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NATURAL ENVIRONMENT RESEARCH COUNCIL

National Oceanography Centre

Cruise Report No. 12

RRS *James Cook* Cruise 62

24 JUL -29 AUG 2011

Porcupine Abyssal Plain -
sustained observatory research

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2012

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ABSTRACT

Science rationale for the activities comes from the fact that during the EU Framework programme IV project BENGAL (1996 to 1999) radical changes were noted in fauna living on the abyssal seafloor (Progress in Oceanography, Billett 2001). The changes appeared to be related to changes in upper ocean productivity and the flux of organic matter to the abyss (Wigham et al., 2003). Various hypotheses have been created concerning the effect of total organic carbon input, shown by Lampitt et al (2010) to vary by an order of magnitude between years, the quality (organic geochemistry) of the organic material, and the timing (episodic or regular) of the inputs of organic matter. Large-scale changes in the abundance of the large epibenthic invertebrates by greater than two orders of magnitude, are now known to be mirrored by similar changes, but of a lower magnitude, in the protozoan meiofauna (c. 50 to 250 um in size) (Gooday et al. 2010), metazoan meiofauna (notably nematode and polychaete worms) (Kalogeropoulou et al. 2010) and macrofauna (250 to 1000 um in size) (Soto et al. 2010). The results have been brought together in a Special Volume in Deep-Sea Research II (Lampitt, Billett, and Martin 2010). The work below will help detail how deep-sea ecosystems change naturally with time and space and in response to climate-change phenomena. It will be useful in predicting how deep-sea ecosystems will change under various climate change scenarios. In addition, coupled with other time series studies in the NE Pacific (e.g. Smith et al. 2009) and sampling around the Crozet Islands (Wolff et al. 2011), it will indicate how deep-sea ecosystems might change in relation to potential geo-engineering solutions for carbon sequestration by the oceans.

KEYWORDS

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1.0 Itinerary

Itinerary

Leg 1: Departed 24 July Falmouth, UK
Arrived 2 August, Cork, Ireland
Leg 2: Departed 2 August, Cork, Ireland
Arrived 29 August Falmouth, UK

2.0 Background & Objectives

Science rationale for the activities comes from the fact that during the EU Framework programme IV project BENGAL (1996 to 1999) radical changes were noted in fauna living on the abyssal seafloor (Progress in Oceanography, Billett 2001). The changes appeared to be related to changes in upper ocean productivity and the flux of organic matter to the abyss (Wigham et al., 2003). Various hypotheses have been created concerning the effect of total organic carbon input, shown by Lampitt et al (2010) to vary by an order of magnitude between years, the quality (organic geochemistry) of the organic material, and the timing (episodic or regular) of the inputs of organic matter. Large-scale changes in the abundance of the large epibenthic invertebrates by greater than two orders of magnitude, are now known to be mirrored by similar changes, but of a lower magnitude, in the protozoan meiofauna (c. 50 to 250 um in size) (Gooday et al. 2010), metazoan meiofauna (notably nematode and polychaete worms) (Kalogeropoulou et al. 2010) and macrofauna (250 to 1000 um in size) (Soto et al. 2010). The results have been brought together in a Special Volume in Deep-Sea Research II (Lampitt, Billett, and Martin 2010). The work below will help detail how deep-sea ecosystems change naturally with time and space and in response to climate-change phenomena. It will be useful in predicting how deep-sea ecosystems will change under various climate change scenarios. In addition, coupled with other time series studies in the NE Pacific (e.g. Smith et al. 2009) and sampling around the Crozet Islands (Wolff et al. 2011), it will indicate how deep-sea ecosystems might change in relation to potential geo-engineering solutions for carbon sequestration by the oceans.

While there has been an increase in the understanding of how climate and surface processes affect deep-sea communities, the ability to understand these links further is thought to be limited by sampling error from unaccounted habitat heterogeneity (i.e. irregular or uneven habitat distributions). Features like hills, valleys, depressions, small rock outcrops, and biogenic mounds add to habitat complexity, but links between such features and the animals that live among them are very poorly resolved in abyssal plain habitats using current methods.

Our efforts aimed to address the following objectives:

- We serviced the PAP1, PAP3 and Bathysnap long-term observatory systems. These systems provide data that is critical in understanding connections between climate, surface ocean processes, and change in deep-sea habitats.
- We ecologically surveyed the region around the PAP - Sustained Observatory (SO) to understand how the topography of the seabed alters the abundance and distribution of fauna in abyssal habitats. This surveying employed the use of acoustic mapping, megacoring, box coring, a baited camera lander, towed cameras, an amphipod trap, and trawling.
- We also conducted a number of specialised research studies including research on low bandwidth observatory telecommunications, phytoplankton community structure, bioluminescence, the impacts of crude oil on benthic sediment communities, and the effects of pressure on photoreceptors, and the potential impacts of trawling on slope habitats in the

Porcupine Seabight. These studies took advantage of the equipment above with the addition of conductivity temperature and depth (CTD) rosette casts and laboratory facilities.

In addition to links with Porcupine Abyssal Plain – SO activities, the project will impact the NERC Strategic Research Programme Oceans 2025 more broadly, as well as research programmes such as EuroSITES (http://www.eurosites.info/), PROTOOL (www.protool-project.eu), Hotspot Ecosystem Research and Man's Impact on European Seas (HERMIONE, http://www.eu-hermione.net/), and the European Seas Observatory NETwork (ESONET) Network of Excellence, and European Multidisciplinary Seafloor Observatory (EMSO, www.esonet-emso.org) programmes which are demonstrating observing techniques, outlining best-practice and interoperability standards, and creating a lasting integration among deep-sea researchers.

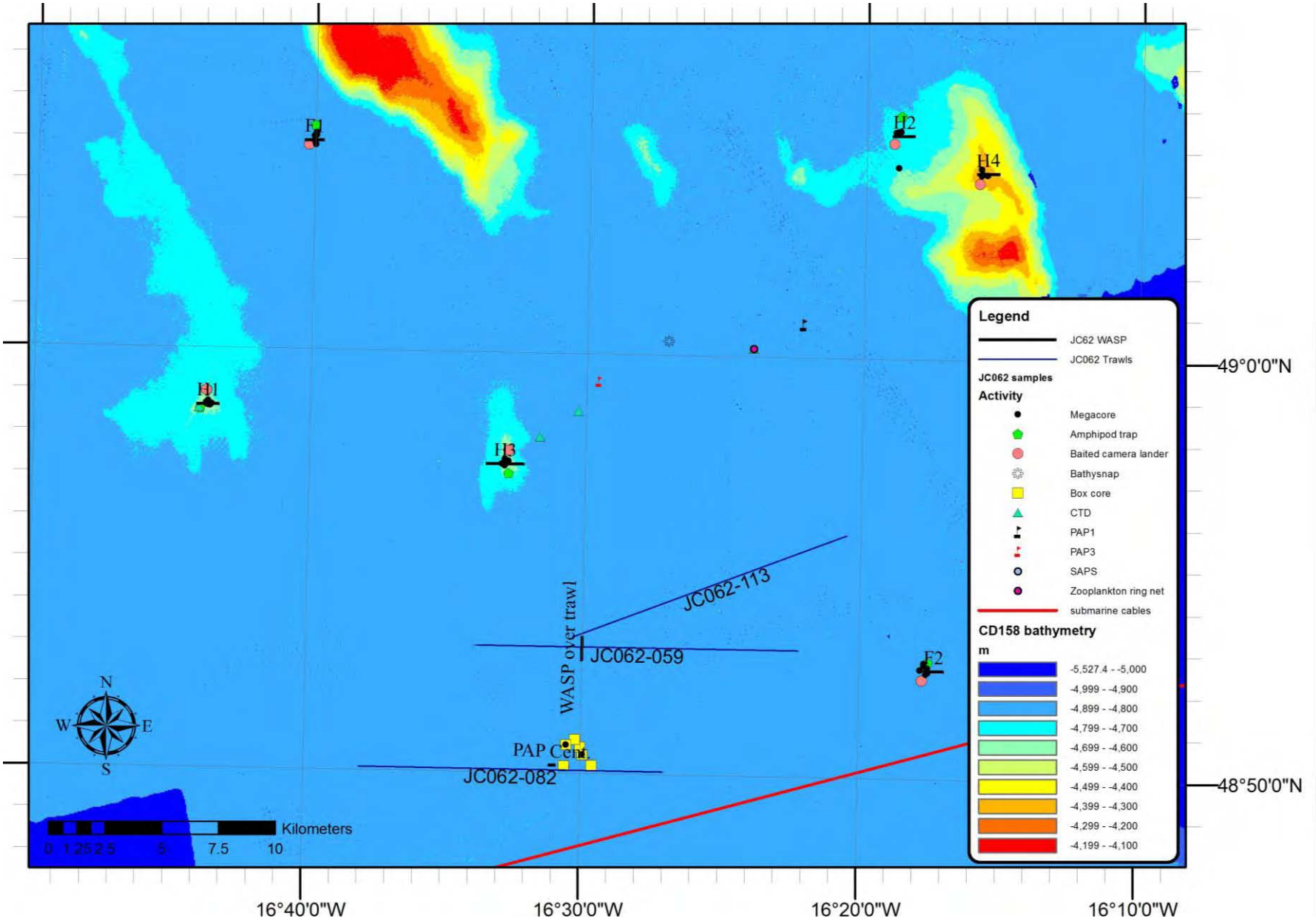


Figure 2.1.1. Chart of PAP research. Locations for each station are in the full station list in section 5.

3.0 Narrative

Sunday July 24: The cruise departed on time, which was appreciated given delays in the preceding refit and lack of a trials cruise beforehand. First activities of the cruise included getting the underway systems activated including acoustic mapping, non-toxic seawater supplies, getting underway sensors operating including the fast repetition rate fluorometer, and starting the production of liquid N. The moorings teams got started on PAP1 replacement sensor rigging, chain layout, release preparation etc., and the CTD users met and discussed the use of water. The non-toxic water was ready for use by the evening. And the coring groups got together and discussed alignment of various protocols for sample processing.

Monday 25 July: We arrived to Goban Spur in mid morning and set to configuring the dynamic positioning systems since they had not been used since the refit. We were then ready for the first CTD for experiment water from just above the seafloor (~1000 m depth). Then a second CTD was conducted for bioluminescence sampling, Dissolved inorganic carbon (DIC) & phytoplankton sampling. We then conducted a series of megacore deployments for collecting sediment cores for the crude oil impact experiment. The first megacore went down with 8 tubes and no extra weight. Material was sandy and penetration was about 10cm or less. So we examined the charts and decided to head south about 10 nm to try a new area. We added 4 lead bars to the megacore and then reduced to 4 tubes, which recovered 4 good cores. We then tried 6, but this was not successful, so we went back to 4 for an additional 2 successful deployments before we had to depart for PAP.

Tuesday 26 July: As we arrived into the PAP working area (see Fig. 2.1) in the late afternoon we sailed past PAP1 to visually check the condition of the buoy. We then proceeded to conduct a full depth CTD cast to test the acoustic release systems and collect water for DIC & phytoplankton followed by a night bioluminescence sample collection CTD.

Wednesday 27 July: Very early in the morning we then started the first PAP megacore. It soon became clear that one of the bushings in the coring winch was leaking grease when it warmed. The core proceeded as planned albeit more slowly once the leak was assessed. By 08:30 PAP3 had been recalled and was visible. The next PAP3 mooring was ready to be deployed by 12:30 and was confirmed on the seabed just after 15:00. We then proceeded to conduct a WASP run at the PAP central working area (PAP Cent.). About 40 min. into the survey it became clear there was a fault and the system was recovered. It was found that the video bulbs had burnt out and replacements were ordered for delivery during the port call in Cork. A second megacore deployment was then started.

Thursday 28 July: The megacore was recovered in the early morning and we then proceeded to the PAP1 site to begin recovery at about 06:00. The top end of PAP1 system was recovered without incident, but important improvements were noted for subsequent recoveries, which are noted in the PAP1 section. The systems were dismantled and the service for the next deployment was started. We then stayed attached to the PAP1 anchor overnight. A shallow CTD and zooplankton tow were both conducted overnight with the zooplankton tow finishing on the 29th.

Friday 29 July: The PAP1 service continued into the next day. It was deployed in building seas with details provided in the PAP1 section. We then proceeded back to the PAP Cent. site for another megacore deployment overnight.

Saturday 30 July: During the overnight megacore deployment another problem of leaking grease occurred. A box core was then deployed and the leaking grease issue reoccurred. While no full repair was possible, a fix of additional winch cooling and additional banding around the gasket area seemed to eliminate further impact on coring. The box core did not trigger and the pull wire stopper

was adjusted and all further box cores triggered well. Bathysnap was recovered on deck from the long term deployment just after 12:30 and details are reported in the Bathysnap section. We then returned to box coring with two more deployments at the PAP Cent. site.

Sunday 31 July: The last of the above mentioned box cores came on deck in the early morning and a dawn CTD was then done for bioluminescence samples. Two more megacore deployments were then made. We then conducted a brief acoustic survey of the northern extent of the larger PAP working area as we proceeded slowly to Cork for staff exchange.

Monday 1 August: By early morning we had finished the acoustic survey and began making best speed to Cork.

Tuesday 2 August: We arrived into Cork for the morning port call on time and were on our way to Goban Spur just after 13:00.

Wednesday 3 August: We arrived at Goban Spur around 07:00 and proceeded to conduct another full depth CTD followed by 5 megacore deployments to collect samples for a second crude oil impact experiment. We then departed for PAP just after 17:00.

Thursday 4 August: We arrived back at PAP around 15:00 after conducting additional acoustic surveying on the approach to PAP. Then we proceeded to launch Bathysnap for a short-term deployment during the cruise. The baited camera lander was then deployed at the first of several areas that included topographic highs (H sites) and flat abyssal plain areas (F sites) in the greater vicinity of PAP (site H1). Due to the baited system being reconfigured because of a faulty battery, we were not able to deploy it with a known in water weight. The system was deployed but did not sink and it was then recovered and one float rack was removed. The system was then deployed with new bait. The amphipod trap was then deployed about 1 km to the south. Then WASP was set up for deployment for a ~1 km run between the landers. A fault with the pinger occurred early in the deployment and it was brought back on deck for inspection. We then proceeded to conduct a series of 3 megacore deployments (H1-1, H1-2, H1-3).

Friday 5 August: The above mentioned mega core deployments went on until about noon the following day with mixed success due to sandy harder sediments than is normally found at PAP. We began to get useful samples by reducing from 8 10 cm tubes to 6 tubes. We then conducted a successful WASP run at the site followed by an additional megacore deployment.

Saturday 6 August: One more megacore was conducted at the site before recalling and recovering the baited camera and amphipod trap respectively. The scrolling of the coring wire was becoming increasingly problematic adding more and more time to recovery. We then moved to our first otter trawl position and began the first trawl around 16:00. The traction winch overheated occasionally during the payout but remained functional.

Sunday 7 August: The seas began to build overnight with winds peaking in the early morning. With delays in recovery due to overheating and scrolling problems the bridal was sighted around 06:30 entangled with fishing line. Once this was freed the haul was brought on board. It had to be used for non-quantitative sampling due to a large tare in the net. More details are in the otter trawl report. By 18:30 we had resumed work after a weather hold and started a megacore back at the H1 site.

Monday 8 August: Another megacore was conducted in the early morning. We then proceeded to the first flat site, F1. There we deployed the baited camera and amphipod trap about 1 km apart.

Then WASP was deployed for a 1 km run at the site. We then began a series 6 megacore deployments.

Tuesday 9 August: Megacore deployments at the F1 site continued throughout the day and into the night. The sediments were noticeably loose with very fine sediments. All tubes were eventually used on the corer to improve the trigger rate.

Wednesday 10 August: One more F1 megacore was done in the morning and then we proceeded to recover the baited camera and amphipod trap. We then proceeded to the F2 site and deployed the baited camera and amphipod trap upon arriving, again about 1 km apart. We then proceeded with megacoring.

Thursday 11 August: After 5 megacores were completed we moved to conduct a second service of the PAP1 systems. This was to try and reset the Met Office Iridium systems. This reset was not successful and so additional service plans were started for another visit during the following week. We then returned to the F2 site to conduct the WASP for that site.

Friday 12 August: We started the day by conducting 2 box cores at the PAP Cent. area. We then proceeded to the next trawl location and deploy the trawl just after 13:00 to ensure that we would get a night recovery, even with potential winch issues.

Saturday 13 August: The trawl was recovered just after 1 am without either winch or entanglement issues. The haul was larger than the first and used for quantitative sampling, as well as other uses described in the trawling section. We then proceeded to the H2 station where we deployed the baited camera and amphipod trap and then conducted a WASP survey. After confirming from the video that there were no rocky outcrops, we proceeded with megacoring.

Sunday 14 August: Megacoring continued with 4 deployments being done before we then recovered the baited camera and amphipod trap. We then conducted three more megacore deployments at the H2 site.

Monday 15 August: With the last of the above mentioned megacores finishing in the early morning we then had a short weather hold. We then decided to move to a SAPS deployment followed by a shallow CTD. We then proceeded to collect the last of the box core samples for the trip. The first of these triggered, but leaked upon recovery. The second went well giving a total of five quantitative samples from the PAP Cent. area.

Tuesday 16 August: Two megacores were conducted at the PAP Cent. site before moving to try another repair to the PAP1 Met Office telemetry system. In this instance we first tried a new antenna, and then took the mast off and removed the electronics from their main housing. We swapped the Iridium system and swapped a corroded connector and tested the system on deck. With all but the temperature and heave sensors reporting properly, we redeployed the system. In order to get a more complete set of samples we returned to the F1 site for two more megacore deployments.

Wednesday 17 August: With the above mentioned F1 megacores being completed by just after 08:00 we moved to the new H3 site where we deployed the baited camera and amphipod trap. We then conducted a WASP between the landers as had been done at the other sites. A series of four complete megacore deployments was then done and one that was aborted due to drifting off position.

Thursday 18 August: The last of the above mentioned megacore deployments was completed by about 07:00 when then proceeded to recall and recover the baited camera and amphipod trap, as

well as Bathysnap from its test deployment. We then conducted two more megacore deployments at the H3 site.

Friday 19 August: In the early morning we completed work at the H3 site for the time being and moved to collect two more megacore sample sets from the F2 site. We then proceeded to the otter trawl start position and the net was in the water by about 16:00. This trawl was set roughly parallel and north to the other two, but with a slightly more southerly course accommodating the prevailing weather.

Saturday 20 August: The trawl came up about 04:00 as expected and the haul was the largest yet. There also seemed to be more mud than the previous trawls. The trawl was processed in the same general way as the last one, except that the clinker and other anthropogenic materials were all retained for HERMIONE. Once the trawl was on deck and secure we then moved to the H1 site to conduct two more megacore deployments there followed by one more at the H3 site.

Sunday 21 August: We continued to revisit sites to collect more megacore samples next stopping at H2 for two samples before moving to launch Bathysnap for a long term deployment. With time for one more complete site visit, we moved to a high lying area H4 and deployed the baited camera and amphipod trap. This site had the highest topographic relief with steeper slopes than other sites. So we confirmed that the seafloor was indeed suitable for coreing by conducting a WASP deployment and first viewing the video before launching the megacorer. It was quickly seen that this area indeed had a suitable soft bottom and we then conducted a series of six megacore deployments at the site.

Monday 22 August: Megacoring ran all day. The second of the above megacores had all tubes slipped, but the remainder of the deployments collected nearly all useable tubes.

Tuesday 23August: We revisited the H2 site for two more megacores and the F1 site for one last megacore at that site. WASP was then deployed to cross over the track of one of the trawls.

Wednesday 24 August: When WASP was recovered in the early morning, there was time for one last megacore deployment at the F2 site before departing for Goban Spur.

Thursday 25 August: We arrived at Goban Spur in building seas. We began a CTD just before 11:00 but this deployment was in marginal conditions and a hold was placed on activity that lasted until about 17:00. The seas had begun to lay down and we started a series of 5 megacore deployments for the crude oil incubation experiments.

Friday 26 August: the last of these experimental core sampling deployments was finished in the early morning and we then proceeded to the Porcupine Seabight for the trawling impact study. We arrived at the first site and began a WASP deployment by almost 18:00. The first two deployments of WASP used the video system as had been done on the PAP transects.

Saturday 27 August: These first transects indicated that sponges were indeed in the area and we then prepared WASP for a set of longer transects with the video taken off the system and the camera frame rate set for longer intervals. We also took the baited camera lander camera and strobe systems and mounted them on WASP in a forward and downward looking position. We used this new arrangement for two deployments at the first Porcupine Seabight site and then once at two more locations.

Sunday 28 August: The last WASP deployment ended just before 05:00 and the longer was deployments with the Oceanlab digital still photographs gave indications of trawling, as well as differences in sponge communities between the surveyed areas.

Monday 29 August: The incubation experiment was finished and packing efforts were wrapping up as we progressed towards Falmouth. By mid afternoon we had arrived offshore Falmouth and waited to be piloted to the quayside.

4.0 Research strategy & Outcomes

The cruise achieved its main objectives including servicing of mooring infrastructure, ecological mapping of the PAP area, and a survey of potentially impacted sponge communities on the N PSB slope. We were favoured by good weather and what proved to be mainly minor issues with winches and other equipment. We surveyed three abyssal plain areas and four hill areas within the greater vicinity of the PAP-SO (Fig. 2.1). At all of these seven sites we conducted a WASP transect and at least 5 megacore deployments. At all seven survey sites except, PAP Cent., we conducted a baited camera and ampipod trap deployment as the deposition of ballast at PAP Cent. was to be avoided. At the PAP Cent. site we also conducted series of five box core deployments. Details on specific activities, their objectives and initial results are provided below including ancillary activities conducted at Goban Spur and the Porcupine Seabight.

4.1 PAP1 – The atmospheric and surface ocean observatory system

Paul Provost, Jon Campbell, Thanos Gkritzalis, Steve Whittle et al.

The PAP1 mooring serves as the platform for a diverse set of physical, chemical and biological sensors mounted to a frame at about 30 m depth and an atmospheric sensor suite mounted on an Ocean Data Acquisition System (ODAS) buoy. The main objective for our PAP1 effort was to service both the atmospheric and oceanographic sensors by bringing both platforms on deck, but leaving the mooring anchored to the seabed. Here we report a summary of the operations and outcomes. More detailed reports have been made for both the platform and sensors service.

The deck setup for the ODAS buoy recovery used the ship fitted trawl winch fed astern over the pendulum block of the aft gantry and the deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2 m behind the double barrel winch platform. A 14 mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck. Two deck mounted (one starboard and one port) 5t general purpose (GP) winches were used with a 16 mm pennant wire through a snatch-block shackled to the foreword most lifting lug on the starboard pedestal with each positioned diagonally towards their respective quarter.

The vessel approached the buoy stern-to and was hooked on the mast lifting lug at 08:42 on 28 July 2011 using a 5t RH25 SeaCatch hook attached to the end of the core wire. The hook was controlled by a 5 m aluminium pole which was withdrawn once the hook was attached securely. Further wide-jawed hooks shackled to the port and starboard 5t GP winch wires were clipped into the mast frame of the buoy using the pole at length to act as steadying wires. The load was taken on the wire and the buoy was lifted clear of the water and hauled up the transom of the vessel. At this point the safety rails were taken down.

As recovery to deck commenced the steady-line winches took up the slack to prevent unwanted motion of the buoy. Before the keel of the buoy had cleared the transom these lines were brought up too tightly causing the attached hooks to become deformed and twist off. At this point the coring winch rendered as the hoist limit had been set to 6.5t for this operation, exceeding the expected weight of the buoy of 4.5t.

This wire payout introduced slack wire at the A frame block and the buoy was lowered back into the water. After confirming no damage had occurred, the core winch hoist limit was increased to 8.5t to account for any surge or dynamic force that may be encountered, while remaining within the operational limit of the wire in use.

Once again the buoy was hoisted from the water, with the gantry slightly inboard so that the buoy remained against the transom. When the deck of the buoy was level with the working deck, 16 mm rope steady-lines were attached and tied to the mast, running to cleats on the inside of each pedestal.

As the buoy was lifted, the slack was taken on the steady-lines to prevent the buoy from swinging. Once the buoy was well in board, but still remained suspended, the wire from the double barrel winch was connected to the keel and hauled in to make the buoy vertical, where it was landed on deck and secured using pad eyes and ratchet straps (four off). The top of the chain, immediately below the buoy was stopped off using a 5t GP winch.

Using a sequence of lifts coordinated between the gantry Rexroff winch and the port 5t GP winch, the chain suspending the instrument frame was recovered to deck and brought inboard. As the instrument frame was lifted from the water the gantry was moved further outboard to prevent the frame (and instruments contained in) from being dragged up the transom of the vessel.

Once the instrument frame was on deck, the starboard 5t GP winch was used to stop off the mooring rope allowing the pinned shackle, etc., to be broken and replaced. A strop was attached through the rope thimble and secured to deck as a secondary preventer.

The Met Office buoy and NOC sensor frame were recovered 312 days after being serviced. We had hoped to be able to buoy-off the mooring rope to allow the vessel to carry out other work while the buoy and frame were serviced on deck. However the buoyancy sphere that had been brought for this purpose was considered to have inadequate buoyancy in the current conditions, and the vessel therefore remained attached to the mooring while the servicing was carried out.

The current system using a Met Office K-series buoy and rope mooring was originally deployed from the James Clark Ross on cruise JR221 on 1st June 2010. The system was serviced aboard the Celtic Explorer on cruise CE10005 on 19th September 2010. The telemetry link to the sensor frame failed in January 2011, but the satellite telemetry system on the buoy continued to send data until the buoy's power system failed a few days before recovery. Prior to January, telemetry data had been received from all sensors apart from the Aanderaa Seaguard. It was subsequently discovered that the Seaguard had in fact recorded internally for the complete deployment, but a wiring error in the data hub meant that its messages were not received.

Upon recovery in July 2011, the data control and logging hub was found to be lost and as a consequence all cables that were connected with it were ripped apart. This had an effect on the bulkhead connectors of some of the sensors. Additionally the flow of current from any loose power supply cables created favourable conditions for electrochemical corrosion and all 4 sacrificial anodes that were on the sensor frame were completely consumed. It was also noted that the large bulldog grips used to attach the two armoured cables to the 30m length of chain were no longer gripping the cables tightly.

Fifty-three days into the deployment started on in September 2010, messages from the Satlantic ISUS abruptly ceased. When recovered this instrument was found to be damaged and flooded. After 105 days the WET Labs fluorometer stopped sending data, and after 114 days (11th January 2011) all data from the hub ceased. The log file recorded in the buoy controller shows that there were 3 computer restarts between 11th and 17th January that were almost certainly caused by the failure of the armoured cable carrying the hub power supply, which would have caused a short circuit.

On 23rd January 2011 (after 126 days) the last data were received from the two MicroCATs in the sensor frame although they continued to record internally until recovered. These sensors use an inductive telemetry system which is completely independent of the data hub and uses a second armoured cable connected to the buoy. The buoy controller continued to operate without the data hub, sending back position and housekeeping data. By the middle of February the buoy battery voltage was hovering around 11V (for a nominal 12V battery) and commands were sent to the buoy to minimize power consumption.

As the days lengthened the solar panels on the buoy gradually increased the battery voltage, but on 13th June 2011 the solar charging stopped and the battery volts declined steadily. The last Iridium dial-up data transfer from the buoy occurred on the 14th July 2011, by which time the battery voltage had declined to 6V. Data recorded internally in the buoy controller show that its computer was still working when recovered despite the battery voltage having dropped to around 4V.

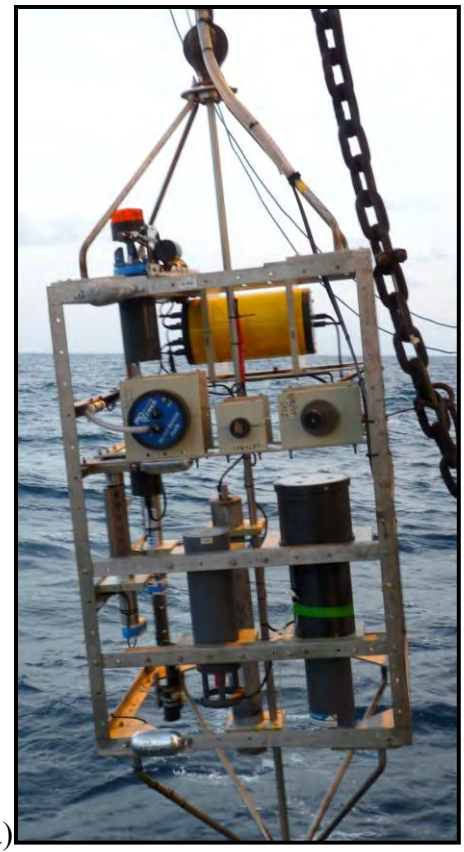
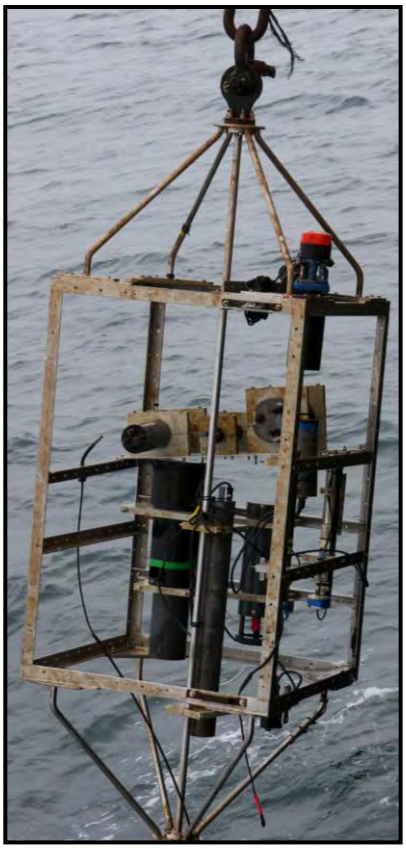
a)  b) 

Figure 4.1.1. PAP1 oceanographic sensor frame at a) deployment on September 2020 and b) recovery in July 2011. Note the loss of the yellow data hub, broken sensor brackets, consumed zinc anodes, and severed armoured communication cable.

Recovered PAP1 oceanographic sensors

Satlantic ISUS (S/N: 60): The instrument that suffered the most was the Satlantic ISUS Nitrate Sensor. The telemetry bulkhead connector was completely destroyed and the power supply

bulkhead connector was also damaged. When the sensor was detached from the frame there was degassing from the telemetry bulkhead connector and upon transportation to the lab it was obvious that the instrument had flooded. Jon Campbell and Thanos Gkritzalis dismantled the instrument in an attempt to recover any information from the sensors flash disk. The disk data was recovered, but no data was present after the time that the data hub was believed to be lost and the ISIS system damaged.

Seaguard (S/N:219): The Seaguard was still operating after the recovery, but there are clear indications of corrosion on the body and on the optode and the DCS head had several marks, which were probably caused by the loose inductive cable. The communication cable was cut off from one end but it did not damage the instrument's bulkhead connector. The data were downloaded successfully. The instrument recorded error logs which might provide further information of when events happened.

NAS 3x Nitrate Analyser (S/N: 2673): From the very first day of its deployment it was evident that the NAS was not producing reliable data. As was expected the granular Cd column was almost exhausted and the column's extension tube was detached. The protecting cases were slightly damaged by the hub when it was lost. There were clear signs of biofouling on the instrument both on its surface but also inside the reagents and standards compartment. Biofouling was also evident on the bag surfaces. Gordon Patterson from the Natural History Museum collected samples from the biofouling film and he will communicate to us the results. Issues involving the biofouling, reagent endurance, and power will be investigated further.

Wetlabs ECO FLNTUSB (S/N:269): The Wetlabs 269 fluorometer was recovered with the telemetry connector exposed and the power connector was heavily corroded. After inspection it was found that the instrument was still functional. Kate Larkin and Corinne Pebody successfully downloaded the data from the instrument which span from 19/09/10 to 28/07/11.

Microcats SBE IMP (S/N:6904 and 6907) As mentioned the inductive cable had parted so there was no communication with the microcats. Both of the microcats had minor scratches and one of them was missing two screws from the pumps protecting case, which is something common after a one year deployment in a rough environment. Both microcats operated as scheduled during their deployment. Data were successfully downloaded after recovery and the two microcats were deployed on CTD 06 (see Appendix II for more details on CTD set up). The instruments will be further calibrated in NOC for temperature and conductivity.

ProOceanus sensors (pCO2 s/n: 29-095-45, GTD s/n: 29-100-15) The ProOceanus pCO_2 sensor was recovered with damaged bulkhead connectors as a result of the loss of the hub, but it is minor damage that is relatively easy to fix. The same applies for the recovered GTD sensor. The instruments had no data as they rely on the hub's logging system.

Satlantic radiometers OCR-507 R10W s/n 095 and OCR-507 ICSA s/n 201) The OCR-507 R10W was installed in the sensor frame and was connected to the hub. Fortunately the instrument did not suffer any damage and only the connecting cable was damaged. The instrument is not equipped with a logger so there were no data from it after the hub loss. The OCR-507 ICSA was positioned on the surface buoy to measure atmospheric radiance. There were no signs of damage on the sensor apart from ageing. Both of them were redeployed and so far data flow is normal.

Recovered PAP1 Met Office systems

The buoy was heavily fouled after more than a year on the surface, but was superficially undamaged with the solar panels intact and relatively clean. However, when the hatch covering the electronics and battery pods was removed, the connector space underneath was found to be flooded.

Despite this the connectors were dry inside the electronics housing and in serviceable condition. The pods were then lifted out of the buoy hull. The electronics pod was found to have suffered slight water ingress and the main power cable running to the battery pod was found to be damaged.

JC062 PAP1 deployment

ODAS buoy: The buoy hull hatch seal was replaced and new battery pod, power cabling and data loggers were installed by Adrian Bunting from the Met Office. The new logging electronics were placed into the previously deployed housing and placed atop the new battery pod and then back into the buoy hull. The buoy keel was also replaced along with the 30 m of chain and the armoured cables to the sensor frame. The buoy was reassembled and the Met Office systems were tested overnight including telemetry. Everything worked apart from the air temperature sensor which had already been working intermittently for a number of months. The suspicion is that water has penetrated one of its connectors or cables.

Oceanographic sensor frame: The condition of the sensor frame upon recovery suggested that a strengthening was required. So additional angled supports were taken from the previously deployed sensor frame and added to the frame that was to be deployed. And the new sensor frame also had 6 anodes instead of 4. All of the mounting brackets were then welded into place rather than just bolted. In addition all the clamp bolts were double-nutted with the outer nut being a nylock, and the hub was fitted with a third clamp for extra security. Altogether these measures resulted in a stronger and more rigid frame, which should be better able to withstand the rigors of a winter in the Atlantic. The previous servicing visit in September 2010 had highlighted the inadequacy of many of the cable harnesses within the frame, and this had been addressed by replacing all the data hub connectors and cables with penetrators and tougher, polyurethane jacketed harnesses.

Deployed oceanographic sensors:
NAS 3x S/N: 2675 (Gkritzalis): The NAS nutrient analyser has already been tested in the lab. The main tests were related to identify the efficiency of the Cd reduction column and of the sensors linearity. For the past deployment the NAS was deployed with a custom built granular Cd column. Although the columns efficiency was very good in the beginning of the deployment, it was found that the column was gradually consumed and the efficiency reduced. For this reason it was decided to deploy the NAS with the Open Tubular Cadmium Reactor (OTCR) that is suggested by the manufacturer (Envirotech). Tests in the lab indicated that the column is stable but the efficiency is approximately 80%. Further tests were conducted during JC062 before the instrument was deployed. The new tests were conducted with OSIL NO_3 and NO_2 stock standards (1000 and 100 μM respectively), and NH_4Cl with 84 μl/l 2%$CuSO_4$ for the buffer solution. The OTCR behaviour was still the same.

A few hours before the deployment a fresh set of reagents was connected to the sensor and a new set of standards was prepared. The standards (1 and 10 μM) were prepared from the OSIL NO_3 1000 μM stock standard with Artificial Seawater made from 10 litres MQ water (from the on-board unit) and 400g of NaCl (Analar). Each standard was 1 litre and placed in a clean collapsible blood bag and spiked with 150 μl of 10% $HgCl_2$. The reagent volumes used for the deployment were: 2l of NH_4Cl buffer, 250 ml of Sulfanilamide, 250 ml of Napthaethylenediamine. Samples were collected from the two standards and the ASW that will be analysed in NOC. When all the reagents and standards were connected the sensor was primed, the NAS clock was synchronised with the PC clock (synchronised to ships GMT) and programmed to sample every 12 hours (00:00 and 12:00) and every week will measure the two standards. Data flow from the NAS is normal.

Satlantic ISUS Nitrate Sensor S/N:59 (Gkritzalis, Pebody): The ISUS 59 was first calibrated in the lab using MQ water, as recommended by Satlantic. After that the performance of the instrument was evaluated using 5 standards (same as those used for the NAS 2675 linearity test). The next test was the CTD calibration of the ISUS. The ISUS was interfaced with the Seabird CTD and the analogue output of the ISUS was calibrated with the Seabird CTD. This was performed by Provost and Gkritzalis. The CTD cast took place on the 27/07/11 (CTD cast 04). Nutrient samples were collected from Niskin bottles against which the ISUS will be compared. Before deployment, the ISUS was set on scheduled mode and programmed to sample every 4 hours. Data flow from the ISUS is normal.

Wetlabs ECO FLNTUSB fluorometer (S/N: 269[238 not deployed]): The ECO 238 was set for continuous operation and deployed on the CTD cast 05 cast. Even though the fluorometer's LED was flashing when the data from the CTD deployment were downloaded it was obvious that the instrument was not performing well. The downloaded file was only 10 KB in size and when the file was opened the values indicated that there is an error with the instrument. Further tests in the lab verified the problem and the instruments behaviour was erratic (e.g. it was not possible to set the correct date and time). Because of that it was decided not to deploy the ECO 238 fluorometer and we focused on repairing the recovered 269. Jon Campbell managed to service the recovered 269, replace the batteries, short circuit the power circuit in order to provide power from the battery pack and programme it to sample every 6 hours. The 269 instrument was successfully deployed and so far data flow is normal.

Seaguard (S/N: 217): The main preparation for the Seaguard platform is the calibration CTD cast down to 200m (CTD cast 04). During the CTD the DCS current meter was disabled and the sampling frequency was set to 10 sec. Comparison of the Seaguard parameters against the CTD were made. Data flow from the Seaguard 217 is normal.

Microcats IMP (S/N: 6917 and 9030 IDO): The two microcats were calibrated against the CTD on CTD cast 04. After that the two microcats were programmed for deployment with a sampling interval of 15 min. The real time data flow was normal.

Pro Oceanus pCO_2 sensor (S/N: 29-097-45): The ProOceanus pCO_2 sensor has just returned from a service from the manufacturer and tests in the lab showed the warming up period for the instrument to reach equilibration is slightly faster than previous tests but still high for our requirements. The manufacturer suggested cleaning the sensor with detergent and fresh water and testing again the equilibration time. This was performed on 23/07/11, but still the sensor had a slow response. It was decided to deploy the instrument 'as is' and change sampling frequency and equilibration time as dictated by the sensors performance.

Star-Oddis: The Star-Oddis are micro CTD devices that were to be deployed below the sensor frame in order to replace the mixed layer Seabird Microcats. The instruments were not deployed on any CTD cast as they have already been calibrated in NOC. Unfortunately the recovery of any extra length of mooring line was not possible, so it was decided to deploy one on the sensor frame and the five others on the chain between the surface buoy and the sensor frame (approx. 4 m apart from each other). The Star-Oddis were secured with cable ties between the grips that secure the chain and the inductive cable. All of the instruments were set to start and the sampling interval was set to 15 min. According to the battery and memory calculations the instruments will be operating until March 2013.

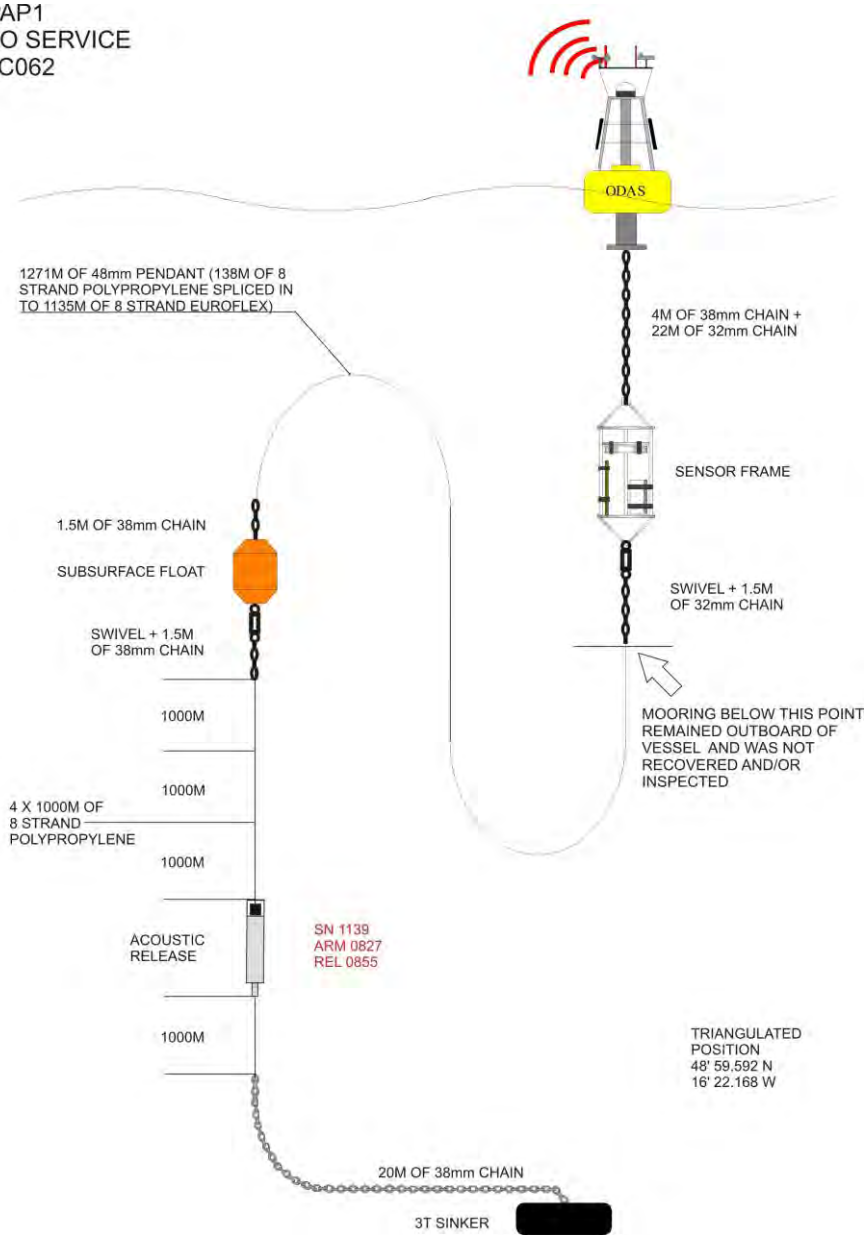
Osmotic Sampler: The osmotic sampler was prepared in NOC and a few hours before deployment it was assembled and positioned in the frame. The produced samples will be analysed for nutrients. The sampler is equipped with a preservation osmotic pump that injects continuously approx. 100 μl

of 2% HCl in the captured sample. It should be mentioned that the current design of the sampler may not be robust for the conditions at the mooring site during the winter, but if the deployment is successful the gain will be significant as it will provide a time series for all macro nutrients which no other device van provide.

The PAP telemetry system has evolved over the past few years and currently comprises a buoy telemetry electronics unit and a data concentrator hub in the sensor frame. Schematic drawings of these two units as configured for this deployment are shown in the full sensors report. Data are transmitted via the Iridium satellite system every 6 hours (typically) and are automatically displayed on the EuroSITES website: http://www.eurosites.info/pap/data.php. Short status messages are also sent via the Iridium SBD (Short Burst Data) email system every 4 hours (typically). The SBD email system is also used to send commands to the buoy to change sampling intervals, disable/enable sensors and to vary other settings.

With the vessel attached to the mooring and hence severely limited in terms of what science could be performed, and with the weather deteriorating, the decision was taken to redeploy the frame and buoy on the evening of the 29th July. This meant that the final assembly of the oceanographic sensors into the frame and the securing of the cable harnesses was rushed.

PAP1
TO SERVICE
JC062



Several days after deployment the Met Office systems stopped reporting to shore. It was thought that by un-powering the Met Office systems the effective reset might get the telemetry system working again. This was attempted on 11 August. The recovery of the buoy onto the deck went well. However, the system reboot did not solve the telecommunication problem.

After several more days another plan was formulated to try and get the Met Office telecommunication systems working. On the morning of 16 August the buoy was again well recovered on the deck. After a series of trouble shooting exercises the system was again working. This included removing the electronics pod from the buoy, a test swap of the Iridium antenna and a swap of the transmitter electronics, as well as the swap of a coaxial cable connection on the top of the electronics housing. This was done because the IGPS bulkhead connector had corroded such that the pin had broken. So the unused ITx connector was used instead.

At the time of writing all the sensors are returning sensible data excepting those for air temperature and wave data. Special thanks are due to Paul Provost, Steve Whittle and Mick Minnock for their skill in recovering and redeploying the buoy and sensor frame without damage multiple times, sometimes in less than ideal conditions, to Ben Poole for welding up the sensor frame, to Adrian Bunting from the Met Office for servicing the buoy and Steve Lankester for help from ashore, and to all the others who cheerfully and willingly helped along the way (see also Appendix I).

4.2 Web enabled sensor experiment

Barry Tao

We have designed and deployed a system that enables near real time 2-way sensor communication in a low bandwidth, intermittent VSAT internet connection. The distributed system works in unreliable and restricted narrow-bandwidth internet connections by integrating functional components of RS232 communication, UDP broadcasting, cloud computation, database management and replication of sensor data (measurement and metadata) from a research vessel (James Cook) at sea. The purpose of the experiment is to allow near real time communication to happen in order to assist near real time measurement and control in oceanographic sensors.

Two types of data sources have been used in the experiment, namely direct sensor data via RS232 interfaces and legacy ship-board sensors data being broadcasted using UDP within the ships internal network. An Aanderaa temperature sensor and conductivity sensors were connected through RS232 at a ship node computer, which is also connected to the internal network to listen to UDP broadcasting messages. Labwindow programs were used to communicate with the RS232 sensors for measurement and control data. Java programs were used to intercept UDP broadcasts, in particular APPLANIX, SURFMET and EA600 sentences. Selected data were sampled and transferred to a Linux powered cloud node off-ship using a-synchronized file synchronization. We chose the dropbox software to take advantage of its ability of cross-platform deployment, bandwidth management and cloud based computation. Once the data was in the cloud where bandwidth is no longer a problem, data was archived in a database, interfaced to the Web, where control commands can be also instructed. In addition, further data relay happened through database replication to a node back in the laboratory (NOCS), where a lab data manager can inspect, quality control and further process the data.

While sensors represented in the UDP messages broadcasting cannot be controlled, the two RS232 sensors could be control by changing their control parameters from the cloud node. Currently the sample rate control parameter has been used in the experiment to change the interval of measurement for sensors connected through RS232 in the ship node computer. The restriction of resources, in particular the unreliable internet and lack of bandwidth can often prevent a centralized real-time system from working properly. Therefore, we de-couple the functions to make it as a distributed system, where more resource hungry processes are moved to the cloud and lab nodes off the ship. During the 10 day cruise from Falmouth to the PAP site to the southwest of Ireland, the VSAT satellite link lost internet connection several times a day, particularly during the first several days due to the block of satellite dish by other mast objects during some headings. Measurement data accumulated in the ship node, as did the new instructions at the cloud node. The backlog clears once the internet connection resumes. Ideally, based on this system structure, we would like to plug-in higher level functionalities at the cloud node to provide standard interfaces for data interoperability.

4.3 Bathysnap

Ben Boorman

Bathysnap is a programmable time-lapse camera system. A long term version, with photographs every 8 hours, was recovered on this cruise. The whole system was replaced and deployed for a short deployment with 20 minute photographs before being recovered and re-deployed in the long term mode. In each case it was deployed on a mooring and consisted of an *Imenco* camera and flash, *IXSEA* release with releasable ballast weight and *Benthos* glass sphere buoyancy package.

CE10005 long term recovery – 937 seabed photographs were taken at 8 hour intervals between 01:19 GMT on 21/9/2010 and 08:09 GMT on 30/7/2011. Unfortunately, one of the lander's feet had come off at some stage during deployment and one leg appears to have sunk in to the seafloor. This has resulted in the flashgun being very close to the seabed leading to over exposed photographs at an obvious angle. Usable images have been obtained and an example is below left. A rotated and cropped edit of the CE10005 images should be suitable for some quantitative work.

JC062-045 short term deployment – 998 seabed photographs were taken at 20minute intervals between 16:37 GMT on 4/8/2011 and 13:19 on 18/8/2011 (There is some timing drift over the deployment). An example of the photographs taken is shown above right. This test deployment shows the system acquiring good images and no changes were made for the long term deployment excepting that the interval was lengthened.

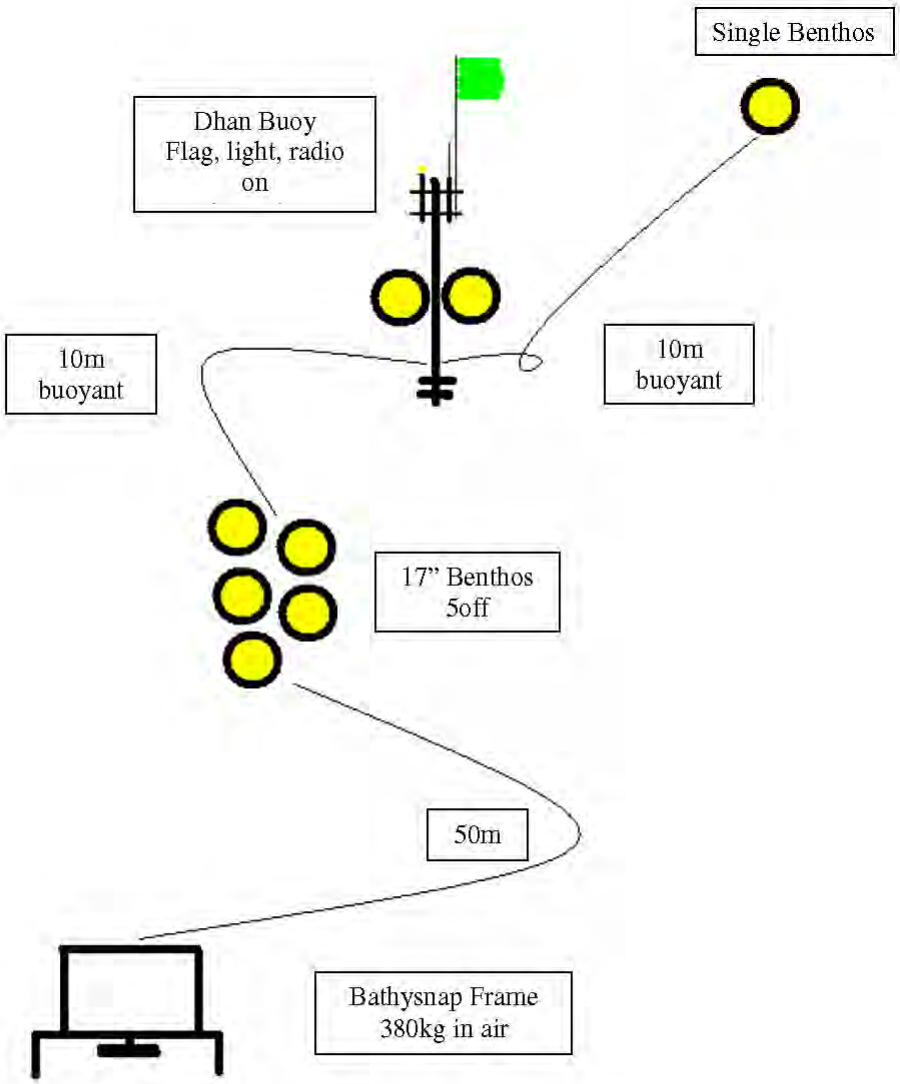


Figure 4.3.1: JC062-119 long term deployment arrangement. An 8 hour interval was set between photographs, 1st flash was observed 20:05 GMT 19/8/2011. It was deployed at 49°0.36' N, 16°26.93'W at 10:00 GMT 21/8/2011. The system was fitted with *IXSEA* release S/N332, flashing light and channel 72 radio beacon.

4.4 Zooplankton net

Corinne Pebody & Ben Boorman

A 200 µm mesh WP2 net was deployed at 00:23 GMT on 29/07/11 at 49°0.22195 N 16°23.9825 W (JC062-024). The net was deployed on the CTD winch and descended steadily to 200 m depth. Two smaller winches were attempted but failed and not be used. At 200m depth the net was brought up at 10 m per minute to the surface, where it was recovered and brought in board. The cod end was emptied and rinsed into a white plastic bucket. The vertical haul had captured amphipods and micro zooplankton. On initial microscopic examination there were numerous calanoid copepods, ostracods, and few pteropods and chaetognaths. The ship was attached to the PAP 1 mooring, which was not been the case of previous samples and the slow descent rate due to using the CTD winch also made the sampling atypical.

4.5 PAP3

Paul Provost, Steve Whittle, Corinne Pebody & Jackie Pearson

The deck setup for the mooring recovery used the electro-hydraulic double barrel winch with an inline reeling winch which was set 2 m behind the double barrel winch platform. The mooring rope was fed outboard of the double barrel capstan through a counting sheave bolted inline and 3m away which ran to a sheave suspended from the port aft pedestal crane. For recovery the reeling winch had a wooden 'recovery' drum installed onto which the used mooring rope was wound and stored. The mooring was released at 07:39 on 27 July 2011 using an IXSEA TT801 connected through the single element transducer on the (raised) drop keel by a patch cable. The mooring was monitored during the buoyant ascent and a rate of approximately 70 m/min was measured. The mooring was initially spotted at 08:34 with all the buoyancy packages visible by 08:40.

On recovery, the recovery line was grappled from the starboard quarter of the vessel and hauled in first. The main buoyancy packages, sediment traps and current meters were recovered without incident. As the final sediment trap was lifted clear of the water, the lower buoyancy spheres immediately above the release were entangled with their rope around the trap. The sediment trap was lifted inboard and the lines were separated and tied off to aid untangling the lines. The final few metres of mooring line above the release was recovered tangled but was taped together and hauled in on the double barrel capstan.

RCM8, s/n 9686, showed no signs of damage, corrosion or fouling, and was continuing to sample. The DSU (s/n 14407) had 46578 words at 19:40, 27/7/11, and counted to 46584 at 20:37. The instrument was stopped logging at 20:42. The DSU was found to be 12 minutes 54 seconds behind current time.

RCM8, s/n 12668, showed no signs of damage, corrosion or fouling, and was continuing to sample. The DSU (s/n 14308) had 46578 words at 19:40, 27/7/11, and counted to 46584 at 20:34. The instrument was stopped logging at 20:42. The DSU was found to be 14 minutes 51 seconds behind current time.

1800 mab Parflux sediment trap, s/n ML12432-01, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 20 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

1750 mab Parflux sediment trap, s/n 520, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 12 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

100 mab Parflux sediment trap, s/n ML12432-03, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 20 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Acoustic release RT661, s/n 255, showed no signs of damage, corrosion or fouling and worked faultlessly. Communications through the drop keel transducer to the TT801, s/n 255, deck unit worked well and no lost or timed out transmissions occurred.

Below in this column are the schedules for the three recovered sediment traps.

Station CE10005-9 (S/N MK7GW-13 & ML12432-03) traps followed the schedule below:
Event 01 of 22 @ 09/22/2010 12:00:00
Event 02 of 22 @ 10/10/2010 12:00:00
Event 03 of 22 @ 10/24/2010 12:00:00
Event 04 of 22 @ 11/14/2010 12:00:00
Event 05 of 22 @ 12/05/2010 12:00:00
Event 06 of 22 @ 12/26/2010 12:00:00
Event 07 of 22 @ 01/16/2011 12:00:00
Event 08 of 22 @ 01/30/2011 12:00:00
Event 09 of 22 @ 02/13/2011 12:00:00
Event 10 of 22 @ 02/27/2011 12:00:00
Event 11 of 22 @ 03/13/2011 12:00:00
Event 12 of 22 @ 03/27/2011 12:00:00
Event 13 of 22 @ 04/10/2011 12:00:00
Event 14 of 22 @ 04/24/2011 12:00:00
Event 15 of 22 @ 05/08/2011 12:00:00
Event 16 of 22 @ 05/22/2011 12:00:00
Event 17 of 22 @ 06/05/2011 12:00:00
Event 18 of 22 @ 06/19/2011 12:00:00
Event 19 of 22 @ 07/03/2011 12:00:00
Event 20 of 22 @ 07/17/2011 12:00:00
Event 21 of 22 @ 07/31/2011 12:00:00
Event 22 of 22 @ 08/14/2011 12:00:00

Station CE10005-9 (S/N 520) trap followed the schedule below
Event #01 09/22/10 12:00:11
Event #02 01/30/11 12:00:32
Event #03 02/27/11 12:00:18
Event #04 03/27/11 12:00:04
Event #05 04/10/11 12:00:32
Event #06 04/24/11 12:00:29
Event #07 05/08/11 12:00:26
Event #08 05/22/11 12:00:23
Event #09 06/05/11 12:00:20
Event #10 06/19/11 12:00:17
Event #11 07/03/11 12:00:14
Event #12 07/17/11 12:00:11
The traps were replaced with three other traps on a similar mooring later the same day (JC062-018) with schedules given below.

Upcoming trap schedule: S/N: ML12432-02 & ML12432-06
Event 1 of 22 = 07/31/2011 12:00:00
Event 2 of 22 = 08/14/2011 12:00:00
Event 3 of 22 = 08/28/2011 12:00:00
Event 4 of 22 = 09/11/2011 12:00:00
Event 5 of 22 = 10/02/2011 12:00:00
Event 6 of 22 = 10/23/2011 12:00:00
Event 7 of 22 = 11/13/2011 12:00:00
Event 8 of 22 = 12/04/2011 12:00:00
Event 9 of 22 = 01/08/2012 12:00:00
Event 10 of 22 = 02/12/2012 12:00:00

Event 11 of 22 = 03/04/2012 12:00:00
Event 12 of 22 = 03/18/2012 12:00:00
Event 13 of 22 = 04/01/2012 12:00:00
Event 14 of 22 = 04/15/2012 12:00:00
Event 15 of 22 = 04/29/2012 12:00:00
Event 16 of 22 = 05/13/2012 12:00:00
Event 17 of 22 = 05/27/2012 12:00:00
Event 18 of 22 = 06/10/2012 12:00:00
Event 19 of 22 = 06/24/2012 12:00:00
Event 20 of 22 = 07/08/2012 12:00:00
Event 21 of 22 = 07/22/2012 12:00:00
Event 22 of 22 = 08/05/2012 12:00:00

Upcoming trap schedule: S/N 532
Event 01 of 14 = 07/31/11 12:00:00
Event 02 of 14 = 01/01/12 12:00:00
Event 03 of 14 = 01/29/12 12:00:00
Event 04 of 14 = 02/26/12 12:00:00
Event 05 of 14 = 03/11/12 12:00:00
Event 06 of 14 = 03/25/12 12:00:00
Event 07 of 14 = 04/08/12 12:00:00
Event 08 of 14 = 04/22/12 12:00:00
Event 09 of 14 = 05/06/12 12:00:00
Event 10 of 14 = 05/20/12 12:00:00
Event 11 of 14 = 06/03/12 12:00:00
Event 12 of 14 = 06/17/12 12:00:00
Event 13 of 14 = 07/01/12 12:00:00
Event 14 of 14 = 08/05/12 12:00:00

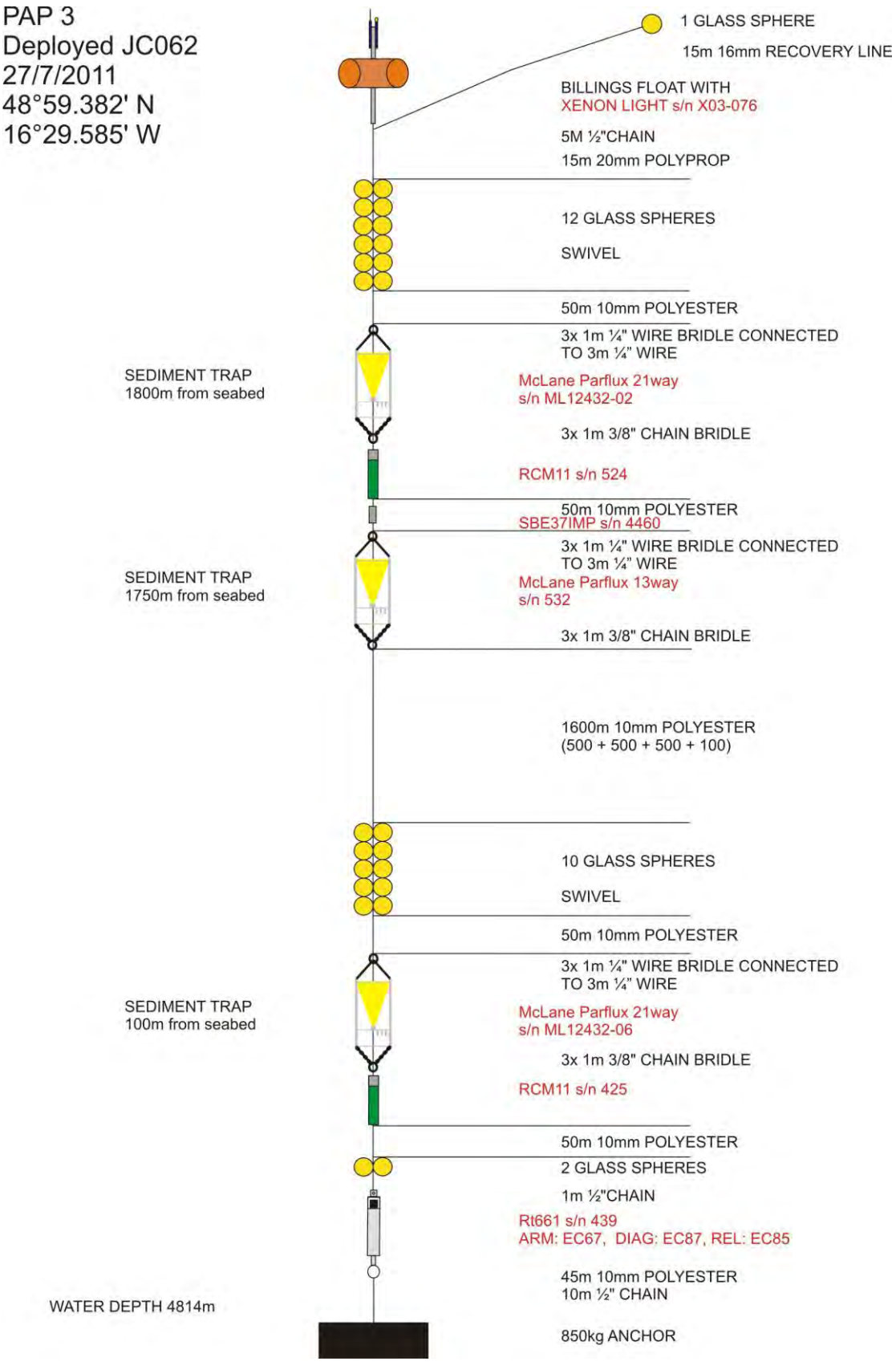


Figure 4.5.1 Mooring arrangement for JC062-018 including the addition of a microcat CTD sensor between the upper two sediment traps.

Deployed systems

RCM11 (s/n 524): had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 08:30 on 26/7/11 with a 30 minute sampling frequency for 6 channels. The acoustic sampling was averaged at 300 pings throughout the 30 min sampling window.

RCM11 (s/n 425): had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 08:30 on 26/7/11 with a 30 minute sampling frequency for 6 channels. The acoustic sampling was averaged at 300 pings throughout the 30 min sampling window.

Parflux sediment trap (s/n ML12432-02): had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling schedule programmed. During deployment the trap was not tilted or inverted.

Parflux sediment trap (s/n 532): had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling schedule programmed. During deployment the trap was not tilted or inverted.

Parflux sediment trap (s/n ML12432-06): had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling schedule programmed. During deployment the trap was not tilted or inverted.

Microcat (IMP 4460): was deployed on the PAP 3 sediment trap mooring at approximately 3025 m. The instrument was calibrated against the CTD on cast 01 and cast 03 at 1000 m and 4800 m respectively (see Appendix II for more details on CTD set up). After the calibration it was programmed to sample every 15 min and deployed on the PAP 3 mooring on 27/07/11.

Acoustic release AR661 (s/n 436): had fresh batteries and was wire tested to 4818 m on 26/7/11.

TYPE RT 661 B2S-DDL
FUNCTION RELEASE TRANSPONDER RT661 - B
SERIAL No. 439
Delivery FEB 2001

Int Frequency Reply Frequency
FR1 = 9.0khz FT1 = 12.5khz
FR2 = 12.5khz FT2 = 9.0khz
FR3 =14.5khz
FR4 = 15.5khz FT4 = 10.0khz
FT0,FT5,FT6,FT7,FT8,FT9,FT10,FT11,FT15 = 12.0khz

Function / Code TT301		Reply	Specifications
WINDOW	EC67	FT0	Wait time sec Active sec
ON FR1-FR2	EC68	FT0	
OFF FR1-FR2-PINGER	EC69	FT0	
RELEASE 1 (W)	EC85	FT0-FT5	
RELEASE 2 (W)	EC86	FT0-FT6	
DIAGNOSTIC(W)	EC87	FT0-FT7	Measure delay sec Vert offset sec
PYROTECHNIC(W)	EC91	FT0-FT11	Wait time s Pulse s
PINGER (W)	EC94	FT0-FT4	Pulse width Ms Recur sec

4.6 Bioluminescence

Kate Larkin, Simon Lunn, Luke Kelly-Granger, Thanos Gkritzalis, Corinne Pebody, & Jackie Pearson

The main aim of this study was to sample and study bioluminescent species of dinoflagellates in the North Atlantic, focusing on the PAP site. Previous studies at the site were conducted in 2009 by Charlotte Marcinko et al. on cruise D341. The D341 study had a) tested modifications to the GLOWtracka instrument used to measure bioluminescence, b) identified bioluminescent dinoflagellates were present at the PAP site through recording bioluminescence and taxonomic composition studies, and c) conducted incubation experiments to assess the controlling factors on bioluminescence including the circadian clock and light intensity.

Building on previous work, the sampling on JC062 (Leg 1) was therefore conducted with two main objectives in mind:

a) to further assess the vertical distribution of bioluminescent dinoflagellates in the upper water column

b) to further assess the impact of natural controls e.g. different light levels on the bioluminescence potential of dinoflagellates

Additional objectives included:

- To characterise the role of luciferin in bioluminescence (assessing how luciferin levels change over the course of a daily cycle and when exposed to different light levels)
- To assess potential bottle effects from using polycarbonate bottles for incubation experiments on phytoplankton community composition or autotrophic : heterotrophic biomass ratios of picoplankton

Bioluminescence was measured with a GLOWtracka bathyphotometer manufactured by Chelsea Technologies Group. The modified set-up for bench-top use with a flow meter and larger settling chamber (see Figure 4.6.1) had been previously tested at the PAP site on D341 by Marcinko et al. and flow variation experiments to test the signal using one, two, three and four litres volumes of water were previously conducted. On JC062, 2L of water were used for each sample. The protocol for bioluminescence measurements involved pouring a 2L sea water sample (collected by CTD cast) into a black settling chamber and leaving it to stand for 5 minutes before processing (see Appendix II for more details on CTD set up). This allowed any bioluminescent cells to rest before being stimulated for measurement. After this time, a data file was created for the sample in the Agilent VEE release 8.5 software. After 5 seconds of recording data, a tap was opened so the sample water flowed at a constant rate through a 2 mm mesh at the base of the black settling chamber. The resulting stimulated bioluminescence was captured by a sensitive photodiode with a sampling frequency of 1 kHz. The water then passed over a flow meter so the rate of flow could be measured. Data files were stored as comma-separated variables (.csv) format. From these measurements the amount of stimulated bioluminescence can be calculated by converting the voltage potential recorded into photons cm^{-2} sec^{-1}.

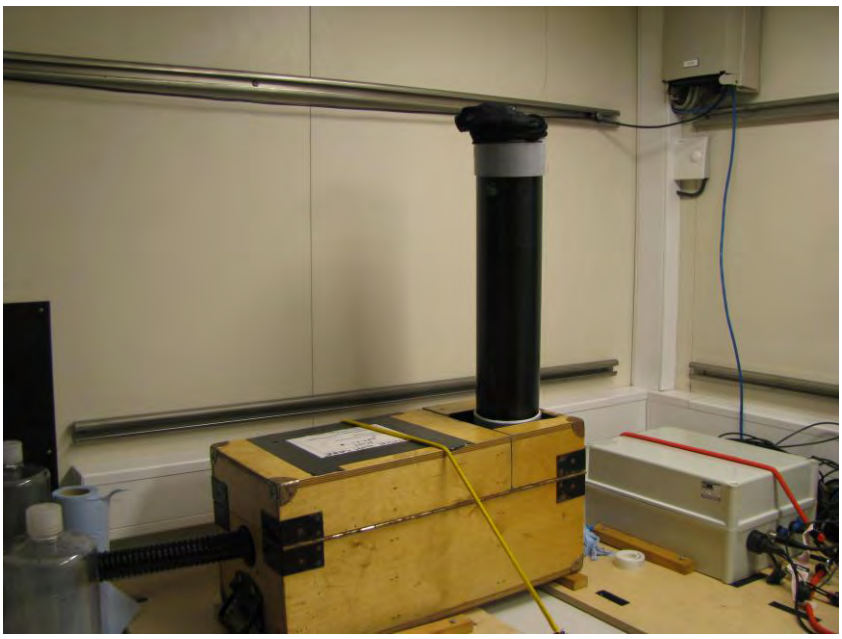


Figure 4.6.1. GLOWtracka set up showing the black settling chamber (tube) and inside a photo diode, flow meter and data logger (grey box) connected to laptop.

Additional biological sampling: From each sampling campaign, water samples were also taken to further assess the community structure of the phytoplankton and picoplankton in samples.

a) *Taxonomic composition of phytoplankton:*100 ml water samples were fixed in 1 ml 2% Lugol's iodine solution containing 10% glacial acetic acid in a brown medicine bottle and sealed with masking tape. Samples were stored in the Controlled Temperature Lab set to 4ºC. These samples were taken for assessing the taxonomic composition of the phytoplankton community.

b) *Flow cytometry analysis of the picoplankton and bacterial community:* 80 µl of paraformaldehyde (20%) was added to a polypropylene 1.5 mL tubes and then 1.6ml of sample water was added and left at room temperature for 1 hour. Samples were then placed in a -80ºC freezer onboard. These samples were also taken throughout incubation experiments to assess any potential effects of bottle enclosure on the autotrophic to heterotrophic biomass ratio in picoplankton during the incubation experiments as an effect from the polycarbonate bottles used (as described by Calvo-Diaz et al. 2011)

c) *HPLC analysis for luciferin:* 2 l of sample water was filtered onto 25 mm GF/F filters for analysis by High Performance Liquid Chromatography (HPLC) to look at luciferin levels. The filter was folded using tweezers dipped in ethanol and placed in a polypropylene 1.5 mL tube and into liquid nitrogen. Tubes were then placed in a -80ºC freezer for storage. Samples could also be used for DNA analysis to look for the presence of the dinoflagellate luciferase gene. All samples prepared for 'other biological sampling' as described above were taken back to National Oceanographic Centre, Southampton, UK for post-cruise analysis.

Water samples for Bioluminescence measurements were taken from a total of 4 CTD casts during JC062 (see Table 4.6.1), including 1 at the Goban Spur site (~ 49.5N, 11.5W) and 3 at the PAP site (~ 49N, 16.5W). The sampling protocol for collecting CTD water was as follows: Water samples were filtered on a 1 mm mesh into collecting bottles or carboys to take out the >1 mm organisms including zooplankton. This was particularly important for the incubation experiments to minimise the change in community composition within the water bottles throughout the experiment through grazing by larger organisms. However, all water samples from CTD casts were sieved on 1mm mesh for consistency with the incubation experiments.

CTD casts were conducted at specific times depending on the research question. 1) To assess the vertical distribution of bioluminescence CTD casts were conducted during the night (~22:30-23:00) to sample a high vertical resolution profile of water from the upper 0-100 m water depth during peak bioluminescence (night-time between ~22:00-02:00). 2) To sample for incubation experiments. At the PAP site (main site), water samples were taken at dawn to enable the incubations to be conducted for a full daylight period before night-time processing. The CTD cast for incubation at the Goban Spur was conducted during the day because time constraints at the Goban Spur site meant that sampling was only possible during the peak daylight period. This incubation was therefore used primarily as a test site for the methods before embarking on the main incubation study at the PAP site.

Table 4.6.1. CTD casts used for Bioluminescence studies. Depths used for incubation studies are marked with *.

Station No.	Depth (m)	Niskin Bottle No.	Sample Time (GMT)	Sample Vol. (L)
JC062-006	5*	17,18,19,20 21,22,23,24	12:26:09	80L
JC062-014	5	24	22:40	6L
	8	22		6L
	15	20		6L
	20	18		6L
	25	16		6L
	30	14		6L
	40	12		6L
	50	10		4L
	75	8		4L
	100	6		4L
				4L
JC062-023	5	24	22:19:40	6L
	8	22		6L
	10	20		6L
	15	18		6L
	19	16		6L
	25	14		6L
	40	10		6L
	50	8		4L
	60	6		4L
	75	4		4L
	100	3		4L
JC062-035	5*	16,18,20,22,24	04:40	42L
	18*	15,14,12,10,8		42L
	30	4		2L
	42	3		2L
	60	2		2L
	80	1		2L

PAP Night CTD casts for Bioluminescence: The horizontal distribution of bioluminescence at the PAP site was investigated by conducting 2 night casts (~11 pm) of the CTD, taking high resolution water profiles between 0-100 m depth and running replicates directly through the GLOWtracka (no incubation).

Incubation experiments: Three incubation chambers (Perspex tanks on stands) were used to conduct experiments to assess how different light levels affect the potential bioluminescence of dinoflagellate communities. Incubators were secured on the aft deck and a continuous through-flow water supply from the surface seawater supply was set up using hosing apparatus to act as a water bath to keep the bottles at an ambient surface water temperature throughout the experiment. Light filters (blue lee filters) were then added in layers to simulate different light levels. Water samples were stored in clear 4.5 l polycarbonate bottles to ensure light penetration during the experiments and water bottles were placed inside the incubators and kept under test light conditions until sampled (see Figure 4.6.2 below).

Previous work on D341 included taking samples from 5 m depth and placing this in different light conditions for the full day cycle before running samples at 1 set time (nominally between 23:00 and 00:00 GMT). On JC062, two different incubation experiments were conducted, one at the Goban Spur and one at the PAP site.

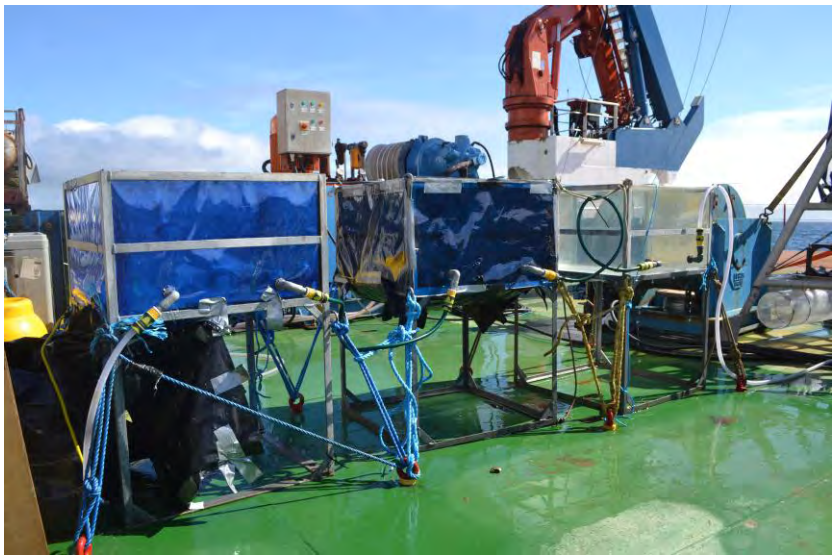


Figure 4.6.2. Incubation chamber set-up on JC062. Example shown from the incubation experiment at the PAP site. Left and middle incubators were used for the PAP incubation experiment with lee (blue) filters fitted in layers to simulate different light intensities. Pluming was set-up to have a continuous flow of sea surface temperature water from the ships non-toxic water inlet into the left-hand incubator and then flowing through into the middle incubator and right-hand incubator before flowing out over the side (the right-hand incubator being filled to maintain the water level in the first two experimental incubators). The incubators acted as a water bath to keep the water bottles at an ambient sea surface water temperature during the experiments.

1. Goban Spur incubation experiment: 26/7/2011 to 27/7/2011: A CTD was conducted at JC062-006 at the Goban Spur site at peak daylight. This site was only occupied during the day so there was no opportunity to conduct a night cast from this site. Because sampling was conducted during daylight, water was only collected at 5 m depth to avoid the issue of sampling different light levels within the water column and keeping these in ambient conditions once on deck. In total 80 l of 5 m depth water was collected from the CTD cast. This was split into 2 x 36 l in clear polycarbonate bottles and placed into 2 incubators set to different light levels to assess the effect of different light intensities on the dinoflagellate communities. A 15 hour incubation experiment was then conducted, starting at 14:00 GMT on 26/7/2011 and finishing at 06:00 on 27/7/2011.
The light conditions were as follows:

Incubator 1: INC1a = 100% light levels using no filters
Incubator 2: INC1b: 55% light levels using 1 x layer of 'misty blue' filter 36 l (5 m depth water)

PAP incubation experiment 31/7/2011 to 1/8/2011: A CTD cast was conducted at station JC062-035 at 04:00 GMT just before dawn at 05:40 GMT. Water was sampled at 2 main depths for incubation experiments. A pre-dawn cast was selected to ensure water was collected during the dark and then the incubation could start at dawn to ensure the water had a full day cycle (sunrise to sunset) in experimental light conditions inside the incubators. The water depths selected for the PAP incubation experiment were 5 m (representative of previous experiments by Marcinko et al.) and 18 m (chlorophyll maximum at the time of sampling) to allow for cross-comparison of results with previous studies and to test the presence of bioluminescent dinoflagellates in the chlorophyll-a maximum. 72 l water was taken from the CTD cast JC062-035 (see CTD log above) and placed directly into 16 x 4.5 l clear polycarbonate bottles darkened with bin liners. At dawn (05:40 GMT) the water bottles were removed from the bin liners and placed in incubators set at 2 light levels as follows:

Incubator 1: 20% light levels using 3 x layer of 'misty blue' filter: 18 l (5 m water) 18 l DCM water (8 x 4.5 l bottles in total)
Incubator 2: 7% light levels using 2 x layer of 'misty blue' filter and 1 x neutral filter: 8l x 5 m water + 18 l x DCM water (8 x 4.5 l bottles in total)

Initial water samples were also taken from each depth and run through the GLOWtracka as a baseline sample. Samples were left in the incubators for a full day cycle from sunrise (05:40 GMT) until sunset (20:45 GMT). A 22 hour time-series experiment was then conducted from 06:00 GMT 31/7/2011 until 04:00 GMT 1/8/2011. After 7 hours incubation time, samples were run through the GLOWtracka at approximate peak daylight (13:00) on 31/7/2011 to measure the lowest potential bioluminescence and then the water samples were left in the incubators for the remaining daylight cycle. At 21:00 on 31/7/2011 just after sunset (20:45) the first night-time sample was taken and run through the GLOWtracka. This night-time sampling was then repeated every hour until 02:00 to record the peak bioluminescence. There was no sampling at 03:00 and the final 2 l sample was run at 04:00 in anticipation of recording the bioluminescence reducing just before dawn (05:44 on 1/8/2011).

Preliminary Results
Early results indicate that the stimulated bioluminescence signal changed over a day-night cycle with peak bioluminescence ~23:00-01:00. Further analysis will be required to distinguish the differences in bioluminescence (and related dinoflagellate species) present at different depth horizons and the response of these dinoflagellate communities to different light conditions from the incubation experiments. Post-cruise processing will include using custom based scripts written in MatLab (The MathWorks, Inc.) to conduct analysis of the Bioluminescence datasets. This will be carried out by Kate Larkin and Charlotte Marcinko at the National Oceanography Centre, Southampton. There is evidence from previous studies that the dinoflagellate communities at the PAP North Atlantic site may be dominated by Gonyaulax (all species), Protoperidinium (some species are bioluminescent-see list) and Ceratium (probably only C. fusus) (Martha Valiadi *pers. comm*.). Analysis of the samples preserved in Lugol's iodine solution is required to determine the full taxonomic composition.

4.7 Dissolved inorganic carbon & phytoplankton sampling.

Denise Smythe-Wright, Diane Purcell & Alex Hart

Objective
The purpose of this work was to collect samples for dissolved inorganic carbon analysis and for the identification and enumeration of phytoplankton using a combination of analytical methods including plant pigment analysis, light and scanning electron microscopy (SEM) and flow cytometry. There were four primary objectives to the work:

- to study the relationship between phytoplankton and carbon chemistry in the ocean.
- to investigate the relationship between individual plant pigments and phytoplankton groups to better classify phytoplankton (possibly even to species level) using pigment ratios.
- to study the movement of pigments and their degradation products throughout the water column and to assess their potential as a food source to the benthos.
- to collect pigment data for the calibration and validation of a new tool for primary productivity measurements being developed under the EU project PROTOOL (see FRRF section).

Methodology: Samples were collected underway from the ships sea water supply at hourly intervals along the transects to and from the PAP site and on an ad hoc basis coinciding with the mooring and benthic operations. A list of the underway stations is given in Table 4.7.1. In addition, samples were collected at up to 12 depth levels at 6 CTD stations; details of these are given in Table 4.7.2 (see Appendix II for more details on CTD set up). All samples were collected, processed and stored as detailed below for subsequent analysis at NOC; results will be available at a later date.

Stand Alone Pump System (SAPS)
A SAPS was brought on the crusie to collect filter samples with various volumes of water pumped through the filters to examin pigments and organic carbon content of suspended particles in deeper section of the water column. Ultimately the need to conduct repeat megacore drops in some areas meant that we were only able to schedule one SAPS deployment. We targeted to 1000 m and 2000 m depth. The weather caused enough of a delay to the SAPS reaching the target depth that the pumps had to run at 600 and 1600 m depth (Station JC062-93).

Dissolved inorganic carbon
Samples were collected directly from the non-toxic supply or from the 10L Niskin bottles into special ground glass topped glass bottles using a small length of narrow bore tubing inserted into the bottom of the bottle. Care was taken to ensure that no gas bubbles were present in the sample by first inverting the bottle and revolving it slowly while returning it to an upright position. Once filled the bottle was flushed from the bottom with three times its volume before inserting the glass stopper. The sample was then opened in a fume hood and 2.5 ml of seawater removed and 50 ul of mercuric chloride added by gently placing the pipette tip below the surface and expelling the liquid. Silicone grease was placed on the stopper and then replaced and sealed into the bottle with tape.

Phytoplankton community
Water samples were collected directly from the non-toxic supply or directly from the 10 l Niskin bottles into plastic 10 l containers. Each sample was then divided for the following:

- *Plant pigment analysis:* 2-6 l of water (dependent on the depth - >200 m requiring 4-6 l) being filtered through 25 mm GFF filters. The filters were placed in cryovials and flash frozen with liquid nitrogen before being transferred to a -80°C freezer.

- *Light microscopy identification and enumeration:* 100 ml transferred to two amber glass bottles one containing 0.4 ml of lugols iodine solution and the other 2 ml of 20% paraformaldehyde solution as preservative. The bottles were stored in a constant temperature laboratory at 8°C.
- *Flow cytometry identification and enumeration:* 1.8 ml pipetted into a cryovial containing 0.2 ml of 20% paraformaldehyde solution as a preservative. These samples were stored at -20°C.
- *Coccolithophore enumeration by SEM:* between 200 -500 ml (sufficient to give colouration) filtered through 25mm 0.8µm membrane filters, which were placed in petri dishes and allowed to air dry before storage.

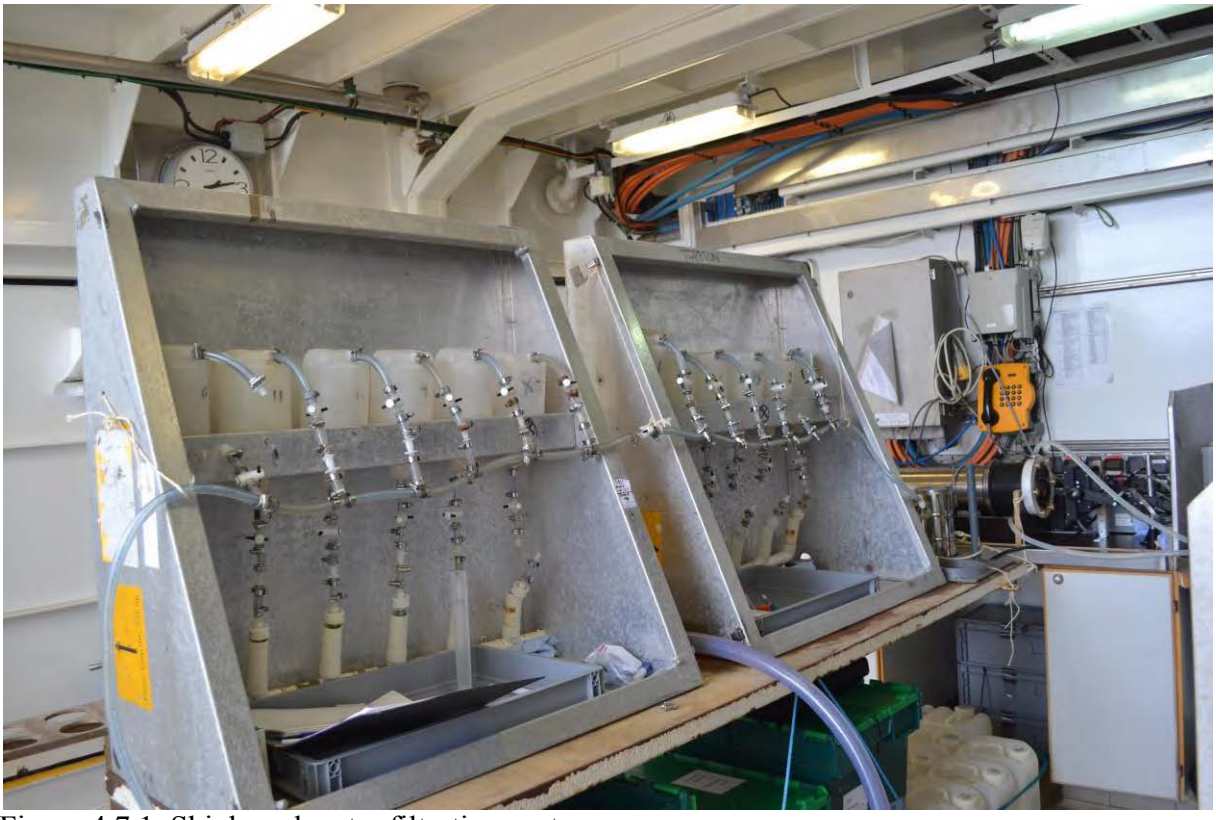


Figure 4.7.1. Shipboard water filtration system.

Table 4.7.1. Underway sampling stations.

Station No	Date dd/mm/yyyy	Time (GMT)	lat	long
JC062 -002:1	24/07/2011	19.00	49° 42.1'	07° 27'
JC062 -002:2	24/07/2011	21.00	49° 43.1'	08° 04.9'
JC062 -002:3	24/07/2011	23.00	49° 43.3'	08° 38.6'
JC062 -004:1	25/07/2011	1.00	49° 43'	09° 11'
JC062 -004:2	25/07/2011	3.00	49° 43'	09° 45'
JC062 -004:3	25/07/2011	5.00	49° 44'	10° 25'
JC062 -004:4	25/07/2011	7.00	49° 44'	10° 55'
JC062 -004:5	25/07/2011	9.00	49° 44'	11° 30'
JC062 -012:1	26/07/2011	2.00	49° 34'	11° 58'
JC062 -012:2	26/07/2011	3.00	49° 31'	12° 20'
JC062 -012:3	26/07/2011	4.00	49° 29'	12° 34'
JC062 -012:4	26/07/2011	5.00	49° 26'	12° 56'
JC062 -012:5	26/07/2011	6.00	49° 25'	13° 10'
JC062 -012:6	26/07/2011	7.00	49° 23'	13° 26'
JC062 -012:7	26/07/2011	8.00	49° 21'	13° 44'
JC062 -012:8	26/07/2011	9.00	49° 19.7'	14° 00.9'
JC062 -012:9	26/07/2011	10.00	49° 16.9'	14° 17.1'
JC062 012:10	26/07/2011	11.00	49° 14.7'	14° 34.1'
JC062 012:11	26/07/2011	12.00	49° 12.7'	14°51.3'
JC062 012:12	26/07/2011	13.00	49° 10.1'	15° 09.9'
JC062 012:13	26/07/2011	14.00	49° 08.3'	15° 26.5'
JC062 012:14	26/07/2011	15.00	49° 06.0'	15° 44.3'
JC062 012:15	26/07/2011	16.00	49° 08.0'	16° 02'
JC062 012:16	26/07/2011	17.00	49° 01.1'	16° 17.8'
JC062 012:17	26/07/2011	18.00	48° 58.5'	16° 29.3'
JC062 012:18	26/07/2011	22.00	48° 59.0'	16° 31.3'
JC062 -015:1	27/07/2011	2.00	48° 50.0'	16° 29.0'
JC062 -021:1	28/07/2011	7.30	49° 00.3'	16° 24.0'
JC062 -021:2	28/07/2011	12.00	49° 00.3'	16° 24.0'
JC062 -021:3	28/07/2011	16.00	49° 00.3'	16° 24.0'
JC062 -021:4	28/07/2011	16.00	49° 00.2'	16° 24.0'
JC062 -025:1	29/07/2011	12.00	49° 00.3'	16° 24.0'
JC062 -029:1	30/07/2011	00:10	48° 50.32'	16° 29.55'
JC062 -029:2	30/07/2011	10.00	48° 50.2'	16° 29.55'
JC062 -029:3	30/07/2011	13.00	49° 00.1'	16° 26.9'
JC062 -029:4	30/07/2011	16.00	48° 50.2'	16° 30.57'
JC062 -029:5	30/07/2011	22.00	48° 50.2'	16° 29.58'
JC062 -034:1	31/07/2011	12.00	48° 50.7'	16° 30.52'

Table4.7.1.Uunderway sampling stations (continued).

Station No	Date dd/mm/yyyy	Time (GMT)	lat	long
JC062 -034:2	31/07/2011	20.00	49° 06.7'	16° 19.9'
JC062 -034:3	31/07/2011	21.00	49° 08.5'	16° 10.03'
JC062 -034.4	31/07/2011	22.00	49° 10.8'	15° 55.5'
JC062 -034.5	31/07/2011	23.00	49° 13.2'	15° 37.5'
JC062 -038:1	01/08/2011	0.00	49° 16.6'	15° 21.5'
JC062 -038:2	01/08/2011	1.00	49° 21.3'	15° 08.5'
JC062 -038:3	01/08/2011	2.00	49° 26.7'	14° 51.8'
JC062 -038:4	01/08/2011	3.00	49° 31.9'	14° 36.9'
JC062 -038:5	01/08/2011	4.00	49° 37.5'	14° 20.2'
JC062 -038:6	01/08/2011	5.00	49° 43.6'	14° 03.4'
JC062 -038:7	01/08/2011	6.00	49° 48.7'	13° 48.6'
JC062 -038:8	01/08/2011	7.00	49° 54.4'	13° 32.7'
JC062 -038:9	01/08/2011	8.00	50° 00.6'	13° 17.3'
JC062 038:10	01/08/2011	9.00	50° 05.5'	13° 03.25'
JC062 038:11	01/08/2011	10.00	50° 11.1'	12° 45.7'
JC062 038:12	01/08/2011	11.00	50° 16.1'	12° 29.8'
JC062 038:13	01/08/2011	12.00	50° 21.9'	12° 14.8'
JC062 038:14	01/08/2011	13.00	50° 27.6'	11° 57.7'
JC062 038:15	01/08/2011	14.00	50° 32.6'	11° 43.8'
JC062 038:16	01/08/2011	15.00	50° 37.2'	11° 21.3'
JC062 038:17	01/08/2011	16.00	50° 41.5'	11° 18.7'
JC062 038:18	01/08/2011	17.00	50° 43.5'	11° 04.1'
JC062 038:19	01/08/2011	18.00	50° 46.2'	10° 50.7'
JC062 038:20	01/08/2011	19.00	50° 51.2'	10° 39.1'
JC062 038:21	01/08/2011	20.00	50° 56.3'	10° 28.2'
JC062 038:22	01/08/2011	21.00	51° 01.5'	10° 16.9'
JC062 038:23	01/08/2011	22.00	50° 06.1'	10° 05.2'

Table 4.7.2. CTD stations for Dissolved inorganic carbon and phytoplankton sampling.

Station	Date	time out (GMT)	Long.	Lat.	# of depths sampled	# of samples HPLC	# of samples SEM	# of samples LIGHT Microscope	# of samples Flow Cyt.	# of samples DIC	Total # of samples
JC062-005	25/07/2011	10:00	11°42.00	49°45.00	9	6	4	4	4	9	27
JC062-006	25/07/2011	11:30	11°42.00	49°45.00	9	6	0	0	0	4	10
JC062-0013	26/07/2011	18.00	16°31.27	48°59.66	9	3	1	1	1	9	15
JC062-0014	26/07/2011	00:00	16°31.40	48°59.20	11	11	9	9	9	11	49
JC062-0023	28/07/2011	06:00	16°23.98	49°00.22	8	8	7	8	8	8	39
JC062-0035	31/07/2011	07:10	06°44.78	56°44.03	6	6	6	6	6	6	30

4.8 Fast Repetition Rate Fluorometer (FRRF) measurements

Denise Smythe-Wright and Diane Purcell

Objective
The purpose of this study was to use a Chelsea *fast tracka* FRRF instrument to better understand the photosynthetic activity of the phytoplankton and hence estimate primary productivity over the entire cruise track. Continuous measurements were made from the ships underway sea water system under variable light conditions. This work, together with the high quality pigment data simultaneously collected, forms part of the EU project PROTOOL (www.protool-project.eu). PROTOOL stands for PROductivity TOOLs and is a 3 year project to develop and adapt technology to measure primary production with automated optical techniques, so that they can be placed on ships of opportunity (SOOP, ferries, container ships). The data collected from this research cruise will be used in the development, calibration and validation of the new instrument.

Methodology
NMFD FRRF instrument (serial number: 182042) was fitted with a continuous flow through cuvette supplied by Jacco Kromkamp, NIOO (Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology) and set with a flow rate of about 1.5 l/min. An LED light panel (also provided by NIOO), which continually cycled through a full rapid light curve in 300 seconds, was placed at a distance of approximately 10 cm in front of the cuvette. The sampling protocol of the FRRF was set to an acquisition sequence of 100 saturation flashes, 20 relaxation flashes per sequence and 3000 m/sec sleep time between acquisitions. The flash duration was of 0.65 µ sec (4 instrument units), and was run in AutoRanging mode (PMT gain=16). Such a sampling protocol provided FRRF fluorescence under varying light intensities in open oceanic waters. The instrument was connected to an HP laptop computer and accessed using hyperterminal. The FRRF's analogue output and logging to internal flashcard modes were disabled and the data was recorded by capturing the text files on the computer. Text files each containing approximately 5600 sequences were saved at approximately 8 hour intervals.

For a correct determination of the quantum efficiency (*fv/fm*) it was necessary to correct the background fluorescence by running blanks. This was achieved by collecting 2L of water from two locations with different environmental characteristics (Goban Spur, and PAP site) and filtering them through 0.2µm polycarbonate filters. Thirty sequences were run in Normal Range mode using all PMT gains (0, 1, 4, 16, 64, and 256) with both light and dark chambers enabled in order to attain minimum and maximum fluorescence.

In addition, the clock that controls the light panel was known to be off by a fraction of a second and so to match the light levels with the FRRF measurements, it was necessary to note down to the exact second (using windows desktop clock) when the LED panel went from the highest light level to no light. This was done at least once a day, to help ensure the precise light conditions for every fluorescence measurement. Nine days of sampling were conducted with an station number to denote each days FRRF sampling (see station list activity 'underway water sampling').

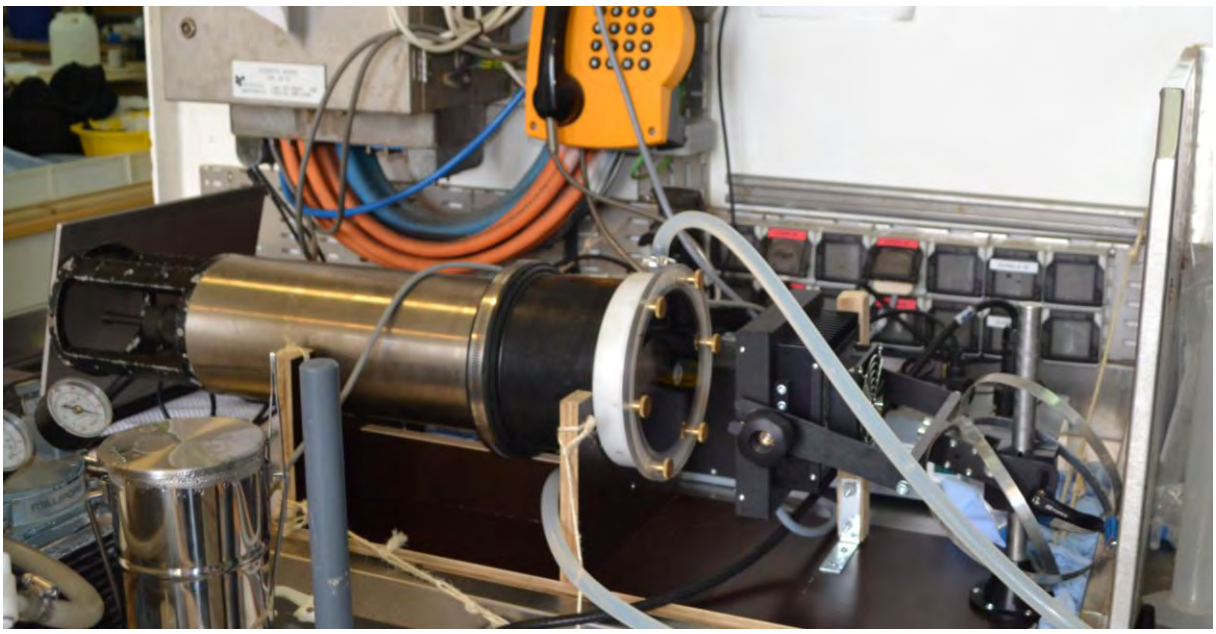


Figure 4.8.1. Chelsea *fast tracka* Fast repetition rate fluorometer used on JC062.

Box coring

Gordon Paterson, Claire Laguionie-Marchais, Lenka Neal, Henry Ruhl

A box coring programme was undertaken at PAP in order to address the following issues. Has the abundance of specific polychaete families or species changed over time? The PAP central site was in the vicinity of previous coring activity at PAP and so samples from here will continue the time series studies, initiated in 1989. Another main purpose of the Box coring sampling is to compare megacorer and box corer polychaete sampling at the site so the change of coring device that occurred in 2002-2006-2009 and 2010 can be accounted for in the time series. And these samples were all preserved in EtOH so that the specimens could be used for molecular analyses.

Box core collection: At PAP central, we aimed to collect 5 replicate samples for macrofauna preserved in absolute ethanol (molecular analyses. A total of 7 deployments were made in the PAP Cent. area. In each case, replicate deployments were conducted at randomly situated points within a circle of 1 kilometre or less. Five deployments were successful and 2 failed (one of them was used as non quantitative sample). Immediately after recovery, the box cores were photographed and measured. During processing, the boxcores were inspected for visually conspicuous organisms and stones. Where possible, these were photographed, carefully picked from the surface and preserved separately.

Sampling processing: The top layer water was removed through 300 micron sieve and the sieved material was concentrated and washed inside the 0-1 cm sampling bucket. Then, the core was sliced into 0-1 cm, 1-3 cm, 3-5 cm layers. The 0-1 cm, 1-3 cm, 3-5 cm layers were sieved and were preserved in 100 % ethanol in a ratio of 1 to 5 (sediment to formalin). Samples will be transported to the Natural History Museum (NHM) where there will be sorted to major macrofaunal groups and polychaetes will be identified to species level using both morphological and molecular methods.

Table 4.9.1 Box coring results

Date	Station	Result
30 July 2011	JC062-030	Failed
30 July 2011	JC062-032	Quantitative sample
30 July 2011	JC062-033	Quantitative sample
12 August 2011	JC062-080	Quantitative sample
12 August 2011	JC062-081	Quantitative sample
15 August 2011	JC062-095	Failed
15 August 2011	JC062-096	Quantitative sample

4.10 Megacoring

Andrew Gooday, Nina Rothe, Claire Laguionie-Marchais, Lenka Neal, Alan Rietdyk & Henry Ruhl

Two main sets of megacores were collected during the cruise, one set for crude oil experimentation (described in the Crude oil spill impact experiments section), and one set for ecological mapping and time-series research purposes around the vicinity of PAP. An extensive megacoring programme was undertaken at PAP in order to address the following questions. Do areas of higher and lower topography (≥ about 10 km spatial scales) have different: 1) sediment characteristics; 2) food quantity and quality in terms of biochemical parameters (bulk organic carbon content, and protein, lipid, and pigment profiles); and 2) microbial, meio, and macrofauna abundances. Replicate megacorer samples for the necessary analyses were collected at three flat sites (PAP Cent., F1, F2; 4812-4820 m water depth) and four somewhat shallower, topographically high sites (H1-H4; 4252-4741 m water depth) within the greater PAP area. The PAP Cent. site was in the vicinity of previous coring activity at PAP and so samples from here will continue the time series studies, initiated in 1989.

Core collection: At each site, we aimed to collect 5 replicate samples for (i) macrofauna fixed in formalin (faunal analyses), (ii) macrofauna preserved in absolute ethanol (molecular analyses), (iii) meiofauna (foraminifera), (iv) prokaryotes, (v) sediment granulometry and (vi) biochemical parameters (Table 4.10.1). A total of 56 deployments were made in the PAP vicinity. The numbers at individual sites were as follows: PAP central (7), F1 (10), F2 (8), H1 (8), H2 (12), H3 (5), H4 (6) (Table 4.10.1). In each case, replicate deployments were conducted at randomly situated points within a circle of 1 kilometre or less. These deployments yielded 254 megacores (100-mm diameter) and 65 multicores (59-mm diameter). The corer was deployed with varying numbers of mega- and multicore tubes, depending on the seafloor characteristics (e.g. degree of resistance to sediment penetration and sediment composition) and the requirement for cores. Success rate varied from zero to 100%; overall, 71.8% and 82.3% of megacore and multicore tubes, respectively, yielded usable cores. Immediately after recovery, the cores were photographed, measured and then taken to the CT laboratory for initial assessment. During processing, the cores were inspected for visually conspicuous organisms and stones. Where possible, these were photographed, carefully picked from the surface and preserved separately (see below).

Core characteristics: Cores that had not obviously slipped ranged in length from 29 to 49 cm, but most were between 32 and 40 cm long. The longest cores came from the Central 1 (39-49 cm), Central 5 (40-46 cm) and H1-4 (46.5-48.5 cm) sites; elsewhere they rarely exceeded 40 cm. The appearance of the cores varied between sites, and also between replicate sampling points within a site. Cores from F1-1 and F1-2 were a uniform light greyish colour, as was one of the cores from F1-3 (JC062-101). The second core from F1-3 (JC062-67) had a distinct whitish horizon near the

base. A similar feature was evident at F2-4 and F2-5. Cores from the H sites were quite variable. Some were a fairly uniformly light in colour with some slight darkening and mottling near the base (H1-1, H1-5, H2-4, H3-3). In other cases (H1-3, H2-2, H2-3, H2-5, H4-2, H4-3) the lower quarter to a third of the core was distinctly darker, sometimes with a hint of a narrow greyish band between the two zones. A dramatic black patch was visible through the wall of a core from H4-3. When excavated, this proved to be a compact mass of crumbly dark material.

Table 4.10.1: Number of deployments for each site and number of cores for each purpose.

Site	Megacorer system deployments	Sed. tubes	Foram. tubes	Prokary. tubes	Biomar. tubes	Molecular Macrof. tubes	Formalin Macrof. tubes
PAP Cent.	7	5	5	5	5	5	23
F1	10	5	4	5	4	5	21
F2	8	5	6	5	5	4	22
H1	8	5	5	5	5	6	16
H2	12	6	4	5	5	4	19
H3	5	5	5	5	5	6	16
H4	6	2	3	5	5	4	12

Picked organisms : Visually conspicuous organisms and stones were picked opportunistically from core surfaces (Table 4.10.2). The organisms removed included three species of xenophyophores: *Galatheammina erecta* (5 specimens), *Reticulammina* sp. (3) and *Aschemonella* sp. (1). Of particular interest were two specimens of the enigmatic foraminiferan *Arborammina* in one core from Site H2-5 (JC062-090). This monotypic genus has never been reported since it was described from the Madeira Abyssal Plain in 1994. The stones provided substrates for various organisms. Some were encrusted with the foraminiferan *Telammina* and various agglutinated domes and mat-like formations. Several hosted hydroids or long narrow curved tubular structures interpreted as foraminiferans. It is notable that, with the exception of a specimens of *G. erecta* from Site F1-1, all of these larger epifaunal organisms were found at the 'high' (H) sites. These elevated locations may be more favourable for suspension-feeding organisms than the deeper flatter areas (F sites).

Table 4.10.2. Stones and organisms picked opportunistically from cores (EtOH = 100% Ethanol preserved).

Station	Site	Depth	Picked stones	Picked organisms
51	H1-1		1 Stone	
52	H1-1	4646		Hydroid on stone
53	H1-2	4650		*Galatheammina erecta, Reticulammina* sp. (xenos)
70	F1-1	4819		*Galatheammina erecta* (xeno
77	F2-7	4818		Projecting tube
88	H2-3	4742	Stone, clinker	
89	H2-4	4743	5 stones	Hydroid on stone
90	H2-5	4744		*Arborammina* (2)
92	H2-2	4744	Several stones	Encrusting forams on stones
101	F1-3	4818		'Drum stick'
105	H3-1	4620	Various dropstones	Encrusting forams and hydroid on stones
108	H3-3	4624	3 stones	
116	H3-2	4618		*Rhizammina* (EtOH)
117	H2-3	4741		*Rhizammina* (EtOH)
123	H4-1	4284		Tubular species (*Marsipella*-like)
125	H4-3	4286	3 stones	(i) Long, narrow erect tube on stone; (ii) 2 fat tubes on stone; (iii) *Galatheammina erecta*
126	H4-4	4252		*Galatheammina erecta, Reticulammina* sp.
127	H4-5	4263		*Galatheammina erecta*
128	H4-2	4280	Clinker; 2 stones	(i) Long, narrow erect tube; (ii) *Rhizammina* (EtOH); (iii) *Reticulammina*; (iv) Worm associated with faecal material
129	H2-5	4744	Several stones	(i) Long, narrow erect tube; (ii) ?xenophyophore; (iii) ?Polychaete in projecting tube
130	H2-5	4742	Small stone	*Aschemonella* (xeno) with attached *Telammina* and worm tube.

Sampling protocols:

Foraminifera: Small multicore samples were sliced into the following layers: 0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0 cm, then 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10 cm. Each layer was placed in a 500 ml plastic Nalgene jar and fixed with 10% buffered formalin.

Prokaryotes: Disposable gloves were worn throughout the core-cutting process. Megacore samples were sliced into the following layers: 0-1, 1-2, 2-3 cm, then 3-5, 5-10, 10-15 cm. The edges of each layer were first trimmed with a knife before being placed in a plastic zip-lock bag. Between each slicing event, the sediment was first washed off the plate, knife and cutting ring with water. All surfaces that could come into contact with the inner part of the core (cutting plate, knife, gloves) were then rinsed with ethanol. The slices from one core were placed inside a larger zip-lock bag and put in the -80° freezer.

*Biomarkers:*Megacore samples (Table 4.10.3) were sliced into the following layers: 0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0 cm, then 2-3, 3-4, 4-5, 5-6, 6-8, 8-10 cm. Each slice was transferred into a labelled petrie dish lined with muffled foil, maintaining slice integrity as far as possible. The rim of the petri dish was taped to secure the sample. If the petrie dish could not be closed fully, the foil was wrapped around the exposed sediment and taped in place. After each section had been sliced, the slicing plate was cleaned by washing in seawater and then rinsed with MilliQ distilled water, using awash bottle. All petrie dishes from one sample were placed in a plastic bag and stored in the -80°C freezer.

Sediment granulomtery: Multicores, or if these were not available megacores, were sliced into the following layers: 0-1, 1-3, 3-5, 5-10, 10-15 cm. Each slice was placed in a labelled plastic bag. All bags from one core were transferred into a larger plastic bag and stored in a refrigerator.

Formalin macrofauna: The top layer water was removed through a 300 micron sieve, the sieved material concentrated and washed into the 0-1 cm sampling bucket. Then, the core was sliced into 0-1, 1-3, 3-5, 5-10 and 10-15 cm layers. The 0-1, 1-3, and 3-5 cm layers were bulk preserved in 20 % formalin (sediment to formalin ratio 1 to 5) without sieving. The 5-10 and 10-15 cm layers were sieved through a 300 micron sieve and the sieved material was concentrated and washed into sampling buckets. Twenty % formalin was added in a ratio of 1 to 5 (sediment to formalin).

Molecular macrofauna: The core-top water was removed through a 300 micron sieve and the sieved material was concentrated and washed inside the 0-1 cm sampling bucket. Then, the core was sliced into 0-1, 1-3, 3-5, 5-10 and 10-15 cm layers. The 0-1, 1-3 and 3-5 cm layers were sieved and were preserved in 100 % ethanol (sediment to ethanol ratio 1 to 5). Samples will be transported to the Natural History Museum (NHM) where they will be sorted to major macrofaunal groups and polychaetes will be identified to species level using both morphological and molecular methods. The 5-10 and 10-15 cm layers were added to the formalin macrofauna samples and processed as described above. Several 'failed' cores that could not be used for other purposes were preserved in alcohol as non-quantitative molecular samples (Table 4.10.4).

Stable Isotope Anaysis (SIA): In order to establish an approximate reference point for the trophic level of the benthic system for SIA, a small number of benthic sediment samples were collected opportunistically from the megacore deployments being conducted for other purposes during the cruise. These samples were taken using a piece of clean foil to remove approximately the upper 0.25 cm (Drazen *et al.* 2008) of the sediment from a 10 cm diameter multicore sample, which was transferred into a small plastic bag and stored immediately at -80°C. A list of the sediment samples taken is shown in Table 4.10.5.

Table 4.10.3. Samples taken for biomarker analysis

Deployment	Depth	Site
JC062-16	4818	PAP Cent. 1
JC062-20	4815	PAP Cent. 2
JC062-28	4815	PAP Cent. 3
JC062-36	4814	PAP Cent. 4
JC062-52	4646	H1-1
JC062-53	4650	H1-2
JC062-60	4645	H1-4
JC062-61	4645	H1-5
JC062-66	4819	F1-2
JC062-67	4818	F1-3
JC062-69	4818	F1-5
JC062-70	4819	F1-1
JC062-73	4818	F2-1
JC062-74	4816	F2-2
JC062-76	4816	F2-4
JC062-77	4818	F2-5
JC062-88	4742	H2-3
JC062-89	4743	H2-4
JC062-91	4747	H2-1
JC062-92	4744	H2-2
JC062-97	4812	PAP Cent. 5
JC062-105	4620	H3-1
JC062-108	~4620	H3-3
JC062-109	4610	H3-4
JC062-110	4620	H3-5
JC062-112	4812	F2-3
JC062-114	4651	H1-3
JC062-116	4618	H3-2
JC062-123	~4290	H4-1
JC062-125	4300	H4-3
JC062-126	~4330	H4-4
JC062-127	~4285	H4-5
JC062-128	~4295	H4-2
JC062-129	4744	H4-5

Table 4.10.4. 'Failed' cores used as qualitative macrofaunal samples for molecular analysis

Date	Station	Site	Sampler	Notes
04/08/2011	JC062-51	H1-1	megacore	2 cores mixed (each ca 6cm layer)
13/08/2011	JC062-86	H2-1	megacore	2 cores mixed, (each ca 5cm layer)
13/08/2011	JC062-87	H2-2	megacore	1 core (ca 5cm layer)
15/08/2011	JC062-95	PAP Cent.	box core	ca 3cm layer
21/08/2011	JC062-117	H2-3	megacore	1 x core (ca 10cm layer)
21/08/2011	JC062-118	H2-5	megacore	2 cores mixed (top few cm)
21/08/2011	JC062-123	H4-1	megacore	1 core (ca 5cm layer)
22/08/2011	JC062-124	H4-2	megacore	2 cores mixed (each ca 10cm layer, split into 2 sampling pots)

Table 4.10.5. Sample numbers and site names for SIA sediment reference collections.

Deployment	Site ID	Deployment	Site ID
JC062-052	H1-1	JC062-091	H2-1
JC062-053	H1-2	JC062-092	H2-4
JC062-060	H1-4	JC062-097	PAP5 (x2)
JC062-061	H1-5	JC062-098	PAP1 (x2)
JC062-068	F1-4	JC062-100	F1-2
JC062-069	F1-5	JC062-101	F1-3
JC062-075	F2-3	JC062-106	H3-2
JC062-088	H2-3	JC062-109	H3-4
JC062-089	H2-4	JC062-110	H3-5

4.11 Crude oil spill impact experiments

Charlotte Main, Daniel Jones, & Henry Ruhl

Three sediment core incubation experiments were conducted using 10 cm diameter cores collected from the seabed at the Goban Spur. The aim of the experiment was to measure oxygen consumption in sealed microcosms, some of which were treated with a water accommodated fraction of crude oil (WAF). Measurements and samples were taken to establish the demands of oxygen (mainly by the sediment community) and to provide some potential for interpretation of the result.

At the Goban Spur, water was collected from as near to the benthic boundary layer as possible using the CTD. The water was stirred in the dark at low energy for 24 hours with crude oil (Wytch Farm crude oil, Dorset, UK) to form a water accommodated fraction (WAF). Sediment cores were collected from the same location and transferred to a modified fridge. The WAF was added in treatment dilutions. The sediment cores were then sealed and oxygen measurements were subsequently measured in small (32 ml) water samples that were removed from the microcosms. The water samples were frozen for possible later nutrient analysis. Oxygen measurements were taken using an optode oxygen sensor. Samples of WAF were preserved for later hydrocarbons analysis.

Table 4.11.1. Number of cores and treatment types in each experimental run

Experimental run	Date collected	Time run (days)	Number of cores incubated	Number of background cores	Treatments (% WAF in core overlying water)
1	25 July 2011	5	11	1	0, 50
2	03 August 2011	4	23	7	0, 25, 50, 85

At the end of each experiment the incubated cores were sliced at sediment horizons 0-1cm; 1-2cm; 2-5cm; 5-10cm. Samples were kept either frozen (-80°C) or in 10% formalin for possible later analyses, which could include prokaryote gene sequencing; faunal size distribution or faunal abundance of taxa. The extent of these future analyses will depend on funds, time and relevance. Some cores were collected to be used as a comparison to "background" levels for these analyses. The number of cores collected for this purpose is shown in the table above.

Water experiments
In addition to the sediment cores experiments, three core tubes were filled with the near bottom seawater and incubated with the sediment cores at the time of the first experimental run. A further experiment was conducted using near bottom seawater at the time of the third experimental run. In this experiment, sixty 250 ml bottles were filled with water or water and WAF and then sealed. Treatment levels were established to reflect those chosen for the third sediment cores experiment (i.e. 0%; 5%; 15%; and 25% WAF). At intervals of opportunity, sets of five replicates from each treatment were opened and the oxygen concentration in the water was measured.

Oxygen reductions were observed in all of the incubated cores. Oxygen was depleted at a faster rate in some of the treated cores than in the controls, although there was high variance in the result at some of the treatment levels all of the data have not been processed yet. Oxygen reductions were observed in the water-only experiment but these were generally very small in comparison to the oxygen reductions seen in the sediment cores.

4.12 Baited camera lander

Alan Jamieson & Stuart Piertney

This system was used to evaluate the abundance and diversity of demersal scavenging fish of the Porcupine Abyssal Plain (NE Atlantic). The diversity and abundance of deep-sea scavenging fish, particular of the family macrouridae, has received regular sampling effort over the last 20 years. The main objective of the University of Aberdeen participants was to continue the long-term time series through the use of repeated standardised baited camera lander deployments and OTSB trawling at depth of ca. 4800 m (see OTSB section).

On JC062, six baited camera lander deployments, comprising a total of 15,942 images were obtained at depths ranging from 4668 to 4844 m. Four of these deployments were dedicated to the long term standardised experiments where by the lander is tethered two meters above the seafloor looking vertically down at ~0.5 kg of mackerel bait. The time course of interception and dispersal of bait was observed by a 5 mega pixel digital camera at one minute intervals. A second camera was placed on the lander orientated down stream with the aim of testing the hypothesis that many fish perhaps remain in the vicinity but down current of the main feeding activity. The results showed that, as predicted, the dominant scavenging fish was the macrourid *Coryphaenoides armatus*, with much less frequent visitation by the synaphobranchid *Histiobranchus bathybius*, and the ophidiids *Barathrites iris* and *Bassozetus* cf. nasus. The preliminary analysis, although subject to more detailed analysis post cruise, do not show any evidence of change from that of historical records in either diversity or macrourid abundance. The down current facing camera did not show any conspicuous signs of fish waiting on the down current periphery.

The other two deployments were rigged in horizontal mode whereby the lander sits directly on the seafloor. This was to collect scavenging amphipods for ongoing phylogenetics and DNA barcoding

work and, to obtain horizontal lateral images of the fish fauna. The lateral shots we intended to examine whether the macrourid population where indeed all *C. armatus* as confident species ID from vertical photography is often difficult. The result showed that although a second macrourid, *C. profundicolus*, was observed, they appeared in extremely low numbers. The amphipods collected were processed for use as described in the OTSB biopsies for population genetics (Piertney).

Table 4.12.1. Details of the Oceanlab baited lander deployments on JC062.

	Deployment (Station)					
	1 (046)	2 (062)	3 (072)	4 (083)	5 (102)	6 (120)
Date	04-AUG	08-AUG	10-AUG	13-AUG	17-AUG	21-AUG
Time (GMT)	18:58	06:46	08:20	05:25	09:32	11:14
Latitude-N	48°59.0164'	49°04.8982'	48°52.3531'	49°05.157'	48°57.69519	49° 04..236'
Longitude-W	16°43.7919'	16°40.2540'	16°17.7544'	16°18.998'	'	16° 15.894'
Mode	Vertical	Horizontal	Vertical	Vertical	16°32.77478	Vertical
Sounding	4660m	4819m	4817m	4740m	'	4608m
Pressure	4776.9 dbar	4942 dbar	4936 dbar	4874 dbar	Horizontal	4464dbar
Depth	4668m	4844m	4840m	4780m	4684	4383m
Bottom time	34hr 38min	24hr 32min	22hr 33min	25hr 25min	4793dbar	19hr 22min
Image Cam1	1965	1472	1353	1525	4700m	1162
Image Cam2	1533	1463	1329	1109	19hr 19min	817
Total	3498	2935	2682	2636	1159	1979
Image#	2.57°C	2.57°C	2.57°C	2.56°C	1053	2.52°C
Temperature					2212	
					2.56°C	

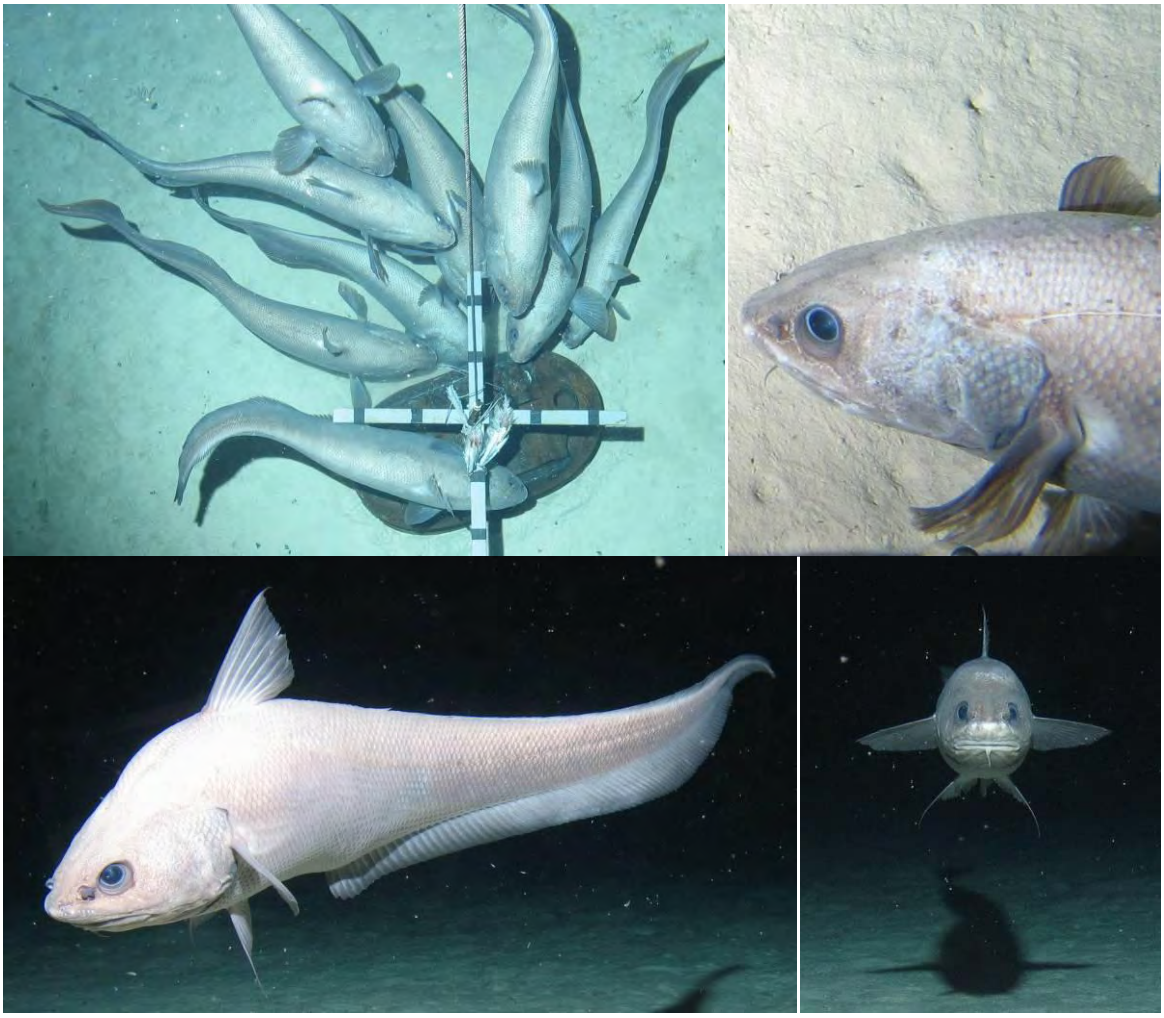


Figure 4.12.1 The abyssal grenadier *Coryphaenoides armatus* at ~4800 m as imaged from the vertical, oblique and horizontal camera.

4.13 Amphipod trap

Ben Boorman &Chrysoula Gubili

The new baited amphipod trap was deployed and recovered at each of the PAP area sites visited during the 2nd leg. The new system (used during the 2010 ECOMAR cruise consists of 4 traps (2 benthic, 2 ~1 m off the seafloor). Whole samples preserved in molecular grade ethanol (100% EtOH) for later sorting by led Tammy Horton at NOC. All traps were baited with mackerel and had amphipods with the lower traps generally having much higher numbers.

Table 4.13.1 Amphipod trap deployment and sample storage details.

Date	Station	# of 500ml containers	# of 5L containers	Soak time (hrs)
04/08/11	JC062-048	1	3	37.5
08/08/11	JC062-063	1	3	27.3
10/08/11	JC062-072	2	2	29.9
13/08/11	JC062-084	2	2	28.8
17/08/11	JC062-103	3	1	29.9
21/08/11	JC062-121	3	1	21.8

4.14 Otter Trawl Semi Balloon (OTSB)

Ben Boorman, Andy Gooday, Chrysoula Gubili, Juliette McGregor, Camilla Sharkey, Stuart Piertney, Rosanna Milligan, Alan Rietdyk & Henry Ruhl

Basic trawl methods
We conducted three otter trawls using a semi-balloon stretch mesh net (OTSB-14) with a spread of 8.6 m. The stretch mesh is 44 mm in the main part of the net, 37 mm in the middle and 13 mm in the cod end liner. The system was towed across the seafloor at about 2 knots, which was limited by the amount of wire on the drum. About 11,300 m of wire was useable. This speed likely restricted the number of fish caught. An acoustic beacon was used to monitor the net on the seafloor and a towed fish with a stern looking receiver was used to pick up the signal with good success.

The first of the three trawls took longer to conduct and recover than planned due to overheating of the traction winch and scrolling problems. It came on deck after dawn and the bridal was initially entangled with thick filament fishing line. A large tear was also found in the net rendering the catch unsuitable for quantitative sampling. After some effort the line was removed and the haul was processed for tissue and specimen samples. The second and third trawls went well with both coming on deck during darkness and having good quantitative samples.

Once the trawl was on deck the haul was placed into large tubes and sorted to major taxa. The fish were removed first to reduce their exposure to light for eye physiology study. And the deck lights were reduced once the safety lines were up for the last two trawls, which came on deck during the night. Below are descriptions of the tissue and specimen sampling. In addition the last two trawls also had wet weight biomass measured with a seagoing balance for each of the major taxa. The

layback corrected trawl distances were JC062-059 14,200 m, JC062-089 13,419 m, and JC062-113 12,813 m.

Physiological and genetic studies into the effect of elevated pressure on deep sea photoreceptors (McGregor & Sharkey)

In contrast to our considerable depth of understanding of visual pigment spectral tuning in deep sea animals, other aspects of their photoreceptor physiology are much less well understood. In particular, how the retinal photoreceptors are adapted to function at high hydrostatic pressures. Given the problems of conducting either behavioural or physiological experiments on deep sea fish, we are adopting a combination of molecular biological and physical measurements to tackle this topic.

We have evidence that visual pigment proteins (opsins) are remarkably pressure tolerant compared with many other proteins. Experiments in our laboratory have shown that high pressures have very small affects on visual pigment absorption or wavelengths of peak absorption (λ_{max}) when visual pigments are measured by standard spectrophotometric methods in detergent extract. In such experiments spectral shifts in λ_{max} of less than 1 nm are typical even at pressures equivalent to average ocean depths. Such small changes that do occur can also be related to opsin sequence in a way potentially analogous to visual pigment spectral tuning in which key amino acids act as 'tuning sites' as well as the proportion of hydroxylated amino acids. What is unknown, however, is the effect of elevated pressures on visual pigments when they are in their native environment within the lipid membranes of photoreceptors. In such conditions, protein conformation may well be different at elevated pressures, not least because water molecules will be less able to interact with protein tertiary structure. There is, therefore, the possibility that deep sea fish visual pigments may show more pressure related effects than is currently appreciated.

We also aim to initiate investigations into other proteins (e.g. transducin, arrestin) concerned with visual transduction and the ability of visual pigments to regenerate after bleaching, in order to ascertain how these have evolved to suit the needs of deep sea fish. Our predictions are that these key components of transduction in deep sea fish rods will favour low noise and slow kinetics; what is completely unknown is how and if their kinetics are affected by hydrostatic pressure. As a first step to understanding such adaptations we will sequence these proteins (and the genes encoding them) from a range of deep sea fishes.

Methods

During JC062 we have collected retinae and from deep sea fish and crustaceans, preserving the samples in a variety of ways including freezing of cryopreserved tissue for spectrographic study, and collection in RNALater and ethanol for molecular biological study. Some samples will be used to determine directly (by microspectrophotometry) the affect of elevated hydrostatic pressure on visual pigment absorption spectra and the fluidity of cell membranes when measured in single rod photoreceptors. Other samples will be used to sequence key enzymes involved in visual cell phototransduction (e.g. transducin, arrestin).

In order to protect photo-labile retinal pigments from exposure to light two of the three catches were brought up in darkness. Fish were quickly transferred from the trawl cod end to a dark room in fish baskets, doubled lined with black bin bags.

Under dim red light, fish were weighed (The mass data were passed to Rosanna Milligan for collation) and eye diameters measured. In the cases of fish with missing eyes the socket diameters were measured. Eyes were removed from the fish and stored in aluminium tubes with a few

millimeters of tris buffered saline and cooled on ice. The fish bodies were passed on to Stuart Piertney from the University of Aberdeen for tissue sampling and Rosanna Milligan at University of Glasgow for biometry, identification and preservation in 10% formalin. Species identification will be confirmed on shore.

Once all fish were processed, retinal tissue was removed and placed into either sucrose or dextran cryoprotectant solution for microspectrophotometry or RNAlater for molecular biology. The RNA samples were incubated overnight at 4^{o}C and then frozen at -20^{o}C. The retinal samples in cryoprotectant were placed in the 4 degree refrigerator for 1hr followed by 1-2hrs in the -20^{o}C freezer before transfer to the -80^{o}C freezer.

Crustacean specimens were collected weighed and processed by Colette Cheng and Alex Hart on behalf of Bristol University. Total biomass data was collected and added to the trawl data. A subset (three specimens for each species, except in the case of the first trawl where 33 samples in total were taken) of the crustacean catch were labelled and photographed for subsequent identification. Light exposed crustacean eyes and tissue were collected from these labelled specimens for molecular biology. Eyes were punctured and preserved in RNA later. Tissue samples were also taken and preserved in ethanol for subsequent DNA analysis. These samples were then incubated overnight and then frozen at -20^{o}C.

Results

Retinal samples were obtained from 85 fish in total as some of the catches were brought up eyeless. (Table TBC). Sixty-nine crustaceans were labelled and processed (Table TBC).The major outcome of this expedition has been tissue collection for subsequent analysis at the University of Bristol and the University of Maryland, Baltimore Country. All collected tissue will be shipped to the University of Bristol except the preserved crustacean specimens, which will be shipped to NOC, Southampton.

Biopsies for population genetics research (Gubili)

Samples of various benthic megafauna were collected from the Porcupine Abyssal Plain for molecular biological analysis using various protocols (e.g. in 100% molecular grade ethanol or fixed in 10% formalin). The intention is to examine the change in genetic diversity of particularly holothurian populations spatially and with time in the NE Atlantic. This comparison will use samples held in collections (Discovery collection held at NOCS) and specimens collected from the Porcupine Abyssal Plain, Mid Atlantic Ridge and *RRS James Cook* cruise 036.

Preliminary results analyses on two mitochondrial genes, the 16S and COI, suggest the paraphyly of both Laetmogonidae and Elpidiidae families, of the Elasipodida order. Correspondence to publicly available sequence data on GenBank (NCBI) and Barcode of Life Data Systems (BOLD) exhibited average values of holothurian homology (80%-94%). Such numbers can be attributed to the lack of an adequate Elasipodida dataset in the public domain compared to a larger dataset of the commercially targeted Aspidochirotida. Furthermore, preliminary analyses of two cosmopolitan holothurian species (*Psychropotes longicauda* and *Oneirophanta mutabilis*) on the same genes, have shown the genetic isolation and geographic structure in three populations found in different ocean basins, the North Atlantic, the North East Pacific and the Indian Oceans.

Overall, 253 samples of holothurians have been collected over three trawls (Table 4.14.1). The 119 specimens of *P. londicauda* and *O. mutabilis* will be used to refine the genetic resolution and the population structure of both species in the N. Atlantic waters. Moreover, 26 biopsies belonging to the Elasipodida order (Amperima sp., Benthodytes sp., Peniagone sp. and *Deima validum*) have also

been sampled in order to investigate phylogenetic affinities and evolution of the order, whilst two unidentified specimens (2nd trawl) will be identified taxonomically using DNA barcodes. Additionally, nine samples of the Molpadiida order (Molpadia sp.), 39 of the Aspidochirotida order (Paroriza sp. and Pseudostichopus sp.), eight of asteroidea and eight of cephalopods were also added to the collections for future research.

Table 4.14.1: Biopsies collected from three trawls.

Collected Species	JC062-059	JC062-082	JC062-113
Psychropotes longicauda	29	30	30
Oneirophanta mutabilis	30	30	30
Molpadia sp.	7	0	2
Pseudostichopus sp.	5	10	10
Peniagone sp.	7	0	0
Benthodytes sp.	3	0	4
Paroriza sp.	4	5	5
Amperima sp.	0	3	6
Deima validum	0	2	1
Unidentified	0	2	0
Asteroidea	0	8	0
Octapoda	0	2	4
Cephalopoda	0	0	2

Biopsies for genetics research (Piertney)

Tissue biopsies were taken from fish and invertebrate samples collected from the OTSB trawls (stations JC062-059, 083 and 113) and baited-lander deployments (stations JC062-062 and 102) to serve as sources of DNA and RNA for several different molecular studies:

DNA Barcoding: DNA barcoding is a taxonomic method that uses a short region of the mitochondrial cytochrome oxidase I gene as a diagnostic marker to identify an individual as belonging to a particular species. The utility of DNA barcoding is contingent on public libraries of DNA barcodes that have been linked to named specimens that allow unknown samples to then be identified. Whilst these databases are well populated with barcodes from some groups and habitats, others, especially the deep sea, are less well represented. An overarching goal here was to collect samples for barcoding from all fish and invertebrate species sampled where DNA quality and quantity is sufficient to generate unambiguous DNA sequence. In all cases a biopsy was taken into 100% ethanol and RNA later, with immediate storage at -20°C. The remainder of the sample was preserved in 10% borax-buffered formalin in seawater as a voucher specimen. The following groups, with the number of putative species, were sampled: asteroids (n=4); crinoids (n=1); cephalopods (n=4); holothurians (n=3); gastropods (n=2); pycnogonids (n=1); ophiuroids (n=2); actinarians (n=2); poriferans (n=2); bivalves (n=1); amphipods (n=5); polychaetes (n=2); decapods (n=3). DNA extraction, then PCR and DNA sequencing of the mtDNA COI locus will commence as soon as possible after return to the UK. Voucher specimens will be sent to taxonomic experts to confirm preliminary identifications.

Molecular phylogenetics: A perceived disadvantage of the DNA barcoding approach is that the PCR amplicon is too small to provide the resolution necessary to determine evolutionary relationships below the species level. As such, DNA sequence data will also be generated from the fish and amphipod species that allows evolutionary histories to be reconstructed. For the fish species caught in the OTSB trawls (stations 059, 083 and 113), PCR fragments for the mitochondrial 16S and nuclear 18S ribosomal RNA genes will be sequenced to resolve species phylogenies. For the amphipods from baited lander deployments (stations 062 and 102), gene trees

will be produced from multiple candidate genes to examine the signature of selection associated with the deep sea environment.

Gene expression analysis: Isolation and subsequent sequencing of the mRNA population present in a tissue biopsy provides a snap-shot of the genes being upregulated in that individual at that time. Accumulated data across individuals can then be used to define the exome of a species, the component of the genome that is formed from the coding regions of genes. Here, aims are to: (i) characterise the genes of the major histocompatibility complex (MHC) among fish species to examine levels of genetic diversity and evolutionary signatures of balancing natural selection relative to shallow water equivalents, and (ii) produce a cDNA library from *Coryphaenoides profundicolus* from which part of the exome that can be examined. To this end, liver (n = 85) and gill (n = 21) tissue biopsies were taken from fish samples from OTSB trawls (stations 059, 083 and 113) which was immediately stored in RNALater and placed at -20°C. Upon return to the UK, mRNA will be extracted from these samples, converted to cDNA and PCR products from the MHC generated for sequence analysis. Species orthologues will be aligned and the ratio of synonymous to non-synonymous mutation calculated for each species as an indicator of selection. For *Coryphaenoides profundicolus*, where n = 58 individuals were sampled, levels of within-species diversity (no of alleles and heterozygosity) will be calculated, and a cDNA library generated then sequenced.

Biomarker reference collections (Rietdyk)

In addition to the sediment material collected for biomarker analysis, samples of holothurian tissue were taken from each of the 3 trawl catches (Table 4.14.2). Each sample was weighed and individually wrapped in aluminium foil and stored in bags at -80°C.

Table 4.14.2. Holothurian species from which tissue samples were taken for comparison with sediment biomarker samples.

Trawl	Species	Quantity
JC062-59	*Psychropotes longicauda*	5
JC062-59	*Oneirophanta mutabilis*	5
JC062-82	*Psychropotes longicauda*	5
JC062-82	*Oneirophanta mutabilis*	5
JC062-82	*Pseudostichopus* spp.	5
JC062-113	*Psychropotes longicauda*	5
JC062-113	*Oneirophanta mutabilis*	5
JC062-113	*Pseudostichopus* spp.	5

Fish ecology (Milligan)

An investigation is being done that aims to investigate how a range of anthropogenic factors may impact on fish populations in deep-water areas. While direct human effects are relatively limited at abyssal depths compared to coastal or bathyal waters, there is increasing evidence that human impacts in these shallower waters, such as fishing for example, may nonetheless have wider impacts that affect fish communities in deep slope and abyssal regions (e.g. Bailey *et al.,* 2009). However, given the challenges of recovering samples from the deep-sea, relatively little is known about the feeding ecology or life history strategies of many of the fish from this area, and data are often limited to samples from relatively few individuals. The aim of the present study was therefore to

collect samples from trawled fish for dietary and life history analysis trawled, and to add data to the long-term time series that already exists for this area (e.g. Priede *et al.,* 2010). These data will then be used to inform a model of fish in the PAP region, to investigate the effects of variations in energy input from the surface waters on the fish communities in the abyss.

Preliminary Results

A total of 52, 29 and 38 fish specimens were collected from trawls JC062-059, -082 and -113 respectively, which included both demersal and pelagic species, though only the demersal specimens will be used in further investigations. Each individual was tentatively identified and the wet weight, total, standard, pre-anal fin and head lengths were measured wherever possible, and muscle samples were taken from the dorsal musculature just behind the head of each fish for stable isotope analysis (SIA). All samples were wrapped in foil and stored at -80°C within 30 minutes of collection. Where samples could not be stored at -80°C immediately, they were kept on ice until they could be transferred. Voucher specimens for each identified species, and all those which could not be identified were stored in 10% borax-buffered formalin in seawater to be identified at the University of Glasgow at a later date. The saggital otoliths were removed from the remaining specimens and stored dry in glass vials for later analysis.

Fish: A preliminary list of the demersal fish collected from each trawl has been made (Table 4.14.3) and the lengths measured (Figure 4.14.1) among other metrics. In addition, a number of pelagic fish were captured including *Anoplogaster cornuta, Poromitra capito,* an oneirodid and individuals from up to 17 indeterminate species. Identification of these specimens will be conducted on return to the UK.

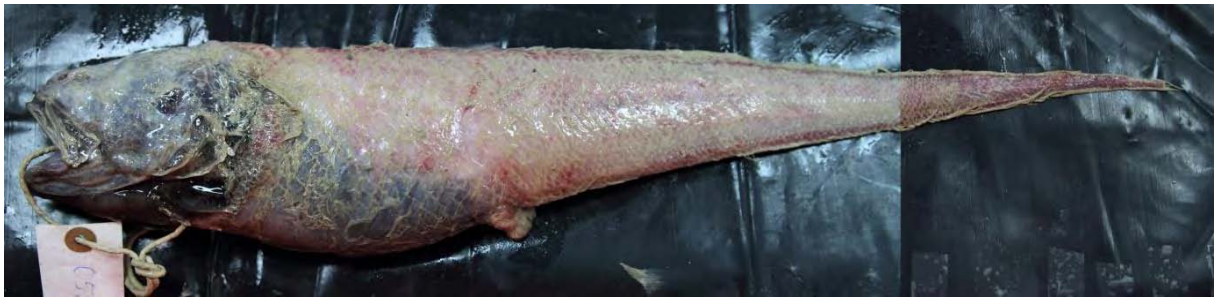
Table 4.14.3 Tentative species list of fishes captured during JC062-059, -082 and -113.

JC062-059	JC062-082	JC062-113
Alepocephadidae sp. 1	*Alepocephalidae (Bathytroctes sp. 1)*	*Alepocephalidae (Bathytroctes sp. 1?)*
Alepocephadidae sp. 2	*Alepocephalidae sp. 4?*	*Conocara salmonea*
Alepocephadidae sp. 3	*Alepocephalidae sp. 5?*	*Coryphaenoides profundicolus*
Bathytroctes sp. 1	*Bathytroctes sp. 1*	*Histiobranchus bathybius*
Coryphaenoides profundicolus	*Bathytroctes sp. 2*	*Holomycteronus squamosus*
Macrouridae	*Coryphaenoides profundicolus*	
	Histiobranchus bathybius	
	Holomycteronus squamosus	
	Macrouridae sp. 1	

(a)

(b)

(c)



(d)

Figure 4.14.1. Representative images of the demersal fish species captured during the study (eyes removed). They are tentatively identified as: (a) *Coryphaenoides profundicolus;* (b) *Histiobranchus bathybius;* (c) *Holomycteronus squamosus* (d) Indet. Species (Possibly *Bathytroctes*)

Invertebrates: In addition to the samples of fish muscle collected for SIA analysis, a number of samples were collected opportunistically from a number of invertebrates captured in the trawls in order to provide additional reference samples against which the fish could be compared. In total,

samples were taken from two species of crustacean, (*Munnidopsis* sp. (3 samples) and a currently unidentified species (2 samples)), a holothurian (*Psychropotes* sp.; 3 samples) and an unidentified octopus (1 sample). Each of these samples was collected from an area of dense musculature (i.e. crustacean tail muscle, octopus arm and holothurian 'mouth') and calcareous areas were avoided. The samples were wrapped in foil as for the fish samples and stored immediately at -80°C.

4.15 Wide Angle Seabed Photography (WASP)

Dan Jones, Brian Bett, David White, Ben Boorman, Alan Jamieson & Henry Ruhl

Seabed survey photography was undertaken using the National Oceanography Centre (NOC) Wide Angle Seabed Photography (WASP) vehicle. The WASP vehicle is an off-bottom (1-3 m altitude) towed camera platform (towed at 0.5 kn), operated using an acoustic telemetry system, carrying a vertically mounted still camera (OSIL Mk 7), and a vertically mounted video camera (Sony DCR-VX1000E). WASP was typically operated for one hour at the seabed, yielding some 250 still photographs (35 mm Kodak Vision 250D colour negative; to be processed ashore) and continuous video footage (mini digital video cassette). A USBL beacon was attached to WASP for all deployments. Unfortunately the USBL beacon experienced various problems, particularly through the beacon going offline and stopping data transmission. This resulted in incomplete or lost records of the position of WASP throughout many of the deployments.

Figure 4.15.1. WASP vehicle with standard camera arrangement

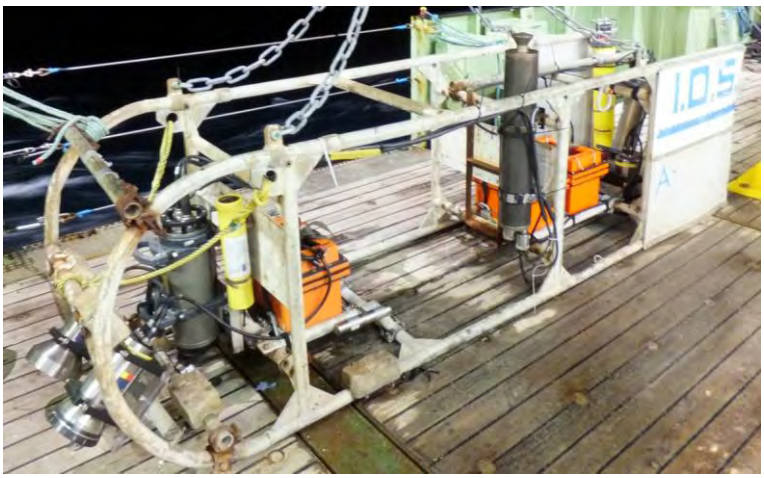


Figure 4.15.2. WASP vehicle with video camera removed and two Oceanlab digital still cameras fitted

Porcupine Abyssal Plain

We used WASP to obtain video and still photographic images of the seabed at a series of locations on the Porcupine Abyssal Plain to assess spatial variation in the megabenthos and seabed environment. Operations were carried out at a series of four abyssal plain locations (PAP-Cent., PAP over-trawl, F1 and F2) and four abyssal hill sites (H1, H2, H3 and H4) on the Porcupine Abyssal Plain, SW of Ireland (Figure 4.15.3). One successful photographic transect was carried out at each location (Table 4.15.1).

Abyssal plain sites (PAP Cent., PAP over trawl, F1 and F2): The WASP video of these sites showed a flat, soft sediment seabed devoid of any obvious major physical features. Bioturbation was high, with evidence of burrowing activity (e.g. from echiurans) and surface feeding traces (e.g. from holothurians). Megafaunal density was generally low; the most commonly observed megafauna were holothurians.

Abyssal hill sites (H1, H2, H3 and H4): These areas of elevated topography showed a slightly different seabed structure to the abyssal plain sites. Although the seabed was primarily soft sediment, iceberg-rafted drop-stones were often visible in the video, occasionally reaching the size of large cobbles and small boulders. The seabed elevation was variable over the video transects at most of the abyssal hill sites, particularly at H3 (83 m range in wire out over the video transect). Megafaunal density and diversity appeared to be higher than the abyssal plain sites. Holothurians again dominated the visible megabenthos.

Porcupine Seabight

To carry out a series of photographic transects in the northwest quadrant of the Porcupine Seabight, c. 1,200 m water depth, to approximately match a number of epibenthic sledge tows carried out during the Institute of Oceanographic Sciences (now National Oceanography Centre) Porcupine Seabight Benthic Biological Survey in the 1980s, specifically those detailed by Rice et al. (1990) in connection with the mass occurrence of the hexactinellid sponge, *Pheronema carpenteri* in this region of the Seabight.

Operations were carried out at six sites on the slope of the northern Porcupine Seabight, SW of Ireland (Figure 4.15.4). One successful photographic transect was carried out at each location (Table 4.15.2). **JC062-140 & 141** transects utilized the video and film still set up that had been used throughout transecting at PAP. For the last four of the Porcupine Seabight deployments the two Kongsberg OE14-208 stills camera systems from the Oceanlab DAVE lander were added to WASP, one camera and flash pair was positioned vertically, the other at 45 degrees looking forward.

Summary: The WASP video and stills of these sites showed a flat, soft sediment seabed with no obvious physical features. Bioturbation was relatively high, with seabed burrows being most common type. Anthropogenic impact to the seafloor was observed from communications cables, trawl scars and litter. More detailed overviews of the four sites with digital still photos are provided, but quantitative inputs will only be possible after photogrammetric analysis.

JC062-142: Ascidians were very common at this site. Large *Pheronema* were observed as well as spicule mats from dead individuals. Echinoderms were common, with at least one holothurian, several asteroids (including *Hymenaster*, c.f. *Ceramaster* and a brisingid), abundant small ophiuroids and one large echinoid. Fish were seen in vertical shots, including halosaurs, synaphobranchids and chimera. Cnidarians were common and included cup corals, anemones of several species (including the venus-fly-trap anemone c.f. *Actinoscyphia aurelia*), alcyonaceans (including *Anthomastus* sp.), as well as some gorgonians. Crustaceans were observed (galatheid and *Nephropsis*). One benthic octopus was seen (*Bathypolypus* or *Benthoctopus*). No trawl scars or other evidence of anthropogenic activity were observed at this site.

JC062-143: The densities of sponges and ascidians at this site were much lower than site 142 in the majority of images. A few higher density patches of sponges and ascidians occurred. In terms of megafaunal species, the site was similar to site 142, with most of the same species present. Species first seen at this site included a stalked sponge (resembling *Stylocordya*), alepocephalid fish (slickheads) were seen in the forward looking camera. Some litter was observed at this site, trawl scars were encountered (12:14) and a sub-sea telecommunications cable was imaged (seen at 11:19 and possibly at 12:32).

JC062-144: This site had high densities of small *Pheronema* sponges. There were lower densities of ascidians than site 142. There were several new observations for this site: large gastropod, large asteroid, a large skate, an urchin resembling *Phormosoma*. A tin can was seen (19:43). An old trawl scar was observed (19:54). In general, the trawl scars are very difficult to observe in the vertical camera photographs.

JC062-145: This site has few ascidians. Patches of very small *Pheronema* (at high densities) were seen, but no large individuals were observed (e.g. as were common at site 142 and site 144). A patch of tall stalked cnidarians (or possibly gorgonian/pennatulid) was found with 4 individuals over three frames (02:57). The scorpionfish, *Cottunculus* sp., was seen for the first time. There were patches (e.g. 03:41, 04:14) with very high densities (> 10 per frame) of cup corals, usually found in the same places as the small *Pheronema*. Trawl scars were seen in several places (e.g. 03:57) and this site has the most evidence of trawl activity.

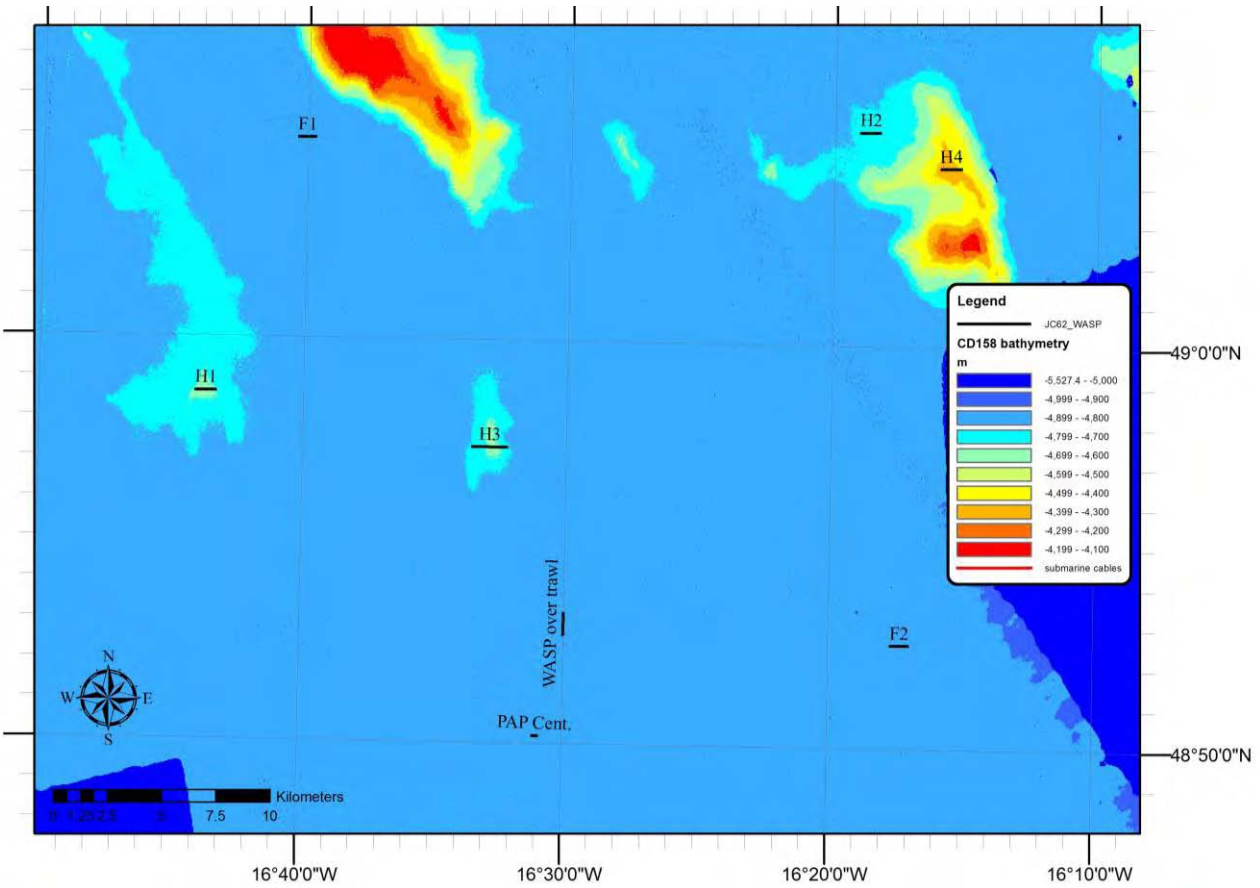


Figure 4.15.3. Chart of WASP transects in the PAP area.

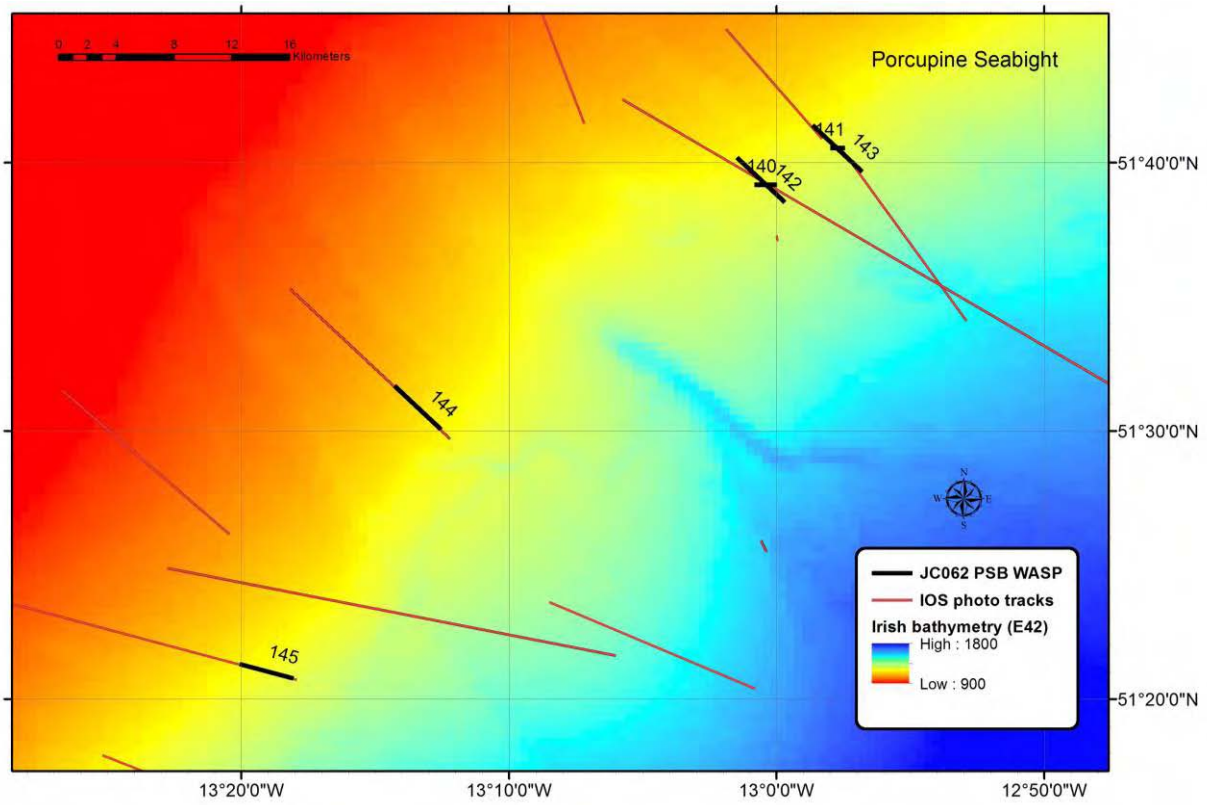


Figure 4.15.4. Chart of WASP transects in the Porcupine Seabight, also showing locations of IOS photo tracks from Rice et al (1990). [Note: short crossing track on JC062-142 is transect JC062-140 and that short crossing track on JC062-143 is transect JC062-141]

Table 4.15.1. Details of WASP transects on the Porcupine Abyssal Plain. Latitude and longitude are ship's position in decimal degrees (WGS '84). Depths are in metres and taken from the EA600 12kHz echo sounder (sound velocity 1501 ms^{-1}).

Station	Site	Date	Camera on time	Camera off time	Min. depth	Max. depth	Lat. Cam. on	Long. Cam. on	Lat. Cam. off	Long. Cam. off	Stills film reel no.	Notes
JC062-019	PAP Cent.	27 July 2011	18:45	19:44	4815	4818	48.83692	-16.5143	48.83697	-16.5192	1	All systems down at 19:41, video run but no video lamps on; film run to jam c. 40 mins
JC062-050	H1											Aborted shortly after deployment
JC062-054	H1	05 August 2011	14:49	15:55	4644	4662	48.9777	-16.7352	48.9777	-16.7213	2	Film and video run
JC062-064	F1	08 August 2011	10:28	11:33	4818	4821	49.0833	-16.6735	49.0833	-16.6613	3	Film and video run
JC062-079	F2	11 August 2011	20:18	21:24	4813	4817	48.8767	-16.2946	48.8767	-16.2818	3	Film and video run
JC062-085	H2	13 August 2011	08:59	10:04	4720	4750	49.0892	-16.3181	49.0892	-16.3042	4	Film and video run
JC062-104	H3	17 August 2011	12:50	13:59	4605	4630	48.9562	-16.5601	48.9562	-16.5367	4	Film and video run
JC062-122	H4	21 August 2011	14:20	15:28	4318	4370	49.0744	-16.2668	49.0748	-16.2526	5	Film and video run
JC062-132	PAP trawled area	24 August 2011	00:39	01:38	4815	4817	48.8885	-16.5000	48.8785	-16.5000	5	Film and video run

Table 4.15.2. Details of WASP transects on the Porcupine Seabight. Latitude and longitude are ship's position in decimal degrees (WGS '84). Depths are in metres and taken from the EA600 12kHz echo sounder (sound velocity 1501 ms^{-1}).

Station	Site	Date	Camera on time	Camera off time	Min. depth	Max. depth	Lat. Cam. on	Long. Cam. on	Lat. Cam. off	Long. Cam. off	Stills film reel no.	Notes
JC062-140	PSB-sponge 1	26 August 2011	18:28	19:34	1227	1249	51.6530	-12.9998	51.6530	-13.0138	6	film and video run
JC062-141	PSB-sponge 2	26 August 2011	22:53	23:37	1236	1249	51.6760	-12.9573	51.6760	-12.9664	6	film and video run
JC062-142	PSB-sponge 3 long	26 August 2011	03:27	07:33	1193	1266	51.6417	-12.9949	51.6698	-13.0249	7	film run + Oceanlab cameras run (forward facing and downward looking, both at 30s intervals)
JC062-143	PSB-sponge 4 long	26 August 2011	10:23	14:38	1203	1288	51.6605	-12.9465	51.6897	-12.9777	8	film run + Oceanlab cameras run (forward facing and downward looking, both at 30s intervals)
JC062-144	PSB-sponge 5 long	26 August 2011	18:47	22:43	1114	1184	51.5013	-13.2093	51.5282	-13.2381	9	film run + Oceanlab cameras run (forward facing and downward looking, both at 30s intervals)
JC062-145	PSB-sponge 6 long	26 August 2011	02:00	04:45	1186	1246	51.3458	-13.3011	51.3549	-13.3347	10	film run + Oceanlab cameras run (forward facing and downward looking, both at 30s intervals)

5.0 Station list

Below: JC062 Event Log (Page 1 of 6). The dates provided are for the time at bottom. Events start times that occurred during the previous day are shown in italics as are event end times that occur during the following day. Bottom times for baited camera and amphipod trap recoveries are the times of acoustic release.

Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
24 July 2011	JC062-001			aborted					FRRF	Smythe-Wright
24 July 2011	JC062-002								Underway water sampling	Smythe-Wright
25 July 2011	JC062-003								FRRF	Smythe-Wright
25 July 2011	JC062-004								Underway water sampling	Smythe-Wright
25 July 2011	JC062-005	1	49° 44.996'	11° 42.077'	1009	09:06	09:48	10:31	CTD	Ruhl
25 July 2011	JC062-006	2	49° 45.054'	11° 42.113'	500	11:22	11:49	12:26	CTD	Smythe-Wright/Larkin
25 July 2011	JC062-007		49° 45.018'	11° 42.031'	1022	13:31	14:15	14:36	Megacore	Ruhl
25 July 2011	JC062-008		49° 35.615'	11° 50.869'	994	17:34	18:12	18:46	Megacore	Ruhl
25 July 2011	JC062-009		49° 35.614'	11° 50.867'	994	19:14	19:56	20:33	Megacore	Ruhl
25 July 2011	JC062-010		49° 35.614'	11° 50.866'	995	20:48	21:27	22:06	Megacore	Ruhl
25 July 2011	JC062-011		49° 35.613'	11° 50.869'	995	22:34	23:15	23:57	Megacore	Ruhl
26 July 2011	JC062-012								Underway water sampling	Smythe-Wright
26 July 2011	JC062-013	3	48° 58.662'	16° 30.281'	4830	17:13	18:49	21:27	CTD	Smythe-Wright
26 July 2011	JC062-014	4	48° 58.033'	16° 31.665'	200	22:36	22:51	23:30	CTD	Smythe-Wright/Larkin
27 July 2011	JC062-015								Underway water sampling	Smythe-Wright
27 July 2011	JC062-016		48° 50.472'	16° 29.919'	4818	01:14	03:40	06:17	Megacore	Gooday
27 July 2011	CE10005-9		48° 59.249'	16° 29.207'	4816			10:50	PAP3 recovery	Lampitt
27 July 2011	JC062-018		48° 59.369'	16° 29.562'	4814	12:44	14:14	15:11	PAP3 deployment	Lampitt
27 July 2011	JC062-019		48° 50.215'	16° 30.864'	4813	16:30	18:45	21:55	WASP	Jones
28 July 2011	JC062-020		48° 50.164'	16° 30.477'	4815	*22:30*	00:50	03:15	Megacore	Gooday
28 July 2011	JC062-021								Underway water sampling	Smythe-Wright
28 July 2011	CE 10005-5		49° 0.812'	16° 22.189'	4813			08:42	PAP 1 top end recovery	Lampitt
28 July 2011	JC062-023	5	49° 0.22'	16° 23.98'	4813	22:18	22:32	22:30	CTD	Smythe-Wright
29 July 2011	JC062-024		49° 0.22'	16° 23.98'	4814	00:22	00:44	01:06	Zooplankton ring net vertical tow	Pebody
29 July 2011	JC062-025								Underway water sampling	Smythe-Wright

Below: JC062 Event Log (Page 2 of 7). The dates provided are for the time at bottom. Events start times that occurred during the previous day are shown in italics as are event end times that occur during the following day. Bottom times for baited camera and amphipod trap recoveries are the times of acoustic release.

Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
29 July 2011	JC062-027		49° 0.812'	16° 22.189'	4813			06:39	PAP 1 top end deployment	Lampitt
30 July 2011	JC062-028		48° 50.222'	16° 29.572'	4815	*23:21*	02:07	04:30	Megacore	Gooday
30 July 2011	JC062-029								Underway water sampling	Smythe-Wright
30 July 2011	JC062-030		48° 50.473'	16° 29.919'	4815	05:30	07:57	08:50	Box core	Ruhl
30 July 2011	CE 10005-10		49° 0.342'	16° 26.908'				12:39	Bathysnap recovery	Boorman
30 July 2011	JC062-032		48° 50.193'	16° 30.578'	4815	14:49	17:05	18:57	Box core	Ruhl
30 July 2011	JC062-033		48° 50.22'	16° 29.58'	4813	19:30	21:25	23:45	Box core	Ruhl
31 July 2011	JC062-034								Underway water sampling	Smythe-Wright
31 July 2011	JC062-035	6	48° 50.22'	16° 29.58'	4814	04:02	04:16	04:45	CTD	Larkin
31 July 2011	JC062-036		48° 50.650'	16° 30.008'	4814	05:25	07:37	10:03	Megacore	Gooday
31 July 2011	JC062-037		48° 50.701'	16° 30.518'	4814	10:58	13:08	13:21	Megacore	Gooday
1 August 2011	JC062-038								Underway water sampling	Smythe-Wright
3 August 2011	JC062-039	7	49° 35.628'	11° 50.776'	985	07:08	07:38	08:26	CTD	Ruhl/Smythe-Wright
3 August 2011	JC062-040		49° 35.629'	11° 50.776'	995	08:55	09:37	10:07	Megacore	Ruhl
3 August 2011	JC062-041		49° 35.63'	11° 50.780'	993	10:42	11:21	11:59	Megacore	Ruhl
3 August 2011	JC062-042		49° 35.630'	11° 50.775'	992	12:22	13:00	13:31	Megacore	Ruhl
3 August 2011	JC062-043		49° 35.628'	11° 50.776'	993	13:57	14:35	15:20	Megacore	Ruhl
3 August 2011	JC062-044		49° 35.628'	11° 50.776'	995	15:39	16:13	16:57	Megacore	Ruhl
4 August 2011	JC062-045		49° 0.362'	16° 26.932'	4822	15:08			Bathysnap deployment	Boorman
4 August 2011	JC062-046			aborted		17:12		18:30	Baited camera lander deployment	Jamieson
4 August 2011	JC062-047		48° 58.991'	16° 43.769'	4657	18:57			Baited camera lander deployment	Jamieson
4 August 2011	JC062-048		48° 58.557'	16° 43.973'	4660	19:27			Amphipod trap deployment	Horton
4 August 2011	JC062-049	8	48° 58.575'	16° 44.017'	4657	19:51	20:00	20:30	CTD	Smythe-Wright
4 August 2011	JC062-050			aborted		20:46		21:05	WASP	Jones
4 August 2011	JC062-051		48° 58.668'	16° 43.755'	4686	21:45	23:56	*02:10*	Megacore	Gooday

Below: JC062 Event Log (Page 3 of 7). The dates provided are for the time at bottom. Events start times that occurred during the previous day are shown in italics as are event end times that occur during the following day. Bottom times for baited camera and amphipod trap recoveries are the times of acoustic release.

Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
5 August 2011	JC062-052		48° 58.667'	16° 43.756'	4646	02:33	04:38	07:00	Megacore	Gooday
5 August 2011	JC062-053		48° 58.633'	16° 43.612'	4650	07:22	09:33	12:10	Megacore	Gooday
5 August 2011	JC062-054		48° 58.662'	16° 44.154'	4660	12:36	14:49	18:47	WASP	Jones
5 August 2011	JC062-055		48° 58.662'	16° 43.563'	4654	19:05	21:12	*00:39*	Megacore	Gooday
6 August 2011	JC062-056		48° 58.663'	16° 43.565'	4650	01:05	03:13	07:09	Megacore	Gooday
6 August 2011	JC062-047		48° 58.991'	16° 43.769'	4657		07:38	09:51	Baited camera lander recovery	Jamieson
6 August 2011	JC062-048		48° 58.557'	16° 43.973'	4660		10:16	12:21	Amphipod trap recovery	Horton
6 August 2011	JC062-059		48° 53.01'	16° 30.23'	4824	15:45	21:18	*06:20*	OTSB – 14,200 m in length	Billett
7 August 2011	JC062-060		48° 58.633'	16° 43.681'	4645	18:25	20:23	23:28	Megacore	Gooday
8 August 2011	JC062-061		48° 58.735'	16° 43.689'	4645	00:07	02:35	05:30	Megacore	Gooday
8 August 2011	JC062-062		49° 4.895'	16° 40.229'	4815	06:43			Baited camera lander deployment	Jamieson
8 August 2011	JC062-063		49° 5.361'	16° 40.010'	4814	07:25			Amphipod trap deployment	Horton
8 August 2011	JC062-064		49° 5.000'	16° 40.410'	4818	08:11	10:28	14:20	WASP	Jones
8 August 2011	JC062-065		49° 5.093'	16° 40.030'	4825	14:30	16:52	21:05	Megacore	Gooday
9 August 2011	JC062-066		49° 5.118'	16° 39.960'	4819	*21:44*	00:15	04:15	Megacore	Gooday
9 August 2011	JC062-067		49° 4.980'	16° 40.030'	4818	04:45	07:04	09:22	Megacore	Gooday
9 August 2011	JC062-062		49° 4.895'	16° 40.229'	4815		09:26	11:54	Baited camera lander recovery	Jamieson
9 August 2011	JC062-063		49° 5.361'	16° 40.010'	4814		11:54	14:47	Amphipod trap recovery	Horton
9 August 2011	JC062-068		49° 5.118'	16° 39.960'	4818	14:45	17:12	19:14	Megacore	Gooday
9 August 2011	JC062-069		49° 4.894'	16° 39.988'	4818	19:54	22:09	*00:27*	Megacore	Gooday
10 August 2011	JC062-070		49° 5.092'	16° 40.032'	4819	01:16	03:26	05:32	Megacore	Gooday
10 August 2011	JC062-071		48° 52.37'	16° 17.72'	4818	08:20			Baited camera lander deployment	Jamieson
10 August 2011	JC062-072		48° 52.802'	16° 17.514'	4817	08:52			Amphipod trap deployment	Horton
10 August 2011	JC062-073		48° 52.722'	16° 17.651'	4818	09:18	11:42	14:00	Megacore	Gooday
10 August 2011	JC062-074		48° 52.665'	16° 17.532'	4816	14:30	16:49	19:59	Megacore	Gooday

Below: JC062 Event Log (Page 4 of 7). The dates provided are for the time at bottom. Events start times that occurred during the previous day are shown in italics as are event end times that occur during the following day. Bottom times for baited camera and amphipod trap recoveries are the times of acoustic release.

Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
10 August 2011	JC062-075		48° 52.620'	16° 17.792'	4816	19:15	21:19	23:25	Megacore	Gooday
11 August 2011	JC062-076		48° 52.558'	16° 17.515'	4816	00:02	02:13	04:20	Megacore	Gooday
11 August 2011	JC062-077		48° 52.52'	16° 17.57'	4818	04:44	06:54	09:00	Megacore	Gooday
11 August 2011	JC062-071		48° 52.37'	16° 17.72'	4818	-	09:08	11:58	Baited camera lander recovery	Jamieson
11 August 2011	JC062-072		48° 52.802'	16° 17.514'	4817	-	11:58	14:16	Amphipod trap recovery	Horton
11 August 2011	JC062-027		49° 0.812'	16° 22.189'	4813	-	-	15:48	PAP1 service	Lampitt
11 August 2011	JC062-078		49° 0.812'	16° 22.189'	4813	16:36	-	-	PAP1 deployment	Lampitt
11 August 2011	JC062-079		48° 56.600'	16° 17.515'	4815	17:51	20:18	21:30	WASP	Jones
12 August 2011	JC062-080		48° 50.467'	16° 29.921'	4818	01:15	03:32	06:00	Box core	Ruhl
12 August 2011	JC062-081		48° 50.649'	16° 30.007'	4814	06:30	08:49	11:40	Box core	Ruhl
12 August 2011	JC062-082		48° 50.10'	16° 35.82'	4814	13:16	18:27	*01:00*	OTSB – 13,419 m in length	Billett
13 August 2011	JC062-083		49° 5.157'	16° 18.998'	4740	05:21	-	-	Baited camera lander deployment	Jamieson
13 August 2011	JC062-084		49° 5.822'	16° 18.736'	4763	05:43	-	-	Amphipod trap deployment	Horton
13 August 2011	JC062-085		49° 5.352'	16° 19.084'	4750	06:36	08:50	12:26	WASP	Jones
13 August 2011	JC062-086		49° 5.418'	16° 18.938'	4747	13:27	15:48	17:54	Megacore	Gooday
13 August 2011	JC062-087		49° 5.424'	16° 18.868'	4741	18:30	20:39	23:00	Megacore	Gooday
14 August 2011	JC062-088		49° 5.386'	16° 18.854'	4742	*23:00*	01:41	03:46	Megacore	Gooday
14 August 2011	JC062-089		49° 5.447'	16° 18.772'	4743	04:20	06:35	08:57	Megacore	Gooday
14 August 2011	JC062-083		49° 5.157'	16° 18.998'	4740	-	08:53	11:22	Baited camera lander recovery	Jamieson
14 August 2011	JC062-084		49° 5.822'	16° 18.736'	4763	-	11:29	13:28	Amphipod trap recovery	Horton
14 August 2011	JC062-090		49° 5.430'	16° 18.882'	4744	14:00	16:24	18:28	Megacore	Gooday
14 August 2011	JC062-091		49° 5.418'	16° 18.935'	4747	19:00	21:05	23:23	Megacore	Gooday
15 August 2011	JC062-092		48° 5.423'	16° 18.861'	4744	*23:51*	02:00	04:05	Megacore	Gooday
15 August 2011	JC062-093		48° 50.697'	16° 30.517'	4814	08:59	10:26	11:26	SAPS	Smythe-Wright
15 August 2011	JC062-094	9	48° 50.694'	16° 30.371'	4814	12:04	12:22	12:53	CTD	Smythe-Wright

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Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
15 August 2011	JC062-095		48° 50.833'	16° 30.194'	4815	13:23	15:41	15:46	Box core	Ruhl
15 August 2011	JC062-096		48° 50.698'	16° 30.517'	4812	18:18	20:25	-	Box core	Ruhl
16 August 2011	JC062-097		48° 50.699'	16° 30.519'	4812	*23:00*	01:12	03:30	Megacore	Gooday
16 August 2011	JC062-098		48° 50.471'	16° 29.923'	4866	03:56	06:17	08:37	Megacore	Gooday
16 August 2011	JC062-078		49° 0.812'	16° 22.189'	4813	-	-	10:09	PAP1 service	Lampitt
16 August 2011	JC062-099		49° 0.812'	16° 22.189'	4813	21:13	-	-	PAP1 deployment	Lampitt
17 August 2011	JC062-100		49° 5.177'	16° 39.965'	4820	*21:35*	00:49	03:10	Megacore	Gooday
17 August 2011	JC062-101		49° 4.980'	16° 40.027'	4818	03:39	05:59	08:18	Megacore	Gooday
17 August 2011	JC062-102		48° 57.695'	16° 32.775'	4640	09:25	-	-	Baited camera lander deployment	Jamieson
17 August 2011	JC062-103		48° 57.143'	16° 32.780'	4648	10:06	-	-	Amphipod trap deployment	Horton
17 August 2011	JC062-104		48° 57.371'	16° 33.064'	4648	10:24	12:50	13:59	WASP	Jones
17 August 2011	JC062-105		48° 57.331'	16° 32.921'	4620	16:30	18:32	20:23	Megacore	Gooday
17 August 2011	JC062-106		48° 57.479'	16° 32.907'	4616	20:58	23:10	*01:25*	Megacore	Gooday
18 August 2011	JC062-107		-	aborted	-	01:58	-	02:20	Megacore	Gooday
18 August 2011	JC062-108		48° 57.370'	16° 33.019'	4624	02:43	04:47	06:52	Megacore	Gooday
18 August 2011	JC062-102		48° 57.695'	16° 32.775'	4640	-	06:58	09:36	Baited camera lander recovery	Jamieson
18 August 2011	JC062-103		48° 57.143'	16° 32.780'	4648	-	09:43	12:35	Amphipod trap recovery	Horton
18 August 2011	JC062-109		48° 57.442'	16° 32.780'	4610	16:36	18:40	21:03	Megacore	Gooday
18 August 2011	JC062-110		48° 57.347'	16° 32.939'	4620	21:30	23:49	*01:58*	Megacore	Gooday
19 August 2011	JC062-111		48° 52.669'	16° 17.530'	4814	04:12	06:29	09:06	Megacore	Gooday
19 August 2011	JC062-112		48° 52.620'	16° 17.789'	4812	09:36	11:49	14:05	Megacore	Gooday
19 August 2011	JC062-113		48° 53.810'	16° 28.250'	4814	16:00	20:08	*04:30*	OTSB – 12,813 m in length	Billett
20 August 2011	JC062-114		48° 58.663'	16° 43.564'	4651	05:57	08:00	10:34	Megacore	Gooday
20 August 2011	JC062-115		48° 58.687'	16° 43.755'	4684	11:04	13:13	15:44	Megacore	Gooday
20 August 2011	JC062-116		48° 57.481'	16° 32.904'	4618	17:10	19:12	21:18	Megacore	Gooday

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Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
21 August 2011	JC062-117		49° 05.388'	16° 18.851'	4741	*22:44*	00:54	03:18	Megacore	Gooday
21 August 2011	JC062-118		49° 05.429'	16° 18.880'	4744	03:44	05:47	08:45	Megacore	Gooday
21 August 2011	JC062-119		49° 0.360'	16° 27.060'	4819	09:55			Bathysnap deployment	Boorman
21 August 2011	JC062-120		49° 4.236'	16° 15.894'	4383	11:14			Baited camera lander deployment	Jamieson
21 August 2011	JC062-121		49° 4.692'	16° 15.660'	4330	11:43			Amphipod trap deployment	Horton
21 August 2011	JC062-122		49° 4.464'	16° 16.010'	4370	12:04	14:20	18:06	WASP	Jones
21 August 2011	JC062-123		49° 4.434'	16° 15.618'	4370	18:44	20:50	23:03	Megacore	Gooday
22 August 2011	JC062-124		49° 4.577'	16° 15.831'	4315	*23:32*	01:32	03:39	Megacore	Gooday
22 August 2011	JC062-125		49° 4.434'	16° 15.618'	4300	04:04	06:18	08:19	Megacore	Gooday
22 August 2011	JC062-120		49° 4.236'	16° 15.894'	4383		08:29	10:48	Baited camera lander recovery	Jamieson
22 August 2011	JC062-121		49° 4.692'	16° 15.660'	4330		10:50	13:00	Amphipod trap recovery	Horton
22 August 2011	JC062-126		49° 4.421'	16° 15.831'	4330	13:45	15:53	18:00	Megacore	Gooday
22 August 2011	JC062-127		49° 4.464'	16° 15.781'	4280	18:19	20:17	22:15	Megacore	Gooday
23 August 2011	JC062-128		49° 4.581'	16° 18.834'	4292	*22:43*	00:41	03:06	Megacore	Gooday
23 August 2011	JC062-129		49° 5.432'	16° 18.822'	4744	04:04	06:19	08:40	Megacore	Gooday
23 August 2011	JC062-130		49° 5.448'	16° 18.775'	4742	09:09	11:18	13:42	Megacore	Gooday
23 August 2011	JC062-131		49° 4.896'	16° 39.981'	4818	15:27	17:45	20:01	Megacore	Gooday
24 August 2011	JC062-132		48° 53.182'	16° 30.001'	4815	*21:39*	00:39	04:19	WASP	Jones
24 August 2011	JC062-133		48° 52.772'	16° 17.653'	4870	05:43	07:59	10:40	Megacore	Gooday
25 August 2011	JC062-134	10	49° 35.665'	11° 50.552'	995	10:50	11:35	12:44	CTD	Ruhl
25 August 2011	JC062-135		49° 35.630'	11° 50.802'	993	17:14	17:56	18:40	Megacore	Ruhl
25 August 2011	JC062-136		49° 35.631'	11° 50.798'	994	19:00	19:38	20:27	Megacore	Ruhl
25 August 2011	JC062-137		49° 35.632'	11° 50.804'	994	20:45	21:25	22:10	Megacore	Ruhl
25 August 2011	JC062-138		49° 35.631'	11° 50.802'	994	21:26	23:11	23:56	Megacore	Ruhl
26 August 2011	JC062-139		49° 35.630'	11° 50.804'	996	00:15	00:56	01:42	Megacore	Ruhl

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Date	Station	Cast	Latitude (N)	Longitude (W)	Uncorrected sea floor depth (m)	Time IN Water (GMT)	Time at BOTTOM (GMT)	Time OUT Water (GMT)	Activity	Contact
26 August 2011	JC062-140		51° 39.181'	12° 59.985'	1246	17:39	18:28	20:22	WASP	Bett
26 August 2011	JC062-141		51° 40.562'	12° 57.497'	1249	22:02	22:53	23:35	WASP	Bett
27 August 2011	JC062-142		51° 38.504'	12° 59.691'	1266	02:35	03:27	07:30	WASP	Bett
27 August 2011	JC062-143		51° 39.632'	12° 56.792'	1288	09:30	10:23	14:35	WASP	Bett
27 August 2011	JC062-144		51° 30.077'	13° 12.587'	1184	17:57	18:47	22:43	WASP	Bett
28 August 2011	JC062-145		51° 20.745'	13° 18.063'	1246	01:10	02:00	04:42	WASP	Bett

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Appendix I

PAP 1 and PAP3 Mooring Servicing

Paul Provost and Steve Whittle,
Sensors and Moorings Group, National Marine Facilities Sea Systems
National Oceanography Centre, Southampton

The purpose of the moorings exercise was to recover the PAP3 sediment trap mooring deployed from the Celtic Explorer in September 2010 and redeploy with a fully replaced, but similar, mooring. The PAP1 (Met Office) buoy was to be serviced and the subsurface sensor frame was to be recovered and replaced.

PAP3 recovery

1) Operations Summary

The deck setup for the mooring recovery used the electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. The mooring rope was fed outboard of the double barrel capstan through a counting sheave bolted inline and 3m away which ran to a sheave suspended from the port aft pedestal crane. For recovery the reeling winch had a wooden 'recovery' drum installed onto which the used mooring rope was wound and stored.

During this voyage there was a hydraulic leak from pipe work within the port aft pedestal crane mounting. This was not able to be fixed during the cruise as it required the removal of the crane from the pedestal.

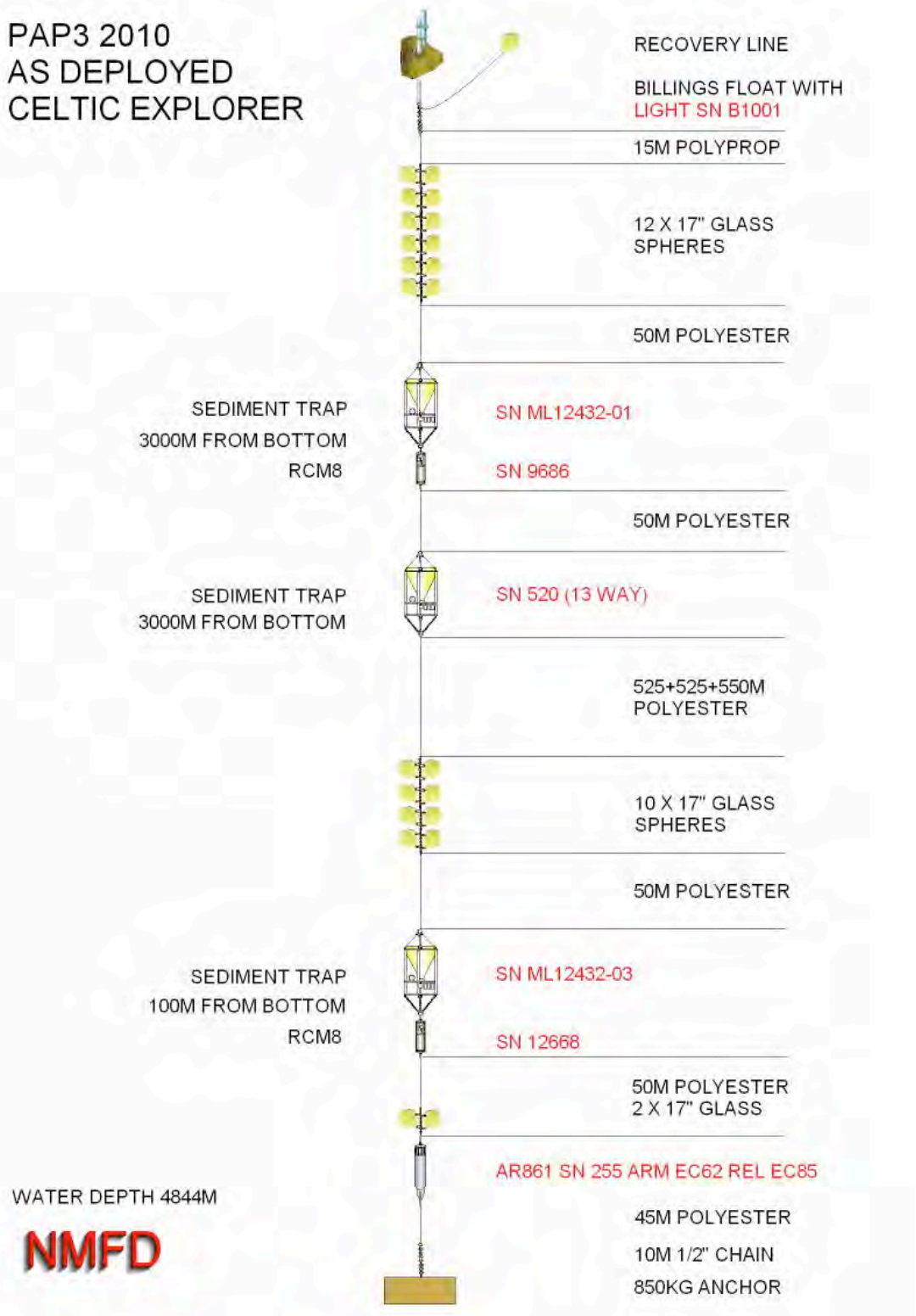
The mooring was released at 07:39 on 27 July 2011 using an IXSEA TT801 connected through the single element transducer on the (raised) drop keel by a patch cable. The mooring was monitored during the buoyant ascent and a rate of approximately 70 m/min was measured. The mooring was initially spotted at 08:34 with all the buoyancy packages visible by 08:40.

On recovery, the recovery line was grappled from the starboard quarter of the vessel and hauled in first. The main buoyancy

packages, sediment traps and current meters were recovered without incident. As the final sediment trap was lifted clear of the water, the lower buoyancy spheres immediately above the release were entangled with their rope around the trap. The Sediment trap was lifted inboard and the lines were separated and tied off to aid untangling the lines. The final few metres of mooring line above the release was recovered tangled but was taped together and hauled in on the double barrel capstan.

2) Mooring Diagram

PAP3 recovered mooring


PAP3 2010
AS DEPLOYED
CELTIC EXPLORER
RECOVERY LINE
BILLINGS FLOAT WITH
LIGHT SN B1001
15M POLYPROP
12 X 17" GLASS
SPHERES
50M POLYESTER
SEDIMENT TRAP
3000M FROM BOTTOM
RCM8
SN ML12432-01
SN 9686
50M POLYESTER
SEDIMENT TRAP
3000M FROM BOTTOM
SN 520 (13 WAY)
525+525+550M
POLYESTER
10 X 17" GLASS
SPHERES
50M POLYESTER
SEDIMENT TRAP
100M FROM BOTTOM
RCM8
SN ML12432-03
SN 12668
50M POLYESTER
2 X 17" GLASS
AR861 SN 255 ARM EC62 REL EC85
45M POLYESTER
10M 1/2" CHAIN
850KG ANCHOR
WATER DEPTH 4844M
NMFD

3) Instrumentation

All of the recovered instruments were in good condition and in working order.

RCM8, s/n 9686, showed no signs of damage, corrosion or fouling, and was continuing to sample. The DSU (s/n 14407) had 46578 words at 19:40, 27/7/11, and counted to 46584 at 20:37. The instrument was stopped logging at 20:42. The DSU was found to be 12 minutes 54 seconds behind current time.

RCM8, s/n 12668, showed no signs of damage, corrosion or fouling, and was continuing to sample. The DSU (s/n 14308) had 46578 words at 19:40, 27/7/11, and counted to 46584 at 20:34. The instrument was stopped logging at 20:42. The DSU was found to be 14 minutes 51 seconds behind current time.

Parflux sediment trap, s/n ML12432-01, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 20 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Parflux sediment trap, s/n 520, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 12 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Parflux sediment trap, s/n ML12432-03, showed no signs of damage, corrosion or fouling, and had not completed its full sampling schedule with bottle 20 in position. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Acoustic release RT661, s/n 255, showed no signs of damage, corrosion or fouling and worked faultlessly. Communications through the drop keel transducer to the TT801, s/n 255, deck unit worked well and no lost or timed out transmissions occurred.

Below are the downloaded schedule histories from the sediment traps.

```
          McLane Research Laboratories, USA
             ParFlux 21-Cup Sediment Trap
           Version: PST-21_3.c   S/N: ML12432-01

           É͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸»
           º          Main Menu          º
           È͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸¼
              Wed Jul 27 16:03:43 2011

           <1> Set Time           <5> Create Schedule
           <2> Diagnostics        <6> Deploy System
           <3> Fill Containers    <7> Offload Data
           <4> Sleep              <8> Contacting McLane

            Selection  ? 2

Press any key to pause/continue display, <X> to exit

 07/27/2011 16:04:08   16.6 Vb    18 øC  aligned
 07/27/2011 16:04:09   16.5 Vb    18 øC  aligned
 07/27/2011 16:04:10   16.5 Vb    18 øC  aligned
 07/27/2011 16:04:11   16.4 Vb    18 øC  aligned
 07/27/2011 16:04:12   16.4 Vb    18 øC  aligned


Battery voltage is abnormally low.  Check/replace
main battery pack before deploying system.


Press any key to continue.
```

```
          McLane Research Laboratories, USA
             ParFlux 21-Cup Sediment Trap
           Version: PST-21_3.c   S/N: ML12432-01

           É͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸»
           º          Main Menu          º
           È͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸¼
              Wed Jul 27 16:04:16 2011

           <1> Set Time           <5> Create Schedule
           <2> Diagnostics        <6> Deploy System
           <3> Fill Containers    <7> Offload Data
           <4> Sleep              <8> Contacting McLane

            Selection  ? 7

           É͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸»
           º  Offload/Display Data File  º
           È͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸¼
              Wed Jul 27 16:04:22 2011

           <1> Display data file
           <2> Display backup EEPROM
           <M> Main Menu

            Selection  ? 1

To copy the instrument data file to a disk file, initiate
your communication program's file logging command now and
then press any key to start the transfer.  The instrument
data file will remain resident and is not erased by this
```

offload procedure.

Software version: PST-21_3.c
Compiled: Mar 23 2007 14:01:32
Electronics S/N: ML12432-01

Data recording start time = 09/20/2010 13:52:45
Data recording stop time = 07/27/2011 16:03:43

HEADER
_____

pap2010/11trapa
t60-a

SCHEDULE
_____

Event 01 of 22 @ 09/22/2010 12:00:00
Event 02 of 22 @ 10/10/2010 12:00:00
Event 03 of 22 @ 10/24/2010 12:00:00
Event 04 of 22 @ 11/14/2010 12:00:00
Event 05 of 22 @ 12/05/2010 12:00:00
Event 06 of 22 @ 12/26/2010 12:00:00
Event 07 of 22 @ 01/16/2011 12:00:00
Event 08 of 22 @ 01/30/2011 12:00:00
Event 09 of 22 @ 02/13/2011 12:00:00
Event 10 of 22 @ 02/27/2011 12:00:00
Event 11 of 22 @ 03/13/2011 12:00:00
Event 12 of 22 @ 03/27/2011 12:00:00
Event 13 of 22 @ 04/10/2011 12:00:00
Event 14 of 22 @ 04/24/2011 12:00:00
Event 15 of 22 @ 05/08/2011 12:00:00
Event 16 of 22 @ 05/22/2011 12:00:00
Event 17 of 22 @ 06/05/2011 12:00:00
Event 18 of 22 @ 06/19/2011 12:00:00
Event 19 of 22 @ 07/03/2011 12:00:00
Event 20 of 22 @ 07/17/2011 12:00:00
Event 21 of 22 @ 07/31/2011 12:00:00
Event 22 of 22 @ 08/14/2011 12:00:00

DEPLOYMENT DATA
_____

Event 01

Scheduled start time: 09/22/2010 12:00:00
Event start time: 09/22/2010 12:00:00
Event stop time: 09/22/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	20.0	3 øC
Stop:	Y	20.2	3 øC

Event 02

Scheduled start time: 10/10/2010 12:00:00
Event start time: 10/10/2010 12:00:00
Event stop time: 10/10/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.8	3 øC
Stop:	Y	19.3	3 øC

Event 03

Scheduled start time: 10/24/2010 12:00:00
Event start time: 10/24/2010 12:00:00
Event stop time: 10/24/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.6	3 øC
Stop:	Y	18.9	3 øC

Event 04

Scheduled start time: 11/14/2010 12:00:00
Event start time: 11/14/2010 12:00:00
Event stop time: 11/14/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.1	3 øC
Stop:	Y	18.2	3 øC

Event 05

Scheduled start time: 12/05/2010 12:00:00
Event start time: 12/05/2010 12:00:00
Event stop time: 12/05/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	17.6	3 øC
Stop:	Y	17.7	3 øC

Event 06

Scheduled start time: 12/26/2010 12:00:00
Event start time: 12/26/2010 12:00:00
Event stop time: 12/26/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	17.2	3 øC
Stop:	Y	17.2	3 øC

Event 07

Scheduled start time: 01/16/2011 12:00:00
Event start time: 01/16/2011 12:00:00
Event stop time: 01/16/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.9	3 øC
Stop:	Y	16.9	3 øC

Event 08

Scheduled start time: 01/30/2011 12:00:00
Event start time: 01/30/2011 12:00:00
Event stop time: 01/30/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.9	3 øC
Stop:	Y	16.7	3 øC

Event 09

Scheduled start time: 02/13/2011 12:00:00
Event start time: 02/13/2011 12:00:00
Event stop time: 02/13/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.8	3 øC
Stop:	Y	16.5	3 øC

Event 10

Scheduled start time: 02/27/2011 12:00:00
Event start time: 02/27/2011 12:00:00
Event stop time: 02/27/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.7	3 øC
Stop:	Y	16.3	3 øC

Event 11

Scheduled start time: 03/13/2011 12:00:00
Event start time: 03/13/2011 12:00:00
Event stop time: 03/13/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.6	3 øC
Stop:	Y	16.1	3 øC

Event 12

Scheduled start time: 03/27/2011 12:00:00
Event start time: 03/27/2011 12:00:00
Event stop time: 03/27/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.6	3 øC
Stop:	Y	16.0	3 øC

Event 13

Scheduled start time: 04/10/2011 12:00:00
Event start time: 04/10/2011 12:00:00
Event stop time: 04/10/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.6	3 øC
Stop:	Y	15.9	3 øC

Event 14

Scheduled start time: 04/24/2011 12:00:00
Event start time: 04/24/2011 12:00:00
Event stop time: 04/24/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.5	3 øC
Stop:	Y	15.8	3 øC

Event 15

Scheduled start time: 05/08/2011 12:00:00
Event start time: 05/08/2011 12:00:00
Event stop time: 05/08/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.5	3 øC
Stop:	Y	15.7	3 øC

Event 16

Scheduled start time: 05/22/2011 12:00:00
Event start time: 05/22/2011 12:00:00
Event stop time: 05/22/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.5	3 øC
Stop:	Y	15.7	3 øC

Event 17

Scheduled start time: 06/05/2011 12:00:00
Event start time: 06/05/2011 12:00:00
Event stop time: 06/05/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.5	3 øC
Stop:	Y	15.7	3 øC

Event 18

Scheduled start time: 06/19/2011 12:00:00
Event start time: 06/19/2011 12:00:00
Event stop time: 06/19/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.4	3 øC
Stop:	Y	15.6	3 øC

Event 19

Scheduled start time: 07/03/2011 12:00:00
Event start time: 07/03/2011 12:00:00
Event stop time: 07/03/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.3	3 øC
Stop:	Y	15.6	3 øC

Event 20

Scheduled start time: 07/17/2011 12:00:00
Event start time: 07/17/2011 12:00:00
Event stop time: 07/17/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.2	3 øC
Stop:	Y	15.4	3 øC

Schedule was not completed.

System recovered early.

End of instrument data file.

McLane Research Laboratories, USA
MK7GW-13 ITC Sediment Trap
Operation Program V1.35A

****
* MAIN MENU *
****

S/N 520 Clock reads 07/27/11 16:13:21

<1> Display time, temperature & voltage
<2> Fill bottles / align rotor
<3> Create schedule
<4> Run schedule and deploy
<5> Display / offload data
<6> Go to sleep

<CTRL-C> Call MAIN MENU

Select a number 1

Press ANY KEY to stop & start ('X' to exit)

07/27/11 16:13:25 19.5 Vb 8.1 Vr 17.6 C Rotor aligned
07/27/11 16:13:26 19.5 Vb 8.1 Vr 17.6 C Rotor aligned
07/27/11 16:13:27 19.4 Vb 8.1 Vr 17.6 C Rotor aligned
07/27/11 16:13:28 19.5 Vb 8.1 Vr 17.6 C Rotor aligned
07/27/11 16:13:29 19.5 Vb 8.1 Vr 17.6 C Rotor aligned
07/27/11 16:13:30 19.4 Vb 8.0 Vr 17.6 C Rotor aligned

McLane Research Laboratories, USA
MK7GW-13 ITC Sediment Trap
Operation Program V1.35A

****
* MAIN MENU *
****

S/N 520 Clock reads 07/27/11 16:13:36

<1> Display time, temperature & voltage
<2> Fill bottles / align rotor
<3> Create schedule
<4> Run schedule and deploy
<5> Display / offload data
<6> Go to sleep

<CTRL-C> Call MAIN MENU

Select a number 5

To capture the following data in a disk file, initiate your
communication program's FILE LOGGING command now, then -
Press ANY KEY ...

TRAP V1.35A
PAP 2010/11 Trap B T60-B
S/N 520 09/20/10 14:43:00

#01 09/22/10 12:00:11 22.0 Vb 8.1 Vr 1.4 C Rotor aligned
09/22/10 12:00:48 21.0 Vb 8.1 Vr 1.9 C Rotor aligned

#02 01/30/11 12:00:32 19.8 Vb 7.8 Vr 1.4 C Rotor aligned
01/30/11 12:01:09 18.9 Vb 7.8 Vr 1.9 C Rotor aligned

#03 02/27/11 12:00:18 19.8 Vb 7.8 Vr 1.9 C Rotor aligned
02/27/11 12:00:55 18.7 Vb 7.8 Vr 1.9 C Rotor aligned

#04 03/27/11 12:00:04 19.7 Vb 7.8 Vr 1.4 C Rotor aligned
03/27/11 12:00:41 18.3 Vb 7.8 Vr 1.4 C Rotor aligned

#05 04/10/11 12:00:32 19.7 Vb 7.8 Vr 1.4 C Rotor aligned

```
   04/10/11  12:01:09  18.3 Vb  7.8 Vr   1.4 C  Rotor aligned

#06  04/24/11  12:00:29  19.7 Vb  7.8 Vr   1.4 C  Rotor aligned
   04/24/11  12:01:06  18.3 Vb  7.8 Vr   1.4 C  Rotor aligned

#07  05/08/11  12:00:26  19.6 Vb  7.8 Vr   1.9 C  Rotor aligned
   05/08/11  12:01:03  18.3 Vb  7.8 Vr   1.4 C  Rotor aligned

#08  05/22/11  12:00:23  19.5 Vb  7.9 Vr   1.4 C  Rotor aligned
   05/22/11  12:01:00  18.1 Vb  7.8 Vr   1.4 C  Rotor aligned

#09  06/05/11  12:00:20  19.6 Vb  7.8 Vr   1.9 C  Rotor aligned
   06/05/11  12:00:57  18.0 Vb  7.8 Vr   1.9 C  Rotor aligned

#10  06/19/11  12:00:17  19.5 Vb  7.8 Vr   1.9 C  Rotor aligned
   06/19/11  12:00:54  17.8 Vb  7.8 Vr   1.9 C  Rotor aligned

#11  07/03/11  12:00:14  19.4 Vb  7.8 Vr   1.4 C  Rotor aligned
   07/03/11  12:00:51  18.0 Vb  7.8 Vr   1.4 C  Rotor aligned

#12  07/17/11  12:00:11  19.4 Vb  7.8 Vr   1.4 C  Rotor aligned
   07/17/11  12:00:48  17.8 Vb  7.8 Vr   1.4 C  Rotor aligned

No more data Press ANY KEY ...



          McLane Research Laboratories, USA
            ParFlux 21-Cup Sediment Trap
         Version: PST-21_3.c   S/N: ML12432-03

         É͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸»
         º          Main Menu          º
         È͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸͸¼
            Wed Jul 27 15:46:26 2011

         <1> Set Time           <5> Create Schedule
         <2> Diagnostics        <6> Deploy System
         <3> Fill Containers    <7> Offload Data
         <4> Sleep              <8> Contacting McLane

          Selection  ? 2

 Press any key to pause/continue display, <X> to exit

 07/27/2011 15:47:04   16.4 Vb    18 øC  aligned
 07/27/2011 15:47:05   16.3 Vb    18 øC  aligned
 07/27/2011 15:47:06   16.3 Vb    18 øC  aligned
 07/27/2011 15:47:07   16.2 Vb    18 øC  aligned
 07/27/2011 15:47:08   16.2 Vb    18 øC  aligned
 07/27/2011 15:47:09   16.2 Vb    18 øC  aligned
 07/27/2011 15:47:10   16.2 Vb    18 øC  aligned


 Battery voltage is abnormally low.  Check/replace
 main battery pack before deploying system.


 Press any key to continue.
```

```
          McLane Research Laboratories, USA
            ParFlux 21-Cup Sediment Trap
```

Version: PST-21_3.c S/N: ML12432-03

ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
º Main Menu º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
Wed Jul 27 15:47:12 2011

<1> Set Time <5> Create Schedule
<2> Diagnostics <6> Deploy System
<3> Fill Containers <7> Offload Data
<4> Sleep <8> Contacting McLane

Selection ? 7

ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
º Offload/Display Data File º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
Wed Jul 27 15:47:17 2011

<1> Display data file
<2> Display backup EEPROM
<M> Main Menu

Selection ? 1

To copy the instrument data file to a disk file, initiate
your communication program's file logging command now and
then press any key to start the transfer. The instrument
data file will remain resident and is not erased by this
offload procedure.

Software version: PST-21_3.c
Compiled: Mar 23 2007 14:01:32
Electronics S/N: ML12432-03

Data recording start time = 09/20/2010 13:03:40
Data recording stop time = 07/27/2011 15:46:26

HEADER
_____

PAP 2010/11 TRAP C
T60-C

SCHEDULE
_____

Event 01 of 22 @ 09/22/2010 12:00:00
Event 02 of 22 @ 10/10/2010 12:00:00
Event 03 of 22 @ 10/24/2010 12:00:00
Event 04 of 22 @ 11/14/2010 12:00:00
Event 05 of 22 @ 12/05/2010 12:00:00
Event 06 of 22 @ 12/26/2010 12:00:00
Event 07 of 22 @ 01/16/2011 12:00:00
Event 08 of 22 @ 01/30/2011 12:00:00
Event 09 of 22 @ 02/13/2011 12:00:00
Event 10 of 22 @ 02/27/2011 12:00:00
Event 11 of 22 @ 03/13/2011 12:00:00
Event 12 of 22 @ 03/27/2011 12:00:00
Event 13 of 22 @ 04/10/2011 12:00:00
Event 14 of 22 @ 04/24/2011 12:00:00
Event 15 of 22 @ 05/08/2011 12:00:00
Event 16 of 22 @ 05/22/2011 12:00:00
Event 17 of 22 @ 06/05/2011 12:00:00
Event 18 of 22 @ 06/19/2011 12:00:00

Event 19 of 22 @ 07/03/2011 12:00:00
Event 20 of 22 @ 07/17/2011 12:00:00
Event 21 of 22 @ 07/31/2011 12:00:00
Event 22 of 22 @ 08/14/2011 12:00:00

DEPLOYMENT DATA
_____

Event 01

Scheduled start time: 09/22/2010 12:00:00
Event start time: 09/22/2010 12:00:00
Event stop time: 09/22/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	19.8	3 øC
Stop:	Y	20.3	3 øC

Event 02

Scheduled start time: 10/10/2010 12:00:00
Event start time: 10/10/2010 12:00:00
Event stop time: 10/10/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	19.1	3 øC
Stop:	Y	19.3	3 øC

Event 03

Scheduled start time: 10/24/2010 12:00:00
Event start time: 10/24/2010 12:00:00
Event stop time: 10/24/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.6	3 øC
Stop:	Y	18.9	3 øC

Event 04

Scheduled start time: 11/14/2010 12:00:00
Event start time: 11/14/2010 12:00:00
Event stop time: 11/14/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.1	3 øC
Stop:	Y	18.2	3 øC

Event 05

Scheduled start time: 12/05/2010 12:00:00
Event start time: 12/05/2010 12:00:00
Event stop time: 12/05/2010 12:00:25

	Aligned	Battery	Temperature
Start:	Y	17.6	3 øC
Stop:	Y	17.7	3 øC

Event 06

Scheduled start time: 12/26/2010 12:00:00
Event start time: 12/26/2010 12:00:00
Event stop time: 12/26/2010 12:00:25

	Aligned	Battery	Temperature

Start: Y 17.2 3 øC
Stop: Y 17.1 3 øC

Event 07

Scheduled start time: 01/16/2011 12:00:00
Event start time: 01/16/2011 12:00:00
Event stop time: 01/16/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.8	3 øC
Stop:	Y	16.8	3 øC

Event 08

Scheduled start time: 01/30/2011 12:00:00
Event start time: 01/30/2011 12:00:00
Event stop time: 01/30/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.8	3 øC
Stop:	Y	16.5	3 øC

Event 09

Scheduled start time: 02/13/2011 12:00:00
Event start time: 02/13/2011 12:00:00
Event stop time: 02/13/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.6	3 øC
Stop:	Y	16.3	3 øC

Event 10

Scheduled start time: 02/27/2011 12:00:00
Event start time: 02/27/2011 12:00:00
Event stop time: 02/27/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.5	3 øC
Stop:	Y	16.2	3 øC

Event 11

Scheduled start time: 03/13/2011 12:00:00
Event start time: 03/13/2011 12:00:00
Event stop time: 03/13/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.5	3 øC
Stop:	Y	16.0	3 øC

Event 12

Scheduled start time: 03/27/2011 12:00:00
Event start time: 03/27/2011 12:00:00
Event stop time: 03/27/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.4	3 øC
Stop:	Y	15.9	3 øC

Event 13

Scheduled start time: 04/10/2011 12:00:00

Event start time: 04/10/2011 12:00:00
Event stop time: 04/10/2011 12:00:26

	Aligned	Battery	Temperature
Start:	Y	16.4	3 øC
Stop:	Y	15.7	3 øC

Event 14

Scheduled start time: 04/24/2011 12:00:00
Event start time: 04/24/2011 12:00:00
Event stop time: 04/24/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.4	3 øC
Stop:	Y	15.6	3 øC

Event 15

Scheduled start time: 05/08/2011 12:00:00
Event start time: 05/08/2011 12:00:00
Event stop time: 05/08/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.3	3 øC
Stop:	Y	15.5	3 øC

Event 16

Scheduled start time: 05/22/2011 12:00:00
Event start time: 05/22/2011 12:00:00
Event stop time: 05/22/2011 12:00:26

	Aligned	Battery	Temperature
Start:	Y	16.3	3 øC
Stop:	Y	15.4	3 øC

Event 17

Scheduled start time: 06/05/2011 12:00:00
Event start time: 06/05/2011 12:00:00
Event stop time: 06/05/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.2	3 øC
Stop:	Y	15.5	3 øC

Event 18

Scheduled start time: 06/19/2011 12:00:00
Event start time: 06/19/2011 12:00:00
Event stop time: 06/19/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.2	3 øC
Stop:	Y	15.4	3 øC

Event 19

Scheduled start time: 07/03/2011 12:00:00
Event start time: 07/03/2011 12:00:00
Event stop time: 07/03/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.1	3 øC
Stop:	Y	15.3	3 øC

Event 20

Scheduled start time: 07/17/2011 12:00:00
Event start time: 07/17/2011 12:00:00
Event stop time: 07/17/2011 12:00:25

	Aligned	Battery	Temperature
Start:	Y	16.0	3 øC
Stop:	Y	15.2	3 øC

Schedule was not completed.

System recovered early.

End of instrument data file.

4) Observations, problems and recommendations

As already stated, the only problem was observed on recovery of the mooring where the lower two 17" Benthos glass spheres supporting the acoustic release had become entangled with the sediment trap above. These two spheres had been placed there because on a couple a previous occasions at the PAP3 mooring, the release had been lost though as yet unidentified tangling/chaffing after the mooring anchor was released. This recovery was the first of this new mooring design deployed from the Celtic Explorer. The small effort in untangling the rope from the trap was justified in the safe recovery of all instrumentation.

PAP3 deployment

1) Mooring Operations Summary

The deck setup for the mooring recovery used the electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. The mooring rope was fed outboard of the double barrel capstan through a counting sheave bolted inline and 3m away which ran to a sheave suspended from the port aft pedestal crane. For deployment the reeling winch had a steel drum installed onto which the mooring ropes were wound prior deployment in an order that allowed the top of the mooring to be deployed first and streamed for an anchor last deployment.

During this voyage there was a hydraulic leak from pipe work within the port aft pedestal crane mounting. This was not able to be fixed

during the cruise as it required the removal of the crane from the pedestal.

The mooring operation commenced at 12:44 on 27 July 11 when the first glass sphere was deployed from the deck. The mooring was deployed top first and streamed as the vessel approached the anchor release point. Due to the uniformity of the seabed, the exact deployment position was not critical (within 800m radius).

Once the anchor was released at 14:14, using a SeaCatch hook, the release was interrogated (using an IXSEA TT801 connected through the vessels single element transducer) as it fell to the seabed at an approximate descent speed of 80m/min. The anchor was at rest on the seabed at 15:09

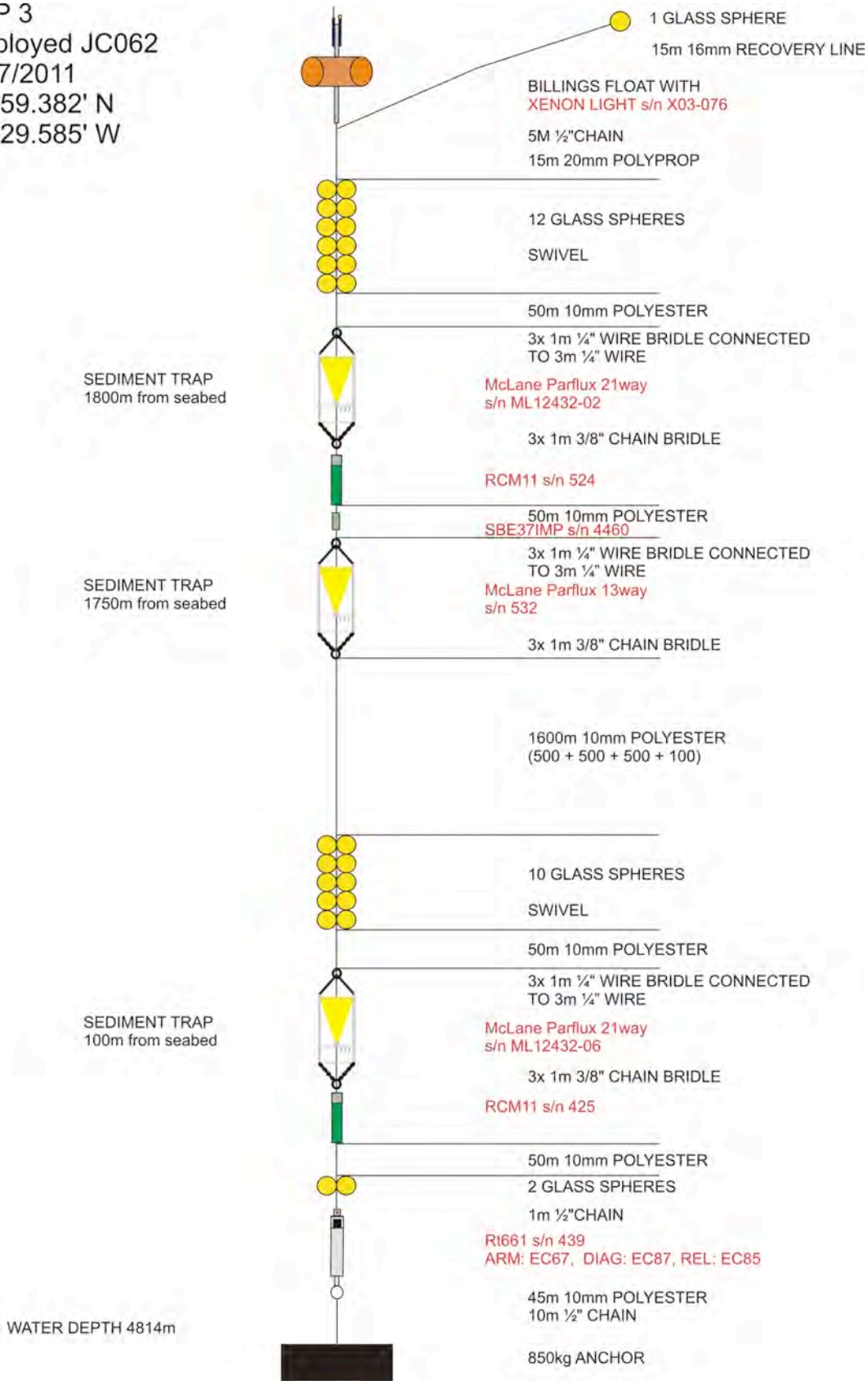
The total distance that the vessel travelled on the 'tow-in' as the mooring was streamed was 2.9km at a bearing of 223^0T, with an average speed of just over 1 knot.

The mooring was deployed in an identical configuration to the previously recovered PAP3 mooring.

2) Mooring Diagrams

PAP3 deployed mooring

PAP 3
Deployed JC062
27/7/2011
48°59.382' N
16°29.585' W



3) Instrumentation

RCM11, s/n 524, had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 08:30 on 26/7/11 with a 30 minute sampling frequency for 6 channels. The acoustic sampling was averaged at 300pings throughout the 30min sampling window.

RCM11, s/n 425, had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 08:30 on 26/7/11 with a 30 minute sampling frequency for 6 channels. The acoustic sampling was averaged at 300pings throughout the 30min sampling window.

Parflux sediment trap, s/n ML12432-02, had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling scheduled programmed. During deployment the trap was not tilted or inverted.

Parflux sediment trap, s/n 532, had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling scheduled programmed. During deployment the trap was not tilted or inverted.

Parflux sediment trap, s/n ML12432-06, had preservative placed in all bottles and topped up prior to fresh batteries being installed. The instrument subsequently had a sampling scheduled programmed. During deployment the trap was not tilted or inverted.

Acoustic release AR661, s/n 436, had fresh batteries installed and had been wire tested to 4818m on 26/7/11.

TYPE RT 661 B2S-DDL
FUNCTION RELEASE TRANSPONDER RT661 - B
SERIAL No. 439
Delivery FEB 2001

Int Frequency	**Reply Frequency**
FR1 = 9.0khz	**FT1 = 12.5khz**
FR2 = 12.5khz	**FT2 = 9.0khz**
FR3 =14.5khz	
FR4 = 15.5khz	**FT4 = 10.0khz**

FT0,FT5,FT6,FT7,FT8,FT9,FT10,FT11,FT15 = 12.0khz

Function / Code	TT301		Reply	Specifications
WINDOW	EC67	FT0	Wait time sec	Active sec
ON FR1-FR2	EC68	FT0		
OFF FR1-FR2-PINGER	EC69	FT0		
RELEASE 1 (W)	EC85	FT0-FT5		
RELEASE 2 (W)	EC86	FT0-FT6		
DIAGNOSTIC(W)	EC87	FT0-FT7	Measure delay sec	Vert offset sec
PYROTECHNIC(W)	EC91	FT0-FT11	Wait time s	Pulse s
PINGER (W)	EC94	FT0-FT4	Pulse width Ms	Recur sec

The sediment trap sampling schedules are shown below.

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Traps
Version: PST-21_3.c S/N: ML12432-02

Schedule Verification

Event 1 of 22 = 07/31/2011 12:00:00
Event 2 of 22 = 08/14/2011 12:00:00
Event 3 of 22 = 08/28/2011 12:00:00
Event 4 of 22 = 09/11/2011 12:00:00
Event 5 of 22 = 10/02/2011 12:00:00
Event 6 of 22 = 10/23/2011 12:00:00
Event 7 of 22 = 11/13/2011 12:00:00
Event 8 of 22 = 12/04/2011 12:00:00
Event 9 of 22 = 01/08/2012 12:00:00
Event 10 of 22 = 02/12/2012 12:00:00
Event 11 of 22 = 03/04/2012 12:00:00
Event 12 of 22 = 03/18/2012 12:00:00
Event 13 of 22 = 04/01/2012 12:00:00
Event 14 of 22 = 04/15/2012 12:00:00
Event 15 of 22 = 04/29/2012 12:00:00
Event 16 of 22 = 05/13/2012 12:00:00
Press any key to continue.

Event 17 of 22 = 05/27/2012 12:00:00
Event 18 of 22 = 06/10/2012 12:00:00
Event 19 of 22 = 06/24/2012 12:00:00
Event 20 of 22 = 07/08/2012 12:00:00
Event 21 of 22 = 07/22/2012 12:00:00
Event 22 of 22 = 08/05/2012 12:00:00

Modify an event (Yes/No) [N] ? n
Current Header reads:

Do you want a different header (Yes/No) [N] ? y
Enter new header (three lines, 80 characters/line)

> PAP LXII
> trap A
> 3000m
Current Header reads:

PAP LXII
trap A

3000m

System status:

07/26/2011 20:08:18 20.9 Vb 20 øC aligned

Caution: Deployment will overwrite the
EEPROM data backup cache.

Proceed with the deployment (Yes/No) [N] ? y

>>> Remove communication cable and <<<
>>> attach dummy plug. <<<
>>> Sediment trap is ready to deploy. <<<

<07/26/2011 20:08:25> Waiting for Event 01 of 22 @ 07/31/2011 12:00:00

NB capture not on after rebatterying. but schedule visibly checked by Paul and Corinne, def ok

McLane Research Laboratories, USA
MK7GW-13 ITC Sediment Trap
Operation Program V1.35A

****
* MAIN MENU *
****

S/N 532 Clock reads 00/00/00 00:40:48

<1> Display time, temperature & voltage
<2> Fill bottles / align rotor
<3> Create schedule
<4> Run schedule and deploy
<5> Display / offload data
<6> Go to sleep

<CTRL-C> Call MAIN MENU

Select a number 4

Enter a new schedule (Y/N) n

----------VERIFICATION----------

Event 01 of 14 = 07/31/11 12:00:00
Event 02 of 14 = 01/01/12 12:00:00
Event 03 of 14 = 01/29/12 12:00:00
Event 04 of 14 = 02/26/12 12:00:00
Event 05 of 14 = 03/11/12 12:00:00 Press ANY KEY ...
Event 06 of 14 = 03/25/12 12:00:00
Event 07 of 14 = 04/08/12 12:00:00
Event 08 of 14 = 04/22/12 12:00:00
Event 09 of 14 = 05/06/12 12:00:00
Event 10 of 14 = 05/20/12 12:00:00 Press ANY KEY ...
Event 11 of 14 = 06/03/12 12:00:00
Event 12 of 14 = 06/17/12 12:00:00
Event 13 of 14 = 07/01/12 12:00:00
Event 14 of 14 = 08/05/12 12:00:00

Modify an event (Y/N) n

Please wait for sorting of input information DONE

The schedule is in chronological order.
Press ANY KEY ...

Clock reads 00/00/00 00:41:44

Change time & date (Y/N) y

Enter YEAR (0 TO 99) 11
Enter MONTH (1 TO 12) 7
Enter DAY (1 TO 31) 26
Enter HOUR (0 TO 23) 21
Enter MIN. (0 TO 59) 20
Enter SEC. (0 TO 59) 0

Press RETURN to set clock

Clock reads 07/26/11 21:20:00

Change time & date (Y/N) n

The previous data set will now erase - continue (Y/N) y

Please wait for memory initialization - DONE

Current header reads -

_____ _____€_____"_____ _____
_____À_____ _____@_____ ___

Do you want a different header (Y/N) y

Enter new header (240 Chrs. MAX.) - PAP LXII trap B 3000m

Current header reads -

PAP LXII trap B 3000m

Do you want a different header (Y/N) n

Is the rotor aligned to the open hole (Y/N) y

System shows the following -

07/26/11 21:20:54 21.8 Vb 8.5 Vr 20.0 C Rotor aligned

Are you ready to deploy (Y/N) y

Header stored

Clock reads 07/26/11 21:21:03

System is ready. Remove communication cable & deploy.

Clock reads 07/26/11 21:21:03
Waiting for next Event 01 of 14 = 07/31/11 12:00:00

Version: PST-21_3.c S/N: ML12432-06

ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
º Main Menu º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
Tue Jul 26 20:26:50 2011

<1> Set Time <5> Create Schedule
<2> Diagnostics <6> Deploy System
<3> Fill Containers <7> Offload Data
<4> Sleep <8> Contacting McLane

Selection ? 6

Is the rotator aligned to the
open hole (Yes/No) [N] ? y

Clock reads 07/26/2011 20:27:36
Change time & date (Yes/No) [N] ? n

Existing deployment data file will be
erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? n

Schedule Verification

Event 1 of 22 = 07/31/2011 12:00:00
Event 2 of 22 = 08/14/2011 12:00:00
Event 3 of 22 = 08/28/2011 12:00:00
Event 4 of 22 = 09/11/2011 12:00:00
Event 5 of 22 = 10/02/2011 12:00:00
Event 6 of 22 = 10/23/2011 12:00:00
Event 7 of 22 = 11/13/2011 12:00:00
Event 8 of 22 = 12/04/2011 12:00:00
Event 9 of 22 = 01/08/2012 12:00:00
Event 10 of 22 = 02/12/2012 12:00:00
Event 11 of 22 = 03/04/2012 12:00:00
Event 12 of 22 = 03/18/2012 12:00:00
Event 13 of 22 = 04/01/2012 12:00:00
Event 14 of 22 = 04/15/2012 12:00:00
Event 15 of 22 = 04/29/2012 12:00:00
Event 16 of 22 = 05/13/2012 12:00:00
Event 17 of 22 = 05/27/2012 12:00:00
Event 18 of 22 = 06/10/2012 12:00:00
Event 19 of 22 = 06/24/2012 12:00:00
Event 20 of 22 = 07/08/2012 12:00:00
Event 21 of 22 = 07/22/2012 12:00:00
Event 22 of 22 = 08/05/2012 12:00:00

Modify an event (Yes/No) [N] ? n
Current Header reads:

Do you want a different header (Yes/No) [N] ? y
Enter new header (three lines, 80 characters/line)

> pap LXII
> trap C
> 100mab
Current Header reads:

pap LXII

```
trap C
100mab

Do you want a different header (Yes/No) [N] ? n

System status:


 07/26/2011 20:28:59   21.0 Vb    20 øC  aligned


Caution:  Deployment will overwrite the
        EEPROM data backup cache.

Proceed with the deployment (Yes/No) [N] ? y

 >>> Remove communication cable and <<<
     >>> attach dummy plug. <<<
>>> Sediment trap is ready to deploy. <<<


<07/26/2011 20:29:20> Waiting for Event 01 of 22 @ 07/31/2011 12:00:00

07/26/2011 20:29:22 Sleeping . . .
```

4) Observations, problems and recommendations

No problems noted

PAP1 recovery

1) Operations Summary

The deck setup for the ODAS buoy recovery used following winches:
Ship fitted trawl winch fed astern over the pendulum block of the aft gantry.
Deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. A 14mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck.
Deck mounted (starboard) 5t general purpose (GP) winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside starboard pedestal. The winch was positioned diagonally towards the port quarter.
Deck mounted (port) 5t general purpose winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside port pedestal, The winch was positioned diagonally towards the starboard quarter.

The vessel approached the buoy stern-to and was hooked on the mast lifting lug at 08:42 on 28 July 2011 using a 5t RH25 SeaCatch hook attached to the end of the core wire. The hook was controlled by a 5m aluminium pole which was withdrawn once the hook was attached securely.

Further wide-jawed hooks shackled to the port and starboard 5t GP winch wires were clipped into the mast frame of the buoy using the pole at length to act as steadying wires. The load was taken on the wire and the buoy was lifted clear of the water and hauled up the transom of the vessel. At this point the safety rails were taken down.

As recovery to deck commenced the steady-line winches took up the slack to prevent unwanted motion of the buoy. Before the keel of the buoy had cleared the transom these lines were brought up too tightly causing the attached hooks to become deformed and twist off.
At this point the coring winch rendered as the hoist limit had been set to 6.5t for this operation, exceeding the expected weight of the buoy of 4.5t. This generated a near miss report (JCNM07-11)

This wire payout introduced slack wire at the A frame block and the buoy was lowered back into the water. After confirming no damage had occurred, the core winch hoist limit was increased to 8.5t to account for any surge or dynamic force that may be encountered, while remaining within the operational limit of the wire in use.

Once again the buoy was hoisted from the water, with the gantry slightly inboard so that the buoy remained against the transom. When the deck of the buoy was level with the working deck, 16mm rope steady-lines were attached and tied to the mast, running to cleats on the inside of each pedestal.

As the buoy was lifted, the slack was taken on the steady-lines to prevent the buoy from swinging. Once the buoy was well in board, but still remained suspended, the wire from the double barrel winch was connected to the keel and hauled in to make the buoy vertical, where it was landed on deck and secured using pad eyes and ratchet straps (four off). The top of the chain, immediately below the buoy was stopped off using a 5t GP winch.

Using a sequence of lifts coordinated between the gantry Rexroff winch and the port 5t GP winch, the chain suspending the instrument

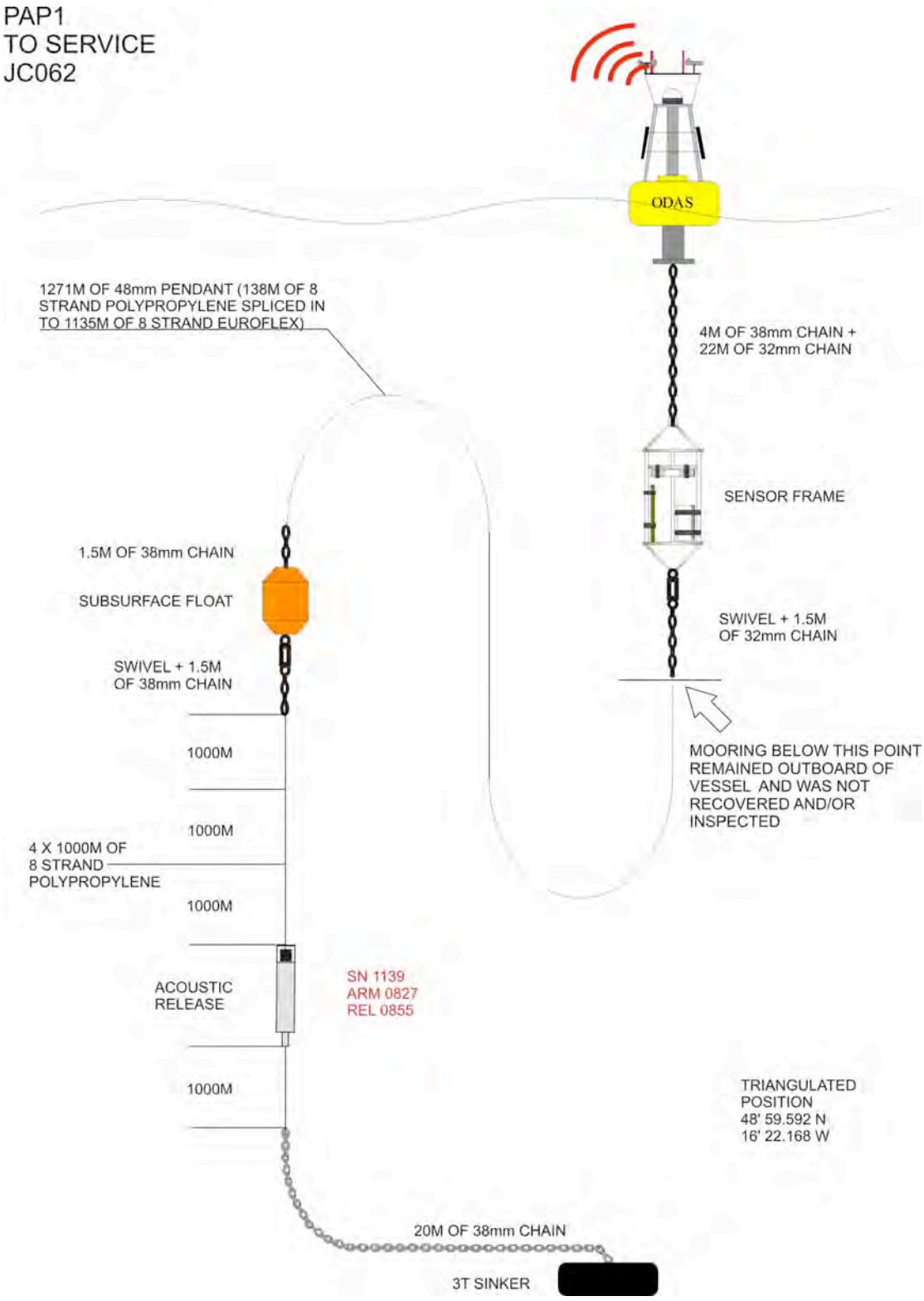
frame was recovered to deck and brought inboard. As the instrument frame was lifted from the water the gantry was moved further outboard to prevent the frame (and instruments contained in) from being dragged up the transom of the vessel.

Once the instrument frame was on deck, the starboard 5t GP winch was used to stop off the mooring rope allowing the pinned shackle, etc., to be broken and replaced. A strop was attached through the rope thimble and secured to deck as a secondary preventer.

At the Masters discretion, the ship remained attached to the mooring rope throughout the buoy and subsurface frame service as, in his opinion, the 48" sphere supplied was not sufficient. Inflatable RO-MAR buoys have been recommended as these are used in similar applications in the cable laying industry, the use of these should be investigated for the next buoy service.

As a result the vessel remained dynamically positioned attached to the 48mm mooring rope until 23:00 on the 29 July 2011, when the mooring was deployed, some 38 hours after recovery.

2) Mooring Diagram


PAP1
TO SERVICE
JC062
ODAS
1271M OF 48mm PENDANT (138M OF 8 STRAND POLYPROPYLENE SPLICED IN TO 1135M OF 8 STRAND EUROFLEX)
4M OF 38mm CHAIN + 22M OF 32mm CHAIN
SENSOR FRAME
1.5M OF 38mm CHAIN
SUBSURFACE FLOAT
SWIVEL + 1.5M OF 38mm CHAIN
SWIVEL + 1.5M OF 32mm CHAIN
1000M
1000M
4 X 1000M OF 8 STRAND POLYPROPYLENE
1000M
MOORING BELOW THIS POINT REMAINED OUTBOARD OF VESSEL AND WAS NOT RECOVERED AND/OR INSPECTED
ACOUSTIC RELEASE
SN 1139
ARM 0827
REL 0855
1000M
TRIANGULATED POSITION
48' 59.592 N
16' 22.168 W
20M OF 38mm CHAIN
3T SINKER

3) Instrumentation

The buoy was serviced by a Met Office engineer (Adrian Bunting). This involved accessing the hatch of the buoy and unplugging at the connections, removing the mast and lifting clear, removing the main lid of the buoy and lifting clear, removing the internal locking ring and lifting the electronics and battery pod from the buoy casing.

It was at this point that the buoyant collar of the buoy was removed from its keel and attached to a new keel and chain assembly. The new keel of the ODAS buoy had the 4m of 38mm chain fitted ashore where access under the keel was performed in a controlled manner without the danger of swinging generated by ship movement.

The entire length 32mm (22m) of chain was replaced, along with a replacement sensor frame and instruments. The 32mm (2m) chain and swivel below the frame was also replaced. The two armoured communications wires were also replaced and mounted to the chain using bulldog grips and specially constructed U-clamps.

The buoy was rebuilt in reverse order of breakdown.

Prior to deployment the frame was strengthened with welding at cross members and extra brackets were fitted to provide support.

4) Observations, problems and recommendations

During recovery, the use of large winches to control a load should be avoided. The control they offer is limited and the consequences of over-tensioning unpredictable. Lighter more controllable steady lines were subsequently used effectively and afforded good control.

The recovered instrument frame was in poor condition, and has been described in detail in a report produced by John Campbell and Thanos from USL.

The internal hull of the buoy was found to be flooded, this was traced to a missing rubber seal that should have been installed inside the main hatch of the buoy.

Video is available of the operation.

PAP1 deployment

1) Operations Summary

The deck setup for the ODAS buoy deployment used following winches:
Ship fitted trawl winch fed astern over the pendulum block of the aft gantry.
Deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. A 14mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck.
Deck mounted (starboard) 5t general purpose (GP) winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside starboard pedestal. The winch was positioned diagonally towards the port quarter.
Deck mounted (port) 5t general purpose winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside port pedestal, The winch was positioned diagonally towards the starboard quarter.

Prior to the commencement of deployment operations, the keel was shackled to the pennant wire of the double barrel winch and the port 5t GP winch. The starboard 5t GP winch was holding the mooring rope. A large SeaCatch hook (SWL 17t) was fitted to the end of the core wire and connected into the lifting eye of the buoy.

The deployment of the subsurface frame was the reverse of the recovery, with a system of lifting and luffing operations coordinated between the 5t GP winch and the gantry mounted Rexroff winch. Taking a few links at a time the frame and chain was lowered over the transom, stopped off each time using a strong rope threaded through the chain and the weight taken using a ship mooring capstan.

Once the weight of the chain was on the keel of the buoy, the buoy was lifted from the deck and floated outboard using the 5t GP winch to keep the fore-aft swing of the keel in check. The keel was dragged outboard by the weight of the mooring chain and subsurface frame and this weight also prevented the keel from swinging side to side.

Once the chain was vertical over the transom, the load was gradually released from the 5t winch, allowing the wire to be removed. The gantry was luffed out and the buoy lowered into the water and released from the SeaCatch hook once afloat.

PAP1 recovery

1) Operations Summary

The recovery of the ODAS buoy was performed again because the iridium communications of the Met Office equipment on the buoy had stopped shortly after redeployment on the 29 July 2011. It was thought that a power reboot would restart the communications.

The deck setup for the ODAS buoy recovery used following winches:
Ship fitted trawl winch fed astern over the pendulum block of the aft gantry.
Deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. A 14mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck.
Deck mounted (starboard) 5t general purpose (GP) winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside starboard pedestal. The winch was positioned diagonally towards the port quarter.
Deck mounted (port) 5t general purpose winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside port pedestal, The winch was positioned diagonally towards the starboard quarter.

The vessel approached the buoy stern-to and was hooked on the mast lifting lug at 15:48 on 11 August 2011 using a 5t RH25 SeaCatch hook attached to the end of the core wire. The hook was controlled by a 5m aluminium pole which was withdrawn once the hook was attached securely.

The load was taken on the wire and the buoy was lifted clear of the water and hauled up the transom of the vessel with the gantry slightly inboard. When the deck (mast foot) of the buoy was level with the working deck, 16mm rope steady-lines were attached and

tied to the mast, running to cleats on the inside of each pedestal. At this point the safety rails were taken down.

As the buoy was lifted, the slack was taken on the steady-lines to prevent the buoy from swinging. Once the buoy was well in board, but still remained suspended, the wire from the double barrel winch was connected to the keel and hauled in to make the buoy vertical, where it was landed on deck and secured. The top of the chain, immediately below the buoy was stopped off using a 5t GP winch.

The access hatch to the buoy hull and the top of the electronics pod was removed and the power cable to the Met Office systems and the NOCS integrated systems were unplugged. After 90 seconds, the cables were reattached and the hatch replaced and tightened down. This was all that was deemed necessary to reboot the failure of the Met Office systems and iridium communications. The NOCS systems remained unaffected and working.

Met Office instructions: "*Remove the gland plate that has the largest number of cables entering through it. With the gland plate removed you will see several rows of connectors. The power connectors are in the first row closet to you as you look in through the gland plate opening (see above). This row of connectors consists of 3 x bulkhead connectors plus one cable gland with blue flex emerging from it. The power connectors are two the middle connectors between the cable gland and the far right-hand connector. To remove the connectors grasp the outer black collar of the connector and unscrew. With the connectors lifted clear wait 30 seconds and then re-connect.*"

PAP1 deployment

1) Operations Summary

The deck setup for the ODAS buoy deployment used following winches:
Ship fitted trawl winch fed astern over the pendulum block of the aft gantry.
Deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. A 14mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck.
Deck mounted (starboard) 5t general purpose (GP) winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside starboard pedestal. The winch was positioned diagonally towards the port quarter.
Deck mounted (port) 5t general purpose winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside port pedestal, The winch was positioned diagonally towards the starboard quarter.

Prior to the commencement of deployment operations, the keel was shackled to the pennant wire of the double barrel winch and the starboard 5t GP winch. The port 5t GP winch was holding the mooring chain immediately below the keel. A large SeaCatch hook (SWL 17t) was fitted to the end of the core wire and connected into the lifting eye of the buoy.

The weight of the chain was removed from the port 5t GP winch to the keel of the buoy. The buoy was lifted from the deck and floated outboard using the double barrel winch to keep the fore-aft swing of the keel in check. The keel was dragged outboard by the weight of the mooring chain and subsurface frame and this weight also prevented the keel from swinging side to side.

Once the chain was vertical over the transom, the load was gradually released from the double barrel winch, allowing the wire to be removed. The gantry was luffed out and the buoy lowered into the water and released from the SeaCatch hook once afloat in a gentle and smooth operation.

PAP1 recovery

1) Operations Summary

The recovery of the ODAS buoy was performed again on 16 August 2011 because the iridium communications of the Met Office equipment on the buoy had stopped shortly after redeployment on the 29 July 2011. Unfortunately the power reboot on the second recovery of the buoy on 11 August was unsuccessful.

The deck setup for the ODAS buoy recovery used following winches:
Ship fitted trawl winch fed astern over the pendulum block of the aft gantry.
Deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. A 14mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck.
Deck mounted (starboard) 5t general purpose (GP) winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside starboard pedestal. The winch was positioned diagonally towards the port quarter.
Deck mounted (port) 5t general purpose winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside port pedestal, The winch was positioned diagonally towards the starboard quarter.

The vessel approached the buoy stern-to and was hooked on the mast lifting lug using a 5t RH25 SeaCatch hook attached to the end of the core wire. The hook was controlled by a 5m aluminium pole which was withdrawn once the hook was attached securely.

The load was taken on the wire and the buoy was lifted clear of the water and hauled up the transom of the vessel with the gantry slightly inboard. When the deck (mast foot) of the buoy was level with the working deck, 16mm rope steady-lines were attached and tied to the mast, running to cleats on the inside of each pedestal. At this point the safety rails were taken down.

As the buoy was lifted, the slack was taken on the steady-lines to prevent the buoy from swinging. Once the buoy was well in board, but still remained suspended, the wire from the double barrel winch

was connected to the keel and hauled in to make the buoy vertical, where it was landed on deck and secured. The top of the chain, immediately below the buoy was stopped off using a 5t GP winch.

Met Office instructions:
"It could be the Iridium or it could be the aerial. If it's the aerial this could be replaced by just bringing the buoy on deck and someone going up the mast and exchanging it. The connectors on these aerials are specialist connectors which can be hard to undo but just use pliers on both the knurled rings to untighten. Be careful of excessive pressure on the pliers because sometimes the easily get out of shape (ie: become oval instead of round. We could then wait to see if we get transmissions here at Southampton which could take a couple of hours. When would you want to do this because Steve would have come in if this is required on the weekend. The spare aerials are in the blue box that is half the depth of all the other blue boxes.

If required, there is a possibility of replacing the transmission system completely but this will involve dismantling the buoy as before. The Iridium transmitter that came out of the buoy was working correctly therefore we could exchange that for the one in the buoy. Also, we have spare aerials on board that could be used to replace the Iridium aerial in case that has broken down.

The job would entail disconnecting all plugs from the electronics, taking the mast off, taking the hatch cover off then undoing the clamping ring securing the electronic pod. You would then lift the electronics out of the buoy and place on the deck.

Next, you would only have to undo the 20 odd screws that keep the electronics connected to the pod and lift it out ensuring all cabling is disconnected, especially the battery pod connections from it so it lifts out without stretching any cables. You would NOT have to split the electronics pod from the battery pod.

Once the electronics are on the deck you will see the electronic junction box. Open the door of it and you will see the Iridium transmitter (Large Rectangular blue box on the left). Disconnect cables and undo the 4 screws in each corner to remove it and replace with the old one. The old electronics are in the large silver box that Paul has put in there container. Remove the Iridium as described from this and put into the

buoy electronics. Connect up cables to Iridium and tighten aerial cables, nipping them with pliers but please DO not over-tighten.

Close electronic junction box lid and put electronics back in pod and secure with the 20 odd screws / nylocks. Put pods back into buoy and reclamp using ring. Put hatch cover on, ensuring gasket is still in place. Next, secure mast to buoy, aligning the holes using spikes and then reconnect all plugs and secure gland plate. Put back in water.

As a suggestion maybe labelling the plugs as you disconnect them from the electronics would be a good idea because you could easily damage the pins if you try to connect to the wrong plug. When reconnecting plugs they are a bit sensitive so align key and push down gently whilst screwing plug (Basically push and screw until tight)

All the equipment for dismantling the buoys are in a couple of silver cases that are in the blue boxes. For re-assembling you will need the 4 brass spikes to align the mast which again are in the blue boxes. The final thing you will require is the strop and securing lugs to lift the electronics out which again are in the blue boxes."

The only addition to this was that the IGPS bulkead connector on the electronics pod had corroded away sufficiently that the centre pin came away when the connector was removed. After removing the electronics from the housing, the internal connector on the inside of the failed bulkhead connector was removed an placed on a free bulkhead connector that was to the left of the ITx connector. When all the cables from the mast were reconnected, the IGPS cable was refitted to the alternative bulkhead connector (see below).

PAP1 deployment

1) Operations Summary

The deck setup for the ODAS buoy deployment used following winches:
Ship fitted trawl winch fed astern over the pendulum block of the aft gantry.
Deck mounted electro-hydraulic double barrel winch with an inline reeling winch which was set 2m behind the double barrel winch platform. A 14mm pennant wire was fed from the steel reeling winch barrel around the capstan directly to the aft deck.
Deck mounted (starboard) 5t general purpose (GP) winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside starboard pedestal. The winch was positioned diagonally towards the port quarter.
Deck mounted (port) 5t general purpose winch with 16mm pennant wire through snatch-block shackled to foreword most lifting lug on inside port pedestal, The winch was positioned diagonally towards the starboard quarter.

Prior to the commencement of deployment operations, the keel was shackled to the pennant wire of the double barrel winch and the starboard 5t GP winch. The port 5t GP winch was holding the mooring chain immediately below the keel. A large SeaCatch hook (SWL 17t) was fitted to the end of the core wire and connected into the lifting eye of the buoy.

The weight of the chain was removed from the port 5t GP winch to the keel of the buoy. The buoy was lifted from the deck and floated outboard using the double barrel winch to keep the fore-aft swing of the keel in check. The keel was dragged outboard by the weight of the mooring chain and subsurface frame and this weight also prevented the keel from swinging side to side.

Once the chain was vertical over the transom, the load was gradually released from the double barrel winch, allowing the wire to be removed. The gantry was luffed out and the buoy lowered into the water and released from the SeaCatch hook once afloat in a gentle and smooth operation.

JC062
NMFSS Sensors & Moorings Report
PSO: Dr Henry Ruhl
24th July – 29th August 2011

PAUL G PROVOST
Sensors & Moorings Group
National Marine Facilities Sea Systems
National Oceanography Centre, Southampton

CTD System Configuration

The initial sensor configuration was as follows:

- Sea-Bird 9*plus* underwater unit, s/n: 09P-0943
- Frequency 0 - Sea-Bird 3 Premium temperature sensor, s/n: 03F-5494
- Frequency 1 - Sea-Bird 4 conductivity sensor, s/n: 04C-3873
- Frequency 2 - Digiquartz temperature compensated pressure sensor, s/n: 110557
- Frequency 3 - Sea-Bird 3 Premium temperature sensor, s/n: 03F-5495
- Frequency 4 - Sea-Bird 4 conductivity sensor, s/n: 04C-3874
- V0 - Sea-Bird 43 dissolved oxygen sensor, s/n: 43-0621
- V2 - Benthos PSA-916T 7Hz altimeter, s/n: 41302
- V3 - Chelsea Aquatracka MKIII fluorimeter, s/n: 088163
- V4 – PAR (UWIRR) s/n: 01 *or* ISUS nitrate sensor – nitrate channel (CTD004)
- V5 - PAR (UWIRR) s/n: 05 *or* ISUS nitrate sensor – ancillary channel (CTD004)
- V6 - WETLabs Light Scattering sensor, BBRTD, s/n:759-R
- V7 - Chelsea Alphatracka MKII transmissometer, s/n: 161047

Ancillary instruments & components:

- Sea-Bird 11*plus* deck unit, s/n: 11P-24680-0587
- Sea-Bird 24-position Carousel, s/n: 32-19817-0243
- 24 x Ocean Test Equipment 10L water samplers, s/n: 01A to 24A inc.

PARS sensors were only fitted to the instrument package on casts 2, 5, 6, 8 and 9 due to the depth limitations of the instrument. On cast 4, a Satlantic ISUS nitrate sampler was fitted to the instrument and connected to channels V4 and V5 instead of the PAR sensors. Nitrate concentration was recorded on channel V4 whilst ancillary data was recorded on V5.

CTD Operations

A total of 10 CTD “casts” were completed on this cruise numbered sequentially.

The pressure sensor was located 30cm below the bottom and approximately 75cm below the centre of the 10L water sampling bottles.

The carousel was fitted with a complete set of 24 water samplers.

The configuration file used initially was JC62_stainless_NMEA_1.xmlcon (see Appendix 1) which was changed to JC62_stainless_NMEA_ISUS.xmlcon when the ISUS nitrate sampler was fitted (see Appendix 2).

Sensor Failures

On cast 10 (CTD010) the BBRTD (V6) and the transmissometer (V7) fluctuated to maximum and minimum voltages at 50m and 100m respectively on the downcast. The voltages returned to expected values at the same depths on the up-casts. No errors in data transmission were noted. It is thought that this data failure was a result of a twist that occurred in the cable approximately 5m above the CTD termination on its return to deck. This happened due to excessive pitch, heave and roll during the CTD deployment.

Data Processing

CTD cast data was post-processed using SBE Data Processing (V7.20g) software. The raw data files were converted through the following steps:
DatCnv
Filter (Low pass filter A, time constant 0.03s; Low pass filter B, time constant 0.15s)
BinAve

Salinity measurement

A Guildline Autosal 8400B salinometer, s/n: 68426, was used for salinity measurements. A total of 40 salinity samples were taken during the cruise for CTD analysis. The salinometer was sited in the Electronic Workshop, with the bath temperature set at 21°C, the ambient temperature being approximately 19.5°C. A bespoke program written in Labview called Autosal was used as the data recording program for salinity values, and results were plotted via an Excel spreadsheet (see JC62_SAL). The results showed a higher average error overall for the primary conductivity cell.

APPENDIX 1

The configuration file used during the cruise (except CTD004):

C:\Program Files\Sea-Bird\SeasaveV7\JC062\JC62_stainless_NMEA_1.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : deck unit
Surface PAR voltage added : No
Scan time added : No

1) Frequency 0, Temperature

Serial number : 03F-5494
Calibrated on : 12 March 2011
G : 4.32437698e-003
H : 6.26314464e-004
I : 1.96666845e-005
J : 1.53204569e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-3873
Calibrated on : 17 March 2011
G : -1.01855428e+001
H : 1.35574855e+000
I : -6.82194016e-004
J : 1.19134419e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 110557
Calibrated on : 26 April 2009
C1 : -6.010548e+004
C2 : -1.565601e+000
C3 : 1.823090e-002
D1 : 2.668300e-002
D2 : 0.000000e+000
T1 : 3.020528e+001
T2 : -6.718318e-004
T3 : 4.457980e-006
T4 : 1.203850e-009
T5 : 0.000000e+000
Slope : 0.99994000
Offset : -1.08250
AD590M : 1.280700e-002
AD590B : -9.299644e+000

4) Frequency 3, Temperature, 2

Serial number : 03F-5495
Calibrated on : 12 March 2011
G : 4.38223460e-003

H : 6.31122674e-004
I : 2.04282826e-005
J : 1.62241139e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-3874
Calibrated on : 17 March 2011
G : -1.04963970e+001
H : 1.38757073e+000
I : -6.45475676e-004
J : 1.15805111e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-0363
Calibrated on : 26 January 2011
Equation : Sea-Bird
Soc : 3.51500e-001
Offset : -6.48800e-001
A : -8.26610e-004
B : 1.10740e-004
C : -2.48860e-006
E : 3.60000e-002
Tau20 : 1.12000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

Serial number : 41302
Calibrated on : 20 April 2007
Scale factor : 15.000
Offset : 0.000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

Serial number : 088-163

Calibrated on : 11 February 2010
VB : 0.044200
V1 : 2.046800
Vacetone : 0.201400
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

Serial number : PAR-01
Calibrated on : 14 June 2011
M : 0.44365900
B : 2.19172000
Calibration constant : 100000000000.00000000
Multiplier : 0.99950000
Offset : 0.00000000

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

Serial number : PAR-05
Calibrated on : 14 June 2011
M : 0.48156500
B : 1.66967800
Calibration constant : 100000000000.00000000
Multiplier : 0.99960000
Offset : 0.00000000

12) A/D voltage 6, Turbidity Meter, WET Labs, ECO-BB

Serial number : BBRTD-759R
Calibrated on : 18 May 2010
ScaleFactor : 0.003130
DarkVoltage : 0.048000

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/WET Lab CStar

Serial number : 161-047
Calibrated on : 18 March 2008
M : 23.5882
B : -0.4954
Path length : 0.250

Scan length : 37

APPENDIX 2

On cast 4 (CTD004), a Satlantic ISUS nitrate sampler was connected to channels V4 and V5 in place of the PAR sensors and the configuration was changed accordingly, see 10) and 11).

C:\Program Files\SeaBird\SeasaveV7\JC062\JC62_stainless_NMEA_ISUS.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : deck unit
Surface PAR voltage added : No
Scan time added : No

1) Frequency 0, Temperature

Serial number : 03F-5494
Calibrated on : 12 March 2011
G : 4.32437698e-003
H : 6.26314464e-004
I : 1.96666845e-005
J : 1.53204569e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-3873
Calibrated on : 17 March 2011
G : -1.01855428e+001
H : 1.35574855e+000
I : -6.82194016e-004
J : 1.19134419e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 110557
Calibrated on : 26 April 2009

C1 : -6.010548e+004
C2 : -1.565601e+000
C3 : 1.823090e-002
D1 : 2.668300e-002
D2 : 0.000000e+000
T1 : 3.020528e+001
T2 : -6.718318e-004
T3 : 4.457980e-006
T4 : 1.203850e-009
T5 : 0.000000e+000
Slope : 0.99994000
Offset : -1.08250
AD590M : 1.280700e-002
AD590B : -9.299644e+000

4) Frequency 3, Temperature, 2

Serial number : 03F-5495
Calibrated on : 12 March 2011
G : 4.38223460e-003
H : 6.31122674e-004
I : 2.04282826e-005
J : 1.62241139e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-3874
Calibrated on : 17 March 2011
G : -1.04963970e+001
H : 1.38757073e+000
I : -6.45475676e-004
J : 1.15805111e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-0363
Calibrated on : 26 January 2011
Equation : Sea-Bird
Soc : 3.51500e-001
Offset : -6.48800e-001
A : -8.26610e-004
B : 1.10740e-004
C : -2.48860e-006

E : 3.60000e-002
Tau20 : 1.12000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

Serial number : 41302
Calibrated on : 20 April 2007
Scale factor : 15.000
Offset : 0.000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

Serial number : 088-163
Calibrated on : 11 February 2010
VB : 0.044200
V1 : 2.046800
Vacetone : 0.201400
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

10) A/D voltage 4, User Polynomial

Serial number : ISUS Nitrate
Calibrated on : 26 July 2011
Sensor name :
A0 : -8.37529430
A1 : 27.10209000
A2 : 0.00000000
A3 : 0.00000000

11) A/D voltage 5, User Polynomial, 2

Serial number : ISUS aux
Calibrated on : 26 July 2011
Sensor name :
A0 : -6.76689850
A1 : 14.18739800
A2 : 0.00000000
A3 : 0.00000000

12) A/D voltage 6, Turbidity Meter, WET Labs, ECO-BB

Serial number : BBRTD-759R
Calibrated on : 18 May 2010
ScaleFactor : 0.003130
DarkVoltage : 0.048000

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/WET Lab CStar

Serial number : 161-047
Calibrated on : 18 March 2008
M : 23.5882
B : -0.4954
Path length : 0.250

Scan length : 37