	Behavioural studies
53	02/02/2016 00:22	-60.3077	-46.8456	02/02/2016 00:33	-60.3077	-46.8455	SUCS	S033	Behavioural studies
52	01/02/2016 22:35	-60.3045	-46.8300	01/02/2016 23:50	-60.3070	-46.8310	CTD	S032	Behavioural studies
51	01/02/2016 19:35	-60.3150	-46.7917	01/02/2016 20:27	-60.3150	-46.7906	Stereo Camera	S031	Behavioural studies
50	01/02/2016 06:23	-60.5429	-46.5035	01/02/2016 07:10	-60.5428	-46.4960	Stereo Camera	S029	Western canyon study
49	01/02/2016 02:54	-60.4813	-46.6370	01/02/2016 04:24	-60.4813	-46.6369	CTD	S016	Western canyon study
48	31/01/2016 20:57	-60.3829	-46.7396	31/01/2016 21:16	-60.3829	-46.7396	CTD	S027	Western canyon study
47	31/01/2016 20:12	-60.3829	-46.6950	31/01/2016 20:27	-60.3829	-46.6951	CTD	S026	Western canyon study
46	31/01/2016 19:25	-60.3821	-46.6521	31/01/2016 19:36	-60.3821	-46.6522	CTD	S025	Western canyon study
45	31/01/2016 18:22	-60.3835	-46.6073	31/01/2016 18:45	-60.3835	-46.6073	CTD	S024	Western canyon study
44	31/01/2016 17:23	-60.3832	-46.5647	31/01/2016 17:43	-60.3832	-46.5648	CTD	S023	Western canyon study
43	31/01/2016 16:15	-60.3838	-46.5218	31/01/2016 16:40	-60.3838	-46.5217	CTD	S022	Western canyon study
42	31/01/2016 15:01	-60.3822	-46.4753	31/01/2016 15:33	-60.3821	-46.4753	CTD	S021	Western canyon study
41	31/01/2016 12:45	-60.4818	-46.6376	31/01/2016 12:56	-60.4818	-46.6376	CTD	S020	Western canyon study
40	31/01/2016 11:48	-60.4820	-46.5933	31/01/2016 12:10	-60.4820	-46.5934	CTD	S019	Western canyon study
39	31/01/2016 10:25	-60.4824	-46.5476	31/01/2016 11:00	-60.4824	-46.5490	CTD	S018	Western canyon study
38	31/01/2016 09:41	-60.4830	-46.5052	31/01/2016 09:59	-60.4830	-46.5053	CTD	S017	Western canyon study

37	31/01/2016 09:08	-60.4832	-46.4608	31/01/2016 09:18	-60.4832	-46.4609	CTD	S016	Western canyon study
36	31/01/2016 03:26	-60.5210	-46.5886	31/01/2016 06:27	-60.5696	-46.4909	Deep water micro survey	S011	Western canyon study
35	30/01/2016 21:11	-60.4997	-47.2482	30/01/2016 21:33	-60.4997	-47.2482		S014	Medium scale survey
34	30/01/2016 15:48	-60.5471	-46.5177	30/01/2016 16:41	-60.5545	-46.5141	Mooring	S011	Western canyon study
33	30/01/2016 14:40	-60.5502	-46.5058	30/01/2016 15:16	-60.5502	-46.5142	Mooring	S011	Western canyon study
32	30/01/2016 13:32	-60.5505	-46.5079	30/01/2016 14:03	-60.5503	-46.5113	Mooring	S011	Western canyon study
31	30/01/2016 00:37	-60.2161	-46.8414	30/01/2016 03:15	-60.2161	-46.8414	ADCP		Calibration
30	29/01/2016 19:13	-60.5569	-46.5077	29/01/2016 21:50	-60.5565	-46.5079	Mooring	S011	Western canyon study
29	29/01/2016 15:35	-60.4573	-46.5285	29/01/2016 16:44	-60.4502	-46.5406	Mooring	S010	Western canyon study
28	28/01/2016 22:13	-60.5501	-46.5126	28/01/2016 23:03	-60.5486	-46.5128	SUCS	S011	Western canyon study
27	28/01/2016 19:49	-60.4507	-46.5409	28/01/2016 20:35	-60.4509	-46.5393	SUCS	S010	Western canyon study
26	27/01/2016 21:49	-61.9998	-47.4993	27/01/2016 22:44	-61.9996	-47.4976	Mammoth	S009	NS transect
25	27/01/2016 20:54	-61.9998	-47.4993	27/01/2016 21:38	-61.9998	-47.4992	CTD	S009	NS transect
24	27/01/2016 16:38	-61.4976	-47.4961	27/01/2016 17:18	-61.4974	-47.4915	Stereo Camera	S008	NS transect
23	27/01/2016 15:20	-61.4976	-47.4958	27/01/2016 16:15	-61.4976	-47.4959	Mammoth	S008	NS transect
22	27/01/2016 14:14	-61.4976	-47.4960	27/01/2016 15:05	-61.4976	-47.4960	CTD	S008	NS transect
21	27/01/2016 09:50	-60.9997	-47.5005	27/01/2016 10:46	-60.9998	-47.5005	Mammoth	S007	NS transect
20	27/01/2016 08:35	-60.9998	-47.5004	27/01/2016 09:20	-60.9999	-47.5002	CTD	S007	NS transect
19	27/01/2016 04:00	-60.5000	-47.5003	27/01/2016 05:00	-60.5002	-47.5010	Mammoth	S006	NS transect
18	27/01/2016 03:08	-60.5000	-47.5002	27/01/2016 03:46	-60.5000	-47.5001	CTD	S006	NS transect
17	26/01/2016 22:51	-59.9996	-47.5005	26/01/2016 23:45	-59.9997	-47.5012	Mammoth	S005	NS transect
16	26/01/2016 21:51	-59.9996	-47.5005	26/01/2016 22:35	-59.9998	-47.5011	CTD	S005	NS transect
15	26/01/2016 17:33	-59.5014	-47.5075	26/01/2016 18:21	-59.5014	-47.5073	Mammoth	S004	NS transect
14	26/01/2016 14:54	-59.5015	-47.5074	26/01/2016 15:58	-59.5014	-47.5074	Mammoth	S004	NS transect
13	26/01/2016 13:53	-59.5015	-47.5075	26/01/2016 14:40	-59.5015	-47.5075	CTD	S004	NS transect
12	25/01/2016 13:05	-60.7487	-44.7099	25/01/2016 16:15	-60.7489	-44.7099	RV Doughnut	S003	Calibration
11	25/01/2016 11:45	-60.7492	-44.7093	25/01/2016 12:53	-60.7490	-44.7100	RV Doughnut	S003	Calibration

10	24/01/2016 21:55	-60.7490	-44.7084	24/01/2016 23:08	-60.7490	-44.7081	RV Doughnut	S003	Calibration
9	24/01/2016 20:08	-60.7483	-44.7076	24/01/2016 21:15	-60.7482	-44.7074	RV Doughnut	S003	Calibration
8	24/01/2016 16:55	-60.7481	-44.7061	24/01/2016 17:00	-60.7482	-44.7059	CTD	S003	Calibration
7	24/01/2016 15:52	-60.7483	-44.7082	24/01/2016 15:57	-60.7482	-44.7082	SUCS	S003	Calibration
6	22/01/2016 19:38	-54.7591	-53.6741	22/01/2016 19:47	-54.7592	-53.6740	Mammoth	S002	
5	22/01/2016 18:27	-54.7610	-53.6547	22/01/2016 18:45	-54.7613	-53.6673	RMT25	S002	
4	22/01/2016 17:43	-54.7618	-53.6129	22/01/2016 18:08	-54.7603	-53.6348	RMT25	S002	
3	22/01/2016 16:35	-54.7644	-53.5728	22/01/2016 16:52	-54.7635	-53.5741	CTD	S002	
2	22/01/2016 12:50	-54.5760	-53.8274	22/01/2016 14:40	-54.5819	-53.8288	Wire test	S001	
1	20/01/2016 12:00	-51.9010	-58.4486	20/01/2016 12:00	-51.9010	-58.4486	EM2040		

15.2 Transect log

Table 15-2: Transect log for cruise JR15004. ª indicates start and end times derived from inspection of ArcMap track plots

Survey	Cruise Module	Transect number	Start date	Start time	Start lat	Start lon	End date	End time	End lat	End lon	Comment
Post calibration survey	Post calibration survey	T001[a]	25/01/2016	18:35:00	-60.7760	-44.8462	25/01/2016	20:45:00	-60.4279	-45.0867	
Post calibration survey	Post calibration survey	T002[a]	25/01/2016	20:45:00	-60.4279	-45.0867	25/01/2016	21:51:00	-60.4664	-45.4893	
Post calibration survey	Post calibration survey	T003[a]	25/01/2016	21:51:00	-60.4664	-45.4893	25/01/2016	23:55:00	-60.3001	-46.1065	
Post calibration survey	Post calibration survey	T004[a]	25/01/2016	23:55:00	-60.3001	-46.1065	26/01/2016	01:13:00	-60.5024	-46.0877	
Post calibration survey	Post calibration survey	T005[a]	26/01/2016	01:13:00	-60.5024	-46.0877	26/01/2016	03:45:00	-60.2821	-46.6283	
Post calibration survey	Post calibration survey	T006[a]	26/01/2016	03:45:00	-60.2821	-46.6283	26/01/2016	05:43:00	-60.5878	-46.4986	
Post calibration survey	Post calibration survey	T007[a]	26/01/2016	05:43:00	-60.5878	-46.4986	26/01/2016	08:29:00	-60.2719	-47.0761	
NS transect	NS transect	T008	26/01/2016	18:35:00	-59.5017	-47.5058	26/01/2016	21:42:00	-59.9997	-47.5009	
NS transect	NS transect	T009	26/01/2016	23:51:00	-59.9997	-47.5012	27/01/2016	03:05:00	-60.5000	-47.5001	
NS transect	NS transect	T010	27/01/2016	05:11:00	-60.5002	-47.5008	27/01/2016	08:28:00	-60.9998	-47.5003	
NS transect	NS transect	T011	27/01/2016	10:55:00	-61.0019	-47.5026	27/01/2016	14:10:00	-61.4976	-47.4960	
NS transect	NS transect	T012	27/01/2016	17:22:00	-61.4974	-47.4908	27/01/2016	20:46:00	-62.0000	-47.4986	
Inaccessible western canyon swath survey	Western canyon study	T020[a]	28/01/2016	08:11:00	-60.6299	-46.4961	28/01/2016	08:30:00	-60.6165	-46.3928	
Inaccessible western canyon swath survey	Western canyon study	T021[a]	28/01/2016	08:50:00	-60.5846	-46.4180	28/01/2016	09:15:00	-60.5837	-46.5530	
Inaccessible western canyon swath survey	Western canyon study	T022[a]	28/01/2016	09:30:00	-60.5510	-46.5966	28/01/2016	10:09:00	-60.5510	-46.3860	
Inaccessible western canyon swath survey	Western canyon study	T023[a]	28/01/2016	11:02:00	-60.5169	-46.5152	28/01/2016	11:20:00	-60.5162	-46.6088	
Inaccessible western canyon swath survey	Western canyon study	T024[a]	28/01/2016	11:34:00	-60.4820	-46.6405	28/01/2016	12:06:00	-60.4830	-46.4600	
Inaccessible western canyon swath survey	Western canyon study	T025[a]	28/01/2016	12:27:00	-60.4504	-46.5416	28/01/2016	12:53:00	-60.4494	-46.6839	
Inaccessible western canyon swath survey	Western canyon study	T026[a]	28/01/2016	13:09:00	-60.4174	-46.7290	28/01/2016	13:56:00	-60.4159	-46.4748	

Inaccessible western canyon swath survey	Western canyon study	T027[a]	28/01/2016	14:18:00	-60.3831	-46.4857	28/01/2016	15:04:00	-60.3834	-46.7396	
Inaccessible western canyon swath survey	Western canyon study	T028[a]	28/01/2016	15:17:00	-60.3505	-46.7427	28/01/2016	16:09:00	-60.3499	-46.4716	
Inaccessible western canyon swath survey	Western canyon study	T029[a]	28/01/2016	16:22:00	-60.3169	-46.4711	28/01/2016	17:10:00	-60.3169	-46.7418	
Inaccessible western canyon survey EK60 survey	Western canyon study	T020[a]	29/01/2016	00:17:00	-60.6319	-46.5030	29/01/2016	00:39:00	-60.6163	-46.3922	
Inaccessible western canyon survey EK60 survey	Western canyon study	T021[a]	29/01/2016	00:56:00	-60.5857	-46.4163	29/01/2016	01:21:00	-60.5830	-46.5540	
Inaccessible western canyon survey EK60 survey	Western canyon study	T022[a]	29/01/2016	01:35:00	-60.5522	-46.5841	29/01/2016	02:10:00	-60.5508	-46.3923	
Inaccessible western canyon survey EK60 survey	Western canyon study	T023[a]	29/01/2016	02:34:00	-60.5201	-46.4700	29/01/2016	02:58:00	-60.5170	-46.6031	
Inaccessible western canyon survey EK60 survey	Western canyon study	T024[a]	29/01/2016	03:14:00	-60.4811	-46.6416	29/01/2016	03:50:00	-60.4811	-46.4631	
Inaccessible western canyon survey EK60 survey	Western canyon study	T025[a]	29/01/2016	04:11:00	-60.4511	-46.5412	29/01/2016	04:36:00	-60.4500	-46.6796	
Inaccessible western canyon survey EK60 survey	Western canyon study	T026[a]	29/01/2016	04:53:00	-60.4171	-46.7284	29/01/2016	05:39:00	-60.4167	-46.4767	
Inaccessible western canyon survey EK60 survey	Western canyon study	T027[a]	29/01/2016	05:54:00	-60.3828	-46.4809	29/01/2016	06:41:00	-60.3836	-46.7361	
Inaccessible western canyon survey EK60 survey	Western canyon study	T028[a]	29/01/2016	06:55:00	-60.3520	-46.7430	29/01/2016	07:45:00	-60.3504	-46.4748	
Inaccessible western canyon survey EK60 survey	Western canyon study	T029[a]	29/01/2016	07:59:00	-60.3169	-46.4701	29/01/2016	08:50:00	-60.3170	-46.7457	
Finescale fishery survey T033	Finescale survey	T033[a]	30/01/2016	04:00:00	-60.1532	-46.8496	30/01/2016	05:50:00	-60.4562	-46.8500	
Finescale fishery survey T033	Finescale survey	T033[a]	30/01/2016	05:56:00	-60.4597	-46.8495	30/01/2016	07:48:00	-60.1489	-46.8497	
Inaccessible western canyon survey EK60 survey	Western canyon study	T020[a]	01/02/2016	08:57:00	-60.6327	-46.5054	01/02/2016	09:19:00	-60.6161	-46.3894	
Inaccessible western canyon survey EK60 survey	Western canyon study	T021[a]	01/02/2016	09:38:00	-60.5857	-46.4160	01/02/2016	10:07:00	-60.5831	-46.5545	
Inaccessible western canyon survey EK60 survey	Western canyon study	T022[a]	01/02/2016	10:25:00	-60.5481	-46.5910	01/02/2016	11:01:00	-60.5509	-46.3914	
Inaccessible western canyon survey EK60 survey	Western canyon study	T023[a]	01/02/2016	11:30:00	-60.5193	-46.4757	01/02/2016	11:58:00	-60.5162	-46.6025	
Inaccessible western canyon survey EK60 survey	Western canyon study	T024[a]	01/02/2016	12:14:00	-60.4819	-46.6438	01/02/2016	12:51:00	-60.4842	-46.4454	
Inaccessible western canyon survey EK60 survey	Western canyon study	T025[a]	01/02/2016	13:20:00	-60.4505	-46.5379	01/02/2016	13:53:00	-60.4490	-46.6840	
Inaccessible western canyon survey EK60 survey	Western canyon study	T026[a]	01/02/2016	14:11:00	-60.4184	-46.7306	01/02/2016	14:57:00	-60.4153	-46.4781	

Inaccessible western canyon survey EK60 survey	Western canyon study	T027[a]	01/02/2016	15:10:00	-60.3832	-46.4780	01/02/2016	16:15:00	-60.3836	-46.7382	
Inaccessible western canyon survey EK60 survey	Western canyon study	T028[a]	01/02/2016	16:29:00	-60.3490	-46.7410	01/02/2016	17:17:00	-60.3497	-46.4721	
Inaccessible western canyon survey EK60 survey	Western canyon study	T029[a]	01/02/2016	17:30:00	-60.3159	-46.4719	01/02/2016	18:36:00	-60.3167	-46.7493	
Medium scale survey	Medium scale survey	T050	02/02/2016	15:03:00	-60.6734	-47.4938	02/02/2016	21:42:00	-59.9614	-47.1670	
Medium scale survey	Medium scale survey	T051[a]	03/02/2016	06:36:00	-59.9997	-47.2505	03/02/2016	09:05:00	-60.3333	-47.2492	paused for S037
Medium scale survey	Medium scale survey	T051	03/02/2016	10:00:00	-60.3335	-47.2494	03/02/2016	13:18:00	-60.7991	-47.2510	
Medium scale survey	Medium scale survey	T052[a]	03/02/2016	15:09:00	-60.7996	-47.0017	03/02/2016	19:49:00	-60.0025	-47.0001	
Medium scale survey	Medium scale survey	T053[a]	04/02/2016	06:37:00	-60.0013	-46.6477	04/02/2016	08:24:00	-60.2900	-46.6494	paused for S040
Medium scale survey	Medium scale survey	T053	04/02/2016	09:20:00	-60.2897	-46.6490	04/02/2016	10:35:00	-60.4091	-46.6496	
Medium scale survey	Medium scale survey	T054[a]	04/02/2016	11:13:00	-60.4076	-46.4891	04/02/2016	13:03:00	-60.1570	-46.4975	
Medium scale survey	Medium scale survey	T055[a]	04/02/2016	13:58:00	-60.1561	-46.2601	04/02/2016	15:25:00	-60.3959	-46.2504	
Medium scale survey	Medium scale survey	T056[a]	04/02/2016	16:32:00	-60.5012	-46.0780	04/02/2016	18:00:00	-60.2547	-46.0782	paused for S041
Medium scale survey	Medium scale survey	T056[a]	04/02/2016	20:30:00	-60.2372	-46.0753	04/02/2016	21:32:00	-60.1239	-46.0777	
Medium scale survey	Medium scale survey	T057[a]	05/02/2016	07:21:00	-60.0022	-45.7478	05/02/2016	10:02:00	-60.4247	-45.7484	
Medium scale survey	Medium scale survey	T058[a]	05/02/2016	11:14:00	-60.4562	-45.5037	05/02/2016	12:56:00	-60.1993	-45.5002	
Medium scale survey	Medium scale survey	T059[a]	05/02/2016	13:55:00	-60.2874	-45.2482	05/02/2016	15:29:00	-60.5332	-45.2406	
Medium scale survey	Medium scale survey	T060[a]	05/02/2016	17:38:00	-60.5501	-45.0026	05/02/2016	18:30:00	-60.4126	-44.9993	paused for S043
Medium scale survey	Medium scale survey	T060[a]	05/02/2016	20:06:00	-60.3963	-44.9999	05/02/2016	20:52:00	-60.2834	-44.9969	
Large krill aggregation study mapping day 1	Large krill aggregation study	T077_ 070216[a]	07/02/2016	13:09:00	-6.3274	-46.4134	07/02/2016	13:25:00	-60.2960	-46.4231	
Large krill aggregation study mapping day 1	Large krill aggregation study	T076_ 070216[a]	07/02/2016	13:29:00	-60.2960	-46.4347	07/02/2016	13:46:00	-60.3269	-46.4391	
Large krill aggregation study mapping day 1	Large krill aggregation study	T075_ 070216[a]	07/02/2016	13:51:00	-60.3287	-46.4540	07/02/2016	14:05:00	-60.3018	-46.4614	
Large krill aggregation study mapping day 1	Large krill aggregation study	T074_ 070216[a]	07/02/2016	14:11:00	-60.3024	-46.4762	07/02/2016	14:28:00	-60.3349	-46.4789	
Large krill aggregation study mapping day 1	Large krill aggregation study	T073_ 070216[a]	07/02/2016	14:34:00	-60.3367	-46.4958	07/02/2016	14:54:00	-60.2997	-46.5022	
Large krill aggregation study mapping day 1	Large krill aggregation study	T072_ 070216[a]	07/02/2016	14:59:00	-60.2994	-46.5174	07/02/2016	15:07:00	-60.3142	-46.5170	
Large krill aggregation study mapping day 1	Large krill aggregation study	T080_ 070216[a]	07/02/2016	15:08:00	-60.3154	-46.5143	07/02/2016	15:51:00	-60.3122	-46.3440	

Large krill aggregation study mapping day 1	Large krill aggregation study	T080_ 070216[a]	07/02/2016	16:00:00	-60.3150	-46.3327	07/02/2016	17:02:00	-60.3222	-46.5642	
Large krill aggregation study mapping day 1	Large krill aggregation study	T070_ 070216[a]	07/02/2016	17:03:00	-60.3214	-46.5672	07/02/2016	17:15:00	-60.2993	-46.5703	
Large krill aggregation study mapping day 1	Large krill aggregation study	T071_ 070216[a]	07/02/2016	17:22:00	-60.2972	-46.5474	07/02/2016	17:42:00	-60.3371	-46.5404	
Large krill aggregation study mapping day 1	Large krill aggregation study	T072_ 070216[a]	07/02/2016	17:51:00	-60.3353	-46.5138	07/02/2016	18:12:00	-60.2992	-46.5207	
Large krill aggregation study mapping day 1	Large krill aggregation study	T073_ 070216[a]	07/02/2016	18:18:00	-60.2989	-46.5024	07/02/2016	18:37:00	-60.3364	-46.4937	
Large krill aggregation study mapping day 1	Large krill aggregation study	T074_ 070216[a]	07/02/2016	18:43:00	-60.3369	-46.4796	07/02/2016	19:01:00	-60.3032	-46.4776	
Large krill aggregation study mapping day 1	Large krill aggregation study	T075_ 070216[a]	07/02/2016	19:05:00	-60.3032	-46.4643	07/02/2016	19:18:00	-60.3292	-46.4618	
Large krill aggregation study mapping day 1	Large krill aggregation study	T076_ 070216[a]	07/02/2016	19:24:00	-60.3305	-46.4441	07/02/2016	19:44:00	-60.2958	-46.4443	
Large krill aggregation study mapping day 1	Large krill aggregation study	T077_ 070216[a]	07/02/2016	19:49:00	-60.2961	-46.4286	07/02/2016	19:57:00	-60.3100	-46.4278	
Large krill aggregation study mapping day 2	Large krill aggregation study	T080_ 080216[a]	08/02/2016	06:58:00	-60.3156	-46.4954	08/02/2016	07:45:00	-60.3146	-46.3305	
Large krill aggregation study mapping day 2	Large krill aggregation study	T080_ 080216[a]	08/02/2016	07:49:00	-60.3144	-46.3235	08/02/2016	08:09:00	-60.3150	-46.3877	
Large krill aggregation study mapping day 2	Large krill aggregation study	T070_ 080216[a]	08/02/2016	08:10:00	-60.3141	-46.3895	08/02/2016	08:21:00	-60.2952	-46.3904	
Large krill aggregation study mapping day 2	Large krill aggregation study	T071_ 080216[a]	08/02/2016	08:27:00	-60.2956	-46.4078	08/02/2016	08:46:00	-60.3293	-46.4072	
Large krill aggregation study mapping day 2	Large krill aggregation study	T072_ 080216[a]	08/02/2016	08:53:00	-60.3295	-46.4230	08/02/2016	09:13:00	-60.2957	-46.4250	
Large krill aggregation study mapping day 2	Large krill aggregation study	T073_ 080216[a]	08/02/2016	09:19:00	-60.2969	-46.4414	08/02/2016	09:38:00	-60.3307	-46.4415	
Large krill aggregation study mapping day 2	Large krill aggregation study	T074_ 080216[a]	08/02/2016	09:44:00	-60.3303	-46.4594	08/02/2016	10:08:00	-60.2903	-46.4582	
Large krill aggregation study mapping day 2	Large krill aggregation study	T075_ 080216[a]	08/02/2016	10:14:00	-60.2906	-46.4753	08/02/2016	10:28:00	-60.3157	-46.4743	
Large krill aggregation study mapping day 2	Large krill aggregation study	T076_ 080216[a]	08/02/2016	10:34:00	-60.3160	-46.4923	08/02/2016	11:00:00	-60.2723	-46.4926	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T029[a]	08/02/2016	13:41:00	-60.3167	-46.7425	08/02/2016	14:57:00	-60.3167	-46.4703	
Inaccessible western canyon survey T029 - T021	Western canyon study	T029[a]	08/02/2016	13:41:00	-60.3167	-46.7425	08/02/2016	14:56:00	-60.3166	-46.4738	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T028[a]	08/02/2016	15:13:00	-60.3504	-46.4697	08/02/2016	16:26:00	-60.3502	-46.7412	

Inaccessible western canyon survey T029 - T021	Western canyon study	T028[a]	08/02/2016	15:15:00	-60.3527	-46.4731	08/02/2016	16:26:00	-60.3502	-46.7412	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T027[a]	08/02/2016	16:42:00	-60.3831	-46.7412	08/02/2016	17:46:00	-60.3833	-46.4855	
Inaccessible western canyon survey T029 - T021	Western canyon study	T027[a]	08/02/2016	16:43:00	-60.3837	-46.7384	08/02/2016	17:47:00	-60.3832	-46.4817	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T026[a]	08/02/2016	18:06:00	-60.4158	-46.4750	08/02/2016	19:16:00	-60.4168	-46.7285	
Inaccessible western canyon survey T029 - T021	Western canyon study	T026[a]	08/02/2016	18:08:00	-60.4167	-46.4793	08/02/2016	19:15:00	-60.4163	-46.7253	
Inaccessible western canyon survey T029 - T021	Western canyon study	T025[a]	08/02/2016	19:36:00	-60.4488	-46.6868	08/02/2016	19:41:00	-60.4492	-46.6658	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T025[a]	08/02/2016	19:37:00	-60.4490	-46.6831	08/02/2016	19:41:00	-60.4492	-46.6658	
Inaccessible western canyon survey T029 - T021	Western canyon study	T023[a]	08/02/2016	20:13:00	-60.5159	-46.6145	08/02/2016	20:46:00	-60.5195	-46.4741	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T023[a]	08/02/2016	20:15:00	-60.5162	-46.6077	08/02/2016	20:36:00	-60.5162	-46.5155	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T022[a]	08/02/2016	21:15:00	-60.5492	-46.3875	08/02/2016	22:19:00	-60.5511	-46.5952	
Inaccessible western canyon survey T029 - T021	Western canyon study	T022[a]	08/02/2016	21:15:00	-60.5492	-46.3875	08/02/2016	22:18:00	-60.5502	-46.5930	
Inaccessible western canyon survey T029 - T021	Western canyon study	T021[a]	08/02/2016	22:41:00	-60.5822	-46.5594	08/02/2016	23:23:00	-60.5841	-46.4190	
Inaccessible western canyon acoustic and predator survey	Western canyon study	T021[a]	08/02/2016	22:43:00	-60.5820	-46.5532	08/02/2016	23:23:00	-60.5841	-46.4190	
Large krill aggregation study mapping	Large krill aggregation study	T080_ 090216[a]	09/02/2016	13:08:00	-60.3157	-46.3290	09/02/2016	16:43:00	-60.3174	-46.5805	
Finescale fishery survey T030 - T034	Finescale survey	T030[a]	10/02/2016	07:11:00	-60.4997	-47.1501	10/02/2016	14:10:00	-60.1008	-47.1486	
Finescale fishery survey T030 - T034	Finescale survey	T031[a]	10/02/2016	09:48:00	-60.1022	-47.0540	10/02/2016	12:11:00	-60.5005	-47.0585	
Finescale fishery survey T030 - T034	Finescale survey	T032[a]	10/02/2016	12:30:00	-60.4984	-46.9448	10/02/2016	12:42:00	-60.4665	-46.9420	paused to check depth
Finescale fishery survey T030 - T034	Finescale survey	T032[a]	10/02/2016	13:58:00	-60.4579	-46.9521	10/02/2016	16:05:00	-60.1037	-46.9496	
Finescale fishery survey T030 - T034	Finescale survey	T033[a]	10/02/2016	18:37:00	-60.1504	-46.8513	10/02/2016	20:26:00	-60.4469	-46.8481	
Finescale fishery survey T030 - T034	Finescale survey	T034[a]	10/02/2016	20:54:00	-60.4446	-46.7525	10/02/2016	21:26:00	-60.3790	-46.7505	part of transect completed
Finescale fishery survey T034 - T041	Finescale survey	T034[a]	11/02/2016	17:05:00	-60.3548	-46.7502	11/02/2016	18:20:00	-60.1506	-46.7491	

Finescale fishery survey T034 - T041	Finescale survey	T035[a]	11/02/2016	18:33:00	-60.1498	-46.6820	11/02/2016	19:13:00	-60.2388	-46.6799	paused mid transect
Finescale fishery survey T034 - T041	Finescale survey	T035[a]	11/02/2016	20:02:00	-60.2396	-46.6781	11/02/2016	21:25:00	-60.4474	-46.6802	
Finescale fishery survey T034 - T041	Finescale survey	T036[a]	11/02/2016	22:09:00	-60.5481	-46.5483	12/02/2016	00:17:00	-60.1977	-46.5488	
Finescale fishery survey T034 - T041	Finescale survey	T037[a]	12/02/2016	00:28:00	-60.1983	-46.5007	12/02/2016	01:36:00	-60.3814	-46.4997	
Finescale fishery survey T034 - T041	Finescale survey	T038[a]	12/02/2016	01:58:00	-60.3836	-46.3841	12/02/2016	02:29:00	-60.3014	-46.3805	
Finescale fishery survey T034 - T041	Finescale survey	T039[a]	12/02/2016	02:53:00	-60.2978	-46.2550	12/02/2016	03:32:00	-60.3968	-46.2485	
Finescale fishery survey T034 - T041	Finescale survey	T040[a]	12/02/2016	03:47:00	-60.4085	-46.1784	12/02/2016	04:29:00	-60.2906	-46.1785	
Finescale fishery survey T034 - T041	Finescale survey	T041[a]	12/02/2016	04:44:00	-60.2997	-46.1009	12/02/2016	05:35:00	-60.4345	-46.0998	
Finescale fishery survey T038 - T044	Finescale survey	T038[a]	12/02/2016	16:40:00	-60.3348	-46.3783	12/02/2016	16:53:00	-60.2999	-46.3790	
Finescale fishery survey T038 - T044	Finescale survey	T039[a]	12/02/2016	17:16:00	-60.2999	-46.2518	12/02/2016	17:55:00	-60.3975	-46.2483	
Finescale fishery survey T038 - T044	Finescale survey	T040[a]	12/02/2016	18:08:00	-60.4072	-46.1815	12/02/2016	18:47:00	-60.3001	-46.1804	
Finescale fishery survey T038 - T044	Finescale survey	T041[a]	12/02/2016	19:04:00	-60.2952	-46.0947	12/02/2016	20:33:00	-60.5032	-46.0986	
Finescale fishery survey T038 - T044	Finescale survey	T042[a]	12/02/2016	21:36:00	-60.3903	-45.9246	12/02/2016	22:08:00	-60.3055	-45.9267	
Finescale fishery survey T038 - T044	Finescale survey	T043[a]	12/02/2016	22:26:00	-60.3002	-45.8324	12/02/2016	23:21:00	-60.4282	-45.8323	
Finescale fishery survey T038 - T044	Finescale survey	T044[a]	12/02/2016	23:36:00	-60.4246	-45.7817	13/02/2016	00:28:00	-60.3009	-45.7714	
Inaccessible western canyon survey T029 - T025	Western canyon study	T029[a]	13/02/2016	04:17:00	-60.3163	-46.7411	13/02/2016	05:08:00	-60.3176	-46.4720	
Inaccessible western canyon survey T029 - T025	Western canyon study	T028[a]	13/02/2016	05:26:00	-60.3501	-46.4732	13/02/2016	06:36:00	-60.3510	-46.7396	
Inaccessible western canyon survey T029 - T025	Western canyon study	T027[a]	13/02/2016	06:50:00	-60.3826	-46.7404	13/02/2016	07:38:00	-60.3835	-46.4810	
Inaccessible western canyon survey T029 - T025	Western canyon study	T026[a]	13/02/2016	07:54:00	-60.4134	-46.4782	13/02/2016	09:15:00	-60.4172	-46.7299	
Inaccessible western canyon survey T029 - T025	Western canyon study	T025[a]	13/02/2016	09:38:00	-60.4492	-46.4797	13/02/2016	10:02:00	-60.4487	-46.5497	
Inaccessible western canyon survey T029 - T020	Western canyon study	T029[a]	14/02/2016	05:40:00	-60.3162	-46.7480	14/02/2016	06:32:00	-60.3169	-46.4705	

Inaccessible western canyon survey T029 - T020	Western canyon study	T028[a]	14/02/2016	06:45:00	-60.3495	-46.4730	14/02/2016	07:32:00	-60.3502	-46.7397	
Inaccessible western canyon survey T029 - T020	Western canyon study	T027[a]	14/02/2016	07:47:00	-60.3834	-46.7422	14/02/2016	08:33:00	-60.3832	-46.4784	
Inaccessible western canyon survey T029 - T020	Western canyon study	T026[a]	14/02/2016	08:46:00	-60.4170	-46.4755	14/02/2016	09:30:00	-60.4164	-46.7302	
Inaccessible western canyon survey T029 - T020	Western canyon study	T025[a]	14/02/2016	09:47:00	-60.4494	-46.6842	14/02/2016	10:12:00	-60.4498	-46.5437	
Inaccessible western canyon survey T029 - T020	Western canyon study	T024[a]	14/02/2016	10:32:00	-60.4821	-46.4580	14/02/2016	11:02:00	-60.4833	-46.6241	
Inaccessible western canyon survey T029 - T020	Western canyon study	T023[a]	14/02/2016	11:18:00	-60.5154	-46.6123	14/02/2016	11:44:00	-60.5193	-46.4763	
Inaccessible western canyon survey T029 - T020	Western canyon study	T022[a]	14/02/2016	12:08:00	-60.5483	-46.3901	14/02/2016	12:47:00	-60.5496	-46.5947	
Inaccessible western canyon survey T029 - T020	Western canyon study	T021[a]	14/02/2016	13:09:00	-60.5837	-46.5543	14/02/2016	13:37:00	-60.5877	-46.4061	
Inaccessible western canyon survey T029 - T020	Western canyon study	T020[a]	14/02/2016	13:51:00	-60.6161	-46.4015	14/02/2016	14:12:00	-60.6316	-46.5050	
Large krill aggregation study mapping	Large krill aggregation study	T080_ 140216[a]	14/02/2016	16:10:00	-60.3168	-46.7443	14/02/2016	17:19:00	-60.3118	-46.3894	
Large krill aggregation study mapping	Large krill aggregation study	T070_ 140216[a]	14/02/2016	17:20:00	-60.3107	-46.3863	14/02/2016	17:32:00	-60.2771	-46.3967	
Large krill aggregation study mapping	Large krill aggregation study	T071_ 140216[a]	14/02/2016	17:35:00	-60.2768	-46.4085	14/02/2016	18:00:00	-60.3319	-46.4076	
Large krill aggregation study mapping	Large krill aggregation study	T072_ 140216[a]	14/02/2016	18:04:00	-60.3307	-46.4253	14/02/2016	18:25:00	-60.2746	-46.4261	
Large krill aggregation study mapping	Large krill aggregation study	T073_ 140216[a]	14/02/2016	18:29:00	-60.2739	-46.4434	14/02/2016	18:48:00	-60.3171	-46.4476	
Large krill aggregation study mapping	Large krill aggregation study	T070_ 150216[a]	15/02/2016	06:34:00	-60.3180	-46.3902	15/02/2016	06:52:00	-60.2696	-46.3926	
Large krill aggregation study mapping	Large krill aggregation study	T071_ 150216[a]	15/02/2016	06:57:00	-60.2689	-46.4098	15/02/2016	07:16:00	-60.3158	-46.4087	
Large krill aggregation study mapping	Large krill aggregation study	T072_ 150216[a]	15/02/2016	07:25:00	-60.3374	-46.4193	15/02/2016	07:49:00	-60.2728	-46.4245	
Large krill aggregation study mapping	Large krill aggregation study	T073_ 150216[a]	15/02/2016	07:54:00	-60.2740	-46.4409	15/02/2016	08:19:00	-60.3404	-46.4421	
Large krill aggregation study mapping	Large krill aggregation study	T074_ 150216[a]	15/02/2016	08:23:00	-60.3404	-46.4592	15/02/2016	08:48:00	-60.2703	-46.4588	
Large krill aggregation study mapping	Large krill aggregation study	T075_ 150216[a]	15/02/2016	08:52:00	-60.2699	-46.4740	15/02/2016	09:18:00	-60.3418	-46.4727	
Large krill aggregation study mapping	Large krill aggregation study	T076_ 150216[a]	15/02/2016	09:23:00	-60.3417	-46.4925	15/02/2016	10:00:00	-60.2403	-46.4909	

15.3 CTD calibration sheets

DATA SHEETS TO BE ADDED - AME