Cruise Report

RRS JAMES COOK CRUISE 037

ECOMAR
Ecosystem of the Mid-Atlantic Ridge at the Sub-Polar Front and Charlie Gibbs Fracture Zone.

1 August – 9 September 2009

Principal Scientist

Imants G. Priede

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http://www.mar-eco.no/

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Cover Photograph: Peter Bray lone transatlantic rower on board the *Black Knight* shortly before rescue on 19 August 2009. He then stayed on board the *RRS James Cook* for the rest of the voyage.

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The Ship's Company[1]

The ship's company in Bantry Bay 7 September 2009

Left to right. Jessica Craig, Thom Linley, Nikki King, Victor Martinez, Andy Dale, Malcolm Graves, Martin Cox, Rebecca Hunter, Alex Robinson, Holly Bik, Nataliya Budaeva, Claudia Alt, Susan Evans, Tom Letessier, Gary Robinson, Antonina Rogacheva, Gavin Tilstone, Will Reid, Robert Simpson, Pedro Ribeiro, Matthew Turner, Peter Sargeant, Andrew Olivier, Vanessa Laidlaw, Amy Whaler, Paul Duncan, Darren Caines, Steve Smith, Peter Bray, Dean Hope, Graham Mingay, David Shale

[1] Some are in fancy dress celebrating the end of the cruise. Guess who?

SCIENTIFIC PERSONNEL

PRIEDE Imants (Monty) G. (Principal Scientist)	U. Aberdeen	UK
KING Nicola J.	U. Aberdeen	UK
CRAIG Jessica	U. Aberdeen	UK
LINLEY Thomas D.	U. Aberdeen	UK
HUGHES Alan.	NOC Southampton	UK
BOORMAN Benjamin	NOC Southampton	UK
ALT Claudia	NOC Southampton	UK
BIK Holly M.	NOC Southampton	UK
ROGACHEVA Antonina	Shirshov Moscow	Russia
BUDAEVA Nataliya	Shirshov Moscow	Russia
COX Martin J.	U St. Andrews	UK
LETESSIER Tom B.	U St. Andrews	UK
EVANS Susan K.	U St. Andrews	UK
SIMPSON Robert	U of Durham	UK
HUNTER Rebecca C.	U of Glasgow	UK
DALE Andrew	SAMS Oban	UK
OLIVIER Andrew	SAMS-UHI Oban	UK
TILSTONE Gavin	PML Plymouth	UK
MARTINEZ Victor	PML Plymouth	UK
ROBINSON Alexander	U of Oxford	UK
WIGHAM Benjamin	U. Newcastle	UK
REID William	U. Newcastle	UK
ROBINSON Gary J.	U. Newcastle	UK
RIBEIRO Pedro M.	U. of Azores	Portugal
SHALE David M.		UK
SHORT Jonathan B.	NMFS Sea Systems	UK
BENSON Jeffrey R. (to 14 Aug Cork)	NMFS Sea Systems	UK
DUNCAN Paul A.	NMFS Sea Systems	UK
POOLE Benjamin	NMFS Sea Systems	UK
WHITTLE Stephen P.	NMFS Sea Systems	UK
WYNAR John B. (from 14 Aug, Cork)	NMFS Sea Systems	UK

SHIP’S PERSONNEL

SARGEANT, Peter G.	Master
TURNER, Matthew	Chief Officer
GRAVES, Malcolm	2nd Officer
LAIDLOW, Vanessa R.	3rd Officer
PARKINSON, George G.	Chief Engineer
HAGAN, John A.	2nd Engineer
COLLIN, Ian S.	3rd Engineer
WYTHE, Vivian M.	Deck Engineer
PARKER, Philip G.	Elec Tech Officer
LUCAS, Paul	Purser
LUCKHURST, Kevin R. (to 14 Aug Cork)	CPO Deck
POOK, Glen A. (from 14 Aug Cork)	CPO Deck
SMITH, Stephen J.	CPO Scientific
THOMSON, Iain N.	PO (Deck)
DALE, John E.	Seaman
CANTLIE, Ian M.	Seaman
COONEY, Charles H.	Seaman
BACKHOUSE, Paul	Seaman
HILLIER, Leslie J. (to 14 August Cork)	Engine Room PO
CAINES, Darren A.	Head Chef
HOPE, Dean A.	Chef
MINGAY, Graham	Steward
WHALEN, Amy K.	Assistant Steward

SUPERNUMERARY

BRAY, Peter (from 19 August) Rescued from *Black Knight* 48°45’N 30°23’W

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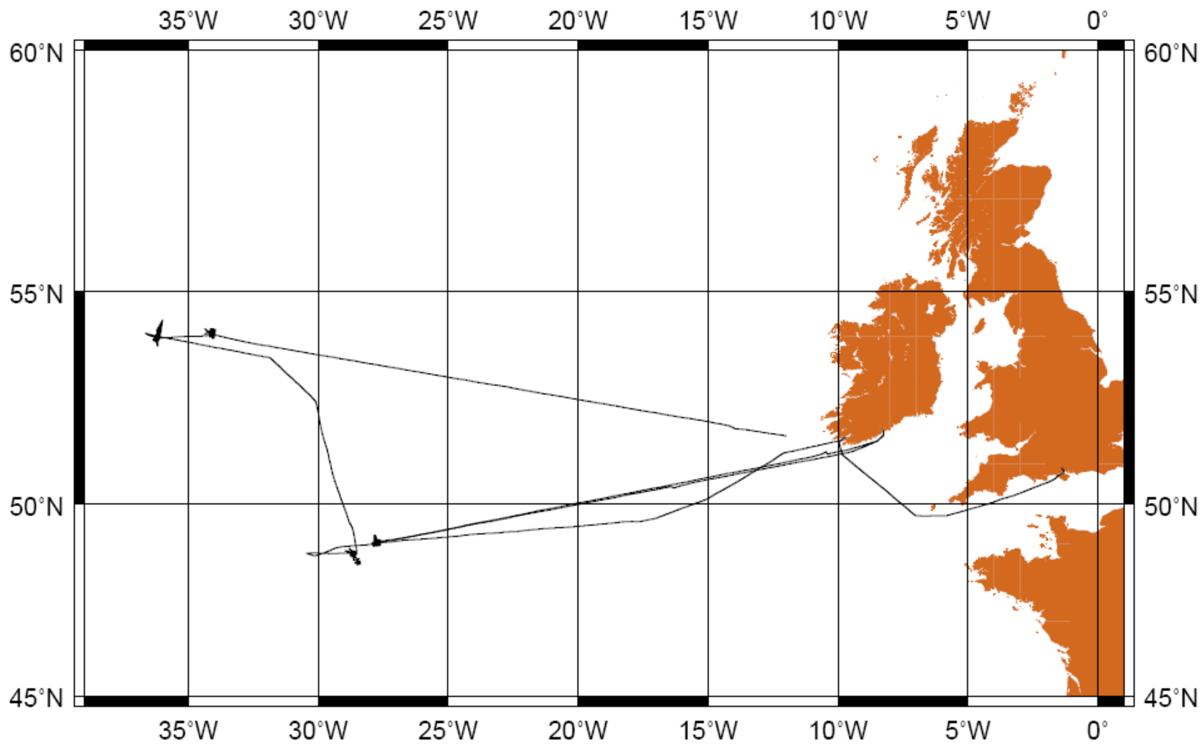

Figure 1 JC0371 Cruise track. Sailed from Southampton 1 August, diverted to Cork 11 August, arrived 14 August and returned to the SE Station on 17 August. Diverted to rescued lone rower Peter Bray 48°45'N 30°23'W on 19h August and docked in Falmouth, England on 9 September 2009

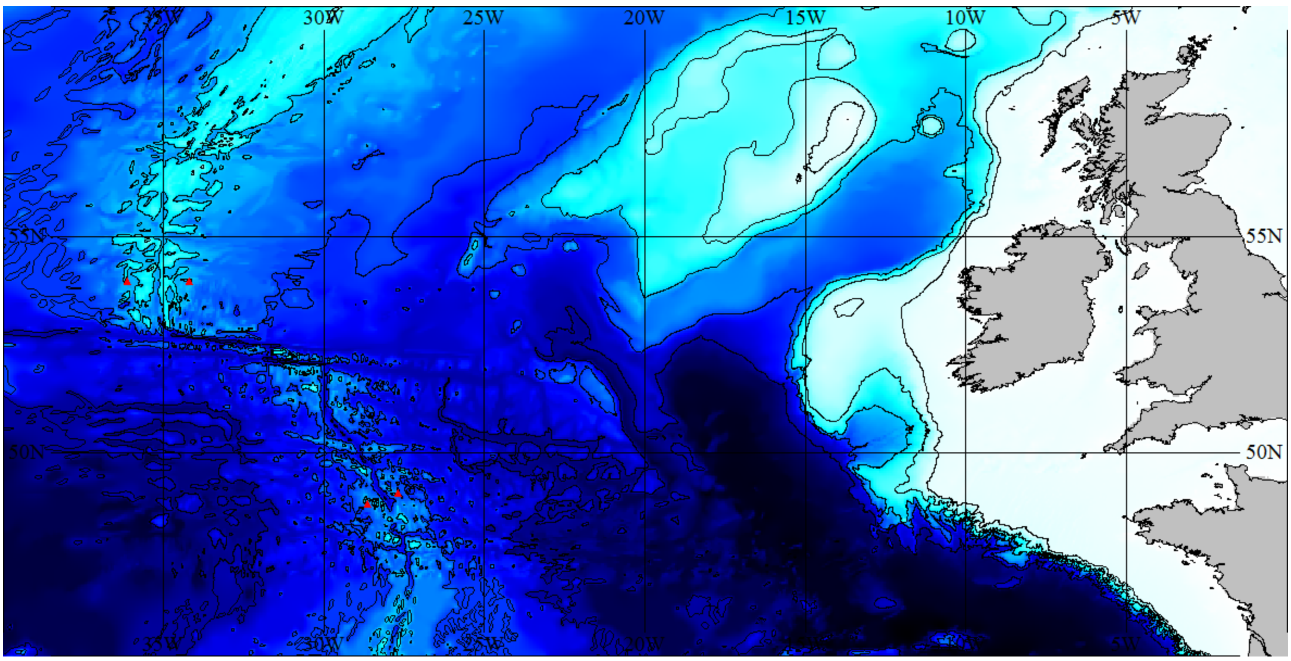

Figure 2. Chart showing the four superstations, SE, SW, NE and NW (red triangles)

ITINERARY

Depart:	Southampton, England,	Saturday	1 August 2009
Sonar Calibration:	Bantry Bay, Ireland	Monday	3 August 2009
Exchange Personnel:	Cork Ireland	Friday	14 August 2009
Sonar Calibration:	Bantry Bay Ireland	Monday	7 September 2009
Arrive:	Falmouth, England	Wednesday	9 September 2009

OBJECTIVES:

This was the third cruise undertaken to the Mid-Atlantic Ridge as part of the NERC-funded consortium project (NE/C512961/1) entitled **ECOMAR - Ecosystem of the Mid-Atlantic Ridge at the Sub-Polar Front and Charlie Gibbs Fracture Zone. ECOMAR - Ecosystem of the Mid-Atlantic Ridge at the Sub-Polar Front and Charlie Gibbs Fracture Zone.** http://www.oceanlab.abdn.ac.uk/ecomar/index.php

Previous cruises in the series were:

1. *RRS James Cook* JC011 13 July – 18 August 2007: PSO- Imants G. Priede
2. *RRS Discovery* 24 July – 15 August 2008 : PSO- Phil Bagley

And a final 4th cruise is scheduled with the UK ISIS ROV:

RRS James Cook JC048 26 May – 2 July 2010 : PSOs Priede/Bagley

ECOMAR forms part of the Census of Marine Life MAR-ECO project which is an international study of life in the northern mid-Atlantic Ocean with scientists from 16 nations participating in research of the waters around the mid-Atlantic Ridge from Iceland to the Azores (http://www.mar-eco.no).

ECOMAR is focussed on patterns and processes in an area approximately half way between Iceland and the Azores in the vicinity of the Charlie-Gibbs Fracture Zone. The fracture zone represents a major discontinuity in the structure of the ridge but is also the latitude at which the north Atlantic current crosses the ridge from west to east delineating the position of the sub-polar front with cooler productive waters to the north and warmer more oligotrophic to the south. A voyage of the *RV GO Sars* in 2004 had indicated important differences in fauna across this boundary. Cruise JC011 had made detailed bathymetric surveys of 4 main stations at 2500m depth at *ca.* 49°N and 54°N with a two stations west of the ridge axis and two stations east of the ridge axis i.e. SW,NW,SE and NE, on cross ridge transects north and south of the Charlie Gibbs Fracture Zone. The aim of *RRS James Cook* cruise 037 was to continue detailed studies at these four stations.

The specific objectives were to:

1. By remote sensing to determine the locations of fronts in the study area.
2. Study the characteristic water masses in this area and their movements by means of CTD casts including a series casts along a transect between the SW and NW station along the track of the TOPEX POSEIDON satellite traversing the axis of the north Atlantic current.
3. Measure processes of primary production in the study area by remote sensing and ship-borne measurements in relation to fronts and the current regime defined by 1 & 2.
4. Measure and characterise pelagic biomass in the vicinity of the four super stations by means of multi-frequency echo-sounding and mid-water trawling.
5. Recover and redeploy moorings equipped with sediment traps at other instrumentation at each of the four super stations.
6. Observe benthic bioluminescence using a lander equipped with an ICDeep camera.
7. Sample the benthic fish and invertebrate fauna at each of the four super stations using an otter trawl.
8. Observe and record sounds of benthic fauna attracted to baits at each of the four super stations using a lander.
9. Obtain megacorer samples of sediment and its fauna at each of the 4 superstations.
10. Capture motile benthic epifauna by means of free fall traps at each of the four superstations.

Table 1 List of Gears Used

Amphipod trap - A free fall baited trap with acoustic releases and buoyancy

CTD - Conventional conductivity, temperature depth rosette sampler with 24 bottles, ADCP and other sensors.

CTD YoYo – The CTD rosette deployed for repeated cycles without the bottles.

EK60 - Kongsberg multi-frequency echosounder for measuring targets in the water column.

EM120- Kongsberg swath bathymetry system coupled to an OLEX display.

EM710 – Kongsberg high frequency swath system for detecting structure in the water column; complementary to the EK60.

ICDeep - Lander equipped with a sensitive ICDeep video camera for observing bioluminescence

Megacorer - A multi-corer for sediment sampling

Optics Rig – A frame equipped with optical measurement devices lowered on a cable often simultaneous with the CTD.

OTSB – Otter Trawl Semi-Balloon

PAL – Photographic Acoustic lander. Also equipped with Additional an ADCP (Acoustic Doppler Current Profiler) and a CTD recorder

RMT 8 +1 – Rectangular Mid-Water Trawl, two nets, 8m^2 and 1 m^2

Ring Net – 1m diameter circular net towed vertically from 150m to the surface to sample plankton.

SVP – Sound Velocity Profiler.

Thermistor Chain – Vertical mooring with recording thermistors for monitoring high frequency changes in water masses.

Moorings – 4 moorings equipped with sediment traps, current meters and other instrumentation. One at each of the 4 super stations.

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Statement

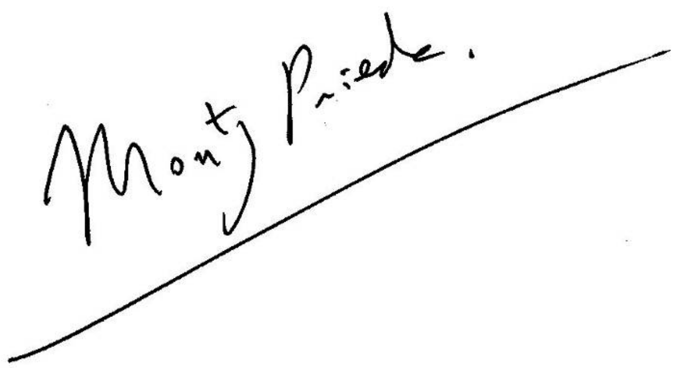
This cruise was exceptional in that in addition to days lost through bad weather or technical problems there were two unavoidable diversions on humanitarian grounds:

1. To repatriate crew members in Cork, Ireland entailed breaking off work at the SE station during 1230h 11 August to 0530h 17 August = 5days 17h lost.
2. To rescue Peter Bray on *Black Knight* 2100h 18 August to 1800h 19 August, time lost 21h

In the latter case it is questionable whether much work would have been done in view of the poor weather conditions and some passage time would have been incurred in any case.

However the loss of *ca* 6 days was equivalent to 20-25% of the planned research time. This discrepancy was first made up by cancelling all work on the transect between the southern (49°N) and northern (54°) stations. Only one CTD/optics cast was done in the vicinity of the sub polar front (Sta. JC037/50 on 24 August at 51°05.53’N). Secondly the RMT/OTSB trawl programmes were curtailed and no megacorer samples were taken at the NW station. All aspects of the science programme were affected to greater or lesser degree.

Overall a balanced science programme, given reduced time, was achieved as described in the following reports. The cruise was very demanding with a wide range of gear types including 27 recoveries of free-floating gear, landers, free-fall traps and moorings. I very grateful to the scientific party, technicians, the Master and the ship’s company for their co-operation and skilful execution of the cruise programme in often demanding circumstances.



I.G. (Monty) Priede. Principal Scientist.

CRUISE NARRATIVE

All times BST until clocks were changed to UTC on Wednesday 5 August

Saturday 1 August,
0900h Southampton NOC Empress Dock ready to sail
0910h Depart Southampton, grey cold drizzling with rain.

1226h Proceeding westwards in calm seas across Torbay

1830h First scientific meeting in the Conference Room

Sunday 2 August
0700h South of Scilly Isles proceeding westwards. Weather fine.
0830h 1st Ship's management meeting.
Work continued throughout the day preparing equipment.
The BAS rigs for deployment of the calibration sphere were placed around the ship.

1830h Second scientific meeting in the Conference room

2000h Approaching the coast of Ireland, dull grey weather.

2350h Passed Sheep's Head light at entrance to Bantry Bay.

Monday 3 August
0115h Settled on DP on location for calibration. On south side of Bantry Bay. Smooth conditions but with gale forecast.

0149 h **Station JC037/001 Sound Velocity Profiler. 40m 51°38.24'N 09°39.92'W**
Deployed on hydro-wire
0152h Out to 35m
0155h SVP recovered in board

0200h Commence EK60 calibration preparations
0210h Rope over the bow
0220h Rope under the keel, driving rain and wind increasing, unpleasant weather.
0240h Tungsten carbide ball in the water
0250h All lines paid out to the marks
0251h Ball found on the EK60 display. Record time; 31 min from throwing line over the bows.
0320h Lowered the starboard keel to commence calibration.

0845h All 5 EK60 transducers calibrated

0900h The Master spoke to the launch and arranged a rendezvous off Castletown at 1100h.
0930h The calibration gear was all in board.
0946h Starboard keel stowed.

0953h Started moving the vessel towards the rendezvous position at the entrance of Bearhaven.

1038h 51°38.93’N 09°45.58’W
1054h Launch “*Trefrey*” arrived
1058h The calibration gear all on board the launch to be transferred to BAS.
1100h *RRS James Cook* clear to depart towards the South East station.

Tuesday 4 August
0800h The vessel proceeded westwards overnight. Average speed was a disappointing 7-8 knots which would mean arrival on station will be about a day late.

Whales were spotted from the Mess at breakfast time.

1200h 50°17.6’N 14°34.2’W making 6.8 knots
Throughout the day the wind speed built up to 35-45 knots. A more southerly track was followed to avoid the weather but by the evening progress slowed to 4-5 knots.
Dolphins were seen near the ship

2000h Continuing slow progress against bad weather.

Wednesday 5 August

Clock changed. All times henceforth are UTC = GMT

0800h 49°35.0’N 17°16.9’W Weather easing, increased speed to 7.3 knots

1020h Commenced slowing down for CTD wire test
1029h Vessel stopped on DP

1057h **Station JC037/002 CTD + Tests 3000m 49°33.92’N 17°43.13’W**
CTD deployed to obtain bottom water for sediment traps and with 6 acoustic releases attached for test. Water was to be retrieved on the up-cast near the surface for the PML team.
1205h 3000m of wire out. Started testing releases.
1225h Release tests completed, one was suspect.
1340h CTD back in board. The vessel resumed passage.

1440h Vessel hove to again for a second CTD wire test.

1505h **Station JC037/003 CTD + Tests 3000m 49°34.32’N 17°54.11’W**
CTD deployed to obtain bottom water for aquaria with 7 acoustic releases attached for test, including a failed one from the previous cast.
1610h 3000m wire out commenced testing.
1653h Tests complete started hauling.
1755h CTD In board, all releases had worked.

2000h Continuing on passage @ 8.5 knots 49°33.4’N 18°120.1’W 22 knots of head wind.

Thursday 6th August

0900h Continuing passage @ 11.4 knots 49°23.5’N 21°16.3’W 3 engines running

1200h 49°20.9’N 22°00.0’W averaging 9.6 knots

Friday 7th August

0220h Reduced speed owing to rough conditions
0400h Increased speed again

0900h Commenced test of CTD wire termination in preparation for the first work at the SE Station. Vessel making up to 11 knots.

1046h The vessel started to slow down on arrival at the SE station. Overcast but relatively calm weather.

1118h **JC037/004 CTD + Optics rig 2600m 49°02.06’N 27°41.93’W**
CTD deployed
1205h Optic rigs into the water from the starboard aft crane using a small deck winch. Lowered to 100m
1214h Optic rig inboard for fitting of a filter.
1220h Optic Rig redeployed, CTD at the bottom, commenced hauling.
1251h Optic rig recovered after a full cast.
1352h CTD inboard, the vessel remained on station for deployment of the Thermistor chain.

1408h Commenced deploying the thermistor chain.
1413h All the gear was in the water and the weight was held on the quick release until the ship arrived on position. Overcast sky but calm warm weather.

1427h **Station JC037/005 Thermistor chain 2600m 49°02.031’N 27°41.927’W (49°01.91’N 27°41.97’W)** [2]
Ballast released and the thermistor chain was deployed.

1525h **Station JC037/006 PAL Lander 2546m 49°01.866’N 27°42.068’W**
The PAL lander was deployed on ridge as part of the experiment with the thermistor chain. Additional instruments were an ADCP and a CTD recorder.

The vessel then moved off towards the ICDeep location towards the west

1615h Commenced deploying the ICDeep mooring line.
1623h All the mooring was deployed.
1628h Vessel on position and the ballast was released.

1629h **Station JC037/007 ICDEEP Lander 1701m 49°01.886’N 27°47.287’W**
ICDEEP flag sank below the surface.

[2] Subsequently determined accurate location by triangulation see 18 August.

The vessel moved off towards the SE Station mooring recovery site Discovery 331T Sta. 16437 deployed on Thursday 31st July 2008

1700h Arrived at the mooring site and commenced interrogating the acoustic releases
1708h Confirmation of an execute command.

1725h First part of the mooring arrived on the surface, just before dinner time.
1800h Top section of the mooring was inboard
1818h Upper sediment trap inboard with a small catch including shrimps
1852h Lower part of the mooring was tangled making recovery difficult.
1915h All in board, the lower sediment trap was very full in some months.
The vessel remained hove to in calm conditions while the mooring was prepared for redeployment.

2005h Commenced deployment of the new SE mooring.

2125h **Station JC037/008 SE Mooring 2500m 49°02.600'N 27°43.480'W**
Mooring ballast released with allowance for back swing to land on the target location.
The vessel waited on station to verify descent.
2150h Confirmed that the mooring was on the bottom.

2200h *RRS James Cook* on a short passage to the megacorer site.

2224h Vessel on DP at the Megacorer site.

2311h **Station JC037/009 Megacorer 2720m 49°05.388'N 27°50.239'W**
Corer deployed on the plasma rope
2318h USBL starboard boom deployed

Saturday 8th August

0039h Megacorer on the sea floor.
0044h Gear on deck, complete set of 8 cores.

0248h **Station JC037/010 Megacorer 2720m 49°05.40'N 27°50.22'W**
Second megacorer at the SE station.
0415h on the sea floor.
0420h Commenced hauling
0534h Gear on deck, complete set of 8 cores.

0603h **Station JC037/011 Megacorer 2720m 49°05.40'N 27°50.22'W**
Third megacorer at the SE station.

0700h It was reported that the RMT controller was damaged and no midwater trawling would be possible today.
0725h Corer on the sea floor.

0819h USBL retracted

0837h The starboard keel was deployed in preparation of EK60 work.

0840h Megacorer on deck with another full set of eight cores. Shells of Pteropod molluscs (Order: Opisthobranchia, Suborder: Thecosomata) and patches of phytodetritus on the sediment surface.

The RMT controller housing end cap 'O' ring seal was defective. Anodising on the seating face of the end of the housing barrel had peeled away. This could not be rapidly fixed. The weather was calm and smooth so it was decided to proceed with an EK60 survey instead of the proposed RMT tow.

0855h The vessel moved to the start position for the EK60 survey

0913h **Station JC037/012 EK60 survey 49°06.000'N 27°47.750'W**
EK60 survey started at waypoint 1.

Synchronisation of the EK60 and EM710 worked well. The vessel was making 9.5 to 10 knots and producing good clean data. Described as the best data ever achieved by any vessel.

1917h Waypoint 20 end of Station JC037/012 survey 49°06.000'N 27°37.400'W
Weather cloudy overcast with 20 knots of wind from the SW. The vessel moved to the ICDeep recovery position

2013h Vessel hove to for ICDeep recovery, JC037/007 49°01.886'N 27°47.287'W started sending release commands.
2014h Command executed.

2101h ICDeep on the surface.
2118h Grappled and pellet float in board.
2131h ICDeep all in board just after sunset

2217h Vessel positioned for start of deployment of the Amphipod trap.

2235h **Station JC037/013 Amphipod trap 2501m 49°02.00'N 27°43.44'W**
Trap deployed after some delays owing to attempt to deploy at high precision.

2307h Vessel on station for commencement of YoYo CTD experiment.

2317h The winch controller malfunctioned and CTD lifted unexpectedly. The system had to be reset and work resumed.

2334h **Station JC037/014 Yoyo CTD +ring net 2611 m 49°01.708'N 27°42.215'W**
CTD in the water with ring net casts to at 3h intervals.

The CTD was lowered to the sea floor and raised to 2000m (wire out) repeatedly. The ring net was lowered from the starboard stern quarter using the optic rig crane and winch system.

Sunday 9th August

0153h **Station JC037/014/#1 ring net to 150 m 49°01.708'N 27°42.215'W**
0221h Ring net in board. Catch rich in phytoplankton

0439h **Station JC037/014/#2 ring net to 150 m 49°01.708'N 27°42.215'W**
0502h Ring net in board

0801h **Station JC037/014/#3 ring net to 150 m 49°01.708'N 27°42.215'W**
0820h Ring net in board. Catch included brown jelly fish that were very conspicuous in the surface waters.

1050h **Station JC037/014/#4 ring net to 150 m 49°01.708'N 27°42.215'W**
1111h Ring net in board, small catch including a ctenophore

Sunny weather in the afternoon as the vessel continued to hold on station for the YoYo CTD.

1350h **Station JC037/014/#5 ring net to 150 m 49°01.708'N 27°42.215'W**
1412h Ring net in board, gelatinous catch.

1648h **Station JC037/014/#6 ring net to 150 m 49°01.708'N 27°42.215'W**
1711h Ring net in board. A big change in the catch with many salps and spectacular *Saphirina* spp. harpacticoid copepods presumably coming to the surface anticipating dusk.

1947h **Station JC037/014/#7 ring net to 150 m 49°01.708'N 27°42.215'W**
2018 Ring net in board. Catch included salps and ctenophores.

A foggy damp evening with everything wet on deck but relatively calm. A current setting from the NNE.

2247h **Station JC037/014/#8 ring net to 150 m 49°01.708'N 27°42.215'W**
2305h Ring net in board. Catch with euphausids and salps, few medusae.

Continued with recovery of the CTD at the end of its Yoyo sequence.

2335h Winch stopped at 100m wire out owing to problems with remote controller.
2342h Winch restarted.
2350h CTD in board end of Station JC037/014

Monday 10th August

0000h Vessel set off for the start of the trawl station.
0105h In position for the start of trawling, the PES fish was deployed.

0114h **Station JC037/015 OTSB 2700m 48°58.73'N 27°51.01'W**
Net deployed with the intention of trawling from south to north across the SE station trawl ground.
0150h Veering ceased owing to winch scrolling problems.

0213h Resumed pay out of wire.
0230h Further problems with the scrolling, reduced speed of the vessel.
0239h Increased speed again to 4 knots as the winch worked again. Personnel in the winch room operated the scrolling manually.
0416h Vessel position 49°08.1'N 27°49.61'W, 6601 m of wire paid out.
0420h Reduced speed to 1.5 knots to ensure the net touched down.
0432h 1 knot
0439h Commenced hauling owing to reaching end of the flat area available for trawling
0709h Vessel position 49°11.14'N 27°49.17'W, net on the surface.

0735h Net in board with a good catch of both fish and invertebrates.
It was not possible track the net because the PES fish was not detecting the signal from the net monitor. There was great uncertainty regarding how much area was fished.
0750h Vessel hove to for optics rig. Overcast day with poor visibility.

1045h **Station JC037/016 Shallow CTD + Optics 49°01.9'N 27°42.1'W**
Optics rig in the water deployed by aft crane.
1048h CTD in the water.
1115h Optics rig in board.
1145h CTD in board with water samples.

There was dense fog and it was questioned whether any work on retrieving landers would be possible. However the fog suddenly disappeared and there was sunny afternoon.

Before recovery of the PAL lander (Station JC037/006) it was decided to locate the lander precisely by triangulation. Slant range was measured acoustically using the Port keel transducer linked to a MORS/IXSEA deck unit. Then the vessel steamed round a triangle.

1216h 49°01.424'N 27°43.340'W   Ranging point one.
1250h 49°02.917'N 27°42.094'W   Ranging point two due north.
1321h 49°01.371'N 27°40.669'W   Ranging point two.

From this it was later calculated that PAL had drifted 422m SSW towards 201° relative to true north after deployment from the ship.
A sunfish *Mola mola* was observed.

1325h Release command sent.
1419h PAL on the surface Station JC037/006 in bright sunny calm conditions.
1435h Grappled
1445h All in board.

1527h On station for the ICDeep deployment

1542h **Station JC037/017 ICDeep 2467m 49°01.497'N 27°43.500'W**
ICDeep deployed.

1620h Recovery of Amphipod Trap Station JC037/013. The trap was released after some delays by which time conditions had suddenly become very foggy. Visibility was down to 100m and the trap had to be tracked acoustically before it was found.

1718h Floats spotted on the surface after careful acoustic ranging.
1726h Line grappled and pellet float in board.
1737h Trap in board with a good catch of small amphipods.
The trap was quickly rebaited and reset for redeployment

1920h **Station JC037/018 Amphipod Trap 2500m 49°01.2'N 27°42.03'W**
Trap deployed at a new location

The vessel moved off towards the start of the night trawl location. Problems with the PES fish transducer were checked out because during the previous night it had not been possible to detect the pinger on the net.

The vessel remained hove to until work was due to begin.

2330h Vessel on the start point for the OTSB.

2356h **Station JC037/019 OTSB 2700m 48°58.05'N 27°51.6'W**
Commenced deployment of the net.

Tuesday 11 August

0124h 3052m of wire out.
0242h 6875m of wire out ceased veering and reduced speed to 1 knot.
0308h Net on the sea floor 48°08.15'N 27°50.16'W
0322h Increased speed to 2 knots
0330h Commenced hauling.
0655h 49°14.36'N 27°49.29'W Net in board with a good catch, rich in benthic invertebrates.

0920h Vessel in position for the PAL lander deployment. The weather was damp and foggy.
0935h The deployment was abandoned owing to failure of the camera programme to start. The deployment was aborted and work switched to the CTD & Optics station.

0957h **Station JC037/020 Shallow CTD + Optics 200m 49°02.02'N 27°41.97'W**
CTD in the water.
1007h Optics rig in the water.
1048h Optics rig out of the water.
1058h CTD in board
By this time the PAL camera problem had been resolved and deployment could recommence.

1111h The vessel was in position for the PAL lander deployment.

1132h **Station JC037/021 PAL 2546m 49°02.24’N 27°41.49’W**

The lander was accurately deployed at this location, 422m on a bearing of 21° from the JC037/006 drop point in anticipation that it would drift down on the SW current to hit bottom at that location (49°01.866’N 27°42.068’W)

Scientific Work was then suspended since the vessel was required to divert to Cork to put a crew member ashore on compassionate grounds.

1230h Azimuth thruster and Starboard keel were raised.

1240h 49°02.24’N 27°41.49’W The vessel departed for Cork, Ireland.

Wednesday 12th August

Vessel on passage to Cork. The weather was relatively calm with low cloud and poor visibility all day.

Thursday 13th August

Vessel on passage to Cork all day. Dolphins and porpoises seen around the ship while moving over the Porcupine Bank and into the Celtic sea. Sunny day with people out on deck for much of the time.

Friday 14th August

0730h In Cork Harbour. Kevin Luckhurst (CPO), Jeffrey Benson (NMF) and Leslie Hillier (Engine Room PO) disembarked onto a launch. Hillier whose hand was injured was put off using the ship’s boat. The new CPO, “Tiny” Pook and NMF technician John Wynar came on board.

The vessel departed for SE station. The weather was calm and numerous dolphins could be seen in Cork harbour.

2200h Heading out into the Atlantic towards the Porcupine Bank. Fairly rough but good speed.

Saturday 15th August

On passage all day

Sunday 16th August

On passage all day.

1230h Scientific meeting to discuss strategy in view of time lost. It was agreed to attempt to complete the full work programme at the SE station and drastically curtail the SW station and the delete the Topex-Poseidon Transect.

2000h Sunny skies with scattered cloud as sunset approaches in very fine calm conditions.

Monday, 17 August

0225h The engine room reported a strange vibration in the propulsion system

0253h Reduced speed.

0318h Vessel stopped to inspect over the side, something was suspect with the starboard screw, lights were switched on over the side.

0324h The master manoeuvred the ship ahead on the port screw and astern on the starboard.

0327h Both engines were stopped and sheets of plastic like material and brown lumps were seen floating free from under the stern.

0329h The vessel moved ahead on both screws and made some turns to test the systems. Everything seemed in order and the excessive vibration had cleared.

0420h *RRS James Cook* continued on passage at full speed and shortly arrived back at the working area of the SE Station.

Resumption of Scientific Work

0550h **Station JC037/022 Acoustic Ranging 49°01.399'N 27°40.653'W**
It was decided to triangulate on the PAL lander (JC037/021) and the thermistor chain (JC037/05) to determine their relative positions as accurately as possible by ranging on the IXSEA releases. The same reference points were used as before on this cruise. The weather was calm and the sun could be seen to rise.

0550h Triangulation point 3.
49°01.399'N 27°40.653'W Ranging to thermistor chain (JC037/05), 3170.4m
Through port keel.
0558h 49°01.465'N 27°40.634'W Ranging to PAL (JC037/21) 3308.4m
Dunking transducer

0620h Triangulation point 2.
0622h 49°02.952'N 27°42.079'W Ranging to thermistor chain (JC037/05), 3211.8m
Through port keel.
0625h 49°01.465'N 27°40.634'W Ranging to PAL (JC037/21) 3256.0m
Dunking transducer

0649h Triangulation point 1
49°01.424'N 27°43.340'W Ranging to thermistor chain (JC037/05), 3168.6m
Through port keel.
0652h 49°01.424'N 27°43.340'W Ranging to PAL (JC037/21) 2940.4m
Dunking transducer

0655h The release command for PAL was sent.
The exact position of PAL was calculated by Andy Dale as:
49°01.898'N 27°42.265'W and depth 2553m this was 517m on a bearing of 227° from the deployment position.

The exact position of the thermistor chain was calculated by Andy Dale as:
49°01.913'N 27°41.969'W and depth 2562m, this was 224m on a bearing of 195° from the deployment position.

0749h PAL on the surface, by this time the wind was over 20 knots from the SW.
0808h The mooring was grappled.
0820h The PAL was all inboard. (JC037/021)
The vessel moved off to the northwest to the RMT start position.

0948h The PES fish was deployed
0952h The ship manoeuvred into position for the start of the RMT tow while the Master was in the engine room inspecting the starboard screw through the viewing

window. No damage was reported from the collision with the mystery object during the night.

0958h **Station JC037/023 RMT8+1 to 800m 49°05.36'N 27°34.61'W**
Net in the water.
1055h First net opened at 800m depth.
1529h Last net closed and start hauling to the surface.
1546h 48°57.11'N 27°52.33'W Net all in board. A massive catch of salps in the shallowest nets.

1620h **Station JC037/024 Shallow CTD + Optics 200m 48°56.983'N 27°51.592'W**
Optic rig deployed, at the end of the RMT track
1625h CTD in the water.
1655h Optic Rig back in board.
1707h CTD rig back in board.
1714h The vessel then moved off to the ICDeep location to recover the lander. Benign relatively calm weather.
1816h JC037/017 49°01.50'N 27°43.50'W On station sent release command to the ICDeep.
1928h ICDeep on the surface.
1948h ICDeep grappled
2000h Lander on deck and the vessel proceeded to JC037/018 the amphipod trap.

2016h JC037/018 49°01.2'N 27°42.03'W Amphipod trap recovery release command sent.
Sunset was about 2115h so there was a serious concern about getting this lander in board since it has no lights, flag or radio to aid detection.
2108h The floats were spotted on the surface.
2124h The floats were grappled.
2135h The amphipod trap was all in board with a modest catch including a gastropod shell. The trap had been in the water much too long so a repeat deployment was prepared immediately.

The vessel moved off to the western part of the study site to investigate areas not hitherto looked at to redeploy the Amphipod trap and ICDEEP.

2302h Attempted to drop the trap on the summit of a ridge to the west side of the SE site.

2311h **Station JC037/025 Amphipod Trap 1830m 49°02.229'N 27°53.66'W**
The trap was released to fall to the bottom

The vessel moved to the ICDeep location on an adjacent hill
2343h Commenced streaming the ICDeep mooring

2351h **Station JC037/026 IC Deep Lander 1697m 49°02.189'N 27°55'559'W**
ICDeep flag sank.

Tuesday 18 August

0049h Vessel arrived at the OTSB start point, difficult conditions with force 6-7 SW winds across the proposed tow track

0104h **Station JC037/027 OTSB 2700m 48°57.34'N 27°49.83'W**
Net into the water for the usual south to north tow at this site.

0350h 6890m of wire out ceased veering.
0424h Estimated time of net on the bottom.
0449h Started hauling.
0538h Net lifted off the bottom.
0738h Net on the surface. 49°13.553'N 27°50.923'W
0802h Net all in board with heavy squally rain hitting the ship. The cod end was full of mud and the fish catch was largely in the belly of the net. This trawl had clearly ploughed deep and caught rich variety of benthic fauna.

1019h **Station JC037/028 PAL lander 2504 m 49°01.324'N 27°42.984'W**
PAL lander deployed in quite nasty conditions.

1050h **Station JC037/029 Shallow CTD 200m 48°56.983'N 27°51.592'W**
Shallow CTD for production studies, it was decided the sea was too rough for the optics rig.

1115h CTD back in board.
The vessel then moved towards the ICDeep lander location.

1254h On station for recovery of ICDeep JC037/026 49°02.2'N 27°55'6W
Release command executed.
Pilot whales and skuas around the ship while waiting for the lander to ascend.
Sunny with 30 knots of wind.
1347h Rain showers
1352h Lander on the surface somewhat later than expected, it was likely deeper than expected having drifted south to land on the slopes of the peak we had been aiming for.
1421h The lander was grappled.
1431h The lander was all in board.

1436h The vessel proceeded so the amphipod trap release location, reversing the half mile or so under DP.

1506h Recovery of amphipod trap JC037/025 49°02.2'N 27°53.7'W
Release command sent.
Bright and sunny conditions 30 knot winds.
1520h Spotted on the surface. JC037/025
1652h Pellet float grappled.
1708h Amphipod trap in board Blustery with bright sunshine No significant catch.

The vessel proceeded to recover the thermistor chain which had been accurately located on the sea floor on the previous day.

1813h Began attempts to range on and release the thermistor chain
1826h JC037/005 49°02.031'N 27°41.927'W
Release command sent
1835h The buoys were spotted on the surface. There is confusion as to how it came up so quickly. It was later concluded that the release must have worked immediately on the first command attempt and the low drag of the rig made for a fast rise time.
1900h Grappled.
1930h Pilot whales around the ship, plus rainbows in a squally rain shower, such a beautiful sight.
1933h Thermistor chain all recovered in board.

1941h Retrieval of PAL Lander Station JC037/028 49°01.3'N 27°43.0'W
Release command sent. Spectacular skies towards sunset with a large pod of pilot whales around the ship. A pod of some 30 individuals of all sizes. Winds 30knots alternating sunny spells and showers.

2033h The lander surfaced.
2053h The lander was grappled.
2108h All the gear was inboard this concluding the work at the SE station.

2110h **Received MAYDAY to rescue Peter Bray** a transatlantic rower 110 miles to west.

2400h Heading westward, e.t.a. with the rower ca. 1000h tomorrow, a rough night 30 knots of wind from the west.

Wednesday 19 August

0700h There had been contact with Peter Bray via Falmouth coastguard providing position information and better estimates of drift.

0830h Management meeting on board. Agreed instructions from base were to rescue the person but not to attempt to salvage the boat or other equipment. Also we are asked not to take photographs, in particular Email unofficial photos to shore. It was agreed David Shale would take "official" photos. The ship's team will manage the rescue.

0930h Wind 30 to 40 knots, sunny with occasional squalls, spray being blown off the tops of the waves.

1000h 48°45'N 30°23'W approaching the location of Bray's boat.

1010h *Black Knight* sighted, as small white boat bobbing on the Ocean.

1125h Bray on board, he was fit and well, wearing appropriate heavy weather dry suit clothing. He was able climb up the pilot ladder unaided and bags with personal possessions were also brought on board.
The Vessel turned and proceeded back to the SW site abandoning *Black Knight*..

1815h Arrived on site. Waited for conditions to die down for the start of megacoring.

2207h Station JC037/030 Megacorer 2555m 48°45.762'N 28°38.521'W
Conditions had calmed down sufficiently to do this, the first physical sampling from the SW site, since none had been possible on previous cruises.

Thursday 20 August

0060h Corer on the bottom reading 2562m depth on the USBL. Veering had been very slow because of using the plasma cable in fairly rough conditions.
0012h Pull out. Start hauling.

0121h Megacorer on deck with 8 good cores with some interesting layers

0144h **Station JC037/031 Megacorer 2555m 48°45.762'N 28°38.521'W**
Second megacorer repeating the first as exactly as possible

0308h on the seabed.
0317h pull out.
0423h Megacorer on deck. Short cores, penetrated only 5-10cm.

The vessel repositioned for the CTD closer to the SW mooring. The wind speed was ca. 5 knots, much calmer than the last few days but with swell remaining.

0614h **Station JC037/032 CTD + Optics 2529m 48°46.33'N 28°38.45'W**
A deep CTD with acoustic releases for test plus the thermistor chain mounted on it for calibration.
0734h The optics rig was deployed for a cast to 200m
0807h The optics rig was inboard
0848h The CTD was recovered in board.

0855h The IXSEA transducer was deployed for communicating with the acoustic release on the SW mooring Sta. D16438 deployed at 48° 46.80'N 28° 38.43'W on 1 August 2008 Depth 2501m,
0856h Release command sent

0920h First floats in the surface very close to the vessel. There was concern that the mooring drifted southwards. The ADCP on PAL subsequently recorded quite strong currents in this area.
0929h Rest of the mooring on the surface. Close in to recover the mooring.
0950h Pellet float grappled and recovery of the mooring commenced.

1048h All the mooring was recovered inboard.
1100h The deck was secure and the vessel moved off to reposition for redeployment of the mooring.

1217h Commenced streaming the new SW mooring

1340h **Station JC037/033 SW Mooring 2500m 48°46.82'N 28°38.50'W**
SW Mooring deployed.
1556h On the sea floor, position checked.

The vessel returned to the Megacorer location. The weather was calm with 0-5 knot winds with a swell from the previous storm.

1442h **Station JC037/034 Megacorer 2555m 48°45.786'N 28°38.444'W**
1556h Megacorer on the sea floor
1605h Pull out 0.74 tonne began hauling.
1711h Corer on deck with 6 good but short cores.

1744h **Station JC037/035 Megacorer 2555m 48°45.763'N 28°38.458'W**

1830h A meeting of scientists was held in the conference room to discuss the work plan. The weather was calm and sunny with the Megacoring work in progress. It jhad been planned, after the megacorer was completed, to steam north westwards to the NW station. The Master pointed out that by the time we arrived we would be experiencing bad weather during the coming weekend and would probably get little work done. Furthermore we would be in the direct predicted path of tropical storm (Hurricane) "Bert" which would pass through later in the week. After much discussion regarding the problems of changing the science programme it was agreed to stay at the SW Station and attempt a full programme of work. Work at the Northerly stations would have to be drastically curtailed in view of the time already lost through diversions to Cork and the *Black Knight.*

1903h Megacorer on the sea floor.

2051h Megacorer on deck with 8 full cores.

In view of the decision at the scientific meeting the landers were reprogrammed in the hanger and preparations made for deployment.

2118h **Station JC037/036 PAL Lander 2505 m 48°44.242'N 28°37.318'W**
First deployment of the PAL lander at the SW site.

2121h The drop keel was lowered in preparation for use of the EK60.
The vessel moved to the ICDeep deployment site

2159h **Station JC037/037 ICDeep 2450 m 48°45.026'N 28°36.295'W**
ICDeep deployed in calm conditions with light winds and clear glow of the sun below the horizon in the west.

2222h **Station JC037/038 Amphipod trap 2440 m 48°45.780'N 28°37.043'W**

2312h **Station JC037/039 RMT 8+1 to 800m 48°43.168'N 28°36.274'W**
RMT net launched for fishing through the night with the EK60 active.

Friday 21 August

0058h RMT net fully paid out.

0453h RMT net on the surface. 48°53.475'N 28°48.883'W

0500h All gear in board. JC037/38 Complete
A good catch distinctly different from previous catches in the SE station.
The vessel moved off back to the central position near the SW mooring site.

0704h Vessel on station.

0730h **Station JC037/040 CTD + Optics to 200m 48°45.000'N 28°38.000'W**
CTD & Optics rigs both into the water.
22 knot wind and pouring rain as the equipment was lowered into the water. Nasty weather but the sea state was perfectly workable and a second day-time RMT is planned at the SW station.
0759h Optics rig back inboard
0821h CTD out of the water.
0828h All secure the vessel moved off to a CTD start position down wind while the net was reset.

0915h **Station JC037/041 RMT 8+1 to 800m 48°44.145'N 28°36.707'W**
RMT launched for a day-time tow.
1200h 1000m of wire out.
1300h Rain had stopped, wind moderated, quite a pleasant afternoon.
1436h Net in board with a good catch. 48°52.74'N 28°47.69'N
1528h 48°53.22'N 28°48.38'W
The EM120 was activated for a short test swath bathymetry run on the way back to the centre of the SW station. Ran at 5 knots

1730h 48°45.087'N 28°37.180'W
End of EM120 run. The vessel continued to the lander recovery site.

1750h PAL released.

1826h ICDeep released to retrieve two lander before dark.
In the mean time visibility had decreased to few hundred meters.

1842h PAL lander surfaced. JC27/036 spotted with difficulty
1857h grappled
1913h PAL secure in board.

The vessel then moved to the ICDeep recovery site where the lander was already on the way up.
1938h ICDeep JC037/037 on the surface.

1950h Grappled

2006h ICDeep secured on deck.

The vessel moved the start of a swath survey.

2300h **Station JC037/042 EM120 swath 2000-3000m 48°37.40'N 28°28.10'W**
30 knot winds it had proved not possible to get good data in any direction other than down wind so a series of swaths at 72° were planned searching for possible OTSB trawl sites.

Saturday 22 August
0400h End of swath survey. 48°29.73'N 28°23.96'W

The vessel returned to lander sites to enable the proposed EK60 survey to start in the morning after the landers have been deployed. No suitable trawl area has been found.

0624h On station commenced deploying the ICDeep lander.

0631h **Station JC037/043 ICDeep 2631m 48°43.938'N 28°38.783'W**
Deployed on flat area south of the megacoring site.

0706h Commenced deployment of PAL.

0712h **Station JC037/044 PAL Lander 2601 m 48°44.840'N 28°38.782'W**
Lander deployed north of the ICDeep on a flat plain.

0718h The vessel remained on station waiting for the CTD and optic rig personnel to have breakfast and for the sun to rise further.

0813h **Station JC037/045 CTD + Optics to 200m 48°44.819'N 28°38.871'W**
CTD in the water.
0823h optics rig deployed.

0835h Very bright sunshine while the CTD optic cast was in progress; the bridge was requested to rotate the ship so that the ship's shadow does not affect results. 35 knot wind 270°.
0853h Optics cast completed, instrument package in board.
0845h CTD in board.

The vessel moved to the start of an EK60 survey grid. Some time was taken deciding on the orientation of the grid.

1020h **Station JC037/046 EK60 + EM710 48°42.846'N 28°45.828'W**
Start of Survey as the vessel passed through waypoint one on the first of 10 planned runs each 10 miles long at bearings 30° and 330°T .

Winds 30 knots, bright and sunny.

2006h End of survey at run number 8, terminated as zooplankton began their dusk migration to the surface. 48°40.46'N 28°39.146'W

The vessel returned to the centre of the working area to wait to see if it would be possible to do RMT trawls in the prevailing conditions which were marginal.

2308h **Station JC037/047 RMT 8+1 to 1000m 48°44.88'N 28°39.09'W**
The RMT was fished deeper in order to avoid effects of rough weather.

Sunday 23 August
0024h RMT veered to 1600m to commence fishing at 1000m

0540h Net on the surface 48°49.517'N 28°57.327'W

0602h All secure in board with a small catch. Station JC037/047 complete

0747h The vessel arrived at the amphipod trap site JC037/038
0756h The amphipod trap was released.

0810h A violent squall with 40 knot gusts hit the ship.
0820h Weather calmer and sunny with 30knot wind from NW.
0836h Trap on the surface. Wind 24-28 knots 309°.
0849h Grappled
0905h All in board.

The vessel moved towards the PAL lander recovery position where it was proposed to do CTD and optics casts.

0950h **Station JC037/048 CTD to 200m 48°45.240'N 28°38.680'W**
A shallow CTD without the Optics rig because the vessel was pitching too much in the prevailing conditions.

1026h CTD finished out of the water.
1029h CTD in board and secure.

1030h PAL lander, JC037/044 released
1125h PAL on the surface. Bright sunny weather.
1159h PAL all inboard

The vessel moved the short distance to the ICDeep location.

1226h Release successfully activated on the ICDeep.

1344h ICDeep Station JC037/043 surfaced.

Wind decreased to 25 knots.
1357h Grappled.
1409h ICdeep in board and the vessel moved off to the first waypoint of the short EK60 survey.

1509h Station JC037/049 EK60 survey 48°46.77'N 28°31.88'W
Commencement of 2 x 10 mile lines to complete to 10 x 10 grid survey of the previous day Station JC037/ 046

Vessel passed through the first waypoint of the survey; beam onto the wind and seas.

1720h End of EK60 survey 48°46.40'N 28°30.10'W

Work completed at the Southern Station, it had not proved possible to find suitable ground for bottom trawling. Vessel moved off towards the northern station. The drop keel was retracted for maximum speed.

Monday, 24 August

Overnight the vessel pursued a course of 340° east of the Topex Poseidon transect in order to gain maximum distance north before the forecast ex-Bill hurricane depression passed through the area.

0805h 51°03.208N 29°33.372W sea surface temperature has dropped to 12.6°C and the chlorophyll reading was 1.66 $\mu g.l^{-1}$, indicating a primary production peak at the sub polar front interface.

0823h Vessel start to heave to for CTD and optics on the front.

0829h **Station JC037/050 CTD + Optics to 200m 51°05.530'N 29°34.342'W**
Casts just north of the chlorophyll peak. Optics into the water.
0830h CTD into the water.
0901h Optics in board
0904h CTD at the surface
0907h CTD in board
0910h All was secured the vessel moved off on course 345°. Wind had dropped to 15 knots and the sea was much calmer but there was concern about the forecast track of the remnants of hurricane Bill that should pass nearby to the south.

1615h Muster with practice at donning the survival suits.

1720h 52°27'N 30°05'W. 10 knots of wind calm seas and the ship continued northwards over the Charlie Gibbs Fracture Zone. Ex-Bill was due to pass just south of us at 0600h tomorrow.

2110h 52°57'N 30°52'W The vessel was heading 314° towards the NW station and the barometer was dropping steeply past 999 mbar.

Tuesday, 25 August

0915h 53°46.704'N 34°16.40'W Calm seas the barometer was climbing again indicating that ex Bill had been successfully evaded. It was sunny and the wind was 18 knots from 319° as the vessel was heading towards the NW station.
1520h Approaching NW Station wind 28 knots 285°. Sunny overcast with thin cloud.

1604h Arrived at the CTD station near the NW mooring.

1614h **Station JC037/051 CTD + Optics to 2521m 53°59.339'N 36°07.710'W**
CTD into the water.
1615h Optics rig deployed.

1617h CTD retrieved when the signal was lost the cable had to be reterminated. The Optics cast continued.
1650h Optics rig inboard. Wind was 23 knots 271°
1824h The CTD cable was reterminated.
1848h The CTD was relaunched.
1850h CTD in the water and working satisfactorily.
2129h CTD on the surface
2132h CTD in board just as the sun was setting.

The vessel moved to the amphipod trap deployment position.

2152h **Station JC037/052 Amphipod Trap 2570m 53°59.320'N 36°08.119'W**
Trap deployed with no difficulties.

2228h PAL mooring was deployed

2230h **Station JC037/053 PAL 2559m 53°58.381'N 36°07.730'W**
PAL lander sank below the surface.

Trawling was planned at the NW site from south to north at 10° but with the wind at force 4-5 from the SW this would be very demanding on the vessel.

2250h Stopped for tests on positioning the ship for trawling.

2315h 53°58.4' 36°09.3'W Hove to in the trawl start position wind 210° 30 knots.

2355h Attempted start of trawl but abandoned because of ship handling problems. The vessel was unable to hold a stable course while towing in the prevailing sea and weather conditions.

The vessel moved off to start swath bathymetry.

Wednesday, 26 August

0108h **Station JC037/054 EM120 swath bathymetry 54°09.56'N 36°11.27'W**
Swath survey to the north of the existing known trawl area.
0122h Traversing at 6 knots.
0311h 54°220.61'N 36°00.23'W End of swath survey. A new potential trawl track 5.5 miles long was identified.

The vessel then moved to the NW mooring site to prepare for recovery early in the morning.

0611h Vessel on station at 53°59.444'N 36°06.722'W waiting for daylight. Sunrise at 0730h.
0643h Began interrogating the acoustic release.
0652h First buoy on the surface. Vessel waiting for all buoys to surface.
0735h Grappled.
0825h Recovery of the mooring commenced.

0950h Steve Whittle was hit in the face by a swivel on the mooring. He fell to the deck but was not unconscious. He went off duty for the injury to be attended to. Later his left cheek and eye were swollen.
1020h Mooring all gathered in.
1105h Vessel waiting stopped in the mooring redeployment position.

1200h Preparation of the mooring continued.
1239h Started deployment.

1459h **Station JC037/055 NW Mooring 2504m 53°59.340'N 36°07.375'W**
Mooring deployed very close to the position of the previous moorings.
1505h The vessel waited on position to check the descent of the mooring by acoustic telemetry. Ranging was not very successful.
1600h Broke off to go to the ICDeep deployment position.
1626h Commenced deploying floats

1632h **Station JC037/056 ICDeep 2339 m 53°58.673'N 36°06.092'W**
ICDeep deployed near the NW mooring site as winds were increasing to 35-40 knots. The hard disc of ICDeep had been completely reconfigured with new software and the system rebuilt since the previous day.

1704h **Station JC037/057 EK60 + EM710 survey 53°59.110'N 36°07.268'W**
The vessel passed through the first waypoint on the survey. Wind was 35-40 knots from 270°. Acceptable quality data were collected running diagonally across the wind and sea.

1930h 53°59.455'N 36°06.714'W passed through waypoint 4 on the survey with 2 lines completed the survey was aborted owing to failing light and plankton ascending in the water column.

The vessel hove to for the night to wait for the weather to abate.

2200h Wind 280° 45 Knots

Thursday, 27 August
During the night the vessel gradually moved westwards hove to the wind and seas.

0600h 54°03.530'N 36°39.190'W The vessel turned to travel back to the working area for pick up of the amphipod trap. The wind had moderated to 25 knots.

0811h On station for recovery of Station JC037/052 Amphipod Trap.
Release command sent from the keel transducer.

Grey skies 25 knots of wind from 313°.

0905h Amphipod trap on the surface Station JC037/052
0920h Grappled
0936h Trap all inboard with a large catch of amphipods and ostracods.

0939h Release command sent to JC037/053 PAL lander from the keel transducer.
1028h PAL on the surface JC037/053
1038h Grappled
1054h PAL all in board.

1100h The vessel remained on station for the CTD station.

1115h **Station JC037/058 Shallow CTD to 200m 53°58.23'N 36°07.73'W**

CTD deployed but the optics cast that had been planned was cancelled owing to the rough sea state.

1158h CTD in board

1246h **Station JC037/059 EK60 + EM710 survey 53°59.485'N 36°08.136'W**

The survey continuing the grid from where left off from Station JC037/057 on the previous day, i.e. starting the third line at waypoint 5.

The seas gradually calmed down during the afternoon with winds of less than 10 knots by the evening. The vessel was able to work at 9-10 knots.

2010h 53°54.785'N 36°21.563'W End of survey at waypoint 18. Stopped owing to failing light. One line left to do, was postponed until the next day.

The vessel turned to head towards the amphipod trap site.

2120 Arrived at the amphipod trap site with a view to deploying the trap and recovering the ICDeep in quick succession. A delay ensued while problems with the thrusters were resolved

2129 The vessel stabilised on station and the dunking transducer was placed in the water.
2130h Release command was successfully sent to the IC Deep.

Work immediately started on deployment of the trap.

2143h **Station JC037/060 Amphipod Trap 2340 m 53°58.459'N 36°06.116'W**

Trap deployed near the position of ICDeep JC037/056

The vessel then moved onto the ICDeep recovery position as darkness fell. The wind freshened to 20 knots from the SW.

2240h ICDeep Station JC037/056 on the surface.
2255h Grappled
2307h The lander was all secure in board.

The vessel departed northwards towards the new trawl grounds revealed in the JC037/54 EM120 swath survey, some 2.5h travel time. The sea was calm with good prospects for trawling.

Friday, 28 August
0100h *En route* to trawl site at the north end of the NW station

0213h **Station JC037/061 OTSB 2600-2620 m 54°19.62'N 36°00.87'W**
Started streaming the net.

0229h The vessel passed through the trawl start position. 54.19.226'N 36°01.171'W

0503h 6500m of wire out.
0516h Net on the sea bed.
0545h Commenced hauling.
0701h Net off the bottom.
0837h Net recovered in board. 54°04.956'N 36°07.984'W. A good catch of fish with many *Antimora rostrata* and pycnogonids. The net was covered with fibrous *Rhizammina algaeformis* a benthic agglutinated branching foraminifera. Sunny bright morning with pilot whales around the boat.

The vessel moved off to the PAL deployment position further south.

0940h Arrived at the PAL Location
1014h Started deploying PAL.

1020h **Station JC037/062 PAL Lander 2513m 53°58.397'N 36°08.216'W**
PAL deployed, flag down.

Work continued to prepare the CTD and optics rig.

1032h **Station JC037/063 CTD + Optics to 200m 53°58.333'N 36°08.170'W**
Optics rig into the water.
1043h CTD into the water.
1100h Optics out of the water.
1112h CTD on the surface.
1120h All gear secured in board and the vessel moved off to the start of the RMT tow.

1154h **Station JC037/064 RMT 8+1 to 800m 53°58.21'N 36°14.49'W**
RMT deployed on course 160°. Wind 20 knots and the seas were still relatively calm.
1300h RMT in progress but the flow meter was not giving accurate readings.
1314h Veered to 1400m of wire out.
The tow continued as the flow meter failed completely.
1812h RMT on deck; 53°46.455'N 36°10.496'W
1828h All gear stowed in board, the vessel turned to head for the start of the EK60 survey.

1914h **Station JC037/065 EK60 + EM710 survey 53°51.537'N 36°11.515'W**
Start of line 10 of the NW station EK60 survey. Vessel travelling at 9 knots.
2011h End of survey line 53°58.534'N 36°04.620'W

The vessel moved the short distance to the ICDeep deployment position.

2052h Start deployment of ICDeep.
2057h Released

2058h **Station JC037/066 ICDeep 2560 m 53°59.326'N 36°08.126'W**
Flag sank below the surface. ICDeep deployed.

The vessel moved off north to the start of the OTSB tow. It was a damp foggy night with poor visibility and wind was 20-28 knots 154°. Trawling would be from north to south against the wind.

2338h Vessel stopped for OTSB deployment.

2348h **Station JC037/067 OTSB 2600-2620 m 54°19.50'N 36°01.11'W**
Net in the water.

Saturday, 29 August

0223h Wire veered to 6475 m
0250h Net on the bottom
0321h Commenced hauling
0410h The wire jumped off the sheave with a big bang. 54°07.63'N 36°06.62'W
Course 199° wind 215° 18 knots. Vessel slowed and stopped
0436h Vessel started moving slowly astern to slack the wire. Technicians and crew pulled the wire back onto the sheave. It had jumped off the sheave and jammed between the cheek and the sheave, cutting through the plastic fairing.
The vessel continued moving astern hauling wire.
0757h The vessel stopped with 3395m wire out in 2650m depth of water. 54°08.179'W 36°06.353'W. Continued hauling until the net lifted off the bottom.
0832h Vessel started moving ahead as the net lifted off the bottom.
0936h Net on the surface. Undamaged but very full of mud.
1019h Large ball of mud on the deck. 54°06.553'N 36°07.135'W
The scientific party set to searching through and washing the catch. A nice sunny day.

1237h Deck clear of mud. Suspended sieving activity to allow the optics cast to take place. The vessel moved one mile further south to clean water.

1300h Vessel on station.

1312h **Station JC037/068 CTD + Optics to 200m 54°03.77'N 36°07.82'W**
CTD in the water.
1324h Optics rig in the water.
1352h Optics rig out of the water.
1353h Optics rig in board.
1414h CTD in board station JC037/068 complete

Work continued to prepare for launching the RMT. Sieving and washing the OTSB catch continued.

1455h **Station JC037/069 RMT 8+1 800m 54°03.49'N 36°08.03'W**
RMT in the water.
At the opening of the first net an anomalous pulse was received from the net controller but fishing continued on the assumption that the net had opened. The second net opening failed to indicate.
2000h The net was recovered and it was found no nets had triggered. A very small catch was found in the first 8m^2 net that had squeezed through the mouth 53°54.289'N 36°18.599'W.

2030h The vessel turned and headed north for the OTSB trawl start position.

2359h **Station JC037/070 OTSB 2600 m 54°19.231'N 36°01.170'W**
OTSB in the water ready for a tow towards the south.

Sunday 30 August.
0235h Wire veering out to 6450m
0300h Net on the sea floor.
0336h Commenced hauling
0630h Net in board 54°03.645'N 36°08.416'W with a good clean catch.
0647h All secured and the vessel headed for the ICDeep location.

0722h At the ICDeep station beginning acoustic interrogation.
0724h ICDeep released. In order to recover two landers as quickly as possible the vessel moved to the PAL site while ICDeep was ascending.
0810h PAL released.

0843h ICDeep on the surface. Station JC037/066
0854h ICDeep grappled
0900h PAL surfaced Station JC037/062
0904h ICDeep on deck the vessel moved to pick up the PAL lander that had surfaced in the mean time. Sunny weather with relatively high seas.
0935h PAL grappled.
0947h PAL on deck
1013h All secured in board, the vessel moved off to the amphitrap position.

1030h Amphipod trap released.
1115h Amphipod trap on the surface, JC037/60
1125h Grappled. Wind 320° 30 knots.

The weather was blustery and sunny; the seas were considered too rough for a proposed megacorer. Therefore the vessel departed to travel eastwards along the 54°N parallel to the NE site.

1303h **Station JC037/071 EK60 53°56.94'N 36°06.29'W**
The EK60 was monitored during the transit to the NE site.

1732h The vessel arrived at the first CTD site on the northern transect.
1748h **Station JC037/072 CTD + Optics 1300m 54°00.03'N 34°57.06'W**
A deep CTD on the eastern crest of the mid-ocean ridge together with an optics cast at the end of the CTD upcast. The CTD entered the water.

1849h Optics rig into the water.
1920h Optics rig in board.
2000h CTD in board

2005h The vessel moved off eastwards, the weather had moderated during the afternoon permitting the optics rig deployment. Wind 330° 23 knots.

2145h **Station JC037/073 CTD 2272m 53°59.87'N 34°36.92'W**
CTD on the eastern flank of the ridge.
2339h CTD in board.

The vessel departed for the NE station.

Monday, 31 August

0215h Hove to on the NE station CTD position. The weather was now quite rough and some time was taken to assess whether to do the CTD.

0237h **Station JC037/074 CTD 2500m 54°01.12'N 34°10.62'W**
CTD at the NE Station deployed in wind 325° 30knots.
0352h Stopped at 2445m of wire veered.
0502h CTD out of the water
0506h CTD secured in board. End of JC037/071 EK60 transect.

0604h Hove to at the NE Mooring site but with the wind at 36 knots 320° it was too rough to start work on the mooring. It was decided to do the EK60 survey instead.

0805h **Station JC037/075 EK60 EM710 54°01.903'N 34°11.122'W**
Start of EK60 survey line 1. Throughout the day it was sunny and wind was decreasing. The survey grid was with legs at 10° and 190° across the wind which was at 300°.
1320h Continuing survey in winds of 24 knots.

1937h Completed the EK60 survey 54°00.65'N 33°59.71'W wind 280° 11knots and sea calming down.

The vessel moved to the area for deployment of the amphipod trap and other landers.

2012h Started deploying the amphipod trap.

2016h **Station JC037/076 Amphipod trap 2552m 53°58.944'N 34°02.944'W**
Amphipod trap released to the west of the trawl track.

2053h **Station JC037/077 PAL lander 2535m 53°57.973'N 34°03.191'W**
Flag down, PAL deployed ca. 1 mile south of the Amphipod trap.

2120h commenced deploying ICDeep.

2123h **Station JC037/078 ICDeep 2536m 53°56.933'N 34°03.374'W**
ICDeep deployed in the lander cluster.

The vessel then moved northwards to prepare for an OTSB tow along the successful tracks used in 2007.

2320h Preparing for launch of the OTSB, the wind was moderate and there was just residual swell from previous winds. The forecast was for relatively calm weather throughout the rest of the voyage.

2327h **Station JC037/079 OTSB 2440m 54°03.600'N 33°58.839'W**
Net in the water in preparation for a tow towards the south.

Tuesday, 1 September.

0047h 53°59.49'N 34°00.10'W 202° 5 knots wind. While veering, the trawl wire jumped off the sheave on the main 'A' frame block. The vessel and winch were stopped immediately with 2577m of wire out in 2475 m of water depth.
0055h The wire was vertical.
0136h It was noted that the net was still sinking.
0212h The wire was heaved back onto the sheave.
0214h Commenced hauling and the vessel started moving forwards.
0326h The net was on the surface.
0356h The net was recovered 53°57.69'N 34°00.55'W

Trawling was abandoned and the vessel moved to the mooring area for a megacorer deployment on the same site as was used in JC011 in 2007. A few benthopelagic fish were caught in the net including *Antimora rostrata* and *C.brevibarbis*

0510h **Station JC037/080 Megacorer 2486m 54°06.651'N 34°10.418'W**
0624h corer on the sea floor
0629h Commenced hauling.
0736h Corer on deck, 5 successful cores.

The vessel moved to recover the NE Mooring.

0746h Release command sent.
0745h First floats on the surface. 53°59.926'N 34°10.173'W
The vessel waited until most of the buoyancy had surfaced before closing in.
0846h Pellet float grappled.
Recovery was delayed by some of the floats and equipment being tangled.
1040h Mooring recovery complete.

1145h Work continued on preparing the instruments for the new mooring in ideal calm weather.

1305h 53°57.961'N 34°09.233'W. Started streaming the NE mooring.

1502h **Station JC037/081 NE Mooring 2500 m 54°00.046'N 34°10.580'W**

Mooring released and deployment complete for recovery in 2010.

1558h **Station JC037/082 CTD + Optics 200m 54°00.118'N 34°10.655'W**
Shallow casts on the site of the NE Mooring. Optics rig deployed.
1601h CTD into the water.
1630h Optics rig in board.
1641h CTD in board.
The vessel proceeded to recovery of the amphipod trap.

1731h Pinging commenced
1733h Successful release command sent.
1824h Amphipod trap surfaced, Station JC037/076
1842h mooring grappled.
1854h The amphipod trap was all in board.

The vessel moved south one mile to the PAL position.
1918h Release command sent to PAL
2009h PAL on the surface. Station JC037/077
2030h PAL grappled.
Whale spouts were seen around as the lander was being retrieved.
2043h PAL all in board

2106h ICDeep released.
2221h On the surface on a clear night. Station JC037/076
2233h Grappled
2243h IC Deep all inboard.

The vessel steamed back to near the mooring site for deployment of the Amphipod trap. Repairs had been done to the trap.

2356h Commenced deploying the amphipod trap.

Wednesday, 2 September

0002h **Station JC037/083 Amphipod Trap 2452 m 54°02.307'N 34°09.538'W**
The amphipod trap deployed under a clear sky with a full moon and a planet visible to the left of the moon.

The vessel repositioned for the megacorer station.

0042h **Station JC037/084 Megacorer 2493 m 54°00.64'N 34°10.41'W**
Corer into the water.
0158h Corer on the bottom
0204h Pull out and started hauling.
0311h Megacorer on deck.

0337h **Station JC037/085 Megacorer 2493 m 54°00.651'N 34°10.418'W**
0452h Corer on the bottom.
0457h Pull out and start hauling.
0605h Megacorer on deck.

0628h Megacorer secured in board and the vessel moved the short distance to the ICDeep recovery location.

0710h Vessel on the ICDeep position and work began on preparing the ICDeep for deployment.

0750h Commenced deployment.

0756h **Station JC037/086 ICDeep 2501 m 54°04.491'N 34°09.836'W**
ICDeep deployed on the flat plain near the mooring site.

The vessel moved to the PAL deployment site.

0830h On station for PAL deployment, a clear calm morning with light winds.

0850h **Station JC037/087 PAL Lander 2479 m 54°03.374'N 34°09.473'W**
PAL deployed.
The vessel stayed on station for the CTD and Optics casts.

0912h **Station JC037/088 CTD + Optics 200 m 54°03.404'N 34°09.563'W**
Optics rig deployed
0913h CTD deployed.
0939h Optics rig in board.
0950h CTD recovered.

While the CTD cast was in progress the RMT was prepared for deployment after repairs to its net trigger system. The vessel then proceeded to the RMT start position.

1047h Started deployment of the net.

1051h **Station JC037/089 RMT 8+1 800 m 54°04.877'N 34°01.879'W**
RMT in the water the tow commenced towards the west.

Calm ideal conditions and the refurbished net control system appeared to be working.

1612h 54°02.59'N 34°22.69'W. RMT in board and all the nets had released and fished properly. The catch was low diversity and modest in volume.

The vessel moved back eastward to the centre of the NE study area to begin a second shorter tow before it got dark.

1722h **Station JC037/090 RMT 8+1 800 m 54°04.482'N 34°13.026'W**
The RMT was redeployed for a second tow of the day.

2049h 54°09.980'N 34°21.715'W The net was recovered before sunset at the end of a second successful tow at the NE site. The catch was very similar to the previous one.

2109h All the gear was secured and the vessel departed to the ICDeep recovery position.

2221h Pinging ICDeep
2226h ICDeep released
2345h ICDeep surfaced Station JC037/086. Strobe light conspicuous in clear visibility conditions.
2352h grappled

Thursday 3 September

0002h ICDeep recovered on board on a moonlit night.

0016h The vessel moved to the megacorer site.

0111h **Station JC037/091 Megacorer 2493 m 54°00.67'N 34°10.42'W**
0224h corer on the sea floor.
0231h Pull out and commenced hauling.
0339h Corer on deck with a full set of 8 core tubes.

The vessel hove to for a period before scheduled lander recoveries after first light. The amphipod trap and PAL were to be recovered in tandem.

0727h Amphipod trap interrogated and released.
0800h PAL lander released.

0823h Amphipod trap on the surface. Station JC037/083
0837h Amphipod trap pellet buoy grappled.
0848h Amphipod trap all in board.

0851h PAL on the surface. Station JC037/087
0920h PAL grappled. Wind 240°, 20knots
0931h PAL all in board.

The vessel then settled on station for the CTD and Optics.

0956h **Station JC037/092 CTD + Optics 200 m 54°03.17'N 34°09.65'W**
Optics rig into the water.

0959h CTD deployed.
1024h CTD deployed.
1024h optics rig recovered in board.
1045h CTD in board.

This marked the end of scientific work on the Mid-Atlantic Ridge with a brisk westerly breeze blowing and sunny spells.

1048h 54°03.1'N 34°09.7'W the vessel set a course of 100° towards Bantry Bay.

Friday 4 September

1200h 53°16.00'N 26°59.8'W Vessel making 10 knots with a following wind and sea 240° 30 knots wind.

1830h 1st Post cruise science meeting was held in the Conference room to review the overall achievements of the cruise and issues relating to the cruise report and demobilisation.

Saturday 5 September

1200h 52°32.9'N 20°08.2'N Vessel continuing to make good speed, 10.6 knots with a following wind and sea 240° 25 knots wind.

1230h 2nd Post cruise science meeting held in the Conference room reviewing results from primary production and pelagic surveys.

1830h 3rd Post cruise science meeting with a show of images by David Shale and review of results from Physical Oceanography and the sediment traps.

2000h Principal Scientist's RPC.

Sunday 6 September

0830h Post cruise debrief meeting.

1200h 51°49.7'N 13°41.5'N Vessel continuing to make good speed, 10.2 knots with a following wind and sea 220° 20 knots wind.

1230h 4th Post cruise science meeting discussing results of benthic sampling.

1830h Science meeting to discuss the proposed cruise of the *RRS James Cook* in 2010 with the ISIS ROV. In the mean time the winches for the EK60 calibration were being set up ready for the following morning. Line was accurately measured out and fitted to the new winches produced by NMF.

Monday 7 September

0105h 51°31.52'N 10°06.33'N The vessel was passing Sheep's Head at the entrance to Bantry Bay.

0310h The vessel arrived at a suitable calibration site on the south side of the bay 6 cables off White Horse Point.

0326h Sound velocity probe lowered into the water.

0330h Started deploying the lines for suspending the calibration ball.
0334h Sound velocity probe in board.
0430h The ball was detected in the EK60 sonar beam
0450h The Starboard drop keel was lowered. Calm weather with light winds.

1130h Calibration of the last EK60 transducer completed.

1200h All checks on the EK60 finished.

1307h Starboard keel retracted.

1314h Calibration lines and the tungsten carbide ball retrieved in board. The vessel remained on station for testing of boats.

1322h The man overboard boat (MOB) was lowered, driven by the 1st officer and a ship's team plus a scientist Martin Cox.

1332h Starboard lifeboat lowered.
1340h The starboard lifeboat was released from the falls and some of the crew from the MOB transferred to start the engine and test all functions.
1401h The starboard lifeboat was recovered.
1423h The MOB was recovered and all ship's personnel were back on board.
1436h The vessel departed for Falmouth with rail falling and increasing wind speed with gales forecast from the south for later in the evening.

Tuesday 8 September

Vessel on passage all day to Falmouth

Wednesday 9 September

1600h Alongside at Falmouth end of voyage.

DESCRIPTIONS OF WORK:

1. Remote Sensing.

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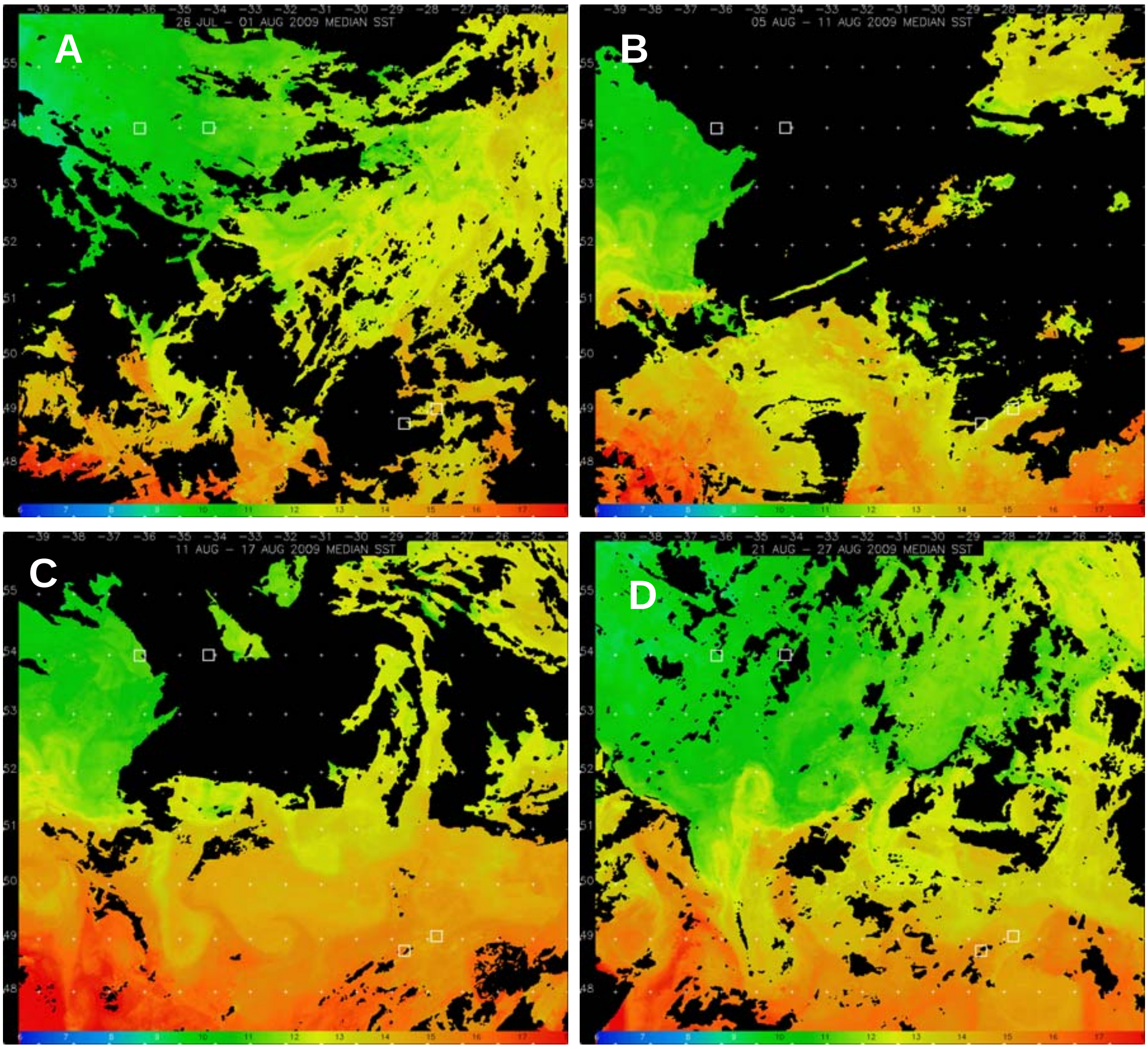
OBJECTIVES: By remote sensing, appropriately calibrated with in situ incubations, PML will produce regional estimates of surface primary production over the study area.

METHODS: ***AVHRR and MODIS Images.*** AVHRR and MODIS-Aqua (1.1 x 1.1 km) Local Area Coverage (LAC) data were received by Dundee Satellite Receiving station, decoded and transferred to the Remote Sensing Group at Plymouth Marine Laboratory (PML). AVHRR level 1b data were processed using the PML processing software Panorama. MODIS level 1b passes were processed using SeaDAS v5.1. The following quality flags were implemented for the MODIS passes to eliminate erroneous data: (1) atmospheric correction failure, (2) land, (3) bad ancillary data, (4) high sun glint, (6) high satellite viewing angle (>60°), (8) negative water leaving radiance, (15) low water leaving radiance and (13) high solar zenith angle (>70°).

RESULTS: The satellite imagery for the duration of the ECOMAR cruise JC037 (01 August – 09 September) was hampered by cloudy conditions and there was not a single clear overpass over the study area. Research activities were guided by composite images, when available.

AVHRR Sea Surface Temperature (SST). Prior to the cruise, the boundary between the sub-polar front could be clearly seen between 50 & 51°N and 28-31°W separating colder (11 – 12°C), arctic overflow water north of the front from warmer (14 – 16°C) sub-tropical water to the south (*Figure 1a*). This feature gradually migrated northward, residing closer to 51°N between 11 & 17 August (*Figure 1c,d*), with a number of meso-scale eddies around the front, demarked by intrusions of 13°C water to the south of the front. Between 21 & 27 August the western boundary of the front shifted towards the east.

Figure 1. *AVHRR SST composites for (a.) 26 July – 1 August, (b.) 5 – 11 August, (c.) 11 - 17 August, (d.) 21 - 27 August 2009 (d.).*



Ocean Colour MODIS-Aqua Chl-a: Prior to the cruise, between 21 & 26 July Chla was patchy and between 0.1 and 1 mg m^{-3} in the study area with similar values at the Southern an Northern stations between 0.5 & 1 mg m^{-3}; *Figure 2a*). The week prior to the cruise there was evidence of a bloom between the Southern and Northern stations over the TOPEX-POSEIDON transect when Chla concentrations reached 5 mg m^{-3} (*Figure 2b*). From the 16 to 22 August Chla concentrations diminished over the region and remained at between 0.5 & 1 mg m^{-3} at northern and southern stations (*Figure 2b,c*).

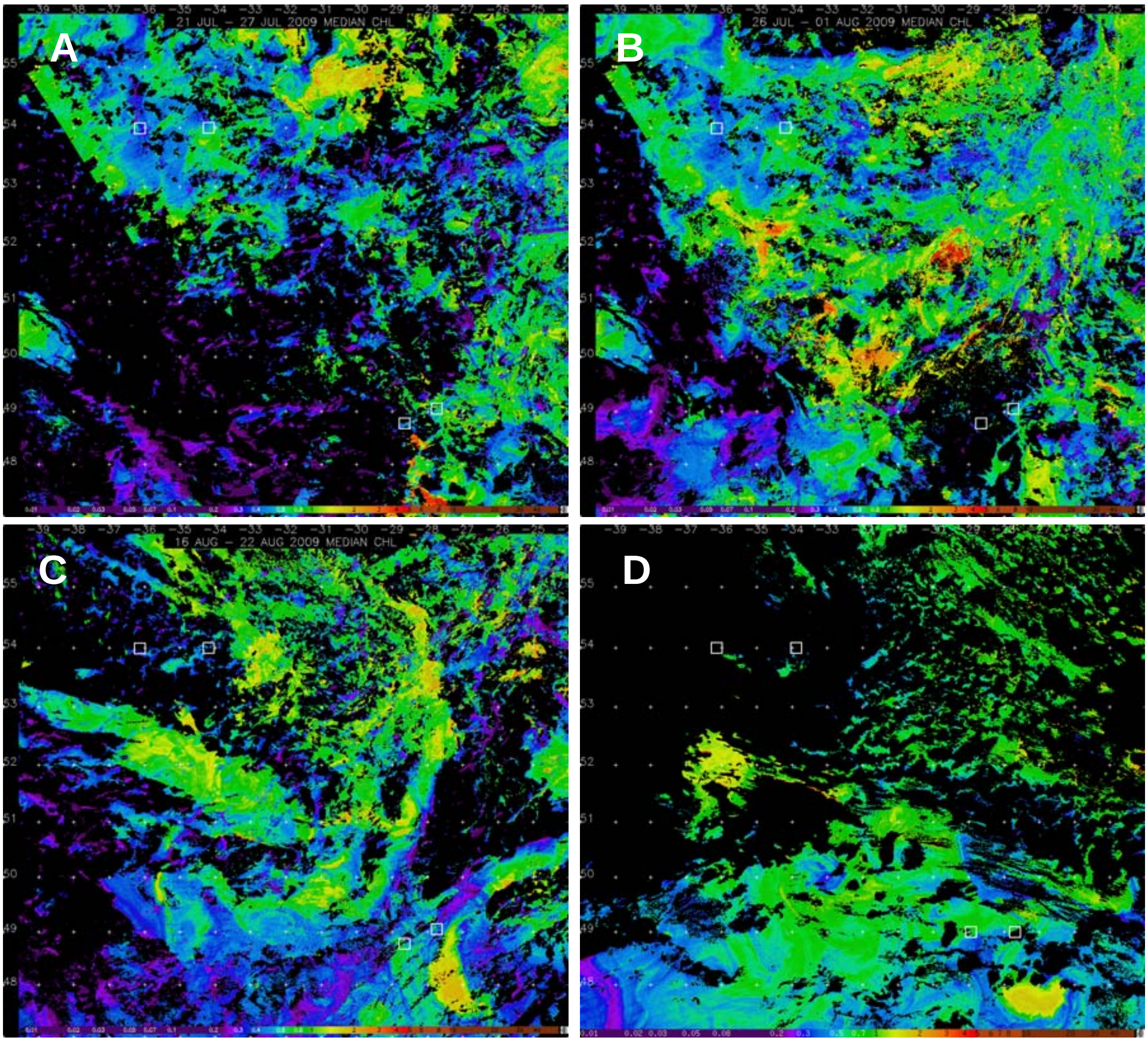


Figure 2. MODIS-aqua Chl-a (OC3 algorithm) composite images for (a.) 21 – 27 July, (b.) 27 July – 1 August, (c.) 16 - 22 August, (d.) 27 August 2009.

Figure 3 presents individual MODIS-Aqua ocean colour scenes during JC037, processed using the standard NASA OC3 algorithm. The satellite imagery was generally cloudy throughout the cruise, though there were images coincident with the sampling stations at the SE and SW when Chla was ~0.5 mgm^{-3} (*Figure 3c,d*). The MODIS imagery indicated that Chla concentrations were between 0.5 & 1 mgm^{-3} in the surface waters at the northern stations (*Figure 3a,b*). There were no coincident satellite match ups at the Northern stations. The best coverage was on 25 August 2009 when the ship was on passage between the SW and NW stations.

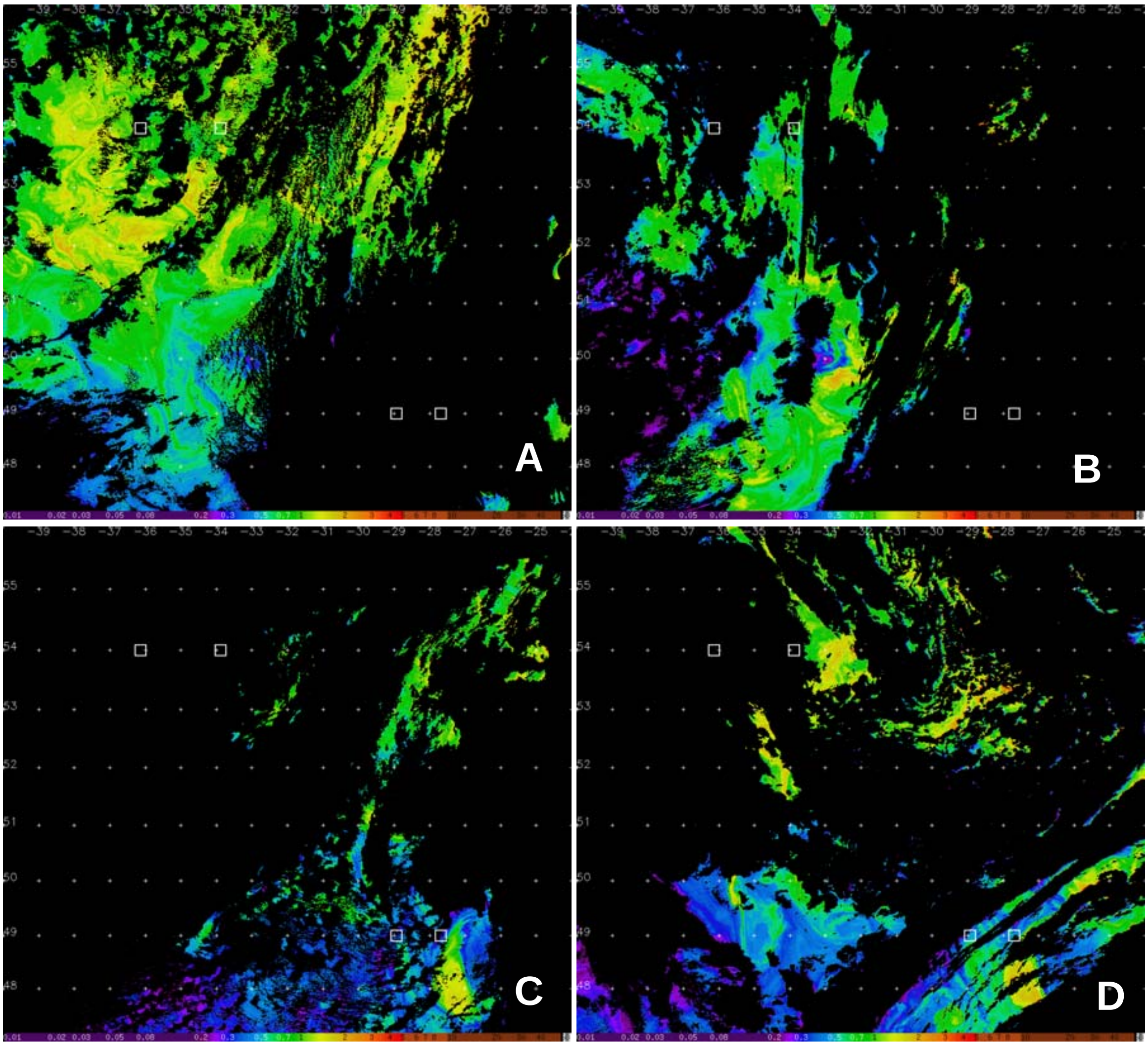


Figure 3. MODIS-Aqua Chl-a images for (a.) NW station on 25 August, (b.) NE station on 29 Augsut, (c.) SW station on 18 August, (d.) SE station on 16 August 2009.

Satellite estimates of Primary Production: The wavelength resolving model of Morel (Morel, 1991) was implemented following Smyth et al. (2005) and Tilstone et al. (2005). Integration was performed over all daylight hours, for wavelengths 400–700 nm and to the 0.1% light level and computed through the iterative approach of Morel and Berthon (Morel and Berthon, 1989). Composite satellite maps of primary production were generated for the region following Smyth et al. (Smyth et al., 2005) forced with weekly satellite fields of NASA MODIS Chl-a, SST and PAR (Frouin and Pinker, 1995).

Figure 4 presents the satellite primary production estimates for the whole cruise period, alongside whole-cruise summaries of the other remotely-sensed parameters of SST, thermal fronts (Miller, 2009) and Chl-a.

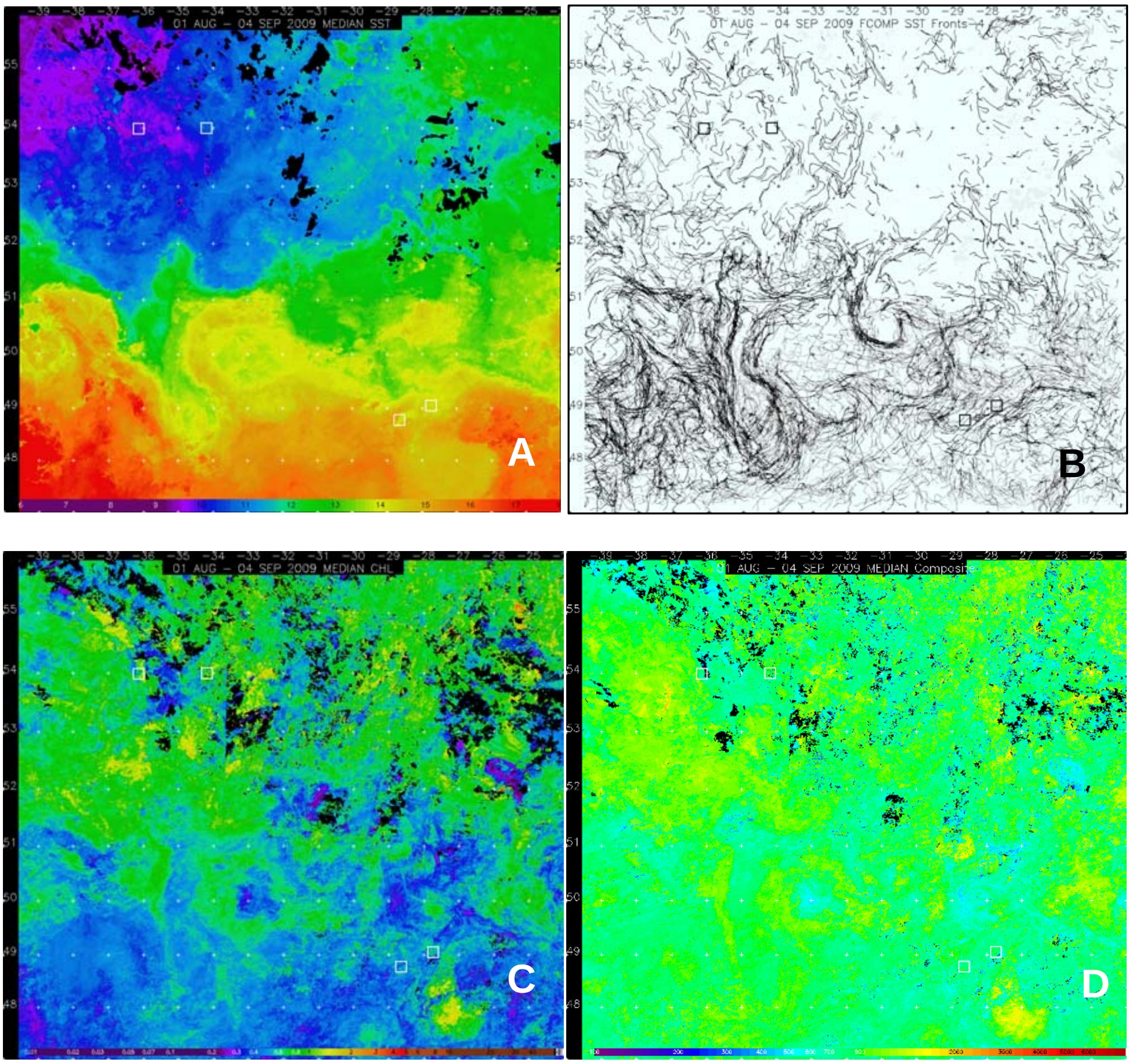


Figure 4. Remote sensing data summaries for whole cruise period 01 Aug.-04 Sep. 2009: (a.) SST (using different colour scale to Fig 1.) (b.) Thermal fronts indicating mesoscale features, (c.) MODIS-Aqua Chl-a, (d.) Primary production.

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2. Primary Production and Marine Optics.

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OBJECTIVES.
Do the mid Atlantic Ridge and Charlie Gibbs Fracture Zone create areas of high primary production and what is the likely export flux of carbon to the sea floor? Remote sensing, in situ incubations and bio-optical variables will be used to assess whether there are varying regimes of primary production between these regions and either side of the sub polar front.

METHODS. Water samples were taken from 10l niskin bottles on the CTD rosette from between 4 and 5 depths in the euphoic zone from 18 stations to measure the parameters described below. Coincident optical casts were also performed during the upcast of the CTD.
Primary Production. 76 Photosynthesis-Irradiance experiments were conducted; 52 to measure total production and 24 to measure size fractionated production in two size classes of phytoplankton, >0.7 and >2.7μ. The experiments were conducted in photosynthetrons illuminated by 50 W, 12 V tungsten halogen lamps following the methods described in Tilstone *et al.* (2003). Each incubator houses 15 sub-samples in 60 ml polycarbonate bottles which were inoculated with between 185k Bq (5 μCi) and 370 kBq (10 μCi) of ^{14}C labelled bicarbonate.

Figure 1. *Filtration of Photosynthesis-Irradiance curves.*

The samples were maintained at *in situ* temperature using the ships non-toxic supply or a digital temperature controller. After 1 to 2 h of incubation, the suspended material were filtered through 25 mm Whatman GF/F filters (*Fig. 1*) to measure the total production or sequentially filtered through GF/D (pore size ~2.7μ) and then GF/F filters (pore size ~0.7μ) to estimate the nano and pico-phytoplankton production respectively.

The filters were exposed to concentrated HCl fumes for 12 h immersed in scintillation cocktail and ^{14}C disintegration time per minute (DPM) was measured on board using a WinSpectral 1414 liquid scintillation counter and the external standard and the channel ratio methods to correct for quenching. The broadband light-saturated Chla-specific rate of photosynthesis P_m^B [mg C (mg chl a)$^{-1}$ h^{-1}] and the light limited slope α^B [mg C (mg chl a)$^{-1}$ h^{-1} (µmol m^{-2} s^{-1})$^{-1}$] will be estimated by fitting the data to the model of Platt *et al.* (Platt et al., 1980). The photosynthetically active radiation absorbed by phytoplankton [E_{PUR} (µmol m^{-3} s^{-1})] at each position in the incubator and for each sampling depth was estimated according to (Dubinsky, 1980). The maximum quantum yield of carbon fixation [ϕ_m mol C fixed (mol photons absorbed)$^{-1}$] will be determined by fitting the Chla-specific photosynthetic rates P_z^B [mg C (mg chl a)$^{-1}$ h^{-1}] to the photosynthetically available radiation absorbed by phytoplankton [E_{PUR} (µmol m^{-3} s^{-1})] following Figueiras *et al.* (Figueiras et al., 1999). The daily integrated PP (mgCm^{-2}d^{-1}) will be estimated using a bio-optical model which inputs E_{PUR}, Chla and spectral photosynthetic parameters calculated from measurements of the phytoplankton absorption coefficient ($a_{ph}(\lambda)$) and integrates primary production at minute by minute intervals, down to 0.1% irradiance depth following Tilstone *et al.* (Tilstone et al., 2003).

Inherent and Apparent Optical Properties.

Optical profiles: Coincident optical profiles of particulate and dissolved absorption and attenuation coefficients were measured with WetLabs ac-s and ac-9, particulate backscattering coefficients were measured using Hobilabs Hydroscat-6 and Wetlabs backscatter meter, BB3, Conductivity-Temperature-Density with a Seabird 19, downwelling irradiance using SATLANTIC hyperspectral Radiometer (*Fig. 2*) at 16 stations. Photosynthetically Available Radiation using a Chelsea instruments PAR sensor and phytoplankton photo-physiology using Chelsea instruments Fast Repetition Rate Fluorometer were also measured at 7 stations during shallow casts of the CTD (Table 1). The Wetlabs ac-s and ac-9 instruments were calibrated with pure seawater every 2 days and the FRRF was calibrated with seawater filtered through a 0.2 µ filter at every station.

Discrete Samples: Water samples from six to three depths at 17 stations were filtered onto GFF filters for the analysis of phytoplankton pigments by High Performance Liquid Chromatography (HPLC) using the methods described in Barlow et al. (1997), particulate, phytoplankton and detrital absorption coefficients using the methods described in Tassan and Ferrri (1995), Total Suspended Matter (TSM) and Particulate Organic Carbon (POC) concentration following van der Linde et al (1998), particle size distribution by coulter counter and phytoplankton community composition by flow cytometry. In addition, these parameters will also be measured from 13 stations on GFD filters to give an estimate of the bio-optical properties of the nano-phytoplankton.

Water samples were also filtered through 0.2 µ filters for the analysis of absorption coefficient of coloured dissolved organic matter (CDOM) following Tilstone et al. (2004). Seawater samples were collected at the depth of the pigments samples and in addition to those, 8 more were collected every 10m in the water column down to 150m. These water samples were fixed in Gluteraldehyde to analyse the phytoplankton community composition by flow cytometry.

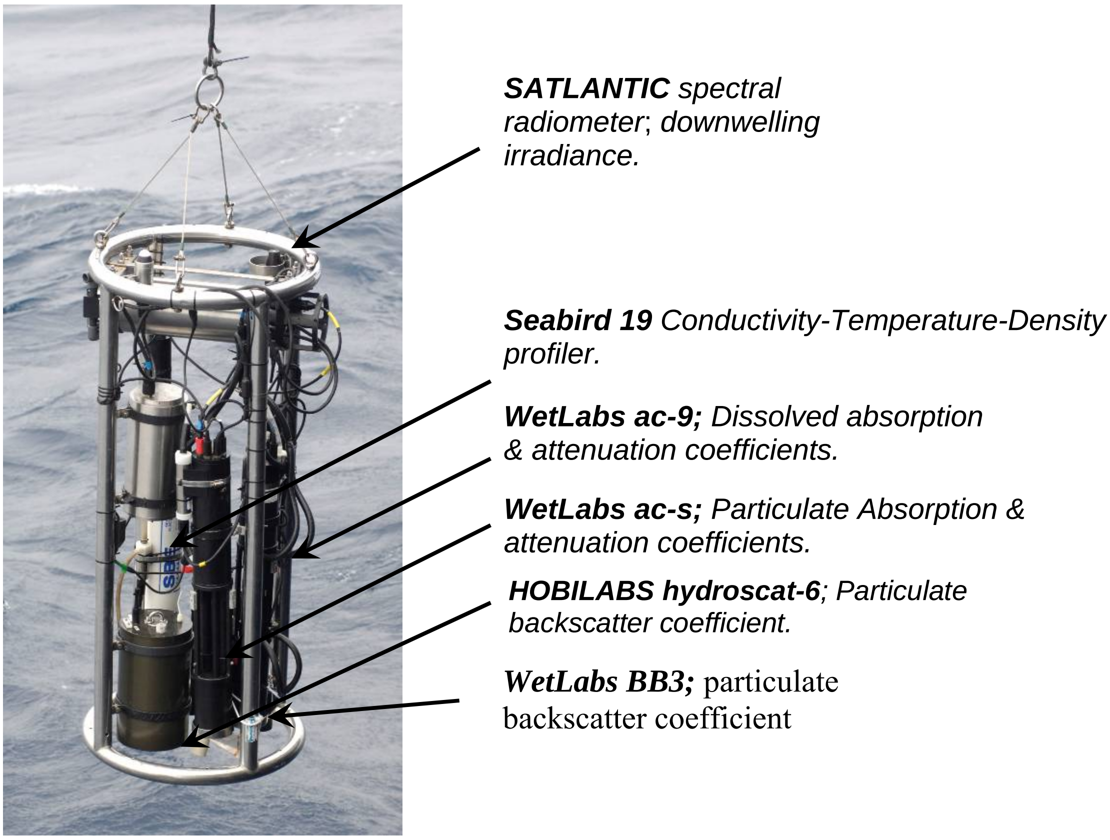


Figure 2. *Plymouth Marine Laboratory optical profiler; the main instruments are indicated.*

Table 1. *Primary production sampling stations and measurements taken.*

Station No. (CTD No.)	Date	Time GMT	Latitude	Longitude	Discrete sample depths (m)	Measurements taken*
2 (ctd01)	05 Aug	1054	49° 33.92’N	17°43.12’W	0, 20, 40, 60	PE, HPLC, Pabs, POC, CDOM, FCM.
4 (ctd03)	07 Aug	1119	49°02.06’N	27°41.92’W	0, 20, 40, 60	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, CTD, Ed.
16 (ctd05)	10 Aug	1050	49°01.87’N	27°42.05’W	0, 10, 30, 50	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, Size Frac FCM, CDOM, ac-9, ac-s, bb6, bb3, CTD, Ed.
20 (ctd06)	11 Aug	1000	49°02.03’W	27°41.79’W	0, 20, 40, 50	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb3, CTD, Ed, PAR, FRRF.
24 (ctd07)	17 Aug	1050	48°56.88’N	27°52.61’W	0, 10, 18, 50	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, CTD, Ed.
29 (ctd08)	18 Aug	1050	49°01.30’N	27°48.05’W	0, 10, 18, 50	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, Size Frac FCM, CDOM. No Optics rig deployment due to bad weather .
31 (ctd09)	20 Aug	0614	48°46.33’N	28°38.45’W	0, 15, 30, 45.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, Size Frac FCM, CDOM, ac-9, ac-s, bb6, bb3, CTD, Ed.
39 (ctd10)	21 Aug	0730	48°44.99’N	28°38.03’W	0, 20, 40, 60.	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, CTD, Ed, PAR, FRRF.
45 (ctd11)	22 Aug	0813	48°44.81’N	28°38.89’W	0, 20, 40, 50.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, Size Frac FCM, CDOM, ac-9, ac-s, bb6, bb3, CTD, Ed, PAR, FRRF.
48 (ctd12)	23 Aug	0950	48°45.23’N	28°38.69’W	0, 20, 30, 45.	PE, HPLC, Pabs, POC, CDOM, FCM, PAR, FRRF. No Optics rig deployment due to bad weather

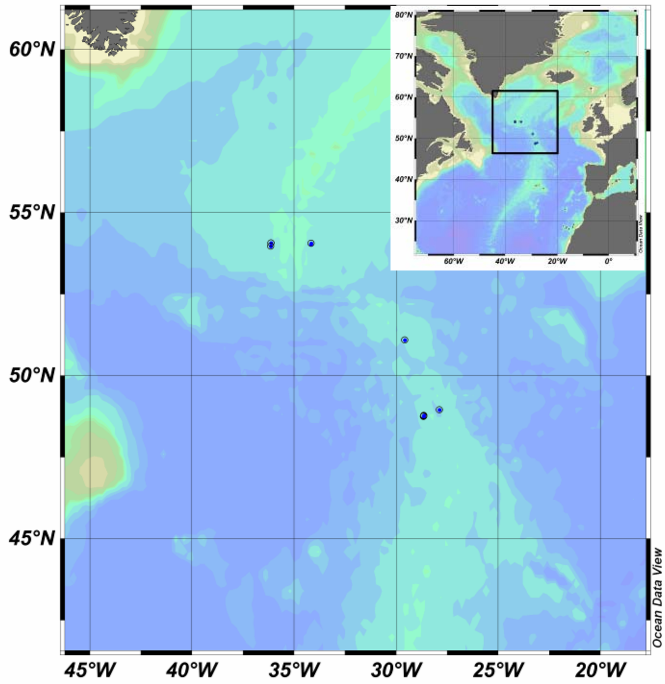
50 (ctd13)	24 Aug	0828	51°05.53'N	29°34.33'W	0, 25, 50, 60.	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, CTD, Ed, PAR, FRRF.
51 (ctd14)	25 Aug	1613	53°59.34'N	36°07.71'W	NA	ac-9, ac-s, bb6, bb3, CTD, Ed. CTD failure. No discrete samples
58 (ctd15)	27 Aug	1119	53°58.24'N	36°07.75'W	0, 20, 40, 50, 60.	PE, HPLC, Pabs, POC, CDOM, FCM No Optics rig deployment due to bad weather
63 (ctd16)	28 Aug	1044	54°03.77'N	36°07.82'W	0, 20, 40, 50.	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, Size Frac FCM, CDOM, ac-9, ac-s, bb6, bb3, CTD, Ed.
68 (ctd17)	29 Aug	1314	53°24.74'N	35°16.13'W	0, 15, 25, 45, 55.	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, CTD, Ed.
72 (ctd18)	30 Aug	1748	54°00.03'N	34°57.06'W	0, 10, 30, 50.	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, Ed.
82 (ctd21)	01 Sept	1558 1641	54°00.12'N	34°10.65'W	5, 25,47, 55	Size Frac PE, Size Frac HPLC, Size Frac Pabs, Size Frac POC, Size Frac FCM, CDOM, ac-9, ac-s, bb6, bb3, CTD, Ed, PAR, FRRF.
88 (ctd22)	02 Sept	0912 0950	54°03.40'N	34°09.56'W	5, 20, 30,40, 50	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, ac-s, bb6, bb3, CTD, Ed.
92 (ctd23)	03 Sept	0956 1045	54°03.17'N	34°09.65'W	5,10,20 45, 55	PE, HPLC, Pabs, POC, CDOM, FCM ac-9, bb6, bb3, CTD, Ed, PAR, FRRF.

***** PE – photosynthesis-irradiance experiments, HPLC – phytoplankton pigments by High Performance Liquid Chromatography, Pabs – particulate, phytoplankton & detrital absorption coefficients, POC – particulate organic carbon & total suspended material, CDOM – absorption coefficient of coloured dissolved organic material, FCM – flow cytometry, Size Frac – measurements fractionated onto 0.7 & 2.7µ filters.

† ac-9, ac-s, bb6, FRRF & CTD are optical profiles with hyper- or multi-spectral measurements made with the following instruments: ac-9 - particulate absorption & attenuation by *WETLabs ac-9,* Ed - Downwelling irradiance *SATLANTIC radiometer,* ac-s *Dissolved absorption & attenuation by WETLabs ac-s, bb3* - Backscattering coefficient by *WETLabs backscatter meter,* bb6 - Backscattering coefficient by *HOBILABS Hydroscat-6,* FRRF - Photo-physiology by *Fast Repetition Rate Fluorometer Chelsea-FRRF*, CTD - Conductivity-Temperature-Density by *SeaBird 19 plus.*

Preliminary Results.

Figure 2: *Position of the stations sampled for bio-optical measurements, phytoplankton photosynthesis and primary production during JC037.*



Backscattering Coefficient and Slope.

The particulate backscatter coefficient at 532nm presents some variability above the surface mixed layer (depths less than ~50m, *Fig.3*). However, the spectral slope of the particulate backscatter was rather constant (*Fig.3*), being higher (less negative) near the surface (~2.2) and lower (more negative, ~3.2) below the mixed layer. This indicates that although the particle load may change from south to north, the dominating size remains constant in the upper layer. Compared to JC011, higher slopes correspond to bacteria dominated environments. These preliminary findings will be verified with the analysis in the laboratory using flow cytomtry of the water samples collected.

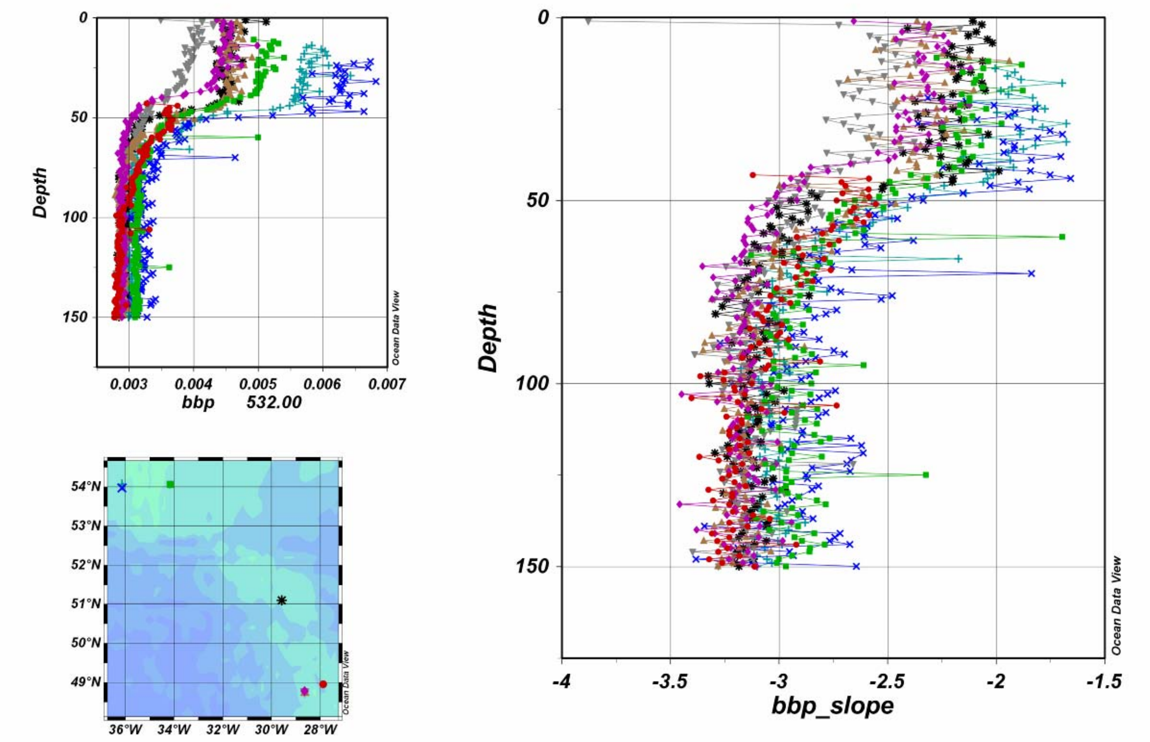


Figure 3. *Backscattering coefficient at 532 nm and slope at the stations corresponding to the locations given in the map at the bottom of the figure.*

Phytoplankton photosynthesis and primary production:
At the SE station there were higher maximum photosynthetic rates in the surface waters than at any of the other stations (*Fig. 4*), indicative of low light adaptation in stratified waters. On our return to the SE station on 17 August 2009 both maximum photosynthetic rates and light limited slopes were lower and similar at the SW and Polar Front stations. Maximum photosynthetic rates in the surface waters were lower at NE & NW stations and at the NW station the light limited slope was the lowest encountered, suggesting low light adaptation in a well mixed water column.

Fluorometric Chl a values varied from 0.57 to 0.98 mg m^{-3} between stations, with higher values at the SE and NW stations. We used the empirical model of Behrenfeld et al. (1998) to calculate primary production which varied within a narrow range from 454 and 610 mgC m^{-2} d^{-1} with slightly higher values at the SE & NW stations (*Fig. 5*).

Figure 4. *Photosynthesis-irradiance curves in surface waters at example stations during JC037. Pm & α given in the legend of each figure are non normalised maximum photosynthetic rates and light limited slope, respectively.*

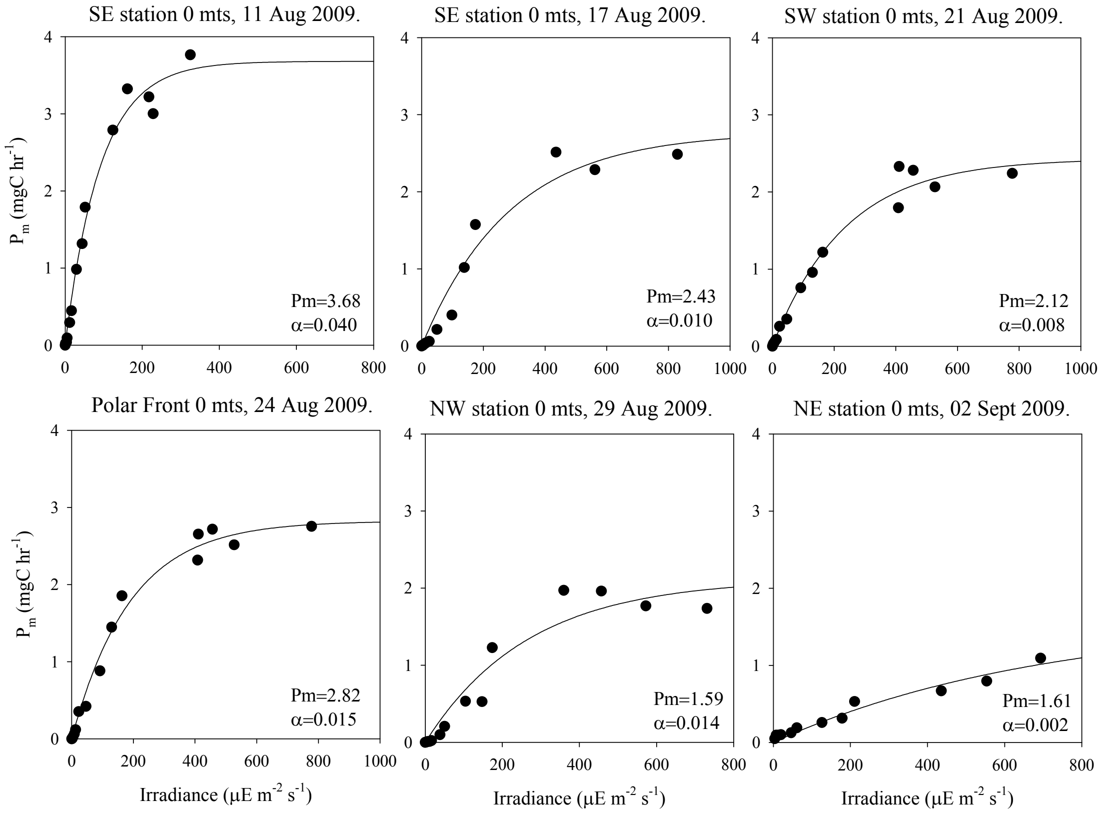
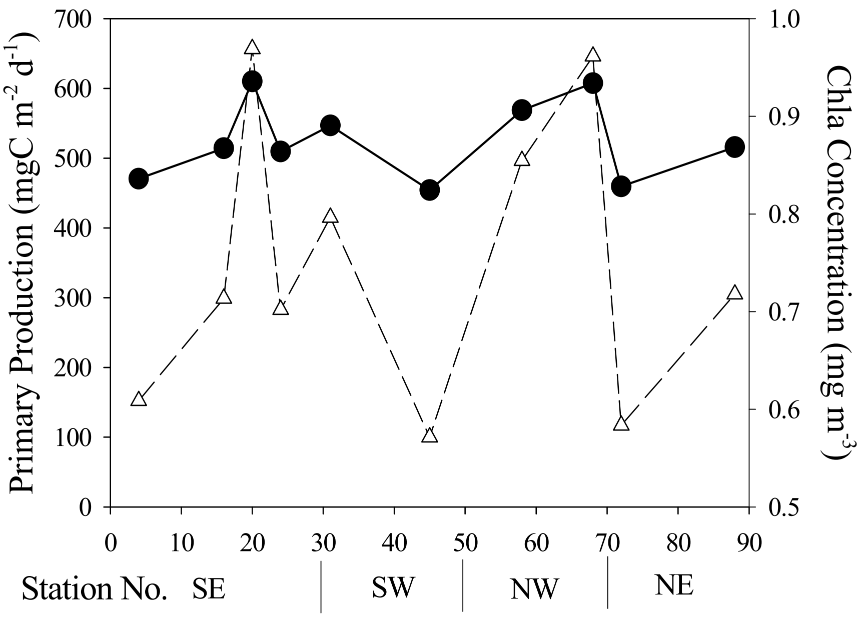


Figure 5. *Variation in Fluorometric Chla and estimated primary production during JC037.*



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3. Carbon to Chlorophyll Ratio Studies .

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Aims

My aims for the cruise were to develop a new method of measuring Carbon to Chlorophyll ratios. This was to be achieved by a combination of flurometric measurements of Chlorophyll and the use of Photosynthesis – Irradiance curves to assess growth rates. These ratios can then be applied to remotely sensed satellite data to give large scale biomass estimates. In addition I hope to be able to estimate grazing rates from microzooplankton.

Methods

Water samples were taken from the 10l bottles on the CTD rosette. In order to be relevant to remotely sensed data, only surfac water was used. A series of dilutions were then made up using filtered seawater taken from the underway supply having passed through a 0.1um Acropack filter in order to change the grazing pressure form zooplankton. This method followed Landry and Hassett (1982). Dilutions were as follows: Unfiltered, 3:1 (unfiltered to filtered), 1:3, 1:9.
These dilutions were then placed in 1l glass incubation flasks under sodium lamps for a period of 6 hours. This was chosen to represent the same total irradiance as a full day on deck. The following measurements were taken both before the start of the incubation and at the end.

Flurometry
A turner designs benchtop flurometer was used to measure chlorophyll levels. The Holm-Hansen method was followed with extraction taking place using 90% acetone. A series of calibrations were then performed using a pure chlorophyll standard, and a spectrophotometer.

Taxonomy samples
At each station samples were collected for flow cytometry analysis. These were preserved using guteraldehyde, and stored at -80. In addition 100ml samples were taken and preserved using Lugols iodine for taxonomic counts.

Primary Production
This was measured following the methods of Tilstone et al (2003), using a 14C tracer and linear incubators. Except in areas with high irradiance sodium lamps were used in order to allow closer comparisons with the 6hour solar simulator incubations. See section 2 (above) of this cruise report for further details of the method.

Table 1 Stations sampled

Station No. (CTD No.)	Date	Time GMT	Latitude	Longitude	Measurements taken*
4 (ctd03)	07 Aug	1119	49°02.06'N	27°41.92'W	Chlorophyll, Production, Flow cytometry, Lugols
16 (ctd05)	10 Aug	1050	49°01.87'N	27°42.05'W	Chlorophyll, Production, Flow cytometry, Lugols
24 (ctd07)	17 Aug	1050	48°56.88'N	27°52.61'W	Chlorophyll, Production, Flow cytometry, Lugols
31 (ctd09)	20 Aug	0614	48°46.33'N	28°38.45'W	Chlorophyll, Production, Flow cytometry, Lugols
58 (ctd15)	27 Aug	1119	53°58.24'N	36°07.75'W	Chlorophyll, Production, Flow cytometry, Lugols
68 (ctd17)	29 Aug	1314	53°24.74'N	35°16.13'W	Chlorophyll, Production, Flow cytometry, Lugols
88 (ctd22)	02 Sept	1708 1755	54°09.85'N	36°05.96'W	Chlorophyll, Production, Flow cytometry, Lugols
92 (ctd23)	03 Sept	1252 1320	53°56.49'N	36°11.41'W	Chlorophyll, Production, Flow cytometry, Lugols

In addition to samples taken from the CTD rosette, 3 further experiments were performed using the underway water supply on 13/8/09, 31/8/09, and 5/9/09. These consisted of comparisons between the solar simulators and on deck incubations over the entire dawn – dusk cycle.

4. Small-Scale Physics &Tidal Interaction With Bathymetry

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During JC011, intriguing observations were made from Oceanlab's PAL lander at the SE ECOMAR site of a rapid drop in temperature once each tidal cycle, suggestive of a sharp bore or front passing the lander location. During JC037, physical observations were again made from the PAL lander on all nine deployments, with those at the SE site accompanied by a thermistor chain mooring and a 24-hour yoyo of the ship CTD in a concerted effort to understand the tidal physics of that particular location.

Figure 1: *ADCP and CTD locations on the PAL lander frame (photos are from JC011, but the location of instruments was identical during JC037).*

PAL Instrumentation

An upward-looking 300 khz RDI Workhorse Sentinel ADCP (SN 6358) was mounted towards the top of the PAL lander frame (Figure 1) such that the transducer heads were 1.6 m above the base of the frame (and around 4 m above the bed when deployed). A Seabird SBE37-IMP CTD (SN 4718; NERC Marine Equipment Pool) was also attached within the lander frame such that its pumped intake was 1.03 m above the base of the frame (around 3.4 m above the bed when deployed).

ADCP sampling used a 10 second ensemble with 15 pings. The vertical bin length was 2 m, with the first bin centered 4.23 m above the transducer (around 8.2 m off the bed). This gave a battery endurance of around 8 days. The ADCP did not return reliable velocity measurements above around bin 25 (55 m above the bed) due to weak echo return. During lander descents and ascents the range was greater, however, so the poor performance appears to have been due to unfavorable conditions in the lower water column. The ADCP also records temperature and pressure, although the temperature readings are suspected to be unreliable and often diverged from those made from the SBE37. The SBE37 was set to sample with a 10 second interval.

Thermistor Chain

The thermistor chain was manufactured by RBR Ltd and consisted of a 100 m cable with 16 equally-spaced thermistor temperature sensors and an XR420TiD logger unit incorporating a pressure sensor. The mooring consisted of (bottom-top) a 150 kg ballast weight, a 2 m chain, an acoustic release, two glass buoyancy packs, the thermistor chain itself taped to a mooring line, the logger unit, four glass buoyancy packs and a pickup float. The chain was coiled in a dustbin for ease of handling, and deployment proceeded smoothly. In its moored configuration, the height of the lower thermistor above the bed is estimated at 11 m, with 15 equal spaces to the upper thermistor at 109 m and the logger unit/pressure sensor at 110.5 m above the bed (these figures subject to revision following measurement of the chain ashore).

The thermistor chain has a quoted accuracy and factory calibration to within 0.0001˚C, however errors of the order of 0.1˚C were apparent in the data from the SE site. At times there was also a clear calibration drift with time; of the 16 thermistors, 5 showed obvious drift. A calibration dip with the thermistor chain coiled and hung from the CTD rosette frame did not provide a useful calibration, and a further two thermistors failed (became erratic in their readings) during this procedure. It is suspected that these problems result from pressure effects on the thermistors, and that their calibration changes with pressure cycling. This will be pursued with RBR. There also appeared to be a ~0.05˚C sensitivity to whether the CTD package was moving through the water column or stationary (cooler when moving).

CTD yoyo configuration

The 24-hour CTD yoyo at the SE site used the ship CTD rosette in a standard configuration which included the bottle rosette. Secondary T and C sensors were mounted on a lateral fin, so should be relatively unaffected by stirring of the water column by the CTD package during upcasts. The CTD was cycled vertically between 10 m and around 600 m off the bottom a total of 39 times, giving 78 up- and downcasts during the 24-hour period. The package was paused for 2 minutes at the top and bottom of each cast in order to allow water disturbed by the previous cast to advect away, and also to provide better temporal spacing near the top and bottom of the cast. Lowered ADCP (LADCP) data was collected from a single downward-looking 300 khz instrument. The upward-looking 'slave' unit was not used in order to extend battery life to the entire 24-hour deployment.

Summary of observations from the SE site

The SE site was a saddle point at around 2500 m depth, providing the deepest connection across a ridge on the flanks of a larger seamount. A hypothesis, based on JC011 observations, is that dense (cool) water is fluxed over this saddle on each tidal cycle. During JC037, the following data were obtained at this site:

Thermistor-chain (near saddle summit, triangulated at 49˚01.913'N, 27˚41.969'W)

[16 thermistor time series over the period yeardays 219.629-228.875]

CTD yoyo (~500 m downslope to the SW of the saddle at 49˚01.708'N, 27˚42.215'W)
[CTD and LADCP data for a 24-hour period, yeardays 221-222]

PAL1 (close to the yoyo location, triangulated at 49˚01.665'N, 27˚42.198'W)
[CTD and ADCP data for yeardays 219.685-222.560]

PAL2 (~300 m west of the saddle, triangulated at 49˚01.889'N, 27˚42.265'W)
[ADCP data for yeardays 223.521-230.821; CTD from yearday 227.510]

PAL3 (~2000 m to the SW of the saddle deployed at 49˚01.318'N, 27˚42.906'W)
[CTD and ADCP data for yeardays 230.467-230.821]

The thermistor chain showed highly periodic (tidal) temperature evolution. On many tidal cycles, the lower thermistors showed rapid coolings similar to the JC011 observations. Higher in the water column, however, the sudden drop was not present (Figure 2) with a much more sinusoidal tidal cycle. The front observed near the bottom appeared to be the head of a gravity current of order 50 m thickness (variable) consisting of cool water crossing the saddle to the west once each tidal cycle. This current shows many of the features of a classic gravity current, with a sloping head and apparent overturning in its wake (Figure 3).

The CTD yoyo, just 500 m distant from the saddle and the thermistor chain, revealed a much less clearly periodic behaviour in the bottom 100 m (Figure 4). The upper water column showed a 6-hour periodicity which is suspected to be due to radiating internal energy from either side of the saddle. There is evidence of lee-wave formation in downward intrusions of warmer water towards the bottom at days 221.05 and 221.55 and the release of lee-waves from the opposite flank in anomalies at the 2400 db level at days 221.35 and 221.95. The bottom 150 m is a weakly-stratified boundary layer with many density overturns. The PAL lander, sitting almost exactly beneath the yoyo, observed two sudden downward temperature steps during this period, at around days 221.6 and 221.9. These are tentatively identified as two different phenomena, the first resulting from the release of a steep lee-way and propagating upslope, and the second being associated with a cool patch of water propagating downslope as a gravity current.

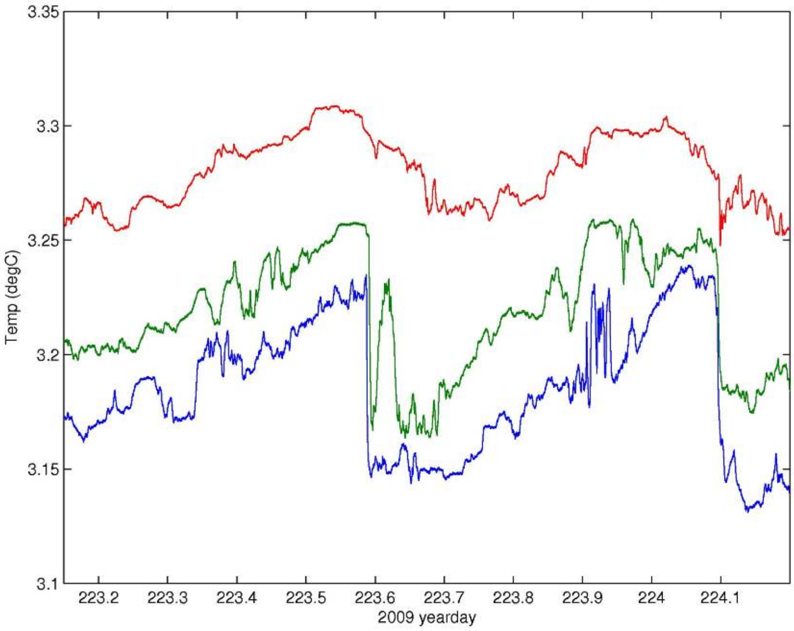

Figure 2: *Time series of temperature from three thermistors, 11 m above the bed (blue), 109 m above the bed (red) and at an intermediate depth (green). (Temperatures are uncalibrated).*

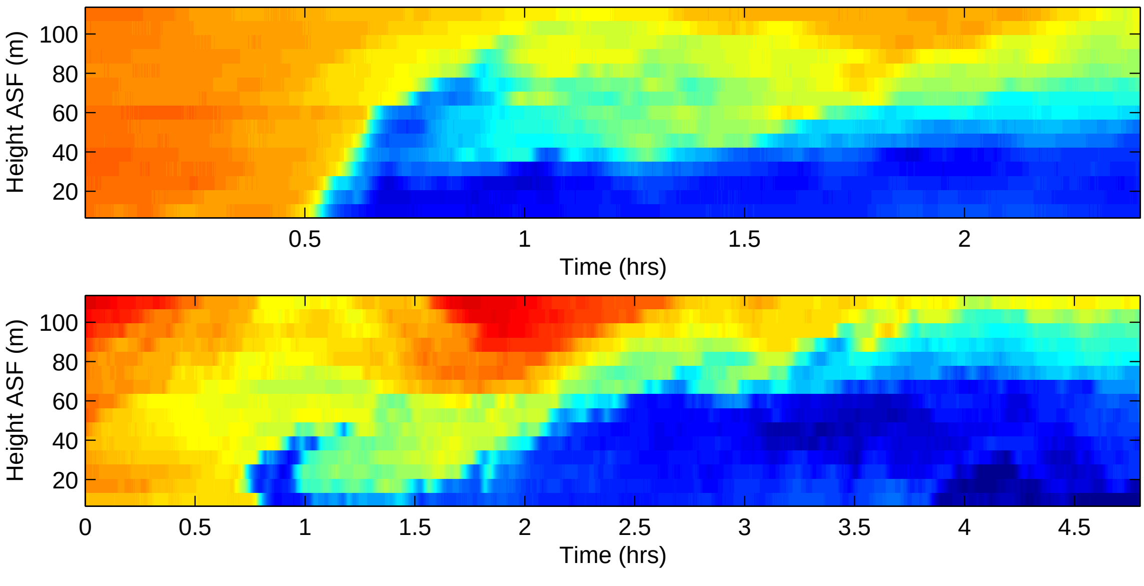

Figure 3: *Time series from all thermistors on two distinct tidal cycles, showing cold pulses crossing the saddle with structure resembling a gravity current. Calibration has assumed a uniform mean temperature gradient. The total temperature range is 0.1˚C.*

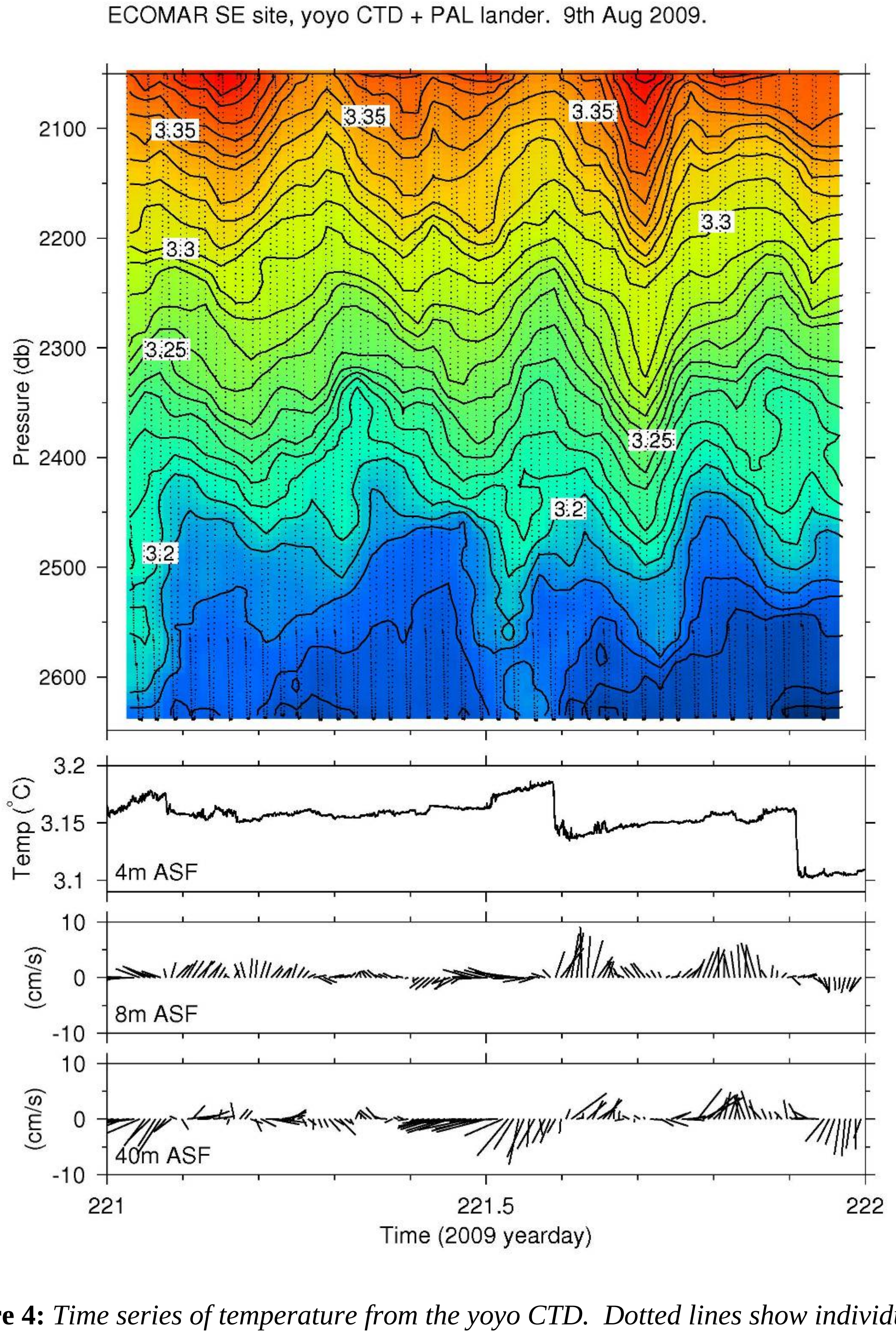

Figure 4: *Time series of temperature from the yoyo CTD. Dotted lines show individual casts. The lower panels show observations of temperature and velocity from the PAL lander sitting almost immediately beneath the CTD.*

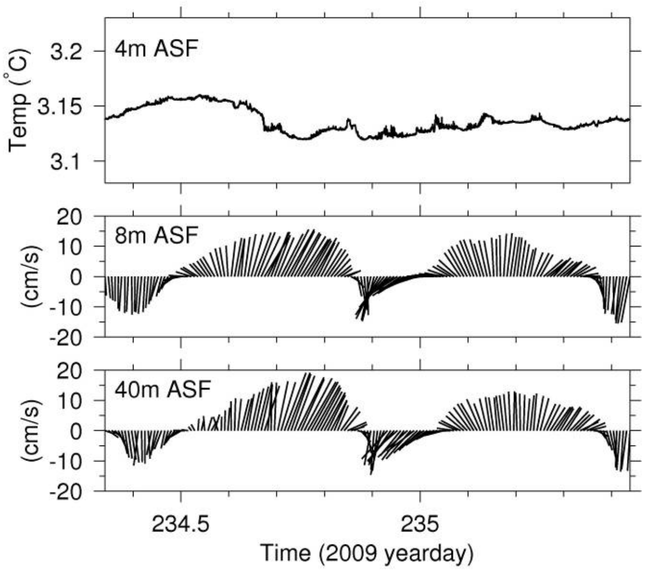

Figure 5: *Time series of temperature and velocities from the PAL lander at the SW site, showing tidal currents of up to 20 cm/s.*

PAL deployments at the SW, NW and NE sites

The SW, NW and NE PAL sites had relatively simple bathymetry, such as in the bottom of sedimentary basins, and the complex temperature structure of the SE site was not encountered elsewhere. However, surprisingly strong tidal currents were observed at the SW site (to 20 cm/s; Figure 5). It is not yet clear why this is the case.

5. Sediment Traps

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Recovery of sediment traps from D331T moorings

During the 2008 *RRS Discovery* cruise D331T, moorings were deployed at the four ECOMAR sites (SW, SE, NW, NE). Each mooring included two McLane sediment traps, nominally 100 m and 1000 m above the sea floor respectively in a total water depth of 2500 m. Each trap was paired with an Anderaa current meter. Precise locations, water depth and mooring composition can be found in the D331T moorings report. In the course of JC037, all of these moorings were successfully recovered and replaced. The NW and NE moorings were tangled on recovery, however all traps were brought on board upright with no apparent bottle leakage.

Serial numbers of the recovered sediment traps and their paired current meters were:

SE mooring:	Deployed:	31 July 2008
	Recovered:	07 August 2009
	100 m ASF	McLane 21-way, SN 12283-02 (500 ml bottles)
	1000 m ASF	McLane 21-way, SN 12283-01 (500 ml bottles)
SW mooring:	Deployed:	01 August 2008
	Recovered:	20 August 2009
	100 m ASF	McLane 21-way, SN 11262-10 (250 ml bottles)
	1000 m ASF	McLane 13-way, SN 520 (250 ml bottles)
NE mooring:	Deployed:	08 August 2008
	Recovered:	01 September 2009
	100 m ASF	McLane 21-way, SN 11804-06 (500 ml bottles)
	1000 m ASF	McLane 21-way, SN 11804-04 (500 ml bottles)
NW mooring:	Deployed:	06 August 2008
	Recovered:	26 August 2009
	100 m ASF	McLane 21-way, SN 11804-03 (250 ml bottles)
	1000 m ASF	McLane 21-way, SN 11262-09 (250 ml bottles)

On recovery, activity logs were downloaded from each trap. All had executed correctly and traps were open at the expected bottle at the time of recovery (including the 13-way trap on the SW mooring which reported misalignment of the rotor; see note in D331T cruise report). Each trap was allowed to drain then the sample bottles were removed and capped. To each 500 ml sample bottle was added approximately 1 ml of buffered 37% formaldehyde solution (proportionally less for 250 ml bottles). Used sample bottles, the currently-open sample bottle, and unused bottles were all treated in an identical manner. Bottle caps were sealed with parafilm and the bottles stored at 4˚C.

Line-up photographs (Figures 1-4) provide an indication of the relative quantity of material collected during each sample period by each trap. Some bottles represent a full month of collection, while others represent a half month (date labels in grey on the photographs represent half-month samples).

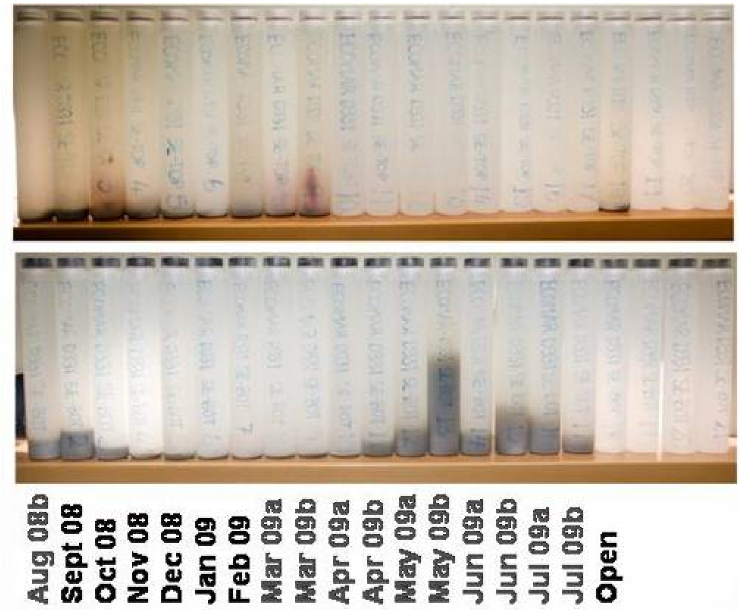

Figure 1. *Recovered bottles from the SE mooring (upper and lower). Periods labeled in grey represent half-months. Those in black represent full months. Photos: David Shale.*

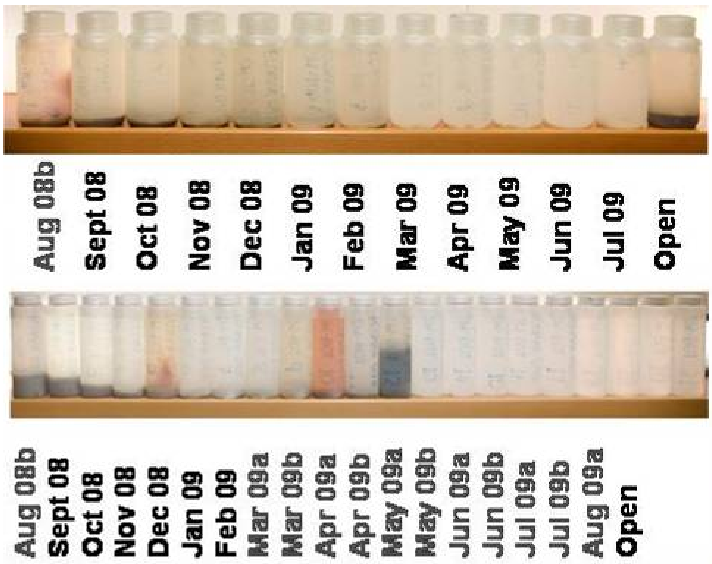

Figure 2. *Recovered bottles from the SW mooring (upper and lower).*

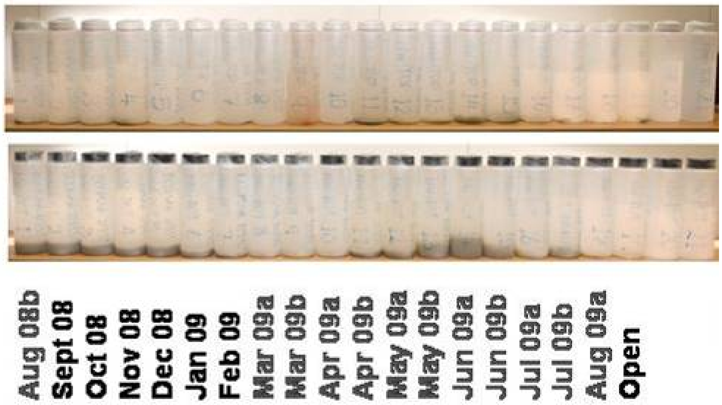

Figure 3. *Recovered bottles from the NW mooring (upper and lower).*

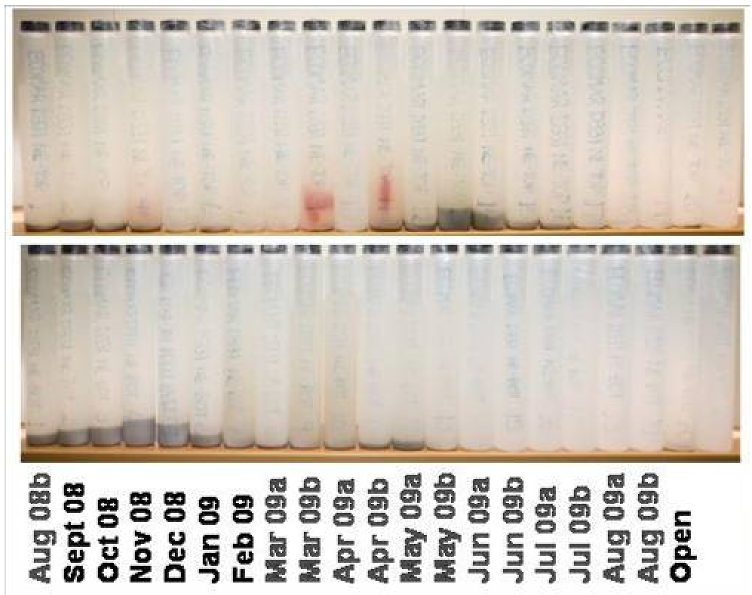

Figure 4. *Recovered bottles from the NE mooring (upper and lower).*

Deployment of sediment traps

Moorings similar to those recovered were redeployed at all sites (see mooring report). Sediment trap sample bottles were primed with deep water from near the SE or SW mooring sites. To this was added 5 mg of salt and 25 ml of a buffered 37% formaldehyde solution (half of these quantities for 250 ml bottles). Bottles were then loaded onto the rotor and topped up with additional deep water. Traps were deployed upright and there was no apparent bottle leakage. All bottles were labeled with a permanent marker and etched in the form 'JC037 NW - TOP ##' where '##' is the bottle sequence number.

The following traps were deployed:

SE mooring:	Deployed	07 August 2009
	100 m ASF	McLane 21-way, SN 11804-02 (500 ml bottles)
	1000 m ASF	McLane 21-way, SN 11804-05 (500 ml bottles)
SW mooring:	Deployed	20 August 2009
	100 m ASF	McLane 13-way, SN 532 (250 ml bottles)
	1000 m ASF	McLane 13-way, SN 543 (250 ml bottles)
NE mooring:	Deployed	01 September 2009
	100 m ASF	McLane 21-way, SN 12283-02 (500 ml bottles)
	1000 m ASF	McLane 21-way, SN 11262-10 (500 ml bottles)
NW mooring:	Deployed:	26 August 2009
	100 m ASF	McLane 21-way, SN ** (500 ml bottles)
	1000 m ASF	McLane 21-way, SN ** (500 ml bottles)

** The serial numbers of these traps was not recorded.

Sample schedules for the SE site followed the previous two years, however following the SE mooring deployment we received news that the 2010 ECOMAR cruise would be earlier than previous years, so the schedules were adjusted to make better use of the number of bottles available. Schedules are as follows (the first event represents the beginning of collection in the first bottle and subsequent events represent advance to the next bottle):

SE mooring (both traps)

```
Event   1 of  22 = 08/16/2009 00:00:00
Event   2 of  22 = 09/01/2009 00:00:00
Event   3 of  22 = 10/01/2009 00:00:00
Event   4 of  22 = 11/01/2009 00:00:00
Event   5 of  22 = 12/01/2009 00:00:00
Event   6 of  22 = 01/01/2010 00:00:00
Event   7 of  22 = 02/01/2010 00:00:00
Event   8 of  22 = 03/01/2010 00:00:00
Event   9 of  22 = 03/16/2010 00:00:00
Event  10 of  22 = 04/01/2010 00:00:00
Event  11 of  22 = 04/16/2010 00:00:00
Event  12 of  22 = 05/01/2010 00:00:00
Event  13 of  22 = 05/16/2010 00:00:00
```

```
Event  14 of  22 = 06/01/2010 00:00:00
Event  15 of  22 = 06/16/2010 00:00:00
Event  16 of  22 = 07/01/2010 00:00:00
Event  17 of  22 = 07/16/2010 00:00:00
Event  18 of  22 = 08/01/2010 00:00:00
Event  19 of  22 = 08/16/2010 00:00:00
Event  20 of  22 = 09/01/2010 00:00:00
Event  21 of  22 = 09/16/2010 00:00:00
Event  22 of  22 = 10/01/2010 00:00:00
```

SW mooring (both traps)

```
Event  01 of 14 = 09/01/09  00:00:00
Event  02 of 14 = 10/01/09  00:00:00
Event  03 of 14 = 11/01/09  00:00:00
Event  04 of 14 = 12/01/09  00:00:00
Event  05 of 14 = 01/01/10  00:00:00
Event  06 of 14 = 02/01/10  00:00:00
Event  07 of 14 = 03/01/10  00:00:00
Event  08 of 14 = 04/01/10  00:00:00
Event  09 of 14 = 04/16/10  00:00:00
Event  10 of 14 = 05/01/10  00:00:00
Event  11 of 14 = 05/16/10  00:00:00
Event  12 of 14 = 06/01/10  00:00:00
Event  13 of 14 = 06/16/10  00:00:00
Event  14 of 14 = 07/01/10  00:00:00
Event  13 of 14 = 06/16/10  00:00:00
Event  14 of 14 = 07/01/10  00:00:00
```

NW mooring (both traps)

```
Event   1 of  22 = 09/01/2009 00:00:00
Event   2 of  22 = 09/16/2009 00:00:00
Event   3 of  22 = 10/01/2009 00:00:00
Event   4 of  22 = 10/16/2009 00:00:00
Event   5 of  22 = 11/01/2009 00:00:00
Event   6 of  22 = 11/16/2009 00:00:00
Event   7 of  22 = 12/01/2009 00:00:00
Event   8 of  22 = 12/16/2009 00:00:00
Event   9 of  22 = 01/01/2010 00:00:00
Event  10 of  22 = 01/16/2010 00:00:00
Event  11 of  22 = 02/01/2010 00:00:00
Event  12 of  22 = 02/16/2010 00:00:00
Event  13 of  22 = 03/01/2010 00:00:00
Event  14 of  22 = 03/16/2010 00:00:00
Event  15 of  22 = 04/01/2010 00:00:00
Event  16 of  22 = 04/16/2010 00:00:00
Event  17 of  22 = 05/01/2010 00:00:00
Event  18 of  22 = 05/16/2010 00:00:00
Event  19 of  22 = 06/01/2010 00:00:00
Event  20 of  22 = 06/16/2010 00:00:00
Event  21 of  22 = 07/01/2010 00:00:00
Event  22 of  22 = 07/16/2010 00:00:00
```

NE mooring (both traps)

```
Event   1 of  22 = 09/02/2009 00:00:00
```

Then remainder of the schedule is as for the NW mooring.

6. Pelagic Sampling

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1 Summary

We successfully collected acoustic samples of the pelagic realm at each of the four stations thus partially fulfilling the data collection requirements of grant deliverable four. Our acoustic samples were collected using the RRS *James Cook* permanently installed calibrated EK-60 scientific echosounder (Simrad, Norway). A balanced line transect survey design will enable inter-site statistical comparisons of acoustic data and potentially of pelagic biomass.

Concurrent scientific net a multi-net rectangular mid-water trawl (RMT (1+8)m) and acoustic samples were also collected at each site. Despite unbalanced inter-site net sampling effort we are hopeful that we will be able to estimate point and variance estimates of pelagic biomass.

2 Materials and methods

Observations of the pelagic realm were collected using scientific net and acoustic samples. The RMT (1+8)m (Fig. 1) enabled us to sample three discrete depth horizons during a trawl. Nominally these depth ranges were 800 to 500 m; 500 m to 200 m, and 200 m to the surface. Each depth horizon was sampled using an RMT 1 (mesh size 330 µm, mouth area 1m²) and an RMT 8 (mesh size 4.5 mm, mouth are 8m²). Nominal towing speed was 2 knots. Multi-frequency acoustic data (18, 38, 70, 120 and 200 kHz) were observed using a calibrated (see Foote et al 1987 and Simmonds and MacLennan, 2005 for calibration procedure) EK-60 scientific echosounder. The pulse duration was 1024 us with a 0.22 Hz pulse repetition rate. The echosounder transducers were mounted on a drop keel (8.3 m deployed depth). An EM-710 (70 kHz) shallow-water multi-beam echosounder was used concurrently with the EK60 during all acoustic and mid-water fishing operations.

Fig. 1: Deployment of the rectangular mid-water trawl multi-net, RMT (1+8)m.

Combining net and acoustic samples will enable us to estimate pelagic biomass by solving the “inverse problem” (see Greenlaw, 1979; Holliday 1992). The SIMFAMI multi-frequency inversion algorithm will be used to identify pelagic organisms, estimate, size distributions and biovolume (SIMFAMI, 2005).

Korneliussen et al. (2008) made recommendations about collecting multi-frequency acoustic data, which we followed:

> Potential acoustic interference between the EK-60 scientific echosounder and the EM-710 multibeam echosounder was minimised by using the permanently installed Simrad Synchronisation Unit (SSU). Each instrument was manually allocated a ping duration time which was dependent on water depth for the EK-60 and to a two-way range of 600 m for the EM-710.
>
> Integrated elementary distance acoustic sampling intervals (EDSUs, 500 m along transect distances and 20 m depth horizons) were calculated for all frequencies on a common spatial grid. This grid resolution minimised errors caused by the spatial separation of transducers and the frequency-specific acoustic beam dimensions.
>
> Spurious acoustic returns (including noise spikes and dropped pings) will be identified using PERG in-house data post-processing algorithms that have been

implemented in the Echoview acoustic processing software (v4.8, Myriax, Hobart, Australia). Time varied gain noise was removed using the technique described by Watkins & Brierley (1996). Acoustic data quality was monitored in real-time using the EK-60 echosounder control software and Echoview running in Liveview mode on a PERG computer.

Sampling took place using two survey designs. Acoustic data were observed along ten line transects with a systematic survey design (length = 8 nautical miles, inter-transect spacing = 0.75 nautical miles) with a random start point. Line transect surveys were oriented to minimise vessel pitch and reduce bubble entrainment and the vessel was also trimmed to minimise pitch. The vessel's azimuth thruster was retracted to reduce water turbulence. During trawling the vessel was orientated into the weather and where operationally possible net sampling took place within the EK-60 survey region.

2.1 RMT sampling

RMT catches were removed from the net cod-end and transferred to sub-temperature seawater for processing in the wet laboratory. Voucher specimens were removed for photography and the catch sieved in a 300µm sieve. The RMT 8 net catches were sorted down to species and identified using keys and microscopes. Sub-samples of the dominant zooplankton species were collect for Stable Isotope (SI) and Fatty acid (FA) laboratory analysis (SI specimens and tissue samples were frozen at –80 °C, FA specimens were flash frozen in liquid nitrogen then transferred to –80 °C). Weight of each species group was recorded and the total weight of the catch was calculated and standardized for effort. RMT 1 samples were collected and were fixed and preserved in BORAX-buffered formaldehyde (4%).

2.2 Ring net sampling

Zooplankton was collected using a ring net (mesh size of 200µm, mouth area 3.14m^2) deployed from the starboard side deck of *RRS James Cook* on 20090809 to a depth of 150m. A record was made of the time of deployment and recovery, and flow meter reading before and after each vertical haul. A *General Oceanics* (GO) flow meter was mounted in the mouth of the net to allow the volume of water filtered to be determined. The contents of the cod-end were washed into sub-temperature seawater on retrieval.

Acoustic data were obtained simultaneously with net sampling using the EK-60. Acoustic signals were transmitted, received and processed by the EK-60 and the volume backscattering strength data (S_v) were recorded for post-processing.

Echoview v4.8 software (Myriax, Hobart, Australia) was used to image the calibrated echograms. Acoustic data from the EK-60 were selected from an hour either side of the time of ring net deployment in every case. The acoustic data was used to determine the mean volume backscattering strength (MVBS) in 5 minute intervals, split into 5m depth horizons. The acoustic data were manipulated so the echograms showed data to 150m only as this was the depth to which the ring net sampled (Fig. 1). The mean volume backscattering strength coefficient data were recorded in a comma separated variable file for analysis.

Laboratory method: Ring net samples
Samples were filtered using a 125um sieve and preserved in 4% formaldehyde buffered with borax immediately after sampling for subsequent laboratory analysis

3 Summary of activities

3.1 Summary of RMT(1+8)m activities
During the transit from Southampton the SE station the RMT (1+8)m was assembled by PERG personnel and David Shale, under supervision from Ben Boorman.

20090808: RMT was deemed unserviceable due to blisters around the opening of the sub-sea electronic housing. EK60 survey conducted instead. Companionate return to Cork allowed for replacement housing to be sent from NMF-SS to the ship.

20090817 South East station (JC037/023): Successful deployment of net to nominal depths ranges at day (0 to 200, 200 to 500, and 500 to 800m). 52 kg of Salpidae was caught in the shallow RMT8. Given this catch mass it was decided to reduce the fishing time of the shallow net pair to 30 min.

20090820 and 20090823 South West station (JC037/038/040/047): Three successful RMT hauls (all but one net pair were fished at nominal depth range; station JC037/047 was fished deeper due to adverse weather).

20090828 and 20090829 (JC037/064/069): One deployment (JC037/064) in which the net depth-sensor occasionally malfunctioned. The depth recorded for this haul need to be carefully analysed. During the subsequent deployment the net failed to open (JC037/069), which was due to malfunction of a “net state indicator relay” in the release jaw control electronics.

20090902 (JC037/089/090): Two successful hauls. The second haul was conducted at shallow depths (500 m to 350 m; 350 m to 200 m, and 200 m to the sea surface, Table 1) to save time and avoid diel vertical migration bias.

Station Number	Depth ranges (m)	Start latitude		Start longitude		Fishing time (min)	Distance Towed (m)
		deg	min	deg	min		
23	0-200, 200-500, 500-800	49	3.4	-27	-38.1	275	8487
38	0-200, 200-500, 500-800	44	45	-37	-90	268	8271
40	0-200, 200-500, 500-800	48	45.48	-28	-38.39	244	7530
47	200-500, 500-800, 800-1000	45	31	-42	-80	232	7160
64	0-200, 200-500, 500-800	53	56.39	-36	-13.41	265	8178
89	0-200, 200-500, 500, 800	54	4.52	-34	-5.3	241	7438
90	0-200, 200-350, 350-500	54	6.04	-34	-16.35	113	3487

Table 1: Summary of RMT (1+8)m fishing activities during JC037.

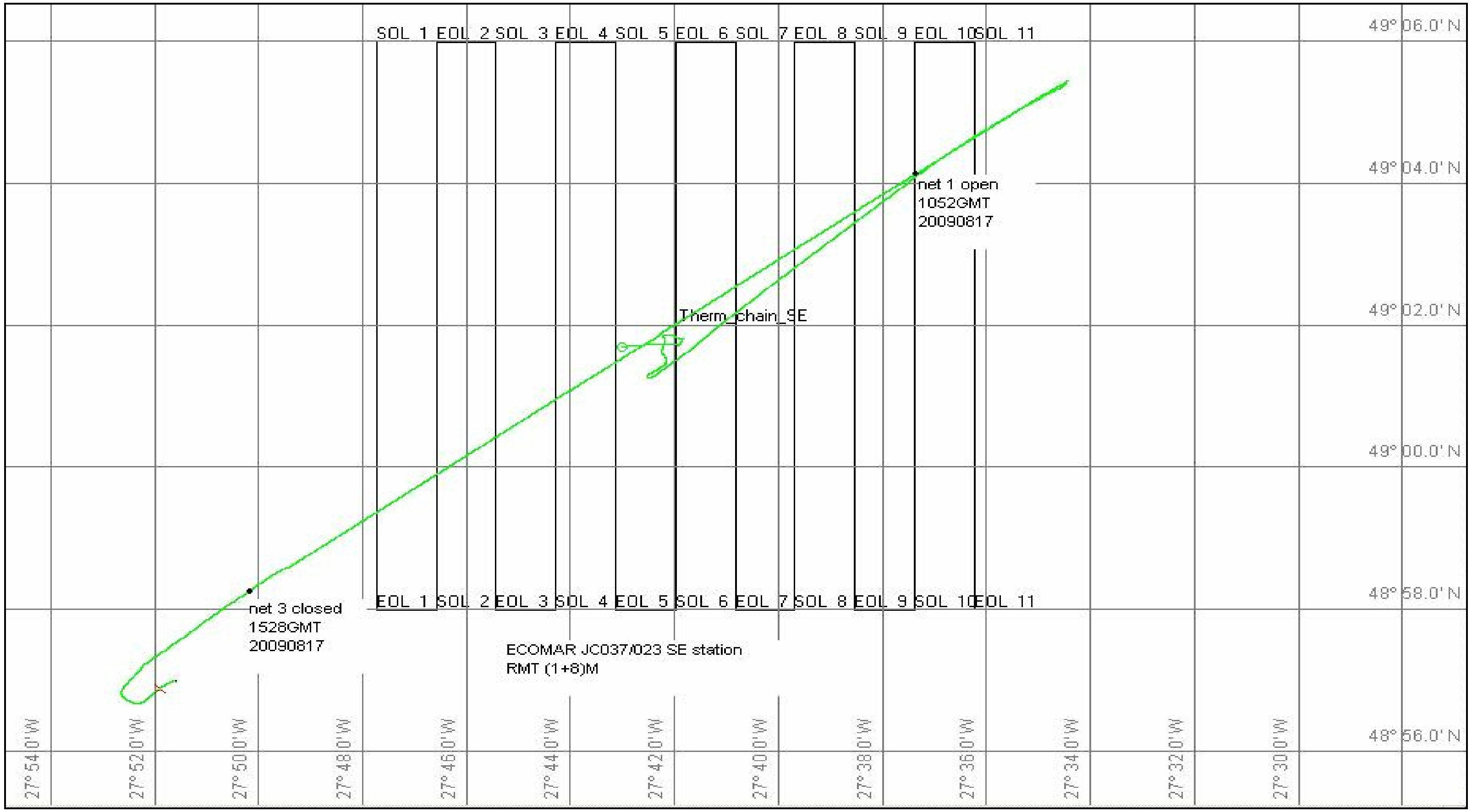

Fig.2 An example RMT (1+8)m trawl track (JC037/023) at the South East station shown in green. The black lines are the EK-60 line-transect survey design.

3.2 EK-60 activities

The EK-60 was calibrated in Bantry Bay , Ireland (51º 38’ N 009º 39’ W) before and after sampling using standard sphere techniques (see Appendix A1 for before-sampling calibration results).

Acoustic data were collected using the EK-60 during line transect surveys conducted at each station (Table 2). The line transect surveys comprised of 10 lines each 8 nautical miles long and were systematically designed (0.75 nautical mile transect spacing) with a random start point (Fig. 2). The surveys were orientated to minimise V/l pitching.

Station No.	Date	Time GMT	Orientation (degrees)	Station and number of transects (each 8 nautical miles long)
012	8 Aug	0913 1917	000	SE/10
46	22 Aug	1020 2006	030	SW/8
49	23 Aug	1509 1720	030	SW/2
57	26 Aug	1704 1930	030	NW/2
59	27 Aug	1246 2010	030	NW/7
65	28 Aug	1914 2011	030	NW/1.
71	30 Aug 31 Aug	1303 0506	090	75 mile transect between the NW and NE stations.
75	31 Aug	0805 1937	010	10

Table 2: Summary of EK60 sampling activities

3.3 Ring net sampling

Deployment occurred roughly every 3 hours for a period of ~24 hours during which time the ship was stationary (Table 3).

Sample #	Date	Station	Depth (m)	Time down	Time up	Time out
1	09/08/09	014	150	01:48:30	01:51:00	02:16:00
2	09/08/09	014	150	04:33:00	04:44:00	04:57:00
3	09/08/09	014	150	07:54:00	08:02:00	08:14:00
4	09/08/09	014	150	10:50:00	10:55:00	11:08:00
5	09/08/09	014	150	13:47:00	13:52:00	14:08:00
6	09/08/09	014	150	16:48:00	16:53:00	17:09:00
7	09/08/09	014	150	19:47:00	19:52:00	20:07:00
8	09/08/09	014	150	22:48:00	22:53:00	23:06:00

Table 3. Ring net deployments at the SE Station JC037/014

4 Preliminary findings

4.1 RMT(1+8)m

The preliminary findings of our data show the difference in volumetric density of pelagic fauna between depth ranges and stations. The greater density was located between 500 m and the surface. The catches were highly variable in the southern stations, and many different species were caught in each hauls. Greatest species diversity was located in the southern stations. Many species of fish and amphipod caught are considered rare and the specimens of voucher quality. The greatest catch was located in the SE station (52 kg of salpidae). We found few similarities between the RMT catch on the JC011 and the JC037 at the SW station.

There were some notable similarities between catches in the NE stations on both cruise. Typical in both years is the large catch of Calanoeid copepods, *Sergestes arcticus, Meganyctiphanes norvegica* (Northern krill) and some myctophidaes (typically *Benthosema glacialis*). Similarly the diversity of species caught was considered low compared to the SW, and few fish were caught.

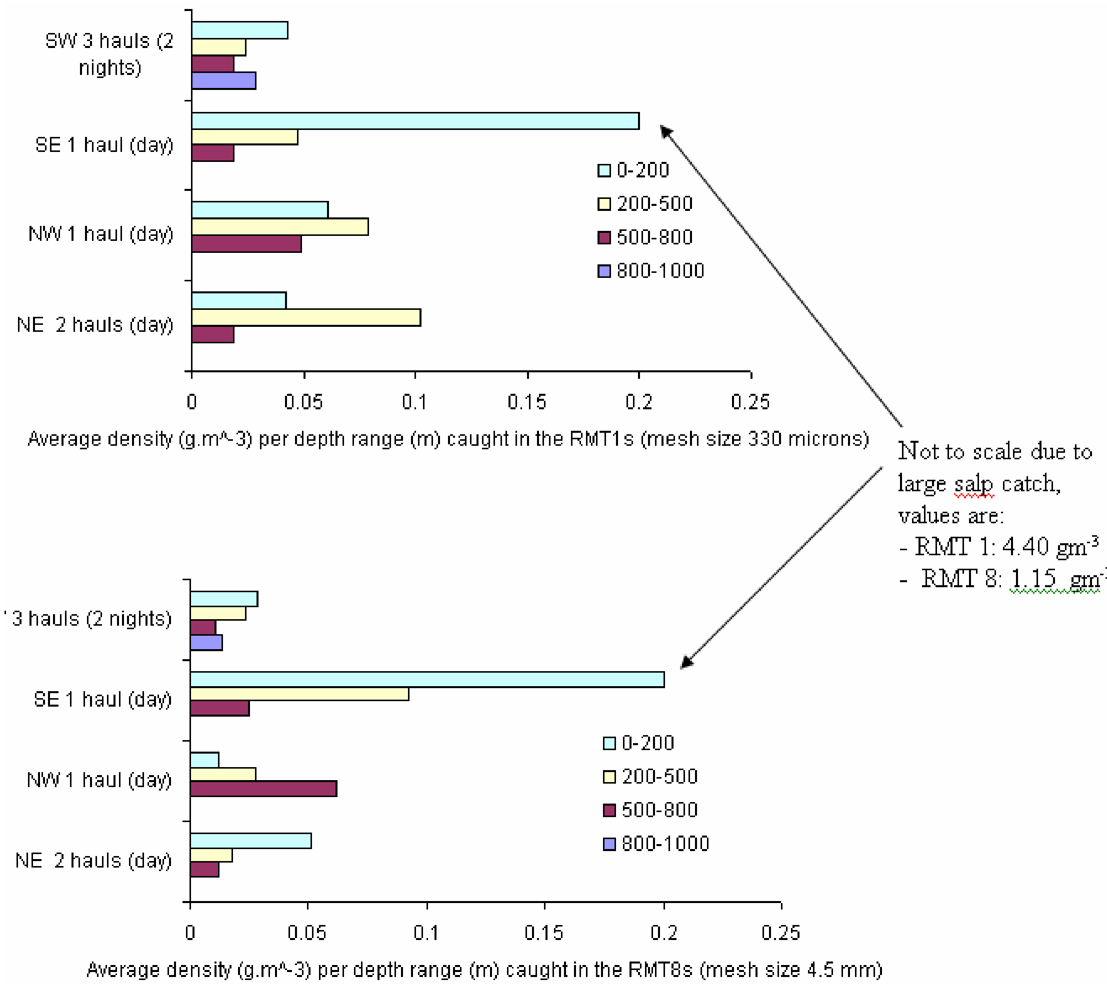

Fig. 3 Mean volumetric wetmass density per station caught with the RMT (1+8)m.

4.2 EK-60

Visual inspection of the EK-60 echograms showed distinct differences in scattering layers inter-acoustic-frequency (Fig. 4) and inter-site. Inter-site differences appear to be most marked between the northern sites.

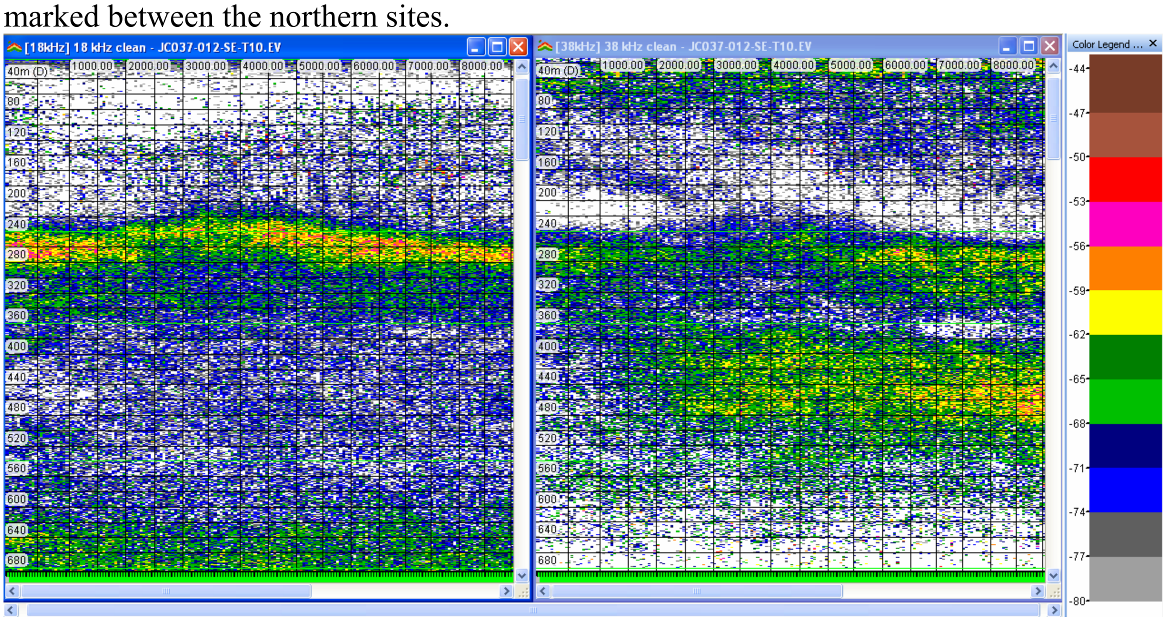

Fig. 4: Example of 18 and 38 kHz acoustic echograms. Sea surface is along the upper x-axis and the y-axis is depth. The grid is common between the frequencies and is 500 m horizontally and 20 m vertically. Stronger acoustic returns are shown in red. A strong scattering layer is evident at 18 kHz between depths of 240 and 300 m.

The EK-60 data quality has been greatly improved *cf* JC011. This is a result of retracting the azimuth thruster during Ek-60 surveys, trimming the V/l and selecting an appropriate survey orientation to minimise V/l pitch.

4.3 Vertical ring net

A preliminary qualitative inspection of the echograms showed distinct acoustic scattering layer present with a significant change in distribution of the 24hours of sampling. These scattering layers vary with acoustic frequency and sample number (fig.6).

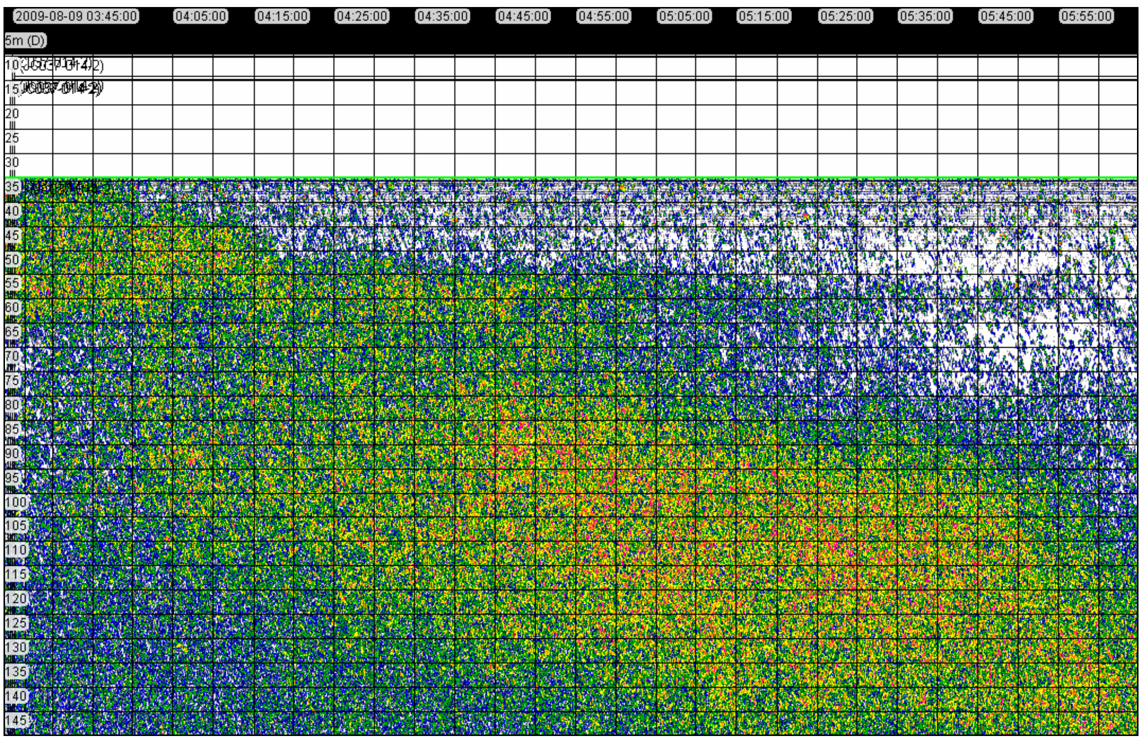

Fig. 6. Example EK-60 18 kHz echogram over a depth of 150m showing diel vertical migration (DVM) of zooplankton from the south east station during the time of ring net sampling. Grid size 5 min horizontally and 5 m vertically.

5 Research intentions

Given the data we have collected during JC037 we may be able to quantitatively estimate the pelagic biomass at the four site sites. Paucity of net sampling data and the time mismatch between EK-60 survey and RMT samples at the SE site will, however, make this difficult. Nevertheless we are confident that we can characterise acoustic scattering layers at the four sites, determine trophic interactions and assess diel vertical migration.

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7. OTSB Trawling - Demersal Ichthyofaunal Assessment

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Fish processing team: Nicola King, Jessica Craig, Thomas Linley, Rebecca Hunter, Gary Robinson, Robert Simpson, Rebecca Hunter, Pedro Ribeiro, Andrew Olivier, Susan Evans and Tom Letessier.

Aims and objectives:

The aims and objectives are to assess the demersal ichthyofaunal biodiversity, abundance and biomass at the stations north and south of the sub-polar front which traverses the mid-Atlantic ridge, and to determine any differences in biodiversity, abundance and biomass between regions. Demersal fish trawl data has been accumulated from ECOMAR cruises JC011 and JC037 and will result in a synthesis paper. Demersal fish specimen identification from trawls will also be used to verify fish imaged within PAL lander still images.

Trawl processing:

Fish data were retrieved from 7 OTSB trawls (Table 1). Three trawls were conducted at the southeastern station, three trawls at the northwestern station and one at the northeastern station, which failed to yield a significant catch.

Table 1

Trawl	Station	Start position	End position	Depth (m)	Distance run (km)	Area fished (km^2)
1	15	49° 05.040' N	49° 06.587' N	c 2750 m	2.87	0.02
		27° 50.073' W	27° 49.843' W			
2	19	49° 04.641' N	49° 07.164' N	2754 - 2724 m	4.69	0.04
		27° 50.660' W	27° 50.297' W			
3	27	49° 04.786' N	49° 07.863' N	2755 - 2702 m	5.70	0.05
		27° 50.293' W	27° 50.509'W			
4	61	54° 13.043' N	54° 09.827' N	2598 - 2619 m	6.17	0.05
		36° 04.071' W	36° 05.576' W			
5	67	54° 13.073' N	54° 09.961' N	2598 - 2625 m	5.98	0.05
		36° 04.030' W	36° 05.490' W			
6	70	54° 13.002' N	54° 10.534' N	2604 - 2615 m	4.74	0.04
		36° 04.084' W	36° 05.239' W			
7	79		53° 59.553' N	c 2420 m		
			34° 00.126' W			

Both demersal and pelagic specimens within the trawl were identified to the lowest taxonomic level possible. Specimens that could not be identified to species level on board have been kept, and white muscle samples have been taken for phylogenetic analyses in some cases. All fish were given an individual number for tracing, and where possible total wet weight, total length, standard length, head length and pre-anal length were recorded.

Further data was specifically taken for the macrouridae (rattails), halosauridae, and moridae, which were sexed, stomach, gonad and liver weight recorded (when not regurgitated), and the stomach fullness and sexual maturity assessed. Otoliths were also taken from *Coryphaenoides brevibarbis, C. armatus, H. macrochir* and *Antimora rostrata*.

Preliminary results:

Thriteen taxonomic groups were sampled at the SE station, eight at the northwestern station and four at the northeastern site. The SE station was the most diverse. A total of 1455 demersal fish were caught, totalling approximately 282 kg wet weight (Table 2).

At the SE station the biomass was dominated by *Halosauropsis macrochir* and *Spectrunculus* sp. a, where as at the NW station the biomass was heavily dominated by *Antimora rostrata* and *Coryphaenoides brevibarbis* (Figure 1). *Coryphaenoides brevibarbis* was the numerically dominant species at the NW site, where as at the SE site *H. macrochir* was the most abundant species (Figure 2).

Table 2 Total biomass and abundance, and species richness for each trawl.

Trawl	Station	Total wet weight (kg)	Standardised biomass (kg.km2)	Total no fish	Standardised abundance (ind.km2)	Species Richness
1	15	61.91	2.51	96	3889	14
2	19	27.94	0.69	111	2752	12
3	27	35	0.71	122	2489	12
4	61	83.03	1.56	351	6615	8
5	67	22.64	0.44	193	3753	7
6	70	50.32	1.23	575	14106	9
7	79	1.28		7		4

Analysis:

Analysis of the OTSB trawl data will consist of a) statistical determination of differences in biodiversity, biomass and abundance between the southern and northern stations, and sites east and west of the ridge, b) length-weight relationships of all demersal fish taxa for all regions where sufficient data is available, and the appropriate statistics to determine if there are differences in the length-weight relationships between sites, c) official identification of difficult specimens by taxonomists, and d) stomach content analysis for all species sampled.

Specifically for the macrouridae length frequency analysis will be conducted to determine age classes, and analysis of condition using the liver and gonad weight. Stomach content analyses will also be used to determine the demersal fish diet, and will be used to complement trophic level studies using stable isotopes carried out by Will Reid at Newcastle University (for sample list see Table 2).

Samples:

White muscle samples were taken from all specimens of *Coryphaenoides armatus* for a study on the population genetic structure of previous MAR-ECO specimens of the Mid-Atlantic Ridge. For an additional population genetic study, tissue samples were taken from *Antimora rostrata, C. brevibarbis*, and *Halosauropsis macrochir,* by Robert Simpson on behalf of Dr Rus Hoelzel at the University of Durham (Table 3). Additional genetics samples were taken by Pedro Ribeiro, IMAR-DOP, University of Azores. Liver, muscle and gonad samples were also taken for specimens of *A. rostrata* and *C. armatus* to determine lipid content. Stomachs were taken for content analysis when not regurgitated, these will be stored at Oceanlab, University of Aberdeen. Otoliths were also taken from *C. armatus, C. brevibarbis, H. macrochir* and *A. rostrata* these will be lodged as part of the

MAR-ECO otolith collection at IMR, Norway. Gonads were taken by Rebecca Hunter, University of Glasgow, to assess fecundity and sexual maturity in *C. brevibarbis, A. rostrata, C. armatus* and *Histiobranchus bathybius* as her undergraduate honours thesis. Samples of eyes, white muscle and liver were taken from several species for a study on gene expression by Prof Julian Partridge, University of Bristol.

Table 3 Trawl composition summary (non-transformed data). The total trawl swept area (km^{-2}) is provided for each haul. Total number of fish and biomass (kg) per trawl are listed for each species, in each trawl.

Station	**JC037/015 SE**		**JC037/019 SE**		**JC037/027 SE**		**JC037/061 NW**		**JC037/067 NW**	
Distance towed (nm)	**1.55**		**2.53**		**3.08**		**3.33**		**3.23**	
Total swept area (km^{-2})	**0.02**		**0.04**		**0.05**		**0.05**		**0.05**	
Total trawl catch	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**	**No. of fish**	**Biomass (kg)**
Halosauropsis macrochir	16	1.52	34	3.66	29	2.05	4	1.27	7	1.27
Bathysaurus ferox	1	0.066	4	1.21	1	1.38	1	0.86	1	1.20
Antimora rostrata	8	5.85	10	10.04	15	18.49	51	59.02	11	9.69
Coryphaenoides armatus	17	7.93	9	2.07	15	4.85	10	5.97	4	2.04
Alepocephalidae	13	3.24	9	2.26	17	1.44	5	2.90		
Coryphaenoides brevibarbis	2	0.12	16	0.59	27	1.10	264	11.25	162	
Polyacanthonotus challengeri	6	0.368			2	0.21				
Coryphaenoides sp b	2	0.16	9	0.68	4	0.28				
Juvenile and unidentified macrourids	8	0.099	9	0.013	3	0.03	12	0.073	6	0.01
Coryphaenoides sp a	4	0.66	5	1.87	4	1.44	3	1	1	0.68
Coryphaenoides sp c			1	0.03						
Spectrunculus sp. B	1	0.75								
Spectrunculus sp. A	4	32.10	4	4.56	1	0.71				
Histiobranchus bathybius	9	9.06	1	0.89	4					
Hariotta raleighana						1	1	0.03		
Pelagics		0.43		0.83		1.16		0.94		0.30
Total	**91**	**61.93**	**111**	**28.70**	**122**	**34.14**	**351**	**83.3132**	**192**	**15.19**

	JC037/070 NW		JC037/079 NE	
Distance towed (nm)	**2.53**			
Total swept area (km^{-2})	**0.04**			
Total trawl catch	**No. of fish**	**Biomass (kg)**		
Halosauropsis macrochir	5	1.03		
Antimora rostrata	16	15.95	1	0.18
Coryphaenoides armatus	4	2.91	1	0.47
Alepocephalidae	4	3.58		
Coryphaenoides brevibarbis	536	25.94	5	0.63
Polyacanthonotus challengeri	1	0.08		
Juvenile and unidentified macrourids	7	0.03	1	0.006
Coryphaenoides sp a	1	0.56		
Histiobranchus bathybius	1	0.27		
Pelagics		0.65		0.16
Total	**575**	**51.00**	**8**	**1.44**

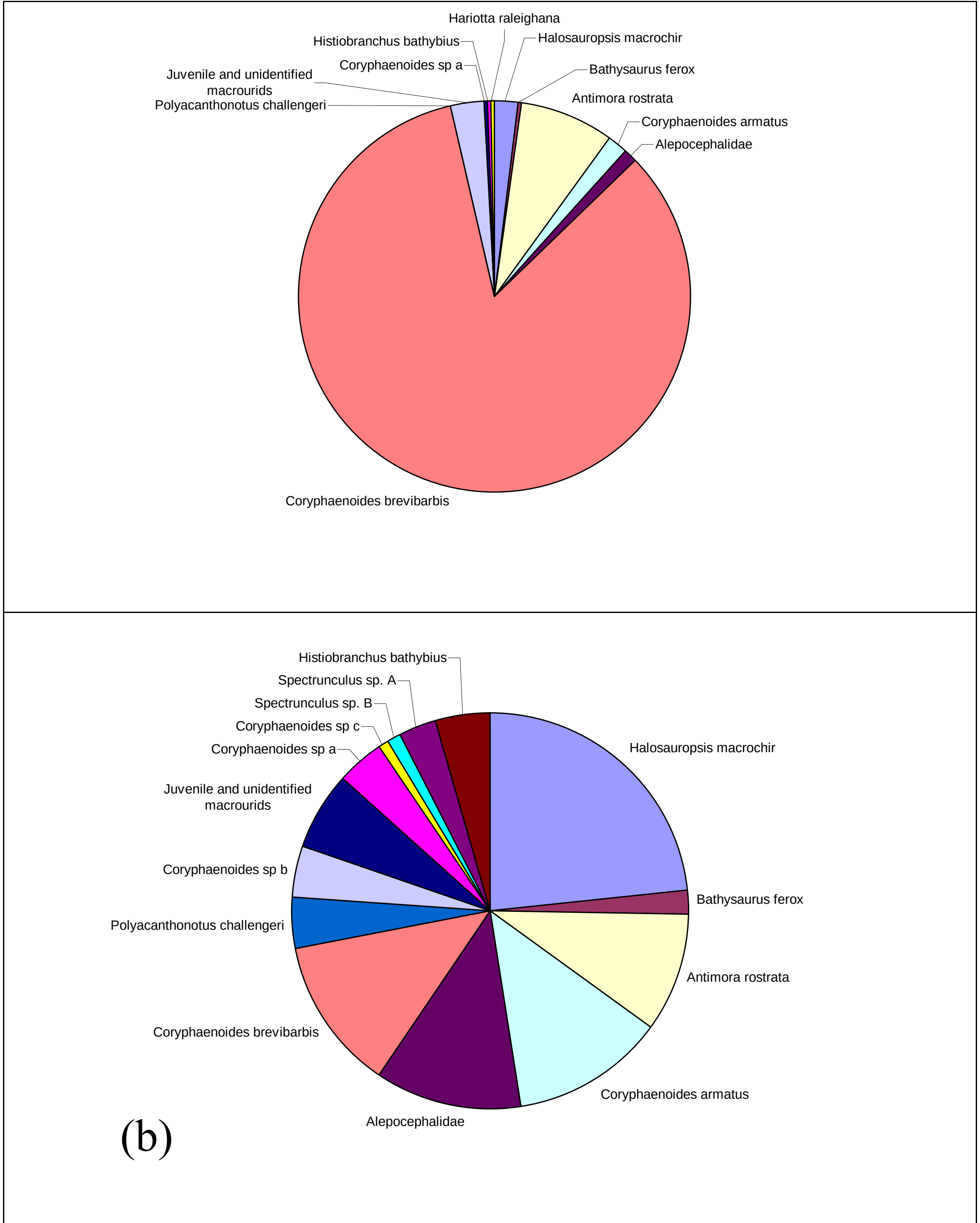
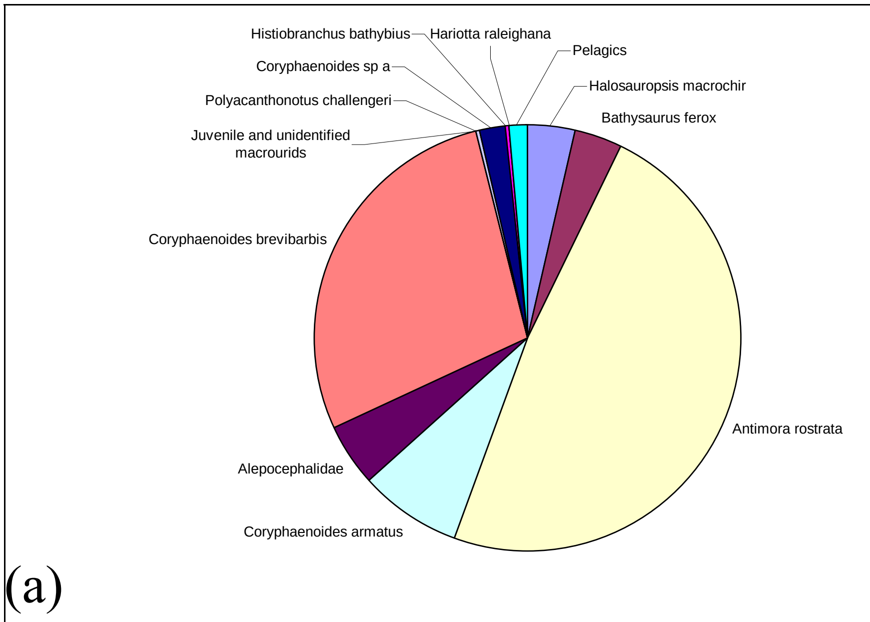


Figure 1 Comparison of demersal fish contributions to mean abundance for (a) northwestern site (n = 3), (b) and southeastern site (n = 3).



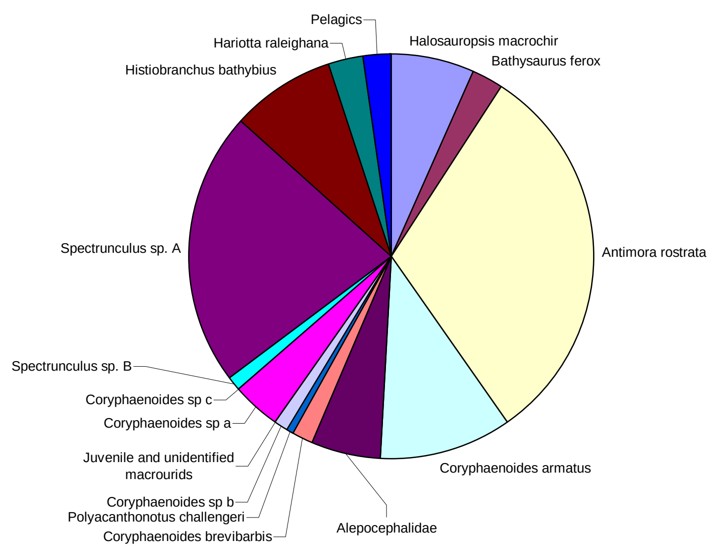


Figure 2 Comparison of demersal fish contributions to mean biomass for the (a) northwestern site (n = 3), (b) and southeastern site (n = 3).

8. OTSB Trawling - Megafaunal Ecology

Alan Hughes, Claudia Alt, Ben Boorman, Holly Bik, Antonina Rogacheva, Nataliya Budaeva, Will Reid & Ben Wigham
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Following recovery of the trawls, all specimens were identified to the lowest possible taxonomic group, and wet weight biomasses were obtained. Samples were taken for isotopic (University of Newcastle) and genetic (NOCS) studies, with the majority of specimens fixed in 10% Formalin for future taxonomic and ecological studies. The fauna in all the trawls was abundant and varied, and was noticeably different at all three sites.

At the Southern stations (JC037/015, 019 and 027), holothurians dominated the megafaunal biomass, with *Benthothuria funebris*, *Benthodytes gosarsi* and *Abyssocucumis abyssorum* dominating. Asteroids were also represented in high numbers, notably *Freyella elegans*, *Hymenaster* spp. and Porcellenasterids. Also present in high abundances were the solitary scleractinian coral *Flabellum angulare*, the octocoral *Anthomastus agaricus* and the sipunculan *Sipunculus norvegicus*. A large, dead, fragment of black coral was also recovered in JC037/015.

The three trawls carried out at the Northwest station (JC037/061, 067 and 070) revealed a noticeably different megafaunal community to that at the southern site. *Benthodytes gosarsi* again dominated the biomass, although the other dominant species in terms of biomass were the spatangoid sea urchin *Urechinus naresianus*, pycnogonids, the asteroid *Bathybiaster vexillifer* and cephalopods (although only a few large specimens of these were recovered). Other taxa found in appreciable biomass and numbers were the echinoid *Tromikosoma koehleri*, Porifera, the asteroid *Freyella elegans*, and the holothurians *Benthothuria funebris* and *Psychropotes depressa*.

The biomass of the fauna recovered at the Southeast site was extremely high (12.65 kg Ha^{-1}) compared with 2.4 kg Ha^{-1} in the one trawl carried out on JC011 in 2007. The high biomass observed during this cruise was attributable to large numbers of large *Benthothuria funebris* present in the samples. At the Northwest site the biomass was lower (4.05 kg Ha^{-1}), although this was again higher than in the single trawl obtained in 2007, where a biomass of 2.4 kg Ha^{-1} was observed.

Although the one OTSB deployment at the Northeast site (JC037/079) was aborted, this did touch the seafloor and recovered a few megafaunal species. Although this cannot be considered to be a quantitative sample, it did provide material for molecular analyses. The sample was noticeable in that it contained large numbers of Porifera, some Portalesiid echinoids, and some *Peniagone* spp. holothurians.

9. Phylogenetic And Population-Genetic Analyses

Robert Simpson[1], Pedro Ribeiro[2]
[1]University of Durham
[2]University of the Azores

Samples of fish and invertebrates were collected from the OTSB trawls for use in Genetics studies by Prof. Rus Hoelzel an ECOMAR PI at the University of Durham

Table 1. Number of individuals of benthic species collected for phylogenetic and population-genetic analyses at the University of Durham,

Order	Genus	Species	Number sampled
	Fish		
Gadiformes	Antimora	rostrata	96
Gadiformes	*Coryphaenoides*	*armatus*	15
Gadiformes	*Coryphaenoides*	*brevibarbis*	92
Albuliformes	*Halosauropsis*	*macrochir*	74
	Asteroids		
Brisingida	*Freyella*	*elegans*	4
Paxillosida	*Plutonaster*	*bifrons*	3
Paxillosida	*Plutonaster*	*Unknown*	2
Paxillosida	*Hyphalaster*	*inermis*	8
Paxillosida	*Porcellanaster*	*coeruleus*	3
Paxillosida	*Bathybaster*	*vexillifer*	3
Spinulosida	*Hymenaster*	*Unknown Sp.A*	1
Spinulosida	*Hymenaster*	*Unknown Sp.B*	1
Spinulosida	*Hymenaster*	*Unknown (Small Purple)*	3

Samples of white muscle were taken from four fish species; *Antimora rostrata, Coryphaenoides armatus, Coryphaenoides brevibarbis*, and *Halosauropsis macrochir* (Table 1).

Samples of nine Asteroid species were also collected by Rob Simpson from trawl stations to use for his honors project later this year in which a molecular phylogeny will be constructed. Four of the species were not identified on station, the remaining five species were: *Freyella elegans, Plutonaster bifrons, Hyphalaster inermis, Porcellanaster coeruleus,* and *Bathybiaster vexillifer*

An additional set of samples was collected by Pedro Ribeiro for a studies at University of Azores. Samples of the most representative species were collected to assess the degree of genetic differentiation between populations from the Azores and the Charlie-Gibbs Fracture Zone.

Table 2. Samples collected for the University of the Azores

	Number of specimens sampled per station				
Species	JC037/015	JC037/019	JC037/027	JC037/061	Total
Antimora rostrata	8	10	15	31	64
Halosauropsis macrochir	13	18	8		39
Plyacanthonotus challenger	3				3
Histiobranchus bathybius	5				5
Coryphaenoides armatus	15	9	13	10	47
Coryphaenoides brevibarbis	2	12	19	31	64
Alepocephalidae	3				3

10. Megacorer

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Station Number	Date	Depth (m)	No. cores	Mean core depth (cm)	Notes.
009	7 Aug	2720	8/8	32.9	1 x F; 1 x MM; 1 x NG; 1 x UN ; 4 x Macro.
010	8 Aug	2720	8/8	29.3	1 x F; 1 x MM; 1 x NG; 1 x UN ; 4 x Macro.
011	8 Aug	2720	8/8	41.1	1 x F; 1 x MM; 1 x NG; 1 x UN ; 4 x Macro.
30	19 Aug	2562	8/8	41.5	1 x F; 1 x PSA; 1 x NG; 5 x Macro.
31	20 Aug	2562	6/8	16.7	1 x F; 1 x NG; 4 x Macro.
34	20 Aug	2555	6/8	19.2	1 x F; 1 x NG; 1 x UN; 3 x Macro
35	20 Aug	2555	8/8	33.4	1 x F; 1 x PSA; 1 x NG; 1 x UN; 4 x Macro.
80	1 Sep	2486	5/8	36.4	1 x F; 1 x PSA; 1 x NG; 1 x UN; 1 x Macro.
84	2 Sep	2493	5/8	36.2	1 x F; 1 x NG; 3 x Macro.
85	2 Sep	2493	7/8	41.6	1 x F; 1 x PSA; 1 x NG; 4 x Macro.
91	3 Sep	2493	8/8	37.1	1 x NG; 7 x Macro.

Table 1: F = Foraminiferal sample (sectioned to 0.0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 cm sediment depth, and fixed in 10% buffered Formalin). MM = Metazoan meiofauna (sectioned to 0.0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 cm sediment depth, and fixed in 10% buffered Formalin). NG = Nematode genetics (0.0-5.0 cm. Half the sample was fixed in DESS solution and half was frozen at -80 ºC. For analyses by Holly Bik). UN = University of Newcastle (Isotope being carried out by Will Reid. These cores were sectioned into 0.0-0.5 and 0.5-1.0 sections and frozen at -80 ºC). Macro = Macrofaunal samples (Sectioned in 0.0-2.0 and 2.0-6.0 cm sections, sieved using a 300 µm mesh, and fixed in 10% buffered Formalin). PSA = Particle Size Analysis (sectioned to 0.0-1.0, 1.0-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 cm sediment depth, and frozen at -80 ºC).

The Megacorer was deployed on a positively buoyant Kevlar cable. To allow adequate core penetration it was left on the seafloor for five minutes before hauling. The corer was deployed with eight coring heads on all deployments.

The Megacorer was deployed eleven times in total (Table 1): 3 times at the Southeast station (JC037/009, 010 and 011), 4 times at the Southwest site (JC037/030, 031, 034, and 035), and 4 times at the Northeast site (JC037/080, 084, 085 and 091). Note that due to confusion over station numbers, the samples at the Southwest site are labelled as JC037/029, 030, 033 and 034, respectively.

At the Southeastern site, cores from all three deployments had large numbers of pteropod tests on the sediment surface; these were absent from deeper sediment layers. A thin layer of phytodetritus (up to a few millimetres thick) was also present on the sediment surface. The sediment was a slightly "grainy" uniform light brown silt/clay, with no obvious redox potential discontinuity layers visible.

The sediments at the Southwestern site were generally similar to those at the Southeastern site; i.e., uniform brown mud, with pteropod tests on the sediment surface. The phytodetritus was sometimes thicker, however (e.g., up to 5 cm deep in JC037/30) and the pteropod tests appeared to be denser, which was reflected in the reduced penetration of the cores in JC037/31. At both the southern sites, the distribution of pteropod shells appeared to be patchy.

The cores from the Northeast station were noticeably different to those at the southern sites; the surficial sediments in the cores from all four deployments was a light brown mud approximately 18 cm deep. Below this lay soft, grey mud (Figure 39). The sediments at this site were extremely soft, and no phytodetritus was observed in the cores. This surfical brown layer may represent sediment deposited during the Holocene, which suggests a sediment accumulation rate of approximately 2 cm ky^{-1} at this site.

Cores from each of the sites were processed for a variety of analyses. For the examination of benthic Foraminifera, cores were sectioned to 5 cm sediment depth, and fixed in buffered 10% Formalin. On return to the laboratory, these samples will be wet-sorted for benthic foraminifera, including soft shelled and agglutinated taxa, as well as metazoan meiofauna. Cores were also sectioned and frozen, for particle size and various geological analyses. Cores for Macrofaunal analysis were sieved using a 300 µm mesh; although these samples are too small to provide quantitative macrofaunal samples, they will provide material for taxonomic studies.

Megacorer samples designated for nematode genetics will be analysed using high-throughput sequencing protocols (using the GS FLX platform by 454 Life Systems) at the Hubbard Centre for Genome Studies, University of New Hampshire. Frozen sediment samples will be used to analyse nematode community structure based on DNA barcodes extracted from environmental DNA. Core subsamples stored in DESS preservative will be used for taxonomy and single-nematode DNA extractions to supplement environmental data.

11. Amphipod Trap Deployments

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The amphipod trap (= "Amphitrap") was deployed eight times during the cruise: Three times at the Southeast site (JC037/013, 018 and 025), once at the Southwest site (JC037/38), twice at the Northwest site (JC037/052 and 060) and twice at the Northeast site (JC037/076 and 083).

Overall, these deployment were very successful and recovered large numbers of amphipods. The exception to this was the one deployment at the southwest site (JC037/38) when the bottom (i.e., square) trap was lost. This may have been due to the motion of the trap in the water, and two of the retaining clips were broken off. There were only 6 amphipods in the top, cylindrical trap.

Station Number	Date	Time	Depth (m)	Notes
013	8 Aug 10 Aug	2235 1718	2501	Reasonable catch. Specimens retained in Formalin and ethanol.
018	10 Aug 17 Aug	1920 2108	2500	Modest catch including a gastropod. Specimens retained in Formalin and ethanol.
25	17 Aug 18 Aug	2311 1520	1830	On top of a ridge at the SE station. Small catch. Specimens retained in Formalin.
38	20 Aug 23 Aug	2222 0836	2440	Deployed east of the SW mooring site. The lower trap on the frame has fallen off, only 6 amphipods caught in the top trap; all retained in Formalin.
52	25 Aug 27Aug	2152 0905	2570	First deployment of the trap NW Station. Large catch of ostracods and amphipods. Specimens retained in Formalin and ethanol.
60	27 Aug 30 Aug	2143 1115	2340	Excellent catch of amphipods, ostracods and other crustacea. Specimens retained in Formalin and ethanol.
76	31 Aug 1 Sep	2016 1824	2552	Deployed near the NE Station OTSB trawl track, A very rich catch of amphipods, distinct from the NW station. Specimens retained in Formalin and ethanol.
83	2 Sep 3 Sep	0002 0823	2452	A large catch of small amphipods. Specimens retained in Formalin and ethanol.

Table 2: Details of the Amphipod trap deployments carried out on the cruise.

For the deployments at the northern sites, a second circular trap replaced the square trap. In addition, two smaller traps made from discarded core tubes, were added; the position of these was altered at the Northeast site, but putting them both as low down on the frame as possible appeared to return the highest catch, so the trap was deployed with this configuration at both of the deployments at the Northeast site.

The deployments were carried out for varying lengths of time, ranging from just over 16 hours (JC037/25) to over seven days (JC037/018). The highest catches, at the northern stations, were for approximately one and a half days duration.

A noticeable feature of the deployments at the Northwest site was that many hundreds of bright orange ostracods (*Gigantocypris agassizi*) were recovered. These were particularly abundant in the small traps made from core liners, attached to the bottom of the frame. Large specimens of *Eurythenes gryllus* were also obtained in large numbers in these traps; this species was recovered at all sites except the Southwest.

The amphipods and ostracods will be returned to NOCS for taxonomic studies by Tammy Horton. Specimens were also fixed in ethanol for molecular studies at the University of Durham. Amphipods and ostracods were also collected for isotopic analysis by William Reid and Ben Wigham (Newcastle University) for food web analysis (see Food webs and trophic community structure section for more details).

12. Benthic Trophodynamics Of The Mid-Atlantic Ridge

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Fish, invertebrate and sediment samples were collected for stable isotope analysis (carbon, nitrogen and sulphur)(Table 1). This will build on the work conducted on samples collected during JC011 in 2007. The aims are to (1) examine differences in benthic food webs north and south of the Charlie Gibb Fracture Zone to see whether different productivity regimes influence trophodynamics and energy flow and (2) to look at regional variation in the relationship between size and $\delta^{15}N$ in the dominant species of fish. Sample collection was very successful in the south and northwest but unfortunately no samples were collected in the northeast. The aim will now be a more detailed investigation of the benthic food web and temporal comparison at the southeast station. The regional variation in the relationship between size and $\delta^{15}N$ of fish will still be achievable.

The dominant species of holothurian at the southeast and northwest stations were also sampled for lipid analysis. This study will investigate whether bacterial-derived lipids are assimilated by these deposit feeders. Sediment from the gut contents was sampled in order to compare the bacterial community composition of ingested sediment to that of the surrounding seabed (food source). Bacterial species producing lipids will be indentified in addition to the specific lipids produced. We will then attempt to trace these compounds through muscle, gonad and gut-lining tissues to assess the potential contribution of bacterial lipids to the diet of deep-water holothurians and how these compounds may be assimilated into somatic or reproductive growth.

Megacorer samples (Stations 9, 10, 11, 33, 34, 80)

Sediment cores were sectioned between 0-5mm and 5-10mm to examine the stable isotope values of the energy source for surface and subsurface deposit feeders. The top 0-5mm of sediment also contained holothurian faecal casts, phytodetritus and pteropod shells in the southern stations but these were absent in the northeast. All pteropod shells were removed from the sample. Sediment samples were also taken to investigate regional bacterial diversity and whether these bacteria can produce polyunsaturated fatty acids. This work will be undertaken at the Dove Marine Laboratory, Newcastle University. All samples were frozen and stored at -80^{o}C in glass vials.

Mobile macro-consumers: Amphipod trap (Station 60) and OTSB (Stations 15, 19, 27, 61 67 & 70)

Mobile macro-consumers were collected using the amphipod trap and OTSB. Samples caught in the OTSB were sorted to lowest taxonomic level and then the most abundant invertebrate and fish species were selected for stable isotope analysis. 2 - 5g of tissue was removed from each specimen, when large enough, and the whole specimen was taken if it was a small individual. All samples were frozen and stored at -80^{o}C in glass vials.

Table 1. Summary of samples taken by Newcastle University on JC037 for stable isotope and lipid analysis (A = Amphipod Trap, M = Megacorer, O = Otter Trawl semi-balloon).

		Southeast						Southwest		Northwest				Northeast
Station Number		9	10	11	15	19	27	33	34	60	61	67	70	80
Gear		M	M	M	O	O	O	M	M	A	O	O	O	M
Sediment Sample	0-5mm	3	2	1				2	3					3
	5-10mm	3	2	2				2	0					3
Invertebrates														
Cnidaria	*Anthomastus agaricus*					4								
Crustacea	Amphipoda spp.									12				
	Gnathophausia zoea				3	3					4			
	Acanthephyra sp.				4						4			
	Ephyrina bifida				1						2			
	Sergestes sp.										2			
	Parapasiphae sulcatifrons										4			
	Munidopsis rostrata				6	10								
	Pentacheles validus						2							
	Polycheles nanus					1	1				3			
	Glyphocrangon sculpta				6	4	5							
	Ostracoda sp.									5	5			
	Goose barnacle				3	1								
Asteroidea	*Freyella elegens*				2	4								
	Hymenaster sp.				3									
	Plutonaster sp.					2	3							
	Plutonaster bifrons					4								
	Hyphalaster inermis				3	3								
	Porcellanaster cerulus				6						4			
Holothuroidea	*Abyssocucumis abyssorum*				9	3								
	Benthothuria funebris				5						1			
	Benthodytes gosarsi				4	1					5			
	Pelopatides grisea				1	1	1							
	Peniagone sp. A				5									
	Peniagone				5									

	longipapillata													
	Pseudostichopus sp. A				3									
	Psychropotes depressa				3		3				5			
	Molpadia musculus					6								
	Gephirothuria sp.						5							
Polychaeta	*Aphrodite* sp.					3								
	Polynoidae sp. 2					2								
Mollusca	Gastropoda sp. C					3								
	Gastropoda sp. D						3							
Sipuncula						6								
Fish														
	Alepocephalus sp.				3									
	Antimora rostrata				8	8	8				38	4	11	
	Bathylagus euryops					2								
	Bathysaurus ferox					3	1							
	Coryphaenoides armatus				15	9	2				10	4	4	
	Coryphaenoides brevibarbis				2	12	4				34	2	10	
	Coryphaenoides sp. A				4	5								
	Coryphaenoides sp. B				2	2								
	Histiobranchus bathybius				7	1								
	Halosauropsis macrochir				16	14						7	5	
	Polyacanthonotus challengeri				3									
	Synaphobranchus sp.				3									
	Spectrunculus sp. A				4	4								

13. Reproductive Ecology Of Deep-Ocean Fishes.

Rebecca Hunter,
Undergraduate Student, University of Glasgow.

The reproductive ecology of many of the most common deep-ocean fish remains a complete mystery and impacts our ability to predict the effects of fisheries and climate change. Acquiring more knowledge on basic reproductive traits will benefit studies on diet, early life history etc. ultimately attaining a more complete biological picture of these important species.

Gonads were sampled from *Antimora rostrata, Coryphaenoides armatus, Coryphaenoides brevibarbis, Halosauropsis machrochir* and *Histiobranchus bathybius*. The reproductive stage of fish at different sizes will be determined by histological analysis of gonad tissue and, where possible, the potential fecundity will also be calculated. However, due to the small number of pre-vitellogenic females in the catch, samples of oocytes for fecundity analysis were only taken from *A. rostrata* (n = 1), *H. machrochir* (n = 1) and *H. bathybius* (n = 4). The relationship between liver energy content and reproductive condition will also be investigated by calculating the hepato- and gonadosomatic indices.

Table 1. Summary of gonad samples taken for histological analysis during JC037.

Species	Trawl Number							Total
	1	2	3	4	5	6	7	
Antimora rostrata	8	10	15	48	-	-	-	81
Coryphaenoides armatus	12	8	10	10	-	1	-	41
Coryphaenoides brevibarbis	-	-	-	-	-	7	-	7
Halosauropsis machrochir	11	8	6	4	-	1	-	30
Histiobranchus bathybius	7	1	4	-	-	-	-	12

During dissection, photographs of the gonads were taken *in situ*. These will be complied with information regarding egg size and stage, as revealed by histology, to create a photographic guide of the reproductive stages for each species. As macroscopic staging of gonads is difficult this will allow future researchers to compare gonads from the fish they catch to a reliable scale, greatly increasing the consistency between data sets.

Figure 1. Dissected gonads from *A. rostrata* (left) and *H. bathybius* (right).

14. Baited Lander Studies

Ichthyofaunal assessment using the Photographic and Acoustic Lander (PAL) at southern and northern stations on the Mid-Atlantic Ridge (MAR).

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Technology

The Photographic and Acoustic Lander (PAL) (Figure 42) is a free-fall lander equipped with a digital stills camera (Kongsberg Maritime, OE14-208), flash unit (Kongsberg Maritime, OE11-242), RDI Teledyne 300 kHz Workhorse Sentinel ADCP (property of SAMS), conductivity, temperature and depth unit (Seabird, SBE 37; property of NERC marine equipment pool), rechargeable Lithium battery pack, custom built digital recording device and hydrophone, and twin acoustic ballast release system (MORS AR and RT).

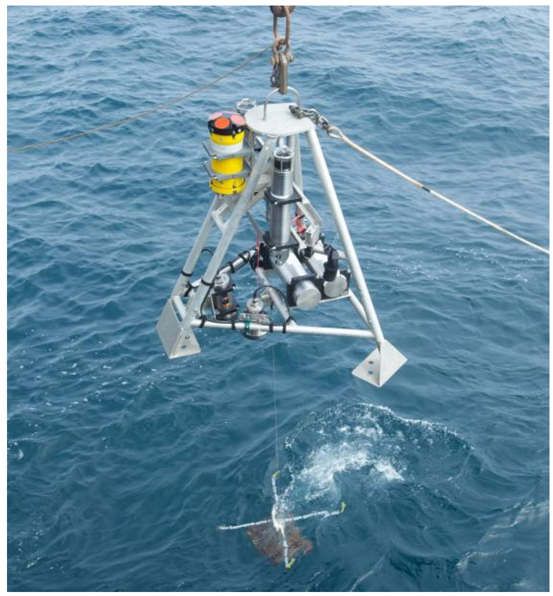

Fig 1: Photographic and Acoustic Lander (PAL) being deployed. Photo courtesy of David Shale.

The ADCP was programmed to measure current velocity, temperature and depth at 10 second intervals at 2 m depth bins, up to 50 m above the ADCP head. The CTD unit measured conductivity, temperature and depth at 10 s intervals. The camera was programmed to take digital photographs at 60 s intervals, with an average of 1622±667 (mean±SD) seabed photos per deployment.

Deployments

The PAL lander was deployed at 9 stations. Capturing 14,599 seabed images, at depths ranging from 2479-2601 m UC (Table 16), and 144 hours of digital hydrophone recordings of the scavengers attending the bait.

Table 1: PAL deployment positions.

Dep.	Stn.	Area	Latitude (N)	Longitude (W)	Depth (m) UC	Date	Time camera on (GMT) (hh:mm)	Duration on seabed (hh:mm)	Number of images on seabed
1	006	SE	49°01.65’	27°42.20’	2546	07/08/2009	15:19	30:03	1802
2	021	SE	49°01.91’	27°42.27’	2546	11/08/2009	11:35	48:25	2184
3	028	SE	49°01.32’	27°42.98’	2504	18/08/2009	10:18	8:29	509
4	036	SW	48°44.24’	28°37.32’	2505	20/08/2009	20:56	19:34	1074
5	044	SW	48°44.84’	28°38.78’	2601	22/08/2009	07:14	26:25	1585
6	053	NW	53°58.38'	36°07.73'	2559	25/08/2009	22:17	34:19	2058
7	062	NW	53°58.40'	36°08.22'	2513	28/08/2009	10:21	44:53	2757
8	077	NE	53°57.97'	34°03.19'	2535	31/08/2009	20:38	21:31	1291
9	087	NE	54°03.37'	34°09.47'	2479	02/09/2009	08:51	22:19	1339

Preliminary results

Dominant species attending the bait in the southern stations are the blue hake, *Antimora rostrata* (Günther, 1878) (Fig. 2c), *Spectrunculus sp* (*Spectrunculus grandis*, the pudgy cusk eel (Günther, 1877)? Figure 2a) and the abyssal grenadier, C*oryphaenoides armatus* (Hector, 1875) (Figure 2b). Other intermittent visitation by deepwater rays (*Bathyraja* sp.?), the deepwater arrowtooth eel, *Histiobranchus bathybius* (Günther, 1877) (Fig. 5a) Kaup’s arrowtooth eel, *Synaphobranchus kaupii* (Johnson, 1862), shortnosed rabbitfish, *Hydrolagus affinis*? (de Brito Capello, 1868), the deep-sea spiny eel, *Halosauropsis macrochir* (Günther, 1878), a slickhead species (Alepocephalidae) and several species of macrourid.

In the northern stations the blue hake and the abyssal grenadier were the most prevalent scavenging species observed. The shortnosed rabbitfish and ray species were noticeably more abundant at these northern sites. Several other species were also seen; the large pale cusk eel observed at the southern sites and a small dark species (Fig. 5b) that had only previously been seen on the rocky southern station (see below), the deepwater arrowtooth eel, Kaup’s arrowtooth eel and several species of macrourid were also seen.

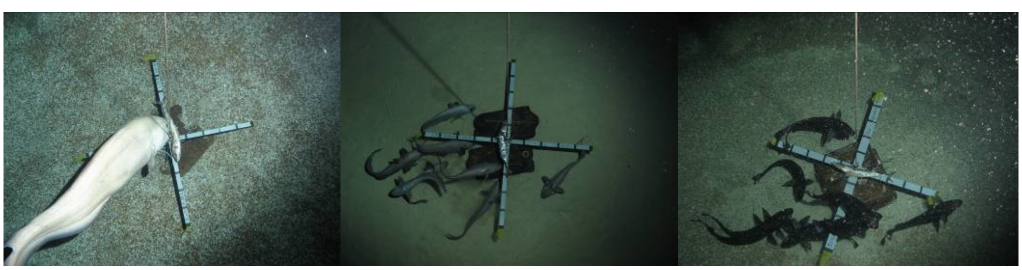

Figure 2: Images from the PAL lander. (a) Large cusk eel, *Spectrunculus sp*. JC037/006 deployment 1 (b) the abyssal grenadier, *Coryphaenoides armatus*. JC037/062, deployment 7, (c) the blue hake, *Antimora rostrata* JC037/036 deployment 4

At the NE station some of the abyssal grenadier showed signs of what may be a bacterial/fungal infection (Fig. 3). This was relatively common at, but unique to, this station.

Figure 3 44: Image from JC037/087 deployment 9 showing abyssal grenadier, *Coryphaenoides armatus* with what may be a bacterial/fungal infection

Invertebrates observed at the bait were decapod shrimps, ophiuroidea, scyphozoa, amphipoda and one cephalopod (possible Dumbo octopus, *Grimpoteuthis sp*. at deployment 8 JC037/053). Amphipods were not present in significant numbers during southern deployments, however were present in high numbers during all northern deployments. Large specimens of *Eurythenes gryllus* were photographed at both northern and southern sites during deployments 2 and 8. Pycnogonida were observed during deployments 6 and 7, and a stone crab (*Neolithodes* p.) was recorded at the bait during deployment 8.

Marine snow appeared to be most prevalent in the southern stations (Fig.4). This is the inverse of what was observed on the previous lander study (JC011) and would require further investigation to explain. Variations were seen during a single deployment suggesting either small scale pulses or resuspension by the scavengers themselves. In the south the sediment was clean golden/brown sand with a patchy distribution of pteropod shells. In the north the substrate appeared homogenous, comprising of a finer and softer golden/brown mud/sand. All areas showed signs of bioturbidation and when the stills are animated into video, burrowing activities can be seen during the deployment.

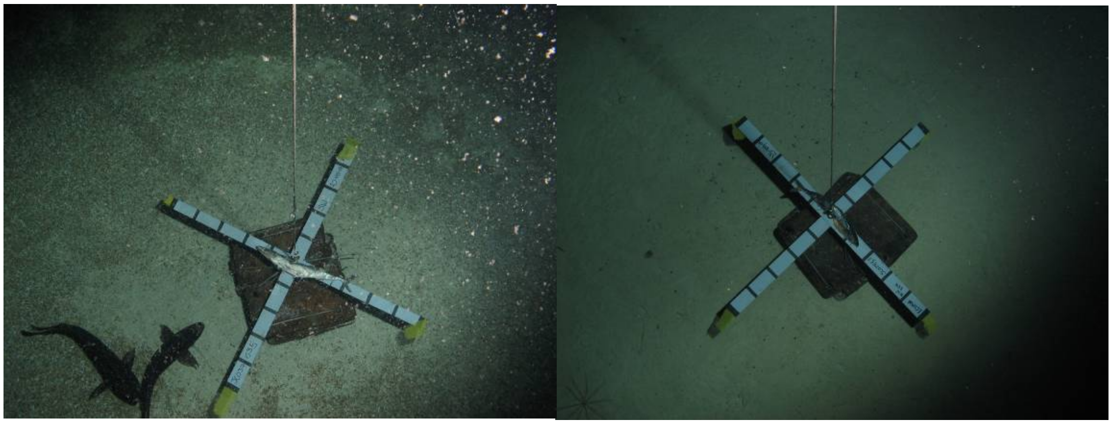

Figure 4 : Sediment and marine snow at southern and northern stations. a) Southern, deployment 3 SE station JC037/028. Sediment surface has a patchy covering of pteropod shells and shows high levels of marine snow. b) Northern, deployment 6 NW station JC037/053 sediment is a fine, clean, homogeneous sand and little marine snow.

Deployment 2, JC037/021 showed the underlying bedrock (likely pillow lava) (Fig. 5) emerging from the sediment. The area also included frequent boulders and cobbles. At this site differences in species composition compared with other southern sites were seen. Most noticeably, a greater abundance of eel species and the small dark *Spectrunculus sp.* species.

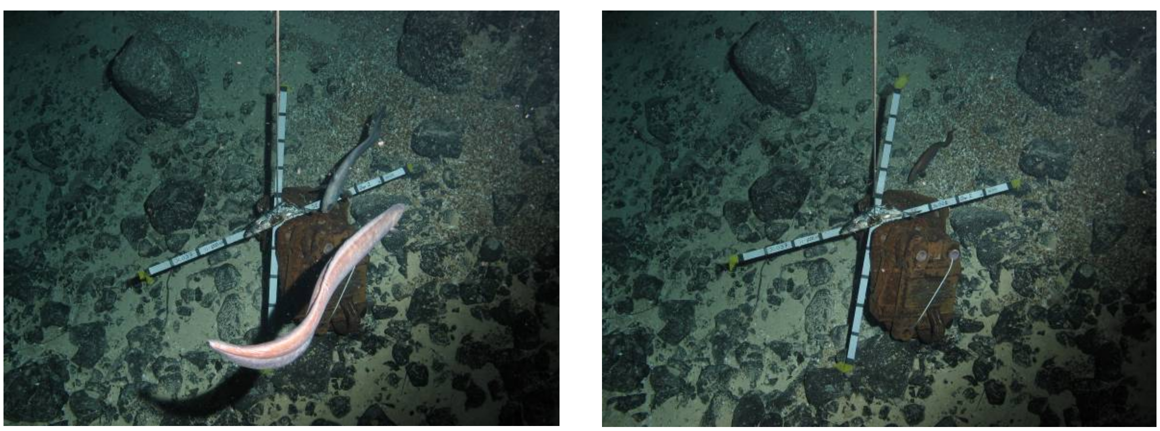

Figure 5: Images of the rocky seabed on deployment 2 JC037/021. a) deepwater arrowtooth eel, *Histiobranchus bathybius* and abyssal grenadier, *Coryphaenoides armatus.* b) small, dark, *Spectrunculus sp.*

Analysis:

Analysis of the PAL data will consist of a) image analysis; simple time series counts, length frequency determination, bait visitation by individuals, local abundance estimation calculation for the numerically dominant species, confirmation of species identification, behavioural observations, and b) collation and interpretation of ADCP data in relation to the scavenging fauna observed. The hydrophone recordings from the PAL deployments will be analysed using acoustic interpretation software.

15. Benthic Bioluminescence On The Mid-Atlantic Ridge

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(With ICDeep Black box tests conducted by: Jessica Craig & Pedro Ribeiro)

Background

In the marine environment, a large number of organisms have the capacity to emit visible light, bioluminescence. The Oceanlab ICDeep (I^2CCD (Image Intensified Charge Coupled Device) for Deep-sea research) is designed to image the bioluminescence of deep-sea animals. This cruise marks the first use of the ICDeep lander for observations of benthic bioluminescence. Previous studies of benthic bioluminescence at the MAR have been has been undertaken with the ISIT (Intensified Silicon Intensifier Tube) during the JC011 cruise (3 deployments south of the CGFZ). Studies with the ISIT lander have also been made within the NE Atlantic to record benthic bioluminescence at artificial food falls, where the number of bioluminescent events.h^{-1} was found to decrease with depth. Patches of elevated levels of bioluminescence in the NE Atlantic were later credited to the presence of the ostracod *Vargula norvegica*.

Objectives:

From benthic deployments of the ICDeep lander we aimed to detect non-stimulated bioluminescent activity using a mackerel bait. We also aimed to identify the bioluminescent organisms present via onboard experimentation on live specimens collected with the Dark trap. This study of benthic bioluminescence on the MAR builds on video data collected during the JC011 cruise using the ISIT lander.

Technology

ICDeep lander

The ICDeep is an ultra low light camera. It integrates I^2CCD (Image Intensified Charge Coupled Device) technology with a custom built computer system for device control and image capture. To image spontaneous bioluminescence in the benthic boundary layer the ICDeep camera was mounted on an aluminium lander and orientated towards bait (*Scomber scombrus*, 500g) attached to a metal arm resting on the sea floor. The camera was positioned 0.8 m above the bait, with a field of view of 0.8 x 0.65 m. A current indicator and a calibration LED were also positioned within the field of view. A red LED was used to illuminate the scene at specified intervals to enable observation and identification of megafauna present. Red light, not visible to most deep sea animals, was used to minimise disturbance of behaviour and damage to eyes. A text program controlled the record timing and gain of the camera and timing of illumination of the red and calibration LEDs. Data were captured as time/date stamped mpeg4 video. (Fig. X)

The camera was programmed to capture video for 2 min 30 sec (gain: 750) with no artificial light, followed by 15s (gain: 650) with the scene illuminated. This sequence was repeated every 5 minutes. This sequence was repeated over a 23 hour period. The calibration LED was illuminated for 10 seconds during the first recording period.

Dark trap

The Dark trap is a small crustacean trap (<15 mm) made of a light-impermeable material with a double entrance to minimise light intrusion and water exchange on recovery of the lander.

SBE 39

A SBE 39 Temperature and Pressure sensor was also mounted on the ICDeep lander at a height of 1.2 mab. This was programmed to take measurements at 30 second intervals.

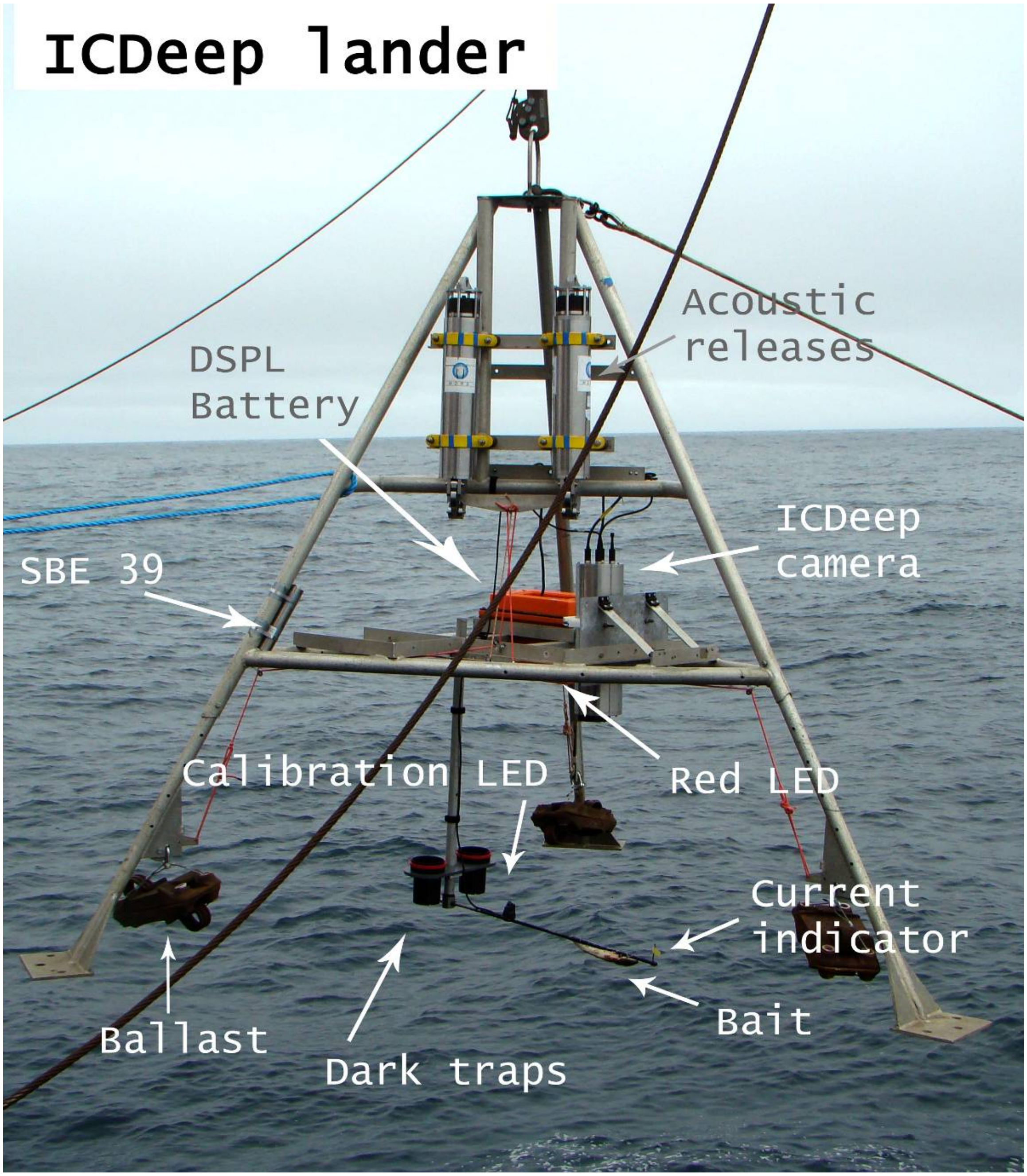


Figure 1. ICDeep lander

ICDeep Blackbox

The ICDeep Blackbox is a light tight box with a tube that feeds into the box. This was mounted below the ICDeep lander while onboard. A mesh tray with 9 separate compartments was placed within a containing tray inside the box. Specimens collected with the Dark trap were maintained in chilled deep water (sourced from 3000 m depth). ICDeep blackbox experiments commenced immediately after recovery of the lander. Specimens were separated roughly into types and placed within the 9 compartments. The box was sealed before recording commenced. The tray was then flooded with 800 ml of 400 mmol KCl solution via the feeding tube. KCl was used to chemically stimulate bioluminescence. The camera was programmed to record with no artificial light for 2 min 30 seconds (gain: 750), then for 15 seconds with red LED illumination (gain: 650). This process was repeated until all collected specimens had been tested. On video playback, specimens within compartments from which bioluminescence was detected were stored separately for future identification. All specimens were stored in 4% formalin, 70% ethanol or frozen at -80 ˚C.

Deployments

The ICDeep lander was deployed 9 times: 3 deployments at the SE station (Dep. 1,2,3), 2 at the SW station (Dep. 4,5), 2 at the NW station (Dep. 6,7) and 2 at the NE station (Dep. 8,9).

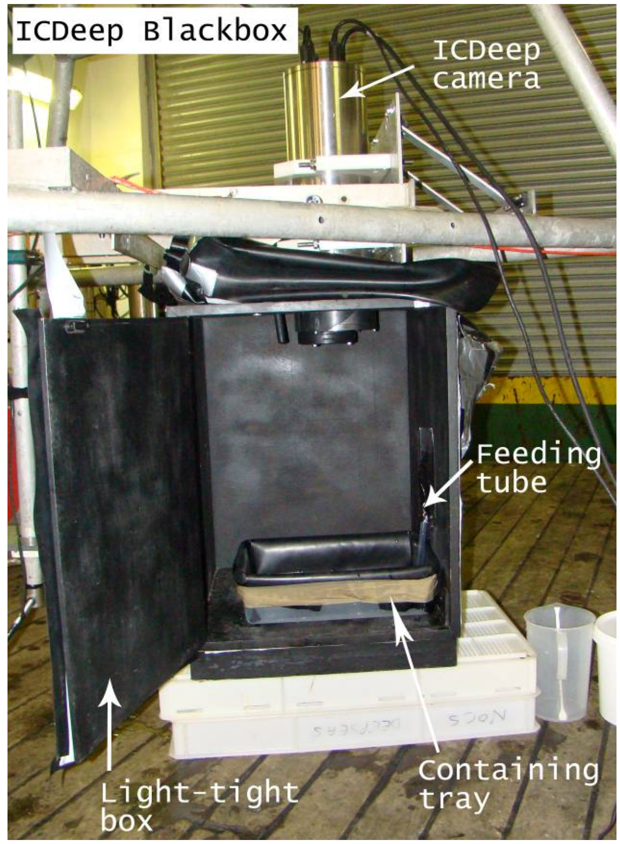


Figure 2 ICDeep blackbox

The full 23 hours of video was captured on Dep. 1 & 2. Problems encountered with the ICDeep camera curtailed the duration of recording of all other deployments (see Table 1 for details). After deployment 5 the ICDeep Windows computer system developed an error and could not be started up. Windows and all necessary software were reinstalled. From this point on a problem was encountered resulting in a periodic pause in captured video throughout all recording periods. The pause occurres for 2 seconds every 7 seconds throughout all videos. This problem affected video collected from Dep. 6,7,8 & 9. However, video obtained during these deployments is still useable.

Preliminary results

ICDeep lander

Initial viewing of the videos recorded at the southern stations show a higher rate of bioluminescent events than that recorded on JC011 with the ISIT lander. Many of these extra BL events were of a very low light intensity (Fig. 3). The higher BL rate is likely an artifact of the greater sensitivity of the ICDeep camera cf. the ISIT camera. BL events were generally of a lower light intensity than the calibration LED. They generally consisted of small static or traveling points of light. During the periods of illuminated recording observations of fish included *Antimora rostrata, Spectrunculus grandis* and deep-water eels.

ICDeep blackbox

Ostracods that were collected in the Dark trap did not display any bioluminescence during tests with the ICDeep blackbox. Bioluminescence was elicited from several amphipods during these tests. These amphipods will be sent to Dr. Tammy Horton (NOCS) for identification.

Dark trap

More specimens were captured in the northern stations compared to the southern stations. Mostly amphipods were collected at the SE, SW and NE stations. At the NW station the catch was roughly half amphipods (including a higher proportion of *Eurythenes gryllus* cf. the SE, SW and NE stations), half ostracods (mostly *Azygocypridina imperialis*)

SBE 39

Temperature and Pressure data was collected from ICDeep deployments 1-8. Data collected from deployments 7 stopped after ca. 40 mins and from deployment 8 after ca. 25 mins. The SBE failed during deployment 9. (Fig.4)

Analysis

Analysis of ICDeep data will consist of image analysis; time series counts of bioluminescent events with shape and size classification of events.

Specimens captured with the Dark trap will be identified by Dr. Tammy Horton (NOCS), including specimens identified as bioluminescent.

Frozen samples will be sent to Dr. Dan Mayor (Oceanlab) for ribosomal DNA studies of amphipods at depths above the Hadal zone (part of HADEEP project).

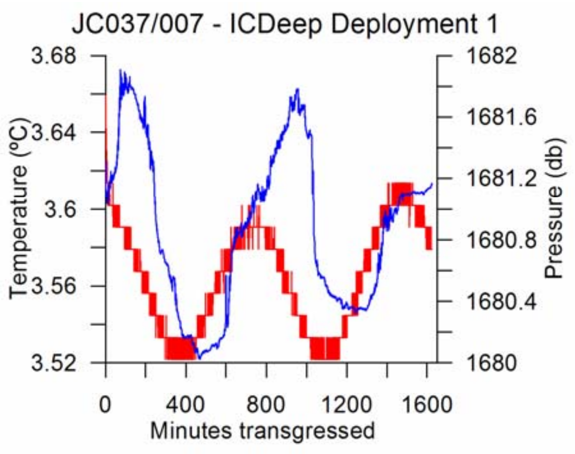
Future work

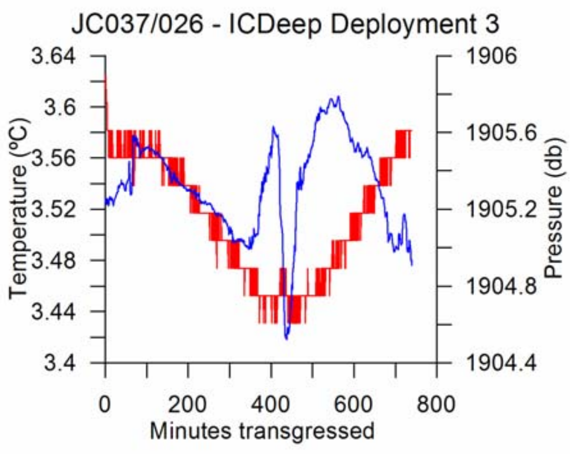
Further ICDeep lander deployments are planned during the 2010 ECOMAR cruise.

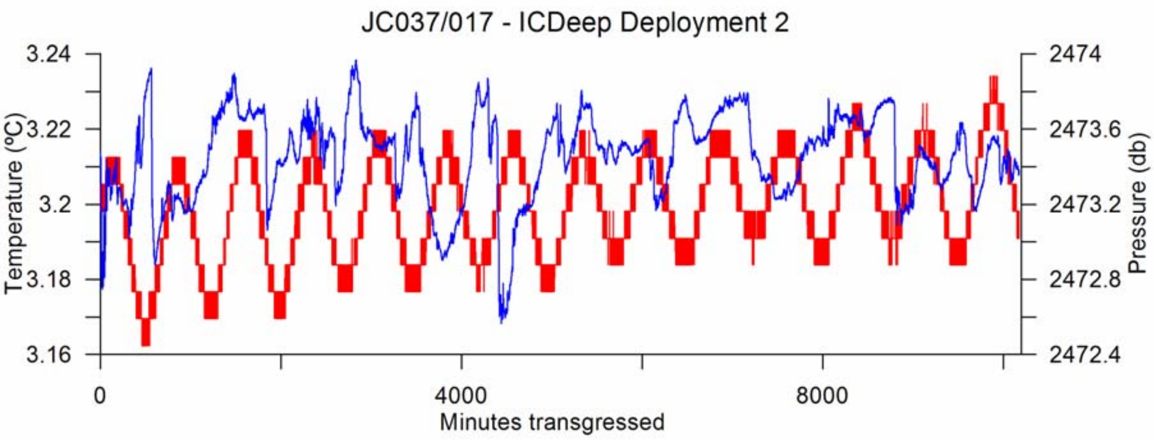
Dep.	Stn	Loc.	Lat.	Lon.	Depth (m)	Date (d/m/y)	Start time (h:m:s)	Total rec. time (h:m:s)	Dark trap catch	ICDeep blackbox	Storage (bottle numbers indicated)		
											4% Formalin	70% Ethanol	- 80 °C
1	7	SE	49° 02.271' N	27° 47.287' W	1707	07/08/09	16:07:11	23:00:00	Low	-		1	
2	17	SE	49° 01.495' N	27° 47.287' W	2474	10/08/09	15:33:18	23:00:00	Medium	-	4	3	2
3	26	SE	49° 02.189' N	27° 55.559' W	1697	17/08/09	23:18:28	10:30:00	Low	-	5		
4	36	SW	48° 45.026' N	28° 36.295' W	2446	20/08/09	21:45:20	00:10:00	Low	No BL		6,7	
5	43	SW	48° 43.938' N	28° 38.783' W	2637	22/08/09	06:20:14	02:30:00	Medium	No BL	9	8	
6	56	NW	53° 58.673' N	38° 06.092' W	2304	26/08/09	15:59:18	10:00:00	High	BL	**10,11,12, 13**,14		21
7	66	NW	53° 59.320' N	36° 08.119' W	2585	28/08/09	20:51:16	01:00:00	High	No BL	15		16
8	78	NE	53˚ 56.922' N	34˚ 03.369' W	2536	31/08/09	21:12:55	01:00:00	High	BL	**18,19**	17	
9	86	NE	54˚ 04.476' N	34˚ 09.799' W	2501	02/09/09	07:48:29	01:30:00	High	BL	21	**20**	

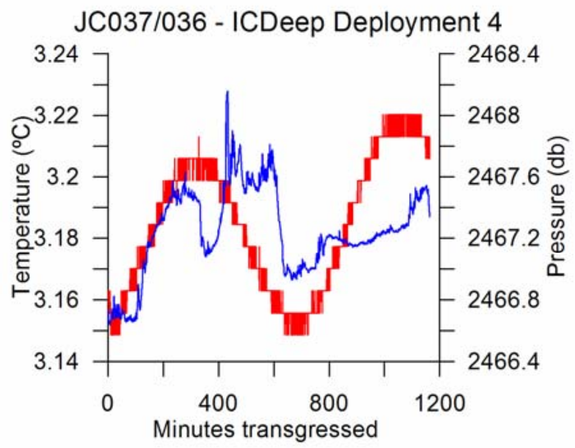
Table 1: ICDeep lander deployment summary table. Bold bottle numbers contain bioluminescent (BL) specimens.

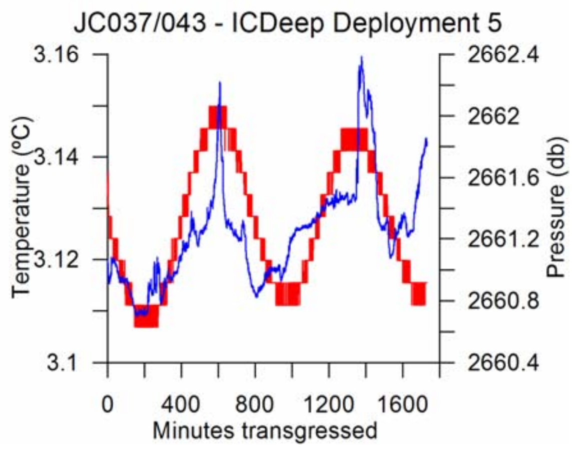
Figure 3 A, B) Example bioluminescent events and C) A deep-water eel observed during ICDeep lander deployment 1


JC037/007 - ICDeep Deployment 1
Temperature (ºC)
Pressure (db)
Minutes transgressed
3.68
3.64
3.6
3.56
3.52
1682
1681.6
1681.2
1680.8
1680.4
1680
0
400
800
1200
1600


JC037/026 - ICDeep Deployment 3
Temperature (ºC)
Pressure (db)
Minutes transgressed
3.64
3.6
3.56
3.52
3.48
3.44
3.4
1906
1905.6
1905.2
1904.8
1904.4
0
200
400
600
800


JC037/017 - ICDeep Deployment 2
Temperature (ºC)
Pressure (db)
Minutes transgressed
3.24
3.22
3.2
3.18
3.16
2474
2473.6
2473.2
2472.8
2472.4
0
4000
8000


JC037/036 - ICDeep Deployment 4
Temperature (ºC)
Pressure (db)
Minutes transgressed
3.24
3.22
3.2
3.18
3.16
3.14
2468.4
2468
2467.6
2467.2
2466.8
2466.4
0
400
800
1200


JC037/043 - ICDeep Deployment 5
Temperature (ºC)
Pressure (db)
Minutes transgressed
3.16
3.14
3.12
3.1
2662.4
2662
2661.6
2661.2
2660.8
2660.4
0
400
800
1200
1600

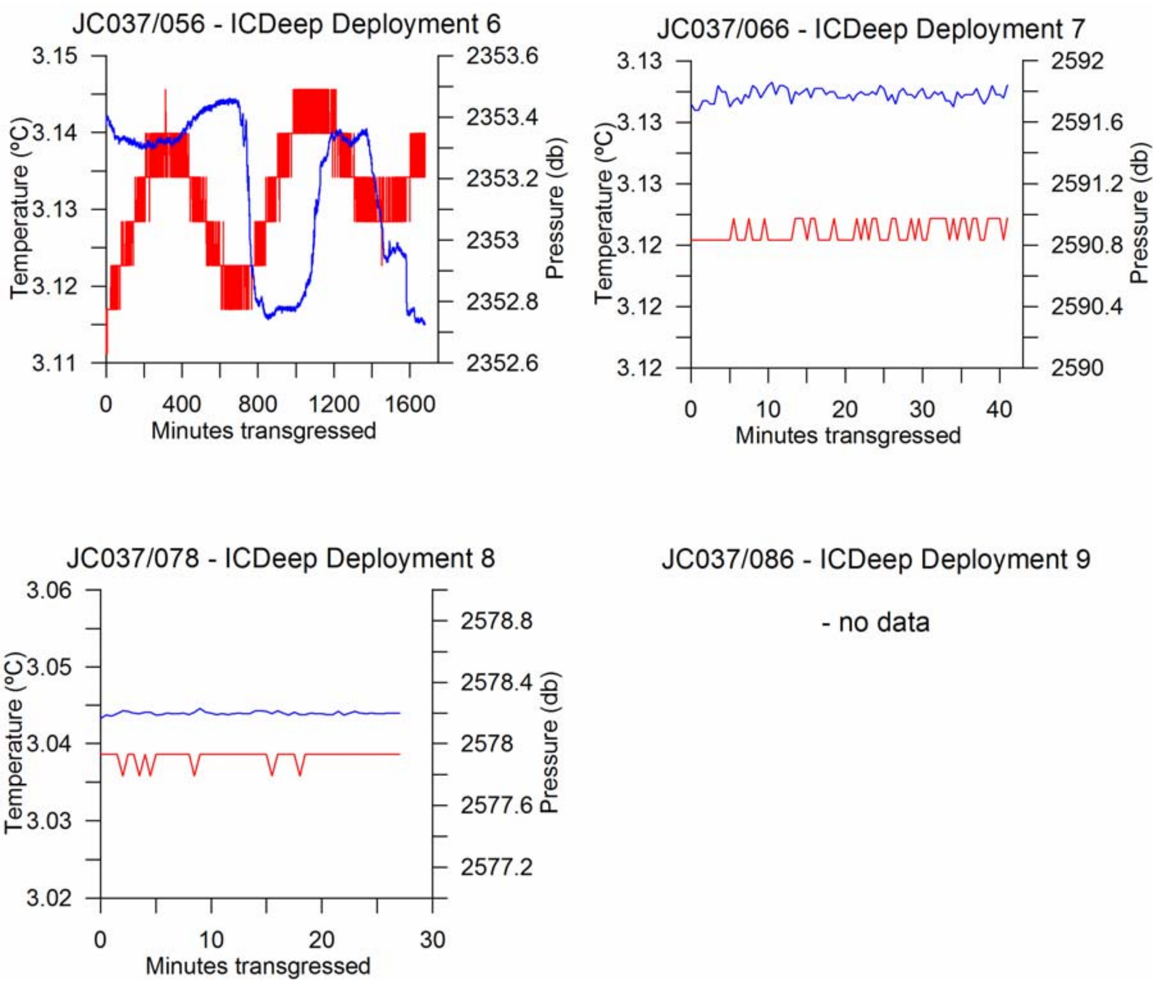


Figure 4 Temperature (˚C) and Pressure (dB) plots obtained from the SBE 39 on deployments 1-9 of the ICDeep lander.

16. Animals of the Deep Sea - Photography

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My aim as in 2007 was to record as many of the species which were collected both by midwater and benthic trawls. This was to provide a photographic database for MarEco and the Census of Marine Life and a source of material for outreach as well as scientific use. I selected the best specimens from the RMT samples and these were supplemented by requests by individuals of animals that I had missed or were considered interesting by other researchers. This principle also was applied to the benthic samples although they are notoriously more difficult due to damage to specimens and sediment contamination. Placing "dirty" specimens in tanks of clean water results in problems and cleaning sediment particles from animals with heavy mucus or sticky epidermal layers is very difficult. However, many specimens were photographed.

For this cruise we had the multiple RMT 1+8. Unlike the single net system we employed in 2007 this net has 3 RMT1 nets with 350µm mesh and 3 RMT8 nets of 4.5mm mesh. The former is collects planktonic organisms and the latter collects nekton. Having three nets means depth horizons can be fished sequentially and the target depths were 800-500m, 500-250m and 250m to the surface.

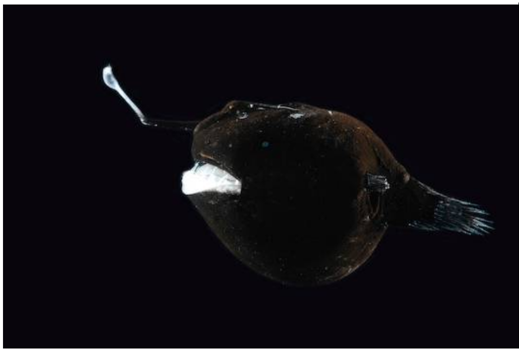
At the South Eastern station while the CTD was being employed a 1m ring net was lowered to 150 and hauled to the surface. This was done every 3 hours through a 24-hour period. It provided me with my first animals of the cruise and although considered common these animals were in good condition and in large numbers.

Pelagia noctiluca

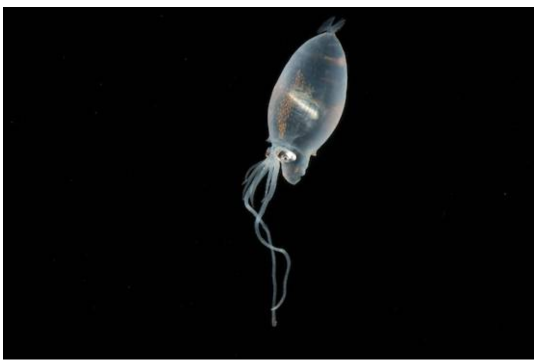
Pelagia noctiluca was abundant as were salps and the copepod *Saphirrina.* These are particularly challenging, as they are small and only visible in a sample when they catch the light. It is only the males that exhibit this colour show that is caused by the refraction of light from the guanine crystals in the body.


Salpa fusiformis *Saphirrina sp.*

We managed to fish one multi-RMT at the SE station and the sample from 800-500m provided me with some excellent specimens. A female angler fish *Chaenophyne sp.* a scopelarchid as yet to be identified and a piglet squid *Helicocranchia*.




Chaenophryne sp. Scopelarchid



Piglet squid *Helicocranchia sp.*

The almost totally transparent amphipod *Cystisoma sp.* the largest of the Hyperiid amphipods is found in deeper waters and is often associated with medusae. This one measured more than 60mm in length. The head is almost all eyes, the retinal pigment is the band of orange pigment at the anterior of the animal. The other orange area is the gut. Two perfectly undamaged and still living specimens of this strange amphipod *Cystisoma* were collected which were not only photographed in my tank but provided specimens for the kreisel tank for video footage. All these specimens in near perfect condition demonstrate the advantage of using the RMT as it does capture animals in very good condition.

In the shallower sample were some specimens of the carnivorous heteropod *Carinaria lamarcki* indicating that we were still in the warmer waters below the polar front.

These appeared again at the South West station and in greater numbers together with another heteropod *Atlanta peroni*.

Both species are predatory and this is the first time they have been collected by us at the Mid Atlantic Ridge.

Phronima sedentaria

I have to include a picture of the strange hyperiid amphipod *Phronima* in her barrel. It is not an uncommon amphipod but all the specimens that have been collected previously, have been without barrels. Again two in one sample complete with barrel and reluctant to be separated. This was one of the specimens on my ‘wish list’, another tick. We also collected specimens of the colonial tunicate *Pyrosoma* which is presumed to be the source of *Phronima’s* barrel. I am still intrigued as to how the transformation is carried out as all barrels seem to be of similar size with different sized apertures anteriorly and posteriorly.

The midwater cephalopod *Histioteuthis* was another of the SW station’s deeper specimens .

Eustomias tetranema a rare specimen of this fish previously known from the African area of the Atlantic

Neocyema erythrosoma

Turning to benthic samples, the most spectacular was a specimen of an orange fish which was identified as *Neocyema erythrosoma*. This was only the 5th specimen ever collected and will be deposited in the NHM. A paper in press by Shannon C. DeVaney Karsten E. Hartel, and Daphne E. Themelis published shortly after this cruise ended. describes the first North Atlantic specimens and this, as it is in such good condition will be a valuable specimen to complement the description. The amazing aspect of this is the fact that it was in near perfect condition and from the OTSB.

I will merely add a number of benthic specimens here as illustrations alone and leave description of sampling to my benthic colleagues.

Stalked barnacle *Echinosigra phiale*

A large Pterasterid starfish

Gephyrothuria sp.

Ostracods
Azygocypridina imperialis

Bathysaurus ferox

Beak and buccal mass of the squid *Gonatus steenstrupi.* The small white structures are spermatophores indicating that this female specimen has been mated

I have to thank my fellow scientists for allowing me first access to any and all specimens as they came on board.

From my point of view another successful and rewarding cruise.

Reference:

DeVaney S.C.,Hartel K.E. & Themelis D.E., (2009) The First Records of *Neocyema* (Teleostei: Saccopharyngiformes) in the Western North Atlantic with Comments on its Relationship to *Leptocephalus holti* Schmidt 1909. Northeastern Naturalist 16(3):409-414. 2009 doi: 10.1656/045.016.n308

17. Computing & Instrumentation Report

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NMF Platform Systems.

Navigation Systems

Applanix PosMV
This is the primary scientific positioning and attitude instrument, integrating two GPS receivers with a motion reference unit. Typical position accuracy, with differential corrections is around 1.5m. The system takes differential corrections from a Fugro Seastar 3510LR spotbeam receiver on the bridge.

This system performed well during the cruise, with no problems requiring any user intervention.

At the request of Applanix, special data logging was performed on the beamformer PC (on which the PosView software runs) for approximately 8 hours during a net tow, and this will be performed again once the vessel is alongside at Falmouth. This is to Allow Applanix (who we have a maintenance contract with) to assess the performance of the system, and evaluate what maintenance may be required.

Kongsberg-Seatex DPS-116
This is the primary positioning system for the vessel's DP system, consisting of a single GPS reciever and integrating this with an IALA (International Association of Lighthouse Authorities) receiver to receive differential corrections via MF. In addition to the IALA corrections, the system also receives corrections from the Fugro Seastar spotbeam receiver.

The system was supplied as part of the bridge navigation suite, but the Sonardyne engineers insisted on using it as the positioning system for the USBL, and it is also logged on the TECHSAS logging system.

The system seems to be based on quite old technology, and uses Microsoft Windows NT 4.0 (first released in August 1996, and no-longer supported by Microsoft as of 30th June 2004) as its operating system. The system needed multiple reboots during the cruise.

Kongsberg Seapath 200
This system was purchased to provide a backup to the Applanix PosMV after it was discovered that, although the PosMV position data was not used by the DP system, its attitude data was. If the Applanix PosMV system were to fail, the DP system would also be unusable.

The system is similar to the PosMV in that it integrates a pair of GPS receivers with a motion reference unit. The big difference between the PosMV and the Seapath 200, is that the Seapath 200 basically runs on PC type hardware, and runs under the Microsoft DOS operating system. One nice thing that this system can do is broadcast NMEA messages over the network via the UDP protocol, and this is how its data is logged on the TECHSAS system. These messages are available to any system on the network with software capable of receiving UDP broadcasts.

For the most part the system ran reliably, although it did need to be restarted on a few occasions. I am not sure if there is a power supply fault, but sometimes the unit will not start up immediately, if at all, when the power is turned on. I understand that Kongsberg engineers will be attending the vessel during the recert, and hopefully they can at least assess the condition of this unit.

Fugro Seastar Spotbeam Receiver
This system receives differential GPS corrections from a number of stations around the World, from a number of satellites. These corrections are supplied to the Applanix PosMV, Seatex DPS-116, Seapath 200 and (when fitted) to the Ashtech ADU-5.

The system ran, and supplied differential messages. At times it was set for AFSat (Africa) and at other times it was set for AMSat (America) or AORWH (Western Atlantic). No matter what satellite it was set to we seemed unable to get it to receive corrections from station 470, located in St Johns, Newfoundland. Our contact at Fugro said that we should be able to receive this station, but by the time we had this information we had already started heading back east. The one thing we did not get around to trying was a full factory reset of the receiver, which would have necessitated Fugro resending the subscription information to the receiver to enable it to receive the broadcasts.

Instrumentation Systems

Surfmet System (including Seabird 45 TSG)
This system is still in a state of development, and since the last ECOMAR cruise on RRS James Cook, much of the sea-surface instrumentation has been upgraded. The ancient FSI TSG and sea-surface temperature instruments have been replaced by a Seabird 45 TSG and a Seabird 38 temperature sensor. The transmissometer has also been replaced. As well as the hardware, the software is also in the middle of being changed, and this caused some confusion on my part as to which version to run. **Because of this, much of the data logged at the very start of the cruise, i.e. before 12:45:57 on day 217, should be disregarded.** This also required slight modifications to the TECHSAS logging module (provided by Chris Barnard).

The Seabird 45, although being successfully logged by the TECHSAS system, has yet to be integrated into the Surfmet display, so scientists at the beginning of the cruise were rather worried that we were not actually getting any sea surface temperature and salinity data. Hopefully new software will be installed during the recert period – I believe the system on RRS Discovery has been upgraded now.

The one Surfmet problem that was not resolved during the cruise was that of the humidity sensor, this was not replaced due to a mix of pressure of other work and the state of the weather at other times.

Dartcom HRPT System
The Dartcom HRPT system was only used to receive a few images at the beginning of the cruise, mainly to demonstrate the system to a scientist who's PhD involved remote sensing.

Sonardyne USBL System
This system was used to track the Megacorer down to the seabed. The system worked well using the Ranger software, only having two problems. The first problem was probably operating system related, where the computer running the ranger software froze. The second problem happened when the system only displayed relative offsets of the beacon from the vessel, rather than an absolute latitude, longitude and depth. The system claimed to be no-longer receiving position information from the DPS-116 positioning system. In both cases, rebooting the computer resolved the problem.

I would have preferred to use the Fusion software to track the Megacorer, as this would have allowed us to log its track down to the seabed with TECHSAS. Unfortunately I could not get the Fusion software to successfully track the beacon.

Air Sea II Gravity Meter
Although not required for this cruise, the Air Sea II gravity meter, S84, has been installed on RRS James Cook for some time, and has been routinely logged during cruises. Unfortunately the meter seems to have developed multiple faults during the previous cruise, and these were not noticed by the technician on board at the time. Some of the faults have been corrected during JC37, but the meter is still not operational at the moment, and a Microg-Lacoste technician will be attending the vessel in Falmouth during the recert.

Sonar Systems

EM-120
The deep-water multi-beam system was basically used for opportunistic swath, and to look for possible sites for OTSB trawls, whilst filling in holes in the data on the Oceanlab Olex system. No post processing of the data was done.

There does seem to be a problem with getting data from the sea-surface sound velocity probe at the moment. The limited amount of fault-finding that was done on this problem suggests that their may be a wiring problem somewhere, since no RS-232 signal was getting to the serial port on the EM-120 SIS computer where the signal is meant to arrive. There is a box that switches the transmit signal from EM-710 to EM-120, and that is probably where I would start looking for the fault, since the EM-710 does receive sea surface sound velocity – at least some of the time.

Whilst the data from the probe was unavailable on the EM-120, I manually put in a value for sea surface sound velocity obtained from the Seabird 45.

EM-710 (running in watercolumn mode)
This was the first time the EM-710 has been run in this mode, and their were a few issues that had to be solved before it worked properly.

Firstly there was a problem with the HASP key which is used to enable the water column logging. This would only work in one of the front panel USB ports, and I was concerned that it might get knocked by someone's leg. Thankfully this did not happen, and it has now been safely returned to the principal scientist!

The second issue was that of the file format in which the logged water column data were stored. Initially when we ran the system, it logged the water column data in a file with a .wcd extension, which the Echoview software used by Oceanlab was unable to read. After an E-mail exchange with Kongsberg, we managed to reconfigure the system, so that it stored the water column data as part of the .all files, which Echoview can read. For future reference, this is done by going into the Installation menu, then selecting the "PU Communication Setup" tab, then within that tab, the "Output Setup" tab. Within there is a box marked "Log watercolumn to seperate file". Make sure this is unchecked.

The final issue was an an area of apparent increased gain in the middle of the water column data. There was another exchange of E-mails with Kongsberg, and If I understand this correctly, this increased gain is caused by the echo sounder trying to search for the bottom. Kongsberg plan to implement a "Sonar mode" in a future release of SIS, but for the moment, the "bottom search mode" can be turned off in the following manner:

```
start/run/telnet 157.237.2.71
->scopemode=1
```

EK-60

This was my first cruise where the EK-60 had been used since the last ECOMAR cruise. Apparently there was one other EK60 cruise during in the intervening period.

Since the last ECOMAR cruise two major hardware changes have been implemented. Firstly, the EK-60 computer has had a significant upgrade. It was found found during the last ECOMAR cruise that the computer supplied by Kongsberg had insufficient processing power to maintain the ping rate required by science. This solved during the cruise by using an old HP desktop machine, but after the cruise a new Dell Poweredge 860 with a Quad-Core Xeon processor was purchased. As well as the increased processor power and RAM, this system had a larger 160GB SATA hard drive, and we immediately added a second hard drive, just to store the EK-60 data. The idea behind this was to avoid the problem on the first ECOMAR cruise of the data area filling up, and of having no choice but to remove data from the machine before the end of the cruise.

The second hardware upgrade was that of the ship's NTP clock system. The previous clock only had a single network port, and so could only be connected to the main ship LAN. A new NTP clock was purchased with four LAN ports, and one of these was routed to the Sonar LAN, which can be accessed by the EK-60 computer.

We initially had a major problem when trying to get the EK-60 running for the first time. None of the five GPTs would talk to the EK-60 computer. Since communication between the computer and the GPTs is via a dedicated network connection, initial suspicions were that a 3Com network switch had failed, but this was not the case. It turned out that merely power-cycling all the GPTs solved the problem. The GPTs had never been switched off between cruises. They will be switched off at the end of this cruise.

EA-600

This unit was run occasionally, but was either off or in passive mode for periods when either moorings were being ranged on or released, or when nets were being towed. Having the sounder in passive mode generates lots of erroneous data, which unfortunately were logged by the TECHSAS and Level C systems. Because no written logs were kept when the system was in passive mode it is difficult to work out what data are real, and which are not. If the sounder is not required, scientists and technicians should be encouraged to exit the EA-600's program rather than leave it in passive mode.

Sonar Synchronisation Unit

Prior to this cruise, Platform Systems had expended much time into trying to find an alternative to the synchronisation unit supplied with the ship. This even involved purchase of components to build a similar unit to that used on the G.O.Sars. Unfortunately the member of staff involved in the building of that unit left the organisation, and at the moment no-one else with the necessary skills has had the time to take the project on.

Some months ago (before cruise JC34T) we visited Sophie Fielding at the British Antarctic Survey to talk with her about the successes they had achieved with synchronising their EK-60 with ADCPs and other sonar sources on RRS James Clark Ross. They had done this by hand-editing the ssu initialisation file. We learned how to get this file off our system, via its FTP mode. Apparently BAS had made a copy of an unofficial Kongsberg document on modifying the initialisation file. After trying, and failing to get our SSU to use a modified initialisation file during JC34T, my impression is that the software installed on the unit installed on RRS James Clark Ross is slightly different from the unit on RRS James Cook.

Not long before the cruise we finally managed to get to Kongsberg Maritime's headquarters in Horten, Norway to attend a training course on the synchronisation units (both the current SSU, and the newer K-Sync unit). We had tried to get this course completed before JC34T, so that what we had learnt could be tried out at sea before JC37. Unfortunately this was not to be, and I was very worried that I would get to sea on JC37 and would not be able to get the SSU or K-Sync units to do what we needed them to do.

During the course Kongsberg insisted that the document that BAS had managed to obtain a copy of did not exist, hence my assumption that it must be an unofficial document used by installation/field service engineers.

The part of the course that dealt with the SSU gave me encouragement that we might well be able to configure the unit to do what we needed to do by using the units Config mode to set a fixed time delay for each sonar device, based on water depth/maximum range plus a small margin for processing time. This turned out to work reasonably well during the cruise.

There is one major problem with the SSU, and that is the hardware on which it is based. It is all very old ISA based PC technology, and no spares are available (apart from the compact-flash card). We jokingly said that we would take the unit they used for teaching home with us. We couldn't because apparently that is the last SSU Kongsberg had. If the SSU fails, we will have no choice but to replace it with a Kongsberg K-Sync unit.

I had mixed feelings about the K-Sync unit. It differs in many respects from the SSU. To me, it still looks very much a prototype system, and indeed Kongsberg have less than a dozen units installed on ships, and are unsure of how many units are seeing regular use. The worrying thing during the course was that the unit used for teaching was only dealing with simulated sonar devices, and only one of those devices (EA600) was a device in use on RRS James Cook.

We decided to try out a K-Sync unit for JC37, but when it arrived at Southampton it did look even more like a prototype unit than the unit in Norway had. It had also suffered damage during transit, despite being very well packed. Unfortunately most of Kongsberg's technicians were on holiday at the time the unit needed to be fitted, and so they were only able to send out a technician whose primary role was as an EM-710 specialist. He was unable to get the K-Sync running with the RRS James Cook's sonar systems, despite working very hard, and also contacting staff back in Norway. Attempts have been made during JC37 to obtain a written report as to why the K-Sync could not be made to work, but so far, no such report has been forthcoming. Bearing in mind the uncertainty over the longevity of the SSU, this is rather worrying.

AML Sound Velocity Profiler

This profiler has only recently returned from being recalibrated and serviced. Unfortunately I do not seem to have much luck with it. I am obviously doing something wrong, as I have yet to get this unit to record any data. It was used for one profile at the beginning of the cruise, in parallel with the Valeport unit, and as usual, no data was recorded.

Valeport Midas Sound Velocity Profiler

Platform Systems now have three of these very reliable profilers. They differ from the AML profilers in that they can only go down to 5000m, instead of 6000m, they use non-rechargeable alkaline batteries instead of rechargeable NiCd batteries, and they actually record data. Two profilers were on board, one of which had just returned from servicing, and this is the one that was used.

The only thing to be aware of with these profilers is that if the red LED flashes, rather than stays on for 15 seconds when the sea plug is inserted to power the profiler, then the plug must be withdrawn and re-inserted, or no data will be recorded.

Computer Systems

TECHSAS Primary Logger

There were problems right at the beginning of the cruise caused by the system losing track of its time zone. This was observed shortly before the boat drill on the day of sailing. The system uses a rather old version of Linux because of the need to maintain compatibility with the PCI serial cards in use. Because of the old version of Linux, proper setting of the time zone to GMT without daylight saving time, involves diving into the Linux command line. I had not needed to sort out time zone problems on these systems for some years, but thanks to the Internet access we enjoy on RRS James Cook, I was able to find the solution in a few minutes, and the timezone was correctly set. It should be noted that data files on the Level C were corrected after this, using the Level C modtime program. We do not have a procedure for changing the timestamp on the TECHSAS NetCDF files, and these are still incorrect for this day.

On 5th of August it was noticed that the TECHSAS module used to log position data from the Applanix PosMV had crashed, and had in fact been down for over two days. Thankfully the other two GPS systems (DPS-116 and Seapath 200) continued to be logged, so we do have continuous navigation.

On 15th August the sea surface sensors were cleaned, and during this power was removed from the Seabird 45. On powering up the system after the cleaning, the SBE45 logging module crashed. Not sure why, but it was restarted without incident, and logging resumed.

Level C Data Processing system

The Level C program bestnav was used to generate the best navigation by combining data from gyro, EM log, and three GPS receivers.

The Windcalc program was used to generate absolute wind speeds.

The interactive data editor was used for “first looks” at a number of data, including winch data and EA-600 data, which had a lot of erroneous data flagged out.

Finally towards the end of the cruise GMT was used to generate an A4 cruise track.

The Level C system did crash once on the 17th August, not sure why, but the interactive data editor was in use at the time, and it is one of our more resource-hungry applications. The system was rebooted, and this resulted in an eight minute gap in the Level C data streams.

ICDEEP Lander Assistance

After an attempt at a normal data recovery failed, after a routing deployment, the computer pressure housing was opened in order to gain physical access to the computer. A monitor, keyboard and mouse were connected directly to the unit, which was then powered up.

It seemed that Windows was unable to boot because one or more of its system files had been corrupted or deleted. The system was booted from a USB flash drive, containing a version of the Ubuntu Linux operating system. Once booted, the Windows hard drive was mounted up, giving access to the ICDEEP data files. An external USB hard drive was connected, and the files for the previous deployment were copied off. An attempt was then made to replace some of the system files that Windows was complaining about. Unfortunately, although the system files copied across okay, it still refused to boot, and a decision was made to rebuild the system from scratch, starting from a fresh installation of Windows XP SP3.

Phil Bagley at Oceanlab was contacted and managed to make the necessary application software available to us partly via E-mail and partly via some strange method that only Martin Cox fully understands! The software was sufficiently large, that a decision was made to disconnect the main ship LAN from the Firewall and give all available bandwidth to the download of the ICDEEP software.

Eventually after a couple of false starts, the system went into the water again, but the resulting video contained jumps and there were problems with the gain control on the image intensifier. The gain control problem was quickly overcome, but the video jumps continued to be a problem. What was not considered at the time, and may have helped was to connect the system to the Internet and allow it to get the latest Windows updates, these may have included updates to the video codecs used by the recording process.

Appendix 1

Station List - *RRS James Cook* Cruise No . 037 August-September 2009 ECOMAR

Station No.	Date	Time GMT	Latitude	Longitude	Gear	Depth (m)	Remarks
001	3 Aug	0149 0055	51°38.24'N	09°39.92'W	SVP	35	Sound velocity profile in Bantry Bay, Ireland prior to EK60 calibration.
002	5 Aug	1057 1340	49°33.92'N	17°43.11'W	CTD Cast 1	3000	CTD lowered with releases strapped on for tests. Water was collected for sediment traps
003	5 Aug	1505 1755	49°34.32'N	17°54.11'W	CTD Cast 2	3000	CTD lowered with releases strapped on for tests. Water was collected for sediment traps
004	7 Aug	1118 1352	49°02.06'N	27°41.93'W	CTD Cast 3 + Optics rig	2600	Full depth CTD plus the optics rig was cast twice over the starboard side by the stern crane
005	7 Aug 18 Aug	1427 1835	49°02.03'N 49°01.91'*	27°41.93'W 27°41.97' *	Thermistor chain	2600	Deployed on a ridge at the same site as the previous CTD. *Accurate location by triangulation
006	7 Aug 10 Aug	1525 1419	49°01.87'N 49°01.65' *	27°42.07'W 27°42.20' *	PAL Lander	2546	Deployed as part of an experiment with JC037/05, with an ADCP and CTD. *Accurate location by triangulation
007	7 Aug 8 Aug	1629 2101	49°01.89'N	27°47.29'W	ICDeep Lander	1701	Very little in the traps but good video of fishes and bioluminescent events
008	7 Aug	2125h	49°02.60'N	27°43.48'W	SE Mooring	2500	Redeployed for recovery in summer 2010. Some sample tubes on the lower trap were very full from spring 2009
009	7 Aug 8 Aug	2311 0044	49°05.39'N	27°50.24'W	Megacorer	2720	Full set of 8 cores retrieved
010	8 Aug	0248 0534	49°05.40'N	27°50.22'W	Megacorer	2720	Full set of 8 cores retrieved
011	8 Aug	0603 0840	49°05.40'N	27°50.22'W	Megacorer	2720	Full set of 8 cores retrieved
012	8 Aug	0913 1917	49°06.00'N 49°06.00'N	27°47.75'W 27°37.40'W	EK60 + EM710		Grid of 10 x 10 nautical mile parallel lines in the NS direction over the sediment trap station. Two sonars synchronised

013	8 Aug 10 Aug	2235 1718	49°02.00'N	27°43.44'W	Amphipod trap	2501	Reasonable catch of amphipods.
014	8 Aug 9 Aug	2334 2350	49°01.71'N	27°42.22'W	Yoyo CTD Cast 4 +Ring net	2611	24h Yoyo CTD between the sea floor and 2000m depth (wire out) experiment with Stas. 5 & 6. Good data throughout
014 #1	9 Aug	0153 0221	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m. Catch rich in phytoplankton
014 #2	9 Aug	0439 0502	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m.
014 #3	9 Aug	0801 0820	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m. Captured jelly fish that are abundant on the surface.
014 #4	9 Aug	1050 1111	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m. Small catch including a ctenophore
014 #5	9 Aug	1350 1412	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m.
014 #6	9 Aug	1648 1711	49°01.71'N	27°42.22'W	Ring net Cast	150	Change in the catch compared with previous casts with many salps and spectacular *Saphirina* spp. harpacticoid copepods.
014 #7	9 Aug	1947 2018	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m. Catch included salps and ctenophores
014 #8	9 Aug	2247 2305	49°01.71'N	27°42.22'W	Ring net Cast	150	Ring net vertical tow from 150m. Catch with euphausids and salps, few medusae
015	10 Aug	0114 0709	48°58.73'N 49°11.14'N	27°51.01'W 27°49.17'W	OTSB	2700	Trawl at the SE station. Net apparently on the bottom for a short time but good catch with large *Spectrunculus grandis*
016	10 Aug	1045 1145	49°01.9'N	27°42.1'W	CTD Cast 5+ Optics	200	A shallow CTD cast plus the optics rig simultaneously,
017	10 Aug 17 Aug	1542 1928	49°01.50'N	27°43.50'W	ICDeep Lander	2467	2nd of ICDeep with dark traps for crustacea

018	10 Aug 17 Aug	1920 2108	49°01.2'N	27°42.03'W	Amphipod Trap	2500	Modest catch including a gastropod
019	10 Aug 11 Aug	2356 0655	48°58.05'N 49°14.36'N	27°51. 6'W 27°49.29'W	OTSB	2700	Parallel track slightly to the west of the previous trawl. Better catch of invertebrates.
20	11 Aug	0957	49°02.02'N	27°41.97'W	CTD Cast 6+ Optics	200	Overcast foggy conditions.
21	11 Aug 17 Aug	1132 0749	49°02.24'N 49°01.91'*	27°41.49'W 27°42.27'*	PAL Lander	2546	2nd deployment near the thermistor array. *Accurate location by triangulation
22	17 Aug	0550 0652	49°01.40'N 49°01.42'N	27°40.65'W 27°43.34'W	Acoustic ranging		Acoustic ranging from three trig points to the PAL lander (JC037/021) and the thermistor chain (JC037/05)
23	17 Aug	0958 1546	49°05.36'N 48°57.11'N	27°34.61'W 27°52.33'W	RMT8+1	800	RMT tow at the SE Station. Captured vast quantities of salps in the shallowest net.
24	17 Aug	1620 1707	48°56.98'N	27°51.59'W	CTD Cast 7 + Optics	200	Casts at the end of the RMT tow
25	17 Aug 18 Aug	2311 1520	49°02.23'N	27°53.66'W	Amphipod Trap	1830	On top of a ridge at the SE station. Very small catch
26	17 Aug 18 Aug	2351 1352	49°02.19'N	27°55'56'W	ICDeep Lander	1697	Aimed at the top of a mound but clearly landed deeper on the slope to the south
27	18 Aug	0104 0738	48°57.34'N 49°13.55'N	27°49.83'W 27°50.92'W	OTSB	2700	Net ploughed deep, came up very muddy but with a good catch
28	18 Aug	1019 2033	49°01.32'N	27°42.98'W	PAL Lander	2504	A short deployment of PAL curtailed by cessation of work at the SE station.
29	18 Aug	1050 1115	48°56.98'N	27°51.59'W	CTD Cast 8	200	Weather too rough for optics rig so only the shallow CTD was completed
30	19 Aug 20 Aug	2207 0121	48°45.76'N	28°38.52'W	Megacorer	2562	1st Megacorer at SW station. 8 good cores. Brown layer in some tubes.
31	20 Aug	0114 0423	48°45.76'N	28°38.52'W	Megacorer	2562	2nd megacorer at the same site but disappointing results with short cores.

32	20 Aug	0614 0845	48°46.33’N	28°38.45’W	CTD Cast 9 + Optics	2529	CTD to full depth near the SW mooring site. The thermistor chain (JC037/005) was attached for calibration
33	20 Aug	1340	48°46.82’N	28°38.50’W	SW Mooring	2500	SW mooring deployed for recovery in 2010
34	20 Aug	1442 1711	48°45.76’N	28°38.46’W	Megacore	2555	6 good but short cores
35	20 Aug	1744 2051	48°45.76’N	28°38.46’W	Megacore	2555	8 good long cores with thick phytodetritus on some. Conclusion of megacoring at the SW site
36	20 Aug 21 Aug	2118 1842	48°44.24’N	28°37.32’W	PAL Lander	2505	1st PAL deployment at the SW station
37	20 Aug 21 Aug	2159 1938	48°45.03’N	28°38.30’W	ICDeep Lander	2450	Deployed to east of SW the mooring site
38	20 Aug 23 Aug	2222 0836	48°45.76’N	28°38.46’W	Amphipod Trap	2440	Deployed east of the SW mooring site. The lower trap on the frame has fallen off, only 6 amphipods caught.
39	20 Aug 21 Aug	2312 0453	48°43.17’N 48°53.48’N	28°36.27’W 28°48.88’W	RMT 8+1	800	A night-time tow of the RMT with EK60 data collected simultaneously.
40	21 Aug	0730 0821	48°45.00’N	28°38.00’W	CTD Cast 10 + Optics	200	Morning cast, cloudy with driving rain.
41	21 Aug	0915 1436	48°44.15’N 48°52.74’N	28°36.71’W 28°47.69’N	RMT 8+1	800	Day-time tow of the RMT with EK60
42	21 Aug 22 Aug	2300 0400	48°37.40’N 48°29.73’N	28°28.10’W 28°23.96’W	EM120 Bathymetry	2000-3000	New mapping to the south of the SW station in a vain search for trawlable ground.
43	22 Aug 23 Aug	0631 1344	48°43.94’N	28°38.78’W	ICdeep Lander	2631	Deployed on flat area south of the megacoring site.
44	22 Aug 23 Aug	0712 1125	48°44.84’N	28°38.78’W	PAL Lander	2601	Lander deployed north of the ICDeep on a flat plain

45	22 Aug	0813 0845	48°44.82'N	28°38.87'W	CTD Cast 11 + Optics	200	In morning bright sunshine
46	22 Aug	1020 2006	48°42.85'N	28°45.83'W	EK60 + EM710		Eight 10 mile runs completed of a 10x10 grid. Vessel across the seas 30 knot winds.
47	22 Aug 23 Aug	2308 0540	48°44.88'N 48°49.52'N	28°39.09'W 28°57.33'W	RMT 8+1 + EK60	1000	Net fished deeper owing to rough weather. Small catch.
48	23 Aug	0950 1026	48°45.24'N	28°38.68'W	CTD Cast 12	200	Shallow CTD cast, weather too rough to perform an optics cast.
49	23 Aug	1509 1720	48°46.77'N 48°46.40'N	28°31.88'W 28°30.10'W	EK60 + EM710		Completion of the last two tracks of the 10x10 grid at the SW station (see JC037/46)
50	24 Aug	0829 0907	51°05.53'N	29°34.34'W	CTD Cast 13 + Optics	200	Casts aimed at the chlorophyll maximum when the vessel crossed the sub-polar front.
51	25 Aug	1614 2129	53°59.34'N	36°07.71'W	CTD Cast 14 + Optics	2521	First samples at the NW station. The CTD was delayed so was not synchronised with the optics
52	25 Aug 27Aug	2152 0905	53°59.32'N	36°08.12'W	Amphipod Trap	2570	First deployment of the trap NW Station. Large catch of ostracods and amphipods.
53	25 Aug 27 Aug	2230 1020	53°58.38'N	36°07.73'W	PAL Lander	2559	First deployment of PAL at the NW Station
54	26 Aug	0108 0311	54°09.56'N	36°11.27'W	EM120 Swath	2000- 3000	Extension of bathymetry at the NW station. A new trawl track was identified.
55	26 Aug	1459	53°59.34'N	36°07.38'W	NW Mooring	2504	Mooring deployed on position of the previous moorings at this site. To be recovered in 2010
56	26 Aug 27 Aug	1632 2240	53°58.67'N	36°06.09'W	ICDeep Lander	2339	First deployment of the ICDeep at the NW Station. Many ostracods caught in the traps.
57	26 Aug	1704 1930	53°59.11'N 53°59.46'N	36°07.27'W 36°06.71'W	EK60 EM710		First part of the pelagic acoustic survey at the NW Station. 2 lines completed

58	27 Aug	1125 1158	53°58.23'N	36°07.73'W	CTD Cast 15	200	Shallow cast for primary production studies. Seas too rough for the optics rig.
59	27 Aug	1246	53°59.49'	36°08.14'W	EK60 EM710		Second part of the pelagic acoustic survey at the NW station, 7 lines completed
60	27 Aug 30 Aug	2143 1115	53°58.46'N	36°06.12'W	Amphipod Trap	2340	Excellent catch of amphipods, ostracods and other crustacea.
61	28 Aug	0213 0837	54°19.62'N 54°04.96'N	36°00.87'W 36°07.98'W	OTSB	2600 2620	A good catch of fish (*Antimora rostrata*) and pycnogonids. Net covered with fibrous *Rhizammina algaeformis*.
62	28 Aug 30 Aug	1020 0900	53°58.40'N	36°08.22'W	PAL Lander	2513	Near the NW mooring site.
63	28 Aug	1032 1112	53°58.33'N	36°08.17'W	CTD Cast 16 + Optics	200	First calm day at the NW site enabled simultaneous Optics and CTD
64	28 Aug	1154 1812	53°58.21'N 53°46.46'N	36°14.49'W 36°10.50'W	RMT 8 + 1	800	Towed towards south. Flow meter failed. Excellent catch. Isopods, chaetognaths
65	28 Aug	1914 2011	53°51.54'N 53°58.53'N	36°11.52'W 36°04.62'W	EK60 EM710		Last line of the NW Station pelagic acoustic survey completed.
66	28 Aug 30 Aug	2058 0843	53°59.33'N	36°08.13'W	ICDeep Lander	2560	Deployed on the site vacated by the amphipod trap, JC037/052. Traps full of ostracods and other crustacean.
67	28 Aug 29 Aug	2348 1019	54°19.50'N 54°06.55'N	36°01.11'W 36°07.14'W	OTSB	2600 2620	Wire jumped of 'A' frame sheave at start of hauling. Vessel backed and lifted net full of mud, good catch.
68	29 Aug	1312 1414	54°03.77'N	36°07.82'W	CTD Cast 17 + Optics	200	Casts in sunshine and partially clouded sky.
69	29 Aug	1455 2000	54°03.49'N 53°54.29'N	36°08.03'W 36°18.60'W	RMT 8+1	800	Nets failed to open. Just a few organisms captured
70	29 Aug 30 Aug	2359 0630	54°19.23'N 54°03.65'N	36°01.17'W 36°08.42'W	OTSB	2600 2620	Third trawl along the same track on the NW Station. A clean catch with many fish.

71	30 Aug 31 Aug	1303 0506	53°56.94'N 54°00.03'N	36°06.29'W 34°57.06'W	EK60		Monitoring during the transit from the NW to NE Station. Total distance 75 miles with stops for CTDs.
72	30 Aug	1748 2000	54°00.03'N	34°57.06'W	CTD Cast 18 + Optics	1336	Deep CTD on the eastern crest of the ridge together with optics rig.
73	30 Aug	2145 2339	53°59.87'N	34°36.92'W	CTD Cast 19	2041	Deep CTD on the eastern flank of the ridge.
74	30 Aug 31 Aug	0237 0502	54°01.12'N	34°10.62'W	CTD Cast 20	2484	CTD at the NE station near the mooring site.
75	31 Aug	0805 1937	54°01.90'N 54°00.65'N	34°11.12'W 33°59.71'W	EK60 EM710		Acoustic survey at the NE station. 10 x 8 nautical mile grid
76	31 Aug 1 Sep	2016 1824	53°58.94'N	34°02.94'W	Amphipod Trap	2552	Deployed near the NE Station OTSB trawl track, A very rich catch of amphipods, distinct from the NW station.
77	31 Aug 1 Sep	2053 2009	53°57.97'N	34°03.19'W	PAL Lander	2535	Deployed near the NE Station OTSB trawl track
78	31 Aug 1 Sep	2123 2222	53°56.93'N	34°03.37'W	ICDeep Lander	2536	Deployed near the NE Station OTSB trawl track. Rich catch of crustacea.
79	31 Aug 1 Sep	2327	54°03.60'N 53°57.69'N	33°58.84'W 34°00.55'W	OTSB	2440	Trawl aborted owing to wire jumping off the 'A' frame block sheave. 7 near-bottom fish captured
80	1 Sep	0510 0736	54°06.65'N	34°10.42'W	Megacorer	2486	5 successful core tubes at the JC011 core site
81	1 Sep	1502	54°00.05'N	34°10.58'W	NE Mooring		Mooring deployed in calm conditions for recovery in 2010.
82	1 Sep	1558 1641	54°00.12'N	34°10.65'W	CTD Cast 21 + Optics	200	Casts at the NE mooring site.
83	2 Sep 3 Sep	0002 0823	54°02.31'N	34°09.54'W	Amphitrap	2452	A big catch of amphipods.

84	2 Sep	0042 0311	54°00.64'N	34°10.41'W	Megacorer	2493	5 core tubes retrieved samples
85	2 Sep	0337 0605	54°00.65'N	34°10.42'W	Megacorer	2493	7 core tubes retrieved samples
86	2 Sep	0756 2345	54°04.49'N	34°09.84'W	ICDeep Lander	2501	ICDeep on plain near NE Mooring
87	2 Sep 3 Sep	0850 0851	54°03.37'N	34°09.47'W	PAL Lander	2479	Replication of location from JC011 at the NE station
88	2 Sep	0912 0950	54°03.40'N	34°09.56'W	CTD Cast 22 + Optics	200	Cast near the NE mooring site
89	2 Sep	1051 1612	54°04.88'N 54°02.59'N	34°01.88'W 34°22.69'W	RMT 8 + 1	800	RMT tow at the NE site with the net trigger mechanism repaired. Modest Low diversity catch.
90	2 Sep	1722 2049	54°04.48'N 54°09.98'N	34°13.03'W 34°21.72'W	RMT 8 + 1	800	Second RMT tow at the NE site. Catch similar to JC037/089.
91	3 Sep	0111 0339	54°00.67'N	34°10.42'W	Megacorer	2493	A full set of 8 cores was recovered.
92	3 Sep	0956 1045	54°03.17'N	34°09.65'W	CTD Cast 23 + Optics	200	Final station of the cruise.

NB: Trawl depths are maximum and minimum depths for each tow. Deployment and recovery positions are given.
For landers, times are flag sinking times and surface times.

Appendix 2:
RRS James Cook JC037 pre-survey
EK60 scientific echosounder calibration report

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1 Summary

The *RRS James Cook* EK60 pre-cruise (JC037) calibration exercise was performed in Bantry Bay (51°38.24'N 009°39.96'W) on 3rd August 2009, using a 38.1 mm tungsten carbide sphere. Calibration was successfully completed on all frequencies: 18, 38, 70, 120 and 200 kHz using LOBE v2.1.0.11 (Simrad, Norway). Post-processed calibration transducer parameter estimates were also obtained for all frequencies using LOBE and Echoview v4.60 (SonarData, Tasmania). Echosounder parameters obtained during this calibration are comparable with those of the JC011 EK60 calibrations.

2 Materials and Methods

Bantry Bay (51°38.24'N 009°39.96'W; water depth under V/L keel = 38 m) was selected to perform the calibration exercise on the permanently installed *RRS James Cook* EK60 scientific echosounders (18, 38, 70, 120 and 200 kHz). Calibration commenced at 0130 GMT 3rd August 2009 and was completed at 0749 GMT.

A CTD cast was performed prior to observing the calibration sphere. The results of this were used to calculate the speed of sound which was entered into the EK60 software and to calculate the theoretical target strength of the calibration sphere.

Three calibration winches were set up at locations described in the JC011 pre-cruise calibration report. The fishing line lengths for each of the winches are given in Table 1, with the lengths measured from the fishing in front of the winch drum to the calibration sphere. **Note**: the line length for the port winches may require adjustment 3 m in either direction to locate the sphere on the 18 kHz beam axis. The weight shackle (mass: 0.95 kg) was suspended 3.2 m (> 2 pulse lengths) below the sphere.

Winch location	Calibration line length (m)
Starboard forward	38.20
Starboard aft	35.00
Port	34.90

Table 1: Line lengths for each of the winches during the Bantry Bay calibration exercise. Lengths were measured from the British Antarctic Survey (BAS) calibration rig winch drum on the calibration winch to the sphere. With the drop-keel fully lowered this gave a transducer to calibration sphere range of approximately 14 m, outside of the transducer near fields (Table 2).

The starboard drop keel was lowered to the survey position (fully lowered, approximately 2.8 m into the water) after the calibration lines had been rigged and the sphere located.

Frequency (kHz)	diameter (m)	near field range (m)
18	0.625	9.38
38	0.48	11.67
70	0.28	7.32
120	0.18	5.18
200	0.12	3.84

Table 2: Transducer nearfield ranges (r_{opt}, m) approximated from $r_{opt} = 2df_0 / c$, where d is the diameter of transducer, frequency (f_0), and c= 1502.7 m/s. The calibration sphere was positioned at ranges greater than r_{opt}.

The beam pattern of each frequency was mapped, and 20 min of on-axis calibration single target sphere observations were collected. Initial calibration parameter estimates for all frequencies (18, 38, 70, 120 and 200 kHz) were obtained using Simrad LOBE immediately after the sphere observations. All calibration data were replayed in the Simrad EK60 software to obtain post-processed calibration parameter estimates for all frequencies. Additionally, post-processed estimates for S_v gain and s_A correction were obtained using Echoview v4.60 (SonarData, Tasmania).

3 Results

3.1 CTD observations

A sound velocity profile was performed 0100 GMT. The mean sound speed (Table 3) was used to determine the theoretical target strength of the calibration sphere and in the EK60 software (environmental parameters).

Parameter	Mean
Temperature	13.9 ^{o}C
Sound speed	1502.7 m/s

Table 3: Mean CTD observations and calculated sound speed, from 8 m to 30 m water depth for the Bantry Bay calibration site.

3.2 Calibration sphere theoretical target strength

The mean sound speed (c = 1502.7 m/s) was entered into the EK60 software and used to estimate the theoretical target strength of the tungsten-carbide calibration sphere (Table 4).

Frequency (kHz)	Target strength (dB m^{-1})
18	-42.60
38	-42.42
70	-41.47
120	-39.54
200	-39.01

Table 4: Theoretical target strength of the 38.1 mm tungsten carbide sphere given *c*= 1502.7 m/s. Calculations performed using MATLAB code provided by David Demer of the Advanced Survey Technology Division, Southwest Fisheries Science Center, USA.

3.3 Calibration parameter estimates

The optimum post-processed transducer calibration estimates (Table 6) are a combination of LOBE and Echoview estimates (transducer gain and s_A correction calculated using Echoview given in square brackets). Note Echoview on-axis echosounder calibration parameter estimates should be used in place of LOBE estimates.

Freq		kHz	18	38	70	120	200
Model			ES18-11	ES38-B	ES70-7C	ES120-7C	ES200-7C
Mean range to calibration sphere[a]		M	15.1	14.5	13.6	14.8	14.8
Gain		dB	23.02 [21.84]	23.87 [23.56]	26.79 [26.70]	26.29 [26.23]	26.79 [25.00]
s_A Corr		dB	-0.75 [-1.19]	-0.52 [-0.78]	-0.4 [-0.56]	-0.39 [-0.08]	0.40 [-0.18]
2-way beam angle		dB	-17.3	-21	-21	-20.9	-20.90
Angle sensitivity	Along	Deg	13.9	21.9	23.0	23.0	23.0
	Athwart	Deg	13.9	21.9	23.0	23.0	23.0
Angle offset	Along	Deg	-0.05	-0.04	-0.03	0.03	0.0
	Athwart	Deg	0.00	-0.1	0.0	-0.06	0.03
3dB beamwidth	Along	Deg	11.39	7.16	6.48	6.45	6.48
	Athwart	Deg	11.25	7.29	6.47	6.53	6.47
Power		W	2000	2000	1000	1000	1000
Pulse length	(us)	micro S	1024	1024	1024	1024	1024
Alpha	(dB/km)	dB / km	2.27	8.79	23.22	43.58	64.88
Bandwidth		kHz	1.57	2.43	2.86	3.03	3.09
serial numbers	transducer		2067	30637	130	345	313
	GPT		102-203321	102-202585	102-202586	102-202587	102-202588

Table 6: Calibration parameter estimates for the *RRS James Cook* EK60 system determined by post-processing the Bantry Bay calibration exercise observations using LOBE (Simrad) and Echoview (SonarData, Tasmania) given in square brackets. [a]range to sphere with starboard drop keel lowered.

4 Discussion

For the duration of the calibration exercise the *RRS James Cook* was kept on station using dynamic positioning. With the drop keel lowered we detected no increase in background noise during the calibration exercise (thrusters operating at 10% power).

Weather conditions during the calibration were acceptable (wind direction SW, 12 knots). However, the weather deteriorated during the 200 kHz calibration, which may have degraded the 200 kHz calibration results.

4.1 EK-60 system stability

The difference between the Brodick Bay minus the Bantry Bay calibration estimates for gain (dB) and s_A correction (dB) are given in Table 7.

Frequency (kHz)	δGain (dB) 2007 Brodick Bay - 2007 Bantry Bay	δGain (dB) 2007 Brodick Bay - **2009** Bantry Bay	δs_A correction (dB) 2007 Brodick Bay - 2007 Bantry Bay	δs_A correction (dB) 2007 Brodick Bay - **2009** Bantry Bay
18	0.28	*-1.38*	*-1.10*	0.0
38	0.51	-0.31	-0.33	-0.18
70	0.84	-0.07	-0.02	-0.16
120	-0.04	0.07	0.09	+0.55
200	-0.28	0.14	-0.10	+0.2

Table 7: Difference (δ, 2007 Brodick Bay- 2007 Bantry Bay)
and (δ, 2007 Brodick Bay- 2009 Bantry Bay) calibration parameter estimates.

During the Uggdalseidet, Norway, July 2006 calibration the 18 kHz system s_A correction = -0.73 dB, whereas the July 2007 Bantry Bay calibration 18 kHz s_A correction = -0.27 dB. During this 2009 Bantry Bay the variability in 18 kHz echosounder calibration parameters occurred in the gain and s_A correction with a δgain of -1.38 dB from the 2007 Brodick Bay (JC011) calibration. This result requires further investigation.

Appendix 3. Swath Bathymetry

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The work of the cruise was based on bathymetric data collected previously during cruise JC011 using the Kongsberg EM120 system displayed on an OLEX system carried on a lap-top PC owned by the University of Aberdeen. This provides a convenient method for cruise planning, plotting and recording. The ability to carry all the data to Aberdeen and use it off-line is very valuable.

During JC037 small additions were made to the areas surveyed during JC011. Limited time and weather constraints did not permit filling in of gaps in the surveys. This will be done if time permits on JC048 in 2010.

Table 1. Bathymetry surveys done during JC037

Station No.	Date	Time GMT	Latitude	Longitude	Gear	Depth (m)	Remarks
42	21 Aug 22 Aug	2300 0400	48°37.40'N 48°29.73'N	28°28.10'W 28°23.96'W	EM120 Bathymetry	2000-3000	New mapping to the south of the SW station in a vain search for trawlable ground.
54	26 Aug	0108 0311	54°09.56'N	36°11.27'W	EM120 Swath	2000-3000	Extension of bathymetry at the NW station. A new trawl track was identified.